ABSTRACTS OF THESES CONCERNING THE GEOLOGY OF UTAH TO 1966

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FOREWORD

In this volume I have attempted to bring together abstracts representing all graduate theses concerned with the geology of Utah; senior theses are omitted. Several theoretical theses are included because of their pertinence to a particular mineral deposit or locality in Utah. Others which should have been included may have been overlooked, and it is hoped that the reader will report omissions to the Utah Geological and Mineralogical Survey so that they may be included in a later volume.

Abstracts are limited to 300 words for Ph.D. theses and 200 for Masters theses. Whenever available and of suitable length, the authors' own abstracts were selected and printed with a final notation *Author abstract.* Abstracts from which material was deleted but with no rewording of the authors' thoughts are marked *From author abstract;* abstracts marked *Abstract revised* have been rephrased. The initials, *B.Y.S.* or *B.C.* following an abstract indicate that Mrs. Bernice Y. Smith or I wrote the abstract. Variations of these notations are self-explanatory.

Due to the general unavailability of theses, published versions are the source of many abstracts. In addition, readily available published versions are listed following the thesis listing. A published abstract is listed if (1) it appears in Dissertation Abstracts, (2) it is the source of the abstract included in this volume, or (3) it contains additional information. The reader is urged to consult bibliographies for complete listings of the authors' publications.

The following editorial changes have been made. Square brackets indicate annotation of thesis title by addition of county. Capitalization of terms in revised abstracts was changed to conform with present usage. Unpublished new names for stratigraphic units are occasionally omitted.

I gratefully acknowledge the assistance of Dr. William P. Hewitt and the Utah Geological Survey. Mrs. Bernice Y. Smith did a large share of the writing and editing. Thanks are due to the University of Utah Library, in particular to Miss Edith Rich, and to the Natrona County Library, for procuring theses. Many university libraries and geology departments sent copies of abstracts and did reference work. Students who wrote brief and informative abstracts and bound them into their theses deserve unqualified congratulations.

Barbara S. Childers, Editor

ABSTRACTS OF THESES CONCERNING THE GEOLOGY OF UTAH TO 1966

1. ABBOTT, WARD OWEN, 1951, Cambrian diabase flow in [Utah County], central Utah: Brigham Young Univ. M. S. thesis.

_____ 1951, Cambrian diabase flow in central Utah: Compass, v. 29, no. 1, p. 5-10, geol. map.

Megascopically the rock appears to be a felsite, dark dull red to purple, with abundant vesicular cavities filled with secondary minerals. Two generations of plagioclase are observed, phenocrysts and groundmass. The primary minerals are labradorite, augite, magnetite, and (possibly) ilmenite.

The following field evidence substantiates the author's conclusion that this is a flow: (1) channeling and erosional surfaces, (2) conglomerate, basal to the overlying Tintic Quartzite, (3) slight contact metamorphism of only the quartzite below, (4) wide areal distribution and uniform stratigraphic position (horizon), (5) conformity to Laramide folds, (6) displacement by faults some of which antedate and some of which are associated with Basin-and-Range deformation, (7) vesicules and amygdules, and (8) absence of apophyses and dikelets.

Abstract of published article (B. C.)

2. ABDEL-GAWAD, ABDEL-MONEIM M., 1960, Alteration features associated with some basal Chinle uranium deposits: Columbia Univ. Ph. D. thesis.
(Abs.): Dissert. Abs., v. 21, No. 3, p. 590, 1960.

_____ and P.F. Kerr, 1963, Alteration of Chinle siltstone and uranium emplacement, Arizona and Utah: Geol. Soc. America Bull., v. 74, No. 1, p. 23-46.

(Reply): Geol. Soc. America Bull., v. 75, No. 8, p. 777-780.

Siltstone at the base of the Chinle Formation on the Colorado Plateau shows alteration features associated with uranium mineralization consisting of silicification, bleaching, argillic alteration, and carbonatization.

Near Cameron, Arizona jasper layers occur in basal siltstones and the silicified zone is accompanied by extensive bleaching which extends downward into the top of the Shinarump Sandstone. Bleaching, primarily caused by the removal of hematite, may occur in spots, in bands along the bedding planes, or along fractures which cross the bedding. The mottled and variegated appearance of the rock may be attributed mainly to partial bleaching and also to locally oxidized sulphide veins.

Basal Chinle outcrops along the Colorado River gorge 11 miles east of Moab, Utah, show similar mottled bleaching associated with silicification. The silicified zone contains jasper and massive or columnar quartz and exhibits pipe-like structures perpendicular to the bedding planes.

On the San Rafael Swell basal Chinle siltstones and mudstones show variegated bleaching, argillic alteration, silicification and carbonatization underneath or near ore bodies. The silicified rocks contain jasper, chert, and quartz in layers, veins, or irregular masses and are bordered by argillic alteration halos. Argillic alteration is marked by the removal of iron, and by the transformation of the montmorillonitic component of mixed-layer clay into mica-clay with a corresponding increase of the 2M over 1M mica polymorph.

Basal Chinle alteration features, where observed on the Plateau, are attributed to hydrothermal solutions which accompanied uranium mineralization. Carbonatization includes the emplacement of calcite and dolomite as nodules, masses, and veins in the siltstones. Argillic alteration and silicification are related. Minor sulphide mineralization is an associated feature. The introduction of hypogene uranium minerals is a part of this sequence.

Author abstract

3. ACOSTA, ALVARO, 1961, Upper Cretaceous paleobotany of northeastern Utah: Univ. of Utah M. S. thesis, 98 p.

Upper Cretaceous rocks of the Coalville area are the Frontier (bottom), Wanship and Echo Canyon (top) Formations. The Wanship flora consists of 41 forms, of which 27 are referred to described species. Groups recognized are Dicotyledonae, Monocotyledonae, Coniferales and Filicales. Dryophyllum subfalcatum, Platanus sp., Platanus cf. P. asperiformis and Ficus planicostata are abundant.

Abundance of palm (Sabalites) and fig (Ficus) indicates that the climate during late Wanship time was warm temperate to subtropical. The Wanship flora correlates with floras of late Montana age of the Mesaverde, Ericson-Almond and lower Adaville. An invertebrate fauna 2,655 feet below the top of the Wanship Formation is of late Niobrara-early Montana age.

This is the first report of an Echo Canyon flora. It consists of 19 forms, of which 11 are referred to described species. Groups recognized are Dicotyledonae, Coniferales, Cycadales and Filicales. Most abundant are Sequoia reichenbachi, Aneimia elongata, Dryophyllum cf. D. subfalcatum, Quercus sp. and Quercus washingtonensis.

Abundance of Sequoia reichenbachi and its occurrence with Podozamites and Ficus indicate that the climate was temperate to subtropical. The Echo Canyon Formation is thought to be of Lancian age on the basis of the Wanship correlation.

Abstract revised (B. C.)

4. ADAMS, O. CLAIR, 1962, Geology of the Summer Ranch and North Promontory Mountains [Box Elder County], Utah: Utah State Univ. M. S. thesis, 57 p., geol. map.

A thick succession of marine rocks was deposited in the area of the Summer Ranch and North Promontory Mountains, in north central Utah, during late Paleozoic time. Deposition from Meramecian through Wolfcampian time is apparently represented by the Great Blue Limestone, Manning Canyon Formation, and Oquirrh Formation. The absence of Missourian fossils, however, may indicate a break in sedimentation. Paleozoic rocks are overlain in pronounced angular unconformity by rocks of Tertiary age. The Salt Lake Formation of Miocene-Pliocene age is present and volcanic rocks of late Pliocene age, possibly Snake River basalt flows, cover the north central part of the mapped area. Extensive deposits of Lake Bonneville underlie the valleys and crop out in the foothills.

Normal high-angle faults of north-south trend border the mountains of the mapped area. Hansel Valley is a typical graben with recently active subsidence in the southern part. *Author abstract*

5. ADAMSON, ROBERT D., 1955, Salt Lake Group in Cache Valley [Cache County], Utah and Idaho: Utah State Univ. M. S. thesis.

_____ C.T. Hardy and J.S. Williams, 1955, Tertiary rocks of Cache Valley, Utah and Idaho: Utah Geol. Soc., Guidebook to the geology of Utah, No. 10, p. 1-22.

The most widespread stratigraphic unit of Tertiary age in Cache Valley is the Salt Lake Group, although a few isolated outcrops of red "Wasatch" conglomerate are also present. The Salt Lake Group is composed (from base to top) of the Collinston Conglomerate (light-gray tuffaceous conglomerate, 1,500 or more feet thick), Cache Valley Formation (light-colored tuff, limestone, sandstone, and conglomerate, 7,674 feet thick) and Mink Creek Conglomerate (light-gray to pale-orange tuffaceous conglomerate, 3,435 or more feet thick). *B. C.*

6. ADDISON, CARL C., 1929, Stratigraphy and correlation of some Carboniferous sections of Nevada and adjacent states: Stanford Univ. M. A. thesis, 173 p.

This thesis consists mainly of a broad study of the Carboniferous formations in the Great Basin Province, Colorado Plateaus Province, a large part of the Sierra Nevada-Cascade Province, and a small part of the northern Rocky Mountains Province, and is based largely upon library work.

The Mississippian System is predominantly limestone indicating (1) a shallow sea over New Mexico, Arizona, and parts of Utah, Nevada and California, (2) an embayment in western Nevada and northern California, and (3) land masses in northeastern Nevada and southeastern Idaho. Many areas have evidence of post-Mississippian unconformity.

The Pennsylvanian System was deposited in many environments and is difficult to correlate. However, south and west of the Colorado Plateaus it is mainly marine limestone. Emergence during Pennsylvanian time affected western California, northern Nevada, northern Utah, and southeastern Idaho.

The Permian System is composed of marine, fluvial, eolian and volcanic deposits. In addition, some deposits were laid down in basins which were at times cut off from the sea. Permian seas periodically increased and decreased, but well-marked unconformities are absent. *B. C.*

7. AKERS, J. P., 1960, The Chinle Formation of the Paria Plateau area, Arizona and Utah: Univ. of Arizona M. S. thesis, 82 p.

In the Paria Plateau area of northern Arizona and southern Utah the Chinle Formation of Upper Triassic age consists of a thick series of lenticular sandstone, siltstone, claystone, and limestone. The series thins northwestward from about 900 feet at Lees Ferry, Arizona to about 600 feet at Paria, Utah.

Four members of the Chinle Formation are recognized: (1) the basal Shinarump Member, composed of conglomerate sandstone and subordinate shale, (2) a unit, herein named the Lowery Spring Member, composed of sandstone and mudstone, (3) the Petrified Forest Member, composed of bentonitic siltstone and claystone and thin sandstone, and (4) the Owl Rock Member, composed of cherty limestone and calcareous siltstone.

Only the Petrified Forest Member is present at all localities in the Paria Plateau area. The Shinarump Member was deposited in topographically low areas on an erosion surface and its distribution is irregular. The Lowery Spring and Owl Rock Members grade and pinch out toward the northwest and are not present at Paria, Utah. The upper contact of the Chinle Formation is locally unconformable.

The three lowermost members were deposited on a broad, flat plain between the Cordilleran geosyncline and highlands to the southeast. In Owl Rock time the rising Cordilleran geanticline cut off the northwestward drainage of Chinle streams and a depositional basin trending southwest was formed.

Author abstract

8. ALLEN, JIM E., 1961, Wall rock alteration, Ontario mine, Keetley [Wasatch County], Utah: Univ. of Utah M. S. thesis, 40 p.

At the Ontario mine, Park City district, Tertiary mesothermal lead-zinc-silver-copper mineralization is located in the Mississippian Humbug and Deseret Formations and is associated with a diorite intrusive. Hydrothermal alteration products were determined in various sedimentary host rocks within the 1,500- and 1,600-foot levels. Systematic studies were made from ore outward into the upper Humbug Limestone and across the Deseret Limestone-Dolomite intrusive contact.

Alteration of the sediments consisted of an inner sericite-quartz zone and an outer kaolinite zone. The width of the sericite-quartz zone ranged from 2 or 3 feet in the limestone to more than 50 feet in the Doughnut Humbug Shale. The kaolinite zone is more widespread in limestone and quartzite than in shale host rock and is greater than 50 feet. The contact zone of the quartz diorite intrusive and the Deseret Limestone-Dolomite has produced high magnesium-iron minerals (serpentine, brucite and magnetite). These are associated with the igneous contact and not with alteration around the ore. Alteration within the intrusive has been varied. Maximum temperature of formation of the contact and altering solution has been estimated to be between 247° C and 425° C. *From author abstract*

9. AMES, ROGER LYMAN, 1963, Sulfur isotopic study of the Tintic mining districts, Utah: Yale Univ. Ph. D. thesis.

Sulfides from ore deposits in the Paleozoic sedimentary rocks are progressively enriched in S^{32} outward from the Silver City monzonite stock. In addition, the ores in the sedimentary rocks have a broader range of δS^{34} values than ores in the intrusive rocks. These trends suggest that the Silver City monzonite was the principal, if not the only, source of the mineralizing solutions and that a crude sulfur isotopic halo exists around the intrusive.

Significant differences exist in δS^{34} values for sulfides in the Burgin ore and sulfides in volcanics of the Burgin-Chief Oxide area. Geologic evidence indicates that the pyrite is older than the ore minerals, therefore, the isotopic composition of the source sulfur changed with time.

Isotopic abundance data show that diffusion was not the dominant transport process during pyritization of the volcanics in the Chief Oxide area, but that mass transport occurred in hydrothermal solutions moving along well-defined fissure zones.

Temperatures of sulfide deposition in the Tintic district, estimated by sulfur isotopic thermometry, vary from 230° to 410° C and agree reasonably well with temperatures estimated by other criteria.

The weighted mean δS^{34} value of all Tintic sulfides is -1.4 permil. This is remarkably close to the meteoritic value, which is assumed to be the primordial sulfur composition, and suggests that the sulfur was derived from the mantle.

The total range of isotopic values for Tintic sulfides is about 34 permil, but the standard deviation from the mean is only 5.4 permil. This wide dispersion of ratios is compatible with a magmatic hydrothermal origin, and is attributed to (1) prolonged formation of sulfides, (2) varied conditions of formation, and (3) the large sampling population. It is suggested that the isotopic dispersion of given mineralized areas be measured by standard deviation, rather than by range. *From author abstract*

10. AMIN, SURENDRA R., 1950, Heavy mineral study of the intrusive rocks of the Antelope Range, Piute County, Utah: Univ. of Utah M. S. thesis, 40 p.

The Antelope Range is largely made up of Early Tertiary Bullion Canyon volcanics which have been intruded by monzonites, and of Tertiary Mount Belknap rhyolite flows of post-monzonite age. Coarse-grained equigranular monzonite and monzonite porphyry are found in an early intrusive body; fine-grained light-colored granitic rock is found in a later intrusive body.

Monzonite altered by magmatic and meteoric waters is lower in heavy mineral content and is devoid of pyrite, which has been decomposed to limonite. Altered monzonite free from iron oxide stains contains a higher percentage of colorless heavy minerals such as zircon and apatite. Pyrite is relatively abundant in rock altered only by magmatic waters.

Autunite occurs as large sulfur-yellow flakes coating joint surfaces chiefly in limonite-stained and gypsiferous monzonite. It is locally associated with torbernite. Autunite flakes decrease in size and number downward to the upper zone of primary pitchblende, where only a few flakes occur. In and below this zone, monzonite is unaltered by meteoric waters and contains abundant pyrite. The ore occurs in relatively definite zones of closely spaced fissures which vary in width from 2 to about 200 feet, and trend generally eastward.

Abstract revised (B. C.)

11. ANDERMAN, GEORGE GIBBS, 1955, Geology of a portion of the north flank of the Uinta Mountains in the vicinity of Manila, Summit and Daggett Counties, Utah, and Sweetwater County, Wyoming: Princeton Univ. Ph. D. thesis, 581 p., geol. map.
(Abs.): Dissert. Abs., v. 16, No. 3, p. 518, 1956.

_____ 1955, Tertiary deformational history of a portion of the north flank of the Uinta Mountains in the vicinity of Manila, Utah: Wyoming Geol. Assoc. Guidebook, 10th Ann. Field Conf., p. 130-134, geol. map.

The Precambrian Uinta Mountain Group is overlain by the Madison Limestone. Disconformities probably separate Mississippian-Pennsylvanian and possibly Pennsylvanian-Permian rocks. Three members of the Park City Formation (Permian) are recognized. After probable continuous deposition from Permian into Early Triassic, shallow-water deposition of the Woodside Formation is postulated. The Stanaker Formation is probably nonmarine. Jurassic System consists of Navajo, Carmel, Entrada, Curtis and Morrison Formations. Deposition was probably continuous from Jurassic into Lower Cretaceous, when Burro Canyon (?) and Dakota (?) Formations and Mowry Shale were deposited. Upper Cretaceous consists of Frontier Formation (which is thin and rests disconformably on the Mowry), Baxter Shale and Mesaverde Group.

The Hiawatha Member of the Wasatch Formation (Paleocene and early Eocene) is fluviatile and partly paludal, and overlies the Mesaverde disconformably. Early Eocene in age and transitionally overlying the Hiawatha, the fluviatile Cathedral Bluffs Member of the Wasatch is red banded and contains coarser clastics than the Hiawatha. Orogenic activity reached its climax in early medial Eocene time during deposition of the Green River Formation, which contains locally derived cobbles and boulders. Transitionally overlying the Wasatch on the east side of the Green River, the Green River Formation is involved in the Henry's Fork fault on the west side of the Green River, and westward an intraformational angular unconformity is developed which is present only where the formation laps highest onto the flanks of the Uinta Mountains. The Green River Formation is overlain transitionally by the fluviatile (locally lacustrine) Bridger Formation.

The major deformation is early medial Eocene and resulted from east-northeast- to northeast-directed compressional forces, with the resultant movement predominantly vertical. The Uinta fault terminates in the Manila area, but, as its displacement decreases westward to zero, displacement along the Henry's Fork fault increases.

Abstract revised (B. C.)

12. ANDERSON, BARBARA J., 1959, Nickel-zinc mineralization in the southern Oquirrh Mountains, Utah: Univ. of Utah M. S. thesis, 64 p.

A small occurrence of nickel mineralization is found in the upper limestone member of the Mississippian Great Blue Limestone in Wells Canyon, southernmost Oquirrh Mountains, Utah. Samples taken from all outcrops in a 300-foot square area were examined spectroscopically for nickel. Average nickel content of area is 0.03 percent, except for a 3-foot square area in which nickel content exceeds 10 percent in places.

Nickel occurs in two minerals with distinctive associations. It occurs in smithsonite with a zinc to nickel ratio of 3:1. The smithsonite is gradational into limestone (80-90 percent calcite) which contains calcite crystals in veins and cavities. The other mineral is associated with limonite and hematite. It occurs in veins with calcite and is extremely fine-grained. The X-ray pattern is identical to that of hydrotalcite, but spectroscopic analysis shows low magnesium and high nickel and zinc. Other tests indicate structural similarity with hydrotalcite group. It is believed to be a new species which is a nickel-zinc analogue of hydrotalcite with the approximate formula

$$(Ni,Zn)_6(Al,Fe)_2(OH)_{16}CO_3 \cdot 4H_2O.$$

Mineralization occurs in a highly fractured zone in which some movement has probably taken place. The minerals were deposited from low-temperature solutions. *Abstract revised (B. C.)*

13. ANDERSON, CHRISTIAN DONALD, 1966, Telluric current surveys in [Tooele and Utah Counties] Utah: Univ. of Utah Ph. D. thesis, 85 p.
(Abs.): Dissert. Abs., sec. B., v. 27, No. 4, p. 1183B, 1966.

During April to October 1965, telluric current surveys were made in Utah in parts of Skull Valley and Cedar Valley. Nine stations were occupied in the Skull Valley area and nineteen stations were occupied in the Cedar Valley area. The Skull Valley survey covered approximately 30 square miles and the Cedar Valley survey covered approximately 50 square miles.

Measurements were made at a station by recording the electric-field potentials across two 1,500-foot nonparallel lines by means of an Offner Co. dual-channel amplifier-recorder. These measurements were made simultaneously at a base station and a roving station for a period of approximately one hour. The data were reduced on a digital computer using standard techniques.

The results possibly indicate Basin and Range grabens underlying both valleys. The position of the boundaries of the grabens is determined to within 1 mile which is the equal to the spacing of the stations. The depth to bedrock at the roving stations relative to the depth to bedrock at the base stations is accurate to about 25 percent. The average signal strength was 0.4 mv/km in the Skull Valley area and 0.8 mv/km in the Cedar Valley area.

Author abstract

14. ANDERSON, DARRELL JOHN, 1966, Marls in Salt Lake County and low-fired marl brick: Univ. of Utah M. S. thesis, 228 p.

Physical properties of marly Lake Bonneville sediments were described, and quality of low-fired brick prepared from typical lake marl and from an artificial marl mixture was determined. The marly sediments crop out as widely distributed irregularly shaped patches in the bottom of Salt Lake Valley. Marly sand and silt with minor clay, distinctly stratified and with weak vertical joints, predominates (62.7 square miles). Marly silt and clay with minor sand, weakly stratified and with strong vertical joints, occupies about 46.4 square miles. Marls from 95 sample sites averaged 0.69 percent water-soluble fraction, 29.40 percent acid-soluble fraction. Specific gravity averaged 2.75. Color was predominantly pale yellow. Of 99 samples, 57 were well graded, 12 poorly graded, and 30 very poorly graded.

Strengths of fired natural and artificial marl generally met requirements (ASTM) for exterior building brick. Absorption of water properties of low-fired brick were mostly poor. Freeze-thaw durability was poor; improved molding or extruding techniques and the use of ideal graded marl and low-temperature glazes are suggested. Mechanical properties of natural marl specimens generally improved with increased molding pressure (optimum of 25,000 psi). Natural marl specimens were more uniform than artificial. *Abstract revised (B. C.)*

15. ANDERSON, JOHN J., 1965, Geology of northern Markagunt Plateau, Utah: Univ. of Texas Ph. D. thesis. (Abs.): Dissert. Abs., v. 26, No. 12, p. 7256, 1966.

The present study is of the Tertiary geologic evolution of a 250-square-mile belt through the northern Markagunt Plateau, the southwesternmost of the High Plateaus section of the Colorado Plateaus. Regional ignimbrites were used as stratigraphic and structural reference planes. Earliest geologic event of which there is record was deposition of Claron Formation (Eocene-Oligocene?). Although largely fluvial and lacustrine, its uppermost beds are volcanic arenite, mudflow-breccia, and volcanic flows. A dome produced by intrusion into upper Claron strata in northeastern corner of area remained an uncovered topographic high until deposition of Cottonwood Canyon Formation (Miocene?-Pliocene?). One ignimbrite of Needles Range Formation (Oligocene) spread across Claron, and was covered by an ignimbrite of the Isom Formation (Oligocene). Another Isom ignimbrite was deposited in low areas in south central part of area. Later, block faulting along lines trending generally east-west formed graben which were filled by ignimbrites of Leach Canyon Formation (Oligocene).

The Bear Valley Formation (Miocene?), herein defined, consists of up to 1,000 feet of wind-deposited volcanic arenite with minor interbeds of tuff, lava flows and mudflow-breccias; this unit blanketed most of the northern Markagunt. Deposition of the Bear Valley Formation was ended by an inundation of at least 2,000 feet of volcanic flows and mudflow-breccias of the Cottonwood Canyon Formation (Miocene?-Pliocene?), which is herein defined. Small laccoliths were then emplaced.

The present structural pattern of the northern Markagunt Plateau is the result of Pliocene (?) and Recent faulting along a conjugate set of faults (the major set trending about N. 35° E., the subsidiary set, about north-south) and of cross-faulting normal to these conjugate faults. The dominant topographic features today are three northeast-trending horsts separated by the graben of Bear Valley and Buckskin Valley. *Abstract revised (B. C.)*

16. ANDERSON, PAUL LEON, 1960, Bloating clays, shales and slates for lightweight aggregate, Salt Lake City and vicinity, Utah: Univ. of Utah M. S. thesis, 120 p.

This study was made to determine if clay, shale, slate, or other material that will bloat during firing and, therefore, be suitable for the production of lightweight aggregate, is present in the Salt Lake vicinity. Pyrometric cone equivalent tests eliminated nonbloating samples. Other firing methods, disk tests, loose particle tests and gradient furnace tests were used to determine the bloating temperature, bloating temperature range, and loss of weight of the sample on ignition.

Black, noncalcareous units of the Manning Canyon Shale and a black slate unit of the Big Cottonwood Series were found to bloat. These yielded an aggregate of about 50 lb/ft^3 below 1,150° C. Tailings of the Kennecott Copper Company and Vitro Uranium Company mills are not natural bloaters, but can be made to bloat by the addition of natural bloating clay, stove oil, or carbonates as gas-producing agents. An aggregate weighing about 50 lb/ft^3 can be thus produced.

A loose-particle testing method, devised during this study, is described and is considered to be the most efficient method for preliminary testing and evaluation of bloatable materials. No correlation between the pH of a clay and its bloating properties could be demonstrated. *Abstract revised (B. C.)*

17. ANDERSON, WARREN L., 1957, Geology of the northern Silver Island Mountains, Box Elder and Tooele Counties, Utah: Univ. of Utah M. S. thesis, 138 p., geol. map.

Schaeffer, F. E., Jr., and W. L. Anderson, 1960, Geology of the Silver Island Mountains, Box Elder and Tooele Counties, Utah: Utah Geol. Soc., Guidebook to the geology of Utah, no. 15, 185 p.

The Silver Island Mountains rise from the Salt Lake Desert in northeastern Basin and Range Province. Paleozoic sedimentary rocks totaling 10,650 feet are divided as follows: Cambrian (?), Middle Cambrian, and Upper Cambrian; Ordovician Garden City Limestone, Lehman-Kanosh (?) Formation, Eureka (?) Quartzite, and Fish Haven Dolomite; Silurian Laketown Dolomite; Devonian Simonson and Guilmette Formations; Mississippian Madison Limestone; Mississippian-Pennsylvanian Chainman Shale; Pennsylvanian Diamond Peak Conglomerate; Pennsylvanian-Permian unnamed sequence; Permian undifferentiated. Two lithofacies of Upper Pennsylvanian-Lower Permian are recognized. Wave-cut terraces, pebble beaches, spits, bars, and calcareous tufa and diatomaceous deposits are evidences of Lake Bonneville.

Physiography suggests an east border fault, but there is no evidence for a west border fault. On Crater Island to the north there are north-south high-angle faults and east-west step faults, probably caused by east-west compression. To the south on northern Silver Island there are a large east-west fault and associated structures apparently formed by early normal faulting followed later by compressive forces from the south. Four igneous stocks composed of granodiorite, monzonite, quartz monzonite, and modifications of these rocks are present. Geologically younger igneous dikes composed mainly of andesite, rhyodacite, lamprophyre, and aplite are abundant. *Abstract revised (B. C.)*

18. APPLE, FLORENCE OLIVE, 1929, The relation of rock alteration to mineralization at East Tintic, Utah: Northwestern Univ. M. S. thesis, 110 p.

Chief production of East Tintic district is silver and lead. Source of the deposits is thought to be an underlying late Tertiary monzonite stock. Stages in mineralization of Upper Cambrian Ophir Formation are as follows: (1) replacement of limestone along fissures by jasperoid silica, (2) alteration of latter to crystalline quartz, (3) brecciation, (4) cementation by second-generation quartz, (5) minor filling and replacement of quartz by barite, (6) filling and partial replacement of quartz by metallic sulfides in following order: pyrite, enargite, chalcopyrite, galena, tetrahedrite, argentite and ruby silver, and (7) supergene alteration of sulfides resulting in chalcopyrite, chalcocite, covellite, anglesite, cerussite and jarosite group.

Tertiary Packard rhyolite, which blankets region, shows progressively increasing alteration toward mineralized area, as follows: (1) shattering and resorption of feldspar and quartz, bending and twisting of biotite, straining throughout, (2) clouding of feldspar by kaolinization, bleaching of biotite and hornblende, (3) sericitization of kaolinized feldspars along cracks, vermiculite-like alteration of biotite, (4) partial silicification of feldspar. chloritization and partial silicification of biotite, slight silicification of groundmass, aggregates of radiating crystals of natrolite, (5) complete silicification of phenocrysts, large amounts of secondary quartz in groundmass, and (6) complete silicification of groundmass and phenocrysts.

Conclusion revised (B. C.)

19. ARMSTRONG, RICHARD L., 1964, Geochronology and geology of the eastern Great Basin in Nevada and Utah (with) section II–Illustrations: Yale Univ. Ph. D. thesis. (Abs.): Dissert. Abs., v. 25, No. 8, p. 4647, 1965.

A new technique of argon analysis by neutron activation utilizing the reactions $Ar^{40}(n,\gamma)Ar^{41}$ (half life 110 min.) and $Ar^{36}(n,\gamma)Ar^{37}$ (half life 35 days) has been perfected for potassium-argon dating of rocks as young as 3 m.y. The precision and accuracy of the analysis are $\sim$5 percent; but nonquantitative yields during sample preparation increase the uncertainty of the dates to +5 percent, -15 percent. Fifty-two dates were obtained on Great Basin volcanic, intrusive and metamorphic rocks.

In the eastern Great Basin, Precambrian basement metamorphosed $\sim$1.5 b.y. ago and locally younger Precambrian sediments underlie the deposits of the Cordilleran geosyncline which existed from Eocambrian to Triassic time. During the Jurassic the area of thickest deposition shifted eastward into Utah as deformation began in the region. During later Jurassic and Early Cretaceous time deformation and regional metamorphism occurred in Nevada and western Utah which resulted in folds and faults in relatively competent supercrustal rocks and recumbent nappes and associated metamorphic structures in deep rocks. The two tectonic levels are separated by a zone of shearing and adjustment. The Cretaceous to Paleocene Rocky Mountain geosyncline received clastics derived from areas undergoing the Sevier orogeny, which produced a fold and thrust belt along the eastern margin of the Great Basin. In middle Tertiary time (between 36 and 15 m.y. ago) a blanket of ignimbrites and other volcanics was spread over much of the region. This was followed by Miocene and later major normal faulting. Arch ranges, intrusive domes, and gravity slides complicate the Tertiary geology.

Intrusive emplacement occurred in lower to middle Cretaceous time in eastern Nevada and during Tertiary time over the entire region. Potassium-argon dates on rocks metamorphosed before middle Cretaceous time are all Tertiary indicating prolonged deep burial after deformation.

From author abstract

20. ARNOLD, DWIGHT ELLSWORTH, 1956, Geology of the northern Stansbury Range, Tooele County, Utah: Univ. of Utah M. S. thesis, 57 p., geol. map.

Stokes, W.L. and D.E. Arnold, 1958, Northern Stansbury Range and the Stansbury Formation: Utah Geol. Soc., Guidebook to the geology of Utah, No. 13, p. 135-149.

The Stansbury Range is located in the northeastern part of the Basin and Range Province. Study of the northern Stansbury Range was undertaken to obtain a detailed stratigraphic section of the Paleozoic rocks, to explain the unusual conglomerate sequence in the Paleozoic section, and to determine the economic geology of the area.

Paleozoic strata range in age from Late Cambrian to Pennsylvanian and include the following formations: Opex Formation, Garden City Limestone, Swan Peak (?) Formation, Fish Haven Dolomite, Stansbury Formation, Madison-Deseret Limestone, Humbug Formation, Great Blue Limestone and Manning Canyon Formation. Three other sequences were described but were not referred to any existing rock-stratigraphic units.

Pre-Mississippian, post-Ordovician disturbance in this area is evidenced by the presence of a marked discordance between Ordovician and Mississippian strata at two localities. The unusual thick conglomerate sequence is dated Devonian, and is correlated with a Devonian clastic section on Stansbury "Island."

Elevations of the Bonneville, Provo and Stansbury Lake stages of prehistoric Lake Bonneville are given and these are compared with the statewide averages of these respective shorelines.

Abstract revised (B. C. and B. Y. S.)

21. ATWOOD, WALLACE W., 1903, Glaciation of the Uinta and Wasatch Mountains: Univ. of Chicago Ph. D. thesis.

_____ 1909, The glaciation of the Uinta and Wasatch Mountains: U.S. Geol. Survey Prof. Paper 61, 96 p., geol. map.

In the Uinta Mountain area the maximum extension of glaciation in an east-west direction was 82 miles; north-south, 42 miles. The total area covered by ice was somewhat over 1,000 square miles. The longest glacier was $27\frac{1}{2}$ miles long. Two epochs of glaciation occurred, as evidenced by two distinct systems of moraines in each of the main canyons. During the earlier epoch there were 30 distinct glacial systems. On the average the earlier glaciers advanced 5-10 miles farther down the canyons than the latter. Glaciation was more extensive on the south slope. Evidences of glaciation are broad U-shaped troughs, hanging valleys, numerous morainic ridges, hummocky topography, striae, grooves, polished surfaces, and roches moutonnées.

Fifty Pleistocene glaciers in the Wasatch Mountains exceeded 1 mile in length; ten exceeded 5 miles. Seven glaciers reached the shores of Lake Bonneville. Little Cottonwood glacier was 12 miles long. Glaciation was more extensive and more vigorous on the west side of the Wasatch Range than on the east. U-shaped valleys and massive moraines indicate maximum extension of the glaciers. The relation of the moraines at the west base of the Wasatch to the fluviatile Bonneville deposits indicates that the last advance of the ice from the mountains occurred late in the history of Lake Bonneville. *B. Y. S.*

22. AUSTIN, CARL FULTON, 1955, Geochemical prospecting as applied to replacement ores in limestones: Univ. of Utah M. S. thesis, 77 p.

Geochemical prospecting as applied to replacement ores was investigated in the Mayberry mine at Copperfield, Utah and the Ontario mine at Keetley, Utah. Chip samples were cut from the area to be tested and taken to the laboratory for drying, crushing and analysis. Analyses were made colorimetrically by using dithizone for the total heavy metal content expressed as a zinc equivalent. Spectrograms were run in conjunction with the colorimetric method; these indicated that only copper, lead and manganese were dispersed in significant amounts from the ore body tested. A trial X-ray spectrogram worked well for the manganese analysis.

The results of the analyses were very favorable. Narrow but definite dispersion patterns were found adjacent to all of the ore bodies tested. The average distance that significant values seemed to travel was 9 feet. Several prominent but unexplained anomalies were found in supposedly barren country. These anomalies may warrant further development.

Author abstract

23. AXENFELD, SHELDON, 1952, Geology of the north Scranton area, Tooele County, Utah: Indiana Univ. M. A. thesis, 32 p., geol. map.

Mapped area consists of about 7 square miles in northern Boulter Mountain quadrangle, west central Utah. Exposed Paleozoic strata exceeding 5,200 feet in thickness consist of: Ordovician Ajax and Opohonga Limestones; Ordovician-Silurian Bluebell Dolomite; Devonian Victoria Quartzite and Pinyon Peak Limestone; and Mississippian Gardner Dolomite, Pine Canyon Limestone, Humbug Formation and Great Blue Limestone. Quaternary sediments cover stream valley floors and Rush Valley on the west.

The structure of the North Scranton area comprises the west limb of asymmetrical Broad Canyon anticline; probable drag folds are superimposed. Normal, tear and thrust faults cut these folds. A normal fault with apparent stratigraphic displacement of 1,500 feet occurs in north central part of area. A large northeast-trending tear fault cuts out 400 feet of strata in southeast corner. A thrust fault places Ordovician-Silurian strata on top of Mississippian rocks near Line Ridge in eastern part. Folds and thrusts probably resulted from medial and Late Cretaceous eastward-directed forces. Folds are probably equivalent to those of Ophir and Tintic districts.

Widespread alteration occurs, with four types recognized: hydrothermal dolomite, jasperoid, ferruginous calcite and calcite. Minor metallization has been noted. *Abstract revised (B. C.)*

24. BAARS, DONALD LEE, 1965, Pre-Pennsylvanian paleotectonics of southwestern Colorado and east central Utah: Univ. of Colorado Ph. D. thesis, 179 p.

A large northwest-trending fault block composed of late Precambrian through Mississippian rocks is exposed in the core of the San Juan Mountains near Silverton, Colorado. The fault block was formed prior to Ignacio (Late Cambrian) time when younger Precambrian quartzites were extensively downfaulted into juxtaposition with older Precambrian gneisses and schists. The quartzites stood topographically high and supplied local talus deposits adjacent to the faults in Ignacio time. Cambrian sedimentary rocks do not cover the fault block, but thicken and become finer-grained away from the structure.

As the Late Devonian seas advanced, the McCracken Sandstone Member of the Elbert Formation was deposited along the flanks of the structure, but did not cross it. The upper Elbert intertidal dolomites were the first sediments to be deposited across the structure and there lie directly on Precambrian quartzites. Latest Devonian or Earliest Mississippian stromatolitic dolomites of the Ouray Formation overlie Elbert strata on the flanks of the old structure, while equivalent normal marine limestones are locally present within the downfaulted block.

The Lower Mississippian Leadville Formation thins abruptly onto the flanks of the graben, where it is intertidal stromatolitic dolomite. Within the graben, Leadville strata are thin or missing except as remnants in the overlying Molas regolith, suggesting that intense post-Leadville weathering removed those rocks across the regionally high structure. A small horst is present within the large structure where Pennsylvanian sedimentary rocks rest directly on upturned Precambrian quartzites. The graben was again downfaulted at some undetermined post-Desmoinesian time, for Middle Pennsylvanian beds are now in fault-contact with Precambrian rocks along the flanking faults.

With this paleotectonic feature as a model, other areas may be more readily interpreted. (The author concludes this interpretation with statements that) ... the salt anticlines developed along the linear trends created by the Precambrian through Mississippian faults ... (and that) pre-Pennsylvanian petroleum reservoir facies are best developed along the high flanks of the faults.

From author abstract

25. BABISAK, JULIUS, 1949, The geology of the southeastern portion of the Gunnison Plateau, [Sanpete County], Utah: Ohio State Univ. M. S. thesis, 97 p., geol. map.

This study embraces about 75 square miles in central Utah. Rock strata exposed are Arapien Shale and Morrison (?) Formation-Jurassic; Indianola Group-Cretaceous; North Horn Formation-Cretaceous and Tertiary; Flagstaff Limestone and Colton, Green River and Crazy Hollow Formations-Tertiary; and Axtell Formation-Tertiary and Quaternary. An angular unconformity exists between the North Horn Formation and Indianola Group. There is also discordance between the Flagstaff Limestone and the North Horn Formation.

Sanpete Valley, east of the Gunnison Plateau, is underlaid by folded and thrust rocks. The Gunnison Plateau is composed of gently dipping rocks which are broken by high-angle faults. Southern Sanpete Valley follows the axis of an eroded anticline which has its east limb at the base of the Wasatch monocline and its west limb in the southeastern prong of the Gunnison Plateau. Superimposed on this anticline, at the south end of the Gunnison Plateau, is a tightly folded syncline of the Morrison (?) Formation. A strip thrust is found in Sanpete Valley which extends southward beyond the area mapped.

From author abstract

26. BACHMAN, MATTIAS E., 1959, Geology of the Water Hollow Fault zone, Sevier and Sanpete Counties, Utah: Ohio State Univ. M. S. thesis, 95 p.

This report concerns the geology of a 75-square mile area which includes the Water Hollow fault zone and a portion of the southern part of the Wasatch Plateau. Bedrock ranges in age from medial Montana to medial Eocene, and has been divided into Upper Cretaceous Blackhawk Formation (550+ feet) and Price River Formation (950 feet), Upper Cretaceous-Paleocene North Horn Formation (900± feet), Paleocene-Eocene Flagstaff Limestone (300-850 feet), Eocene Colton Formation (500 feet) and Green River Formation (1,000+ feet).

The Water Hollow fault zone is a graben whose major faults extend for great distances to the north and south of the area of this report. Although essentially a graben, the sunken prism is so broken by a complex of subsidiary faults, that the term "fault zone" has been adopted. A major vertical movement, probably in late Eocene, brought the Wasatch Plateau to its present position; and the Wasatch monocline together with the great normal faults, the shoulder graben that characterize the western margin of the plateau, were formed. This movement initiated planes of weakness that controlled the gross trend and structure of the Water Hollow fault zone, which was also formed at this time. *B. C.*

27. BADDLEY, ELMER R., 1924, A study of the Tintic Standard ore deposit, Dividend [Utah County], Utah: Stanford Univ. M. A. thesis, 46 p.

The ore deposit is a typical tabular-shaped replacement body conforming to country rock dip and strike. Country rock is calcareous shale of the middle Ophir Formation (Lower Cambrian). Compressive forces from an underlying magmatic mass prior to mineralization resulted in complex folding and faulting which determined the deposit's size and shape.

The igneous rocks exposed in the immediate vicinity of the mine are intrusive and extrusive rhyolites. The ore's source was an underlying igneous mass, probably quartz monzonite. The complex sulphosalts (tetrahedrite and polybasite) indicate moderate temperatures for the solutions precipitating the primary ore. The gangue minerals are barite and quartz.

The order of mineralization was: barite; pyrite; marcasite and quartz; tetrahedrite; sphalerite; chalcopyrite; bornite; galena; stromyerite; anglesite, cerussite, covellite and perhaps jarosite; argentite and native silver; cerargyrite. The rich silver mineral syromyerite indicates that secondary sulphide enrichment due to supergene solutions was important in the deposit. The widespread occurrence of native silver and of argentojarosite, and the immense masses of cerussite and anglesite indicate that the deposit was greatly enriched by oxidation.
Summary revised (B. Y. S.)

28. BAER, JAMES L., 1962, Geology of the Star Range, Beaver County, Utah: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 9, pt. 2, p. 29-52, geol. map.

A new geologic map of the Star Range and adjacent areas near Milford, Utah, shows more than 9,500 feet of Devonian to Jurassic sediments exposed. Formation names used are: Devonian - Sevy (?), Guilmette, Pilot; Mississippian-Redwall; Pennsylvanian-Callville, Talisman; Permian-Kaibab; Triassic-Moenkopi, Shinarump, Chinle; Jurassic-Navajo. These names replace: Devonian-Red Warrior, Mawitza; Carboniferous-Topache, Elephant; Triassic-Harrington, formations proposed by Butler in 1913. Tertiary extrusive and intrusive rocks are also exposed. Latite, andesite, and basalt have been intruded and mineralized by granitic to porphyritic quartz monzonite to granodiorite intrusions. Contact and thermal metamorphism has altered both sedimentary and extrusive igneous rocks.

Laramide thrust faults are exposed and cut by two sets of Late Tertiary normal faults; a northerly striking set cut by a later easterly striking set. Repeated movement has occurred along normal faults with later movements elevating the range to essentially its present position. *Author abstract*

29. BAILEY, JAMES S., 1955, A stratigraphic analysis of Rico strata in the Four Corners region: Univ. of Arizona Ph. D. thesis, 88 p.
(Abs.): Dissert. Abs., v. 15, No. 7, p. 1223-1224, 1955.

Rico strata are recognized throughout the Four Corners region of southwestern Colorado, southeastern Utah, northeastern Arizona, and northwestern New Mexico. The term Rico has been applied to a group of strata which exhibit a lateral and vertical transition between two contrasting environments, the marine Hermosa and the nonmarine Cutler. Two faunal provinces reflect these widely diverse conditions of sedimentation. However, few fossils of diagnostic value have been discovered despite the abundance of fossiliferous strata within the Rico. Rico strata are believed to range between Desmoinesian and Virgilian in age.

Lithofacies data on the Rico were assembled from literature, outcrop sections, and various well logs. These data were then compiled on an isopach-lithofacies map. The isopach-lithofacies map shows the thickness trends and the lithologic variations of Rico strata throughout the region of study.

The tectonic framework of the region is reconstructed from the isopach-lithofacies map and mechanical analyses of the clastic strata. Clastic material in the Rico increases in average grain size from west to east toward the Uncompahgre Uplift suggesting that this area was actively positive during Rico time. The vertical variation of normal marine limestone and clastic redbeds in the Rico reflect an alternately transgressing and regressing sea over much of the Four Corners region. This intricate intertonguing of normal marine limestone and clastic redbeds probably resulted from deposition in a shallow basin on an unstable shelf.

The occurrence of oil, gas, and cement quality limestone in the Rico is examined from an economic aspect. A brief review of the general geology and geologic history of the region is also included.
Author abstract

30. BAILEY, REED W., 1927, A contribution to the geology of the Bear River Range [Cache County], Utah: Univ. of Chicago M. S. thesis, 63 p.

Cache Valley, Bear River Range and Wellsville Mountains are physiographic features of the area. Cambrian, Ordovician, Silurian, probably Devonian, Mississippian, and Pennsylvanian rocks are exposed without physical breaks. The Eocene Wasatch Formation, an Eocene calcareous algae formation and several Miocene (?) beds are also present.

The Bear River Range fault and the Temple Mountain fault are present. The Front Range is the central part of a broad, open syncline; the Temple Range is the east limb of an anticline; the lowland between is an anticline.

During the Mesozoic this area was low-lying land with eroded material transported to and deposited in seas nearby to the east. Folding, faulting and erosion occurred before the Eocene lake was formed. The large quartzite boulders cannot be explained except by postulating pre-Wasatch glaciation. In the Wasatch Epoch the area was deeply submerged and extensive deposition occurred. After Wasatch time north-south faulting began. Miocene sediments were deposited by streams rejuvenated by the faulting and uplift. *B. Y. S.*

31. BAKER, ARTHUR A., 1931, Geology of the Moab District, Grand and San Juan Counties, Utah: Yale Univ. Ph. D. thesis.

______ 1933, Geology and oil possibilities of the Moab district, Grand and San Juan Counties, Utah: U.S. Geol. Survey Bull. 841, 95 p., geol. map.

The Moab district includes an area of about 1,000 square miles in the Colorado Plateau. The Paradox Formation, which contains thick beds of salt, is the oldest formation and has been tentatively assigned to the Lower Pennsylvanian. Most of the information concerning the Paradox has been obtained from wells, for its surface outcrops are limited to small masses of gypsum. Younger rocks that crop out include the Hermosa Formation (Pennsylvanian); Rico and Cutler Formations (Permian); Moenkopi, Shinarump, and Chinle Formations (Triassic); Wingate Sandstone, Kayenta Formation, and Navajo Sandstone (Jurassic ?); Carmel Formation, Entrada Sandstone, and Summerville Formation (Jurassic); Morrison Formation (Cretaceous ?); and Dakota (?) Sandstone and Mancos Shale (Upper Cretaceous). This area is a critical one in the study of Permian stratigraphy, because there is a rapid lateral change in the Cutler sediments from the red arkosic facies typical of southeastern Utah and southwestern Colorado to a massive white quartz sandstone (Coconino Sandstone) which in this report is called the Cedar Mesa Sandstone Member of the Cutler Formation.

The beds have been folded into low anticlines and shallow synclines as a result of several periods of deformation -- one at the end of the Permian, a second at the end of the Lower Triassic, and a third at the end of the Cretaceous. The beds are cut by numerous small normal faults, some of which bound graben.

The anticlines within this area are not considered to be true salt domes. At a few places, however, the flowage of the relatively plastic salt and gypsum has arched or ruptured the thinner portions of the overlying rock cover. *From published abstract*

32. BAKER, WALKER HOLCOMBE, 1959, Geologic setting and origin of the Grouse Creek Pluton, Box Elder County, Utah: Univ. of Utah Ph. D. thesis, 175 p., geol. map.
(Abs.): Dissert. Abs., v. 20, No. 3, p. 1036-1037, 1959.

Sedimentary rocks in the southern Grouse Creek Mountains total about 6,000 feet: 1,000 feet of Proterozoic phyllites, limestone, dolomite and quartzite, 250 feet of Ordovician (?) Pogonip (?) Formation and 450 feet of Eureka (?) Quartzite; 350 feet of Devonian Simonson Formation and in excess of 1,500 feet of Guilmette Limestone; 800 feet of Mississippian (?)-Pennsylvanian (?) Chainman-Diamond Peak (?) Formation, 1,000 feet of Pennsylvanian-Permian Strathearn (?) Formation, and more than 1,000 feet of Triassic Thaynes (?) Formation. Pliocene Salt Lake Formation and a local conglomeratic formation mantle the foothills. The major structural feature is a horst composed of flexed sedimentary rocks broken into numerous fault blocks.

An irregularly shaped Tertiary (?) granitic pluton appears to transect the structure of the sedimentary rocks, although alignment of its borders with major faults in the sedimentary rocks suggests that preexisting faults partly governed the position of its borders. Sedimentary rocks are not domed in the vicinity of the pluton, suggesting essentially passive formation.

The pluton has an exposed area of $10\frac{1}{4}$ square miles and a probable total area of 15 square miles. It is composed of quartz monzonite (93 percent) and quartz diorite (7 percent); minor variants ranging from leucogranite to meladiorite occur within the major phases. Part of the quartz monzonite has been hydrothermally altered with formation of quartz and pyrite veins. Quartz diorite, which occurs on the borders of the pluton, has an aureole of alteration composed of chloritic quartz diorite in which scheelite is locally present in economic amounts. There is a wide range of textures. An unusual textural feature, the "Granitic intergranular," occurs principally near the borders of the quartz monzonite.

The pluton was probably formed by replacement. No evidence favoring magmatic origin was found. Border textures and structures suggest importance of metasomatism in its formation. The quartz diorite is identified as a basic front.

Abstract revised (B. C.)

33. BAMBERGER, CLARENCE G., 1908, Report on the property of the Daly West Mining Co., Park City, Utah: Cornell Univ. M. E. thesis, 66 p.

The Daly West mine is in the Wasatch Mountains, $2\frac{1}{4}$ miles southwest of Park City in the Uintah mining district, Summit County.

Cambrian through Tertiary sediments are present. The structure is complex. An anticline, pitching north with Weber Quartzite at the center, younger formations overlying, is greatly modified by minor folding and extensive faulting. There are three systems of faulting; main fissuring is northeast-southwest. A series of east-west intrusive masses is athwart the anticline. The main fissure veins are the Oz and Daly. Thirty-nine types of ore yield lead, silver, copper, zinc, iron and gold.

The author's detailed descriptions and illustrations of the Daly West mine may be of interest to those studying the history of the district or the history of early mining operations in the area. *B. Y. S.*

34. BARDSLEY, STANFORD RONALD, 1962, Evaluating oil shale by log analysis: Univ. of Utah M. S. thesis, 87 p.

_____ and S.T. Algermissen, 1963, Evaluating oil shale by log analysis: Colorado School Mines Quart., v. 58, No. 4, p. 175-184.

Induction, radioactive and sonic logging methods were employed in an oil - shale study conducted in northeastern Uintah County, Utah. The physical and chemical properties of an oil-shale section [of the Green River Formation] previously cored and assayed by conventional methods, were used to evaluate the response of the various logs. The logging program was designed to measure variable properties of oil shale which relate to oil - yield potential in order that a relationship between assay - oil yield and log-determined properties could be identified, thereby permitting a direct determination of yield potential from logs alone.

The mahogany zone, rich section, mahogany marker, and A and B grooves (oil-shale section markers described by the U.S. Bureau of Mines and U.S. Geological Survey) can be recognized. Potential oil yield and oil - in - place of an oil-shale interval or section can be determined indirectly from the density log through the use of graphs, or may be determined directly from a calibration table developed from the log response-oil yield relationships. Relationship of potential oil yield to response of the sonic log also permits direct determination of yield through use of a calibration table. The neutron log response distinguishes rich oil-shale intervals from lean intervals. Gamma - ray and induction logs indicate only a qualitative relationship to oil-shale yields.

From author abstract

35. BARNETT, JACK ARNOLD, 1966, Ground-water hydrology of Emigration Canyon, Salt Lake County, Utah: Univ. of Utah M. S. thesis, 100 p., geol. map.

The area under study comprises about 29 square miles in the Wasatch Mountains and ranges in altitude from 4,870 to 8,954 feet. The axis of the Emigration Canyon syncline lies near and roughly parallel to the stream channel. The syncline plunges up canyon to the northeast. Of the nearly 120 drilled wells, more than half divert water from bedrock formations, of which the Twin Creek Limestone, Preuss Sandstone, and Kelvin Formation are most important. Others divert water from alluvial material. Water of stream and all but two wells sampled is of calcium bicarbonate type. Although hard, it is of culinary quality. Coliform bacterial contamination was found in stream and in shallow ground water.

Annual precipitation ranges from 20 to 35 inches. Annual stream flow during past 65 years averaged 4,350 acre-feet and ranged from 234 to 13,500 acre-feet. Water in the aquifers is under artesian pressure. Wells generally produce only a few gallons per minute, and their specific capacities are low. As the annual ground - water pumpage is about 100 acre-feet of water, additional drilling of small culinary wells could probably be allowed, but large wells or additional surface-water development could negatively influence already established water rights. *Abstract revised (B. C.)*

36. BAROSH, PATRICK JAMES, 1959, Geology of the Beaver Lake Mountains, Utah: Univ. of California (Los Angeles) M. A. thesis.

_____ 1960, Beaver Lake Mountains, Beaver County, Utah -- their geology and ore deposits: Utah Geol. and Mineralog. Survey Bull. 68, 89 p., geol. map.

The Beaver Lake Mountains lie in the Basin and Range Province, west central Utah. Lower to Middle Cambrian rocks form a transgressive sequence of quartzite, shale and carbonate rocks. Later Middle Cambrian to Late Ordovician rocks are absent. Latest Ordovician (?) to Devonian is represented by a dolomite sequence, overlain by Mississippian limestone. No sedimentary rocks younger than Mississippian have been recognized.

The Early (?) Tertiary is represented by volcanic rocks, which are generally quartz latite in composition, with some granodiorite porphyry. These were followed in the Middle (?) Tertiary by a quartz monzonite intrusion which has altered part of the earlier carbonate and volcanic rocks.

Structurally the area is complex and can be divided into two parts: the northern third which has undergone high-angle faulting, thrust faulting and folding; and the southern two-thirds in which the structure mainly reflects the shape of the intrusion with some modification by high-angle faulting.

From published abstract

37. BAUER, HERMAN LOUIS, Jr., 1952, Fluorspar deposits, north end of Spor Mountain, Thomas Range, Juab County, Utah: Univ. of Utah M. S. thesis, 47 p., geol. map.

Spor Mountain is a small fault block mountain which lies on the western edge of the Thomas Range. Three formations with a total exposed thickness of 2,100 feet are present in the Spor Mountain area: Swan Peak or Eureka Quartzite (Ordovician), Fish Haven (?) Dolomite (Upper Ordovician ?) and Laketown Dolomite (Middle Silurian). Igneous rocks of trachytic to rhyolitic composition occur in the form of dikes, plugs and intrusive breccia, and extrusive flows and tuffs.

The beds strike N. 27°-48° E. and dip 33°-58° NW. Three systems of faults are found: northeasterly trending normal faults with low southeast dips, small northwesterly trending (adjustment) faults, and faults causing present relief of Spor Mountain.

The fluorspar ore bodies are pipe-like, steeply plunging, and have sharp, well-defined contacts with the dolomite wall rock. They vary from 15 feet in diameter to 160 feet long by 60 feet wide. Rhyolite plugs and/or minor faults appear to have acted as structural controls. The fluorspar consists of pulverulent lavender to brown fluorite in the form of a boxwork structure, with minor calcite, clay and quartz. As the fluorine-bearing solutions apparently did not replace dense siliceous rock, fluorite deposits probably terminate at relatively shallow depth, at the contact with the Swan Peak Quartzite.

Abstract revised (B. C.)

38. BAUGHMAN, RUSSELL LEROY, 1959, The geology of the Musinia graben area, Sevier and Sanpete Counties, Utah: Ohio State Univ. M. S. thesis, 110 p., geol. map.

The 60-square-mile area mapped lies on the south central edge of the Wasatch Plateau, and consists of a north-south-trending valley (graben) bordered by ridges. The 3,650-foot sequence of middle Montana to lower Eocene strata contains beds deposited in environments ranging from coastal swamp and lowland to inland floodplain, channel and lake. Exposed rocks (oldest to youngest) include Blackhawk Formation (555+ feet), Price River Formation (210- to 235-foot Castlegate Sandstone below; 710-foot upper portion), North Horn Formation (about 1,000 feet), Flagstaff Limestone (1,250+ feet) and younger terrace, slide and alluvial deposits.

The dominant structural features are the faults tha delimit the Musinia graben and cut the rocks in th downthrown graben block. These features are correlated with the flexing of the Wasatch monocline The Musinia graben is 20 to 25 miles long, up tc $3\frac{1}{4}$ miles wide and contains a central horst. Beds exposed in the marginal fault-line scarps and in the central horst dip north and south away from the east-west arch at Salina Canyon, but the subsidiary fault blocks within the graben are tilted to various attitudes resulting in rapid and large variation in stratigraphic displacement along many faults. *B. C.*

39. BAYLEY, RICHARD W., 1950, A heavy mineral study of th Morrison Formation of south central Utah: Ohio State Univ M. S. thesis, 39 p.

The known Morrison Formation (all continental beds between marine Jurassic and marine Cretaceous strata) in San Rafael Swell were correlated with Morrison (?) occurrences near Castledale, in Salina Canyon, at south end of Gunnison Plateau and at Thistle by means of the heavy mineral suite, which consists of very stable minerals. Unit for unit correlation based on similar heavy mineral suites is impossible except for short distances across a particular unit of sedimentation, because variation is due to selective sorting. Trial and error correlations based on plotted relative frequencies were not useful or successful. Use of a distinctive mineral species within a limited vertical range is believed to involve minimum error.

Four zones were established. If these zones are approximately contemporaneous, each section contains continental beds equivalent to the Morrison Formation of the San Rafael Swell; these continental beds have a lower more persistent and an upper, conglomeratic unit; equivalents of Dakota (?) Formation and sandstone facies of lower Tununk Shale are best developed in Salina Canyon; Morrison strata at Castledale have marine equivalents at Salina Canyon. Fossiliferous Morrison (?) strata are Upper Jurassic. The overlying unfossiliferous continental beds, the upper conglomerate, and the unfossiliferous lower Dakota (?) and Sanpete Formations are considered Upper Jurassic (?)-Lower Cretaceous (?). *B. Y. S. and B. C.*

40. BEACH, GARY A., 1961, Late Devonian and early Mississippian biostratigraphy of central Utah: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 8, p. 37-54.

From the Pinyon Peak Limestone and Gardner Formation of central Utah, the writer has obtained 36 species of 14 conodont genera. Species of Palmatolepis and Polygnathus can be used in refined Devonian zonation; similarly Siphonodella is useful in Lower Mississippian zonation.

Three distinct conodont assemblage zones designated C, D and E have been determined which are useful in detailed biostratigraphic determinations and are correlated with the standard stages based on ammonoid genera in Europe. Zone C is of uppermost Cheiloceras age (III-IV), Zone D is of Wocklumeria (V-VI), and Zone E is of Gattendorfia to lower Pericyclus (Cu I-Cu II α).

Zones C and D, present in the upper Pinyon Peak Limestone and lower Gardner Formation can be correlated with the lower part of the Double Horn Shale Member of the Houy Formation in Texas and the Grassy Creek, Saverton, Louisiana, and possibly the lower part of the Glen Park Formation of the upper Mississippi Valley. Zone E, present in the Gardner Formation, can be correlated with the upper part of the Double Horn Shale and Chapped Limestone of central Texas, the upper part of the Glen Park Limestone, all of the Hannibal Shale, and the lower part of the Chouteau Limestone of the upper Mississippi Valley. *From author abstract*

41. BEARD, JOHN HARVEY, 1959, Microfauna of the Upper Cretaceous-Lower Tertiary rocks of the western Book Cliffs, Carbon County, Utah: Univ. of Utah M. S. thesis, 117 p.

Correlation and stratigraphic zonation of Upper Cretaceous - Lower Tertiary rocks of the western Book Cliffs was based upon 10 assemblages of Foraminifera, ostracodes and charophytes collected from two sections: one in Price River Canyon (near Helper) and one near Sunnyside. Stratigraphic units (ascending) are upper part of Mancos Shale, Star Point Sandstone, Blackhawk Formation, Price River Formation, North Horn Formation and Flagstaff Limestone.

Thirty-two species of Foraminifera (19 arenaceous, 13 calcareous), 14 species of ostracodes and 3 species of charophytes are figured and described. The Foraminifera - ostracode assemblages closely resemble faunas of Gulf Coast states, and also contain species described from Great Plains states.

Dominance of arenaceous Foraminifera in upper Mancos Shale and in shale tongues of Star Point Sandstone suggest deposition in upper heritic zone, probably very near shore. In Price River Canyon the Blackhawk Formation contained only charophytes and was probably deposited in brackish water behind offshore bars, but at Sunnyside the lower Blackhawk fauna is marine, and almost identical to that of the Star Point Sandstone in Price River Canyon. Ostracode-charophyte assemblage of North Horn Formation suggests nonmarine origin; Flagstaff Limestone (lacustrine) contains abundant ostracodes and charophytes. Mesaverde littoral sandstones contained no microfossils. *Abstract revised (B. C.)*

42. BECKER, JOSEPH HENRY, 1959, Upper Devonian conodonts from the eastern Great Basin: Southern Methodist Univ. M. S. thesis.

Clark, D.L. and J.H. Becker, 1960, Upper Devonian correlations in western Utah and eastern Nevada: Geol. Soc. America Bull., v. 71, No. 11, p. 1661-1674.

Certain species of the conodont genus Palmatolepis have been demonstrated to be characteristic of each of the standard Germany Upper Devonian stages, and so it is possible to determine precise Upper Devonian correlations the world over.

The Pinyon Peak Limestone of central Utah, the Pilot Shale in southwestern Utah, and the Devils Gate Limestone in central Nevada were measured and sampled for conodonts. On the basis of samples obtained from 113 beds at 31 different localities, three distinct zones of early Upper Devonian conodonts are recognized. The zones in ascending order are: Zone A containing diagnostic species of the upper Manticoceras-Stufe in Germany; Zone B, containing species considered to be equivalent to the lower Cheiloceras - Stufe; and Zone C, containing species of upper Cheiloceras or Platyclymenia age. Representatives of all three zones were only recognized in the Pilot Shale of the Confusion Range in western Utah.

Correlation with other Upper Devonian rocks throughout North America is suggested where the conodont faunal assemblages are well known.

From some 10,000 specimens obtained, 22 genera and 30 species were identified. Only those species that, in the writer's opinion, have stratigraphic value are described. Approximately 60 percent of the specimens are referable to the genus Palmatolepis, and only forms of this genus are illustrated. *Author abstract*

43. BECKMANN, MARIAN C., 1959, Saline facies of recent sediments in Great Salt Lake, Utah: Columbia Univ. M. A. thesis, 47 p.

Winter samples of recent sediments collected from the east shore of Great Salt Lake and along a traverse from Antelope Island west to the center of the lake were submitted to X-ray analysis for identification. Calcium carbonate occurs in oolites from the west shore of Antelope Island to a depth of 18 feet; thenardite, from 24 to 28 feet; gypsum and halite, in the lake center, 28 to 30 feet in depth.

From a study of the zoned areal distribution of the mineral content of the sediments, it is concluded that evaporites may occur as saline facies. The saline facies as described in this paper are areally restricted zones of a designated evaporite basin whose chemical, and hence mineralogical, nature is significantly different from that of other zones of the basin.

Water-sample investigation suggests stratification of basin water according to specific gravity, caused by concentration, temperature and depth changes. Where stratification in the basin water intersects an uneven basin bottom, different salines may be deposited on neighboring bottom areas at the same time.

Two hypotheses are suggested to explain evaporite facies: chemical fractionation and sedimentary differentiation hypothesis.

From author conclusions

44. BEHRENDT, JOHN C., 1957, Regional magnetic study of Uinta Mountains, Utah: Univ. of Wisconsin M. S. thesis.

_____ and E.C. Thiel, 1963, A gravity and magnetic survey of the Uinta Mountains: Jour. Geophys. Research, v. 68, No. 3, p. 857-868.

The results of a gravity and magnetic survey of the Uinta Mountains and surrounding area are presented and discussed. A relatively high Bouguer anomaly over the core of the range and low anomalies over the flanking basins are caused by low-density sedimentary rock in the basins. A density map and an isopach map of a 'Tertiary' section have been constructed from the gravity data, which are in general agreement with known geology. The mean free-air anomaly of +8 mgal shows that the area, including the basins, is in approximate isostatic equilibrium. The mean Bouguer anomaly of -225 mgal corresponds to a mantle depth of 50 km. A large negative magnetic anomaly is associated with the main structure of the range and has been interpreted as having been caused by a batholithic intrusion of low-susceptibility rock, by upwarping of the Curie isotherm requiring a minimum thermal gradient of 27° C km^{-1}, or by a susceptibility decrease caused by tectonic stresses. A positive magnetic anomaly is associated with a fault zone at the east end of the range; it corresponds to high-density rock that is shown by gravity data.

Published abstract

45. BELL, GORDON L., 1951, Geology of the Precambrian metamorphic terrane, Farmington Mountains [Davis and Morgan Counties], Utah: Univ. of Utah Ph. D. thesis, 101 p., geol. map.
(Abs.): Geol. Soc. America Bull., v. 63, No. 12, pt. 2, p. 1358, 1952.

_____ 1952, Geology of the northern Farmington Mountains: Utah Geol. Soc. Guidebook to the Geology of Utah, no. 8, p. 38-51.

The northern Farmington Mountains, a division of the north central Wasatch Mountains, Utah, are characterized by a well-exposed middle (?) Precambrian terrane. The Precambrian rocks are the products of progressive regional metamorphism and they are classified according to the concept of "mineral facies" of rocks as defined by Eskola. Seven metamorphic facies are recognized that range from low-grade progressive greenschist to the high-grade granulite: (1) greenschist, (2) quartz-microcline-muscovite facies, (3) epidote-quartz facies, epidosite, (4) almandine-biotite facies, (5) migmatite, (6) amphibolite facies, and (7) granulite facies.

Local bodies of moderately coarse-grained hornblende-biotite granite crop out. Pegmatite dikes are widespread, and two types of pegmatite are recognized -- a gray soda-rich pegmatite in the progressive greenschist zone, and a pink potash-rich pegmatite, common in higher-grade zones.

Molecular values calculated from data of chemical analyses are plotted on the Niggli-Becke projection, as an aid to classification of the rocks according to facies and origin.

Two remnants of upper (?) Precambrian quartz schist overlie unconformably the middle (?) Precambrian terrane in the northwest part of the area. The Eocene Knight (?) Formation rests unconformably on the Precambrian terrane along the east side of the mountains.

Ten extensive thrust faults are exposed in Weber Canyon at the north end of the area. They are correlated with lower Laramide thrust faults in the region. Zones of retrograde greenschist are well developed along all of the thrust faults. Characteristic fabric of the diaphthorite is presented. The mountains are essentially a composite series of north-northwest-trending fault blocks bounded by normal faults. The north-trending mountains are bounded on the west by the great Wasatch fault system and on the east by a system of northwest-trending en echelon faults.

From author abstracts

46. BENTLEY, CRAIG B., 1958, Upper Cambrian stratigraphy of western Utah: Brigham Young Univ. (M. A. thesis) Research Studies, Geol. Ser., v. 5, No. 6, 70 p.

Eight sections were measured in an area extending from central Utah westward to the Fish Springs and Deep Creek Ranges and from the Silver Island Range, Tooele County, southward to the Wah Wah Mountains, Beaver County.

A shale and limestone unit which is equivalent to the Dunderberg Shale of Nevada is found as far east as central Utah. In the Oquirrh Mountains Mississippian rocks overlie unconformably the lower part of the Upper Cambrian; and eastward, in the central Wasatch Mountains, no Upper Cambrian is present. In the Tintic district and Stansbury Mountains, complete sections consisting of the Ajax and Opex Formations occur. In the vicinity of the House Range, Upper Cambrian consists of the Weeks, Orr and Notch Peak Formations; in the Deep Creek Range it consists of the Hicks, Lamb and (lower part of) Chokecherry Formations. The thickest section, nearly 5,000 feet thick, occurs in the House Range, near center of the Cordilleran miogeosyncline.

It is proposed that the Dunderberg Shale be recognized as a formation in western Utah, and that the Chokecherry be renamed, at least in the Deep Creek Range, to Pogonip Formation for the Ordovician part, and Notch Peak Limestone for the Cambrian part.

Abstract revised (B. C.)

47. BENVEGNU, CARL JEROME, 1963, Stratigraphy and structure of the Croyden-Henefer-Grass Valley area, Morgan and Summit Counties, Utah: Univ. of Utah M. S. thesis, 33 p., geol. map.

Sedimentary formations exposed include Jurassic Preuss (?), Cretaceous Kelvin, Wanship and Echo Canyon and Tertiary Knight Formations. Preuss (?) Formation consists of reddish-brown thin-bedded sandstone and siltstone. Kelvin Formation (about 4,425 feet) is composed of interbedded tan, gray and pink sandstone; variegated shale, siltstone and claystone; and a unit of white nodular limestone and purple siltstone near base. Wanship Formation (5,315 feet) contains interbedded marine and nonmarine sandstone and shale in lower part, and nonmarine sandstone, shale and conglomerate in upper part, which grades upward into massive red conglomerate of Echo Canyon Formation. Echo Canyon (3,100+ feet) contains red conglomerate, sandstone and siltstone with minor gray and brown claystone. Sandstones near base contain marine invertebrates. Knight Formation (500+ feet) resembles Echo Canyon and lies unconformably upon all older rocks except in axial zone of Stevenson Canyon syncline where beds of Knight Formation are essentially concordant upon those of Echo Canyon Formation.

The Stevenson Canyon syncline and most major structural elements in general area trend northeasterly. Complete thicknesses of Wanship and Echo Canyon Formations comprise mapped portion of southeast limb. The Preuss (?), Kelvin, upper Wanship and Echo Canyon Formations are exposed on the northwest flank, the upper Wanship lying disconformably upon the Kelvin.

Abstract revised (B. C.)

48. BERGE, CHARLES WILLIAM, 1960, Heavy minerals study of the intrusive bodies of the central Wasatch Range, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 7, No. 6, 31 p.

The Little Cottonwood, Alta, Clayton Peak and Park City stocks occur generally in a line from west to east within the north-trending central Wasatch Range at its intersection with the east-west structures of the Uinta uplift, and represent the only large intrusions in either range. A heavy mineral petrographic study of these four stocks showed these intrusions to become progressively more acidic to the west; and a statistical comparison, using Pearson's Product-Moment Correlation Coefficient and Contingency Coefficient, confirmed the presence of greater quantities of early forming minerals in the eastern intrusions. The Park City stock (quartz diorite porphyry), easternmost of the four stocks, and the Little Cottonwood stock (adamellite) on the west, show the greatest contrast in general mineral content and rock texture and in the amount and type of heavy constituents. The Clayton Peak and Alta stocks (granodiorites) appear intermediate in essentially all respects. From west to east, the stocks become more basic showing less quartz, potash feldspar, biotite and sphene, and more plagioclase (more calcic to the east), hornblende, pyroxene, opaques and zircon. The stocks become smaller, more highly altered (hydrothermal) and have solidified at shallower depths.

Author abstract

49. BETHKE, PHILIP MARTIN, 1957, The sulfo-selenides of mercury and their occurrence at Marysvale, Utah: Columbia Univ. Ph. D. thesis, 173 p.
(Abs.): Dissert. Abs., v. 18, No. 5, p. 1765-1766, 1958.

The sulfo-selenides of mercury form a complete isomorphous series defined by the diadochy of sulfur and selenium. This series is here noted as the metacinnabar series and includes the minerals metacinnabar, onofrite and tiemannite. Hartwig has shown that these minerals are isostructural, crystallizing in the F43m space group in a sphalerite-type structure. X-ray fluorescence analyses of some 50 samples establish the regular variation in composition from metacinnabar (HgS) to tiemannite (HgSe). Iron and zinc are known to replace mercury in the mineral series to an appreciable extent. The same relationship is expected of cadmium. Unit cell dimension, knoop hardness and specific gravity vary linearly with composition from $a_o = 5.853$ Å, G (measured) = 7.85, H (knoop) = 75 in HgS to $a_o = 6.073$ Å, G (measured) = 8.21, H (knoop) = 20 in HgSe.

The demonstrated continuous change in composition suggests a revision of the classification presented in Dana. The following classification is proposed:

Metacinnabar series Hg(S,Se)		Isometric
Metacinnabar	HgS to $HgS_{.8}Se_{.2}$	
Onofrite	$HgS_{.8}Se_{.2}$ to $HgS_{.2}Se_{.8}$	
Tiemannite	$HgS_{.2}Se_{.8}$ to HgSe	

Pyrosynthetic studies and analyses of coexisting cinnabars and onofrites from Marysvale indicate that selenium is able to enter the cinnabar structure in only trace amounts. A similar relationship is reported for iron and zinc. It is proposed that the distribution of selenium, iron and zinc between cinnabar and metacinnabar is related to differences in bond type. Aurivillius states that the shortest Hg - S bonds in cinnabar appear to be of the diagonal covalent (sp) type. The Hg - (S, Se) bonds of the metacinnabar series are of the tetrahedral covalent (sp^3) type. Telkes' electrical resistivity data indicate appreciably greater metallic character of the Hg - S bonds in metacinnabar, and that the metallic character increases with increasing selenium content. It is suggested that natural metacinnabars represent compounds stabilized by structural impurities.

Occurrence of sulfo - selenides of mercury in the Lucky Boy deposit is considered to be genetically related to base metal-precious metal deposits, and to represent the outermost fringe of a crude but definite zoning. The above deposits are thought to be related to the well-developed vulcanism of the region and to have been emplaced during the period of fracturing associated with the development of the Tushar fault. *From author abstract*

50. BEUS, STANLEY SPENCER, 1958, Geology of the northern part of Wellsville Mountain, northern Wasatch Range [Cache and Box Elder Counties], Utah: Utah State Univ. M. S. thesis, 84 p., geol. map.

The mapped area consists of about 60 square miles in Cache and Box Elder Counties. Paleozoic sedimentary rocks consist, ascending, of Cambrian Bloomington, Nounan and St. Charles Formations; Ordovician Garden City Limestone (1,698 feet), Swan Peak Quartzite (427 feet) and Fish Haven Dolomite (140 feet); Silurian Laketown Dolomite (1,764 feet); Lower Devonian Water Canyon Formation (555 feet of dolomitic sandstone and dolomite); Devonian Jefferson Formation (850 feet of dolomite and cherty limestone), absent 2 miles south of area mapped; Mississippian Lodgepole Limestone (843 feet) and Brazer Formation (1,836 feet of limestone and sandstone); and Pennsylvanian Oquirrh Formation (6,600 feet of calcareous sandstones and sandy limestones). Fusulinids of Desmoinesian and Virgilian ages occur in lower part of Oquirrh. Unconformities exist between Lodgepole and Brazer, and between Brazer and Oquirrh Formations.

Several hundred feet of beds belonging to the Wasatch Group comprise oldest Tertiary beds. Pliocene molluscs and plants occur in Salt Lake Group, which is represented by Collinston Conglomerate (roughly 1,500 feet) and Cache Valley Formation.

Major structure of Wellsville Mountain is north-northwest-trending, tilted fault block. High-angle faults have two general trends: east - northeast, normal to strike of Paleozoic rocks (Laramide), and north-northwest (Basin-and-Range). Wasatch fault zone bounds steep western front. *B. C.*

51. BEUS, STANLEY SPENCER, 1963, Geology of the central Blue Spring Hills [Box Elder County], Utah-Idaho: Univ. of California (Los Angeles) Ph. D. thesis, 233 p. (Abs.): Dissert. Abs., v. 24, No. 4, p. 1567, 1963.

_____ 1968, Paleozoic stratigraphy of Samaria Mountain, Idaho-Utah: Am. Assoc. Petroleum Geologists Bull., v. 52, No. 5, p. 782-808.

About 210 square miles were mapped. Ordovician through Lower Permian strata, at least 13,000 feet thick, are exposed along a west-dipping homocline in the Samaria Mountain area. The following formations are exposed in westward sequence: Lower to Middle Ordovician Swan Peak Quartzite (400+ feet), Upper Ordovician and Silurian Fish Haven-Laketown Dolomite sequence (1,540 feet), Lower Devonian Water Canyon Formation (455 feet), Middle and Upper Devonian Jefferson Formation (2,060 feet), Lower Mississippian Lodgepole Limestone (330 feet), Meramecian Humbug Formation (940 feet), Upper Mississippian Great Blue Limestone (1,180 feet) and Mississippian-Pennsylvanian Manning Canyon Formation (300 feet).

Pennsylvanian-Permian Oquirrh Formation crops out in western part Samaria Mountain area and in most of central Blue Spring Hills south of Utah-Idaho line. Poor exposures and complex structures prevented measurement of complete thickness, estimated to exceed 6,000 feet. Lower part of Oquirrh is recognized as West Canyon Limestone Member (Morrowan-Atokan). Fusulinids of late Missourian, Virgilian and Wolfcampian age occur in upper Oquirrh. Upper Pennsylvanian section of Oquirrh Formation is apparently an allochthonous slice.

Hyrum Dolomite Member of Jefferson Formation is divided into three new members. New Devonian brachiopod fauna from middle member suggests correlation with fauna of lower Devils Gate Formation, Nevada, and with Allanaria allan fauna of Waterways Formation, Alberta.

Laramide structures include north - trending folds and a thrust fault exposed in northwest corner of area, which brings Upper Pennsylvanian Oquirrh strata on top of a Lower Pennsylvanian through Lower Permian sequence in which Upper Pennsylvanian beds are absent. This thrust is believed to underlie most of area. The area is bounded on north and east by high-angle normal faults (Basin-and-Range) that have imposed block - fault structure on older Laramide structures. A major high-angle fault that occurred after thrusting bisects area from southeast to northwest. *Abstract revised (B. C.)*

52. BICK, KENNETH FLETCHER, 1958, Geology of the Deep Creek quadrangle [Tooele and Juab Counties], western Utah: Yale Univ. Ph. D. thesis.

_____ 1959, Stratigraphy of the Deep Creek Mountains, Utah: Am. Assoc. Petroleum Geologists Bull., v. 43, No. 5, p. 1064-1069.

_____ 1966, Geology of the Deep Creek Mountains, Tooele and Juab Counties, Utah: Utah Geol. and Mineralog. Survey Bull. 77, 120 p., geol. map.

The author mapped the southern part of the Deep Creek Mountains. Oldest rocks exposed are about 8,000 feet of Precambrian schist and quartzite, included mainly in the Horse Canyon Formation, which contains a thick unit of glacial origin. Schist, quartzite and shale of Precambrian and/or Cambrian age total 4,000+ feet and are included mainly in the Goshute Canyon Formation. Cambrian System is about 10,000 feet thick and consists of Lower Cambrian Prospect Mountain Quartzite, Pioche Shale and lower part of Busby Quartzite; Middle Cambrian upper part of Busby, Abercrombie Formation (limestone), Young Peak Dolomite and Trippe Limestone; Upper Cambrian Lamb Dolomite, Hicks Formation (dolomite) and lower part of Chokecherry Dolomite. In northern half of area, Cambrian System is conformably overlain by 600 feet of Lower Ordovician dolomite (upper part of Chokecherry) that is in turn unconformably overlain by 250 feet of Upper Ordovician dolomite (Fish Haven Dolomite). In southern half of area, Lower and Middle Ordovician limestones of Pogonip Group are present, and a 40-foot unit (Eureka Quartzite) intervenes between these rocks and Upper Ordovician dolomite. Middle Silurian Laketown Dolomite (700-1,000 feet) unconformably overlies Ordovician System. A conformable Lower and Middle Devonian sequence (2,200 feet) consisting of Sevy and Simonson Dolomites and Guilmette Formation unconformably overlies Silurian System. Pennsylvanian-Permian limestone, Miocene-Pliocene (?) sediments and Pleistocene gravel and glacial deposits also occur.

Deep Creek Mountains are on southern flank of Tooele arch, Paleozoic positive area which influenced sedimentary history from Precambrian (?) into Mississippian time. Complex deformational history resulted in the following major features, listed in order of decreasing age: thrust fault and overturned anticline in upper plate which exhibit westward transport, north-south-trending anticline, thrust which moved Pennsylvanian-Permian rocks over erosion surface developed on older rocks, east-west-trending faults, granitic (Ibapah) stock, and border faults. *Abstract revised (B. C.)*

53. BIRCH, RONDO O., 1940, The geology of the Little Willow district [Salt Lake County], Wasatch Mountains: Univ. of Utah M. S. thesis, 44 p.

Youngest Precambrian rocks of the region are the Big Cottonwood Series, 12,000 feet of slates and quartzites which terminate at a granite intrusion near the mouth of Big Cottonwood Canyon. Between this granite and the granite south of Little Cottonwood Canyon, both Tertiary in age, are exposed the Precambrian rocks with which this paper deals

Intercalated slates and quartzites of the Little Willow Series lie conformably below rocks assigned to the Big Cottonwood Series and are believed to be a part of the latter series, although they are more highly altered. Their higher degree of alteration may be due to contact metamorphism which resulted from their position on the granite as a roof pendant.

The Little Cottonwood Complex, exposed along the axis of an anticline, lies unconformably below the Little Willow Series and includes the oldest rocks in the area. The schists and gneisses are highly metamorphosed and differ greatly from the rocks which rest upon them. They are much altered as a result of granite intrusions and dikes. The Little Cottonwood Complex is similar in lithology and stratigraphic position to the Archean schists and gneisses east of Farmington.

Abstract revised (B. C.)

54. BISSELL, HAROLD JOSEPH, 1936, Pennsylvanian and Lower Permian stratigraphy in the southern Wasatch Mountains [Utah County], Utah: State Univ. of Iowa (Iowa City), M. S. thesis, 29 p.

_____ 1937, Pennsylvanian stratigraphy in the southern Wasatch Mountains, Utah: Iowa Acad. Sci. Proc., v. 13, p. 239-243.

In the vicinity of Spring Creek and Hobble Creek Canyons, Utah County, about 4,000 feet of Pennsylvanian rocks are exposed, consisting of interbedded limestones and sandstones with minor shales, and two beds of conglomerate. Two units can be recognized, the lower facies (Kelly Formation) consisting of about 1,885 feet of sandstones, limestones, shales and conglomerates, and the upper facies (Hobble Formation) consisting of about 1,750 feet of thick beds of sandstone and limestone.

About 500 feet of buff to reddish-brown calcareous sandstone and very arenaceous limestone (Granger Formation) lie above the Pennsylvanian rocks in Hobble Creek Canyon. Pseudoschwagerina and Schwagerina occur in the lower 400 feet, indicating a probable early Early Permian age. *B. C.*

55. BISSELL, HAROLD JOSEPH, 1948, Pleistocene sedimentation in southern Utah Valley [Utah County], Utah: State Univ. of Iowa (Iowa City), Ph. D. thesis, 364 p.

Late Pliocene sedimentation included deposition of volcanic debris and freshwater limestone (Salt

Lake Formation) in playas or lakes. Volcanism waned during early Pleistocene and alluvial fans extended far into the valley.

The pre-Bonneville Pleistocene deposits in southern Utah Valley, therefore, may record various periods, possibly two, when lakes formed in the valley and each of these was preceded and followed by a period, presumably arid, when fanglomerate and other fluvial deposits were spread far into the interior of the valley. The fans were deeply weathered and covered by a deep soil prior to or during the early stages of Lake Bonneville.

During the earliest stage of Lake Bonneville the Alpine Formation was deposited in the lake. Later the lake rose to the short-lived Bonneville level, its maximum height represented by a thin beach deposit. As Lake Bonneville overflowed into the Snake River via Red Rock Pass the lake fell rapidly to the Provo level (4,800 feet above sea level), where it stood for a long time. Large deltas were built and the Provo Formation was deposited. Late during the Provo stage lake waters dropped, then rose again to within 50 feet of the older shoreline, then dropped again. After the Provo stage the lake fell gradually to the level of Utah Lake and only minor fluctuations have occurred since.

Pleistocene sediments show differences in texture and form controlled more by variations in climate than by structural movements. Deformation has occurred during 5 intervals: post-Archean, post-Algonkian, early "Laramide" (mid-Cretaceous), middle "Laramide" (middle to late Montanan), and late "Laramide" (Early Tertiary). During the "Laramide" orogenic movements strata in what is now Utah Valley were overfolded along axes striking north-south; some rode eastward 10 to 20 miles.

Abstract revised (B. Y. S.)

56. BLACK, B. ALLEN, 1965, Nebo overthrust, southern Wasatch Mountains [Juab County], Utah: Brigham Young Univ. (M. S. thesis), Geol. Studies, v. 12, p. 55-89, geol. map.

An overturned and in part recumbent north-northeast-trending anticline forms the bulk of the southern Wasatch Mountains northeast of Nephi, Juab County, Utah. West half of fold is truncated by Wasatch (normal) fault along west flank of Mount Nebo, whereas southern extension is terminated by Nebo overthrust. Highly dissected eastern portion is partially covered by thick east-dipping Upper Cretaceous and Tertiary sedimentary and volcanic rocks.

Although west- to southwest-dipping at low angle on western margin of area, the Nebo overthrust is nearly horizontal near center of range, where overturned Paleozoic and Mesozoic rocks are in juxtaposition with underlying Jurassic sandstones and shales. Slickensided surfaces in competent rocks near main thrust zone, drag folds associated with minor thrusts in Jurassic Arapien Shale, direction of overturning of larger folds in Arapien, and trend of fold axes in Arapien indicate eastward movement of upper plate of Nebo overthrust along N. 60°-70° E. line. Newly discovered fenstern containing critical stratigraphic units to north of previously mapped position of overthrust indicate 7-mile minimum displacement.

Formations of mapped area attest to at least four compressive phases and two episodes of normal faulting, and probably several more, resulting from Cedar Hills, Laramide and Basin-and-Range deformations.

Abstract revised (B. C.)

57. BLANK, HORACE RICHARD, Jr., 1959, Geology of the Bull Valley district, Washington County, Utah: Univ. of Washington Ph. D. thesis, 177 p., geol. map.
(Abs.): Dissert. Abs., v. 20, No. 7, p. 2755, 1960.

The Bull Valley district is an eruptive-tectonic complex in eastern Great Basin. Igneous activity began in early Tertiary and persisted intermittently until Recent, resulting in emplacement of numerous hypabyssal intrusive bodies and accumulation of 9,000 feet (aggregate total) of volcanic deposits, largely ignimbrites. Initially of widespread, regional distribution, they later tended to be confined by topographic barriers.

In the older of two principal eruptive centers, quartz monzonite porphyry was concordantly emplaced along the axial portion of a Laramide anticline in early- to mid-Tertiary time, forming an elongate intrusive arch. Continued rise of the magma and rapid denudation of the oversteepened structure, probably largely effected by landsliding, resulted in failure of the roof at one end of the arch and violent eruption of great quantities of latite magma. The earliest ejecta were tuff and tuff breccia of probable nuée ardente origin, but these were quickly followed by complete disrupture of the roof and extravasation of a more liquid phase. The later deposit shows a continuous transition from latite crystal tuff at points distant from the source, through latite lava, to monzonite porphyry in the core of the intrusion. The lava and material now entrapped in the vent have microscopic textures and structures nearly identical with those of the ignimbrites, possibly as the result of rapid, turbulent distillation of volatiles from the magma during eruption. Automorphic alteration of the magma apparently occurred throughout the eruptive episode, and is closely related to the formation of iron deposits in the final stages.

Rhyolite intrusion occurred at a second eruptive center in late Tertiary; numerous silicic stocks and plugs were emplaced concurrently with collapse and filling of the area between this center and the monzonite intrusive arch. Repeated movement occurred along the close-spaced, high-angle faults which characterize the district.

From author abstract

58. BLUE, DONALD McCOY, 1960, Geology and ore deposits of the Lucin mining district, Box Elder County, Utah, and Elko County, Nevada: Univ. of Utah M. S. thesis, 121 p., geol. map.

_____ 1963, Ore deposits of the Lucin mining district, Box Elder County, Utah, and Elko County, Nevada; stratigraphy of the Pilot Mountains, Box Elder and Tooele Counties, Utah, and Elko County, Nevada (abs.): Geol. Soc. America Spec. Paper 73, p. 27-28

The Lucin mining district is in the northern Pilot Range. Ore bodies are concentrated in two localities: Copper Mountains, where they occur along north-south faults in (Devonian) Guilmette Formation; and Tecoma Hill, where they occur along east-west and northeast fractures in (Ordovician) Fish Haven Dolomite, (Silurian) Laketown Dolomite, and Guilmette Formation. Major fault trends are pre-Late Tertiary, although Tecoma Hill east-west and northeast fissures are younger than Copper Mountain north-south faults. Intrusion of monzonite stock accompanied faulting, but its relationship to ore formation is uncertain.

Ores are replacement deposits and fracture fillings in favorable carbonate rock, particularly in lower massive limestone of Guilmette Formation. Sulfide ores which filled water-worn cavities have been largely oxidized. Extensive post-Late Tertiary erosion which accompanied uplift of Pilot Range exposed Guilmette and older formations to surface leaching and allowed supergene enrichment to occur.

Rocks originally believed to be Carboniferous range in age from Early Ordovician to Middle Permian. These revised ages are based on fossil zones, on sequence of position, and on lithologic and paleontologic correlation with Silver Island and Crater Island Mountains. *Abstract revised (B. C.)*

59. BODINE, MARC W., Jr., 1956, Alteration of Triassic sediments, Temple Mountain [Emery County], Utah: Columbia Univ. Ph. D. thesis.

_____ and P.F. Kerr, 1956, Hydrothermal dolomitization of sandstone, Temple Mountain, Utah (abs.): Geol. Soc. America Bull., v. 67, pt. 2, p. 1673-1674.

Dolomitization occurred as an alteration prelude to uranium mineralization at Temple Mountain, Utah, on the east flank of the San Rafael Swell. It formed replacement masses in the Wingate Sandstone (Moenave Formation) which in one place measure hundreds of feet across. The emplacement accompanied the formation of pipelike masses of downdropped strata described elsewhere as collapse features.

It is believed that the dolomite was deposited by upward-migrating solutions originating at depth which removed considerable quantities of calcite and dolomite from the Kaibab Limestone and Moenkopi Formation below and also caused argillic alteration. The removal was responsible for the formation of collapse features. The solutions, probably epithermal, underwent a gradual increase in pH upward, and in the higher strata dolomite was deposited and quartz removed.

The Wingate Sandstone is a medium-grained quartzose sandstone with a kaolinite matrix containing minor amounts of detrital potash feldspar. The dolomite forms nodules engulfing and including the kaolinite rather than replacing it. Later stages involve the replacement of the quartz within the nodules accompanied by dolomitic cementation of the rock. At the end there is almost complete replacement of the sandstone. A final stage involves the deposition of dolomite, ankerite and calcite in fractures and cavities. Al_2O_3/SiO_2, K_2O/SiO_2, and K_2O/Al_2O_3 ratios indicate that quartz is preferentially replaced before potash feldspar and kaolinite; kaolinite is the most resistant to replacement.

The occurrence is believed to illustrate dolomitization of detrital sediments by rising thermal solutions. *Published abstract*

60. BONAR, CHESTER M., 1948, Geology of the Ephraim area [Sanpete County], Utah: Ohio State Univ. M. S. thesis, 116 p., geol. map.

The area of study was Sanpete Valley and western edge of Wasatch Plateau, in Tps. 16 and 17 S., Rs. 3 and 4 E. The formations present are: North Horn (Upper Cretaceous-Paleocene); Flagstaff (Paleocene); Colton, Green River and Crazy Hollow Formations (Eocene). The North Horn is evenly bedded shale, sandstone and limestone, partly lacustrine. Flagstaff, exposed over most of the area, is chemically or bacterially precipitated white lacustrine limestone. The Physa zone can be correlated outside the area. Limestone of the Colton Formation crops out along the monocline's base and is composed of three zones. The lacustrine Green River Formation in the Sanpete Valley is dominantly limestone with some varicolored shales. The entire Colton Formation is chronologically equivalent to part of the Green River Formation. Lenticular sandstone deposits of the Crazy Hollow Formation are very restricted in occurrence.

Structurally the area represents a normally faulted monoclinal flexure -- the Wasatch monocline, formed between late Eocene and late Pliocene time. The strata dip consistently northwestward. Ten parallel, normal, gravitational faults striking north-northeast were probably post-monocline in formation, occurring as a result of readjustment to equilibrium by the monoclinal block. *B. Y. S.*

61. BORDINE, BURTON W., 1965, Paleoecologic implications of strontium, calcium and magnesium in Jurassic rocks near Thistle [Utah County], Utah: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 12, p. 91-120.

Strontium, calcium, magnesium, calcium carbonate and insoluble residue determinations were obtained from 75 analyses of micrite, calcareous shale, oolitic limestone, and siltstone from the Middle Jurassic Twin Creek Limestone. Sr/Ca-paleosalinity relationships suggest presence of nonmarine, marine, and hypersaline deposits within the formation. A zoned molluscan fauna occurs in beds with a high Ca/Mg ratio, and an insoluble residue averaging 8 percent, contrasted with 31 percent in adjoining beds. Deposition in water saturated with calcium carbonate is indicated in the high percentage of this compound throughout most of the section. Ripple marks, mud cracks, rain imprints and shoal water faunas suggest shallow water sedimentation throughout most of the lower 620 feet of the Twin Creek Limestone. *Author abstract*

62. BOTBOL, JOSEPH MOSES, 1961, Geochemical exploration for gilsonite: Univ. of Utah M. S. thesis, 42 p.

Gilsonite and ozokerite deposits of the Uinta Basin, Utah, were studied by collection of soil samples along traverses across productive veins: namely, Cowboy vein, Chepeta lode, Carbon lode, Rainbow vein, Pariette vein and Soldier Summit ozokerite deposit.

Three laboratory procedures were developed to separate gilsonite from the soil samples, all based on the specific gravities of gilsonite (1.04) and the soil fraction (about 2.0-2.6). In two, the gilsonite was floated, utilizing tetrabromoethane in benzene and carbon tetrachloride as heavy liquid media. In a third procedure, gilsonite was separated from the soil by panning. The gilsonite fraction was then weighed, and the gilsonite content of each sample was expressed as parts gilsonite per million parts of sample by weight. Precision of the procedures was determined by replicate analyses. Standard deviation of the derived result in the calculation for ppm gilsonite is plus or minus 16.6 percent.

Geochemical anomalies were disclosed over each vein. Background values ranged from 200 ppm to 1,000 ppm; anomalies ranged from 2,910 ppm to 264,000 ppm; and the contrast ranged from 16 to 545. Several anomalies were discerned at a distance from known veins. Gilsonite content and dispersion halos surrounding veins are due to weathering and erosion of gilsonite veins.

Abstract revised (B. C.)

63. BOWES, WILLIAM A., 1952, Distribution and thickness of phosphate ore zones in the Phosphoria Formation: Univ. of Utah M. S. thesis, 60 p.

Commercial phosphate rock occurs in three stratigraphically distinct units within the Phosphoria Formation. The three ore zones of at least 23 percent P_2O_5 are, in ascending order, the lower and upper Idaho (in southeastern Idaho) and the Montana (found in the Garrison-Philipsburg-Melrose areas of Montana).

Nine principal phosphate ore localities are listed in order of decreasing total thickness of 23 percent or better phosphate rock. The most favored areas for prospecting are thought to be: southeastern Idaho, Fort Hall, Idaho, Bear Lake, Idaho-Utah, Centennial Range, Montana-Idaho, western Wyoming, Vernal, Utah, Melrose-Kelly Gulch-Sheep Canyon, Montana, and Wind River Mountains, Wyoming.

In general, isopachs of the total thickness of the Phosphoria Formation indicate a north-trending shelf with a west-dipping slope. Two areas characterized by abrupt thickening and few phosphate deposits occur in southwestern Montana and near Morgan, Utah. Between them, the formation ranges from 350-400 feet thick and the greatest thickness of phosphate occurs in the vicinity of the main southeastern Idaho shelf.

Abstract revised (B. Y. S.)

64. BOYDEN, THOMAS A., 1951, Ground-water geology of Payson-Benjamin [Utah County], Utah: Brigham Young Univ. M. S. thesis.

_____ 1951, Ground-water geology of southern and western Utah Valley -- pt. 1, Southern Utah Valley: Compass, v. 29, No. 1, p. 10-15.

An area aggregating 70 square miles was investigated to determine the subsurface geology and the importance and extent of the various producing aquifers. Unconsolidated materials (fan gravels) of pre-Lake Bonneville Quaternary age and the sediments of Pleistocene Lake Bonneville form the main water-bearing aquifers throughout Utah Valley. These are recharged at outcrops around the periphery of the valley, at the base of the Wasatch Mountains.

Non flowing wells are present in the areas of the benches and fans, and are characterized by higher elevation, smaller amounts of ground water and lowered hydrostatic head. The water table exists

10 to 50 feet below the surface of the embankment. Best flows are at greater depths. Flowing wells exist in the valley lowlands. The water table exists within 10 feet of the surface, but best flows are obtained in wells drilled to depths of 150 to 500 feet. *Abstract of published article (B. C.)*

65. BRADLEY, WHITNEY ALLEN, 1952, Jurassic and pre-Mancos Cretaceous stratigraphy of the eastern Uinta Mountains, Colorado-Utah: Univ. of Colorado M. S. thesis, 74 p.

_____ 1955, Jurassic and pre-Mancos Cretaceous stratigraphy of the eastern Uinta Mountains, Utah-Colorado: Intermtn. Assoc. Petroleum Geologists Guidebook, 6th Ann. Field Conf., p. 21-26.

Eight stratigraphic sections of the units lying between the Triassic Chinle Formation and Cretaceous Mancos Formation were measured in an area of almost continuous exposure from Dinosaur National Monument headquarters, Utah, to Lily Park, Colorado. Units studied include (base to top) Jurassic Navajo, Carmel, Entrada, Curtis and Morrison Formations; Cretaceous (?) transition beds; and Cretaceous Dakota, Mowry and Frontier Formations.

Navajo and Entrada Formations are composed of clean, fine- to medium-grained quartz sandstones of eolian origin. They cannot be distinguished except by presence of Carmel Formation, which consists of reddish-brown siltstones, sandstones and shales. Carmel becomes more sandy and pinches out to east. Transitional Navajo-Carmel contact and conformable Carmel-Entrada contact indicates that the Carmel pinchout is depositional, and that eolian deposition was continuous east of the pinchout.

Interbedded Morrison-like and Dakota-like beds here called "transition beds" overlie the Morrison and are overlain by the Dakota. These interbedded terrestrial and marine sediments resulted from the oscillations of the Cretaceous sea which was advancing westward. Littoral deposition was interrupted locally by torrentially cross-bedded sandstones and conglomerates deposited by eastward-flowing streams. Marine conditions continued through Mancos deposition except for a period during Frontier deposition when the Uinta Mountains area was a swamp.

Abstract of published article (B. C.)

66. BRADLEY, WILMOT H., 1927, Origin and microfossils of the oil shale in the Green River Formation of Colorado and Utah: Yale Univ. Ph. D. thesis.

_____ 1931, Origin and microfossils of the oil shale of the Green River Formation of Colorado and Utah: U.S. Geol. Survey Prof. Paper 168, 58 p.

The Green River Formation is a series of lake beds of middle Eocene age. It occupies the Uinta Basin of northeastern Utah where it is underlain by Wasatch Formation and conformably overlain by Bridger Formation. East of Bitter Creek it is divided into four members, including the Parachute Creek, which contains most of the rich oil-shale beds. To the west the formation is not divided into members.

Beds of rich oil shale were formed under two contrasting sets of conditions. Persistent regular beds with thin laminae originated when Lake Uinta was relatively broad, deep, and thermally stratified, with organic ooze accumulating in the lower stagnant layer. Short lenticular beds, mud cracks and shale breccias indicate water was low and organic matter accumulated in isolated residual pools.

Calcite, dolomite, beidellite clay minerals, analcite, quartz, sanadine, orthoclase, plagioclase, muscovite, hornblende, pyroxene, zircon and apatite are present. Abundant pyrite indicates a strongly reducing medium analagous to modern fetid black organic lake oozes. Chemical analyses were made of two typical oil-shale beds.

Microfossils occur in chert concretions and rich oil shale. Massive organic material derived from partial putrefaction of aquatic organisms contains discrete organisms (resembling preservation in amber). Microfossils include bacteria (doubtful), fungi, spores, pollen, freshwater algae, rhizopods, insects and a mite.

Ancient Uinta Lake had an extraordinarily large area compared with its depth. At first it was large, shallow, stable and fresh. Later, and during most of its existence, it fluctuated considerably, having alternately an outlet and then none. When discharge was restricted, foodstuffs accumulated and water temperature rose, causing production of enormous quantities of minute organisms. When lake was deep, water became thermally stratified and varied deposits accumulated. In later stages, conditions were not as favorable for growth of organisms, and salt was repeatedly deposited at times in parts of the basin. *Published abstract revised (B. Y. S.)*

67. BRADY, MICHAEL J., 1965, Thrusting in the southern Wasatch Mountains [Utah County], Utah: Brigham Young Univ. (M. S. thesis), Geol. Studies, v. 12, p. 3-53.

Laramide deformation occured in at least two separate pulses. The first and least extensive was the result of compressional forces predominantly toward S. 21° E. Later major Laramide structures were formed by forces toward approximately N. 70° E. and were superimposed upon structures formed by southeastward compressional forces in the southern Wasatch area.

Stratigraphic sections at Santaquin Canyon in southern Wasatch Mountains are thinner but little different from those at Long Ridge and East Tintic Mountains to west, indicating that they are close to their relative positions at time of deposition. No evidence was found of major horizontal displacement between these sections. Mapping of Santaquin overthrust suggests they are in the upper plate of a major thrust displaced eastward a minimum of 7 miles.

The Santaquin overthrust projects southward toward and appears to be a northern extension of the Nebo overthrust.

Directional properties associated with the Red Point thrust on the north end of Dry Mountain indicate displacement toward S. 17° E. At the south end of West Mountain thrusting was probably toward N. 45°-70°E.

Mapping in Payson Canyon revealed a large fenster east of Maple Dell Scout Camp in Payson Canyon; erosion of Oquirrh Formation in upper plate exposed Cambrian and Mississippian of lower plate.

Abstract revised (B. C.)

68. BRANSON, CARL C., 1930, Paleontology and stratigraphy of the Phosphoria Formation: Univ. of Missouri Ph. D. thesis; Univ. of Missouri Studies, v. 5, No. 2, 99 p., 1930. (Abs.): Chicago Univ. Abs. theses, Sci. Ser., p. 211-217, 1931.

The Phosphoria is a marine formation of Upper Pennsylvanian and Lower Permian age which occurs in western Wyoming and adjacent parts of Colorado, Utah, Idaho, and Montana. Thickest deposits are in northeastern Utah and southeastern Idaho. The type locality is Phosphoria Gulch, near Meade Peak, Idaho.

In the Wind River and Owl Creek Mountains, Wyoming, the Phosphoria lies unconformably on the Tensleep Sandstone (Pennsylvanian) and is overlain by the Dinwoody Formation (Permian or Triassic). In Utah and Colorado the Phosphoria lies with probable unconformity upon the lower member of the Park City Formation, which in turn rests upon the Weber Quartzite. Above the Phosphoria, without apparent unconformity, is the Woodside Shale (probably Triassic).

The Phosphoria varies from west to east from a basal shale series containing thick beds of phosphate rock, and an overlying cherty limestone (Utah and western area) to a basal chert and limestone series with progressively poorer and thinner phosphate beds overlain by cherty shales and a massive bed of limestone (Wind River and Owl Creek Mountains).

The Phosphoria Formation exhibits an extensive vertical faunal variation, due in large part to faunal facies. Faunas of phosphate beds are unlike those of other beds. Sedimentation occurred over a long period of time, and the base contains a typically Pennsylvanian assemblage, succeeded by one containing both Pennsylvanian and Permian elements, and then by a true Permian fauna.

Systematic paleontology includes the following groups: Phylum Echinodermata, fragments; Class Bryozoa, 4 forms; Class Brachiopoda, 28 species (10 new) belonging to 17 genera; Class Pelecypoda, 24 species (14 new) belonging to 12 genera (1 new); Class Gastropoda, 14 species (7 new) belonging to 9 genera; Class Cephalopoda, 2 species (1 new) belonging to 2 genera; Class Pisces, 3 species, 1 belonging to a new genus.

Abstract of published article (B. C.)

69. BRIMHALL, WILLIS H., 1951, Stratigraphy and structural geology of the northern Deer Creek Reservoir area, Provo Canyon [Wasatch County], Utah: Univ. of Arizona M. S. thesis, 73 p.

The northern Deer Creek reservoir area is located in Wasatch County in the south central Wasatch Mountains. Sedimentary rocks exposed in the area are: Big Cottonwood Quartzite Series (Precambrian); Tintic Quartzite, Ophir Shale (Cambrian); Madison Limestone, Deseret Limestone, Humbug Formation, Great Blue Limestone, and lower half of the Manning Canyon Formation (Mississippian); upper half of the Manning Canyon Formation, Oquirrh Formation (Pennsylvanian); Woodside Shale, Thaynes Limestone, Ankareh Shale (Triassic); Nugget Sandstone and Twin Creek Formation (Jurassic).

The major structural features of the area are a thrust fault and a large anticlinal fold. In the south limb of the fold, 5,300 feet of Triassic and Jurassic sediments are folded and strike N. 45° E. The zone of the thrust fault strikes east-west and extends from Alpine Canyon through this area to Heber Valley. Great movement must have occurred along it before the deformation associated with intrusion of the Cottonwood stock. *B. Y. S.*

70. BRODSKY, HAROLD, 1960, The Mesaverde Group at Sunnyside [Carbon County], Utah: Univ. of Colorado M. S. thesis; U. S. Geol. Survey Rept., Open-file Ser., No. 595, 70 p.
(Abs.): Geoscience abs., v. 3, No. 3, p. 20, 1961.

The Mesaverde Group of Late Cretaceous age at Sunnyside consists, ascending, of Blackhawk Formation, Castlegate Sandstone, and Price River Formation. Massive, wedge-shaped, cut-and-fill structures characteristic of fluviatile deposits are found in the nonmarine Castlegate and Price River Formations. The Mancos Shale, which intertongues with the Blackhawk Formation, is characterized by thin, even bedding formed in an offshore, marine environment.

The Blackhawk Formation formed in a mixed marine and nonmarine environment. Primary structures found in marine tongues of Blackhawk are disrupted bedding with mottling, irregular and uneven bedding, and very thick bedding with cross-stratification resembling lower foreshore laminae. Particle size increases as shoreline deposits are approached. Coal beds are absent in marine, abundant in nonmarine beds of Blackhawk.

Economic coal beds within the Blackhawk are generally reported as "lower" and "upper" seams, but these may be splits of one major coal bed. The relationship of the splits and lithology of the coal indicate that the coal swamp existed on a low-lying coastal plain close to sea level where swamp accumulations were interrupted occasionally by fluviatile deposition.

Published abstract revised (B. Y. S. and B. C.)

71. BROOKE, JOHN P., 1959, Trace elements in pyrite from Bingham [Salt Lake County], Utah: Univ. of Utah M. S. thesis, 50 p.

Several pyrite chip samples were collected from two levels in the lower part of the Lark section of the U.S. and Lark mine. These samples were collected at 5-foot intervals away from a single ore shoot. They were studied spectrographically to determine their trace element content, and mineragraphically to determine their mineralogy, textures, and paragenesis.

Spectrochemical analyses were made with an A.R.L. 1.5 meter grating emission spectrograph. The spectograms were analyzed on an A.R.L. projection comparator densitometer. Using suitable iron lines as internal standards, the logarithm of intensity ratios of Cu, Pb, Ag, In and Rh to Fe were recorded.

On level "A" silver, copper and lead decrease in abundance toward the orebody, while on level "B" silver, lead and copper increase in abundance toward the ore body. Both indium and rhodium increase slightly as the ore body is approached on each level.

Polished surfaces were prepared of pyrite aggregates mounted in bakelite. These were analyzed microscopically. Minerals in the polished surfaces included the following, which are listed in their order of deposition: pyrite, chalcopyrite, sphalerite and galena. *Author abstract*

72. BROOKE, JOHN P., 1964, Alteration and trace elements of volcanics in the San Francisco Mountains [Beaver County]: Univ. of Utah Ph. D. thesis, 50 p.
(Abs.): Dissert. Abs., v. 25, No. 4, p. 2440-2441, 1964.

Field and laboratory studies were made of the alteration of the Squaw Peak, West White Mountain and East White Mountain areas near and south of the Horn Silver mine, San Francisco Mountains.

About 15 different alteration minerals were present (in the 3 areas and in the mine), including a suite of argillic minerals (mainly kaolinite and silica) and a suite of iron minerals (mainly hematite). They are distributed geometrically in discrete zones. The argillic minerals are zoned from most intense to least intense alteration as follows: silica reefs, mixed kaolinite and alunite, chlorite and montmorillonite, and unaltered rock. The second type of zoning consists of dense hematite staining that grades into light staining.

Trace element content of the rock samples was determined by both X-ray spectrograph and emission spectrochemical techniques as follows: copper, 30 ppm; zinc, 66 ppm; lead, 6-35 ppm; and arsenic, 13 ppm. The two series of determinations are closely comparable.

Means of Cu, Pb, Zn, and As were analyzed statistically to show the existence of one or more trace element populations. Trace copper values of the four areas belong to a single population. Trace lead values of the West White Mountain area belong to one population while those from the other three areas belong within another population. The zinc values of the Horn Silver mine are in a different population than the zinc values of samples from other areas. The arsenic values of samples from the Horn Silver mine and East White Mountain areas belong to a single population and the values of the samples from the other areas belong to different populations.

Abstract revised (B. Y. S.)

73. BROOKS, JAMES ELWOOD, 1954, Regional Devonian stratigraphy in central and western Utah: Univ. of Washington Ph. D. thesis, 193 p.
(Abs.): Dissert. Abs., v. 15, No. 2, p. 252, 1955.

_____ 1954, Regional Devonian stratigraphy in the northeast part of the Great Basin (abs.): Geol. Soc. America Bull., v. 65, No. 12, pt. 2, p. 1234.

A study of regional Devonian relationships throughout central and western Utah and adjacent areas of Idaho, Wyoming and Nevada leads to unification and simplification of the existing diverse rock unit nomenclature and the determination of the valid limits of applicability of established formation names. Regional relationships of the Devonian stratigraphy are examined by means of isopach and lithofacies maps.

For purposes of this study the Devonian sequence is arbitrarily divided into three operational lithic intervals which are established on the basis of criteria recognizable throughout the region. Each interval is examined in terms of sediment distribution and depositional environment. Tectonic environment is inferred from thickness and gross lithologic aspect. The three lithic intervals are, in ascending order, the Sevy, the Jefferson and the Three Forks. The Sevy represents predominantly restricted basinal conditions with the ensuing deposition of primary dolomites. The Jefferson sediments are principally normal marine carbonates and indicate sedimentation in basins and on unstable shelves under essentially open ocean conditions. The Three Forks is composed of calcareous shales and, on the stable shelf, of normal marine limestones. The increased clastic content of the Three Forks interval is interpreted as indicative of increased positive tectonism in the source areas. Finally, the three intervals are integrated in an isopach-lithofacies map of the total Devonian sequence. This map, with its supporting data, indicates that the deposition of the Devonian sequence in the area of study was controlled by two tectonic environments -- the stable shelf to the east and south and, peripheral to this, on the west and north, the miogeosyncline. Several subsidiary basins and swells are recognized within the miogeosyncline. The record demonstrates the existence of a complete Devonian section in at least one of these basins and evidence is ample to indicate the transgression of Devonian seas eastward and northward from this basin into the remainder of the miogeosynclinal area and, ultimately, onto the stable shelf. *Author abstract*

74. BROPHY, GERALD P., 1953, Geology and hydrothermal alteration: Papsy's Hope prospect, Marysvale [Piute County], Utah: Columbia Univ. M. A. thesis, 29 p.

_____ and P.F. Kerr, 1951, Preliminary memorandum, Papsy's Hope prospect, Marysvale, Utah: U.S. Atomic Energy Commission, RMO-833, 11 p., lacks sections on alteration and mineralization.

The Tertiary volcanic rocks consist of an earlier group of latitic breccias, tuffs, and flows, called the Bullion Canyon Volcanic Series, and a later group of rhyolites, quartz latites, latites, and tuffs, called the Mount Belknap Volcanic Series. The Bullion Canyon Series is divided into six units, only one of which shows evidence of uranium mineralization in surface exposures.

Two systems of faulting have displaced the entire rock sequence, an earlier pre-Belknap system of normal faults associated with the alteration and mineralization, and a later post-Belknap system which offsets the mineralized and altered zones.

Hydrothermal alteration of the porphyritic andesite (Bullion Canyon Series) has produced a distinctive sequence of mineralogic changes. The path of ascending solutions has been controlled by fractures trending N-S and N 30°-45° W. The distribution of uranium minerals is controlled by the stage of rock alteration, and is disseminated rather than veined. The uranium mineralization is considered at this prospect to be derived from ascending solutions associated with the rock alteration. *B. C.*

75. BROPHY, GERALD P., 1954, Hydrothermal alteration and uranium mineralization in the Silica Hills area, Marysvale district [Piute County], Utah: Columbia Univ. Ph. D. thesis, 204 p.
(Abs.): Dissert. Abs., v. 14, No. 8, p. 1198, 1954.

Tertiary volcanic rocks in the vicinity of Marysvale, Utah are divided into two major groups -- the Bullion Canyon (older) Series, composed mostly of latites and andesites, and the Mount Belknap (younger) Series of rhyolite and rhyolitic tuffs. The Bullion Canyon rocks are intruded by quartz monzonite and granite.

All the volcanic rocks are altered hydrothermally, but the rhyolites show the least effects. Associated with part of the hydrothermal alteration is uranium mineralization, both as vein and disseminated deposits.

Six alteration types are discernable: calcification, zeolitization, alunitization, argillitization, sericitization, and silicification. These can be divided into two major periods of alteration: alunitic and argillic. The younger alunitic alteration is associated only with rocks of Bullion Canyon age, and may represent emanations from more basic magma. Argillic alteration is associated with all rock types.

The uranium bearing solutions, rich in fluorine, are later than most of the argillic alteration and sulphides in the Freedom #2 mine. Quartz monzonite, abnormally high in calcium, has proven to be the most favorable host rock, and rhyolite the least.

One new mineral species, a hydrous uranium molybdate named Umohoite, has been described from the the Freedom #2 mine.

The deposits, on the basis of the $Pb^{206}U^{238}$ ratio, are found to be $9.8 \times 10^6 \pm 1.2 \times 10^6$ years. *Published abstract*

76. BROWN, RALPH SHERMAN, 1950, Geology of the Payson Canyon-Piccayune Canyon area, southern Wasatch Mountains [Utah County], Utah: Brigham Young Univ. M. S. thesis.

_____ 1952, Geology of the Payson Canyon area, southern Wasatch Mountains, Utah: Compass, v. 29, No. 4, p. 331-349.

The mapped area includes approximately 4 square miles and consists of the northern prong of the southern Wasatch Mountains which projects into Utah Valley. Sedimentary rocks of the area in and adjacent to Payson Canyon, and Piccayune Canyon to the south, aggregate at least 7,000 feet in thickness, and contain 13 mappable bedrock formations: 7 Cambrian, 3 Mississippian, 1 Upper Mississippian and Lower Pennsylvanian, 1 Pennsylvanian, and 1 Tertiary. In addition, pre-Lake Bonneville and Lake Bonneville unconsolidated sediments are present around the prong-like northern extension of the range. Major unconformities occur at the base of the Cambrian, the base of the Mississippian, and at the base of the Tertiary.

The strata have been thrown into a series of open to tight folds, and have been thrust to the east and later to the south and southeast by paroxysms of the early and late Laramide orogeny. Normal faulting of the Basin-and-Range type has given the area much of its present relief.

From published introduction

77. BROX, GEORGE STANLEY, 1961, The geology and erosional development of northern Bryce Canyon National Park [Garfield County]: Univ. of Utah M. S. thesis, 77 p., geol. map.

The results of a detailed mapping and laboratory study of northern Bryce Canyon National Park indicate that the main erosional trends are controlled to a large extent by the joint system within the Wasatch Formation. Composition of the individual beds indicates that the vertical variation in hardness of the beds is the result of the relative amounts of carbonate and silt and clay. The more resistant beds have predominant amounts of carbonate, while the softer beds have a preponderance of silt and clay. It is thought that this relationship is a direct result of the near-arid climate of the region and reflects the dominance of mechanical weathering, rather than chemical weathering, in the sculpture of Bryce Canyon. *Abstract revised (B. Y. S.)*

78. BRYAN, G. GREGORY, 1935, Mineragraphy and paragenesis of the ore of the Park City Consolidated Mine, Park City, Utah: Univ. of Utah M. S. thesis.

_____ and A.L. Crawford, 1936, Mineragraphy and paragenesis of the Park City Consolidated Mine, Park City, Utah (abs): Utah Acad. Sci. Proc., v. 13, p. 93.

The Park City Consolidated Mine is a rather high-grade fissure deposit of the "Ontario" type. The country rock consists of a fine-grained quartzite, in which some pyritization and sericitization has taken place. It is cut by altered igneous dikes containing sericitc pseudomorphs after hornblende set in a devitrified groundmass.

The oldest of the vein sulfides is pyrite, which occurs as euhedral pyritohedrons. Beginning near the end of, and continuing after, pyrite deposition is sphalerite, the most abundant sulfide mineral. Chalcopyrite occurs as "pin points" in sphalerite with which it is probably contemporaneous. Quartz and manganodolomite both come in as early gangue minerals and probably continue on through the entire period of hypogene sulfide mineralization. The earliest quartz occurs as concentrically zoned euhedral crystals up to 1 mm. in diameter.

Following the end of the sphalerite deposition, a series of complex copper, lead, silver, antimony sulfo-salts were precipitated, in the following order: tetrahedrite, bournonite, galena, boulangerite (?), "ruby silver," and an unidentified "needle" mineral. The latter two appear to be the chief sources of the primary silver. After the close of primary mineralization, movement, accompanied by shearing and brecciation, took place.

The first of the secondary minerals are calcite and quartz which cement the brecciated material and replace most of the earlier minerals in small veinlets. Secondary sulfides are covellite, bornite, and argentite. The latter occurs in some abundance, at least locally, as a replacement of galena.

From published abstract

79. BUDGE, DAVID R., 1966, Stratigraphy of the Laketown Dolostone, north central Utah: Utah State Univ. M. S. thesis, 86 p.

Field evidence and measured sections in Logan Canyon, Laketown Canyon, the East Fork of Laketown Canyon, at Tony Grove Lake, in Blacksmith Fork Canyon, at Portage, and Four Mile Canyon, north-central Utah, show that the formation is divisible into four members. Member A consists of interbedded light-gray and dark-gray, very finely crystalline dolostone which is thin to very thick bedded and laminated in part, with an average thickness of 300 feet. Member B is composed of medium light-gray to grayish-black, very finely crystalline dolostone which ranges from thin to very thick bedded. Some parts are laminated and others contain intraformational conglomerate. This member averages 600 feet in thickness. Member C is a light-gray to medium-gray, medium-crystalline dolostone that is medium to very thick bedded, partly laminated and lenticular, and averages 350 feet thick. Member D is a dark-gray, very finely crystalline dolostone, thick to very thick bedded and with an average thickness of 200 feet.

Invertebrate fossils indicate that the lowest member is probably of Late Ordovician age. The three upper members are considered to be of Early Silurian, or Middle Llandovery C_1-C_2 age (based on brachiopods). *From author (Stratigraphy)*

80. BULLOCK, KENNETH C., 1942, A study of the geology of the Timpanogos Caves [Utah County], Utah: Brigham Young Univ. M. S. thesis.

_____ 1944 (?) Origin of the Timpanogos caves (abs.): Utah Acad. Sci. Proc. 1941-43, v. 19-20, p. 18-19.

Three caves have been developed in the Mississippian Madison Limestone on the northern slopes of Mount Timpanogos. The fault which developed into the Timpanogos cave fissure strikes N. 40° E. and dips 45° N.; the fault which developed into the Middle and Hansen caves strikes N. 55° E. and dips 75°. Excavation has taken place by solution, by removal of fault gouge and breccia and by corrosion, and is due chiefly to action of surface streams which are tributary to American Fork Creek.

Clay and silt deposits as much as 8 feet deep are exposed in one-third of Timpanogos cave. A few restricted pockets of siliceous stream pebbles up to 3-4 inches in diameter are found in the caves. The most important deposits are travertine deposits, precipitation of which is due largely to free circulation of air which allows rapid evaporation. Water which seeps through rocks may be caught in fissures of decreasing size where it is retarded and compressed. It becomes highly concentrated with calcite dissolved from the walls. Release of pressure upon entrance into cave causes liberation of carbon dioxide and precipitation of calcium carbonate. Precipitation is also caused by agitation of cave water. *Published abstract revised (B. C.)*

81. BULLOCK, KENNETH C., 1949, Geomorphology of Lake Mountain [Utah County], Utah: Univ. of Wisconsin Ph. D. thesis.

_____ 1951, Geology of Lake Mountain, Utah: Utah Geol. and Mineralog. Survey Bull. 41, 46 p., geol. map.

Lake Mountain, in eastern Basin and Range Province, is a partially crescent-shaped, north-south-trending range about 15 miles long with maximum width 7 miles and maximum elevation 7,658 feet. Landform groups include mountain and hill masses, the latter exemplified by Cedar Valley, Pelican, Beverly and Lake Hills; pediments; bajadas and fans; and Lake Bonneville landforms.

Lake Mountain is a broad syncline (Lake Mountain syncline) outlined by Tertiary Basin-Range faulting. Thrust faulting, with forces coming from the west, occurred in Cedar Valley, Pelican and Beverly Hills areas. The southward-tilted block which comprises Lake Mountain has been inactive tectonically since Middle or Late Tertiary. Pre-block fault topography occurs in the summit area, 7 miles long by 2 miles wide.

Pediment development is unusual, being on a sedimentary series. Trough-shaped pediments, likely to be produced from soft, friable rocks, have developed by rill wash and weathering. Fan-shaped pediments, likely to be produced from harder, less friable rocks, have developed by lateral stream planation.

Longitudinal profiles of pediments and fans demonstrate mathematical control of slope development. The constant used in logarithmic plotting of pediment slopes varies with hardness of bedrock. Decrease in pebble size downslope is due to selective transport and pebble wear, and results from decreasing stream competency with lowered gradient.

At least 12,000 feet of strata are exposed, including Deseret Limestone, Humbug Formation and Great Blue Limestone (Mississippian); Manning Canyon Shale (Mississippian-Pennsylvanian); Oquirrh Formation (Pennsylvanian); and Quaternary deposits. Late Eocene-Oligocene volcanic rocks are present in Beverly and Lake Hills.

Geomorphic development of Lake Mountain was: (1) late Mesozoic-Early Tertiary folding and thrusting, (2) development of a mature pre-block fault erosion surface, (3) Middle Tertiary block faulting, and (4) Late Tertiary-Miocene erosion and pedimentation.

B. Y. S. (abstract based in part on author conclusion)

82. BULLÒCK, LADELL R., 1965, Paleoecology of the Twin Creek Limestone in the Thistle [Utah County], Utah area: Brigham Young Univ. (M. S. thesis), Geol. Studies, v. 12, p. 121-147.

The lower 644 feet of Middle and Upper Jurassic Twin Creek Formation contains a variety of calcareous sediments. Six distinct facies are recognizable. Interfingering of eastern shelf and western marginal miogeosynclinal sedimentation along an oscillating shore zone resulted in recurring sequences which represent complete regressive-transgressive cycles. A cycle contains, from base up: paper shale and siltstone facies, redbed facies, oolitic limestone facies and micrite facies. These represent the following environments, respectively: subsiding seas, sub-aerial conditions, transgressing seas and submergence to below wave base. Other facies are represented by a 15-foot calcareous clay bed and a 16.5-foot brecciated limestone unit.

The eastern source of terrigenous debris was probably a low-lying nearly stable shelf that shed only a limited amount of fine clastics into the geosynclinal margin. Most of the sediment consists of chemically precipitated calcium carbonate. The sea was warm, varying from normally saline to hypersaline, saturated with calcium carbonate, shallow, often turbid and agitated. The bottom was unconsolidated and at times shifting. Conditions were generally unfavorable for plant and animal life during most of Twin Creek time. Fossil remains are found, however, in oolite beds and in hashy stringers in the micrite facies.

Abstract revised (B. C.)

83. BULLOCK, NEDRA D., 1940, A summary of the Pennsylvanian sedimentation of Utah: Univ. of Utah M. A. thesis, 51 p.

Deposits of Pennsylvanian age in Utah vary in thickness from 240 feet (Iron Springs district, southwestern Utah) to over 18,000 feet (Oquirrh Mountains). Eighteen hundred feet of Pennsylvanian limestone, sandstone and shale are generally present in southeastern Utah. The two main Utah basins of sedimentation during Pennsylvanian were in northeastern Utah in the area now occupied by the Weber Formation (sandstone) and in the area of the present southern Wasatch Mountains, Oquirrh Mountains and Gold Hill district. The Pennsylvanian formations lens out north of Ogden Canyon in the Wasatch Mountains, indicating that a small positive area probably existed there. Variability of sedimentation during Pennsylvanian was due to crustal deformation or local oscillating conditions which preceded Permian orogenic movements. One of the greatest thicknesses of Pennsylvanian sedimentation of North America is reported in Utah.

Abstract revised (B. Y. S.)

84. BULLOCK, REUBEN LYNN, 1958, The geology of the Lehi quadrangle [Utah and Salt Lake Counties], Utah: Brigham Young Univ. (M. S. thesis), Research Studies, Geol. Ser., v. 5, No. 3, 60 p., geol. map.

The East Traverse Mountains and adjoining parts of the Wasatch Range were mapped for this report, which also includes material compiled from previous work. The bulk of the sedimentary sequence consists of the Oquirrh Formation (Atokan-Desmoinesian), a thick miogeosynclinal orthoquartzite about 5,000 (?) feet thick, which has been thrust eastward into contact with a thin shelf section.

A series of Tertiary andesite flow rocks crop out in a narrow belt in the center of the East Traverse Range; faulted and fissured areas are hydrothermally altered to jasperoid or are kaolinized; pebble dikes are also present. The volcanics are in fault contact with the late Eocene Cottonwood quartz-monzonite stock. A mylonite zone on the south and southwest margins of the stock suggests post-intrusive thrusting.

The East Traverse Mountains are considered a fault block spur resulting from Basin-and-Range faults which locally were most pronounced during late Pliocene to recent time. Most of the relief of the present topography was developed prior to Wisconsin time. The spur is bounded on the north and east by the Wasatch fault which locally expresses possibly 5,000 feet of throw, minor faults transect and flank the spur, internal minor adjustments are numerous.

From author abstract

85. BURGE, DONALD LOCKWOOD, 1959, Intrusive and metamorphic rocks of the Silver Lake Flat area, American Fork Canyon [Utah County], Utah: Brigham Young Univ. (M. S. thesis), Research Studies, Geol. Ser., v. 6, No. 7, 48 p.

This report concerns metamorphism of the thin mantle of Mississippian limestones overlying the Little Cottonwood stock on the southern slope of the divide between American Fork and Little Cottonwood Canyons. The limestones were divided into 4 zones with increasing metamorphism: (zone 1) unmetamorphosed dark gray slightly dolomitic limestone, (zone 2) representing a simple rearrangement of elements, dark gray to black amphibolic limestone containing abundant graphite, diagnostic minerals predominantly of the double chain inosilicate structure, (zone 3) strongly altered metasomatically, white to light gray siliceous limestone with wollastonite, diopside, and idocrase, diagnostic minerals predominantly of the single chain inosilicate structure, and (zone 4) abundant brown garnet with lesser amounts olivine, epidoite, zoisite, serpentine, and microcline, of independent tetrahedral orthosilicate structure.

The most frequent orientation of the axes of the prismatic amphiboles of zone 2 occurs at right angles to the strike of the bedding and was probably caused by slippage along the bedding planes due to compressive stresses during intrusion. The less common orientation of axes parallel to the strike of bedding is probably due to secondary slippage produced by tensional stresses. Moderate amounts of lead, zinc and silver were formerly mined from fissures in the Tintic Quartzite.

Abstract revised (B. Y. S.)

86. BURGER, JOHN ALLEN, 1959, Mesaverde Group in adjoining areas of Utah, Colorado and Wyoming: Yale Univ. Ph. D. thesis.
(Abs.): Am. Assoc. Petroleum Geologists Bull., v. 44, No. 6, p. 954, 1960.

The mixed marine and nonmarine Mesaverde Group (Late Cretaceous) overlies and intertongues with the marine Mancos Shale or its equivalents, and underlies continental strata of latest Cretaceous or Paleocene age. Numerous minor transgressions and regressions of the sea are imposed on a general eastward regression during Mesaverde time followed by a major transgression during Lewis time and a complete withdrawal of the sea after Lewis time.

Stratigraphic units in 7 geographic subdivisions were described and related in terms of "genetic units" to a standard 4-fold section in the rock Springs uplift consisting (ascending) of Blair, Rock Springs, Ericson and Almond Formations. Isopach maps show that basins and relative arches of Late Cretaceous time correspond fairly well with those of Tertiary, and that the maximum thickness of a genetic unit is at the zone of transition from continental to marine sedimentation. There are numerous cyclothems consisting of gray marine shale, tan marine siltstone and sandstone, gray and white beach sandstone, coal, brown carbonaceous shale, and gray to brown carbonaceous siltstone. Two probable controls of intertonguing are: (1) intermittent delivery of sand and mud by streams along a subsiding delta front and reworking by marine currents, (2) several rather rapid changes of sealevel or landlevel, either tectonic or eustatic. Most sediments derived from areas west of the "Wasatch line." Local uplifts in the site of present Uinta Mountains and possibly Wind River Mountains provided a source toward close of Mesaverde sedimentation. Fossil faunas are useful as indicators of paleoenvironments but not for stratigraphic correlations.

No new formation names are proposed. In western Colorado and eastern Utah the Lazeart Sandstone is considered of formational rank while the Rimrock and Asphalt Ridge Sandstones are considered members of the Iles Formation.

Published abstract revised (B. Y. S. and B. C.)

87. BURNHAM, C. WAYNE, 1955, Metallogenic provinces of the southwestern United States and northern Mexico: California Inst. Technology Ph. D. thesis, 180 p.

Some of the metallogenic provinces of the southwestern United States and northern Mexico are defined by the geographic distribution of trace elements in the primary sulfide minerals chalcopyrite and sphalertie. The elements investigated include antimony, arsenic, bismuth, cadmium, cobalt, gallium, germanium, indium, manganese, molybdenum, nickel, silver, tellurium, thallium, and tin. Of these elements, cobalt, gallium, germanium, indium, nickel, silver, and tin exhibit the best defined geographic distribution.

Maps of the geographic distribution of trace elements in chalcopyrite and sphalerite exhibit three main belts of greater than average trace element content, which are called the Eastern, Central, and Western belts. These belts are consistent in trend and position with a beltlike distribution of copper, gold, lead, zinc, silver, and tungsten deposits and with most of the major tectonic features. However, there appear to be no definite time relationships, for as many as four metallogenic epochs, from Precambrian to late Tertiary, are represented by ore deposits within the Central belt.

The evidence suggests that the beltlike features have a deep seated origin, perhaps in the sub-crust or outer parts of the mantle, and that the deposits within each belt might be genetically related through a beltlike compositional heterogeneity in the source regions of the ores. Hence, the belts are regarded as metallogenic provinces. *From author abstract*

88. BUSS, FRED EARLE, 1924, Physiography of the southern Wasatch Mountains and adjacent valley lands, with especial reference to the origin of topographic forms: Stanford Univ. M. A. thesis, 87 p.

The southern Wasatch Mountains are an area 55 miles long and 5-6 miles wide in north central Utah, eastern Utah and Juab Counties. Paleozoic sedimentary rocks are exposed.

Physiographic form of any area is the product of structure, processes at work, and physiographic stage. Early Jurassic folding; thrust faulting; and normal faulting are all prominent. The area is a synclinorium with northeast-southwest axis; anticlines plunge northeast sharply. Movement began in early Eocene and continued intermittently to present along a series of 3 major parallel normal faults. These structural features have determined the outline of the range and positions of valleys. Dominant erosional agents are streams; glaciers were also active. Miscellaneous erosional agents are not important. The southern Wasatch generally are in the late youth-early maturity physiographic stage, but the stage is older between Hobble Creek and Spanish Fork River.

This area received a great series of sediments from Lower Cambrian through Mississippian. Uplift occurred in Permian; northeast-southwest folding in Jurassic; erosion in Cretaceous; uplift again before lower Eocene and yet again along north-south normal faults in mid-Eocene, and has been renewed intermittently since. Glaciation occurred in Pleistocene. *B. Y. S.*

89. BUSS, WALTER R., 1933, A preliminary study of the physiographic types of Utah: Brigham Young Univ. M. S. thesis.

_____ 1933, A progress report on a study of the physiographic types of Utah (abs.): Utah Acad. Sci. Proc., v. 10, p. 47.

The physiography of Utah is not too well known, partly because publication and manuscript studies dealing with this are widely scattered in the literature, and partly because in many areas, only reconnaissance work has been done. The present study is only preliminary and is an attempt to compile the basic information about the state of Utah with emphasis on the Colorado Plateau physiographic province. This present study also includes a bibliography of references dealing with the physiography of the state, which is reasonably complete.

From author letter

90. CADIGAN, ROBERT ALLEN, 1952, The correlation of the Jurassic Bluff and Junction Creek Sandstones in southeastern Utah and southwestern Colorado: Pennsylvania State Univ. M. S. thesis, 163 p.

_____ 1954, Correlative units in the San Rafael Group on the Colorado Plateau (abs.): Geol. Soc. America Bull., v. 65, No. 12, pt. 2, p. 1237-1238.

Correlation of Jurassic Bluff and Junction Creek Sandstones and associated strata of upper San Rafael Group on Colorado Plateau is based mainly upon detailed study of 16 measured sections and upon regional reconnaissance. These units, and any correlative strata lying between the top of the Entrada Sandstone and the base of the Salt Wash Sandstone are subject regionally to abrupt lateral facies changes, but the stratigraphic interval which they occupy is equivalent in continuity with the Entrada and the Morrison.

Junction Creek Sandstone in southwestern Colorado lies below Salt Wash Sandstone Member of Morrison Formation. Near Durango it is underlain by Wanakah Marl, Bilk Creek Sandstone and Pony Express Limestone Members of the Morrison. This sequence overlies Entrada Sandstone. Sixty miles west of Durango, Junction Creek Sandstone is underlain by beds comparable to Moab Tongue Sandstone beds seen in southeastern Utah below the Bluff. The Wanakah Marl resembles lower Summerville of of southeastern Utah, parts of which underlie and intertongue with the Bluff.

Bluff and Junction Creek are considered to be same unit because of their areal continuity, similar stratigraphic position, division of both into 4-part sequence based on sedimentary structures, similar appearance of outcrop, similar thickness, and their respective disconformable relationships with overlying Salt Wash Sandstone.

Abstract revised (B. C.)

91. CALDERWOOD, KEITH W., 1951, Geology of the Cedar Valley Hills area [Utah County], Utah: Brigham Young Univ. M. S. thesis.

_____ 1951, Geology of the Cedar Valley Hills area, Lake Mountain, Utah: Compass, v. 29, No. 1, p. 21-32, geol. map.

An area of about 6 miles was mapped near the eastern margin of the Basin and Range Province. The upper Paleozoic stratigraphic sequence aggregates 8,066 feet thick and is divided into seven formations: Pinyon Peak Limestone (Devonian); Gardner Dolomite, Pine Canyon Limestone, Humbug Formation and Great Blue Limestone (Mississippian); Manning Canyon Shale (Upper Mississippian and Lower Pennsylvanian); Oquirrh Formation (Pennsylvanian). The most prominent structural feature of the general area is the Lake Mountain syncline. The most important faults in the area are thrusts; most of the folds appear to be genetically related to the thrusts, which are Laramide in age.

Abstract of published article (B. C.)

92. CARDONE, A. T., 1966, A statistical forecasting of engineering properties and compression index of soils, Salt Lake City, Utah: Univ. of Utah M. S. thesis, 81 p.

As construction upon compressible soils results in settlement from consolidation, amount of settlement that a structure will experience must generally be calculated. This thesis examines a method of predicting compression index without the usual lengthy and expensive laboratory consolidation test. Soil samples from points along the proposed interstate highway in Salt Lake City, Utah, were analyzed to determine compression index, moisture content, liquid limit, and void ratio. These soil engineering properties were programmed for a statistical correlation and multiple regression analysis to determine if a reliable correlation exists between the compression index and the other properties.

Graphic presentation of frequency distribution of engineering properties for all samples showed a skewed normal population distribution. A high degree of correlation exists between compression index and void ratio, compression index and moisture content, and to some extent compression index and liquid limit. Addition of liquid limit in multiple regression with either void ratio or moisture content improved the coefficient of correlation less than 10 percent. Upper 100+ feet of Salt Lake City soils have characteristics similar to the glacial clays of Boston, Detroit, Chicago and Canada. There is no significant lateral variation of soil properties in Salt Lake City.

Introduction and conclusions revised (B. C.)

93. CARGO, DAVID NIELS, 1966, Polygonal strain systems in the Cordilleran foreland, western United States: Univ. of Utah Ph. D. thesis, 138 p.
(Abs.): Dissert. Abs., sec. B, v. 27, No. 4, p. 1183B, 1966.

The major Laramide structures of the Cordilleran foreland of the western interior of the United States include polygonal shaped basins and uplifts with polygonal patterns. The individual units of the polygonal system include linear, biaxial, triaxial, sinuous, and orthogonal elements.

The theory of polygonal deformation states that deformation of an infinite, homogenous, tabular shaped body under isotropic stress results in the development in the body of a polygonal to reticulate strain system. No restriction is placed on the nature of the stress, which may be either compressional or tensile; the same patterns form in either case. The ideal strain system consists of hexagons, but the ideal system may not form if the tabular body has inhomogeneities of composition and structure. Yielding begins at or along randomly spaced points or zones of weakness and continues along linear, biradial, triradial, sinuous, or other trends. Eventually the zones of deformation become interconnected to form a polygonal to reticulate strain system.

The crust of the Cordilleran foreland is considered to act as an essentially infinite, tabular body. It is suggested that generally isotropic tangential stresses in the upper mantle and crust may have caused polygonal failure of the crust. Differential vertical uplift was an important process in the formation of the Laramide structural patterns. A network of uplifts, arranged mostly in biaxial or triaxial patterns, separates polygonal shaped basins. Because of inhomogeneities in the crust and differences in the intensity of the deforming stress, the theoretical patterns have attained various stages of development. Broad, gentle uplifts and approximately circular basins which are outlined by poorly defined structural trends are considered to have formed under less intense stress than high, elongate uplifts and distinctly polygonal basins separated by definite fold and fault border elements.

From author abstract

94. CARNAHAN, THOMAS S., 1905, The development of the Little Bell Mine, Park City, Utah: Columbia Univ. M. A. thesis, 93 p.

Little Bell Mine is in the Park City mining district, north central Utah. The area is badly folded and faulted. Several thousand feet of sedimentary rock are present. Igneous intrusive fine-grained diorite and coarse-grained porphyry played a very important part in determining extent and formation of ore bodies. Main trend of fissuring is northeast-southwest; dips, northwest-southwest. In order of importance are: silver (in galena and tetrahedrite), lead (galena and cerrusite or angelsite), copper (tetrahedrite and copper pyrite), gold (associated with pyrite), and zinc (almost universally present). The large all-pay ore bodies may be classed as true fissure veins; elongated lenses within limestone, parallel to bedding; or irregular pockets at contact of metamorphic limestone with quartzite.

The author's detailed descriptions of the mine should appeal to those interested in the history of the district or of early mining operations. *B. Y. S.*

95. CHAPMAN, JOHN S., 1958, Conodonts from the Manticoceras zone (Devonian), Confusion Range, Millard County, Utah: Univ. of Kansas M. S. thesis, 53 p.

A well preserved and abundant conodont fauna has been found in association with Manticoceras sp. in the Guilmette Formation in the Confusion Range, Millard County, Utah. The greater number of specimens are referable to the genera Palmatolepis and Polygnathus. The genera Nothognathella, Ancyrodella, Andyrognathus, and Icriodus, which are typically Devonian, are also well represented. One new genus, Mehlognathus, and 15 new species are described. The conodonts indicate that the upper part of the Guilmette Formation is early Late Devonian in age and correlates with parts of several other Upper Devonian formations in the United States. It also correlates with the middle and upper parts of the Adorf Stufe in Europe. It is believed that this fauna provides a basis for further lower Upper Devonian correlations in the Great Basin area.

Author abstract

96. CHILDS, ORLO E., 1938, A physiographic study of Morgan Valley [Morgan County], Utah: Univ. of Utah M. S. thesis, 42 p.

This paper describes the probable physiographic history of Morgan Valley, Utah. This valley parallels the Weber River behind the main part of the Wasatch Range. After Laramide folding but before Eocene deposition Morgan Peak was upfaulted, forming an ancestral depression draining southward, at the present sites of Ogden and Morgan Valleys, between the western highland and eastern fault block. Eocene deposition filled this southern part of the valley with sands and gravels; drainage became northward with eastern outlets.

Oligocene and early Miocene erosion cut the old valley out of soft Wasatch beds. The Ogden and Weber Rivers cut mature canyons through the western ridge. Miocene regional uplift and block faulting raised the eastern region into which Morgan Valley had drained. Therefore a Pliocene lake, probably tapped through Ogden Canyon, extended over the present Morgan and Ogden Valleys.

Pliocene synclinal folding followed; a broad valley floor developed at 5,950 foot elevation. Downfaulting to the west caused entrenchment of the streams, which cut deeply into soft sediments and left a low-lying ridge which now divides the Ogden and Morgan Valleys. During Lake Bonneville's highest level, Morgan and Ogden Valleys were bays of the lake. *B. Y. S.*

97. CHORNEY, RAYMOND, 1943, Scheelite and mineral association at the Reaper mine, Gold Hill [Tooele County], Utah: Univ. of Utah M. S. thesis, 48 p.

Crawford, A.L., and Raymond Chorney, 1941-1943, The tungsten pipe of the Reaper mine: Utah Acad. Sci. Proc., v 19-20, p. 143-149 (abs., p. 28).

The Reaper pipe, an unusual tungsten-bearing ore body with wide assemblage of unusual minerals and unique form is located near the western margin of the main part of a quartz monzonite stock intruded into Paleozoic rocks. Elliptical-shaped at surface, its cross section diminishes with depth. The pipe is localized along intersecting fractures as shown by apophyses; its walls are not sharp, and the minerals are arranged in rough zonal assemblages. Scheelite masses up to 200 pounds were present in the center of the pipe; 5,000 tons of 0.75 percent ore is estimated to be still on the dumps.

Paragenesis is divided into 5 stages: (1) titanite, scheelite, apatite, garnet, and tourmaline, respectively, deposited, (2) minerals of stage 1 embedded in fibrous sheafs of diopside, amphiboles, biotite and molybdenite, (3) pipe-like ore body formed in stages 1 and 2 enveloped by mainly massive orthoclase with minor albite, quartz and anorthoclase; (4) iron oxides, calcite, barite and specks of sulfides developed along margin of pipe, (5) alteration products of earlier-formed minerals.

Pipe apparently was formed by series of replacing solutions. Early deposition was due to pneumatolytic processes which gradually changed to those necessary for formation of a replacement pegmatite.
Abstract revised (B. C.)

98. CHRISTENSEN, A. LEE, 1928, Geology and physiography of Deer Creek and Silver Fork tributaries of American Fork Canyon, Wasatch Mountains [Utah County], Utah: Stanford Univ. M. A. thesis, 103 p., geol. map.

Sedimentary rocks exposed are the Precambrian Little Willow Series and Big Cottonwood Series; Cambrian (lower) quartzite, (middle) shale, and (upper) limestone; dark Mississippian cherts with a distinctive sandstone near the top; Pennsylvanian intercalated limestone and quartzite; Eocene Wasatch Conglomerate; and Quaternary alluvium and glacial drift. Igneous rocks include Little Cottonwood Series granite and dike rocks (mostly aplite). The intrusion did not alter the previously metamorphosed and stable Precambrian slates, schists and quartzites, but a small area of Mississippian limestone was intensely altered by contact metamorphism.

The area of this report is on the south limb of the northeast-plunging Park City anticline. Normal faulting with steep dips and northwest-southeast strikes predominate. Five factors support interpretation of intrusion as a stock not a laccolith: cross-cutting relationships, irregular domical roof, lack of marked doming or folding in adjacent rocks, intense metamorphism in Mississippian limestone, and date of intrusion. Stoping was dominant process of intrusion; assimilation was also important.

Evidences of glaciation occur throughout area. Post-glacial stream erosion was of minor significance until recent rejuvenation. Landslides are common; snowslides indirectly cause much erosion by removing vegetation.
B. Y. S.

99. CHRISTIANSEN, FRANCIS WYMAN, 1937, The geology and economic possibilities of the alunite deposits in Sevier and Piute Counties, Utah: Univ. of Utah M. S. thesis, 97 p.

This report includes the results of a study of the alunite deposits in the Antelope Range, at the western base of the Sevier Plateau east of Marysvale, and at the eastern base of the Tushar Range in Sevier and Piute Counties, Utah.

The lower grade alunite deposits are located in a graben structural valley. The country rock of these mineral veins is a dacite flow material of Tertiary age which has been intruded by a monzonite intrusive body of late Tertiary time. The mineralizing solutions which originated in the crystallizing magma carried, in some phases of the mineralization period, all of the constituents of alunite and where physical and chemical conditions were favorable, the alunite was deposited. The solutions also carried the sulphate radical in quantities great enough to cause the alunitization of the feldspar surrounding the nearly pure alunite veins.

The deposits range from 30 to 80 percent alunite with an average in some deposits of 60 percent. Considering 60 percent alunite rock as a basis for calculation, it was found that this rock does have commerical value as a fertilizer after being ignited above 800° C., providing, however, a market can be found near the deposits.
From author abstract

100. CHRISTIANSEN, FRANCIS WYMAN, 1948, Geology of the Canyon Range [Millard and Juab Counties], Utah: Princeton Univ. Ph. D. thesis, 140 p. geol. map.
(Abs.): Dissert. Abs., v. 15, No. 3, p. 392, 1955.
______ 1952, Structure and stratigraphy of the Canyon Range, central Utah: Geol. Soc. America Bull., v. 63, p. 717-740.

Canyon Range includes about 350 square miles near the east edge of the Great Basin. Exposed sedimentary sequence totalling 36,000 feet consists of Proterozoic (?) quartzite and shale; Tintic Quartzite (Lower Cambrian); Ophir Formation (Middle Cambrian); undifferentiated limestones and dolomites (Upper Cambrian and Ordovician ?); thick continental sequence of coarse conglomerates, sandstone, shale and several freshwater limestone beds correlated with Indianola (?) Group and Price River (?) Formation (Upper Cretaceous); continental sedimentary rocks composed of conglomerates, sandstones, red shales, calcareous siltstone, and limestone which are correlated with North Horn (?) Formation and occur in eastern piedmont (Upper Cretaceous-Lower Tertiary); Oligocene (?) conglomerates; pre-Bonneville alluvial and mudflow deposits (Pleistocene); Lake Bonneville deposits (Pleistocene); Recent alluvial and eolian deposits.

The structure which brought Carboniferous rocks of Gilson Mountains (north) in contact with Precambrian (?) and lower Paleozoic rocks of Canyon Range is covered by Pleistocene and Recent sediments. The most prominent structures of the Canyon Range are two large folds. Core of range is an asymmetrical northward-plunging syncline and southwestern part of range is southward-plunging, asymmetrical and locally overturned, anticline. Synclinal cores of Proterozoic (?) and lower Paleozoic strata consists of a folded, overthrust sheet. Thrust fault along eastern front dips 40°-55° W. and in western part of range dips about 45° E. Interior normal faults of pre-Miocene (?) age occur in southwestern part. Border normal faults occur in southeastern piedmont. Recent scarplets are common.

These structures developed largely during 3 major disturbances. (1) A mid-Cretaceous orogeny with large-scale folding and overthrusting produced major structures of range and elevated a highland source for thick accumulation of Upper Cretaceous rocks. (2) The Laramide orogeny caused folding of Upper Cretaceous rocks, folding of overthrust plane, and thrusting of wedge-shaped core of range over Upper Cretaceous strata. (3) Basin-and-Range faulting began near close of Miocene (?) and has continued to the present. *Abstract revised (B. C.)*

101. CHURCH, CLIFFORD C., 1925, A laboratory study of certain Tertiary formations of the northern Wasatch Mountains, Utah: Stanford Univ. M. A. thesis, 41 p.

The Tertiary strata studied are a 500 to 1,000 foot thick series of whitish, largely oolitic limestone, gray tuffs, and pink to gray conglomerates. The beds generally have a gentle dip)less than 10°) but locally sharp folds and dips up to 45° are present. The whole series dips at a samller angle than the underlying Paleozoic rocks. The beds are largely unfossiliferous; rare fossils are fresh-water. Except for tuffs and conglomerates the beds are well stratified. Tuffaceous beds thin, conglomerates thicken, toward the south. Important structural features are step faulting and tilting of the beds; gentle folding also occurs.

It is concluded that the Tertiary represented terrestrial accumulation on the mountain flanks and in intermontane basins; partly as alluvial fan material, partly as deposits in permanent or intermittent shallow freshwater lakes. Gentle folding has occurred since deposition, resulting in low-angle folds and faulting. Climate has probably been relatively arid since deposition of ash because chemical deposition is unimportant.

The ash beds are similar to beds of the Payette Formation in Idaho and the Fowkes Formation in Wyoming, but exact correlation and age determination are impossible. *Author summaries revised (B. Y. S.)*

102. CLARK, A. F., 1924, Utah hydrocarbons: Univ. of Utah M. S. thesis, 59 p.

_____ and R.F. Newton, 1925, Utah hydrocarbons: Univ. of Utah Bull., v. 15, No. 2 (Eng. Exper. Sta., Bull. No. 15, p. 33-46.

The results of the investigation show (1) that there are no large elaterite deposits in Utah, (2) that due to the smallness of the known veins of elaterite, and due to their comparative inaccessibility there will be nothing of great value done in the future, (3) that gilsonite is being mined to supply the demand. That production could be increased to meet an increase in demand, (4) that waste of the gilsonite is at a minimum and that that wasted is nonrecoverable, (5) that ozokerite deposits await commercial development, (6) that at least 33 percent of the crude ozokerite can be purified to form ceresin wax, which is of commercial value and (7) a suggested flow sheet for the purification of ozokerite would be as given on page 30. *Author summary*

103. CLARK, DAVID L., 1954, Stratigraphy and sedimentation of the Gardner Formation in central Utah: Brigham Young Univ. (M. S. thesis), Research Studies, Geol. Ser., v. 1, No. 1, 60 p.

The Gardner Formation is exposed in many localities throughout central Utah. The age of the lower half is lower Kinderhookian, and the age of the upper half is upper Kinderhookian and lower Osagean. The formation is readily subdivided into 5 lithostromes. The lower 2 were deposited in the neritic zone on a stable shelf in the Madison basin. An algal biostrome, the "curly bed," occurs between the lower and upper lithostromes. It is overlain by strata deposited in the neritic zone upon a slightly unstable shelf. A rich fauna of more than 30 genera occur in the upper lithostromes.

The Gardner was deposited as a clastic limestone; all of the dolomite present is secondary. Low silica content makes the Gardner economically valuable; data indicating chemical composition are presented. *From author abstract*

104. CLARK, DAVID L., 1957, Marine Triassic stratigraphy in the eastern Great Basin: State Univ. of Iowa (Iowa City) Ph. D. thesis.

_____ 1957, Marine Triassic stratigraphy in eastern Great Basin: Am. Assoc. Petroleum Geologists Bull., v. 41, No. 10, p. 2192-2222.

The Lower Triassic rocks of the eastern Great Basin provide a record of the last marine deposition in the Cordilleran miogeosyncline. Sections are present in eastern Nevada, particularly in Elko County, and in northwestern Utah.

Most of the eastern Great Basin sections can be divided into (1) a lower shaly limestone, (2) the Meekoceras limestone zone, (3) an upper shaly limestone and (4) an upper thick-bedded limestone. Thicknesses range from 700 to 3,000 feet. Redbeds are present only in the lower part of the western Utah sections and above the uppermost Triassic limestones near Currie.

The Meekoceras zone contains many ammonoids, nautiloids, and conodonts. Pelecypods, gastropods, brachiopods, echinoderms, crinoids, foraminifers, and fish remains occur in beds above the Meekoceras interval.

The Triassic rests unconformably on Permian rocks throughout the area of study, but no angular discordance was noted. The uppermost Triassic beds are overlain by Tertiary or Recent material. Age determination for the Triassic sections is based on the fossils of the Meekoceras zone which occurs near the base and represents middle Scythic of the European standard. Correlation with adjacent sections in Idaho, Utah and western Nevada indicates that equivalents of additional Lower Triassic zones are probably present in the eastern Great Basin. Clastics above marine limestone in the Currie area may be Middle Triassic.

Names for stratigraphic units have been established in adjacent areas. The Candelaria, Tobin, China Mountain and Dixie Valley Formations of western Nevada and the Moenkopi, Dinwoody and Thaynes Formations of Utah and Idaho can be correlated with the eastern Great Basin Triassic.

Early Triassic seas invaded the northeastern Great Basin from Idaho and transgressed Nevada from east to west. Marine connections with the eugeosynclinal part were probably through California into southern Nevada. As the rate of subsidence varied in the miogeosyncline, marine tongues extended over the more stable craton toward the east. Seas were not uniformly present over western Utah and eastern Nevada and in northeastern Nevada a high area shed coarse detritus into the Lower Triassic sea. Redbeds accumulated in western Utah during early triassic time; the source for this material was probably the "Nye-Lincoln" geanticline, which extended from southern California to the vicinity of Ely, Nevada. During the Middle Triassic, this feature was widened and fused to the craton, occupying the position of the former geosyncline.

Published abstract

105. CLARK, JOHN, 1932, New turtle from the Uinta Basin, northeastern Utah: Univ. of Pittsburgh M. S. thesis.

_____ 1931-1933, New turtle from the Duchesne Oligocene of the Uinta Basin, northeastern Utah: Carnegie Mus. Annals, v. 21, No. 3, p. 131-160.

106. CLARK, ROBERT S., 1953, The structure and stratigraphy of Government Ridge [Juab County], Utah: Brigham Young Univ. M. S. thesis, 75 p., geol. map.

This is a report of the structure and stratigraphy of Government Ridge, a small segment of Long Ridge, Utah. The exposed sedimentary rocks include 2,500 feet of Paleozoic rocks representing 4 systems -- Cambrian, Ordovician, Devonian, and Mississippian -- and 7 formations. The lithology and stratigraphic position is correlated with adjacent areas, especially the Tintic district, the type locality for the formations. Depositional environment was mostly shallow marine water.

Government Ridge is the east limb of an anticline. It is an erosional remnant of Basin-and-Range type block faulting. Pre-Basin-and-Range structures consist of thrust and tear faults with displacements varying from 100 to 2,000 feet.

Volcanic rocks regarded as part of the Laguna latite flows of Long Ridge cover most of the lower hills in the area. Outcrops are few, although residual boulders are widely scattered. *From author abstract*

107. COFFMAN, W. ELMO, 1932, A progress report of metals in Utah: Brigham Young Univ. M. A. thesis; Utah Acad. Sci. Proc., v. 10, p. 51, 1933.

The purpose of this report is to assemble data pertaining to the metal industry in Utah, to present information regarding the metals that are found in Utah, and to bring to data a bibliography of available source material. Because of the wide range of subject matter, the author has limited this discussion to the occurrence, production and future possibilties of metals in Utah.

The production of metals in Utah has, for the most part, been confined to the Bingham, Park City, and Tintic districts though Beaver and Iron Counties have also contributed much wealth to the State. The major production of metals has consisted of gold, copper, iron, lead, silver and zinc. The total production of these metals in Utah including 1931 is as follows: Copper - 4,715,186,026 lbs, $766,456,879; Gold - 6,754,807 oz, $139,488,807; Iron (pig) - 1,053,941 long tons, $18,964,170; Lead - 6,941,819,325 lbs, $188,715,846; Silver -

585,078,693 oz, $433,459,288; Zinc - 854,840,424 lbs, $57,492,964; Total $1,604,577,954.

From published summary

108. COHEN, CAXEL LODEWIJK DAVID, 1959, Preliminary study of coccoliths and discoasterids from the Mancos Shale of eastern Utah and western Colorado: Univ. of Utah M. S. thesis, 158 p.

Coccoliths and discoasterids are a major constituent of the Upper Cretaceous Mancos Shale in the Uinta Basin. Three sections were sampled: Green River section in Uintah County, Utah, and Juniper Springs and Rifle sections in Colorado. Distinctive forms were divided into morphological (numbered) groups for counting purposes. Some groups consist of a few specimens, some consist of several related forms. Due to inconsistencies of numbered groups, incompleteness of sections and irregularity of sampling, the following zones are tentative.

Lower 450 feet of the three sections sampled can be correlated on basis of number 22 (Discolithus insignis n. sp. and D. symmetricus n. sp.). Number 32 (Discoaster tribrachiatus) is far more abundant in lower 1,000 feet of the three sections. The following intervals (expressed in feet above base of sections) contain relative abundances of groups listed: 475 to 800 - number 23 (Discoaster (?) cubiscus n. sp.); 600 to 1,900 - number 30 (Rhabdolithus n. sp.); 1,900 to 2,600 - number 15a (Coccolithites cf. C. circumvallatus Kpt); 2,350 to 2,950 - number 3 (Discolithus cancellatus n. sp. and D. cf. D. crux); 1,660 to 2,725 - number 16 (Discolithus dentatus n. sp., D. crassus n. sp., D. laciniatus n. sp. and D. trochiformis n. sp.). Number 21 (Stephanolithion) seems more abundant in lower 2,500 feet and number 13 (Discolithus cf. D. ponticulus, D. mixtus n. sp. and Zygolithus spicatus n. sp.) from 2,000 feet up. *B. C.*

109. COHENOUR, ROBERT E., 1952, Some techniques for sampling the bottom sediments of Great Salt Lake: Univ. of Utah M. S. thesis, 44 p.

A modified gravity-type coring apparatus is described, which was built and used on Great Salt Lake for taking samples of sediments from the lake bottom. With this instrument cores of mud were obtained from the bottom to depths of 20 feet. It procures cores 5 to 6 feet long. Overlapping cores yield a complete sedimentary section. The use of a pump and casing enables the operator to gain cores from considerable depths utilizing only light, low-powered equipment. The technique of coring herein described can be used only on relatively shallow bodies of quiet water.

A bottom impression apparatus is also described. This device utilizes a plaster of Paris slurry for making a mold of the bottom configuration. The instrument has been used successfully in water 20 feet deep. *Author abstract*

110. COHENOUR, ROBERT E., 1957, Geology of the Sheeprock mountains, Tooele and Juab Counties, Utah: Univ. of Utah Ph. D. thesis, 209 p., geol. map.
(Abs.): Dissert. Abs., v. 18, No. 3, p. 1013, 1958.

_____ 1959, Sheeprock Mountains, Tooele and Juab Counties: Utah Geol. and Mineralog. Survey Bull. 63, 201 p., geol. map.

The Sheeprock Range is a northward-dipping homocline, composed of Precambrian and Paleozoic sedimentary rocks (chiefly), intrusive and extrusive rocks, and late Tertiary and Quaternary pediment gravels, lake deposits and alluvium. Nearly 11,000 feet of Precambrian metasediments, largely slates and quartzites similar to late Precambrian formations in central and western Utah, crop out in the central part of the area. Tillites similar to those found locally in the Wasatch Mountains are the thickest and most distinctive of the Precambrian rocks. Twenty-seven formations having a combined thickness of approximately 20,000 feet represent the Paleozoic Era and include rocks of all Paleozoic periods except (?) Permian. Limestone, dolomite, quartzite, and shale typical of miogeosynclinal environment constitute the Paleozoic rock types, over 80 percent of which are of marine origin, the rest being continental-interior-shelf and shoreline deposits. Excepting minor hiatuses, continuous sedimentation prevailed from Precambrian into Pennsylvanian.

Sequence of deformation is as follows (1) Cedar Hills orogeny (?) - mid-Cretaceous phase, (2) early Laramide orogeny - Montana phase, (3) mid-Laramide orogeny (?) - Paleocene phase, (4) late Laramide orogeny and (5) Basin-and-Range phase. Structures formed during these phases include folds, thrust faults and imbrications, and normal faults. Igneous activity (early Tertiary-Miocene) formed granitic and monzonitic intrusions, and extensive rhyolitic and andesitic flows. A little basalt of undetermined age is present.

Mineral deposits fall into two major groups (1) deposits associated with the West Tintic monzonite cutting Precambrian and Paleozoic rocks have yielded minor quantities of commercial ores of lead, zinc, silver, gold and tungsten, (2) deposits associated with the Sheeprock granite have yielded ores and protores of beryllium, lead, silver, tungsten, thorium and uranium, but none of these has achieved commercial significance.

Abstract revised (B. C.)

111. CONDIE, KENT C., 1960, Petrogenesis of the Mineral Range Pluton [Beaver and Millard Counties], southwestern Utah: Univ. of Utah M. A. thesis, 106 p., geol. map.

The Mineral Range pluton, Beaver and Millard Counties, Utah, is over 20 miles long and up to 6 miles wide. The Lincoln stock (adamellite) and its apophyses are thought to be basic apophyses of the pluton. An extensive "inclusion zone" is described. Most accepted criteria for granitization were present in either the Mineral Range pluton or the Lincoln stock.

Precambrian sediments and possibly plutonic rocks were metamorphosed and eroded before Paleozoic time. Paleozoic and Mesozoic deposits are relatively thin (12,000 feet) and for this reason it is believed that this area represents the western margin of the Colorado Plateau. Floods of conglomerate were deposited in this area during Coloradoan time; the area was folded and domed (E. Montanan ?) and the Mineral Range pluton was formed (L. Montanan ?) during late Cretaceous time; thrusting and cataclastic metamorphism occurred during Paleocene time; lamprophyres, rhyolite and dellenite porphyry dikes were intruded during mid-Tertiary time and east-west high-angle faulting commenced; the Minersville volcanics were deposited and Basin-and-Range faulting commenced in Oligocene time; epeirogony and erosion and finally deposition of the Ranch Canyon volcanics occurred during Plio-Pleistocene time; basalt flows, lake beds and other alluvium were deposited during Pleistocene and Recent time.

Abstract revised (B. C.)

112. CONDIE, KENT C., 1965, Petrology and geochemistry of the Late Precambrian rocks of the northeastern Great Basin: Univ. of California (San Diego) Ph. D. thesis, 260 p. (Abs.): Dissert. Abs., v. 26, No. 10, p. 5974-5975, 1966.

______ 1966, Late Precambrian rocks of the northeastern Great Basin and vicinity: Jour. Geology, v. 74, no. 5, pt. 1, p. 631-636.

The late Precambrian rocks of the northeastern Great Basin and adjacent areas occur as three distinct sedimentary rock associations with quite different geographic distributions. These associations, designated as Subprovinces I, II, and III reflect in varying degrees, different histories of weathering, erosion, and sedimentation and perhaps different source areas. Because of inadequate exposure, complex thrust faulting, and varying degrees of regional metamorphism, the relationships between the subprovinces are not clear. A gradational contact indicative of continuous clastic deposition occurs between late Precambrian and Cambrian rocks west of the Wasatch Range, while a slight angular unconformity indicative of late Precambrian uplift and erosion exists between rocks of these ages within and east of the Wasatch Range. Textural and mineralogical evidence from late Precambrian and Paleozoic rocks in the northeastern Great Basin and adjacent areas indicates widespread post-late-Paleozoic regional metamorphism.

Although textural and structural evidence in the subgraywackes and conglomeratic subgraywackes of Subprovince II suggests a turbidity current-subaqueous mudflow origin, the possibility of contemporary continental or alpine glaciation cannot be eliminated since glacial sediments may be redeposited by these agents.

The subgraywackes and conglomeratic subgraywackes of Subprovince II are composed chiefly of rounded to well rounded clastic quartz grains, rock fragments, and minor feldspar grains in a diagenetic or metamorphic matrix of predominantly mica, chlorite and quartz. With exception of the section in the Big Cottonwood Canyon area, all of the rocks in this subprovince have been metamorphosed to the greenschist or less commonly to the amphibolite facies.

Pronounced differences in mineralogy and major and trace element composition occur between unmetamorphosed and low-grade metamorphic subgraywacke terranes. Such differences appear to be related to a combination of variability in original sediment compositions and compositional changes accompanying progressive metamorphism.

From author abstract

113. CONDON, DAVID D., 1935, A preliminary study of the social and economic geography of Utah with special emphasis on the Tintic Mining district: Brigham Young Univ. M. S. thesis, 155 p.

Although this thesis deals primarily with social and geographic factors, it contains a discussion of the Tintic mining district which would be of interest to anyone making a thorough study of this district.

B. Y. S.

114. COODY, GILBERT L., 1957, Geology of the Durst Mountain-Huntsville area, Morgan and Weber Counties, Utah: Univ. of Utah M. S. thesis, 70 p., geol. map.

The Durst Mountain-Huntsville area is located about 35 miles northeast of Salt Lake City, Utah, and comprises nearly 110 square miles between Ogden and Weber Valleys. The formations exposed are the Precambrian Farmington Canyon Complex; the Cambrian Tintic Quartzite, Ophir Shale, and Cambrian limestones and dolomites undifferentiated; Devonian Three Forks (?) Formation; Mississippian Madison Limestone and the Brazer Formation; the Triassic Thaynes Limestone; and the Tertiary Knight Conglomerate, Norwood Tuff, and Huntsville Fanglomerate.

Three episodes of faulting were noted within the area. The Durst thrust is related to mid-Laramide activity. An east-west episode of normal faulting occurred during the Miocene (?). North-south normal faulting occurred during the Pliocene and Pleistocene. The Herd Mountain erosion surface is the oldest erosion surface within the north central Wasatch Mountains. It is dated as late Oligocene or Miocene age. A more recent erosion surface is the Weber Valley surface. The formation of this occurred in Pliocene or Pleistocene time. An arm of Lake Bonneville extended into both Ogden Valley and Weber Valley. *Author abstract*

115. COOK, EARL F., 1954, Geology of Pine Valley Mountains [Washington County], Utah: Univ. of Washington Ph. D. thesis, 236 p., geol. map.
(Abs.): Dissert. Abs., v. 14, No. 8, p. 1199, 1958.

_____ 1952, Geology of the Pine Valley Mountains -- A preliminary note, in Guidebook to the Geology of Utah: Intermtn. Assoc. Petroleum Geologists No. 7, p. 92-100.

_____ 1957, Geology of Pine Valley Mountains, Utah: Utah Geol. and Mineralog. Survey Bull. 58, 111 p.

The Pine Valley Mountains of southwest Utah lie in a zone which is structurally transitional between the Basin and Range and the Colorado Plateau provinces. The mountains are largely composed of a deroofed monzonite prophyry laccolith which has an exposed extent of 70 square miles and a maximum remaining thickness of 3,000 feet.

Following a long period of marine and continental deposition, with intermittent emergence and erosion but without folding, the region was moderately warped (in Late Jurassic or Early Cretaceous) and Upper Jurassic rocks were beveled. Geosynclinal or foreland trough sedimentation began in the early Late Cretaceous with the deposition of a basal conglomerate followed by a thick accumulation of shale and sandstone.

Near the close of Montana time the area was uplifted; two folds developed along northeast axes, became overturned toward the east, and possibly broke into thrusts of small displacement. The numerous orogenic pulsations recorded in the thick Cretaceous and Tertiary sediments of central Utah apparently did not affect the Pine Valley Mountains area.

Following erosion of Laramide folds, quartzite conglomerate and lacustrine limestone of Claron Formation were deposited, closely followed by an extended series of volcanic eruptions which produced rhyolite and dacite ignimbrites; welded tuff-breccia; andesite, latite, and dacite flows and breccia; mudflow deposits; and minor air-fall tuff and intercalated sediments. Several unconformities within volcanics, some marked by deposits of lacustrine limestone and quartzite gravel, may record either orogenic disturbances or periods of great intrusive folding.

The Pine Valley intrusion spread laterally between the Claron Formation and overlying volcanics, moving in as a half-crystalline mush in which some gravitative settling of mafic constituents took place before solidification of remaining magma. Deuteric alteration was most intense in a thin zone about 1,200 feet above the base of the laccolith. A roughly horizontal color banding in the laccolith is believed to be due partly to gravitational crystal fractionation and partly to differential deuteric alteration.

During the Quaternary, deep erosion, stimulated by spasmodic uplift along block faults (accompanied by widespread thin basalt flows), has stripped the cover from the Pine Valley laccolith, which now stands high above its less resistant sedimentary pedestal. *Abstract revised (B. C.)*

116. COOLEY, I. LaVELL, 1928, The Devonian of the Bear River Range [Cache County], Utah: Utah State Univ. M. S. thesis, 38 p.

The Jefferson Formation of Blacksmith Fork Canyon, Logan quadrangle, is about 2,400 feet thick. Its variable lithology and numerous thin-bedded parts cause it to weather into talus-covered slopes with a few massive ledges. The formation is mainly limestone and dolomite, with dolomite predominating in the lower half. Sand is common in the middle and upper portions. Ptyctodus calceolus (fish teeth) in the lower 200 feet suggest a correlation with the Hamilton Formation of the eastern United States. *B. C.*

117. COOPER, JOHN E., Jr., 1956, Petrography of the Moroni Formation, southern Cedar Hills [Sanpete County], Utah: Ohio State Univ. M. S. thesis, 86 p.

The southern Cedar Hills at north end of Sanpete Valley are composed of rocks ranging in age from Paleocene to Miocene (?) which are divided, ascending, into the Flagstaff Limestone and Colton, Green River, Crazy Hollow and Moroni Formations. The Moroni is the most extensive, and overlies unconformably all other formations. Maximum thickness is 2,147 feet. Age is post-Eocene to pre-Late Tertiary. Lower portion consists of water-deposited sandstone, shale, volcanic conglomerate and pyroclastic rocks; upper portion consists of welded tuffs of rhyolitic to dacitic composition resulting from nuées ardentees.

The Moroni is divided into 6 members, herein. Member 1, lowermost, and Member 3 are friable porous tuff of rhyodacite to rhyolite porphyry. Member 2 is a widespread variable unit of sandstone, shale and volcanic conglomerate. The porous friable tuff at base of Member 4 grades upward to dense tuff with a resistant cap, making this unit widely exposed. Member 5 is black welded tuff. Member 6 is a typical nuée ardentee deposit of three types of tuff.

Cedar Hills lies on axis of north-northeast-trending anticline. Numerous normal faults are downthrown to east. Joints are well developed in upper members of Moroni; columnar jointing is prominent.
B. Y. S. and B. C.

118. COSTAIN, JOHN KENDALL, 1960, Geology of the Gilson Mountains and vicinity, Juab County, Utah: Univ. of Utah Ph. D. thesis, 139 p., geol. map.
(Abs.): Dissert. Abs., v. 21, No. 9, p. 2674, 1961.

The area mapped (185 square miles) includes the Gilson Mountains, Champlin Hills, Jericho Ridge and southern East Tintic Mountains. Precambrian rocks correlated with the Big Cottonwood Series and the Mutual Formation of the Central Wasatch Mountains are exposed north and south of the Sevier River in Leamington Canyon. Rocks of all the Paleozoic systems are represented within the area mapped and an aggregate thickness of approximately 24,000 feet of Paleozoic strata divisible into 18 formations is exposed. The rocks are predominantly marine carbonates with quartzose sandstones present in the Upper Devonian, Upper Mississippian, and Pennsylvanian. Upper (?) Cretaceous conglomerates tentatively correlated with the Indianola Conglomerate of the Gunnison Plateau crop out in the eastern part of Leamington Canyon. Pliocene (?) lake sediments correlative with the Salt Lake Group underlie the pediment surface north and northwest of the Gilson Mountains. Pleistocene sediments of Lake Bonneville are exposed in and near Leamington Canyon. Quartz latite extrusives in the eastern and southeastern parts of the area mapped are correlated with the latite volcanic series of Medial Eocene age in the East Tintic Mountains.

Two reverse faults with stratigraphic displacement of approximately 20,000 feet and 16,000 feet occur at the northern and southern margins of the Gilson Mountains. The northern boundary of the Canyon Range thrust sheet is exposed at the southern margin of the Gilson Mountains.

Four major stages of deformation are (1) Early Cretaceous uplift culminating in stratigraphic displacements of about 20,000 feet, (2) Early Cretaceous emplacement of Canyon Range thrust sheet, (3) renewed uplift of Sevier Arch and deposition of Indianola Conglomerate (correlated with Mid-Cretaceous Cedar Hills orogeny) and (4) Early Laramide renewed movement along Canyon Range thrust and thrusting of Gilson Mountains to the east.

The present course of Sevier River through Leamington Canyon is postulated to have resulted from stream piracy. *Abstract revised (B. C.)*

119. COULTER, HENRY W., Jr., 1954, Geology of the southeast portion of the Preston quadrangle, Idaho-Utah: Yale Univ. Ph. D. thesis, 129 p., geol. map.

______ 1956, Geology of the southeast portion of the Preston quadrangle, Idaho: Idaho Bur. Mines and Geology pamph. 107, 48 p., geol. map.

The area mapped, 235 square miles, includes east central Cache Valley and west central Bear River Range. Precambrian rocks are not recognized. Seven Cambrian formations, about 8,000 feet thick, include clastic Brigham Formation at base and increasing proportion of carbonate rocks upward. Ordovician rocks, about 2,300 feet thick, consist of Garden City Limestone, clastic Swan Peak Formation, and Fish Haven Dolomite. Evidence of angular discordance between Swan Peak Formation (Chazyan) and Fish Haven Dolomite (Cincinnatian) is presented. Silurian Laketown Dolomite, about 1,500 feet thick, is remarkably uniform in lithology; bioherms occur in upper portion. Devonian Water Canyon Formation is of variable thickness and lithology, mainly clastic. Portions of the Devonian Jefferson Formation and the Mississippian Madison Limestone are present in downfaulted blocks. Marls, tuffaceous sandstones and fanglomerates of the Salt Lake Formation (Late Cenozoic ?) occur in foothill benches flanking Cache Valley and are succeeded by Lake Bonneville sediments and later alluvial deposits.

The magnitude and extent of (Laramide ?) folding, which is displayed in the Logan Peak syncline and the Strawberry Valley anticline, within the Logan quadrangle to the south, have been obscured to a great extent in the Preston quadrangle by later high-angle faulting. The Fish Haven syncline (in the Montpelier quadrangle to the east) passes literally into a normal fault which terminates just east of the mapped area. The Smarts Mountain block is interpreted to be a horst. The unusual transverse fault pattern within the Bear River Range shows no demonstrable relationship to the Bannock thrust fault which flanks the eastern slope. Absence of Mesozoic and Early Cenozoic rocks prevents close dating of structural events. Widespread solution by ground water and development of subsurface drainage particularly along fault zones has greatly influenced topography. There is no evidence of glaciation.
Abstract revised (B. C.)

120. CRAMER, HOWARD R., 1950, Tertiary freshwater ostracoda from the Uinta Basin, Utah: Univ. of Illinois M. S. thesis, 31 p.

The Tertiary stratigraphic sequence in the Uinta Basin is, ascending, Wasatch, Green River, and Bridger Formations. The ostracodes were collected from lacustrine and deltaic phases of the Green River Formation and from limestone of the Wasatch tongue. The fossiliferous beds are mostly quite organic calcareous shale but ostracodes were also found in 2 marlstone beds and in 1 sandstone. Preservation of ostracodes is poor in the shale, best in the marlstone.

The following ostracodes were identified: Cyprois cf. C. marginata (Strauss), Cypridea bisulcata Swain, Ilyocypris arvadensis Swain, Candona pagei Swain, C. cf. C. compressa (Koch), C. cf. C. cachensis Swain, C. sp. A, C. sp. B. *B. Y. S.*

121. CRAMER, HOWARD R., 1954, Coral zones in the Mississippian of the Great Basin area: Northwestern Univ. Ph. D. thesis, 175 p.
(Abs.): Dissert. Abs., v. 14, No. 10, p. 1681-1682, 1954.

Mississippian rocks were studied in parts of Montana, Wyoming, Colorado, Arizona, California, and in Utah, Nevada and Idaho. Some of the Mississippian formation names in the Great Basin area are dropped from usage after a consideration of their synonomy. Chief among these are the "Great Blue" Limestone which is stratigraphically and lithologically similar to the more properly though later named Ochre Mountain Limestone, and the Brazer Limestone, which, at its type section and elsewhere south of the Snake River Plain of Idaho, is composed of two discrete formations. The term "Brazer" is used to designate all the Mississippian limestone in Idaho north of the Snake River Plain. Previously these strata were included in the Brazer Formation.

Two worldwide biostratigraphic units are extended to include the Great Basin area. These large units are subdivided by the writer into smaller, more workable units in this area. These units are listed from top to bottom:

- Caninia zone
  - Caninia juddi subzone
  - Clisiophyllid subzone
    - Faberophyllum zonule
  - Ekvasophyllum zonule
  - Lower unnamed unit
- Caninophyllum zone

A comparison of these units and other coral biostratigraphic units in the Great Basin area is made, and a time-rock correlation of the Mississippian System in this area, based upon corals, is proposed. Seventeen genera, three of which may be new, and fourty-four species are described and figured.
From author abstract

122. CROFT, MACK G., 1956, Geology of the northern Onaqui Mountains, Tooele County, Utah: Brigham Young Univ. (M. S. thesis), Research Studies, Geol. Ser., v. 3, No. 1, 45 p., geol. map.

About 45 square miles of the northern Onaqui Mountains were mapped. The mountainous central portion is flanked by sloping bajadas, outlying hills and rock-cut plains which grade into Rush and Skull Valleys. Water for agricultural use is the area's outstanding economic potential.

Paleozoic sedimentary rocks about 9,600 feet thick include the Ordovician, Silurian, Devonian, Mississippian and Pennsylvanian Systems. Unconsolidated Quaternary fanglomerate, Lake Bonneville deposits, sand dunes and alluvium were also mapped. Three species of Didmyograptus are described. Many Ordovician and Mississippian corals are listed.

North-south-trending folds, eastward displaced allochthonous blocks, and various northwest-southeast and east-west high-angle faults formed during the Laramide orogeny. Younger Basin-and-Range type normal faults roughly parallel the Laramide fold structures. *Abstract revised (B. C.)*

123. CRONKHITE, GEORGE, 1936, The analytical composition of the calcareous oolite of the Great Salt Lake: Univ. of Utah M. S. thesis, 18 p.

The oolite examined came from the lake shore near Black Rock. It was fairly homogeneous in appearance, being for the most part composed of more or less spherical granules, grey to white in color and varying in size in the neighborhood of 0.4 mm in diameter. A marked variation from this major component was noted in the form of dark irregularly shaped particles of the same approximate size, composing only a fraction of a percent of the total mass but prominent because of their dark color.

Mean value in percent and maximum deviation from the mean for each component are as follows: Silica (SiO_2) 3.03 ± 0.06; Iron (Fe_2O_3) 0.31 ± 0.011; Aluminum (Al_2O_3) 0.18 ± 0.005; Titanium (TiO_2) 0.0065 ± 0.001; Calcium (CaO) 51.44 ± 0.18; Magnesium (MgO) 1.02 ± 0.01; Phosphorus (P_2O_5) 0.065 ± 0.009; Potassium (K_2O) 0.12 ± 0.005; Sodium (Na_2O) 0.38 ± 0.02; Carbon dioxide 40.83 ± 0.19; Water, hygroscopic 0.33 ± 0.01; Water, firmly held 1.45 ± 0.01; Organic carbon (C) 0.29 ± 0.11; Arsenic (As_2O_3) 0.012 ± 0.002; Nitrogen (N) 0.03 ± 0.006; Sulfur (SO_3) 0.55 ± 0.02; Chlorine trace; Insoluble residue none. *From author introduction and summary*

124. CROSBY, GARY WAYNE, 1959, Geology of the south Pavant Range, Millard and Sevier Counties, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 6, No. 3, 59 p., geol. map.

A complete section of sedimentary rocks, representing every period since Precambrian time, is exposed in the south end of the Pavant Range. In general, Paleozoic strata aggregating 10,122 feet are similar to units described in the Great Basin, though somewhat thinner, and reflect a shelf to proximal miogeosynclinal depositional environment. Mesozoic-Cenozoic sediments are continuous with stratigraphic units of the Colorado Plateau, but lithologies reveal diverse depositional environments.

Extrusive volcanics, which spread north from the Marysvale area during Late Tertiary time, cover much of the south end of the Pavant Mountains. Various types include rhyolite, quartz latite, agglomerate, tuff and basalts. Volcanics of the Mount Belknap Series, mostly rhyolite, cover the south end of the area investigated.

The Pavant overthrust fault places Cambrian quartzites and carbonates on top of Jurassic sandstone. Minimum displacement along this fault is 15 miles and the southern edge of the upper plate probably lies within the mapped area. Normal faulting is a common structural feature in the range, especially along the west face.

Sulfur, fluorspar, and minor base metals, genetically associated with intrusives in the Tushar Range immediately to the south, occur as vein minerals of commercial grade in the area.

From author abstract

125. CROSSON, ROBERT S., 1964, Regional gravity survey of parts of western Millard and Juab Counties, Utah: Univ. of Utah M. S. thesis (copyright 1968).

During September through November 1962, and again in June 1963, a regional gravity survey was conducted in parts of western Juab and Millard Counties, Utah, for the primary purpose of ascertaining the major Basin-and-Range structures in the area. A total of 235 gravimeter stations were occupied in the approximately 1,600 square miles surveyed. The gravity data were reduced to complete Bouguer values and an anomaly map constructed having a contour interval of 2 mgal. Selected anomalies were analyzed quantitatively using a two-dimensional graticule, and the resulting interpretive cross-sections of the bedrock - alluvium contacts were compiled. A density contrast of 0.5 gm/cc was assumed between the bedrock of Paleozoic age and older and the Cenozoic valley fill sediments.

The results of the gravity survey permitted the outlining of the major Basin-and-Range structures in the area and the delineating of two structures of probable pre-Tertiary age in the Confusion Range. A prominent gravity high exists over the northern Confusion Range which, in varying degrees, affects the surrounding anomalies. It is postulated that this high arises from an intrusion at depth. The gravity data indicate that the southern part of White Valley is a graben with major faulting located near the west margin of the House Range and some distance from the east front of the Confusion Range. The maximum depth of valley fill in the southern part of White Valley is indicated at greater than 5,000 feet.

The gravity data indicate that Snake Valley is a more complex graben which consists of several relatively depressed blocks, in the northern, central and southern parts of the valley; the blocks are separated by bedrock saddles. On the west side of the northern part of Snake Valley, a major gravity interpreted fault zone corresponds to a geologically mapped fault. On the east side of the valley, step faulting with a combined displacement of approximately 4,700 feet is postulated from the gravity data. This interpretation is susceptible to error because of the distorting effect on the gravity data of the Confusion Range gravity high. In the central part of Snake Valley, a graben is evident, though gravity data are lacking on the west side. Major Basin-and-Range faulting is postulated along the west margin of the Confusion Range, and this fault zone extends southward along the west flank of the Conger Range. The minimum depth of valley fill in the central part of the valley is postulated to be about 3,900 feet. The southern part of Snake Valley, though mostly outside the surveyed area, appears to be an even more pronounced graben than the northern and central parts.

Author abstract

126. CURTIS, BRUCE F., 1949, Structure and stratigraphy of Linwood-Spring Creek area, Utah-Wyoming: Harvard Univ. Ph. D. thesis, 158 p., geol. map.

The Linwood-Spring Creek area lies on north flank Uinta Mountains, and is mainly in Daggett County, Utah. Most of the stratigraphic sequence between the Precambrian Uinta Mountain Group and the Pennsylvanian Weber Sandstone is cut out due to faulting. The Weber is overlain unconformably by Permian Phosphoria Formation, a few hundred feet thick. Permian-Triassic Red Wash Formation, more than 1,400 feet thick, is overlain unconformably by a few hundred feet of Triassic Stanaker Formation with Gartra Conglomerate at base. Jurassic sequence consists of Navajo Sandstone (up to 800-900 feet), Carmel Formation (a few hundred feet), Entrada Sandstone (about 150 feet), Curtis Formation (about 180 feet), and Morrison Formation (over 1,000 feet). An 80-foot conglomeratic sandstone called the Dakota (?) Sandstone (Upper Cretaceous ?) overlies Morrison with possible unconformity. Upper Cretaceous sequence consists of Aspen Shale (about 200 feet), Frontier (?) Formation (about 130 feet), Hilliard Shale (more than 6,000 feet), and Adaville Formation (about 1,700 feet). Adaville is overlain with angular unconformity by at least several thousand feet Wasatch (?) Formation, which is tentatively correlated with Almy and Knight Formations (Paleocene ? and Eocene) of southwestern Wyoming. Most of the formations become thinner toward the east.

The structure is homoclinal with a north dip, modified by two anticlinal noses or bowings and disturbed by thrust faults. The Uinta fault is a thrust with known stratigraphic throw of at least 11,500 feet in eastern part of area, and at least 1,900 feet in western part. Dip probably exceeds 50° S. Henrys Fork fault, a high-angle south-dipping thrust, branches off Uinta fault.

Strong pre-Wasatch (?) folding and possible faulting occurred, and an orogenic pulse contemporaneous with Wasatch (?) may have occurred. The prominent thrust faulting is at least partly post-Wasatch (?) in age. *Abstract revised (B. C.)*

127. DAHL, CHARLES LAURENCE, 1959, Trace ferrides in iron ores from the Iron Springs district, Cedar City, Utah: Univ. of Utah M. S. thesis, 68 p.

Investigation of the trace ferrides, cobalt, manganese, nickel, titanium and vanadium was made on samples of ore collected from accessible iron deposits associated with three monzonite porphyry intrusions in the Iron Springs district, Utah. Iron mineral grains were separated and spectrochemically analyzed on a 1.5 meter, 24,400 lines-per-inch grating, Abney mount spectrograph. Iron was the variable internal standard. Polished sections of separated iron grains of all samples collected were studied and mineral relationships and the percentages of magnetite, hematite, limonite and sulfides were determined. Quantitative data obtained were subjected to statistical analyses.

Results of the analyses revealed several specific relationships (1) trace ferrides are of the same primary genetic population, based on similar abundances of cobalt, titanium and vanadium, (2) degree of oxidation of iron ores in Iron Mountain area is significantly different from that of iron ores in Granite Mountain-Desert and Three Peaks areas, (3) manganese and nickel from iron ores of Granite Mountain-Desert and Three Peaks areas belong to one statistical population, whereas manganese and nickel of Iron Mountain area belong to another. This difference is apparently related to state of oxidation of the iron ores; in more oxidized areas, nickel has been enriched and manganese impoverished. *Abstract revised (B. C.)*

128. DAHL, HARRY M., 1954, Alteration in the central uranium area, Marysvale [Piute County], Utah: Columbia Univ. Ph. D. thesis, 151 p.
(Abs.): Dissert. Abs., v. 14, No. 9, p. 1357-1358, 1954.

Tertiary volcanic history of Marysvale area begins with deposition of thick series of latite and andesite tuffs, flows and agglomerates on Tertiary, Mesozoic and Paleozoic sediments, followed by extensive alunitization and kaolinization. Successive emplacement of quartz monzonite porphyry, and quartz monzonite and granite followed deposition of Bullion Canyon volcanic Series. Tectonic forces which caused Marysvale graben and Antelope Range horst also produced a series of prominent fractures which, when opened by tensional forces, became hydrothermal conduits.

Commercial uranium mineralization is believed to be related to the differentiation of the hydrothermal solutions. Prominent barren clay zones occur along N.-S., N. 30° E., N. 60° E., E.-W., N. 50° W. and N. 20° W. trends. Later, N.-S. and N. 30° E. trends, followed by the N. 60° E. and E.-W. trends, were most favorable to the entry of weak uranium-bearing solutions. Upon further differentiation, hydrothermal solutions became ore-bearing and formed pitchblende, fluorite, pyrite, quartz, adularia veins in N. 60° E. and E.-W. fractures. During subsequent differentiation, uranium content of hydrothermal solutions decreased until only barren fluorite, jordisite, quartz and calcite veins were emplaced.

Progressive decrease in average intensity of slightly mineralized clay zones, alteration adjacent to commercial uranium-bearing veins and that adjacent to barren fluorite, jordisite, quartz and calcite veins suggests that effect of altering solutions on wall rock gradually diminished from formation of barren clay zone or slightly mineralized argillic zones to formation of late barren veins.

Pitchblende and fluorite occur in fissure veins located within several distinct types of alteration halos. Position of ore shoots seems to be controlled by available open space. Emplacement of commercial uranium veins was probably rapid. Origin of pitchblende may be due to decrease in pressure of uranium tetrafluoride and subsequent formation of pitchblende and hydrogen fluoride. The latter reacted with calcium to form fluorite.

Abstract revised (B. C.)

129. DANE, CARLE H., 1932, Geology of Salt Valley anticline and the northwest flank of the Uncompahgre Plateau [Grand County], Utah: Yale Univ. Ph. D. thesis.

_____ 1935, Geology of the Salt Valley anticline and adjacent areas, Grand County, Utah: U.S. Geol. Survey Bull. 863, 184 p., geol. map.

The oldest exposed rocks, which are of Precambrian age and crop out only in the Uncompahgre Plateau, in the northeastern part of the area, are hornblende and biotite gneisses and schists, intruded by a coarse-grained granite. On the peneplaned surface of the Precambrian rocks lie redbeds of Permian and Triassic age. The Precambrian rocks represent part of the southwestern margin of a land mass which shed erosional debris southwestward to produce a series of sedimentary formations of Pennsylvanian, Permian and Triassic age. These formations thin northeastward toward the old land mass, of which a portion occupied the present site of the Uncompahgre Plateau.

Exposed sedimentary formations from oldest to youngest are Pennsylvanian (?) unnamed conglomerate, Pennsylvanian Paradox and Hermosa Formations, Cutler Formation, Triassic Moenkopi and Chinle Formations, Jurassic (?) Glen Canyon Group (Wingate Sandstone, Kayenta Formation and Navajo Sandstone), Jurassic San Rafael Group (Carmel Sandstone, Entrada Sandstone with Moab Sandstone Member at top, and Summerville Formation) and Morrison Formation (Salt Wash Sandstone Member at base), Upper Cretaceous Dakota (?) Sandstone and Mancos Shale.

During Upper Cretaceous, the large northwestward-trending anticlinal arch of the Uncompahgre Plateau was formed, and beds with northwestward dip in the eastern part of the area here described form part of the northwestern flank of this major fold. Rocks of the western part of the area dip generally northward, away from the La Sal Mountains and toward the Uinta Basin. There are many normal faults, some of which have throws of more than a thousand feet. The most prominent fold, the northwestward-trending Salt Valley anticline, is broken by many faults and its crest is in part dropped by a complicated fault system into a structural trough. During folding, salt and gypsum beds (Paradox Formation) were forced upward through overlying beds in several places. *Published abstract revised (B. C.)*

130. DAVIDSON, DAVID M., Jr., 1963, The nature and origin of silica occurrences in the Mount Peale quadrangle, Grand and San Juan Counties, Utah: Columbia Univ. M. A. thesis, 34 p.

Three unique large-scale occurrences of silica from the Mount Peale quadrangle, Grand and San Juan Counties, Utah, are examined as to: (1) A description of the occurrence; (2) the relationship of the local structure and stratigraphy to the deposit; (3) a petrographic treatment of the deposit; (4) the consideration of related minerals, or mineralization; and (5) the origin of the deposit. Two of the three deposits (Cutler and Burro Canyon) are shown to be of probable hydrothermal origin, while the silica in the Summerville is thought to have been formed by a diagenetic, low temperature process. The results are based largely on field data and petrographic studies. *Author abstract*

131. DAVIS, BRIANT LeROY, 1959, Petrology and petrography of the igneous rocks of the Stansbury Mountains, Tooele County, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 6, No. 2, 56 p.

The igneous rocks of the Stansbury Mountains consist of several hypabyssal intrusions of intermediate and basic composition and four patches of extrusives.

Two sills, one sole injection, and two plugs represent an andesitic to trachyandesitic phase of intrusion and three or four diabase dikes appear to be volcanic fissures. Minor rock types include augite andesite, syenogabbro, and olivine and augite calci-phonolite.

The first stage of volcanic extrusion, probably contemporaneous with intrusion, effused a series of andesite and hornblende andesite flows, tuffs, and tuffaceous volcanic breccias, and very minor amounts of basalt. Two major areas of these effusives, one each on the eastern and western flanks of the range, appear to have been once continuous. Slightly later extrusive activity poured forth calcic phonolites and soda-basalts from fissures farther to the north. On the west flank the series measures 905 feet thick; on the east flank near South Willow Canyon the total section is 1,630 feet thick.

Some low-temperature hydrothermal alteration exists in the area although no contact metasomatic zones have been recognized.

Igneous activity is dated as Eocene to Oligocene and appears to have had the following history: (1) intrusion of stock-sized pluton with projecting cupolas, dikes, and sills of trachyandesite or andesite, (2) extrusion of intermediate composition flows contemporary with stage 1, (3) extrusion of near-basic to locally undersaturated flows, and (4) normal faulting, tilting, and erosion of the flows to their present condition. *Author abstract*

132. DAVIS, DEL E., 1956, A toxonomic study of the Mississippian corals of central Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 3, No. 5, 50 p.

Seven sections of Mississippian rocks were studied, within a 2,500-square-mile area bounded by Grantsville (west), Timpanogos Cave National Monument (north), Provo (east) and Santaquin (south). Thirty-nine species of coral belonging to 15 genera are recognized: 9 species belonging to Order Tabulata and 30 belonging to Order Tetracoralla.

Three tentative zones were used to assist in the recognition of stage boundaries: Triplophyllites "zone" (Kinderhookian and Osagean), Ekvasophyllum-Caninia "zone" (Meramecian), and Faberophyllum "zone" (lower Chesteran). Many new forms are believed to be present but an insufficient number of specimens have been studied to justify naming new genera and species. *Abstract revised (B. C.)*

133. DAVIS, H. CLYDE, 1952, Geology of the Culmer gilsonite vein of Duchesne County, Utah: Brigham Young Univ. M. S. thesis, 90 p.

The Culmer vein is in the Uinta Basin, T. 8 S., R. 13 E. (SLBM). The gilsonite is in veins of a solid homogeneous black mass with brilliant luster and conchoidal fracture. Culmer gilsonite is a high-grade ore having a lower melting point that other gilsonites. It is used mainly as a noncorrosive agent. Commercial gilsonite occurs in two large fractures which are 24 to 39 inches wide. Lateral veins of lesser widths occur parallel to the main fractures.

The gilsonite originated in rich bituminous material entombed in Green River marlstones. As plastic mass the gilsonite was forced up toward the surface between walls of rock which were fractured by tensional force associated with differential compaction and by hydraulic action. The widening of the vein and emplacement of gilsonite were probably concomitant or penecontemporaneous.

Abstract revised (B. Y. S.)

134. DAVIS, LELAND M., 1951, Characteristics, occurrence and uses of the solid bitumens of the Uinta Basin, Utah: Brigham Young Univ. M. S. thesis.

_____ 1951, Characteristics, occurrence and uses of the solid bitumens of the Uinta Basin, Utah: Compass, v. 29, No. 1, p. 32-39.

This short report combines a summary of previous work with data obtained by the writer. Gilsonite is emphasized because it is the most important solid bitumen in the Uinta Basin. Others discussed are wurtzilite (elaterite) and ozokerite.

Veins that have been worked tend to widen at depth. However, the widening is confined mainly to the Uinta Formation. Occurrence of different types of gilsonite within a given vein indicates different stages of intrusion, suggesting that the fissures were formed and widened slowly. Of 34 gilsonite veins listed on the map, variation in strike is not over 30°. Veins farthest north and west have a more north-south strike than southeastern veins, suggesting subsurface structural control.

The Green River marlstones were deposited on an eroded Cretaceous surface. Tensional stresses due to differential compaction over irregular highs may have resulted in a series of en echelon fissures that furnished upward relief for the accumulating liquid hydrocarbons and resulted in the present gilsonite-filled fissures.

B. C.

135. DEARDEN, MELVIN O., 1954, Geology of the central Boulter Mountains area [Utah County], Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 1, No. 5, 85 p., geol. map.

The mapped area lies in southwest Utah County. Exposed Paleozoic rocks totaling 11,000 feet in thickness are divided into 17 formations ranging from Lower Cambrian to Upper Mississippian. Tertiary volcanic deposits and Quaternary alluvium are also present. The North Tintic anticline is the chief structural feature. Two major tear faults displace the near-vertical strata eastward. A low-angle thrust fault joins the tear faults and cuts out some of the formations. Development of clay and metallic minerals is possible.

Abstract revised (B. C.)

136. DEMARS, LORENZO C., 1956, Geology of the northern part of Dry Mountain, southern Wasatch Mountains [Utah County], Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 3, No 2, 52 p., geol. map.

About 6 square miles in southern Utah County were mapped. Rocks ranging in age from Precambrian to Recent are exposed, and total about 6,000 feet thickness. Two formations of Precambrian age, eight of Cambrian age, three of Mississippian age, two of Tertiary age, and Quaternary gravel, silt, and clay of the Lake Bonneville Group are present. Unconformities exist at the top of the Archean, Algonkian, Cambrian and Mississippian.

Compressional stresses of Laramide orogeny formed large north-south trending folds, followed by thrust faulting and tear faulting. After deposition of Wasatch Formation, volcanic eruptions distributed latite flows and tuffs in the general area. At this time, metal mineralization developed, which consists of small and spotty veins and bedded replacements of silver-bearing lead-zinc, and veins of copper. The lead-zinc deposits occur in rather pure limestone, whereas the copper occurs in veins in the Precambrian granitic gneiss and quartzite. Structure was later modified by Basin-and-Range normal faulting. *Abstract revised (B. C.)*

137. DENNAN, WILLIAM L., 1920, Yampa vein of Bingham [Salt Lake County], Utah: Massachusetts Inst. Technology M. S. thesis, 38 p., geol. map.

The most important metal from the Yampa vein has been copper, with some lead, zinc and silver. A thick quartzite bed (Bingham Quartzite) with several lenses of intercalated limestone was intruded by dikes and sills of quartz monzonite porphyry. The principal limestone lens is the lowest, the Highland Boy Limestone. Between Highland Boy and Yampa Limestones lie 250 feet of Bingham Quartzite. The Yampa Limestone influenced the sulfide ore bodies and reveals facts regarding contact metamorphism. The 2-foot thick Yampa vein is a contact metamorphic deposit which generally follows the Yampa Limestone - Bingham Quartzite contact although it may lie entirely within one or the other. Under compression, slipping and brecciation occurred along this contact and provided a passageway for ores. During metamorphism silica, iron sulfide, iron oxide, alumina, magnesium oxide and carbon dioxide were added to the limestone; organic material was removed.

In addition to 14 nonmetallic minerals, the following metallic minerals occur: pyrite (75 percent of the metallic content), chalcopyrite (principal ore mineral), minor amounts of magnetite and hematite, rare chalcocite and enargite, galena, bornite, and sphalerite (the most common sulfide mineral).

B. Y. S.

138. DENNIS, ELDON, 1931, A preliminary survey of Utah nonmetallic minerals: Brigham Young Univ. M. A. thesis.

139. DENSON, NORMAN M., 1942, Late Middle Cambrian trilobite faunas and stratigraphy of Alberta, Montana, Wyoming and Utah: Princeton Univ. Ph. D. thesis, 208 p.
(Abs.): Dissert. Abs., v. 12, No. 3, p. 281, 1952.

The Middle-Upper Cambrian boundary is now known, in the Cambrian sections of northern Utah, western Wyoming, and Montana, to lie either at or near the top of a shale series, either in the shale or in a partly equivalent limestone which transgresses the shale. That the upper part of this shale series is of about the same age in all these regions is indicated by the presence of two widely and readily recognizable trilobite faunules which are here defined as the Brookscodia (the younger) and the Deissella (the older) faunules. The 70 species of trilobites (60 of them new) represented in these faunules and in the next oldest Thomsonaspis fauna are described and figured. Twenty of the genera are new.

The discovery in the late Medial Cambrian beds of the north central Cordilleran region of a number of trilobite genera previously known only from the North Atlantic region and eastern Asia shows that these genera had wider geographic ranges than had previously been suspected. *Author abstract*

140. DeVRIES, NEAL H., 1959, Contact between the North Horn and Price River Formations, east front of the Gunnison Plateau, Sanpete County, Utah: Michigan State Univ. M. S. thesis, 87 p.
The Cretaceous-Tertiary North Horn Formation and the underlying Cretaceous Price River Formation contact, north of South Coal Canyon along the east front of the Gunnison Plateau in central Utah, has been in question since men first began studying the geology of the area. Upon first examination it appears that the basal conglomerate at the foot of the plateau slowly grades into an arenaceous conglomerate and then into conglomeratic sandstone, in one continual, gradational contact, as one proceeds up the plateau front.

Upon detailed examination, and with the aid of several measured sections at spaced intervals along the plateau front, it became evident that the boundary between the North Horn and Price River is not one of transition but has an angular unconformable relationship, although heretofore the former was assumed to be correct. That the contact was thought to be of a transitional nature is due to the abundance of talus along the plateau front which tends to mask the section, the highly similar lithology of many of the units, and the knowledge that the contact between the two formations can be demonstrated to be conformable at their type localities and in other areas throughout central Utah.

Author abstract

141. DIXON, HOWARD B., 1938, The building and monumental stones of the State of Utah: Brigham Young Univ. M. A. thesis, 68 p.

Utah does not rank as a major producer of stone, although good stone of many varieties occurs within the State. Most of the stone used for monuments can be imported more cheaply than it can be quarried.

Most of the stone produced in Utah for both exterior and interior uses has been oolitic limestone of Tertiary age. The most popular interior stone is the so-called "Bird's eye" marble, a brown stone. Cottonwood granite has been used for exterior building purposes. Other stones that could be used more frequently are Nugget Sandstone, quarried in Emigration Canyon; Eocene sandstone occurring near Kyune station; and volcanic rocks of Beaver County.

Author introduction revised (B. Y. S.)

142. DOELLING, HELLMUT H., 1964, Geology of the northern Lakeside Mountains and the Grassy Mountains and vicinity, Tooele and Box Elder Counties, Utah: Univ. of Utah Ph. D. thesis, 354 p., geol. map.
(Abs.): Dissert. Abs., v. 25, No. 5, p. 2928, 1964.

The northern Lakeside Mountains and Grassy Mountains, north-south-trending mountain ranges, include about 500 square miles in the Basin and Range Province, northwestern Utah, on the west side of Great Salt Lake.

Twenty-nine formations representing all Paleozoic periods are exposed. Included are 7,003 feet of Cambrian, 3,094 feet of Ordovician, 653 feet of Silurian, 2,462 feet of Devonian, 6,646 feet of Mississippian, 3,541 feet of Pennsylvanian, and 14,517 feet of Permian strata. The 37,916-foot measured section and the 43,293-foot estimated thickness of strata in the area represents one of the thickest Paleozoic sections in Utah. The northern Lakeside Mountains expose Cambrian to Pennsylvanian strata and the Grassy Mountains expose Pennsylvanian and Permain strata. A Tertiary augite basalt porphyry flow is found in the southwestern corner of the area, and the unconsolidated Quaternary alluvial and eluvial deposits in the intermontane areas, complete the exposed rock suite of the area.

Normal faults and open folds of the Lakeside Mountains are related to Paleocene uplift of northern Utah highland, of which they formed the west flank. Concurrent uplifts in Newfoundland area and northern Utah highland compressing the intervening Grassy Mountain area, which resulted in overturning, tight folding and thrusting of the strata. Both Lakeside and Grassy Mountains were later affected by Basin-and-Range block faulting.

A Tertiary fissure-type eruption in southwest corner of area (Grayback Mountain) and several related dikes occur in the Grassy Mountain area.

Lakeside mining district consists of several mines in the central Lakeside Mountains; ore deposits are fault-controlled and consist chiefly of oxidized lead and zinc minerals. *Abstract revised (B. C.)*

143. DOLAN, WILLIAM M., 1957, Location of geological features by radio ground wave measurements in mountainous terrane: Univ. of Utah M. S. thesis, 36 p.

Near-surface geologic features have been located with significant success by observation of variations in broadcast radio ground wave intensities over these features in regions of little or no topographic relief. Topography has a distinct effect upon ground wave propagation and thus as investigation of the method in a region of mountainous terrain was warranted. Radio field intensity measurements were made in the East Traverse Range, at the border of Utah and Salt Lake Counties, Utah, using the fields of seven different radio stations at different locations. Effects on the radio signals due to geology can be resolved from those due to topography by measuring the field intensities of radio stations in opposite directions at each field station along a traverse.

Radio intensity anomalies of about 2,500 microvolts per meter were observed along profiles across the Wasatch fault zone and the inferred fault on the northern margin of the East Traverse Range.

From author abstract

144. DUKE, DAVID ALLEN, 1959, Jasperoid and ore deposits in the East Tintic mining district: Univ. of Utah M. S. thesis, 60 p.

Samples collected from drill hole core, surface exposures, and from jasperoid masses in the new Burgin mine were prepared for petrographic and spectrographic analysis. Minerals, textures and structures were determined petrographically. In addition, semiquantitative spectrographic analyses were obtained for aluminum, copper, iron, lead, magnesium, manganese, silver, titanium and zinc.

The petrographic study indicated that differences exist between those jasperoids which occur within 100 feet of ore and those which do not. The presence of barite, galena, hematite and sphalerite is good evidence that the jasperoid is near ore. Clay minerals, chalcedony and jarosite are more common in jasperoids which are removed from ore. Textural features such as microbrecciation, variable quartz sizes, and vugs are all indicative of jasperoid which occurs near ore.

Spectrographic data suggest that traces of silver, lead, and zinc, as determined spectrographically, distinguish the productive from the nonproductive jasperoid. The spectral intensities of other trace constituents are not as clearly an indicator. However, a statistical treatment of these data shows a significant variation between the jasperoids within 100 feet of ore mineralization and those removed from ore. *From author abstract*

145. DUKE, WALTER CLIFFORD, 1965, Turonian (Cretaceous) stratigraphy and micropaleontology, Cumberland Gap, Wyoming-Woodside, Utah: Univ. of Colorado M. S. thesis, 103 p.

Twenty-two species of calcareous foraminifers, 11 species of arenaceous foraminifers, 4 species of ostracods and 1 radiolarian were recovered from Turonian strata (interbedded sandstones and shales of marine and marginal marine origin) measured and sampled at Cumberland Gap, southwestern Wyoming and Woodside, east central Utah. Of five microfossil assemblages recognized, only the Marginulinopsis amplaspira microfauna is used in correlation. This microfauna has not been found beyond the combined stratigraphic ranges of Inoceramus labiatus and Selwynoceras woollgari, and marks a regional index zone in lower Turonian strata. Middle Turonian strata are correlated using the middle Turonian unconformity and the latest middle Turonian zone of Prionocyclus wyomingensis.

At Cumberland Gap, the lower 687 feet of Upper Frontier Formation comprise 3 lower Turonian members: Coalville Member bears Inoceramus labiatus, Allen Hollow Shale Member contains M. amplaspira microfauna, and Oyster Ridge Sandstone Member bears Selwynoceras woollgari. Basal 450 feet of Mancos Shale at Woodside comprise the Tununk Shale Member, Ferron Sandstone Member and lower 63 feet of Blue Gate Shale Member. Basal Turonian unconformity separates Dakota Sandstone (uncertain age) from overlying Mancos. Lower portion of Tununk Shale bears M. amplaspira and S. woollgari zones. Ferron and Blue Gate Members lie in zone of P. wyomingensis. *Abstract revised (B. C.)*

146. DUNN, DAVID EVAN, 1959, Geology of the Crystal Peak area, Millard County, Utah: Southern Methodist Univ. M. S. thesis.

Ordovician rocks exposed in the Crystal Peak area are, in ascending order: The Canadian Fillmore and Wahwah Limestones; the Champlainian Juab Limestone, Kanosh Shale, Lehman Formation, Swan Peak Quartzite, Crystal Peak Dolomite, and Eureka Quartzite; and the Cincinnatian Fish Haven Dolomite.

Crystal Peak is a Tertiary volcanic vent composed of white quartz rhyolite which exhibits both extrusive and hypabyssal phases. The areal extent of the rhyolite is several times as great as that of Crystal Peak itself. Some contact metamorphism is indicated by xenoliths of the country rock altered to garnet and diopside.

Structural features include: several northwest-southeast trending high-angle faults having stratigraphic throws up to 500 feet; collapse breccias having maximum stratigraphic displacements up to 2,000 feet; and a large xenolith, 600 feet in diameter, 2,000 feet below its normal stratigraphic position. These structural features are genetically related to explosions of the vent and the emplacement of the rhyolite. *Author abstract*

147. EARDLEY, ARMAND J., 1930, Structure, stratigraphy and physiography of the southern Wasatch Mountains, Utah: Princeton Univ. Ph. D. thesis.

_____ 1932, Stratigraphy of the southern Wasatch Mountains, Utah: Mich. Acad. Sci. Paper 18, p. 307-344.

_____ 1933, Structure and physiography of the southern Wasatch Mountains, Utah: Mich. Acad. Sci. Paper 19, p. 377-400.
(Abs.): Geol. Soc. America Bull., v. 44, p. 83-84

Unconformably overlying the Archean basal complex are algonkian quartzites and shales (500-1,000 feet), Lower (?) Cambrian Tintic Quartzite (900 feet), Lower Middle Cambrian Ophir Shale (200-300 feet), Cambrian and undifferentiated limestones and dolomites (about 2,300 feet), Mississippian Madison and Brazer (1,600 feet), Pennsylvanian intercalated series (about 10,000 feet), Lower Triassic (?) Woodside Formation (200-500 feet), Lower Triassic Thaynes Formation (500-1,000 feet), Triassic (?) Ankareh Formation (1,400 feet), Upper Jurassic shales (3,000-9,000 feet), lower Eocene Wasatch Conglomerate (0-1,200 feet), Pliocene (?) volcanic rocks (0-800 feet), Pleistocene Salt Creek Fanglomerate (about 100 feet), and Pleistocene and Recent alluvium (0-3,000 feet).

[From Mich. Acad. Sci. Paper 180]

Laramide revolution and Basin-and-Range deformation were cheifly responsible for existence and structure of southern Wasatch Mountains. The first disturbance resulted in a great overturned fold and thrust fault. Thrust fault occurred at the base of the overturned flank of the fold and has a horizontal displacement of about one mile. Total crustal shortening of fold and fault together is calculated to be about 13 miles. The overriding block moved from west to east.

Three erosion surfaces older than the present one but younger than the Laramide revolution are recognized, the first pre-dating the deposition of the lower Eocene Wasatch Conglomerate and having a relief of, at least, 10,000 feet; the second pre-dating Pliocene (?) volcanism and having a relief of about 7,000 feet; and the third pre-dating initiation of block-faulting and having a relief of 3,500 feet.

Block faulting began at the close of the Tertiary and has continued to the present time. Total displacement is about 6,000 feet, all but 100 feet of which transpired before the older glaciation (Iowan ?) of the Wasatch Mountains. The fault planes dip about 50° to the west. The larger, westward-flowing streams maintained their courses across the rising and tilting fault blocks by cutting deep gorges through them.

Abstract (Geol. Soc. America Bull.)

148. EARLL, FRED NELSON, 1957, Geology of the central Mineral Range, Beaver County, Utah: Univ. of Utah Ph. D. thesis, 112 p., geol. map.
(Abs.): Dissert. Abs., v. 17, No. 12, p. 2978, 1957.

Stratified rocks, exposed within the mapped area, include from the base to the top: 3,000 feet of Precambrian gneiss, schist, and metaigneous rocks; 3,000 feet of lower Paleozoic limestone and dolomites; 1,000 feet of Mississippian limestones referred to the Topache Formation; the Permian Coconino and Kaibab Formations aggregating almost 2,000 feet; the Triassic Moenkopi Group some 2,000 feet in thickness; the Jurassic Navajo Sandstone and Carmel Limestone with an aggregate thickness of roughly 2,000 feet; the Cretaceous Claron (?) Conglomerate; and Quaternary deposits of Bonneville age which are exposed on the western flanks of the range.

Unconformities are recognized above the Precambrian, at the base of the Mississippian, at the base of the Permian and at the base and at the top of Cretaceous. Two stages of faulting are recognized in the late Cretaceous or early Tertiary time associated with the Laramide orogeny.

Igneous rocks include the Mineral Range pluton; the small Lincoln stock and numerous related bodies; andesite, aplite, and pegmatite dikes; large granite sills; a northern rhyolitic volcanic series; and a southern volcanic series composed of basal andesites, grading into quartz latites, and capped by basalt.

Emplacement of the Mineral Range pluton is believed to have occurred in Late Cretaceous or Early Tertiary time. The body is remarkably homogenous, throughout its central part, being composed of coarse-grained granite which is characterized by a marked deficiency in the normal ferromagnesian components and calcium. The western margin of the body, however, has a gradational contact with the Precambrian rocks which forms a linear belt of ferromagnesian rich rock. The southern volcanics post-date folding and initial fault movements, and pre-date the second stage of faulting. The northern, Late Tertiary volcanics, post-date uplift of the range and pre-date the Pleistocene Lake Bonneville.

Although mining is near standstill, the Bradshaw, Lincoln, Granite and North Granite mining districts have produced complex ores of gold, silver, lead, and copper, and some tungsten. Total production is valued at about $516,000.00. Beryllium ore has recently been discovered. Pumice, perlite and some building and decorational stone have also been exploited. *From author abstract*

149. EAST, EDWIN H., 1956, Geology of the San Francisco Mountains of [Beaver County] western Utah: Univ. of Washington M. S. thesis, 138 p.

_____ 1957, Evidence of overthrusting in the San Francisco Mountains, Beaver County, western Utah (abs.): Geol. Soc. America Bull., v. 68, No. 12, pt. 2, p. 1825-1826.

Presence of an extensive overthrust necessitates the following stratigraphic revision: 3,000 feet Prospect Mountain Quartzite, Precambrian (?)-Lower Cambrian; 670 feet Ely Limestone, Pennsylvanian; 1,440 feet Pogonip Group, predominantly Kanosh Shale, Ordovician; and 3,440 feet limestone and dolomite undifferentiated, Middle (?)-Upper Cambrian.

The thrust plate of Prospect Mountain Quartzite underlies the crest of the mountains in the northern part of the area mapped and forms the bulk of the range farther north. Two small klippes remain at the southern end of the range.

Middle (?) and Upper Cambrian carbonates form the western base of the mountains. They are truncated by the overthrust and by faulting against Kanosh Shale. The Kanosh Shale is exposed beneath the overthrust on both flanks of the range. The Ely Limestone, which is not in contact with the thrust sheet, is faulted against questionable Cambrian carbonates in the southern end of the range. The Ely Limestone, the questionable Cambrain carbonates, and the klippes are separated from the main mass of sedimentary strata by a quartz monzonite intrusion.

Exposures beneath the thrust sheet on both sides of the range indicate that the overthrust has no root within the range and has an apparent horizontal displacement greater than the 4-mile width of the range. *From published abstract*

150. EDMISTEN, NEIL, 1952, Micropaleontology of the Salt Lake Group, Jordan Narrows, Utah: Univ. of Utah M. S. thesis, 78 p.

The Salt Lake Group is exposed in the Jordan Narrows about 25 miles south of Salt Lake City, Utah. The Pliocene (?) nonmarine sediments are primarily white marls, but clays, sands, pumicite, and a fanglomerate are present; commonly in unconformable relationship. Two beds of marl have yielded microfossils. Charophyta (calcareous algae) belonging to one family, three genera, eight species (four new), and one new variety are described and figured alone with Ostracoda belonging to three families, five genera, eight species (four new), and one new variety. The environment indicated by these forms is a shallow, freshwater lake of wide extent. A general description of the Charophyta and their stem fragments, and a growth study of a species of the Ostracoda are presented. The term "Salt Lake Group" is retained to include the sediments previously described as formational. *Author abstract*

151. EDVALSON, FREDRICK M., 1947, Stratigraphy and correlation of the Devonian in the central Wasatch Mountains, Utah: Univ. of Utah M. S. thesis, 58 p.

This investigation of the Devonian rocks in the central Wasatch Mountains involved (1) determination of the age of the rocks, (2) examination of literature on Devonian formations in surrounding states, (3) detailed measurement and description of a section of Devonian rocks on Beck's Spur, (4) review of certain Devonian problems as derived from literature, (5) preparation of faunal table of Devonian formations between the Sierra Nevada Mountains and Rocky Mountains, and (6) preparation of tentative paleogeographic maps of the West. Results indicate that the Devonian rocks of the central Wasatch Mountains closely resemble the Upper Devonian Ouray Limestone of Colorado, and that a faunal correlation may be made. The name Beck's Formation has been proposed for this Utah formation. *From author abstract*

152. EGBERT, ROBERT L., 1954, Geology of the East Canyon area, Morgan County, Utah: Univ. of Utah M. S. thesis, 34 p., geol. map.

The East Canyon area is located about 20 miles northeast of Salt Lake City, Utah, and is comprised of nearly 140 square miles in Morgan County, Utah. The formations exposed are the Preuss Formation of Late Jurassic age, the Kelvin Formation of Early Cretaceous age, the Frontier and Wanship Formations of Late Cretaceous age, and the Almy, Fowkes, Knight, Norwood and Pliocene (?) fanglomerate of Tertiary age.

Structures of the area include three synclines, each a result of a different period of deformation ranging from early Laramide to latest Laramide time. A high-angle reverse fault of Paleocene age thrust the Jurassic Preuss Formation beds against the Paleocene Almy beds and turned them up sharply. Post-Oligocene normal faulting along the Paleocene fault dropped Norwood beds against the upturned Almy beds. The later movement has been termed the East Canyon fault.

The area underwent four, and possibly five, orogenic impulses. The first was the Cedar Hills orogeny of the Early Cretaceous. Early, middle and late Laramide disturbances are recognized and the most recent is one of volcanism which resulted in deposition of the Norwood Tuff. *Author abstract*

153. EHLMANN, ARTHUR J., 1958, Pyrophyllite in shales of north central Utah: Univ. of Utah Ph. D. thesis, 105 p. (Abs.): Dissert. Abs., v. 19, No. 8, p. 2099, 1959.

_____ and L.B. Sand, 1959, Occurrences of shales partially altered to pyrophyllite, in A. Swineford, ed., Clays and clay minerals: Internat. Ser. Mons. Earth Sci., v. 2, p. 386-391.

Examination of samples from various exposures in north central Utah has revealed an unusual association of disseminated pyrophyllite with clay minerals in apparently unmetamorphosed shales. The pyrophyllite occurs in widely separated locations in three stratigraphic units: the Manning Canyon Formation (Mississippian-Pennsylvanian), the Great Blue Formation (Mississippian), and the Big Cottonwood Series (Precambrian). Associated clay minerals occurring with the pyrophyllite are illite, illite-montmorillonite mixed-layer clay, chlorite, kaolinite and sericite.

Outcrops of the Manning Canyon Formation in and near the Lake Mountains contain shales with higher pyrophyllite content than other outcrops of shale in the area studied. The pyrophyllite particles are relatively large and concentrate in the coarse size fractions of the shale, whereas, the other clay minerals are finer-grained.

Several explanations of genesis are considered and the most acceptable hypothesis is that of hydrothermal alteration. It is hypothesized that magnesium, iron, and interlayer cations were removed from some of the original clay minerals, which, with the addition of silicon, formed pyrophyllite. *Author abstract*

154. EICHER, DON LAUREN, 1955, Stratigraphy and micropaleontology of the Curtis Formation, northwestern Colorado and northeastern Utah: Univ. of Colorado M. S. thesis, 102 p.

_____ 1955, Microfossils of the Curtis Formation, eastern Uinta Mountains, Utah-Colorado: Intermtn. Assoc. Petroleum Geologists, 6th Ann. Field Conf., Guidebook, p. 27-31.

The Upper Jurassic Curtis Formation of northwestern Colorado and northeastern Utah consists of dark shales, fine-grained sandstones, and thin, fragmental and oolitic limestones, all of which contain glauconite. It is 200 feet thick in northeastern Utah, thins southeastward, and pinches out in northwestern Colorado.

Twenty-one species of Foraminifera, one new, and eleven species of Ostracoda are recorded. The Foraminifera are mainly calcareous, and most species belong to the Lagenidea. Though they are varied and well preserved, they are relatively rare in the Curtis of this area. Ostracods, however, are common. The microfauna substantiates correlation with the Swift Formation of eastern Wyoming and adjacent areas.

Aparchitocythere is the most abundant ostracod genus and is typical of the Curtis as a whole. Within the Curtis two ostracod assemblages were found; the lower one contains Progonocythere and the upper one contains Leptocythere and Cytherura. These are equivalent to zones provisionally designated in the Swift Formation.

A widespread, fossiliferous, flat-bedded sandstone which occurs above the underlying Entrada Formation is a basal (transgressive) sandstone of the Curtis Formation. Curtis sedimentation occurred mainly in a normal marine environment. Near Meeker, Colorado, Curtis rocks interfinger with contemporaneous continental deposits. Continental sedimentation followed closely the ultimate retreat of the Curtis sea. *Abstract revised (B. C.)*

155. ELISON, JAMES H., 1952, Geology of the Keigley quarries and the Genola Hills area [Utah County], Utah: Brigham Young Univ. M. S. thesis, 76 p., geol. map.

The Keigley quarries and Genola Hills area covers about 4 square miles on the eastern edge of the Basin and Range Province, on the northern end of Long Ridge and the southern end of West Mountain. Paleozoic strata aggregate 6,800+ feet. Cambrian strata include: Tintic Quartzite, Ophir Formation, Teutonic Limestone, Dagmar Limestone, Herkimer Limestone, Bluebird Dolomite, Cole Canyon Dolomite, and Opex Dolomite. Thus Cambrian sedimentation progressed from coarser to finer clastics and to chemical deposits. The Pinyon Peak Limestone is an offshore, clear-water marine Devonian deposit. Mississippian formations include the neritic Gardner Dolomite, Pine Canyon Limestone, Humbug Formation and Great Blue Limestone. Quaternary sediments are present also.

Mapped area is part of a large overthrust sheet, displaced an unknown distance from west or southwest during Cedar Hills and/or Montana phase of early Laramide orogeny. Faulting, related to the thrusting, is prevalent. Cambrian limestones and dolomites are used as fluxes in local steel mills.

Abstract revised (B. Y. S.)

156. El-MAHDY, OMAR RASHEED, 1966, Origin of ore and alteration in the Freedom No. 2 and adjacent mines at Marysvale [Piute County], Utah: Univ. of Utah Ph. D. thesis, 216 p.
(Abs.): Dissert. Abs., sec. B, v. 27, No. 8, p. 2744B-2745B, 1967.

Uranium mineralization, developed probably in the Pliocene, was emplaced in the quartz monzonite, the granite, the aplite dikes, and in the Mount Belknap rhyolite. The uranium occurs mostly as pitchblende-bearing fluorite breccia vein systems trending N. 55°-85° E., N. 20°-30° W., and north-south. These vein systems coincide with faults having mostly vertical or near-vertical dips. Secondary uranium minerals including autunite, torbernite, and schroekingerite, formed by supergene action in the veins and in the associated country rocks.

It is suggested that the main cause of alteration in these mines is the solutions resulting from the oxidation and solution of the pyrite associated with the veins and the country rocks. The lower percentage of pyrite in the near surface levels is due to its being oxidized and dissolved thus yielding slightly acidic solutions that altered the veins and the surrounding country rocks.

The presence of alteration in and around the veins depends mainly upon the availability of open spaces or permeability, and upon the proximity of the veins and the country rocks to the altering solutions. The rocks exposed on the surface, and on the upper levels of the mines are closer to the surface and action of the supergene solutions than are the rocks exposed on the deeper levels. In addition, the surface rocks appear to be more fractured, and thus more permeable, than those of the deeper levels.

Three types of alteration were recognized: deuteric, hydrothermal and supergene. The deuteric alteration produced mainly minor amounts of sericite and illite scattered in the feldspars; chlorite and magnetite rims on the biotite; and the development of graphic and myrmekite textures. The hydrothermal alteration consisted of silicification and pyritization of the veins and the country rocks, and the formation of some calcite. Supergene alteration produced mainly montmorillonite, illite, allophane, kaolinite and iron oxides. Some calcite and quartz formed by supergene alteration. *From author abstract*

157. EMIGH, GEORGE D., 1956, The petrography, mineralogy and origin of phosphate pellets in the western Permian formation and other sedimentary formations: Univ. of Arizona Ph. D. thesis, 157 p.
(Abs.): Dissert. Abs., v. 16, No. 8, p. 1428, 1956.

_____ 1958, The petrography, mineralogy, and origin of phosphate pellets in the Phosphoria Formation: Idaho Bur. Mines and Geol. Pamphlet, No. 114, 60 p.

Specimens for chemical analysis and petrographic examination were collected from different sedimentary phosphate deposits in the United States. The formations covered include: the Permian formation of Montana, Idaho, Wyoming and Utah; the Ordovician formations of middle Tennessee; the Pennsylvanian formation of northern Arkansas; and the nodular phosphorites on the sea floor off the coast of California.

Petrographic examination reveals the phosphate to be similar in physical form and mineralogy in all the formations studied. Physically, the phosphate is present as rounded pellets of diverse origin. A classification of five pellet types has been set up: fossil, encased, nodule, oolite, and multiple. Mineralogically, the pellets are microcrystalline aggregates of what appears to be one mineral. This is the carbonate-fluorapatite mineral francolite.

It is proposed that the phosphate pellets are replaced calcium carbonate pellets. The carbonate pellets were formed originally on the sea floor by the action of ocean currents. The phosphate was derived from normal sea water and is not dependent on unusual concentrations of phosphorus or necessarily on ocean conditions favorable to chemical precipitation of calcium phosphate.

If the hypothesis of formation and origin of the phosphate pellets is correct, phosphate can be formed under any marine conditions but will be more concentrated under certain conditions.

The confusion as to the definition of the term "phosphorite" is reviewed and a new definition proposed.

A new classification of sedimentary phosphates is proposed.

The geology of the western Permian phosphate formation is reviewed briefly and is augmented with a few special comments on the formation in southeastern Idaho. Among these is the proposal that the microcrystalline quartz of the Rex Chert Member of the Phosphoria Formation is derived from the diagenesis of beds of siliceous sponge spicules.

From author abstract

158. ERICKSON, MAX P., 1940, Thermal metamorphism of the ancient tillite of the Alta region [Salt Lake County], Utah: Univ. of Utah M. S. thesis, 36 p.

Stringham, B.F. and M.P. Erickson, 1948, Thermal metamorphism of tillite at Alta, Utah: Am. Mineralogist, v. 33, Nos. 5-6, p. 369-372.

The tillite of Alta contains a green mineral occurring in masses which resemble rock fragments in size, shape and distribution. Carbonate rock fragments are absent from the tillite, though present in abundance in tillites of other localities.

The green mineral is found to be actinolite and relationships indicate that it was formed by reaction of dolomite rock fragments with solutions containing silica and iron. Replacement features are found that indicate that the silica and iron were derived from the matrix adjoining the dolomite fragments.

Other less noticeable features of metamorphic and metasomatic processes are found in thin sections.

Author abstract

159. ERIKSSON, YVES, 1960, Geology of the upper Ogden Canyon, Weber County, Utah: Univ. of Utah M. S. thesis, 55 p., geol. map.

Ogden Canyon is located immediately east of Ogden, Utah, and traverses the north central Wasatch Mountains to Ogden Valley. The formations exposed in the upper Ogden Canyon are: overthrust Proterozoic beds; the Devonian Jefferson Dolomite, subdivided into the Hyrum and Beirdneau Members; the Mississippian Madison Limestone, Deseret Limestone, and Humbug Formation; and the Tertiary Knight Conglomerate and Norweed Tuff.

Unconformities are recognized between the Beirdneau Member of the Jefferson and the Madison Limestone, and between the Madison and the Deseret Limestones. An emergent area to the northwest at the end of Madison deposition is proposed.

Several north-south-trending normal faults of small displacement, probably of Laramide age, cut the rocks at the head of Ogden Canyon. The west side of Ogden Valley is marked by a northwesterly trending normal fault of the Basin-and-Range system.

Proterozoic rocks rest across the beveled edges of the Paleozoic formations on both sides of Ogden Canyon. This is the Willard thrust, and problems of its mode of emplacement and direction of movement are discussed.

Author abstract

160. ESKELSEN, QUINN M., 1953, Geology of the Soapstone Basin and vicinity, Wasatch, Summit and Duchesne Counties, Utah: Univ. of Utah M. S. thesis, 45 p., geol. map.

The Soapstone Basin area is located about 12 miles southeast of Kamas, Utah. Rocks present include Precambrian, Paleozoic, Tertiary and Quaternary formations. Mesozoic and Cenozoic formations have been removed by erosion. Ordovician and Silurian rocks were not deposited and Devonian strata were removed by subsequent erosion.

Structurally, the area is located on the southern limb of the Uinta arch. The South Flank fault extends across the area as a complex zone of fractures. Two major unconformities are present: (1) the basal Cambrian unconformity, represented by angular discordance of the Tintic Quartzite on older rocks, and (2) the unconformity below the basal Madison Limestone (Mississippian) which rests on rocks of Cambrian age and locally upon Precambrian strata.

The Gilbert Peak surface, which was developed in Miocene (?) time, is projected into the area. The streams are generally in harmony with the structure and some have been modified by glaciation. Run-off from the area contributes to both Great Basin and Colorado River drainage systems.

From author abstract

161. EVANS, MAX THOMAS, 1951, Geology and ore deposits of the Great Western mine, Marysvale region [Piute County], Utah: Brigham Young Univ. M. S. thesis.

_____ 1953, Geology and ore deposits of the Great Western mine, Marysvale region, Utah: Compass, v. 30, No. 2, p. 102-108.

The Great Western mine, Ohio mining district, Piute County, is one of the five largest gold-silver-lead producers in the Bullion Canyon region. The more widely known alunite and uranium mineralization occur some miles to the east.

The mineralogic and paragenetic sequences of the minerals in the mine appear to be quartz, siderite, fluorite, calcite, pyrite, sphalerite, tetrahedrite, galena, chalcopyrite, late quartz, gold and silver.

The ores deposited in complete sequences under changing conditions, so variations in the proportions of minerals are abrupt. Oxidation and minor secondary enrichment of primary ores occurred. The largest ore bodies occur at intersections of north-south and east-west faults, and indicate apparent structural control by these faults.

Quartzite adjacent to the vein shows little alteration except for some pyritization. Volcanic wall rock, however, shows considerable alteration along and near the veins. These volcanics and the primary minerals in them have been altered by abundant quartz, pyrite, sericite, calcite, chlorite and kaolinite. *Abstract of published article (B. Y. S.)*

162. EVENSEN, CHARLES G., 1953, A comparison of the Shinarump Conglomerate on Hoskinnini Mesa with that in other selected areas in Arizona and Utah: Univ. of Arizona M. S. thesis, 88 p.

The Shinarump Conglomerate is believed to have been deposited by braided stream systems, due to uplifts near margins of present Colorado Plateau during Late Triassic time. Thickness (50-100 feet) is remarkably uniform over an area of about 100,000 square miles. The Shinarump underlies and may be the basal conglomerate of the Chinle Formation (Upper Triassic). In most areas it overlies Moenkopi Formation (Lower and Middle Triassic) but in places it rests upon De Chelly Sandstone (Permian). Upper contact is gradational whereas basal contact is a conspicuous erosional unconformity, with bleached Moenkopi strata below.

The Shinarump consists of sandstone, conglomerate and minor mudstone. Sedimentary structures include lenses, planar- and trough-type cross strata, sand concretions, ripple marks, mud cracks, current lineation marks, and unconsolidated rock deformation. Direction of dip of cross-strata can be used to divide the formation at any one locality into vertical zones. Lithology and sedimentary structures indicate source areas to the south and east.

Uranium mineralization is apparently controlled by pre-Shinarump erosion channels, permeability, clay deposits, carbonized wood, and possibly by regional structures. Mineralizing solutions appear to have travelled in a manner characteristic of ground-water movement. *Abstract revised (B. C.)*

163. EVERETT, KAYE R., 1958, Geology and ground water of Skull Valley, Tooele County, Utah: Univ. of Utah M. S. thesis, 92 p., geol. map.

Unconsolidated sediments of Tertiary and Quaternary age predominate in Skull Valley. Outcrops of Paleozoic rocks ranging in age from Cambrian to Late Mississippian protrude through the sediments. Ground water comes exclusively from the unconsolidated lake and fan sediments, with Paleozoic outliers acting as barriers to ground-water movement.

Dominant structural features are folds and faults. The largest fold comprises the main part of the Stansbury Mountains. Normal faults bound the mountain block and traverse the valley in parallel fashion, making up the Skull Valley fault zone. Canyon and valley springs are mainly related to the faulting.

Topography and vegetation indicate that the water table rises northward and valleyward. The water becomes increasingly saline in these directions. Measurements (made by steel tape) of accessible wells reveal no interference from one well to another, and show no depletion of the ground-water reservoir. The area can be divided into a northern (saline) reservoir and a southern (freshwater) reservoir. An accelerated drilling program to increase the number of acres under cultivation is justified in the southern reservoir. Drilling in the northern reservoir must be limited and confined to the alluvial fans. *Abstract revised (B. C.)*

164. EZELL, ROBERT L., 1953, Geology of the Rendezvous Peak area, Cache and Box Elder Counties, Utah: Utah State Univ. M. S. thesis, 50 p., geol. map.

The Rendezous Peak area is centrally located in a little known and critical area between the Logan Peak syncline in the Bear River Range and the more complex structures in the Wasatch Range. Rocks of all periods of the Paleozoic era except Pennsylvanian and Permian are exposed. Rocks of Tertiary age overlap Paleozoic rocks in northeastern part of area. A conspicuous syncline in Paleozoic rocks, which plunges north-northwest, as well as many high-angle faults of Basin-and-Range age are found. The high-angle faults trend mostly north-south as do major faults in Logan quadrangle to the north. Other high-angle faults in the area trend east-west. One major fault extends northeast-southwest.

Two high-level erosion surfaces are recognized: the Rendezvous Peak erosion surface, found on the higher peaks composed of Paleozoic rocks, which slopes eastward toward the southern part of Cache Valley, and the McKenzie Flat surface which is lower and truncates Tertiary and adjacent Paleozoic rocks in the northeastern part of the area. *Introduction revised (B. C.)*

165. FAGADAU, SANFORD PAYNE, 1949, An investigation of the Flagstaff Limestone between Manti and Willow Creek Canyons in the Wasatch Plateau, central Utah: Ohio State Univ. M. S. thesis.

Flagstaff Formation covers almost the entire Wasatch Plateau. It is underlaid conformably by the North Horn Formation (Upper Cretaceous-Paleocene) except at one locality where it rests unconformably on rocks of the North Horn Formation and the Indianola Group. It is overlain by Colton Formation (Eocene). The formation is composed of argillaceous limestones; minor amounts of oolitic and ostracodal limestones; beds of chalk, chert, gypsum and travertine; and at many places shales, sandstones, and pebble conglomerates. Stratigraphic sections give thickness and lithologic composition at ten localities; petrography was studied by insoluble residues and thin sections of selected specimens.

Fauna has great stratigraphic range. Many invertebrate genera occur in the underlying North Horn and overlying Colton and Green River Formations. Fossils are found in argillaceous limestones and shales. Some genera inhabited small ponds and enclosed bays; others lived in streams. Lithologies and relative abundance of freshwater mollusca suggest lacustrine environment. Environmental conditions frequently changed to halt deposition of one lithology and initiate the deposition of another lithology. Assignment of the Flagstaff Formation to Paleocene age was based largely on stratigraphic relationships, however, this assignment is amply justified by the invertebrate evidence. Twenty-four species of invertebrate fossils are identified. *From author abstract*

166. FAULK, NILES RICHARD, 1948, The Green River Formation in the Manti-Spring City area of [Sanpete County] central Utah: Ohio State Univ. M. S. thesis, 84 p.

Lacustrine Green River beds totaling approximately 500 feet in thickness are exposed in a series of cuestas from Spring City to Manti. Although continuity is broken at each cuesta, three distinct zones may be correlated easily.

Basal zone A consists dominantly of green and brown shales, averaging 240 feet in thickness. Also present are volcanic tuffs, "coffee ground beds" -- weakly cemented algal (?) material, brown algal reefs, iron-stained volcanic ash layers, and "shale-pebble" conglomerates.

Zone B averages 180 feet of siliceous oolitic limestones, massive algal reefs, chert beds, argillaceous limestones and calcareous shales with a basal, massive, white, porous, ledge-forming 4- to 6-foot algal reef. A marker bed of ledge-forming brown volcanic tuff 40-45 inches thick separates zones B and C.

Zone C, uppermost and thinnest (30-35 feet thick), is dominantly brownish, platy, dense, thin-bedded limestone which rings like china when struck. Banded brown and black chert concretions with jasperoid and chalcedonic centers are common.

Summary and conclusions revised (B. Y. S.)

167. FETZNER, RICHARD W., 1959, Pennsylvanian paleotectonics of the Colorado Plateau: Univ. of Wisconsin Ph. D. thesis. (Abs.): Dissert. Abs., v. 19, No. 8, p. 2062-2063, 1959.

_____ 1960, Pennsylvanian paleotectonics of Colorado Plateau: Am. Assoc. Petroleum Geologists Bull., v. 44, No. 8, p. 1371-1413.

During the Pennsylvanian interval of time, the Colorado Plateau area underwent the most active period of tectonic activity of the Paleozoic and Mesozoic eras. Sediments that resulted from this activity present the most diverse lithologic types encountered in the entire stratigraphic section of the area. From stratigraphic and lithologic data acquired from 172 control points, the paleotectonic relationships of the Pennsylvanian period have been reconstructed. This was accomplished through the use of isopach maps, lithologic ratio maps, vertical sandstone distribtuion maps, field evidence, and paleontological data.

The Pennsylvanian tectonic elements of this area defined a parageosyncline that was occupied by a continuous seaway. Greatest submergence occurred in the north where the Paradox Salt Basin formed. To the south, depositional centers formed in the ancestral San Juan Basin and the Lucero Basin. This seaway opened northwest into the rapidly subsiding Oquirrh Basin, northeast into the Colorado trough, southeast into the southern Colorado trough, and southwest into the Sonora geosyncline. The seaway was bounded to the northwest by the Emery uplift, to the northeast and east by the Uncompahgre and Santa Fe uplifts, and to the west and southwest by the Kaibab-Zuni uplift. The Defiance uplift, a structural subsidiary or the Kaibab-Zuni lineament, projected north into the Paradox Salt Basin where it strongly affected depositional patterns during Pennsylvanian time. The Penasco uplift existed in the southern part of the seaway and partially separated it into two depositional basins.

None of these structural elements was tectonically contemporaneous, and each had different influences upon Pennsylvanian sediments. *From author abstract*

168. FIERO, G. W., Jr., 1958, Geology of Upheaval Dome, San Juan County, Utah: Univ. of Wyoming M. S. thesis, 87 p., geol. map.

Upheaval Dome, a circular structure 3 miles across, lies in northern Paradox Basin between the laccolithic intrusions of the Abajo, La Sal and Henry Mountains, in the region of the northwest-trending salt anticlines. Exposed formations are primarily continental Triassic and Jurassic strata, aggregating about 1,700 feet in thickness.

Salt intrusion theory of origin is favored. The first upward movement occurred in Late Triassic. Following deposition of the Jurassic Navajo Sandstone, renewed uplift took place, and a peripheral syncline developed. Unconsolidated Wingate and Kayenta Formation, with high-water content, were stretched and thinned plastically in the trough of the syncline. Normal faults with average displacement of 20 feet were developed over the crest of the dome and in the outer limb of the syncline due to tension. An indistinct diverse joint pattern was superimposed upon the pronounced northwest trend. Small radial folds developed. Sand from the White Rim Member of the Permian Cutler Formation intruded the Moenkopi Formation at the crest of the structure in the form of dikes and masses, during an early phase uplift. High-angle reverse faults with maximum displacement of 60 feet occurring peripheral to the uplifted central area were created by Laramide deformation. *Abstract revised (B. C.)*

169. FINCH, WARREN IRVIN, 1954, Geology of the Shinarump No. 1 mine, Grand County, Utah, with a general account of uranium deposits in Triassic rocks of the Colorado Plateau: Univ. of California (Berkeley) M. S. thesis.

_____ 1954, Geology of Shinarump No. 1 mine, Seven Mile Canyon area, Grand County, Utah: U.S. Geol. Survey, Circ. 336, 14 p., geol. map.

_____ 1959, Uranium deposits in Triassic rocks of Colorado Plateau: U.S. Geol. Survey Bull. 1074D, p. 125-164.

Shinarump No. 1 mine is in lowermost of three uranium-bearing zones in lower 25 feet of Chinle Formation. The uranium deposit consists of discontinuous lenticular layers of mineralized rock, irregular in outline, that, in general, follow the bedding. Ore minerals, mainly uraninite, impregnate the rock. Uraninite and chalcocite occur in high-grade seams along bedding planes. Guides to ore are bleached siltstone, carbonaceous matter and copper sulfides. Origin of deposit is thought to be hydrothermal.

Important uranium deposits are widely distributed in Triassic rocks of Colorado Plateau region, mostly in the Shinarump and Moss Back Members of Chinle Formation, but also in lower members of Chinle, particularly in beds within 50 feet of the Middle Triassic unconformity. The chief unoxodized uranium minerals, uraninite and coffinite, and the oxidized uranium minerals, carnotite and tyuyamunite, impregnate the rocks, forming disseminated ores. The ore bodies are irregularly distributed and form uneven tabular and concretionary masses that lie essentially parallel to the bedding of channels and lenses filled with coarse clastic material. It is believed that in early Tertiary time uranium and other ore metals were leached and redeposited by ground water in favorable sedimentary and tectonic structures. *Published abstract revised (B. C.)*

170. FOGRASCHER, ARTHUR CARL, 1956, The stratigraphy of the Green River and Crazy Hollow Formations of part of the Cedar Hills (Sanpete County), central Utah: Ohio State Univ. M. S. thesis, 88 p., geol. map.

Exposed rocks of southeastern part of Cedar Hills are Tertiary in age, strike generally north and dip 5°-10° west. Five north-striking faults are present. Oldest strata are fluviatile conglomerate, sandstone and variegated shale of Colton Formation. Next overlying is the lacustrine Green River Formation, consisting of a lower 250-foot green and brown shale with tuff; middle 700-foot algal, ostracodal, oolitic and massive limestone with tuff and green, brown and gray shale; upper 25- to 75-foot unit of shale, tuff, limestone and chert. The Green River is correlative with Green River of Manti-Spring City area. The overlying Crazy Hollow Formation, 175 to 220 feet thick, consists of variegated shale, sandstone, conglomerate and limestone. Remnants of a lacustrine sand bar in lower Crazy Hollow contains fragments of limestone and chert identical with limestone and chert beds in upper Green River. Dominant Crazy Hollow lithology in northern part of area is fluviatile conglomerate; whereas in southern part, conglomerate is absent. Youngest strata in the area are tuffs, 100 feet thick, belonging to the Moroni Formation, lying disconformably upon Crazy Hollow Formation. *Abstract revised (B. C.)*

171. FORRESTER, JAMES D., 1935, Structure of the Uinta Mountains: Cornell Univ. Ph. D. thesis.

_____ 1937, Structure of the Uinta Mountains: Geol. Soc. America Bull, v. 48, p. 631-666.

The Uinta Mountains, 160 miles long and 45 miles wide, are the largest east-west trending range in the western hemisphere. Part of the Rocky Mountain System, the Uintas extend west to Wasatch Range and east to Grand Hogback. The Uinta trough was part of the Rocky Mountain geosyncline, and an arm of the Wasatch trough, which received sediments from Algonkian to Laramide time.

Formations represented are: Red Creek and Uinta Series (Precambrian); Ophir and Pine Valley (Cambrian); Madison and Weber - intercalated (Carboniferous); Park City (Permian); Woodside, Thaynes, and Ankareh (Triassic); Nugget, Twin Creek and Morrison (Jurassic); Dakota, Mancos and Mesaverde (Cretaceous); Wasatch, Green River, Bridger, Uinta, Duchesne River, Bishop, and Browns Park (Tertiary). Tertiary extrusives are present; no intrusives were found.

Structurally the Uinta Mountains are a broad open anticline, somewhat overturned and arcuate to the north. The axis trends roughly east-west, pitches southeast toward Cross Mountain, west-southwest into Kamas Valley and continues under the flows separating the Uinta and Wasatch Ranges. The exact point of reversal in pitch is indefinite but nearer the western end. Minor folds cause local complexities.

Major fault zones include the South Flank, Brush Creek, Yampa, Uinta or Crest, and North Flank. Some faulting was contemporaneous with folding but most occurred thereafter.

Three major periods of diastrophism are responsible for a vertical uplift of about 45,000 feet (maximum) in the Uinta Mountains. These diastrophic events were: folding of the Uinta and Wasatch geosynclines during the Laramide Revolution, due to compressive forces (arches up about 10,000 feet); vertical uplift and large-scale faulting in the late Eocene, raising the area a maximum of 25,000 feet; and late Pliocene or early Pleistocene continental uplift of the general plateau area (8,000- to 10,000-foot rise). *Abstract of published article (B. Y. S.)*

172. FOSTER, JOHN M., 1959, Geology of the Bismark Peak area, North Tintic district, Utah County, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 6, No. 4, 95 p.

The Bismark Peak area is part of the Boulter and East Tintic Mountains near Eureka, Utah. Seventeen Paleozoic formations are present ranging in age from Lower Cambrian to Upper Mississippian. Over 11,000 feet of stratigraphic section is exposed. Some volcanic rocks of very minor extent occur in the area.

The major structural feature is a north-trending north-plunging anticline known as the North Tintic anticline. It is overturned on the east flank and has moderate to gently dipping beds on the west flank. This fold is approximately 6 miles wide with a minimum known length of 15 miles and an amplitude of 16,000 feet. Erosion has breached the anticline so that a valley is now present along the axis except in the area of this report. An overthrust has occurred in the Boulter Peak area which has displaced the beds along the east limb approximately $1\frac{1}{2}$ miles eastward. *From author abstract*

173. FOUTZ, DELL R., 1960, Geology of the Wash Canyon area, southern Wasatch Mountains [Juab and Utah Counties], Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 7, No. 2, 37 p., geol. map.

The Wash Canyon area includes 16 square miles in central Utah belonging to the southern Wasatch Mountains and to Juab Valley (Middle Rocky Mountain and Great Basin Physiographic Provinces). About 6,000 feet of Paleozoic marine sedimentary rocks are exposed, which in some sections are covered with an unknown thickness of Tertiary, Quaternary and possible Upper Cretaceous rocks, mostly composed of coarse clastics.

Although pre-Laramide normal faults of east-west trend occur, most deformation resulted from the Laramide orogeny. Sole of Nebo thrust (Late Cretaceous) probably underlies area. Eocene and Oligocene epochs were marked by north-south folds, and Pliocene and Recent by north-south normal faults, including the Wasatch fault.

Water, gravel, and deposits of calcite are resources of economic value. However, prospecting for lead and silver failed to locate important metallic deposits. *From author abstract*

174. FOWKES, ELLIOTT J., 1964, Pegmatites of Granite Peak Mountain, Tooele County, Utah: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 11, p. 97-127.

Pegmatites constitute 10 to 15 percent of Granite Peak Mountain. They occur mostly as tabular dikes enclosed in leucogranite and biotite granite-gneiss country rock. Three main zones are seen in many pegmatites: a borderwall zone, an intermediate zone and a core. The most common minerals present are microcline, quartz, plagioclase and muscovite. Beryl, tourmaline, garnet and hematite are found in varying lesser amounts. Other minerals are rare. Origin of the pegmatites is considered to be the result of Precambrian magmatic action and/or granitization.

Economic importance of the pegmatites and areas of metallization in the country rock is not considered to be great. *Author abstract*

175. FOX, FERAMORZ, 1906, General features of the Wasatch Mountains: Univ. of Utah M. S. thesis, 57 p.

The purpose of this paper is to present in compact form the principal facts already on record, particularly those found in the publications of the United States Geological Survey. *B. C.*

176. FRANSON, ORAL M., 1950, Sedimentation of the basal Oquirrh Formation, Provo Canyon [Utah County], Utah: Brigham Young Univ. M. S. thesis, 55 p.

The lower Oquirrh represents part of the Springeran, all of the Morrowan and part of the Atokan stages (Pennsylvanian). As a result of this detailed study of the basal 1,360 feet of the Oquirrh Formation, it is possible to determine that the sedimentary environment was marine, on a stable to slightly unstable shelf on the eastern edge of a miogeosyncline in shallow epineritic water. These rocks are in an allochthon (thrust sheet).

Abstract revised (B. Y. S.)

177. FRAZIER, NOAH A., 1951, Heavy mineral study of the Morrison (?) Formation and the Indianola Group of southern Sanpete and northern Sevier Counties, Utah: Ohio State Univ. M. S. thesis, 31 p.

Two transitional sections of rocks of questionable age (Upper Jurassic-Upper Cretaceous) were studied in Red Hills and Salina Canyon, Gunnison and Wasatch Plateaus, and compared with the type section of the Indianola Group, Six Mile Canyon. Regional sequence is: Morrison, Morrison (?), Cedar Mountain Group, Indianola Group -- Sanpete, Allen Valley, Funk Valley, and Six Mile Canyon Formations. In Red Hills section the Morrison (?) is overlain by 950 feet of unnamed conglomerate and sandstone and the Sanpete Formation. In Salina Canyon the Morrison (?), Sanpete, Allen Valley and Funk Valley Formations are present. The Dakota (?) Formation (Cedar Mountain Group) may be present but unrecognized.

The heavy minerals zircon, tourmaline, rutile, garnet and staurolite are found in sections studied and the type Sanpete Formation. Although similarities are evident so little variation occurs in the heavy mineral suites that formational or zonal correlation is impossible.

The type Sanpete is equivalent to 800 feet of sandstone in the Red Hills section. Morrison (?) Formation in the areas studied is equivalent to the Morrison and probably the Cedar Mountain Group at San Rafael Swell. Sedimentation was continuous from late Upper Jurassic (Morrison (?) Formation) through the Sanpete. Part of the Morrison (?) Formation and/or the basal Indianola, as well as the strata between them, may be Lower Cretaceous.
B. Y. S.

178. GAINES, PATRIC W., 1950, Stratigraphy and structure of the Provo Canyon-Rock Canyon area [Utah County], south central Wasatch Mountains, Utah: Brigham Young Univ. M. S. thesis, 66 p., geol. map.

An area embracing approximately 12 square miles in and between Provo Canyon and Rock Canyon in the south central Wasatch Mountains was mapped in detail. Sedimentary rocks of late Proterozoic, Cambrian, Devonian (?), Mississippian, and Pennsylvanian ages are well exposed in the canyons and mountains, and Lake Bonneville sediments are in Utah Valley which lies to the west. The rocks are predominantly types of limestones, although much dolomite is present. In addition, there is a considerable amount of orthoquartzite and shale.

The area has been profoundly affected by at least three orogenic movements: late Proterozoic, mid-Cretaceous, and Late Cretaceous-Early Tertiary. Thrust faulting on both large and small scale has displaced rock masses eastward. Post-thrusting normal faulting of the Basin-and-Range type, has been instrumental in blocking out much of the range; throw on some faults, especially the Wasatch frontal, amounts to almost 10,000 feet.

The area contains but few materials of economic value. No metals are being mined, and other than construction materials of gravel, sand, silt and clay, and some building stone, there is little promise of development in the future. *Author abstract*

179. GARDNER, WESTON CLIVE, 1954, Geology of the West Tintic mining district and vicinity, Juab County, Utah: Univ. of Utah M. S. thesis, 43 p., geol. map.

The region of study is important, not only from the standpoint of additions to geologic knowledge in the Basin and Range Province, but, also, economic aspects justify research in the area.

Sediments ranging in age from Lower Ordovician to Lower Pennsylvanian have been recognized. The dominant structure of the region is the West Tintic thrust plate, which overlies folded and faulted Paleozoic sediments. Structure has been to a great extent obscured by extrusives which cover a large portion of the area.

Geologic history of the region, as interpreted from stratigraphic and structural relations, indicates the following sequence of events: (1) deposition of approximately 12,000 feet of clastic sediments in the Sheeprock - Cottonwood trough in Precambrian time; (2) deposition in the slowly subsiding Cordilleran geosyncline during paleozoic time, with sediments reflecting minor tectonic activity; (3) folding followed by large-scale thrusting during the Cedar Hills orogeny in mid-Cretaceous time; (4) emplacement of monzonitic composition magmas, followed by extensive vulcanism in Eocene time; (5) Basin-and-Range faulting, followed by erosion, has resulted in the present topography. *Author abstract*

180. GARMOE, WALTER J., 1958, A preliminary study of the Mississippian and Lower Pennsylvanian formations in the Park City district, Utah: Univ. of Minnesota M. S. thesis, 62 p.

In the present workings of the mines of the United Park City Mines Company, rocks exposed beneath the Weber Quartzite (Pennsylvanian) include parts or all of the Morgan, Doughnut and Humbug Formations. Thicknesses of the measured formations are as follows: Pennsylvanian Morgan Formation, 329 feet; Mississippian Doughnut Formation, 339 feet; Mississippian Humbug Formation, 740 feet; Mississippian Deseret Formation, 896 feet; Mississippian Madison Limestone, 463 feet. Lack of distinct marker beds, presence of alteration and contact metamorphism, facies changes, and thickness differences from surrounding areas hampered identification and correlation of the formations.

The bedded and irregular replacement-type mineral deposits now being exploited in the Park City district occur in favorable limestone horizons of the Humbug Formation. Location of these ore bodies can be attributed to (1) a chemically favorable host rock, (2) an increase in porosity due to recrystallization, and (3) a development of an effective secondary permeability by fracturing. *B. C.*

181. GATES, JOSEPH SPENCER, 1960, Hydrology of Middle Canyon, Oquirrh Mountains, Tooele County, Utah: Univ. of Utah M. S. thesis, 63 p., geol. map.

_____ 1961, Hydrology of Middle Canyon, Oquirrh Mountains, Tooele County, Utah: Utah Water and Power Board, 7th Biennial Report, p. 56-72.

_____ 1963, Hydrogeology of Middle Canyon, Oquirrh Mountains, Tooele County, Utah: U.S. Geol. Survey, Water Supply Paper 1619K, p. K1-K40.

Middle Canyon is cut into the Pennsylvanian-Permian Oquirrh Formation of sandstones and limestones exceeding 16,000 feet in thickness. Quaternary deposits in the drainage basin include alluvial, colluvial and some glacial material. High-angle normal faults with displacements in the order of 100 feet are concentrated in the upper canyon. The thicker surficial deposits in the upper canyon make it a more important storage area than the lower canyon, and any zones of leakage in the upper canyon such as fault and fracture zones, joints or solution channels, would likely result in greater water loss than would similar outlets farther down canyon.

Total annual discharge of Middle Canyon per unit of precipitation (since 1910) has decreased, probably due mostly to climatic change. However, in 1947, about 50 percent of water estimated to be available for stream flow and channel underflow was unaccounted for, and was assumed to represent leakage out of the drainage basin. In addition, as highly mineralized water from Utah Metals tunnel has little effect on water quality at the canyon mouth, it is probably lost by leakage in the upper canyon. It is recommended that movement of water through channel fill be investigated by drilling in north center of Sec. 6, T. 4 S., R. 3 W.

Abstract revised (B. C.)

182. GATES, ROBERT W., 1951, Ground-water geology of the Spanish Fork-Springville area [Utah County]: Brigham Young Univ. M. S. thesis.

_____ and R. O. Warner, 1951, Ground-water geology of east Utah Valley, Utah: Compass, v. 29, No. 1, p. 39-47.

Utah Valley is an intermont situated along the eastern edge of the Basin and Range Province and is bounded on the east by the western escarpment of the south central Wasatch Mountains. This short (published) report, which summarizes the findings of both authors' theses, concerns the ground-water geology of the east side of Utah Valley from Orem (north) to Spanish Fork (south), about 125 square miles. Data was obtained mainly from logs of water wells; other sources include unpublished data from files of the geology department and its faculty.

Numerous aquifers are present above a depth of 1,200 feet throughout eastern Utah Valley which can provide pure water for culinary and commercial purposes. Most water needs can be met with wells drilled to depths not exceeding 600 feet. A panel diagram (scale 1:12,000) illustrating the nature, depth, thickness and extent of each producing aquifer is on file in the geology department, along with appendices. *B. C.*

183. GEHMAN, HARRY MERRILL, Jr., 1954, Geology of the Notch Peak intrusive, Millard County, Utah: Cornell Univ. M. S. thesis, 69 p., geol. map.

_____ 1958, Notch Peak intrusive, Millard County, Utah -- Geology, petrogenesis, and economic deposits: Utah Geol. and Mineralog. Survey Bull. 62, 50 p., geol. maps.

A stock-like porphyritic quartz monzonite body about 3 miles in diameter is intrusive into Cambrian limestones. Main features are slight doming in sedimentary rocks, steeply dipping contacts, large sill extending about 1 mile to southwest, aplite dikes and sills up to 50 feet thick, orthoclase phenocrysts produced by endomorphism, and pegmatite zones.

Metamorphic effects include widespread isochemical thermal metamorphism, widespread silica metasomatism, and iron-silica metasomatism localized with tungsten and molybdenum ore. Thermally metamorphosed rocks, of the amphibolite facies, are interlayered nearly horizontally with silica-metasomatized zones. Silica-bearing solutions were introduced along bedding-plane joints. Silica metasomatized rocks are characterized by widespread development of idocrase with grossularite, diopside, wollastonite, albite and epidote. This mineral assemblage is of the albite-epidote amphibolite facies and represents the reaction between components originally present in the rock, activated and enriched in silica by circulating solutions.

Sequence of magmatic activity was intrusion of quartz monzonite, isochemical thermal metamorphism, silica metasomatism, aplite intrusion, and iron-silica metasomatism by tungsten- and molybdenum-bearing fluids. Tungsten and molybdenum ores have been formed in tactite bodies localized at intersection of favorable beds with quartz monzonite contact, aplite dikes and joints.

Abstract revised (B. C.)

184. GELNETT, RONALD H., 1958, Geology of southern part of Wellsville Mountain, Wasatch Range [Cache and Box Elder Counties], Utah: Utah State Univ. M. S. thesis.

_____ and S.S. Beus, 1958, Geology of Wellsville Mountain, Wasatch Range, Utah (abs.): Utah Acad. Sci. Proc., 1957-58, v. 35, p. 179 (see also Beus, S.S., 1958).

Wellsville Mountain is 10 miles west of Logan, Utah, at the northern extremity of the Wasatch Range. Paleozoic rocks form a northeast-dipping homocline bounded in part by north-trending high-angle faults and cut by a series of northeast-trending high-angle faults. A major transverse fault, with a stratigraphic displacement of 4,500 feet, divides the mountain into two distinct blocks.

Precambrian rocks crop out in Box Elder Canyon, just east of Brigham City, and are overlain by at least 20,000 feet of northeast-dipping Paleozoic rocks of every period except possibly the Permian. The Beirdneau Sandstone Member of the Jefferson Formation of Devonian age and the Leatham Formation of Lower Mississippian age are not recognized in the area. A new fauna, in the Jefferson Formation, is tentatively correlated with that of the upper Devils Gate Limestone of central Nevada. The presence of Desmoinesian fusulinids at the base of the Oquirrh [(thickness about 6,600 feet)] and upper Virgilian fusulinids throughout the interval from 1,000 to 2,000 feet above its base indicate an absence of Lower Pennsylvanian rocks and suggest that the upper 4,400 feet may be in part Permian. Mesozoic rocks are not found in the area.

From published abstract

185. GILL, JAMES R., 1950, Flagstaff Limestone of the Spring City-Manti area, Sanpete County, Utah: Ohio State Univ. M. S. thesis, 209 p.

The Flagstaff Limestone was studied on the western slope of the Wasatch Plateau, an area of transition between the Great Basin and Colorado Plateau Provinces. The dominant structural element is the Wasatch monocline. The Flagstaff is generally gradational with the underlying North Horn and overlying Colton Formations, although intertonguing and unconformably relationships with older beds occur locally. The lower portion contains freshwater molluscs of the Paleocene Fort Union Formation; the upper portion is Eocene. Fossils identified include 42 species belonging to 25 genera, and are used to establish zones which may allow regional correlation (three in the Flagstaff and one at the base of the Colton).

The Flagstaff was divided into seven units, ascending: shale and minor limestone, limestone and minor shale, shale and sandstone, massive limestone, shale and channel sandstones, shale and impure limestone, impure limestone and shale. These vary greatly laterally. Early sediments indicate steady westward advance of lake, shallow water. After deposition of massive limestone, the lake receded. The water returned and may have exceeded its former extent, although still shallow. During medial Flagstaff time, a change to fluviatile conditions occurred, with gypsiferous saline deposits to the east. Younger lacustrine beds contain Eocene fauna. Special features of Flagstaff lithology include limestone dessication breccias and conglomerates, ostracodal limestone and oil shale. *B. C.*

186. GILLILAND, WILLIAM N., 1948, Geology of the Gunnison quadrangle [Sanpete and Sevier Counties], Utah: Ohio State Univ. Ph. D. thesis, 177 p., geol. map.

_____ 1951, Geology of the Gunnison quadrangle, Utah: Nebraska Univ. Studies, n. ser., No. 8, 101 p., geol. map.

The Gunnison quadrangle is in central Utah at the junction of Sevier and Sanpete Valleys, and includes portions of Wasatch Plateau, Gunnison Plateau and Valley Mountains.

Exposed rocks range in age from Jurassic to Quaternary and are nonmarine except for Arapien and Twist Gulch Formations. Sharply contrasting Cretaceous environments, the nature of continental sedimentation and late Mesozoic and Early Tertiary orogenies caused vertical variations and lateral shifting of environments, resulting in a series of stratigraphic units which are difficult to correlate. Formations present in the quadrangle include Arapien and Twist Gulch (Jurassic), Price River (Upper Cretaceous), North Horn (Upper Cretaceous-Paleocene), Flagstaff (Paleocene), Colton, Green River and Crazy Hollow (Eocene), Bald Knoll and pyroclastics (Oligocene), Axtell (Pliocene), and volcanic gravel and beach sand (Pleistocene).

Important structural features of the area include the Sevier and Sanpete Valleys (structural troughs), the highly faulted (nearly vertical normal dip-slip) monoclinal Valley Mountains, Japs Valley (a large graben), Gunnison Plateau (an anticline of faulted and gently folded rocks of Cretaceous and Early Tertiary age), hogbacks and cuestas (characterized by low-angle thrust faulting in the southeastern portion of the quadrangle) which are foothills of the Wasatch Plateau, and the Redmond Hills anticline.

Since Late Jurassic or Early Cretaceous time, central Utah has been the scene of considerable crustal unrest. Within this quadrangle five principal episodes of deformation occurred, as follows: mid-Cretaceous orogeny, early Laramide orogeny, pre-North Horn (?) movement, pre-Flagstaff movement, and normal faulting and associated disturbances in the Oligocene. A positive area existed in the region of central Sevier and Sanpete Valleys from early Laramide until Green River time.

Salt, bentonite, limestone and gravel are the principal economic deposits. *B. Y. S.*

187. GILLULY, JAMES, 1926, Geology of part of San Rafael Swell [Emery County], Utah: Yale Univ. Ph. D. thesis.

_____ and J. B. Reeside, Jr., 1928, Sedimentary rocks of the San Rafael Swell and some adjacent areas in eastern Utah: U. S. Geol. Survey Prof. Paper 150, p. 61-110.

Although the rocks exposed in the districts discussed in this report range in age from Pennsylvanian to Upper Cretaceous, the Triassic and Jurassic formations are the most widely exposed, and are the main concern of this paper. The stratigraphic sequence, ascending, consists of Permian Coconino Sandstone and Kaibab Limestone; Triassic Moenkopi Formation, Shinarump Conglomerate and Chinle Formation; Jurassic Glen Canyon Group-Wingate Sandstone, Todilto (?) Formation, Navajo Sandstone-and San Rafael Group-Carmel Formation, Entrada Sandstone, Curtis Formation, Summerville Formation; Cretaceous Morrison Formation, Dakota Sandstone and Mancos Shale. *B. C.*

188. GLISSMEYER, CARL HOWARD, 1959, Microfauna of the Funk Valley Formation [of Indianola Group, Sanpete Valley], central Utah: Univ. of Utah M. S. thesis, 60 p.

The middle shale member of the Funk Valley Formation has three microfaunal assemblages with 20 genera and 39 species of Foraminifera and 4 genera and 5 species of Ostracoda. The microfauna indicates a lower Niobrara (Fort Hays) age on the basis of similar calcareous-arenaceous benthonic assemblages from the lower Niobrara age-equivalent part of the basal Cody Shale in north central Wyoming and on the basis of Fort Hays age assemblages from the Great Plains region. The middle shale member of the Funk Valley Formation is correlated with the lower part of the Blue Gate Shale Member of the Mancos Shale.

The Funk Valley microfauna has a ratio of 65 percent calcareous species to 35 percent arenaceous species of Foraminifera. The family Lagenidae dominates the fauna with 17 species and the families Lituolidae and Textulariidae combined are represented by 9 species. The Pelagic Foraminifera are represented by the genera Globigerina and Gumbelina. The Ostracoda of the Funk Valley Formation bear a close affinity with the ostracod assemblages of the Niobrara Formation of the Great Plains region and also with the Eagle Ford-Austin age ostracod assemblages of the Gulf Coast region.

From author abstract

189. GOODE, HARRY D., 1959, Surficial deposits, geomorphology, and Cenozoic history of the Eureka quadrangle [Utah and Juab Counties], Utah: Univ. of Colorado Ph. D. thesis; U. S. Geol. Survey, Open File Ser. 1959, No. 43, 126 p.
(Abs.): Dissert. Abs., v. 20, No. 10, p. 4075-4076, 1960.

_____ 1959, Surficial deposits, geomorphology, and Cenozoic history of the Eureka quadrangle, Utah: U.S. Geol. Survey, Open File Ser., No. 43, 126 p.

The main divide of the East Tintic Mountains, one of the easternmost Basin Ranges, crosses the Eureka $7\frac{1}{2}$-minute quadrangle from its northwest corner to the center of its southern border. Rocks range in age from Early Cambrian to Recent, but Pennsylvanian rocks are absent. Nearly 10,000 feet of Paleozoic rocks were folded into a north-trending asymmetric syncline whose western limb is nearly vertical. Except where stripped off, Middle Eocene tuffs, flows, and intrusive rocks as much as 2,000 feet thick cover the Paleozoic rocks.

Surficial deposits consist of loess; alluvial and colluvial silt, sand, and gravel; and Lake Bonneville deposits (Wisconsin). Of pre-Lake Bonneville (Yarmouth ?) age, the loess is probably the oldest surficial deposit, and was the source of silt-size quartz grains redeposited in most younger sediments. Younger deposits include: (1) extensive alluvial and colluvial gravels of pre-Lake Bonneville age occurring in many canyons and along mountain fronts, (2) lacustrine deposits of Alpine and Bonneville Formations (Lake Bonneville Group) which overlap the gravels, (3) alluvial silt and gravel correlated with Lake Bonneville Group and (4) Recent alluvium and colluvium of silt, sand and gravel which partly fill most valleys and overlap Lake Bonneville deposits.

Movement of the major divide from east to west, activated by an 850-foot difference in altitude between eastern and western base levels, is manifest on the eastern slope in stream piracies, landslides, and steep canyons, whereas on the western slope the topography is submature. Features of the present landscape include exhumed pre-volcanism rugged topography of Paleozoic rocks near axis of syncline; uplifted erosion surfaces; large, wedge-shaped, uplifted Diamond Divide Block; areas of accelerated erosion due to structural or lithologic weakness of bedrock; and periglacial features such as inactive talus slopes and buried frost-action deposits. *Abstract revised (B. C.)*

190. GOULD, LAURENCE M., 1925, Geology of the La Sal Mountains of [Grand and San Juan Counties], Utah: Univ. of Michigan Ph. D. thesis.

_____ 1926, Geology of the La Sal Mountains of Utah: Mich. Acad. Sci. Paper 7, p. 55-106, geol. map.

The La Sal Mountains near Moab in eastern Utah have peaks ranging in height from 11,000 to 13,000 feet, those in the central group being the highest. The following sedimentary rocks are exposed: Permian Cutler Formation (800 feet), Triassic Shinarump Conglomerate (200 feet) and Chinle, Triassic (?) Wingate (100-200 feet), Jurassic La Plata Group, Todilto (200 feet) and Navajo Sandstone (800 feet), Jurassic (?) McElmo (1,000 feet), Cretaceous Dakota Sandstone (200 feet) and Mancos Shale (600 feet).

Igneous rocks are found in the core of the range and in syenite porphyry dikes. The intrusives are diorite porphyry, monzonite porphyry, and syenite porphyry.

Structurally the northern and southern end groups of the La Sals are quite similar. Here the intrusions have caused doming and strata have rather steep dips. The central group is quite different structurally. A slight doming has occurred and patches of sedimentary rocks occur on various peaks. A second deeper intrusion may explain these phenomena.

There is no evidence that the entire mountain uplift is not the result of a single or of a number of closely spaced periods of igneous activity. La Sal Mountains appear to illustrate unusually well the profound effects that orogenic stresses may have upon the structures produced by laccolithic intrusions. Differences in the structure of the end groups as compared with the central group may be entirely accounted for by the fact that in the central group the intrusion was not influenced by folding stresses, hence the complex structures and semi-stock-like character of parts of this group. In the end groups horizontal compression to the extent of folding affected the intrusions in such a manner as to allow the doming of the surrounding strata without the development of widespread tensional effects.

Age of intrusion and formation of mountains was post-Cretaceous.

Author conclusion revised (B. Y. S.)

191. GOULD, WILBURN JAMES, 1959, Geology of the northern Needle Range, Millard County, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 6, No. 5, 47 p., geol. map.

The Needle Range lies in the extreme southwestern part of Millard County, about 25 miles south of Garrison, and is bounded by Utah State Highway 21 (north), Antelope Valley (east), Beaver County (south), and Nevada (west). The exposed stratigraphic section of Middle Devonian to Lower Permian (basal Wolfcampian) rocks consists of (Devonian) upper part of Guilmette Limestone and Pilot Shale, totaling 1,800 feet; (Mississippian) upper part of Pilot Shale, Joana Limestone, Chainman Shale, and Illipah Formation, totaling more than 3,000 feet; (Pennsylvanian) lower Ely Limestone, 2,000 feet; and (Permian) upper Ely and Arcturus Limestones, 690 and 1,000 feet respectively.

An asymmetrical syncline forms the major structural feature of the range. Thrust plates moving in a northeast direction have overridden the west limb. The northwestern part of the range has been involved in a major fan fold. The folds and accompanying thrust faults probably formed during the various phases of the Laramide orogeny. Numerous normal faults occur throughout the range, but have only minor displacement. Flow rock in the southeast part of the range indicates a slight eastward tilting of the region.

Strucutral complexities that exist in the range may have precluded possibility of oil and gas accumulation.

Abstract revised (B. C.)

192. GRANGER, ARTHUR EARLE, 1939, Geologic aspects of torrential floods in northern Utah: Univ. of Washington M. S. thesis, 57 p., geol. map.
(Abs.): Washington (State) Univ. Abs., Thesis Ser., v. 4, p. 168.

Torrential floods of the "mudflow" type have occurred and caused considerable damage of property and loss of life in the Farmington section of the Wasatch Mountains of Utah. This type of flood is interpreted as being an important geologic agent, not only in the Wasatch Mountains, but in the entire Great Basin Province. They provide the means by which much of the material of the uplands is transported to the lowlands. The causes of the floods are four-fold: (1) steep, rough topography, (2) sudden torrential rainstorms restricted to small areas, (3) filling and choking of stream channels by debris, and (4) lack of vegetation.

Accompanying the mudflow floods have been periods of gullying and headward erosion, occasioned partly by the lowering of local base levels by mudflows and partly by removal of the vegetative cover.

The federal and state governments have spent much time and money in the attempt to control these erosive and destructive geologic activities. The principal method of control has been the use of contour-trenches in the stream headwaters, designed to trap and hold back water from torrential storms. This is known as "upstream" engineering work. A supplementary method, known as "downstream" engineering work, consists in the employment and construction of catchment basins at the point where streams enter the valleys. These are designed to trap flood waters and force them to drop their loads of debris, and also to confine them within certain limits.

An analysis of the entire problem, with a consideration of the time factor from a geologic rather than humanistic standpoint, is given.

Published abstract

193. GRANT, SHELDON KERRY, 1966, Metallization and paragenesis in the Park City district, Utah: Univ. of Utah Ph. D. thesis.
(Abs.): Dissert. Abs., sec. B, v. 27, No. 8, p. 2804B-2805B, 1967.

In Park City district, ore deposits are both bedded and fissure types. They occur mainly in Paleozoic sedimentary rocks, are controlled by northeasterly trending fractures, and are related to a group of aligned Oligocene intrusives. The most important mine in the district, the Ontario, was studied in detail.

The major minerals formed in the following order: galena, sphalerite, pyrite, quartz, and calcite. Zoning is expressed by the minor ore minerals and major and minor metallic constituents of ore and gangue minerals. In plan, chalcopyrite is concentrated in an inner zone, tetrahedrite in an intermediate zone, and argentite in an outer zone. Silver and lead decrease and zinc increases with depth. Minor metal constituents in minerals show vertical zoning. Minor metals heavier than the major metallic constituent of a mineral are concentrated upward. Minor metals lighter than the major metallic constituent are concentrated downward. Manganese and iron in calcite and lead in sphalerite increase in concentration upward. Iron in sphalerite and zinc in galena increase downward.

There is a direct correlation between depth of precipitation of minerals and their minor constituents and their position in the paragenetic sequence at any point. Those minerals and metals that are concentrated at greater depths are deposited later at any point. The correlation between zoning and paragenesis is a function of two factors: direction of migration of the zone of precipitation and the specific orthogenesis of the monoascendent fluid. The name orthogenesis is introduced to describe the sequence of minerals deposited from each increment of fluid. In the Park City district the orthogenesis was probably calcite, quartz, pyrite, sphalerite, and galena. Because the zone of precipitation migrated upward, the paragenesis was the reverse of the orthogenesis.

The Park City deposits formed from upward-moving solutions, the source of which was at considerable depth. Transportation of the metals was predominantly as complexes. *From author abstract*

194. GRAY, IRVING B., 1961, Nature and origin of the Moenkopi-Shinarump hiatus in Monument Valley, Arizona and Utah: Univ. of Arizona Ph. D. thesis, 94 p.
(Abs.): Dissert. Abs., v. 22, No. 8, p. 2752, 1962.

The Triassic age Moenkopi Formation, prior to recent erosion, was less than 20 feet to about 450 feet thick in the Monument Valley region of southeastern Utah and northeastern Arizona.

It is believed that the streams which deposited the latest Moenkopi were incised into the Moenkopi Formation during a regional uplift which brought Moenkopi deposition to a close. These streams may have continued to erode the pre-Moenkopi outcrops of their headwater areas and to transport this material through their valleys much as they had done during Moenkopi time. After a period of time the downcutting must have ended and the coarsest sediments in transit came to rest in the valley bottoms as earliest Shinarump. Valley widening followed as the streams aggraded their valleys during Shinarump time. The valleys were progressively opened upward during aggradation until the streams and their deposits coalesced across the interfluve areas and formed the Shinarump blanket deposit.

The streams which deposited the Shinarump as valley fills were probably slowly aggrading streams near grade; i.e., a slight but gradual steepening of the longitudinal profile of the streams was required (and satisfied by aggradation) to enable them to handle their loads. As they filled their valleys they progressively approached, and then finally attained graded conditions, when they achieved the vertical position at which the blanket-shaped Shinarump stratum was formed.

The Shinarump blanket deposit was emplaced upon the older Shinarump valley fills and adjacent beveled Moenkopi strata by streams at grade: i.e., by streams whose gradients were such that they provided just the velocity required to transport all of the supplied load. The surface upon which this blanket rests is a pediment surface. The Shinarump valley fills and pediment mantle were deposited pari passu with the development of the erosion surface in those areas where Shinarump was deposited. Thus, the long lapse of time between the Moenkopi and Shinarump is represented by both the unconformity and the gravel sheet. *From author abstract*

195. GRAY, RALPH S., 1925, A study of the Wasatch Mountains: Univ. of Utah M. S. thesis, 86 p.

The Wasatch Front Range from Nephi to Collinston, Utah, was studied. Long continued deposition, dominantly marine, was followed by intense folding and overthrusting, accompanied and followed by vulcanism, both intrusive and extrusive. Erosion and local sedimentation created a surface of low relief which has subsequently been broken into tilted blocks, now maturely dissected by streams whose canyons have in many instances been modified by glaciation. The mountain flank has been terraced by the wave action of an ancient lake, whose deltas were now trenched by stream valleys with the dessication of the lake.

An ancient peneplain is indicated by even crest line and uniform altitude of mountain peaks. Folding is correlated with the Laramide disturbance. Faulting is thought to have been initiated during middle Miocene and has continued intermittently until the present. Evidences of faulting are indifference of folded structure to abrupt western escarpment, spur-end facets, recent fault escarpments at base of range which cut recent fans, deltas, and moraines, occurrence of hot springs along fault line, absence of alluvial aprons appropriate to their valleys, and deformation of Bonneville terrace. Faulting is of normal type; three periods are recognized, major, minor and minimum. *Abstract revised (B. C.)*

196. GRAY, ROBERT CHARLES, 1966, Crustal structure from the Nevada test site to Kansas as determined by a gravity profile: Univ. of Utah M. S. thesis (copyright 1968).

A gravity profile consisting of 402 new gravity stations and 77 pre-existing stations was made from the Nevada test site area to the Colorado-Kansas border. The gravity profile is essentially coincident with a U.S. Geological Survey seismic refraction profile crossing the eastern half of the Basin and Range Province, Colorado plateaus, southern Rocky Mountains and the western part of the Great Plains Province.

A plot of the simple Bouguer values, free-air values, and elevation versus distance from the Nevada test site was made. The simple Bouguer anomaly was smoothed twice, once to smooth out local anomalies and a second smoothing was made by considering regional surface geologic features.

Using the Talwani two-dimensional method, gravity anomalies were computed for theoretical crustal models and the computed gravity anomalies were fitted to the observed smoothed simple Bouguer anomaly. Three possible crustal models were found to achieve a fit between the computed gravity anomalies and theoretical gravity anomalies. The depth to the M discontinuity was assumed to be 25-26 km under the Basin and Range Province, 42 km under the High Plateaus of Utah, 38 km under the Canyonlands, 50 km under the southern Rocky Mountains (53 km in one model), and 48 to 50 km under the Great Plains Province. These crustal models have depths to the Mohorovičić discontinuity that agree with the results of the seismic refraction profile except for the shallower depth of 38 km under the Canyonlands area of the Colorado plateaus. In the areas where the crust is thicker than 26 km, either a single layer (density = 3.1 gm/cc) or two high-density layers (densities of 3.0 and 3.1 gm/cc) are possible representations of the crust below depths of 26 km; these high-density crustal layers are indicated under all of the area east of the Basin and Range Province. The velocity (6.7 km/sec) corresponding to the upper of the two high-density layers (density 3.0 gm/cc) agrees with the velocity of a high-velocity crustal layer observed by several authors. The 7.2 km/sec velocity of the second high-density layer (3.1 gm/cc) has not been observed in the lower crust, but fits in the velocity range for the lower crust and the southern Rocky Mountains and Great Plains indicated by Hamilton and Pakiser (1965) for the lower crust. With the exception of the 3.1 gm/cc layer at the base of the crust, the velocities match the results of seismic data for the densities involved if the velocity is related to the density according to the Nafe-Drake velocity-density curves. The necessary inclusion of the 3.1 gm/cc layer in the crustal models indicate the possibility of increasing densities with depth in the crust down to the M discontinuity or possibly a 3.1 gm/cc layer that has not been observed to date by seismic refraction studies.

If the normal upper-mantle density is 3.4 gm/cc a low-density upper mantle of 3.3 gm/cc is indicated under the Basin and Range Province and a high-density upper mantle of 3.5 gm/cc was indicated under the southern Rocky Mountains and the Great Plains Province. The low-density upper mantle corresponds with the low velocities observed in the upper mantle by several authors. The high-density layer in the upper mantle has a corresponding velocity 8.4 km/sec which also agrees with seismic refraction data of several authors. Each of the models indicates a different distribution of the high-density upper mantle with a possible high-density upper mantle under the Great Plains Province exclusive of the southern Rocky Mountains, or a high-density layer under both the southern Rocky Mountains and the Great Plains Province. *Author abstract*

197. GREEN, JACK, 1954, The Marysvale Canyon area, Marysvale [Piute County], Utah: Columbia Univ. Ph. D. thesis, 214 p. (Abs.): Dissert. Abs., v. 14, No. 9, p. 1358-1359, 1954.

The Marysvale Canyon area is located about 200 miles south of Salt Lake City, Utah. The area is underlain by Tertiary volcanics which have been intruded by quartz monzonite. The volcanics present a most unusual display of the effects of hydrothermal alteration, although the quartz monzonite is the chief uranium-bearing rock.

Inspection of the rock analyses of the Marysvale area indicates that differentiation followed the normal calc-alkalic trend. Deuteric action preferentially altered hornblende in the flow rocks with respect to augite.

Hydrothermal alteration is governed largely by the rock chemistry of the Marysvale Canyon area with the extensive formation of potash-rich clays in the latites and monzonites and alunite in the tuffs. With increasing intensity of alteration in the latites, the mixed lattice clay types (montmorillonite-illite) tend toward sericite as observed at Big Rock Candy Mountain. Increasing intensity of alteration in the tuffs possibly produces silicification at the expense of kaolinization in alunitized areas.

The preference for secondary uranium mineralization in the pyroxene andesite of the Bullion Canyon volcanics is shown at East Slope and Copper Butte where geologic relationships are similar.

The inherent nature of the host rocks for primary uranium mineralization supports the hypothesis that uranium was introduced early in a cobalt, nickel, molybdenum-copper-silver sequence after the formation of alunite. The relatively higher calcium content of the quartz monzonite host, as well as its greater susceptibility to alteration, facilitated the precipitation of uraninite and hydrofluoric acid upon the reaction of uranium tetrafluoride with steam. The hydrofluoric acid reacted with the available calcium to form the associated fluorite. The accompanying hydrogen sulphide fluids, because of lesser reactivity, travelled farther than the hydrofluoric fluids to form the pyritic blanket at Big Rock Candy Mountain. *Published abstract*

198. GREEN, PAUL REED, 1959, Microfauna of the Allen Valley Shale [of Indianola Group], central Utah: Univ. of Utah M. S. thesis, 86 p.

The Allen Valley Shale, a 630-foot sequence of marine shale interbedded with sandstone and siltstone, contains the earliest reported Cretaceous Foraminifera in central Utah. Of the 46 species of Foraminifera and 2 of Ostracoda described in this report, 33 are reported for the first time from the State of Utah, and 14 for the first time from the Rocky Mountains. The Foraminifera belong to 23 genera and 10 families, with a 4:1 ratio of calcareous to arenaceous forms. Marginulinopsis is abundant in a wide variety of species. The microfauna shows greater affinity with faunas of Frontier Formation (Montana and Utah) and Tununk Shale Member of Mancos Shale (central Utah) than with those of other Upper Cretaceous formations of the western interior. The formation correlates with Tununk Shale, and parts of Frontier Formation and Tropic Shale.

The lower two-thirds of the formation is of Greenhorn age and the upper one-third is of early Carlile age. The uniform nature of the Allen Valley Shale indicates tectonically stable conditions. Microfossil evidence suggests that the Allen Valley Shale was laid down in waters that were temperate to subtropical and neritic to upper bathyal. An open seaway probably existed during deposition.

Abstract revised (B. C.)

199. GROENEWOLD, BERNARD CYRUS, 1960, Subsurface geology of the Mesozoic formations overlying the Uncompahgre uplift in Grand County, Utah: Univ. of Utah M. S. thesis, 133 p.

The subsurface stratigraphy of the Mesozoic formations in northeastern Grand County, Utah, was studied, with particular emphasis on the Entrada Sandstone, Morrison Formation, Dakota Group, Mancos Shale and Castlegate Sandstone, which have been the main oil and gas producers. Oil and gas production on top of the Uncompahgre uplift, except from the Entrada Sandstone, seems to be controlled more by stratigraphic conditions than by structural conditions.

Included in the thesis are sand-shale ratio maps, believed to represent in graphic form the total amount and relative abundance of shale permeability barriers in the Morrison Formation and Dakota Group, isopach maps of Dakota Group and Morrison Formation, structural contour map on top of the Greenhorn Member of Mancos Shale, north-south and east-west stratigraphic cross-sections, typical electric logs, and an appendix of sample descriptions and electric log formation tops.

The Uncompahgre uplift was an active structural element through, at least, Glen Canyon time (Late Triassic-Early Jurassic). Secondary anticlines and synclines which overlie it were folded sometime after Green River deposition (Eocene). Uncompahgre uplift and the salt domes of the Paradox Basin are related, in so far as time of uplift or intrusion is concerned. *Abstract revised (B. C.)*

200. GROFF, SIDNEY LAVERN, 1959, Geology of the West Tintic Range and vicinity, Tooele and Juab Counties, Utah: Univ. of Utah Ph. D. thesis, 183 p., geol. map.
(Abs.): Dissert. Abs., v. 20, No. 5, p. 1741, 1959.

_____ 1959, Geology of the West Tintic Range and vicinity, Juab and Tooele Counties, Utah (abs.): Geol. Soc. America Bull., v. 70, No. 12, pt. 2, p. 1777.

The area discussed, about 200 square miles, includes the West Tintic Range and part of the Sheeprock Range. Sedimentary and metasedimentary rocks exposed include from older to younger: at least 13,000 feet of Precambrian schist, banded and unbanded phyllite, tillite, quartzite, argillite, and conglomerate of the Sheeprock Series, and the

Mutual (?) Formation; at least 11,500 feet of Paleozoic carbonates and clastics which represent parts of all periods except the Permian; Tertiary strata, thought to represent all of the Tertiary epochs, and possibly being several thousand feet in thickness; several hundred feet of Pleistocene pediment gravels, recent alluvium and aeolian deposits. Mesozoic sediments, with the possible exception of an unnamed greenstone, are absent.

Igneous rocks include the West Tintic monzonite intrusive and a younger granite intrusive. Extrusive rocks are abundant and include from oldest to youngest: a diabasic rock, which may represent a Precambrian flow; a rhyolite sequence, tentatively correlated with the Packard Latite of the East Tintic Range; an andesite and agglomerate sequence which unconformably overlies the granite, is intercalated with beds of known mid-Eocene Green River age, and is correlated with the latite and agglomerate sequence of the East Tintic Range; a few remnants of basalt flows, probably of Late Tertiary or Early Quaternary age.

Three orogenic episodes are tentatively correlated with Cedar Hills, Laramide, and Basin-and-Range orogenies and are attributed to Cretaceous, earliest Tertiary and later Tertiary. Structures considered contemporaneous with Cedar Hills orogeny include the West Tintic anticline, Brown's Ridge homocline, and the monocline north of Little Valley. Structures assigned to Laramide orogeny include Sheeprock thrust system and recumbent folds and tear faults in the allochthon. Basin-and-Range structural features consist of range-defining high-angle faults such as Vernon Creek fault and flexures and folds in Green River-Salt Lake strata.

From author abstract

201. GROSS, LARRY THOMAS, 1961, Stratigraphic analysis of the Mesaverde Group, Uinta Basin, Utah: Univ. of Utah M. S. thesis, 290 p.

The Upper Cretaceous Mesaverde Group in Uinta Basin consists of 3 principal facies: littoral or nearshore sandstone facies, lagoonal or coal-bearing facies, and an inland or noncoal-bearing facies. It overlies Mancos Shale and is divided, ascending, into Star Point Sandstone, Blackhawk Formation and Price River Formation.

Although a massive sandstone in Wasatch Plateau, the Star Point in the Book Cliffs area consists of Panther and Storrs sandstone tongues, separated by westward-extending tongues of the Mancos. Blackhawk Formation is a sequence of cyclic sandstones, siltstones, shales and coals which tongues into Mancos Shale in eastern Book Cliffs, but is present in most of the Uinta Basin. Asphalt Ridge Sandstone (Vernal) is Blackhawk equivalent.

Lower Price River Formation consists of three sandstone members: Castlegate, most consistent unit of formation; Sego, recognized where Buck Tongue of Mancos is present; and Rim Rock, equivalent to Castlegate and Sego in Vernal area. Upper Price River east of Green River is divided into coal-bearing Neslen facies and, overlying it, noncoal-bearing Farrer facies.

In Book Cliffs, Mesaverde is apparently conformably overlain by Cretaceous (?) strata, but in the northern part of the Basin it is disconformably overlain by Cretaceous (?), Eocene and younger strata.

Abstract revised (B. C.)

202. GROTH, FREDERICK A., 1955, Stratigraphy of the Chinle Formation in the San Rafael Swell [Emery County], Utah: Univ. of Wyoming M. A. thesis, 76 p.
(Abs.): Geol. Soc. America Bull., v. 66, No. 12, pt. 2, p. 1675, 1955.

The unit formerly mapped as Shinarump Conglomerate in the San Rafael Swell, Utah, is in reality a medial unit of the Chinle Formation, and the name Mossback Sandstone is applied in accordance with the present U.S. Geological Survey nomenclature. The overlying interval, formerly mapped as Chinle Formation, is renamed Upper Chinle. Because of its prominence and consistency, the Mossback Sandstone is raised to member status in the Chinle Formation, and the name Monitor Butte is applied to the Chinle interval below the Mossback, which is also considered to be a member of the Chinle Formation.

The lithology of the Upper Chinle, Mossback Sandstone Member, and the Monitor Butte Member is described in detail. A correlation stereogram, showing the correlation of the various member units of the Chinle Formation around the San Rafael Swell is included and is discussed. Stokes' pediment concept of deposition for the Shinarump Conglomerate is described, and applied to the Mossback Sandstone. Generalizations concerning the climate and environment of deposition are presented.

Author abstract

203. GRUNDY, WILBUR D., 1953, Geology and uranium deposits of the Shinarump Conglomerate on Nokai Mesa, Arizona and Utah: Univ. of Arizona M. S. thesis, 88 p.

The Shinarump Conglomerate, of Late Triassic age, caps Nokai Mesa and many buttes and monuments in Monument Valley. It lies on the Moenkopi Formation with erosional unconformity. The Shinarump is composed mostly of medium- to coarse-grained sandstone with lesser amounts of quartz pebble conglomerate and greenish-gray claystone. Silicified wood is scattered throughout. Due to channeling at the base, the Shinarump Conglomerate on Nokai Mesa varies from 100 to 285 feet in thickness.

The primary control of uranium deposition in the Shinarump Conglomerate is channels cut into the underlying strata. Clay and carbonized wood are of importance because of their precipitating action on uranium solutions. A channel probably must also be situated in a favorable structural position such as a synclinal trough so that uranium solutions will pass through it in sufficient volume to be precipitated as ore. *From author summary and text*

204. GUNDERSON, WAYNE, 1961, An isopach and lithofacies study of the (Upper Cretaceous) Price River, (Upper Cretaceous-Paleocene) North Horn, and (Eocene) Flagstaff Formations of central Utah: Univ. of Nebraska M. S. thesis, 48 p.

Some of the numerous crustal movements of central Utah may be more closely related to positive areas than to regional crustal movements. Numerous unconformities, marked thinning in many sections, and spectacular facies changes attest to the influence of topographic highs that existed in central Utah during deposition of Price River, North Horn and Flagstaff Formations. Higher percentage of clastics in North Horn and Flagstaff Formations about some highs indicate their role as sources.

Evidences that the Sanpete-Sevier Valley anticline stood topographically positive are (1) facies differences in Price River and North Horn Formations on opposite sides of the anticline and (2) increase in clastic content of Flagstaff Formation flanking the anticline, although inundation was nearly complete near the close of Flagstaff deposition so the lithofacies map of the Flagstaff does not show the distinction so well. The Redmond anticline never achieved the continued influence that the Sanpete-Sevier Valley anticline did, and the high in the Levan area is probably not a northern component of the Redmond anticline.

Although data are lacking for reconstruction of paleogeographic environments and time-stratigraphic units cannot be discerned, isopachous and lithofacies studies of this type are valuable in delineating paleostructures and may lead ultimately to location of time planes.

Author conclusions revised (B. C.)

205. GUNNELL, FRANCIS H., 1930, Telotremata of Brazer Limestone of northern Utah: Univ. of Missouri M. A. thesis.

_____ 1932, Brazer Formation of northern Utah and its Telotremata: Am. Midland Naturalist, v. 13, p. 282-301.
(Abs.): Geol. Soc. America Bull., v. 42, No. 1, p. 330, 1931.

The Brazer Formation in northern Utah consists of 2,000 feet of limestone, dolomite, shale, sandstone and quartzite. A distinct unconformity exists between the Brazer and the underlying Madison Limestone of the Lower Mississippian. No unconformity is distinguishable between the Brazer and the overlying Wells Formation of the Pennsylvanian. Eighteen old and 8 new species included in 12 genera of Telotremata are recognized. The fossiliferous upper portion of the formation from which the fossils were collected contains forms similar to those which occur in the Amsden of Wyoming, the Maroon of Colorado, and the Chester and Saint Genevieve of the Mississippi Valley.

Published abstract (Geol. Soc. America Bull.)

206. GWYNN, THOMAS ANDREW, 1948, Geology of the Provo Slate Canyon in the southern Wasatch Mountains [Utah County], Utah: Brigham Young Univ. M. S. thesis, 91 p., geol. map.

Provo Slate Canyon is a stream-cut canyon about 2 miles southeast of Provo, western Wasatch Range. Algonkian through Mississippian rocks are exposed, as follows: Precambrian Algonkian Quartzite and Tillite; Cambrian Tintic Quartzite, Ophir Shale and Maxfield Limestone; Devonian Jefferson Dolomite; and Mississippian Madison and Deseret Limestones. Unconformities are present above and below the Algonkian Tillite and Jefferson Dolomite. The structure appears to be essentially a fold, overturned to the east, with a trend of N. 10° W. Axis of anticline is near the center of the valley. Continuing compression from the west may have caused the axis of a stretch-thrust fault in the anticline. Thrust faulting, Basin-and-Range block faulting and antithetic faulting are all present and result in a complex fault system.

During the Algonkian this area was sometimes glaciated but was generally submerged beneath a fluctuating shallow sea. Following Early Cambrian volcanism the sea became deeper and thousands of feet of limestone were deposited. First folding occurred in Early Tertiary-Late Cretaceous. Tensional forces caused Miocene Basin-Range faulting.

B. Y. S.

207. HAENGGI, WALTER T., 1957, Geology of the Cowboy Pass area, Confusion Range, Millard County, Utah: Univ. of Texas M. A. thesis, 65 p., geol. map.

Paleozoic, Mesozoic and Cenozoic rocks totaling about 15,000 feet in thickness are exposed in the Cowboy Pass area in the Confusion Range. The Paleozoic sedimentary rocks are carbonates, with small amounts of sandstone and shale, and the Mesozoic sedimentary rocks are shallow water limestone and shale. Cenozoic deposits are alluvium, lacustrine beds and small amounts of volcanic material. The trend of major folds and faults changes sharply from northerly to northeasterly at Cowboy Pass, and this change is accompanied by minor faulting and folding. Major structures are the result of post Lower Triassic-pre-Cenozoic orogeny. During Cenozoic time, high-angle normal faults developed, accompanied by local volcanic activity. *Author abstract*

208. HAFEN, PRESTON LON, 1961, Geology of the Sharp Mountain area, southern part of the Bear River Range [Cache and Weber Counties], Utah: Utah State Univ. M. S. thesis, 72 p., geol. map.

Rocks representing every Paleozoic system from Cambrian to Devonian are present within the Sharp Mountain quadrangle. There are no Mesozoic rocks present within the mapped area. Cenozoic deposits are represented by the Wasatch Formation and the Salt Lake Group, both of Tertiary age, which unconformably overlie older rocks along the eastern edge of the area. The Salt Lake Group is also exposed in the northwestern corner of the area. The Sharp Mountain quadrangle is a segment of the westernmost of two ridges which make up the Bear River Range. This ridge is limited on the west by the East Cache faults. Sharp Mountain is bounded on the west by a separate set of north-trending faults that apparently intersect the East Cache faults north of James Peak. The geologic structure of the mapped area, which includes Sharp Mountain and the southwestern part of Ant Valley, constitutes the west flank of a broad anticline that is a southward continuation of the Strawberry Valley anticline. There are also several high-angle faults within the Sharp Mountain quadrangle. No evidence of thrusting was found within the area. *B. C.*

209. HALVERSON, MARK OLSON, 1960, Regional gravity survey of northwestern Utah and part of southern Idaho: Univ. of Utah M. S. thesis, 33 p.

A total of 529 gravity stations was occupied in an area of some 4,000 square miles: 300 by the writer and 229 previously by others. Earlier work on Black Pine area was incorporated. Gravity data were reduced to bouguer anomaly values and contoured with a 2-mgal interval. A two-dimensional Jung graticule was used to evaluate three observed gravity profiles in terms of geologic structure.

The gravity anomalies are generally of large magnitude. Data indicate northward-trending graben in Junction Creek, Upper Raft River Valley and Black Pine areas with associated normal faults having displacements up to about 5,000 feet. The valley containing Grouse Creek represents a probable graben. A gravity high of at least 6-mgal closure, which overlies and surrounds the Raft River Mountains, and the gravity high over the southeastern portion of the Grouse Creek Mountains may represent dense materials at depth.

Abstract revised (B. C.)

210. HAMBLIN, WILLIAM K., 1954, Geology and groundwater of northern Davis County, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 1, No. 2, 51 p., geol. map.

Northern Davis County lies on the boundary between the Basin and Range Province and the Wasatch Mountains. It comprises the southern part of the Weber delta district of the East Shore groundwater unit.

Interbedded sand and clay alternating with fluvial gravel and sand are evidence of pre-Lake Bonneville lake and interlake stages and are Pleistocene and probably Pliocene. The Alpine Formation of the Lake Bonneville Group contains large quantities of silt and sand, due to erosion of soils and to an estuary in Weber Canyon. Weber delta is mainly Alpine silt and clay. The Bonneville stage, marked by embankment gravels higher than the Alpine beds, was terminated by an overflow at Red Rock Pass. Stabilization at 4,800 feet produced the Provo level in which coarse sediments predominate.

An isometric fence diagram reveals three principal aquifer zones separated by impermeable silt and clay. Recharge occurs in the floodplain immediately west of the mouth of Weber Canyon. The groundwater reservoir can be increased by supervised drilling, pumping and artificial recharges.

Abstract revised (B. C.)

211. HAMILTON, EDWARD ALRICKS, 1949, The sedimentology of the Upper Jurassic formations in the vicinity of Escalante, Utah: Johns Hopkins Univ. Ph. D. thesis, 93 p.

This report concerns the sedimentary petrology and stratigraphic relations of the Navajo Sandstone, Carmel Formation, Entrada Sandstone, Summerville Formation, Morrison Formation and Dakota (?) Sandstone on the northeast edge of the Kaiparowits Basin, Garfield County. The upper Jurassic strata are composed chiefly of fine- to very fine-grained quartzose sandstones which are massive-bedded. Erosional breaks occur within the Carmel, and above and below the Morrison Formation.

Impoverishment of heavy mineral suite, extreme rounding of grains, and overgrowths, together with a high degree of sorting and occurrence of chert indicate derivation of most material from pre-existing sediments. Zircon, tourmaline and garnet are the most abundant heavy minerals, staurolite is common to scarce, and apatite and rutile are rare to scarce.

Although the heavy mineral assemblage of each formation is not characteristic enough for correlation, certain mineral zones persist and have a restricted value. Titanite occurs only in the upper part of the Carmel Formation. There is a staurolite zone in upper Entrada-lower Summerville, and a garnet-rich zone in middle Entrada. Variations in angularity, sphericity or euhedral character of the minerals are also used to distinguish parts of the stratigraphic sequence.

Lithology and paleontology suggest the following interpretation of this cycle of deposition: arid terrestrial conditions were followed by marine encroachment which was in turn followed by humid terrestrial conditions, prior to widespread incursion of the Cretaceous sea. Eolian deposition and desert conditions of Navajo times were terminated by marine encroachment and deposition of Carmel limestones and gypsum. Entrada strata may be of aqueous origin; the Escalante Member was probably deposited in aeolian and nearshore deltaic environments. Volcanic ash falls occurred from Entrada through Morrison deposition. Summerville was deposited by shallow water with currents strong enough to produce ripple marks. Morrison and Dakota (?) were deposited under low-lying fluviatile and swampy conditions. *B. C.*

212. HAMILTON, RICHARD P., 1955, Small nonmarine gastropods from the Paleocene of Wyoming and Utah: Univ. of Missouri M. A. thesis.

Discussions of 19 species of nonmarine Paleocene gastropods in a fair to good state of preservation and ranging from 3.0 to 0.5 mm in size from the Hoback Formation of Wyoming and the Flagstaff and Colton Formations of Utah comprise the systematic paleontological descriptions of this paper. Two new species are recognized and new and more complete descriptions are presented for two species whose original reference is brief. Seven species belonging to the subclass Prosobranchia, order Mesogastropoda, and ten species of the subclass Pulmonata are described and illustrated. Of the latter subclass, members of the order Basommatophora and Stylommatophora are represented. Two species are discussed under incertae sedis.

From author abstract

213. HAMMOND, WELDON WOOLF, 1930, The Spiriferidae of the Madison Formation of the Logan quadrangle [Cache County], Utah: Univ. of Missouri M. S. thesis, 22 p.

The family Spiriferidae, as represented in the Madison collections, consists of four genera and eight species. Spirifer centronatus is the most abundant and universal species. Spirifer madisonensis, n. sp., is found only in a horizon a few feet above the Devonian-Mississippian contact. The genus, Pseudosyrinx, is new to the Madison. More complete collection and study of Madison Spiriferidae will bring to light new species and will prove of great value in establishing more exact faunal relations between Madison, Lake Valley, Chouteau, Burlington and Banff Formations. Three Madison species are common to Chouteau Formation of Mississippi Valley, two to Lake Valley Formation of New Mexico, and three to lower Banff Formation of Alberta, Canada. *From author summary and conclusions*

214. HAMPTON, O. WINSTON, 1955, Methods and costs of uranium exploration and mining on the Colorado Plateau: Univ. of Colorado M. S. thesis, 170 p.

The cost of locating and mining ore bodies has been extremely variable and generally has been greater than anticipated. Losses might be avoided at any of three critical stages: aquisition of prospective uranium property, exploratory and development drilling, and planning for mining a known ore body. The observations listed below may help the prospective investor and operator to reduce these losses. (1) Development drilling is normally necessary after a uranium show is located at the surface. (2) Expert advice is needed to evaluate radiation detection instruments before purchase. (3) The need for deep exploratory drilling in the Colorado Plateau is increasing. (4) The advice of a geologist is recommended before purchasing uranium property. (5) Location of a valid uranium mining claim is relatively expensive. (6) Ore extraction which requires a vertical shaft or incline more than 40 feet deep is very expensive. (7) Most Colorado Plateau uranium bodies are unprofitable to develop and mine due to low grade and/or tonnage. (8) Ore bodies located beyond the 100-mile U.S. Government haulage limit may not be large enough to be profitable.

Abstract and conclusions revised (B. C.)

215. HANKS, KEITH L., 1962, Geology of the central House Range area, Millard County, Utah: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 9, pt. 2, p. 115-136, geol. map.

The House Range is a northerly trending fault block typical of eastern Great Basin structures. The thick Cambrian section exposed in the range was accumulated near the center of deposition in the Cordilleran miogeosnycline. An aggregate approximately 7,700 feet thick of Lower, Middle, and Upper Cambrian quartzites, shales and limestones are well exposed in the map area. Strata commonly strike northeast and have a gentle to moderate southeasterly dip. Unconsolidated alluvium and conglomerates of Tertiary age cover dip slopes on the eastern flank of the range. Quaternary sediments include alluvial fans, lake terraces, stream deposits, and valley fill.

A granitic stock intruded in the sedimentary units caused doming and metamorphism of adjacent strata. Isolated remnants of roof cover lie on the granite at the crest of the divide and on the western front of the range. Tubular dikes and sills associated with the orthomagmatic body extend into sedimentary units near the contact.

Low-grade tungsten mineralization in tactite zones near the periphery of the stock has given rise to limited mining operations. Placer gold occurs in arkosic sands and gravels derived from mechanical weathering of the porphyritic granite.

Author abstract

216. HANSEN, ALAN R., 1952, Regional stratigraphic analysis of the Uinta Basin, Utah and Colorado: Northwestern Univ. M. S. thesis, 50 p.

The purpose of this study is to analyze regional stratigraphy of the Uinta Basin by lithofacies studies, to establish the regional tectonism, and to compare these regional aspects with the Ashley Valley oil field. Some original observations plus all available data concerning thickness and lithologic aspect for the units below were assembled and used in constructing cross sections and maps indicating lithofacies, isopach and sandstone vertical variation relationships. Four operational stratigraphic units were selected (top to bottom): Cretaceous-Dakota Sandstone, 5 to 300 feet of nonmarine strata-upper sandstone, middle shale, basal sandstone; Jurassic-Morrison Formation, 5 to 1,600 feet of varicolored nonmarine shales with limestone, chert, and cross-bedded sandstone locally; Jurassic-San Rafael Group, 350 to 1,850 feet of marine deposits of various types; and Jurassic-Triassic Glen Canyon Group plus remaining Triassic section, 1,200 to 3,700 feet of strata dominated by nonmarine clastic sedimentary types, including aeolian deposits.

The study of Dakota and Morrison maps suggests that occurrence of oil and gas is dominantly controlled by rapid facies change. The area of most significant change is a wide north-south linear belt along the Utah-Colorado border which includes Clay Basin, Ashley Valley, Rangely, North Douglas Creek, Bar-X, Garmesa and Cisco Dome. *B. C.*

217. HANSEN, OTHELLO T., 1930, Productidae of the Madison Formation of the Logan quadrangle [Cache County], Utah: Univ. of Missouri M. A. thesis, 39 p.

Outcrops of the Madison Formation in the Logan quadrangle are abundantly fossiliferous. The Madison is one of numerous Lower Mississippian (Kinderhookian) outcrops in the Rocky Mountain area. The nine previously described productid species have widespread distribution and thus are useful in correlation. Nine new forms of Productidae are plentiful in this formation, including three species of Avonia, five of Productus and one of Pustula. Three undetermined species are also present.

Author summary revised (B. Y. S.)

218. HANSEN, STEVEN C., 1964, Geology of the southwestern part of the Randolph quadrangle, Utah-Wyoming: Utah State Univ. M. S. thesis.

Marine Paleozoic rocks, Cambrian to Devonian in age, are exposed in the southwestern part of the Randolph quadrangle. The formations present are: (1) Bloomington Formation, Middle Cambrian, (2) Nounan Formation, Middle (?) or Late Cambrian, (3) St. Charles Formation, Late Cambrian, (4) Garden City Formation, Early Ordovician, (5) Fish Haven Dolomite, Late Ordovician, (6) Laketown Dolomite, Middle Silurian, and (7) Water Canyon Formation, Early Devonian. The absence of the Swan Peak Formation, Middle Ordovician, which is present north and west of the area mapped, is evidence for an unconformity. Rocks younger than the Water Canyon Formation as well as Mesozoic rocks have been removed from the area by erosion. The nonmarine Wasatch Formation of Paleocene or Eocene age is the only Cenozoic formation in the area.

The area mapped is on the east flank of the Strawberry Valley anticline; however, the east flank of the anticline is difficult to recognize due to high-angle faulting. Fault block mountains and graben valleys of Basin-and-Range age are present in the area. High-angle faults display two dominant trends: (1) north-northeast, and (2) northwest. The north-northeast-trending faults are located near the east and west boundaries of the area.

Author abstract

219. HANSON, ALVIN MADDISON, 1942, Phosphate deposits in western Summit, Wasatch, Salt Lake, Morgan, and Weber Counties, Utah: Utah State Univ. M. S. thesis, 44 p.

Williams, J.S. and A.M. Hanson, 1942, The phosphate reserves of Utah, revised estimate: Utah Agr. Expt. Sta., Bull. 304, 24 p.

To supplement the work reported by the senior author in Bulletin 290 of the Utah Agricultural Experiment Station, the writers have visited the phosphate outcrops in Weber, Morgan, and Salt Lake Counties, as well as those in the Park City district of Summit County and others west of Midway in Wasatch County. These areas were found to contain considerable phosphatic shale of 25 to 35 percent grade, but no rock of 40 percent grade, the minimum quality included in the estimates in Bulletin 290. However, the data recorded for the sections visited are valuable in showing the leanness of these areas, which because of their proximity to the industrial centers of the state, have often been suggested for early development. On the basis of these results the tables from Bulletin 290 setting forth Utah's reserve of phosphate by areas, by counties, and by quality of rock are revised and restated. *From published abstract*

220. HANSON, ALVIN MADDISON, 1949, Geology of the southern Malad Range and vicinity in [Cache and Box Elder Counties] northern Utah: Univ. of Wisconsin Ph. D. thesis, 128 p., geol. map.

An area of 160 square miles in the southern Malad Range vicinity was mapped. Exposed rocks range in age from Middle Cambrian to Cenozoic, although post-Silurian Paleozoic and Mesozoic rocks were removed by post-Laramide erosion. Middle Cambrian formations are, ascending: Ute Formation (439+ feet thin-bedded limestone), Blacksmith Limestone (444 feet), and Bloomington Formation (lower 326-foot shale, upper 103-foot limestone) with possible unconformity at the top. Upper Cambrian Nounan Formation contains dolomite in the lower 908 feet; limestone in the upper 500 feet is correlated with Crepicephalus zone. The St. Charles Formation contains 75-foot Worm Creek Quartzite Member at the base, overlain by a 368-foot limestone and a 630-foot dolomite. Five tentative zones (ascending: Elvinia, Ptychopleurites, Orygmaspis, Taenicephalus and Ptychaspis) are suggested for middle limestone, which is the probable age equivalent of Elvinia, Ptychopleurites, Conaspis and Prosaukia-Ptychaspis zones of the standard Upper Cambrian (Franconian) section.

Lower Ordovician Garden City Limestone (about 1,800 feet) is overlain by Middle Ordovician Swan Peak Quartzite (606+ feet, containing basal black shale), which is, in turn, unconformably overlain by the Upper Ordovician Fish Haven Dolomite (about 50 feet). The latter is mapped with overlying Middle Silurian Laketown Dolomite (2,000+ feet).

Tertiary tuffs, limestones and conglomerates occurring in Junction Hills, Bergeson Hill and along flanks of the range are correlated with the Salt Lake Group. Rocks of Pleistocene age include lake beds and terrace deposits (Lake Bonneville) and fluvial deposits (alluvial fans and valley fill).

The southern Malad Range lies near the eastern margin of the Basin and Range Province in which block faulting was superimposed upon older Laramide structures. Remnants of a high-level erosion surface which truncates Paleozoic and Tertiary rocks are correlated with the Rendezvous Peak surface. Relatively undissected pediment surfaces developed on rocks of the Salt Lake Group on the southern and eastern margins of the range are correlated with the McKenzie Flat surface. *B. C.*

221. HARDMAN, ELWOOD, 1964, Regional gravity survey of central Iron and Washington Counties, Utah: Univ. of Utah M. S. thesis, 107 p.

Cook, K.L. and Elwood Hardman, 1967, Regional gravity survey of the Hurricane fault area and Iron Springs district, Utah: Geol. Soc. America Bull., v. 78, No. 9, p. 1063-1076.

A regional gravity survey, consisting of 660 stations, was made in the transition area between Basin and Range and Colorado Plateaus Provinces, which includes the Hurricane Cliffs, St. George Basin, Iron Springs mining district, Cedar Valley and Escalante Desert. Data were reduced to complete Bouguer anomaly values and presented as a contour map along with generalized geology.

The Washington and Hurricane faults (Basin-and-Range type) intersect the northeast-trending Virgin-Kanarra fold; Virgin anticline and Kanarra fold were a continuous Laramide fold prior to dislocation by the Hurricane fault zone. Several faults of Basin-and-Range type are indicated within the subsurface of Cedar Valley and the Escalante Desert; these largely parallel older Laramide trends. Several graben in this area include Avon and Lund graben in Escalante Desert and the Cedar Valley graben.

The monzonite that crops out as aligned stocks in the Iron Springs district apparently continues at depth to the southwest from the Stoddard Mountain area. A gravity high corresponding with Antelope Range may represent another monzonite body or may indicate a structural block existing throughout the Iron Springs district. At least one anomaly apparently reflects topographic relief that existed prior to extrusion of ignimbrite deposits.

Abstract revised (B. C.)

222. HARDY, CLYDE THOMAS, 1948, Stratigraphy and structure of a portion of the western margin of the Gunnison Plateau [Sanpete County], Utah: Ohio State Univ. M. S. thesis.

_____ and H.D. Zeller, 1953, Geology of the west central part of the Gunnison Plateau, Utah: Geol. Soc. America Bull., v. 64, No. 11, p. 1261-1278, geol. map.

Geologic mapping of a portion of the western margin of the Gunnison Plateau, Utah ($SE\frac{1}{4}$ Axtell No. 2 quadrangle, Manti area) has revealed a number of important relations of regional significance. In the southern part of the area the Paleocene or possibly lower Eocene Flagstaff Limestone is in distinct angular unconformity with the conglomerate of the Upper Cretaceous Price River Formation, whereas in the northern part of the area the Price River Formation, Upper Cretaceous-Paleocene North Horn Formation and the Flagstaff Limestone are all apparently conformable. This implies that the orogenic movement involved in the angular unconformity was contemporaneous with the deposition of the Price River Formation itself. The movement is definitely later than the early Laramide orogeny of central Utah and possibly earlier than the pre-Flagstaff movement.

A major fault extends along the western margin of the plateau and is paralleled to the east by a graben between escarpments of the Price River Formation. In the intervening area there is a remarkable series of tilted fault blocks involving the Colton and Green River Formations as well as the North Horn

(?) Formation and Flagstaff Limestone. The youngest stratigraphic unit is the late Eocene (?) Crazy Hollow Formation which overlies the Green River Formation near the eastern margin of the area.

Author abstract

223. HARDY, CLYDE THOMAS, 1949, Stratigraphy and structure of the Arapien Shale and the Twist Gulch Formation in Sevier Valley [Sevier and Sanpete Counties], Utah: Ohio State Univ. Ph. D. thesis.

_____ 1952, Eastern Sevier Valley, Sevier and Sanpete Counties, Utah, with reference to formations of Jurassic age: Utah Geol. and Mineralog. Survey Bull. 43, 98 p., geol. map.

Detailed stratigraphic and structural studies of the Arapien Shale and the Twist Gulch Formation of Jurassic age, in central Utah, reveal five lithologic units in the Arapien Shale apart from the Twist Gulch Formation. The greatest exposed thickness of the Arapien Shale is east of Gunnison, Utah, where about 2,780 feet of strata are evident. E.M. Spieker, however, estimates a maximum possible thickness northeast of Salina, Utah, of 5,000 to 7,000 feet assuming a modified anticlinal structure. The Arapien is lithologically similar to the Carmel Formation of the San Rafael Group inasmuch as Units C and D of the Arapien seem to correspond to the lower gray shales and the upper gray shales with interbedded red shale and gypsum, of the Carmel Formation. The Arapien Shale differs from the Twin Creek Limestone exposed in the southern Wasatch Mountains in being definitely more shaly. The invertebrate marine fauna is typical of the lower part of the Carmel Formation in the San Rafael Swell, although the age of the Carmel is indeterminate between middle and upper Jurassic.

The Twist Gulch Formation is lithologically distinct from the Arapien Shale and is relatively uniform lithologically throughout central Utah. In Salina Canyon, east of Salina, Utah, about 1,900 feet of red siltstone and sandstone are exposed in angular unconformity beneath overlapping Tertiary units, although the base of the formation is not seen. About 175 feet of strata in the upper part of the Twist Gulch in Salina Canyon consist largely of olive-green shale with interbedded layers of grit containing fossils. The Twist Gulch Formation seems to correspond to the Entrada, Curtis, and Summerville Formations of the San Rafael Group.

The major structural feature evident in the Arapien Shale and related formations in the Sevier and Sanpete Valley area is a complexly folded anticline. Nevertheless, the Nugget or Navajo Sandstone, which presumably underlies the Arapien Shale, is nowhere exposed.

Published abstract

224. HARPER, M. L., 1960, The areal geology of Castle Creek Valley [Grand County], Utah: Texas Technolog. College M. S. thesis, 121 p., geol. map.

Castle Creek Valley is a graben faulted from a high plateau area north of the La Sal Mountain laccoliths in Grand County, southeast Utah. Formations outcropping in the valley walls are the Permian Cutler Formation, the Triassic Moenkopi, Chinle and Wingate Formations, and the Jurassic Kayenta Formation. Intrusive into the valley floor is the Paradox Salt Member of the Hermosa Formation, and a steep sided, conical leucoandesite plug of Tertiary age.

This paper presents a study of the drainage, topography, geomorphology, stratigraphy, structure and geologic history of the valley along with the geologic map and a series of topographic profiles.

Several periods of orogenic activity are indicated by angular unconformities at the top of the Cutler and Moenkopi Formations, and by folding and faulting of the remaining formations which occurred primarily during the Laramide Revolution. The Paradox Salt Series has moved intermittently since the close of the Permian continuing almost to the Recent.

Author abstract

225. HARRILL, JAMES REECE, 1962, Geology of the Davis Knolls and northern Big Davis Mountain area, Tooele County, Utah: Univ. of Utah M. S. thesis, 68 p., geol. map.

Big Davis Mountain, southern Skull Valley, and the Davis Knolls comprise the area mapped, from west to east. Formations discernible at the north end of Big Davis Mountain are: Victoria-Pinyon Peak Formation (253 feet), Madison-Deseret Formation (512 feet), Humbug Formation (796 feet), and the Great Blue Formation (2,500 feet exposed). Faulted segments of near vertical or overturned Oquirrh strata (3,800 feet exposed) that are younger from west to east (Pennsylvanian to lower Virgilian) comprise the Davis Knolls.

Southern Skull Valley is a graben; volcanic rocks (hypersthene andesites) are found in proximity to the border faults. Locally, steeply dipping Paleozoic rocks are unconformably overlain by a (Cretaceous or younger ?) conglomerate.

Major structures include a westward extension of the north-dipping Sheeprock monocline (Big Davis Mountain area), a southern extension of the southeast-trending folds of the Cedar Mountains (Davis Knolls), normal faults of relatively large displacement (west side of Big Davis Mountain and east side of the Davis Knolls), normal faults of smaller displacement parallel to larger faults, and older east-trending normal faults (north of Big Davis Mountain).

Lake Bonneville deposits include terraces at Bonneville (5,200 feet) and Provo (4,800 feet) levels, and gravel bars and spits. *Abstract revised (B. C.)*

226. HARRIS, A. WAYNE, 1936, Structural interpretations in the Rock Canyon area of southern Wasatch Mountains, Utah: Brigham Young Univ. M. S. thesis.

227. HARRIS, DeVERLE, 1958, The geology of the Dutch Peak area, Sheeprock Range, Tooele County, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 5, No. 1, 83 p., geol. map.

The term Sheeprock group is proposed in this report for the complete succession of metamorphic rocks which are exposed in the Dutch Peak area. The Sheeprock group, similar in lithology to the Big Cottonwood Series, is divided into two sequences which are separated by a thrust fault.

Quaternary alluvium represents the only unmetamorphosed sediments in the mapped area.

Erosion has exposed granite of the Sheeprock stock with its pegmatitic and hypabyssal differentiates. Intrusion of the stock produced metacrysts of actinolite and pyrite in the low-rank regional metamorphic rocks of the Dutch Peak area.

The major structural feature of the mapped area is the Sheeprock thrust fault. High-angle and reverse faults formed as a consequence of the Sheeprock thrust. Joints are a conspicuous feature in igneous and metamorphic rocks.

Mineral deposits of the Dutch Peak area have been explored and developed for copper, lead, silver, and tungsten metals. So far, no significant production has been realized from any of the properties. At present, the chief interest in metals in the mapped area is the large, low-grade beryllium deposit of the Sheeprock stock. *Author abstract*

228. HARRIS, HAROLD DUANE, 1953, Geology of the Birdseye area, Thistle Creek Canyon [Utah County], Utah: Brigham Young Univ. M. S. thesis.

_____ 1954, Geology of the Birdseye area, Thistle Creek Canyon, Utah: Compass, v. 31, No. 3, p. 189-208, geol. map.

In and adjacent to Thistle Creek Canyon, sedimentary rocks are over 10,250 feet thick. Major unconformities occur at the base of Jurassic, Cretaceous, Tertiary and Quaternary rocks. Twelve mappable formations include the Oquirrh Formation (Pennsylvanian and Permian), Kirkman Limestone, Diamond Creek Sandstone and Park City Formation (Permian), Shinarump Conglomerate and Chinle Formation (Triassic), Wingate (?) Sandstone (Jurassic ?), Navajo Sandstone and Carmel Limestone (Jurassic), Price River-North Horn Formations (Upper Cretaceous-lower Paleocene), Flagstaff Limestone (upper Eocene and Oligocene ?). The Moroni Formation (water-laid pyroclastics) and some Quaternary deposits are also found here.

Structurally, the eastern part of the area, composed of Upper Cretaceous and Tertiary strata tilted gently eastward, is part of the Wasatch Plateau Province and is broken by high-angle northeast-southwest normal faulting. The western part, consisting largely of steep-dipping Paleozoic rocks with intense folding, east-west normal faults, and local thrust faulting (Thistle Canyon fault) is part of the Middle Rocky Mountain Province. In the north central part Mesozoic strata dip steeply eastward to form a hogback. High-angle northeast-southwest normal faulting is of Basin-and-Range type. The ooidal Flagstaff Limestone in this area is sometimes used as an ornamental stone. *B. Y. S.*

229. HATCH, ROBERT A., 1938, Precambrian crystalline rocks of the Wasatch Mountains, Utah: Univ. of Michigan M. S. thesis, 29 p.

The name "Farmington Complex" is chosen for the Archean (pre-Algonkian) gneisses, schists and igneous intrusions well exposed in type sections in Farmington Canyon and on Bountiful Peak. Four types of metamorphic and igneous rocks are present: (1) Metamorphosed sedimentary rocks -- stratification prominent -- include quartz-sericite and quartz-chlorite arkosite, quartz-chlorite conglomerate schist, mica schist, and white quartzite; microscopically, there is thin granulated material coating the grains, universal cracking and undulatory extinction in quartz, schistosity, and no fluid inclusions; quartz is universal and chlorite common. (2) Metamorphosed silicic igneous rocks -- pegmatite, mostly medium-grained light-gray or pink gneissic layers alternating with dark biotite bands; microscopically, there are many alteration products; zircon, apatite and magnetite are the primary accessory minerals. (3) Metamorphosed injection gneisses -- related but more recrystallized than above. (4) Metamorphic mafic igneous rocks -- poorly known, not extensive, and of uncertain origin.

This study, which included petrofabric analyses, revealed that the most intense metamorphism occurred at the close of Farmington Complex time, that it was preceded by at least one less intense episode, and that it was preceded and accompanied by igneous activity. Pressure was the dominant metamorphic agent. *B. Y. S.*

230. HAYNIE, ANTHONY V., Jr., 1957, The Worm Creek Quartzite Member of the St. Charles Formation, Utah-Idaho: Utah State Univ. M. S. thesis, 39 p.

The Worm Creek Quartzite is the basal member of the (Upper Cambrian) St. Charles Formation and is present in the Bear River, Malad, and Promontory Ranges of northern Utah and southeastern Idaho. It is a first-phase sandstone, resulting from erosion of a granitic landmass just north of the Utah-Idaho border, and was deposited by the transgressive Franconian sea.

In general, the Worm Creek is a relatively thin blanket-type quartzite and sandstone. It consists of an upper carbonate unit and a lower quartzite unit which is calcareous in the middle. Near the source area the sandstone is terrestrial and arkosic, but to the south it is a platform sand composed of subangular to rounded quartz grains.

From author introduction and conclusions (B. C.)

231. HAYS, JAMES DOUGLAS, 1960, Study of the South Flat and related formations of central Utah (I-Petrology; II-Palynology): Ohio State Univ. M. S. thesis, 147 p.

The author sampled a composite section of the South Flat Formation of the Gunnison Plateau which was later divided into Indianola Members II, III, IV and the South Flat Formation. Heavy mineral suite is essentially constant, fluctuations being without pattern, probably caused by sorting action of currents.

Except for sandstone in lower Member II and some thin limestone, the samples are of fluvial origin. Calcium carbonate cement was precipitated from fresh-water solutions concomitantly with deposition of clastic material. Calcite cement is absent or nearly absent in beds of possible marine or brackish water origin, such as Member II. The conglomerate and poorly sorted sandstone of Member III and lower Member IV were deposited by strong currents moving down steep gradients. Reduction of gradient due to aggradation caused smaller particles to be transported, and eventually produced areas of stagnant water in which carbonaceous shale and coal of upper Member IV were deposited. Renewed deposition (orogenic movement ?) produced the well-sorted sandstone of the South Flat Formation.

Pollen assemblage from Member IV contains largely subtropical to tropical forms, minor temperate forms, and rare forms of boreal forests. Most forms are derived from the coal swamp, the others coming from highlands to the north and northwest. *B. C.*

232. HEBERTSON, KEITH M., 1950, Origin and composition of the Manning Canyon Formation in central Utah: Brigham Young Univ. M. A. thesis.

_____ 1957, Some characteristics of the Manning Canyon Formation in central Utah, in Guidebook to the Geology of the Uinta Basin: Intermtn. Assoc. Petroleum Geologists, 8th Ann. Field Conf., Guidebook, p. 78-81.

The Manning Canyon Formation was studied in Manning Canyon, northeast Lake Mountain, and Provo Canyon. It consists of orthoquartzite, limestone, and sandy limestone interbedded with variegated shales. It is topographically expressed as a valley between the overlying and underlying more resistant limestones. In Rock Canyon (Wasatch Range) it is underlain by Great Blue Limestone and overlain by Oquirrh Formation.

The Manning Canyon is uppermost Mississippian-basal Pennsylvanian. Upper Manning Canyon is upper Springeran. Correlation by chemical analysis alone proved unreliable. Amounts of iron and carbon were determined by chemical analysis, supplemented by insoluble residue studies. The analyses illustrate the complexity of the formation. Chemical analyses also revealed that the facies change between the Manning Canyon and the underlying Great Blue Limestone results from change in source material and conditions of deposition. Microscopic analysis was made of subgraywacke, clays and orthoquartzites of Lake Mountain area. Insoluble residue analysis reveals considerable graphitic carbon, iron in all shales, and little magnesium oxide.

Sedimentation occurred in a miogeosyncline. The marine subgraywacke in Provo Canyon indicates an actively subsiding platform during this time. Source area was probably a slowly rising landmass to the east and south. *B. Y. S.*

233. HEBREW, QUEY CHESTER, 1950, Ground-water geology of the Lehi, Utah, area [Utah County]: Brigham Young Univ. M. S. thesis, 43 p.

Study of well logs and correlation of sedimentary units revealed three major aquifers: First Aquifer at 40-100 feet, Second Aquifer at approximately 140-220 feet, and the Third Aquifer at approximately 240-280 feet. The three aquifers do not comprise the entire underground water supply and other aquifers of equal extent and value probably will be discovered at greater depths.

Although the aquifers appear to be continuous, successful flows are not always encountered as the result of local unconformity, irregular deposition, cementation, compaction, porosity and/or permeability changes, faulting or a combination of any of these factors.

The history of northern Utah Valley consists of at least three major lacustrine cycles: (1) deposition of fluvial gravels over the valley floor, followed by a lake stage with 60-120 feet of clays and sands, (2) a second cycle like the first -- fluvial deposition then a lake stage, (3) disappearance of second lake and accumulation of fluvial gravels and sands, followed by the final or Lake Bonneville stage. Fluvial sediments of these cycles constitute the major aquifers. *Abstract revised (B. Y. S.)*

234. HEDDEN, ALBERT H., Jr., 1948, The geology of the Pinyon Peak area, East Tintic Mountains [Utah County], Utah: California Inst. Techonology M. S. thesis, 32 p., geol. map.

G.F. Loughlin named and described the Pinyon Peak Limestone and assigned it an Upper (?) Devonian age. This outcrop of limestone on Pinyon Peak is the only known occurrence of Devonian rocks in the Tintic mining district, and was offered by Loughlin as evidence for dating a Lower Mississippian unconformity in the district ... to be correlated with a suspected Lower Mississippian unconformity in other parts of Utah. Loughlin mapped the Pinyon Peak Limestone as occurring below the Gardner Formation and Victoria Quartzite (both Lower Mississippian). Loughlin found little more than 5 or 10 feet of Victoria Quartzite exposed on Pinyon Peak. Recent field work has disclosed that a 200-foot thickness of Victoria Quartzite is present on Pinyon Peak, and that the Pinyon Peak Limestone occurs above this formation. A few poorly preserved fossils were found but nothing of diagnostic value. Attempts to locate Loughlin's original fossils were unsuccessful.

It is suggested that the Pinyon Peak Limestone is a limestone equivalent of a dolomitized member of the Gardner Formation and therefore should be relegated to the status of member of the Gardner Formation. Its age is still in doubt. *Abstract revised (B. C.)*

235. HENDERSON, GERALD V., 1958, Geology of the northeast quarter of the Soldier Summit quadrangle [Wasatch and Utah Counties], Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 5, No. 5, 40 p., geol. map.

Sixty square miles in central Utah near the town of Soldier Summit, previously studied and mapped by Spieker on a regional scale, were mapped in detail.

The stratigraphic section of lacustrine and fluviatile sediments exceeds 5,000 feet. The section begins with Cretaceous and Tertiary North Horn Formation which is overlain by Tertiary Flagstaff Limestone. The Eocene Colton Formation lies above the Flagstaff Limestone and is in turn overlain by the youngest strata present, the Green River Formation of middle Eocene age. Detailed studies indicated that the Green River Formation contains a basal oil shale zone approximately 1,000 feet thick and that the Colton Formation thins to the northwest and northeast and pinches out a few miles to the west.

Broad folds and normal, north-south faults characterize the structure while a series of cuestas dominate the topography.

Correlation of ozokerite deposits with joints and fractures showed that joints controlled deposition of hydrocarbons in this area.

Natural resources found consist of solid hydrocarbons and recently discovered natural gas. The solid hydrocarbons are ozokerite (a mineral wax) and kerogen (oil) shales. *Author abstract*

236. HEPWORTH, RICHARD CUNDIFF, 1963, Heaving in the subgrade of highways constructed on the Mancos Shale: Univ. of Utah M. S. thesis, 98 p.

Heaving in roads built on the Mancos Shale is a serious problem in east central Utah. Heaves are expressed as local bumps, general rises, and severe cracking of the pavement. The heaves usually occur in shale road cuts and are more developed in the winter months.

Three field sites were investigated. At two of these sites the swelling of a fractured shale and bentonite was causing heaves. The third site was free of heaves and the subgrade rock was a massive well-cemented siltstone.

Laboratory studies indicate that the soils at the heave sites were swelling due to the absorption of water. The swelling of compacted soils was lessened by increasing the initial moisture content. Swell tests at various temperatures indicate that water has more influence on swell than temperature except for samples containing sodium sulphate. Samples with sodium sulphate swelled in response to a lowering of temperature. Tests on shale cores indicate that the stability of slaking shale can be preserved by not allowing it to dry out. Salt solutions retarded swelling in samples.

It is recommended that freshly exposed shale be kept wet and that the thickness of the subbase and base courses be increased to minimize the problem. *From author abstract*

237. HEYLMUN, EDGAR B., 1966, Systematic rock joints in parts of Utah, Colorado and Wyoming, and an hypothesis on their origin: Univ. of Utah Ph. D. thesis, 190 p.
(Abs.): Dissert. Abs., sec. B, v. 27, No. 6, p. 1984B-1985B, 1966.

Whereas many fractures break in tension, the controlling forces may be shear. In selected areas of Utah, Colorado and Wyoming, joints are well exposed, and systematic joints striking toward the northwest dominate over most of the region. Systematic sets which strike toward the northeast are generally subordinate. Second-order shearing is well developed in some areas. Very few meridionally or latitudinally oriented systematic joints were observed.

A global shear pattern appears to exist. Most systematic jointing is developed along lines of maximum shear strain relative to the axis of maximum compressive stress (north-south) which has acted upon the earth. Subsequent tectonism and crustal shifting may have changed orientations locally from the dominant northwest- and northeast-trending joint patterns. Various geodynamic hypotheses are reviewed, and a cosmic theory is introduced as a logical mechanism for the origin of systematic rock jointing and the global shear pattern.

The dissertation is concluded with a brief review of the Tamrazian hypothesis, and the writer speculates on the possible effects of wrench faulting in relation to systematic jointing in parts of Utah, Colorado and Wyoming. *Abstract revised (B. C.)*

238. HIGHTOWER, CHARLES HENRY, Jr., 1959, Middle Cambrian stratigraphy of the Wah Wah Range, Beaver County, Utah: Southern Methodist Univ. M. S. thesis.

The Lyndon Limestone (350 feet) consists of thin-bedded, dark-gray limestone overlain by massive, light-gray limestone. The Chisholm Shale (36 feet) is a fossiliferous, olive-brown shale with interbeds of bioclastic limestone; it contains species of Acrothele, Zacanthoides, Alokistocare and Glossopleura. The Peasley Limestone (250 feet) is primarily thin-bedded, dark-gray, pisolitic limestone that contains Ehmaniella (?) sp., Zacanthoides sp., and Kootenia sp. The Burrows Limestone (310 feet) is massive and light-gray. The Burnt Canyon Limestone (370 feet) is primarily thin-bedded, dark-gray limestone with basal shale containing Ehmaniella (?) sp. The Dome Limestone (430 feet) consists of massive, light-gray limestone. The Swasey Limestone (500 feet) is primarily thin-bedded, dark sooty-gray limestone with Condor Member (90 feet) of finely laminated, gray, argillaceous limestone at the base.

The Middle Cambrian sequence of the Wah Wah Range is easily correlated with that of the Pioche district and resembles that of the Snake Range. There is a miscorrelation of several fossil assemblages of the House Range. Fauna found in Burnt Canyon of the House Range is properly correlated with fauna of the Chisholm Shale in the Pioche district and the Wah Wah Range. Fauna of the Condor Member of the Swasey Limestone in the House Range is properly correlated with fauna of the basal unit of Burnt Canyon in the Pioche district and House Range. Formational correlations of the House Range may also need revision. *Abstract revised (B. C.)*

239. HINDS, JIM S., 1960, Controls on Paradox salt deposition in the area of Comb monocline, San Juan County, Utah: Univ. of New Mexico M. S. thesis, 37 p.

Comb monocline extends northward into the Paradox salt basin and forms the east boundary of the Monument upwarp. During the deposition of the middle Paradox salt facies, the Comb structure formed a stable north-trending salient into the southwest shelf area of the northwest-trending basin. Middle Paradox deposits consist of less than 200 feet of black shale, dolomite and gypsum on the crest of the fold, more than 500 feet of hypersaline and penesaline evaporite sediments and black shale on the west side, and more than 1,000 feet of salt, anhydrite, gypsum, limestone and black shale immediately east of the fold, indicating that the fold may have been a slightly inclined, east-tilted anticline during Pennsylvanian time. The monoclinal form may result from Laramide uplift of the Monument area to the west. The wedge-edge of the Paradox halite deposits encircles Comb fold at its northern extremities.

Structural relief of the monocline is about 3,000 feet (top, Triassic Chinle Formation), 4,000 feet (top, Paradox Formation) and 4,900 feet (top, Mississippian Leadville Limestone). Regional tectonic activity during Pennsylvanian, Permian and Late Cretaceous resulted in the episodic rejuvenation of structural growth. The monoclinal fold appears to be the surface expression of a west-dipping, high-angle, reverse fault in the basement complex. *Abstract revised (B. C.)*

240. HINMAN, EUGENE E., 1954, Jurassic Carmel-Twin Creek facies of northern Utah: Washington State Univ. M. S. thesis.

_____ 1957, Jurassic Carmel-Twin Creek facies of northern Utah: Compass, v. 34, No. 2, p. 102-119, 1957.

The Carmel-Twin Creek Formations of Utah represent two facies which range from Lower Bajocian to Middle Callovian in age. They are marine sediments deposited at the southern extremity of a trough which extended from northern Alaska to northern Arizona during Middle and early Upper Jurassic time. Within the trough two negative tectonic elements were operative, and their influence caused the deposition of two facies of a single stratigraphic unit. The Carmel Formation is represented by a facies, characterized by its red color and predominance of clastic sediments, which was deposited on an unstable shelf that occupied what is now the eastern and southern portion of the state of Utah. This unstable shelf upon which the Carmel was deposited was bordered on the east by a low-lying source area and on the west by a miogeosyncline. The Twin Creek Formation is represented by a facies, consisting of gray argillaceous limestones and calcareous shales, which was deposited within this miogeosyncline. *Published abstract*

241. HINTZE, FERDINAND FRIIS, Jr., 1913, A contribution to the geology of the Wasatch Mountains, Utah: Columbia Univ. Ph. D. thesis.

_____ 1913, A contribution to the geology of the Wasatch Mountains, Utah: New York Acad. Sci., Annals, v. 23, p. 85-143.

Before block faulting, the folded formations of the central Wasatch were planed by erosion, and the Little Cottonwood granite, Alta granodiorite and Clayton Peak quartz diorite stocks were uncovered. Tertiary faulting uplifted the Wasatch block, characterized by a steep western face and long gentle eastern back slope. Mature dissection of the block by stream action was accomplished before the Pleistocene. The divide migrated from near the western margin to near the eastern margin of the block; the crest moved eastward only a short distance. Long west-flowing streams such as those in Big and Little Cottonwood Canyons are chiefly obsequent, being consequent only near their mouths. Provo and Weber Rivers are probably obsequent in their canyons across the Wasatch, but their headwaters are captured eastern consequents.

The great quartzite and slate series exposed in Big Cottonwood Canyon is mainly Algonkian. It is overlain by less than 1,000 feet of Lower and Middle Cambrian strata with widespread heavy basal conglomerate, and 500 feet of (Ordovician ?) unfossiliferous limestones and calcareous shales. Middle and Upper Devonian limestones with faunas closely allied to those of western Colorado and Iowa rest disconformably above the Ordovician, with a thin bed of limestone-pebble conglomerate at the base. Lower and Middle Mississippian limestones separated by a continental formation overlie the Devonian conformably. The (Pennsylvanian) Weber Quartzite is separated from the Mississippian of the Cottonwood region by an unconformity representing a considerable erosion interval.

An overthrust block consisting of Algonkian through Mesozoic strata overlies Devonian and older strata in the Alta region. Overthrusting is interpreted as having occurred from east to west accompanying the main (end of Cretaceous) folding of the Wasatch. Subsequently, large irregular granitic and dioritic masses and numerous dikes were intruded into Mesozoic and older formations. Two major faults and numerous minor fractures resulted from north-south faulting near Alta. *Published abstract revised (B. C.)*

242. HINTZE, LEHI F., 1948, An Ordovician section in Millard County, Utah: Columbia Univ. M. A. thesis, 30 p.

Fossil Mountain is a fault block mountain at the northern end of Wah Wah Valley comprised of more than 700 feet of gently westward-dipping limestones and shales of the Pogonip Group, overlain by about 200 feet of Eureka Quartzite, and capped with Tertiary lava.

The following forms, described and illustrated herein, were collected from limestone of the Pogonip Group. Trilobites: Bathyurellus feitleri, Bathyurus sp., Jeffersonia jennii, J. granosa, Eleutherocentrus sp., Bellefontia chamberlaini, Leiostegium sp., Pseudomera barrandei, Pliomerops ? sp., and Parapilekia sp. Ostracodes: Macronotella sp. and Leperditia bivia. Brachiopods: Orthis michaelis, Anomalorthis utahensis and Hesperonomiella minor. Incertae sedis: Receptaculites mammilaris. Some molds of cystoid plates, 4 species of gastropods, and 2 species of orthocones were tentatively identified but not illustrated. *B. C.*

243. HINTZE, LEHI F., 1950, Ordovician stratigraphy from central Utah to central Nevada: Columbia Univ. Ph. D. thesis.

_____ 1952, Lower Ordovician trilobites from western Utah and eastern Nevada: Utah Geol. and Mineralog. Survey Bull. 48, 249 p.

Fifteen faunal zones are recognized in the Ordovician Pogonip Group of west central Utah and eastern Nevada; the lower 11 zones are Canadian and the upper 4 are Chazyan. Zones are defined principally on the basis of trilobite assemblages although brachiopods and other forms are also listed. Faunal lists from western Utah and stratigraphic sections from six eastern Nevada localities are presented to evidence the zonation. Fifty new species of trilobites are names; 42 genera are represented on the plates, 5 of the genera (Parabellefontia, Paranileus, Pseudonileus, Pseudoolenoides and Trigonocercella) being new. *Published abstract*

244. HODGKINSON, KENNETH A., 1961, Permian stratigraphy of northeastern Nevada and northwestern Utah: Brigham Young Univ. (M. A. thesis) Geol. Studies, v. 8, p. 167-196.

Biostratigraphic studies in the eastern Great Basin indicate an aggregate thickness of Permian sediments of 6,185 feet in the Gold Hill district, 5,550 feet in the Pequop Mountains, and approximately 2,050 feet in the northern Leppy Range. Substantial revision of Nolan's 1935 nomenclature in the Gold Hill district and modification of the terminology used in the Pequop Mountains and Leppy Range seems desirable. At Gold Hill the strata of Nolan's "Oquirrh Formation" can better be designated by the following formational names: Ely Limestone (Springeran-Derryan), Hogan Formation (Desmoinesian), Ferguson Mountain Formation (Virgilian-Wolfcampian), Pequop and Loray Formations (Leonardian), Kaibab Limestone (possibly Guadalupean) and the Plympton and Indian Canyon Formations (Guadalupean). This sequence, which is correlative to Nolan's "Oquirrh Formation," is overlain by the Gerster Formation. Deposition of Permian sediments was influenced by: (1) epeirgenic uplifts, (2) retreat and advance of Permian seas, and (3) presence of three major positive areas in the eastern Great Basin. Basis for these conclusions is the existence of several regional unconformities, presence of evaporite sequences associated with normal marine limestones, lateral variation in lithology and lateral variations in thickness of Permian formations. Lower Permian rocks (Wolfcampian, Leonardian) are dated on the basis of contained fusulinids, but more difficulty is encountered in dating Upper Permian sediments due to lack of diagnostic fossils. The Gerster Formation is dated as Capitanian because it contains a diagnostic brachiopod fauna as well as the Capitanian age fusulinids Reichelina and Codonofusiella. No Ochoan age strata are known in the eastern Great Basin. *Author abstract*

245. HODGSON, ROBERT A., 1951, Geology of the Wasatch Mountain front in the vicinity of Spanish Fork Canyon [Utah County], Utah: Brigham Young Univ. M. S. thesis.

_____ 1951, Geology of the Wasatch Mountain front in the vicinity of Spanish Fork Canyon, Utah: Compass, v. 29, No. 1, p. 47-55, geol. map.

The south central Wasatch Mountains form a sharp eastward-facing re-entrant on the east side of Utah Valley where Spanish Fork River enters the valley. It was studied to determine if this feature is a fault scarp or fault-line scarp, and if the Wasatch frontal fault shows a continuous trace along the base of the mountains forming the re-entrant.

The oldest rocks in the area studied belong to the Oquirrh Formation, about 15,000 feet of dark-blue and blue-gray limestones, calcareous sandstones, and quartzites, probably uppermost Pennsylvanian and lower Permian in age. A well-defined joint system of 3 sets is predominantly developed in the Oquirrh Formation. Also present are the Kirkman and Diamond Creek Formations (Permian), the North Horn Formation (Upper Cretaceous and Paleocene), the Salt Lake Formation (Pliocene), pre-Bonneville Pleistocene fan deposits, Lake Bonneville Group and Recent sediments.

It is the writer's opinion that the frontal fault exhibits a continuous trace in the area mapped and is not composed of a set of offset faults. Movement has been intermittent but continuous until present time. A piedmont scarp (Recent) has been formed in Bonneville strata at the west base of Spanish Fork Peak. *B. C.*

246. HODGSON, ROBERT A., 1959, Regional study of jointing in Comb Ridge-Navajo Mountain area, Arizona and Utah: Yale Univ. Ph. D. thesis.

_____ 1961, Regional study of jointing in Comb Ridge-Navajo Mountain area, Arizona and Utah: Am. Assoc. Petroleum Geologists Bull., v. 45, No. 1, p. 1-38.

The spatial relations of joints and, in particular, structural details of individual joints, offer clues of their origin. Important features of joints have been largely neglected in previous joint studies and the present study is an attempt to determine more closely the true nature of joints in sedimentary rocks and to suggest a mode of origin more in line with field observations than is present theory.

The study area comprises about 2,000 square miles of the Colorado Plateau in northeastern Arizona and southeastern Utah where sedimentary rocks ranging from Pennsylvanian to late Cretaceous in age are exposed.

A simple, nongenetic joint classification is presented based on the spatial relations of joints and the plumose structures on joint faces. Joints are grouped as systematic or nonsystematic with cross-joints defined as an important variety of nonsystematic joints.

Plumose structures on joint faces indicate that joints are initiated at some structural inhomogeneity within the rock and propagated outward, thus precluding movement in the direction of the joint faces at the time of formation. Spatial relations of systematic joints point to formation at or near the earth's surface in a remarkably homogeneous stress field.

The regional joint pattern is composed of a complex series of overlapping joint trends. The pattern as a whole extends through the entire exposed rock sequence. Intersecting joint trends have no visible effect on each other and may terminate independently in any direction. Each joint trend of the regional pattern crosses several folds of considerable magnitude but does not swing to keep a set angular relation to a fold axis as the axis changes direction.

In accord with theoretical and experimental evidence, semi-diurnal earth tides are considered as a force capable of producing joints in rocks through a fatigue mechanism. Field observations suggest that joints form early in the history of a sediment and are produced successively in each new layer of rock as soon as it is capable of fracture. The joint pattern in preexisting rocks may be reflected upward into new, nonjointed rock and so control the joint directions. *From published abstract*

247. HODGSON, RUSSELL B., 1925, Reconnaissance of the Crescent Eagle structure and its connection with the Salt Valley anticline [Grand County]: Univ. of Utah M. S. thesis, 44 p.

The Crescent Eagle structure is believed to be closed on the south and connected to the Salt Valley anticline by a structural saddle, but the oil pool is limited in extent due to the low degree of dip and smallness of structure. The well of the Crescent Eagle Company is favorably located 1/4 mile west of the southwest corner Sec. 4, T. 22 S., R. 17 E. Due to a fault near the crest of the structure, the source rock cannot be definitely located. The large number of oil horizons (16) and small oil showing in each may indicate that the oil migrated upward along the fault, which tightened at the top, forcing oil into the porous sands. Both the McElmo Formation and Navajo sands of the La Plata (both Jurassic) were unproductive. Other potentially productive horizons such as the Twelve Mile Sand, Rico-Hermosa Formation and Upper Mississippian rocks may be too deep to be drilled.

A successful well in southern Utah requires a fairly large structure, reservoir rock with appreciable thickness and intergranular space, source rock, an oil-bearing horizon that is not at prohibitive depths, and suitable rig for drilling under conditions generally encountered, of which the Crescent Eagle is typical. *Author conclusions revised (B. C.)*

248. HOFFMAN, FLOYD H., 1951, Geology of the Mosida Hills area [Utah County], Utah: Brigham Young Univ. M. S. thesis.

_____ 1951, Geology of the Mosida Hills area, Utah: Compass, v. 29, No. 1, p. 55-64, geol. map.

The Mosida Hills extend northward from a northern continuation of the East Tintic Mountains. Six Paleozoic formations of Silurian through Mississippian age, consisting mainly of limestone, dolomite, and sandstone, have an aggregate thickness of 2,783 feet. Varying thicknesses of Tertiary volcanic rocks and fresh-water limestone are present. Lake Bonneville strata cover surfaces at lower elevations. Asymmetric folds are common in the Paleozoic strata. The east flanks of the anticlines are steeper than the west, and the axes trend N-S to N. 20° E.

From published introduction

249. HOLLAND, FRANK DELNO, Jr., 1950, Stratigraphic details of lower Mississippian rocks of northeastern Utah and southwestern Montana: Univ. of Missouri M. A. thesis, 86 p.

The Madison Limestone and underlying (new) Leatham Formation of Leatham Hollow, northeastern Utah, are compared and correlated, respectively, with the lower portion of the Madison Group (Lodgepole Limestone) and underlying Sappington Sandstone of the Three Forks area, southwestern Montana, type locality of the Madison.

The "Contact Ledge" of northeastern Utah, previously thought to mark the base of the Madison, is upper Jefferson Limestone. It is at least as young as Chemung, and may correlate with Upper Devonian Three Forks Shale, which underlies the Sappington Sandstone in Montana.

Unconformably overlying the Jefferson are shales, sandy shales and nodular limestones of Lower Mississippian Leatham Formation, with 3-inch conglomeratic limestone (bearing fish teeth) at the base. The top grades into dark-brownish-gray fissile shale (30 feet thick) at the base of the Madison.

The Madison Limestone, alternating dark-gray fine-crystalline limestone and thin shaly limestone, is Kinderhookian in age and underlies the Brazer Limestone of Meramecian and possibly Chesterian age.

The porosity of Lower Mississippian rocks is low, but suitable reservoir rocks for petroleum may be found in areas in which solution or dolomitization has occurred. *Summary of conclusions revised (B. C.)*

250. HOLMES, ALLEN W., Jr., 1954, Upper Cretaceous stratigraphy of northeastern Arizona and south central Utah: Univ. of Colorado M. S. thesis, 113 p.

Upper Cretaceous rocks of Black Mesa, Arizona, and the Kaiparowits Plateau and Henry Mountains, Utah, were studied and found to represent the geosynclinal cycle of deposition: (1-base) thin basal conglomerates and sandstones, (2) thick marine shales, (3) interbedded sandstones, shales and coals, and (4-top) very thick graywackes and conglomerates. The Dakota Sandstone, Mancos Shale, Tropic Shale, Tununk Shale, and Ferron Sandstone of early Colorado age are parts 1 and 2. Large-scale intertonguing of sandstone and shale (part 3) occurred during late Colorado and early Montana time, when the areas were marginal to an oscillating sea to the east and an orogenic belt to the west. The Mesaverde Formation, Straight Cliffs Sandstone, and Wahweap Formation represent sandy westward extensions of tongues, while the Bluegate Shale, Emery Sandstone, Masuk Shale, and Masuk Sandstone represent more shaly eastward extensions. The Kaiparowits Formation is part 4.

The sandstones are mainly quartz, and are mostly fine, well-sorted subgraywackes. Some quartzose sandstones show evidence of winnowing and reworking. The shales are calcareous, siliceous, and some are black. They are probably neritic. Environments of sedimentation were dominantly sublittoral, littoral and brackish, and tectonic environments were stable to moderately stable platform areas. *Abstract revised (B. C.)*

251. HOLT, ROBERT E., 1953, Structure and petrology of the diorite on the 800 level, Mayflower mine, Park City [Wasatch County], Utah: Univ. of Utah M. S. thesis, 100 p., geol. map.

The diorite in the Mayflower mine, Keetley, Utah, has assimilated to some extent the calcareous sediments with which it has come into contact during the process of intrusion. This assimilation is shown by an increase in grain size and a basification of the diorite at and near the contact. Banding present on the 800 level of the mine is evident because of decrease in grain size, decrease in amount of plagioclase, and increase in amount of dark minerals. The symmetry of the petrographic diagrams of the plagioclase suggests that there was flow previous to and during solidification of the diorite, and that there is a relation of the magmatic flow with the contact. The banding is thought to be primary flow structure rather than relic structure. Alteration (chloritization, kaolinization - sericitization and epidotization) within the diorite is due to the action of hydrothermal solutions during successive stages. The alteration probably took place in a mesothermal environment of intermediate temperature. *From author*

252. HOOPER, WARREN G., 1951, Geology of the Smith and Morehouse-South Fork area [Summit County], Utah: Univ. of Utah M. S. thesis, 55 p., geol. map.

The Smith and Morehouse-South Fork area is located on the northward-dipping limb of the Uinta anticline.

A newly discovered unconformity at the base of the Pine Valley quartzite, previously regarded as high in the Cambrian, requires that the Precambrian-Cambrian contact be located at this horizon. Ordovician and Silurian rocks were not recognized. Fossiliferous Devonian strata of probable Jefferson (?) age were identified. Post-Devonian-pre-Madison uplift and erosion is indicated by the deposition of the Madison Limestone upon eroded Precambrian, Cambrian and Devonian sediments. The Brazer Formation is divisible into two lithologic units, probably correlative with the Deseret and Humbug Formations. The Morgan Formation is divided into a lower limestone and upper variegated members, but are left unnamed. The Weber Quartzite and the Park City Fromations are described. Mesozoic and Cenozoic formations were mapped but not studied in detail. Thicknesses are given where measurements were made.

The general geology and geomorphology are discussed, and the significance of landslides as an erosional process is pointed out. *Author abstract*

253. HOSFORD, GREGORY F., 1950, Ground-water geology of Pleasant Grove [Utah County], Utah, and vicinity: Brigham Young Univ. M. S. thesis, 45 p.

Deposition of sediments in northern Utah Valley has apparently followed a cyclic system. Information gleaned from well logs, supplemented by other observation, demonstrates two major stages of lake deposition. One interlake stage is represented by a gravel member continuous throughout the area. The gravel member is a series of coalescing fans spread over lake sediments. A second continuous gravel member, lower in the section, overlies a third lake stage, indicated by the Geneva well. The two lake stages are represented by clay members extending throughout the area, forming impermeable layers between the interlake gravel deposits.

Wells are important sources of culinary, irrigation and industrial water. A large percentage of the wells are flowing wells. Two aquifers, consisting of the interlake gravel deposits, support flowing wells; pump wells either draw their water from the water table or are situated in locations of higher elevation. Deep wells indicate an abundance of water below the aquifers.

Abstract revised (B. Y. S. and B. C.)

HOWARD, JAMES D., 1966, The Upper Cretaceous Panther Sandstone Tongue of east central Utah: Description of sedimentary facies and interpretation of depositional environments: Brigham Young Univ. Ph. D. thesis.

See abstract number 572, at end of collection.

254. HUNT, JOHN PRIOR, 1957, Rock alteration, mica, and clay minerals in certain areas in the United States and Lark mines, Bingham [Salt Lake County], Utah: Univ. of California (Berkeley) Ph. D. thesis, 321 p.

Several rock types occur within the broad zones of altered limestone at Bingham. Silicated limestone may be dominated by one or more of the following: Diopsidic - pyroxene, garnet, tremolite-actinolite, epidote, chlorite, opal. Locally, in dark limestone areas, "sandy" or "punky limestone" is present in which carbonate minerals are partly or wholly removed. In two exposures of marbelized and bleached limestone similar patterns of black limestone-white limestone-banded limestone are found. Saponite veinlets cut both marbelized and silicated limestone.

Quartzites may also contain diopsidic-pyroxene and megascopically resemble silicated limestones. Locally, highly silicified quartzite is present. Within one breccia pipe and in two other places in the U.S. mine altered quartzite contains pale brown, Mg-bearing, 1-layer trioctahedral mica and montmorillonoid clay.

Samples from within Pb-Zn orebodies, their host fissures, and adjacent wall rocks in widely separated areas, well below the original water table, contain a variety of mica and clay minerals. In the eastern part of the U.S. mine the footwall fissure of a limestone horizon contains abundant dioctahedral montmorillonoid and pyrite. Locally the limestone above the fissure is silicified (opal) and argillized (dioctahedral montmorillonoid). Within the fissure there is a pyrite body containing abundant fine-grained dominantly 1-layer, dioctahedral mica having a relatively low temperature thermal breakdown. On strike within the fissure a Pb-Zn orebody is present which contains similar fine-grained dioctahedral mica with both 1- and 2-layer polytypes. Veinlets of dioctahedral montmorillonoid and pyrite cut portions of this orebody.

Dominantly 1-layer and disordered dioctahedral micas (low temperature thermal breakdown) are abundant vein products on six fissures cutting the Last Chance Stock. In one of these a chlorite is also abundant. Sericitized envelopes border these fissures. A narrow zone (< 1 inch) of intense argillization (montmorillonoid) lies between relatively fresh porphyry and the sericite zone.

From author abstract

255. HUNT, ROBERT ELTON, 1948, The geology of the Dry Canyon region, Gunnison Plateau, Utah: Ohio State Univ. M. S. thesis.

Stratigraphic units comprising this portion of the Gunnison Plateau range from Upper Jurassic to Eocene in age. They are the same as those represented in the Wasatch Plateau to the east. The units are much more clastic, however, and in the case of the North Horn Formation the development of lateral lithologic variations is much greater.

The stratigraphic relationships are such as might be expected from the data previously determined for the Wasatch Plateau. Evidence for the Early Laramide, Middle Cretaceous, and Basin-and-Range orogenic episodes was discovered. In addition, the coarse Price River and North Horn indicate that this region also felt the effect of a fourth orogeny during late Fox Hills (?) time.

Structurally, the front of the Gunnison Plateau is very complex. During post-Eocene time the region underwent an episode of either compressional or torsional deformation. During the early stages of this orogeny the beds responded by folding in a north-south direction. This folding was followed possibly in a later stage of the same orogenic episode by both east-west and north-south faulting. It was at this time that the present outline of the eastern Gunnison front took shape.

From author abstract

256. HUNT, ROBERT ELTON, 1950, Geology of the northern part of the Gunnison Platea, Utah: Ohio State Univ. Ph. D. thesis, 267 p.

The northern Gunnison Plateau is a fault block plateau approaching physiographic maturity, in which Basin-and-Range type structures are superimposed upon Colorado Plateau type structures. The area lies within Spieker's western sedimentary province, characterized by geosynclinal deposits.

The exposed stratigraphic sequence consists of Jurassic Arapien Shale (2,693 feet) and Twist Gulch Formation (0-1,800 feet); Cretaceous Indianola Group (6,945 feet), South Flat Formation (433-2,850 feet of brown, tan or buff sandstone, conglomerate and limestone with coal-bearing variegated beds, described for the first time) and Price River Formation (0-1,000 feet); Cretaceous-Tertiary North Horn Formation (0-3,166 feet); Tertiary Flagstaff Limestone (100-963 feet), Colton Formation (311 feet), Green River Formation (33-322 feet), "Tawny beds" (582 feet), pyroclastics (650 feet) and Salt Creek Fanglomerate (500 feet).

Igneous rocks consist of monzonite porphyry intruded discordantly (mostly as dikes but also as a sill) and andesite (as cobbles in the pyroclastic rocks). The igneous rocks are late Eocene to (?) Miocene in age; the monzonite is older than the andesite.

Structure is complex. Two superimposed north-south synclines occur in the south part of the area. West of Hurricane Cliffs, the Arapien is arched into a dome and a doubly-plunging anticline, with a structural low between the apices of the anticline covered by Tertiary deposits. Evidence exists for 9 episodes of folding and faulting from Late Jurassic to Quaternary. Basin-and-Range faulting was instrumental in producing the present relief.

B. C. and B. Y. S.

257. JACOBS, MARIAN B., 1963, Alteration studies and uranium emplacement near Moab, Utah: Columbia Univ. Ph. D. thesis. (Abs.): Dissert. Abs., v. 24, No. 9, p. 3777-3778, 1964.

Kerr, P.F. and M.B. Jacobs, 1964, Argillic alteration and uranium emplacement on the Colorado Plateau, in Clays and clay minerals: 12th Nat'l. Conf., Atlanta, Ga., 1963, Proc.: New York, Macmillan Co., p. 111-128.

Specimens from Cutler and Chinle strata associated with uranium deposits on Lisbon Valley and Cane Creek anticlines have been studied in detail. Available lead/uranium and sulfur isotope data for the Lisbon Valley uranium area have been reviewed.

A major fault follows the crest of the Lisbon Valley salt anticline and strikes northwest across the Big Indian Wash uranium area. Abundant kaolin is found in altered Chinle strata near the fault, and veinlets of dickite occur in the zone of shear, accompanied by tiny veinlets of pyrite and globules of indurated asphalt. Solution activity is indicated by bleaching and silicification. Argillic mineral associations, fracture-controlled copper sulfide deposits, and indurated hydrocarbons indicate that the mineralizing solutions were heated.

On Lisbon Valley anticline porous Cutler "sugar sands" have been bleached by solutions bearing H_2S. In sugar sands close to the Lisbon Valley fault, alteration of feldspar and biotite is interpreted as due to hydrothermal activity. Sugar sands mineralized with uranium and copper are geometrically related to overlying uranium ore deposits and in places are cut by faults and fractures. In Cane Creek area, several mineralized high-angle faults closely parallel the northwest-trending anticlinal axis. Uranium deposition is interpreted as having been caused by reduction of uranium-bearing solutions by H_2S, derived from petroleum and decaying organic material.

Alteration along the Cane Creek and Lisbon Valley structures indicates extensive activity of solutions having a hydrothermal source. Structural and stratigraphic conduits probably extended laterally and vertically to distant reaches and provided ease of movement and possibility for mixing of hydrothermal source solutions with ground waters.

Abstract revised (B. C.)

258. JACOBSON, A. THURL, 1941, Geology of the North Fork and upper Duchesne River region [Duchesne County]: Univ. of Utah M. A. thesis, 61 p.

The Uinta Mountains form an east-west-trending range in northeastern Utah and northwestern Colorado. The region has been much dissected by streams and glaciers and now has a relief of about 8,500 feet. Vertical uplift of about 45,000 feet in the Uintas is a result of three periods of folding and uplifting. The area of this thesis presents a fairly complete stratigraphical column including sediments from pre-Cambrian to present. The shale on the North Fork is Cambrian in age. In the Mississippian Formation Brazer is present. The Curtis was a deposit in the Sundance sea. In the Cretaceous are the Dakota, Aspen, Frontier, Hilliard, and Mesaverde Formations. Kay mapped the variegated, dipping Tertiary series above the Cretaceous here as Duchesne River (Oligocene) Formation. However, this writer considers this formation as being older than Oligocene since it dips under the Uinta (Eocene) Sandstones. This thesis places the formation in lower Eocene and calls it Wasatch. The central part of the Uinta Mountains has been extensively glaciated, and the canyon of the North Fork is a glaciated canyon. *Author abstract*

259. JOHN, EDWARD C., 1964, Petrology and petrography of the intrusive igneous rocks of the Levan area, Juab County, Utah: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 11, p. 67-96.

The intrusive igneous rocks of the Levan area are intermediate to basic in composition. Small stocks, bosses, dikes and sills make up 28 separate intrusions into the Arapien Shale and Green River Formation. Chemical and mineralogical composition shows six rock types that in order of predominance are: porphyritic leucomonzonite, monzonite porphyry, hornblende monzonite porphyry, biotite-augite monzonite, diabase, and syenodiorite porphyry. Relative ages of intrusion were diabase, monzonite porphyry, hornblende monzonite porphyry, porphyritic leucomonzonite, and syenodiorite porphyry. Biotite-augite monzonite is the result of deuteric alteration of hornblende monzonite porphyry. Age of intrusion is post-Green River Formation, that is, post-middle Eocene.

Chemical and mineralogical data indicate a probable correlation between the intrusive rocks of the Levan area and the extrusive rocks of the Moroni Formation. Alterations consist of contact metamorphism, hematite and silica metasomatism, and low temperature hydrothermal alteration. No evidence of economic metallization was found. *Author abstract*

260. JOHNS, KENNETH HERBERT, 1950, Geology of the Twelve Mile Pass area, Utah County, Utah: Brigham Young Univ. M. S. thesis, 100 p., geol. map.

In the Twelve Mile Pass area, eastern edge, Basin and Range Province, 11,152 feet of Paleozoic quartzite, sandstone, shale, limestone, and dolomite are exposed. Sediments of Silurian, Devonian and Permian ages are not present. Minor amounts of Tertiary volcanics occur throughout the area. In Cedar Valley there is an interfingering of Quaternary gravels and Lake Bonneville silt and clay.

The major structural features are the Broad Canyon anticline, Cedar fault, and Twelve Mile Pass thrust fault. Broad Canyon anticline is an asymmetric, north-trending anticlinal structure plunging gently toward the north. Minor folds occur along the limbs of the anticline. Cedar fault cuts the east limb of Broad Canyon anticline at an oblique angle with a horizontal displacement of 2,800 feet. Just south of Twelve Mile Pass is the Twelve Mile Pass thrust fault which shows Opohonga sediments thrust upon stratigraphically younger Bluebell sediments.

The age of folding as indicated within the area is post-Pennsylvanian and pre-volcanic time. The folding in the Oquirrh district has been dated as late Cretaceous or very early Eocene. Since the Twelve Mile Pass area is in a north-south line with the folding of the Oquirrh Mountains, it is probable that the folding in both areas was at the same time.

From author abstract

261. JOHNSON, JOHN BURLIN, Jr., 1956, Regional gravity survey of parts of Tooele, Juab and Millard Counties, Utah: Univ. of Utah Ph. D. thesis, 34 p.

_____ 1957, Regional gravity survey of parts of Tooele, Juab and Millard Counties, Utah: Geophysics, v. 22, No. 1, p. 48-61.

A regional gravity survey was made in parts of Tooele, Juab and Millard Counties, to obtain information on regional geologic trends and facts pertinent to ground-water and mineral exploration. Four hundred and fifty-five gravity stations were occupied with spacings of 2 to 5 miles in an area of about 1,700 square miles, and a Bouguer anomaly map was drawn, contoured at intervals of 2 milligals. Three theoretical profiles were computed with a two-dimensional graticule across three major anomalies found in the region.

The regional gravity map reflects density contrasts resulting from all past geologic events, with anomalies resulting from the recent Basin-and-Range orogeny predominating.

North of the 40th Parallel several regional gravity anomalies indicate probable major Basin-and-Range faults along the eastern margin of the southern end of the Cedar Mountains, west of Davis Mountain, east of Camels Back Ridge and Simpson Buttes, north of the Dugway Range, and east of Granite Mountain. One graben or faulted trough probably lies between Davis Mountain and Camels Back Ridge, and another lies east of Granite Mountain.

South of the 40th Parallel two major breaks trend transverse to the Dugway Range and the Thomas Range. These events probably antedate the Basin-and-Range orogeny.

No steep gravity gradients were discovered in the vicinity of Drum Mountains or Simpson Mountains, although the gravity over the Simpson Mountains has an unusually low value.

The gravity anomalies associated with Basin-and-Range faulting north of the 40th Parallel trend northwesterly. The pre-Basin-and-Range events south of the 40th Parallel trend westerly. A regional gradient of about -1.3 milligals per mile toward the southeast occurs in the surveyed area.

From author abstract

262. JOHNSON, KENNETH DEE, 1959, Structure and stratigraphy of the Mount Nebo-Salt Creek area [Juab County], southern Wasatch Mountains, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 6, No. 6, 49 p., geol. map.

The area between Mount Nebo and Salt Creek lies at the junction of the Great Basin, Middle Rocky Mountains and Colorado Plateaus Provinces. Its southern boundary separates the southern Wasatch Mountains from the Gunnison Plateau. Paleozoic sedimentary rocks comprise the upper plate of the Nebo overthrust; Mesozoic and Cenozoic sedimentary rocks comprise the sole of the thrust, and crop out in foothill and valley areas. The Nebo overthrust and probably the Cedar Ridge thrust resulted from compression during orogeny of mid- and Late Cretaceous time. The Wasatch fault and most of the normal faults in the Salt Creek and Rees Flat area occurred during the Basin-and-Range disturbance (Late Tertiary). Water is presently the most important resource, but rock gypsum has been important in the past. *Abstract revised (B. C.)*

263. JOHNSON, MELVIN COATANY, 1952, Areal geology of the Wanship-Coalville area [Summit County]: Univ. of Utah M. S. thesis, 50 p., geol. map.

A 90-square-mile area in northwest and north central Coalville quadrangle, Summit County, was mapped in detail. Cretaceous marine and nonmarine conglomerates, sandstones and shales totaling about 12,000 feet comprise the Early Cretaceous Kelvin and Aspen Formations and Late Cretaceous Frontier and "Wanship" Formations. Coarseness and red color of some units indicate that Coalville area was near source of Cretaceous sediments and western margin of Cretaceous sea. Angular unconformity between Frontier and Wanship Formations suggests that Coalville anticline was slightly arched in pre-Wanship time. A sequence of variegated sandstone, shale and conglomerate about 3,000 feet thick comprises the Paleocene Almy Formation and early Eocene Knight Formation. Both Almy and Knight Formations overlie older truncated beds.

The mapped area is at the junction of the north-trending Wasatch and the east-trending Uinta Ranges. The local structures and the northeasterly trending Coalville anticline result from several episodes of deformation in both ranges. Overlapping and unconformable relations observed in the sedimentary rocks circumscribing the anticline indicate four episodes of orogeny. A large high-angle reverse fault is situated along the southeast limb of the anticline. *B. C.*

264. JOHNSON, MIKE SAM, 1949, Geology of the Twelve Mile Canyon area [Sanpete County], central Utah: Ohio State Univ. M. S. thesis, 91 p., geol. map.

Exposed bedrock ranges from Jurassic to Tertiary and includes the Upper Jurassic Arapien Shale (probably 1,000-1,500 feet); Upper Cretaceous Price River Formation (400 feet or more); Cretaceous-Paleocene North Horn Formation (1,240 feet or more); Paleocene Flagstaff Limestone (316-1,000 feet or more); Eocene Colton (324 feet or more), Green River (lower 557-foot shale with limestone and tuff; upper 256-foot or more limestone with lava) and Crazy Hollow Formations (60 feet or more); and Pliocene or Pleistocene Axtell Formation (20 feet or more). Glacial and post-glacial unconsolidated deposits of moraine, till, outwash, gravel, talus and alluvium are present in western part of area and in Twelve Mile Canyon.

The Twelve Mile Canyon area lies along the southern part of the Wasatch monocline. The Wasatch monocline forms the west front of the Wasatch Plateau and trends N. 20° E. across a part of central Utah. The shoulder graben which separates the monocline, near its crest, from the Plateau top cuts across the eastern part of the Twelve Mile Canyon area. The area contains numerous normal faults and a few thrusts. Most of the normal faults are longitudinal faults; a few are transverse faults. Three minor folds are present. *B. C.*

265. JOHNSON, WILLIAM W., 1958, Regional gravity survey of part of Tooele County, Utah: Univ. of Utah M. S. thesis, 38 p.

A regional gravity survey was made in northeastern Tooele County. A total of 359 gravimeter stations was established in a 980-square-mile area. The data were reduced to a Bouguer anomaly map with contour interval of 2 milligals.

A major fault zone is present throughout the west margin of the Oquirrh Mountain fault block. Faulting is shown to occur on both the west and east sides of the Stansbury Mountains and along at least the northern part of the Onaqui Mountains. The data help to support the hypothesis that the Oquirrh Mountains, the Stansbury Mountains, and the Onaqui Mountains are horsts. Tooele Valley, Rush Valley and the northern part of Skull Valley are shown to be broad graben with subsidiary or multiple graben and horsts within them. The throw of the faults bordering the graben are shown to be several thousands of feet in places. Cenozoic rocks total about 12,000 feet in Tooele Valley, 6,000 feet in the southern part of Skull Valley, and 8,000 (?) feet in Rush Valley. There is some evidence of (1) structures of pre-Basin-and-Range age (late Devonian and Laramide), (2) igneous intrusion, and (3) density contrasts within the basement.

From author abstract

266. JONES, RAY S., 1924, The manner of occurrence of gold in the jarosite from Marysvale [Piute County], Utah: Columbia Univ. M. A. thesis, 31 p.

The Deer Trail mine is located in the Mount Baldy district, Piute County, Utah, extending along the steep eastern slope of the Tushar Range about 1,900 feet above the Sevier River Valley and 5 miles southwest of Marysvale. The jarosite occurs as a result of the oxidation of sulfides. The gold occurs as free gold.

There was but one period of mineralization during which the sulfides, galena, and pyrite, together with tetrahedrite, gold, quartz and accessory minerals separated. The sulfides were later oxidized either by supergene processes, or by the end-stage magmatic solutions which were highly charged with sulfuric acid and potash. This resulted in the formation of the jarosite and the plumbojarosite, leaving the gold with some of the attendant gangue minerals unchanged as a residue in the friable jarosite.

The end-stage solutions probably played a major part in the final complete sericitization of the replaced limestone, as well as in the formation of the alunite deposits with which the mine property is surrounded at higher elevations.

Introduction and summary revised (B. C.)

267. JORDAN, JACK G., 1957, Correlation of reef calcarenites of the Pennsylvanian Paradox Formation, San Juan Canyon, Utah: Univ. of New Mexico M. S. thesis, 91 p.

The antecedent San Juan River has eroded into the Monument upwarp since Early Tertiary time and has exposed a considerable thickness of Permian and Pennsylvanian strata. The Paradox Formation is representative of shelf sedimentation genetically related to the Paradox Basin. It is dominantly limestone, with gypseous lentils in the eastern end of the area studied. These lentils wedge out westward in the 8 miles between stratigraphic sections. The limestone contains abundant organic fragmental and correlative zones of brachiopods, crinoids, fusulinids, gastropods and pelecypods. The reef calcarenites, biostromes and biohermal zones can be correlated through three stratigraphic sections (21 miles). Bioherms can be traced to bioclastic debris, and biostromal lentils which supported biohermal growth can also be traced.

Important reef trends in the Paradox Formation are aligned generally northwest-southeast with little relation to the present structure. Most of the reefs appear to be equivalent to the middle and lower members of the Paradox Formation, although there are significant trends at the top of the upper member. It is the writer's opinion that reefs found in the subsurface will be patch or barrier reefs with local thickening and zones of porosity important in the search for petroleum. *Abstract revised (B. C.)*

268. KATHERMAN, VANCE EDWARD, 1948, The Flagstaff Limestone on the east front of the Gunnison Plateau of central Utah: Ohio State Univ. M. S. thesis.

The Flagstaff Limestone, a freshwater lacustrine deposit of Paleocene age, is exposed for 30 miles on east front of Gunnison Plateau. Formation is cliff forming, and complete sections are exposed on walls of eight canyons. The Flagstaff ranges in thickness from 510 feet at Axehandle Canyon to 306 feet at Moroni Amphitheater and is chiefly limestone, although it also contains shale and sandstone. Five lithologic zones, lettered A through E from bottom to top, are: A - sandstone and limestone; B and D - shale and limestone; C and E - limestone. Zone C, a massive cliff-forming limestone 74 to 95 feet in thickness, is the most reliable stratigraphic marker.

The Flagstaff Limestone is underlaid by the variegated fluviatile and lacustrine North Horn Formation. The Colton Formation, also fluviatile and lacustrine, overlies the Flagstaff for the southern 28 miles of the Plateau front, but tongues out into the Green River Formation in the north. The Flagstaff-North Horn contact is unconformable in the southern 5 miles with an angular relationship existing at the southernmost exposure. This unconformity is the result of onlap of an anticline in the southern Sanpete Valley by the Flagstaff Lake. This anticline was first folded during the early Laramide orogeny and rejuvenated by the pre-Flagstaff movement. *From author abstract*

269. KATICH, PHILIP J., Jr., 1951, Stratigraphy and paleontology of the pre-Niobrara Upper Cretaceous rocks of Castle Valley [Emery County], Utah: Ohio State Univ. Ph. D. thesis, 208 p.

_____ 1952, Pre-Niobrara Cretaceous stratigraphy of Castle Valley, Utah (abs.): Geol. Soc. America Bull., v. 63, No. 12, pt. 2, p. 1334, 1952.

Castle Valley is between the Wasatch Plateau and the San Rafael Swell in east central Utah. For 80 miles along the east side of the valley there is a continuous line of northeast-southwest exposures of Upper Cretaceous rocks which show evidences of an ancient oscillating shoreline. The time relations of the nearshore sediments of the southwest to the offshore deposits of the northeast were determined with the aid of fossils, particularly the ammonites. Detailed plane-table mapping by the writer revealed rapid lateral facies changes.

The pre-Niobrara Cretaceous rocks of Castle Valley include, in ascending order, the Buckhorn Conglomerate (Lower Cretaceous ?), Cedar Mountain Shale, Dakota Sandstone, Tununk Shale Member, and the Ferron Sandstone Member of the Mancos Shale. The upper part of the Cedar Mountain Shale at its type locality near Castle Dale, Utah, contains the freshwater pelecypod Eupera onestae which is Lower Cretaceous (Aptian) in age. The Dakota Sandstone of Castle Valley is assigned an Albian age on the basis of the occurrence of Inoceramus comancheanus in the middle part of the formation. The Tununk Shale Member and the Ferron Sandstone Member of the Mancos Shale contain successive faunas like those of the Graneros Shale, Greenhorn Limestone, and the Carlile Shale of the standard Cretaceous section of the northern Great Plains. *Published abstract*

270. KAYSER, ROBERT BENHAM, 1964, Sedimentary petrology of the Nugget Sandstone, northern Utah, western Wyoming and eastern Idaho: Univ. of Utah M. S. thesis, 76 p.

The Upper Triassic-Lower Jurassic Nugget Sandstone crops out in Utah, Wyoming, Idaho and Colorado. It is a cross-bedded, buff to red, fine-grained orthoquartzite of eolian origin. Thickness varies from more than 1,700 feet in eastern Idaho to less than 30 feet in eastern Wyoming, probably due to pre-Middle Jurassic erosion. It is equivalent to the Navajo Sandstone of Utah and Arizona.

Average mineral composition is 95 percent quartz, 3 percent orthoclase, 1 percent plagioclase and microcline, and trace amounts of magnetite, ilmenite, tourmaline, zircon and garnet. Grains are highly rounded and spherical, largely frosted. Average grain size ranges from 0.08-0.25 mm. Diagenetic changes include cementation, authigenesis, and introduction of solutions carrying calcite, hematite and limonite. Cement consists of authigenic quartz overgrowths alone or in combination with calcite. Nugget Sandstone cemented by interlocking authigenic quartz overgrowths (overthrust belt and Wasatch Mountains) is hard with low porosity and permeability; Nugget which is poorly cemented with calcite and quartz (Uinta and Wind River Mountains) has variable porosity and permeability.

Eolian characteristics and sparse fossils suggest deposition in arid climate. High-angle compound cross-bedding, typical of dunes, predominates. Thin shale zones, parallel bedded zones, and low-angle multidirectional cross-bedded zones also occur. *Abstract revised (B. C.)*

271. KELLER, GEORGE H., 1956, Sedimentary features of the "White Quartzite" in the western Uinta Mountains, Utah: Univ. of Utah M. S. thesis, 55 p., geol. map.

The "White and Buff" quartzites, western Uinta Mountains, are well-sorted, coarse-grained orthoquartzites with hematite, zircon, sericite, and feldspar (primarily andesine). In thin section the "White" and "Buff" quartzites cannot be distinguished and seem to be facies of the same stratigraphic unit.

This report is concerned with primary vector-type structures such as ripple marks and cross-stratification within the "White and Buff" quartzites. Festoon type cross-stratification indicates former channels of high velocity streams and provides a means of determining current direction. The ripple marks are of the simple or regular oscillation type, indicative of wave action, and the interference type. More than 1400 observations and measurements were made of sedimentary structures in compiling directional data.

The late Proterozoic Uinta trough, an east-west embayment of the Beltian trough, occupied the site of the present Uinta Mountains and was essentially a floodplain. Relief was not great. The trough was not deep, but subsided slowly. A large stream, from the north-northeast and trending southwesterly, is inferred from sedimentary structures. Westward, the stream veered abruptly northwestward. Near Duchesne Tunnel a variance in trend may indicate another stream entering from the east, flowing west.

Abstract revised (B. Y. S.)

272. KELLER, KENNETH F., 1942, Contact metamorphism near Alta, Utah: Univ. of Utah M. S. thesis, 44 p.

Southeast of Alta, Utah, the Clayton Peak stock intrudes Paleozoic quartzite, shale, and limestone, and a contact-metamorphic zone is developed. An attempt was made to determine if the unusual mineral assemblage of this zone (epidote, forsterite, garnet, ludwigite, diopside, tremolite, magnetite, etc.) was the result of simple recrystallization and concentration of impurities in the limestone, or if it was formed by introduction of materials from the cooling igneous mass. Simple recrystallization is suggested by the following: preferential development in impure beds, replacement of chert lenses and silicified fossils by tremolite, and gradation between recrystallized marble and unaltered limestone. Introduction of substances from the magma is shown by presence of the unusual minerals in dikes intruding limestone, abundance of magnetite, presence of molybdenum and copper which clearly could not have been contained in the limestones, and by the presence of contact minerals within the igneous rock. The field evidence thus suggests that in certain areas simple recrystallization of impurities has produced the new minerals while in other places, the new minerals have an igneous origin.

From author abstract

273. KELLEY, DANA R., 1959, Urano-organic ore at Temple Mountain [Emery County], Utah; clay alteration and ore, Temple Mountains, Utah: Columbia Univ. Ph. D. thesis.

_____ and P.F. Kerr, 1957, Clay alteration and ore, Temple Mountain, Utah: Geol. Soc. America Bull., v. 68, No. 9, p. 1101-1116.

_____ 1958, Urano-organic ore at Temple Mountain, Utah: Geol. Soc. America Bull., v. 69, No. 6, p. 701-756.

Urano-organic substances form essential constituents of the uranium ore at Temple Mountain, Utah. These occur in the vicinity of highly altered collapse structures associated with carbonaceous and petroliferous materials. Chemically, the ore is similar to low-rank coals. Geological conditions, the uranium distribution, texture, physical properties, and microscopic characteristics are indicative of a petroliferous origin. The ore is considered a uranium analogue corresponding to thucolite, the thorium and rare-earth radioactive mineral. The writers believe that induration resulted from polymerization and oxidation-devolatilization of hydrocarbons, caused by the interaction of ore solutions and organic materials at elevated temperatures. The limits of temperature postulated are a minimum of 100° C and a maximum possibly as high as 350° C.

The Moss Back Sandstone at Temple Mountain, Utah, exhibits abundant argillic alteration in the grain interstices. Near collapse features and close to ore zones the principal clay minerals, kaolinite and illite, become more abundant. Aggregate birefringence and particle size appear to increase. Specific types of illite also develop. Mixtures of 1M and $2M_1$ mica polymorphs are typical. The $2M_1$ mica-clay polymorph also becomes a more abundant constituent of mixtures. Near collapse areas, micro-vermicular aggregate growths of kaolinite become common.

In unaltered and nonore-bearing sediments, the $2M_1$ mica-clay polymorph has not been observed. Where scattered detrital flakes of $2M_1$ muscovite are found along bedding planes in the unaltered sediments, they appear to be breaking down to a 1M structure.

Hydrothermal synthesis of micas by Yoder and Eugster has shown the transition of 1M to $2M_1$ mica polymorphs which appears to occur between 200° C and 350° C at 15,000 p.s.i. water pressure. The illite at Temple Mountain which contains the $2M_1$ polymorph is believed to have been deposited by hydrothermal solutions accompanying urano-organic ore deposition. Natural conduits for circulation appear to have been provided by the collapse features and by fractures. The source of the clay-

forming elements is probably not only the original interstitial material but also includes detrital feldspar replaced during the development of ore masses.
From published abstracts

274. KEMMERER, JOHN L., Jr., 1934, Gilsonite: Univ. of Utah M. S. thesis, 62 p.

Gilsonite is the patented trade name for a shiny, black, solid hydrocarbon found in commercial quantities only in the Uinta Basin.

The investigation on which this report is based was undertaken primarily for the purpose of obtaining up-to-date information regarding the general geology, origin, mode of occurrence, composition, mining methods and uses of gilsonite, along with the general financial condition of the companies engaged in its production. *B. C.*

275. KEMMERER, MAHLON S., 1935, Rock alteration at the Tintic Prince mine, North Tintic district, Utah: Univ. of Utah M. S. thesis, 22 p.

The property of the Tintic Prince Mining Company is located on the west flank of a large anticline. The mine adit first encounters Tintic Quartzite and passes through the Ophir Formation into the Teutonic Limestone. The rocks have been highly shattered by faulting.

Two periods of hydrothermal alteration and a period of leaching and oxidation were identified. The first period was characterized by intense silification and introduction of iron. Tintic quartzite breccia was cemented by silica and hematite, and shales were pyritized and bleached. Solutions of the second period were not as hot nor as extensive. A small quantity of these solutions, carrying lead, silver, gold, and a little copper, leaked up along slip planes. There was no penetration of wall rock. Oxidation by descending waters did not leave a surface corresponding to the water table, but was controlled by faults and slip planes. Oxidation has reduced silica and iron content.

The mineralization is mesothermal and is probably contemporaneous with that of the Tintic and East Tintic districts, although exact age cannot be determined due to removal of the Tertiary volcanic rocks. *From author abstract*

276. KENNEDY, RICHARD R., 1960, Geology between Pine (Bullion) Creek and Ten Mile Creek, eastern Tushar Range, Piute County, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 7, No. 4, 58 p., geol. map.

The mapped area lies just south of Marysvale, and ranges in altitude from 5,825 to 11,000 feet. Sedimentary rocks total about 6,100 feet in thickness and range in age from Middle Pennsylvanian to Tertiary and Quaternary. The author uses the terms Callville Limestone, Oquirrh Formation, Toroweap Formation, and Winsor Formation. A 65-foot thick "Tushar" limestone conglomerate unconformably overlies the Winsor Formation.

It is postulated that during late Tertiary time a lake was formed in this vicinity and south of Marysvale as a result of a damming action on the Sevier River by volcanic flows and faulting in the Antelope Range.

Volcanic igneous rocks about 3,500 feet thick ranging in age from middle Tertiary to Quaternary (?) are divided into the Bullion Canyon Series (andesites, latite, tuff, agglomerate), Transitional Series (tuff, latite), Mount Belknap Series (rhyolite, tuff, latite), and late Tertiary-Quaternary (?) basalt.
Abstract revised (B. C.)

277. KENNEDY, RICHARD R., 1963, Geology of Piute County, Utah: Univ. of Arizona Ph. D. thesis, 282 p., geol. map. (Abs.): Dissert. Abs., v. 24, No. 4, p. 1571-1572, 1963.

Piute County, south central Utah, is in the High Plateaus portion of western Colorado Plateaus. Middle Pennsylvanian to Late Tertiary-Quaternary sedimentary rocks have a total thickness of about 6,200 feet. The Paleozoic rocks are carbonate with quartzite; Mesozoic rocks, sandstone, quartzite, and shale with carbonate and conglomerate. Extensive middle Eocene to late Pliocene or early Pleistocene flows are intercalated with abundant regional pyroclastics. Six major groups of igneous rocks are recognized, from the oldest: (1) Bullion Canyon Group (latites, andesites, flows, and breccias), (2) monzonitic intrusions, (3) Dry Hollow-Roger Park Group (latite, tuff, and basaltic breccia), (4) granite intrusion, (5) Mount Belknap Group (rhyolitic flows, tuffs, and breccias), and (6) basalt flows. Total thickness is variable, but probably exceeds 10,000 feet. Three Bullion Canyon subgroups are regional, and are useful as reference planes.

C.I.P.W. and Niggle calculations are applied to chemical analyses of the igneous rocks with complimentary results. The rocks are saturated with silica, poor in calcium, alkalies are equivalent. Chemical differences exist but there is regular variation from older to younger rocks.

Structurally, complex folding and thrusting are generally absent, but relatively linear north-south valley and mountain blocks bounded on both east and west by major faults -- probably late Pliocene in age -- are characteristic. Two anticlines and two synclines are present; all northwest trending.

A widespread, variable suite of alteration minerals is present. Generally older igneous rocks were more highly altered by fumarolic-hydrothermal action than younger rocks.

Mines of Piute County have produced about $19 million in mineral products, from alunite to uranium, in vein and replacement deposits formed by ascending magmatic waters under relatively low temperature and pressure during late Miocene and early Pliocene. Open-space filling has been important as a mode of ore deposition. *Abstract revised (B. Y. S.)*

278. KENNEDY, VANCE C., 1961, Geochemical studies of mineral deposits in the Lisbon Valley area, San Juan County, Utah: Univ. of Colorado Ph. D. thesis.
(Abs.): Dissert. Abs., v. 22, No. 9, p. 3154, 1962.

Uranium-vanadium, copper and manganese deposits in the Lisbon Valley area were studied to evaluate various hypotheses of ore genesis. Uranium-vanadium deposits occur as tabular bodies in or near sandstones of the Permian Cutler Formation, the Triassic Chinle Formation and the Salt Wash Member of the Jurassic Morrison Formation.

Cutler ores contain uranium, vanadium, copper, barium and lesser concentrations of other minerals. Copper concentrations are highest in Cutler ore near the Lisbon Valley fault.

Large deposits of uranium and vanadium in basal Chinle sandstones lie along the southwest flank, Lisbon Valley anticline. Vanadium-uranium ratio is highest in southeastern Chinle ores, as are concentrations of arsenic, molybdenum and yttrium; cadmium and copper are most concentrated in the middle part; strontium and beryllium in the northwest. The uranium:lead ratio of 33:1 suggests an age of 225 million years for the Chinle ores. Corrections for alteration of the ore might give a 180-190-million-year age, as indicated by isotopic data.

Salt Wash sandstones may be enriched in arsenic, barium, beryllium, calcium, cobalt, copper, lead, manganese, molybdenum, strontium, uranium-vanadium, yttrium and zinc, but chemical zoning was not noted. Copper minerals occur mainly in veins and bedded deposits near the Lisbon Valley fault zone and the La Sal Mountains. These deposits vary somewhat, but most contain arsenic, barium, molybdenum, selenium and silver. Manganese oxides are present as vein fillings and disseminated deposits along the Lisbon Valley fault. It is thought that the copper and manganese ores were deposited no earlier than the Cretaceous period by solutions spreading from fault zones. However, uranium-vanadium ores were probably carried by connate waters in Triassic or Early Jurassic time.

Abstract revised (B. Y. S.)

279. KEPPER, JACK C., 1960, Stratigraphy and structure of the southern half of the Fish Springs Range, Juab County, Utah: Univ. of Washington M. S. thesis, 92 p., geol. map.

Marine sedimentary rocks ranging in age from Cambrian to Devonian and a thin remnant of a Tertiary (?) andesite flow are exposed in the southern half of the Fish Springs Range. Folded limestone-dolostone laminations within the chert nodules of the upper Marjum Limestone (Middle Cambrian) indicate a possible diagenetic origin for the chert and dolostone. All sandstones and quartzites between the Kanosh Shale and the Fish Haven Dolostone are included in the Eureka Quartzite (Middle Ordovician), which is divided into the Watson Ranch, Crystal Peak and Upper Eureka Quartzite Members.

Fish Springs thrust plate is a separate structural element from the House or Wah Wah thrust plate. The Fish Springs Range has been elevated by movement along two Late Tertiary normal faults.

The structural relationship between the House and Fish Springs Ranges is controlled by the Sand Pass transverse fault, such that their frontal faults are independent elements, the White Valley fault tilting the House Range eastward and the Cane Spring and Fish Springs faults tilting the Fish Springs Range westward. *Author conclusion revised (B. C.)*

280. KHIN, MAUNG AUNG, 1956, Geology of the district north of Indianola, Utah County, Utah: Ohio State Univ. M. S. thesis, 214 p., geol. map.

Exposed rocks include Jurassic Arapien Shale (3,000+ feet) and Twist Gulch Formation (up to 3,000 feet); Jurassic?-Cretaceous? Morrison (?) Formation (1,300-1,800 feet); Cretaceous Indianola Group (probably 8,000-10,000 feet), South Flat Formation (1,650 feet) and Price River Formation (75-1,000 feet); Cretaceous-Paleocene North Horn Formation (1,100-3,500 feet); Paleocene Flagstaff Formation (350 feet); Eocene Green River Formation (655 feet); Late Tertiary pyroclastic rocks (1,500 feet); and Recent terrace gravels and alluvium.

Jurassic and Cretaceous rocks accumulated in a strongly downwarping part of eastern Cordilleran geosyncline and are thus enormously thicker than to east. Coloradoan rocks are thicker and coarser, with piedmont to offshore-marine environmental change (eastward) due to orogenic disturbance nearby to west. Tertiary formations resemble those of central Wasatch Plateau.

The district has been folded into anticlines and synclines which have been broken by two sets of normal faults; the north-south faults being cut off by east-west faults. Folds include the Dry Creek-Hjork Creek and Dry Creek anticlines and Little

Clear Creek Ridge syncline. Rocks of Indianola district contain evidence of seven orogenic episodes: pre-Indianola, late Indianola, pre-South Flat, early Laramide, pre-Flagstaff, post-Flagstaff and post-volcanic. *B. C.*

281. KILDALE, MALCOLM BRUS, 1938, Structure and ore deposits in the Tintic district [Utah and Juab Counties], Utah: Stanford Univ. Ph. D. thesis, 200 p., geol. map.

The Tintic district lies in the East Tintic Mountains, a north-south range in easternmost Great Basin Province (Utah and Juab Counties). A thick series of Paleozoic limestones, quartzites and shales of Lower Cambrian (?) to Mississippian age have been folded into two major north-south-trending anticlines and a syncline. Overturning toward east indicates strong compression from west to east.

These folds are broken by many faults, most of which strike northeasterly, easterly-westerly or northwesterly. First, second and fourth periods of faulting are associated, respectively, with Laramide orogeny, igneous activity and Basin-Range normal faulting. Third period of faulting and fissuring was associated with slight but extensive middle Tertiary earth movements, and created the northeast-striking tension fissures (N. 30° E.) which formed channels for ore-bearing solutions.

Igneous activity occurred between early Eocene and middle Miocene time. Accumulation of a thick series of flows, tuffs and agglomerates was followed closely by an upwelling of magma which intruded the sedimentary and overlying volcanic rocks to form the monzonite stock, plugs and dikes. Quartz-porphyry phase followed immediately. Mineralogical affinities between igneous rocks indicate that they are closely related differentiation products of a common magma.

Known centers of mineralization are associated with major fault zones, with areas of strong alteration in volcanic rocks, with pebble dikes, and with intrusive igneous rocks. Northeast-striking, steeply dipping fissures which traverse all rocks are universally associated with ore deposition. Greatest ore bodies have been localized where replaceable limestone or dolomite beds lie adjacent to planes of weakness or movement in sedimentary strata. Under certain conditions faults, "crease" folds, minor thrust faults and intrusive breccias are "guides" to ore. Also useful are mineralization types, listed in order of decreasing depth: quartz-pyrite, barite-enargite, sphalerite-galena, galena, galena-argentite and carbonate types. *B. C.*

282. KING, HARLEY D., 1965, Paleozoic stratigraphy of the James Peak quadrangle [Cache and Weber Counties], Utah: Utah State Univ. M. S. thesis, 62 p.

The James Peak quadrangle is located in north central Utah between the Wasatch Range on the west and the Bear River Range on the east. The western flank of the Bear River Range extends into the quadrangle.

The Paleozoic rocks exposed in the James Peak quadrangle are Cambrian through Mississippian in age. The Prospect Mountain Quartzite, Early or Middle Cambrian, is 1,100 feet thick and overlies Precambrain rocks. The Middle Cambrian, represented by 3,152 feet of strata, includes the Pioche (?), Langston, Ute, Blacksmith, and Bloomington Formations; the Late Cambrian includes the Nounan and St. Charles Formations with a combined thickness of 2,100 feet. The Ordovician is represented by the Garden City Formation, Early and Middle Ordovician, the Swan Peak Formation, Middle Ordovician, and the Fish Haven Dolostone, Late Ordovician, with a total thickness of 1,539 feet. The Laketown Dolostone of Middle Silurian age is 1,459 feet thick. The Early Devonian Water Canyon Formation and the Late Devonian Jefferson Formation have a combined thickness of 225 feet. The Mississippian formations, with a thickness of at least 3,059 feet, are as follows: The Lodgepole Limestone, Early and Middle Mississippian; the Deseret Formation, Middle Mississippian; and the Humbug Formation and Great Blue Limestone, both Late Mississippian. *Author abstract*

283. KING, NORMAN J., 1953, Physical properties contributing to the relative erosional resistance of sandstone and shale-derived sediments: Univ. of Utah, M. S. thesis, 78 p.

Previous studies and field measurements on the San Rafael Swell, Utah, have shown that shale-derived sediments generally erode twice as rapidly as sandstone-derived sediments. Analyses by established sedimentological procedures of a number of sediment samples from four representative sample areas are presented and discussed in an attempt to relate respective physical properties to known rates of sediment contribution. The erosional significance of the environmental factors, physiography, geology, and precipitation, are discussed for the San Rafael Swell as a whole and related to specific conditions existing within individual sample areas. It is concluded that textural differences, chemical composition, and specific gravity have little or no effect on differential rates of sediment contribution. Methods used in evaluating the erodibility of well-developed soils are not applicable to these sediments. The erosive character of the surface materials is largely determined by the type of clay mineral present, i.e., with or without expanding lattice. Shale-derived sediments contain expanding lattice clays and are relatively impermeable and subject to high runoff, but resist rapid erosion because of the binding action of the clays, Sandstone-derived sediments contain nonexpanding clays, are moderately permeable with little or no binding agent, and are subject to rapid erosion during flash floods and high runoff. Since each sediment type is resistant to erosion in its own way, the rate of erosion depends primarily on the existing precipitation pattern. *Author abstract*

284. KINNEY, DOUGLAS M., 1950, Geology of the Uinta River-Brush Creek area, Duchesne and Uintah Counties, Utah: Yale Univ. Ph. D. thesis.

_____ 1955, Geology of the Uinta River-Brush Creek area, Duchesne and Uintah Counties, Utah: U.S. Geol. Survey Bull. 1007, 185 p., geol. map.

The area described is on the south flank of the Uinta Mountains. The exposed rocks are: Proterozoic Uinta Mountain Group, Cambrain Lodore Formation, Mississippian limestone unit, Late Mississippian black shale, Pennsylvanian Morgan Formation, massive, cross-bedded Pennsylvanian Weber Sandstone, Permian Park City Formation, Early Triassic Moenkopi Formation, Late Triassic Shinarump Conglomerate, Jurassic (?) Navajo Sandstone, San Rafael Group (Carmel Formation -- Middle and Late Jurassic; Entrada Sandstone and Curtis Formation -- Late Jurassic), Late Jurassic Morrison Formation, Early (?) and Late Cretaceous Dakota Sandstone, Late Cretaceous Mancos Shale with three members (Mowry Shale, Frontier Sandstone and upper shale member), Late Cretaceous Mesaverde Formation found only in the southeast, Eocene and Oligocene rocks, and Miocene (?) Bishop Conglomerate.

Three ice advances, designated "Earliest," "Maximum" and "Latest" glaciation periods, are recognized, with corresponding outwash gravels.

The area is divided into two parts by Dry Fork of Ashley Creek and by a line trending S. 60° E. across Ashley Valley. Faulting dominates to the south of this, open folding to the east and northeast. South of the Uinta Mountain axis the Split Mountain and Section Ridge anticlines are separated by Daniels Draw syncline. West of Dry Fork of Ashley Creek, the northwest-trending Deep Creek fault zone intersects South Flank fault zone.

Three periods of deformation are indicated: (1) faulting of Precambrian rocks prior to deposition of Mississippian limestone, (2) gentle westward tilting following deposition of the Moenkopi Formation, and (3) principal deformation which followed youngest Cretaceous and continued during Early Tertiary.

Three widespread Late Tertiary and Quaternary erosion surfaces formed: Gilbert Peak, Lake Mountain and Jensen surfaces. Two strath terraces, the Vernal and Thornburg surfaces, formed along major streams during Pleistocene glaciation.

Coal from the Frontier Member (Mancos) and oil and gas from the Morrison and Weber Formations on the Ashley Creek structure have been commercially produced, as have small quantities of copper, lead and iron. Low-grade phosphate rock occurs. *Published abstract revised (B. Y. S.)*

285. KIRKLAND, PEGGY L., 1962, Permian stratigraphy and stratigraphic paleontology of the Colorado Plateau (Utah, Colorado, Arizona and New Mexico): Univ. of New Mexico M. S. thesis.

_____ 1963, Permian stratigraphy and stratigraphic paleontology of the Colorado Plateau (Utah, Colorado, Arizona and New Mexico): Four Corners Geol. Soc., A Symposium -- Shelf carbonates of the Paradox Basin, p. 80-100.

The Permian System consists of marine and nonmarine sedimentary rocks ranging in age from Wolfcampian to lower Guadalupian (?) which have been divided into 19 stratigraphic units with the collective shape of a great irregular wedge trending northwesterly and thinning toward the southwest. Thickness ranges from 9,000 feet immediately adjacent to the Uncompahgre uplift to 1,600 feet on the west and southwest.

The Cutler Formation is a nonmarine, predominantly coarse-grained, arkosic redbed sequence which crops out in southwestern Colorado, southeastern Utah, and northwestern New Mexico. Thickness varies from 2,000-9,000 feet immediately adjacent to its source, the Uncompahgre uplift, to 1,700-1,800 feet to the southwest, where the formation is finer grained.

In the southern part of the Monument upwarp, Utah and Arizona, the Cutler Formation is divided, ascending, into Halgaito Tongue, Cedar Mesa Sandstone Member, Organ Rock Tongue, and DeChelly Sandstone Member. In the northern part of the Monument upwarp and west of the upwarp, the Organ Rock Tongue is overlain by the White Rim Sandstone. Stratigraphic paleontology of the Permian strata includes invertebrates (160 genera), vertebrates (31 genera), tracks (55 genera) and plants (29 genera). *Abstract revised (B. C.)*

286. KLEWENO, WALTER P., Jr., 1958, Permian stratigraphy of northern Utah, southeastern Idaho and southwestern Wyoming: Washington State Univ. M. S. thesis, 200 p.

Permian rocks in the area studied can be interpreted as belonging to an eastern stable shelf facies consisting of thin units of limestone and sandstone intercalated with redbeds and containing a molluscan fauna, and a western miogeosynclinal facies consisting of limestones, chert, and phosphatic shales, containing a brachiopod-bryozoan fauna. It is suggested that the term Park City Formation be used for the shelf facies and the term Phosphoria Formation for the miogeosynclinal facies.

Permian deposits thicken westward from several hundred feet in southeastern Idaho and northeastern Utah to more than 10,000 feet in south central Idaho and western Utah, due partly to the addition of Lower Permian sandstones of the Oquirrh Formation and its equivalents. In the miogeosyncline, continuous deposition took place from Pennsylvanian through at least most of Guadalupian time and the apparent conformity of Lower Triassic deposits suggests that a complete Permian section may exist. *Abstract revised (B. C.)*

287. KNIGHT, LESTER L., 1954, A preliminary heavy mineral study of the Ferron Sandstone: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 1, No. 4, 31 p.

The data and results of the preliminary petrographic study of the heavy minerals of the Ferron Sandstone are presented. The method of procedure and analysis of their probable effects on the results are briefly outlined. In addition to the list of precise areal and stratigraphic locations, a map is given showing the general locations where samples were taken. Data obtained from grain counts of the heavy mineral fraction of each sample are shown in tables as well as an analysis of this data.

No apparent heavy mineral zones of any value for correlation were discernible in the Ferron Sandstone, but several areal differences in heavy mineral composition were noted. An analysis of these differences is given. *Author abstract*

288. KOTHAVALA, RUSTUM ZAL, 1959, A study of the remnant magnetism of Granite Mountain, Iron Springs district [Iron County], Utah: Univ. of Arizona M. S. thesis, 84 p.

Granite Mountain is a laccolithic intrusion of quartz monzonite associated with peripheral replacement deposits of iron ore. Orientation of remnant magnetism in 50 samples from Granite Mountain was determined by use of a specially constructed astatic magnetometer, capable of detecting fields of the order of 10^{-7} oersteds. Remnant magnetism vectors with similar orientations exist in geographic domains. Most of the vectors are close to the modal azimuth of N. 6^{o} W. The present azimuth of the earth's magnetic field at Granite Mountain is N. 16^{o} E. The magnetic domains are believed to be caused by strong, local magnetic fields due to ore bodies (existing now or in the past). The modal azimuth of the vectors is interpreted to be due to the earth's magnetic field at the time the magnetism was acquired. Intersection of the path of migration of the earth's magnetic pole and the modal azimuth presumably indicates that the time of the Granite Mountain intrusion is Early Tertiary, which is in agreement with the geologically determined age. *From author abstract*

289. KRAETSCH, RALPH B., Jr., 1950, Stratigraphy of the Pennsylvanian-Lower Permian interval in southern Idaho and adjacent area: Northwestern Univ. M. S. thesis, 94 p.

The most detailed work for this regional study of the Pennsylvanian-Lower Permian was done in southern Idaho and northern Utah, but sections from adjacent states are included. The stratigraphic relations of the Utah formations of this part of the column -- the Homestake Limestone, Elephant Limestone, Talisman Quartzite, Oquirrh Formation, Manning Canyon Shale, Weber Quartzite, and Morgan, Youghall, Hell's Canyon and Paradox Formations -- are discussed as are equivalent formations in Montana, Wyoming, Idaho, Nevada, Arizona and Colorado. The isopach map indicates the presence of the Maroon, Oquirrh, Paradox and Wood River Basins with shelf areas in Wyoming and Arizona during the interval studied. The lithofacies map indicates high clastic ratios in northeastern Utah, high carbonate ratios in southern Utah. Rate of change of thickness, tectofacies and regional tectonic framework maps were prepared and interpreted. Petroleum would be most likely to occur in quartzose sand near the peripheries of the basins. *B. Y. S.*

290. KRANSDORFF, DAVID, 1934, The geology of the Eureka Standard mine, Tintic, Utah: Harvard Univ. Ph. D. thesis.

The Eureka Standard mine, in East Tintic district, is the largest gold mine in Utah. Gold ores occur in Lower Cambrian Tintic Quartzite, which is overlain by Ophir Formation and Paleozoic limestone and dolomite formations. Laramide folding was followed by Cordilleran orogeny responsible for faulting, igneous activity and metallization. A red shale-like rock occurring on the 1,300 and 1,350 levels is a basalt intrusion. Pebble dikes are common, and are associated with igneous intrusion and ore deposition. They are pre-ore in age. Pebbles show evidence of movement of thousands of feet, pushed up by igneous dikes and ore solutions.

Three main ore bodies, which rake to the west and consist of several small ore shoots, occur along the Eureka Standard fault zone. Ore is mined from the fault and from breccias and verticals in the Tintic Quartzite. The verticals often flare against both hanging and foot-wall faults. Post-ore faulting is of negligable importance. The mine is located on a separate ore focus, thus suggesting that a lead ore body should be found in the overlying limestones. A local zoning relationship has been found, and the importance of width of open space in each zone is discussed. The zoning relationships are used to explain the origin of the bonanza ore shoots, and to suggest that gold ore ought to be found at depth in the adjoining Apex Standard property.

Paragenesis of vein minerals indicates that gold, hessite and steely galena reached their maximum deposition after tetrahedrite had ceased to form. Hessite consists of two minerals.

Recent magmatic activity is suggested by alkaline ground water with solid content of 5,525 ppm consisting largely of NaCl, $CaCl_2$ and $MgCl_2$, rock and ground-water temperatures up to 140° F, reservoirs of gas consisting largely of CO_2 and N_2.

Author abstract revised (B. C.)

291. KUCERA, RICHARD EDWARD, 1954, Geology of the Joes Valley and north Dragon area [Emery and Sanpete Counties], central Utah: Ohio State Univ. M. S. thesis, 210 p.

More than 2,500 feet of medial Montana to lower Eocene strata comprise the Blackhawk, Price River, North Horn, Flagstaff and Colton Formations. The gently flexed strata in the main body of the Wasatch Plateau have been broken by sets of northward-trending normal faults and graben, of which the Joes Valley graben is an outstanding example.

Differential regional uplift was continuous from late Eocene to present. The Wasatch Plateau experienced accelerated uplift in Oligocene, early Miocene and late Cenozoic time, with possibly decreased intensity in Pliocene and early Pleistocene time. Faulting may have accompanied accelerated uplift. Initial uplift of Plateau occurred during pre-Canyon stage of physiographic development, probably in late Eocene time. Main phase of uplift accompanied by extensive faulting occurred during the Canyon stage. Major tensional phase of uplift (early Miocene ?) is correlated with major flexing and faulting of Wasatch monocline.

Three (four ?) substages of Wisconsin glaciation occurred in the headwaters of Lowry Fork. The Wasatch Plateau may not have been high enough to support glaciers during pre-Wisconsin I glacial stages. It probably arose to its present altitude as the removal of resistant Flagstaff Limestone was unable to keep pace with accelerated uplift during late Cenozoic time. *B. C.*

292. LAMBERT, HUBERT C., 1941, Structure and stratigraphy in the southern Stansbury Mountains, Tooele County, Utah: Univ. of Utah M. S. thesis, 51 p.

The Southern Stansbury Mountains, located in Tooele County, are typical of the Basin and Range Province. Relief is 6,776 feet above the basin plain; topography is mature.

East sides of several high peaks have been considerably glaciated during three epochs of glaciation of decreasing duration. Glacial troughs extend the length of Hickman and Box Elder Canyons. Cirques and moraines were well developed in South Willow, Mining Fork and North Willow Canyons.

The rocks range from Cambrian to Recent, with greatest thicknesses in the Paleozoic (especially Cambrian and Pennsylvanian). Sandstones, quartzites, and limestone are abundant. Igneous pyroclastics (some partially water-laid), shales and conglomerates attain local prominence.

The structure is complicated. Structural features include: Post-Pennsylvanian (Sierra Nevada or Laramide) isoclinal folding, with overturning of folds; three anticlines and two synclines which plunge toward the south; and considerable faulting accompanying the folding. Skull Valley fault is a large-scale normal fault. It is among the youngest faults and has the greatest throw. Overthrusting is present.

Lead, silver and copper ores have been mined in minor amounts, in Mining Fork and at the Bunker Hill property. Development of subsurface water supply has not been undertaken, but conditions are favorable. *Abstract revised (B. Y. S.)*

293. LANKFORD, ROBERT R., 1952, Micropaleontology of the Cretaceous-Paleocene [Summit County], northeastern Utah: Univ. of Utah M. S. thesis, 74 p.

Cretaceous-Paleocene transition sediments, 2,100 to 5,400 feet thick, known locally as the "Wanship" Formation, are exposed in Summit County, Utah, near the towns of Coalville and Wanship. The strata consist primarily of ridge-forming sandstone separated by softer sandstone, siltstone and shale. The finer-grained sediments contain well-preserved Ostracoda, Charophyta, Foraminifera and microfossils of uncertain affinities. Twenty-five species (five new) and one new variety, belonging to eleven genera and three families of Ostracoda, are described and figured. In addition, two species (one new) of of one genus of Charophyta, four species of three genera and three families of Foraminifera are also described and illustrated. A plate of miscellaneous microfossils is also included. The majority of known species of microfossils found in the "Wanship" has been previously described from early Tertiary formations, the remainder from Cretaceous formations. The Cretaceous-Tertiary boundary is not definitely assigned; it is suggested that it lies within the "Wanship" Formation. *Author abstract*

294. LAPHAM, D. M., 1955, A preliminary study of ore samples from Temple Mountain [Emery County], Utah: Columbia Univ. M. S. thesis, 56 p.

Temple Mountain is in the San Rafael Swell in Emery County, Utah. The section mined is in a collapse area, within which the red color of the Triassic formations has been extensively bleached, and the more porous sandstones are commonly petroliferous. Part I describes a radioactive nodule containing quartz, sphalerite, pyrite, native arsenic, thucolite, and realgar. Part II describes uranium-bearing suite of seven hand specimens from which nine thin sections were made.

The uranium-bearing hydrocarbon, thucolite, has not been differentiated from the similar thorium-deficient mineral, asphaltite. It is dull black, with conchoidal fracture and hardness just less than four. It occurs in characteristic blebs and larger masses having a glossy baked appearance. It is usually an interstitial filling in sandstones, particularly coarse and quartzose types. The best criteria for recognizing thucolite in thin-section is associated mineralization: an amorphous russet hydrocarbon, presence of pyrite, and alteration of feldspars to clays, especially kaolinite.

Presence of arsenic, allanite, tourmaline, and of good pyrite crystals, as well as opinions regarding the origin of thucolite, suggest hydrothermal origin for the primary uranium ore, but data present here are insufficient to exclude other theories. *B. C.*

295. LARAWAY, WILLIAM H., 1958, Geology of the south fork of the Ogden River area, Weber County, Utah: Univ. of Utah M. S. thesis, 66 p., geol. map.

The south fork of the Ogden River area, eastern Weber County, comprises part of the north central Wasatch Mountains. Rocks exposed consist of: Precambrian quartzite, quartzitic sandstone, arkosite and phyllite (10,000 feet); Cambrian metaquartzite, limestone, dolomite and shale of the Brigham, Langston, Ute and Blacksmith Formations (3,500+ feet); Ordovician Garden City Limestone and Shale, Fish Haven Dolomite (600± feet); Silurian arenaceous Laketown Dolomite (243± feet); Devonian dolomite, arenaceous limestone and dolomite, sandstone and shale of the Water Canyon, Jefferson and Three Forks Formations (1,144 feet); Mississippian Madison Limestone and Brazer Sandstone (3,300± feet); and Pennsylvanian Round Valley Limestone and Sandstone of Durst Group. The Eocene Knight (?) Formation, a cobble and boulder conglomerate with sandstone lenses, once covered the entire area; Quaternary deposits consist of Lake Bonneville sediments and alluvium. The Upper Cambrian and base of the Ordovician are not exposed. Paleozoic strata correlate with formations of the Logan quadrangle. Detailed measured sections are included. Sedimentation was continuous from Precambrian to Pennsylvanian.

The most important structural feature of the area is a north-trending syncline. The trace of the Willard (?) thrust is exposed in the western part of the area near Ogden Valley. *Abstract revised (B. Y. S.)*

296. LARSEN, ESPER S., III, 1940, The mineralogy and paragenesis of the variscite nodules from the vicinity of Fairfield [Utah County], Utah: Harvard Univ. Ph. D. thesis, 160 p.

_____ 1942, The mineralogy and paragenesis of the variscite nodules from near Fairfield, Utah, pt. 1: Am. Mineralogist, v. 27, No. 4, p. 281-300; pt. 2: No. 5, p. 350-372; pt. 3: No. 6, p. 441-451.

Variscite is found in fractured Mississippian Great Blue Limestone as breccia fragments or as nodules concentrated along bedding fractures adjacent to open fissures. Fourteen distinct species of phosphate minerals have been determined in the variscite nodules; ten are known at no other locality. Three new phosphate minerals are described in detail: overite - $Ca_3Al_8(PO_4)_8(OH)_6 \cdot 15H_2O$, orthorhombic; montgomeryite - $Ca_4Al_5(PO_4)_6(OH)_5 \cdot 11H_2O$, monoclinic; and sterrettite-$Al_6(PO_4)_4(OH)_6 \cdot 5H_2O$, orthorhombic. Deltaite and pseudowavellite are shown to be isostructural and to form a possible isomorphous series expressed by the formula $Ca(Ca,Al)Al_2(PO_4)_2(OH)_{4-5} \cdot H_2O$; wardite and millisite are shown to be isostructural and are expressed by the formulae $CaNa_4Al_{12}(PO_4)_8(OH)_{18} \cdot 6H_2O$ and $Ca_2Na_2Al_{12}(PO_4)_8(OH)_{18} \cdot 6H_2O$, respectively.

Variscite was the first phosphate mineral formed. After its deposition, many nodules were brecciated. The other minerals resulted from alteration of the variscite by introduction of lime and alkalies. Alteration occurred in four stages, each characterized by a group of minerals having distinct chemical qualities. (1) Veinlets and outer shells of pseudowavellite formed first (with some deltaite). Millisite and wardite were deposited in alternating bands, most of the millisite preceding most of the wardite, and accompanied by minor deltaite and lehiite. Late in deposition of wardite, the solutions dissolved more variscite than they deposited wardite, leaving cavities surrounding variscite. Pseudowavellite and some deltaite were again deposited, replacing residual variscite cores. Stage 1 is quantitatively most important. (2) The principal crystallized species developed in cavities in earlier minerals; approximate sequence of formation is: gordonite, englishite, montgomeryite, overite and sterretite. (3) and (4) Minor pseudowavellite was followed by numerous minerals of apatite group.

The variscite and its alteration products were formed from supergene solutions (ground waters), probably beneath the water table. Abundant limonite surrounding the phosphates was deposited when the zone containing the phosphates had risen above the water table. *Abstract revised (B. C.)*

297. LARSEN, NORBERT W., 1960, Geology and ground-water resources of northern Cedar Valley, Utah County, Utah: Brigham Young Univ. (M. A. thesis) Research Studies, Geol. Ser., v. 7, No. 1, 42 p., geol. map.

Northern Cedar Valley is a basin of interior drainage lying between the Oquirrh Mountains (west), Lake Mountain (east), and the Traverse Ridge (north) in the eastern Basin and Range Province. Average annual precipitation is about 10 inches. Alluvial deposits at least 1,258 feet thick are largely pre-Lake Bonneville deposits of fluviatile and lacustrine origin. The Lake Bonneville Group is represented by the Alpine and Bonneville Formations.

The major source of ground water in the valley is pre-Lake Bonneville deposits, and the major source of recharge is winter snow in the Oquirrh Mountains. The most promising areas for ground-water development lie at the toes of the alluvial fans along the north and west sides of the valley.

Abstract revised (B. C.)

298. LARSEN, WILLARD N., 1954, Precambrian geology of the western Uinta Mountains, Utah: Univ. of Utah M. S. thesis, 53 p., geol. map.

Precambrian lithologic units in the Uinta Mountain Group, western Uinta Mountains, are over 11,000 feet thick. The units are silica-cemented sandstones and arkoses, with slight recrystallization. The quartzites are interbedded with brown, green, red and purple micaceous shales. Mud cracks, ripple marks and fluvial cross-bedding are prominent primary structures. The sequence and characteristics of these rocks are similar to the Upper Precambrian of the Wasatch Mountains, with which they have been correlated by others.

An angular unconformity of 20°, most apparent in South Fork Basin, separates the Red Pine Shale of uppermost Precambrian age and the Tintic Quartzite (mapped as Middle Cambrian).

The attitudes of the formations indicate two definite fold axes: one Precambrian and the other Laramide. The Precambrian axis, arcuate to the north, exists parallel to and about 3 miles south of the Laramide axis.

Most of the relief of the western Uinta Mountains was acquired by Late Laramide faulting. A total vertical displacement exceeding 6,000 feet can be attributed to the South Flank fault and "Hoyt Canyon fault." Small faults are also present.

Abstract revised (B. Y. S.)

299. LARSEN, WILLARD N., 1957, Petrology and structure of Antelope Island, Davis County, Utah: Univ. of Utah Ph. D. thesis, 185 p., geol. map. (Abs.): Dissert Abs., v. 17, No. 9, p. 2025-2026, 1957; Geol. Soc. America Bull., v. 68, No. 12, pt. 2, p. 1866-1867, 1957.

Antelope Island, the first range west of the central Wasatch, is nearly surrounded by Great Salt Lake. Rocks are predominantly Precambrian of two ages. The older sequence consisting of 20,000 feet of schists, amphibolites, and metaquartzites has been correlated with the Farmington Canyon Complex of the central Wasatch and is divided into three unnamed units. The oldest is composed of 4,207 feet of quartzo-feldspathic schists with interbedded amphibolites. Above lies 2,583 feet of microcline-rich mica schists, and the remaining 13,000 feet consist of precominantly fine-grained quartzo-feldspathic schists with subordinate amounts of amphibolite and metaquartzite.

The younger sequence is correlated with the upper part of the Big Cottonwood Series of the south central Wasatch and consists of 1,050 feet of tillite, dolomite, slate, and quartzites. These beds occurring chiefly at the northern part of the island lie with a gentle northwest dip unconformably on the Farmington Canyon Complex.

The Wasatch Group of Tertiary age is composed of conglomerate and freshwater limestones with included Madison Limestone and Big Cottonwood Series quartzite boulders and rests unconformably on the Farmington Canyon Complex. These included boulders suggest that the Madison was probably deposited directly on the Big Cottonwood Series and also that Antelope Island was the center of the early Paleozoic northern Utah highland.

The Farmington Canyon Complex forms a doubly plunging, north-south anticline broadly arcuate toward the east, the crest of which is on the west side of the island.

Published abstract

300. LARSON, KENNETH W., 1951, The areal geology of the Rockport-Wanship area [Summit County]: Univ. of Utah M. S. thesis, 46 p., geol. map.

The area of this report is located on the northwest flank of the Uinta Mountains in the zone of transition between the Uinta and Wasatch Ranges. Forces which caused the folding, faulting and thrusting were of a compressional type active at the time of the folding of the Wasatch and Uinta Mountains. Formations present consist of: Lower Cretaceous Kelvin (?), Upper Cretaceous Frontier and "Post-Frontier," and Tertiary Wasatch Group. The "Post-Frontier," with its prominent basal conglomerate, lies unconformably upon the Kelvin (?) and Frontier Formations and is in turn overlain unconformably by the Wasatch Group. The formation is post-Coloradan-pre-Eocene in age and is believed to represent a precursor of the Laramide Revolution. The structural features present are the Crandall and Dry Canyon faults, Crandall Canyon "Z" fold, Dry Canyon anticline and Cherry Canyon thrust. The folding, faulting and thrusting are Laramide in age. The area holds little promise for economic development of any nature. *Author abstract*

301. LAUTENSCHLAGER, HERMAN KENNETH, 1952, The geology of the central part of the Pavant Range [Millard and Sevier Counties], Utah: Ohio State Univ. Ph.D. thesis, 188 p., geol. map.
(Abs.): Dissert. Abs., v. 18, No. 5, p. 1769-1770, 1958.

This report concerns an area of about 300 square miles, largely in the central part of the Pavant Range but including also the adjacent part of Sevier Valley, with elevations ranging from 5,300 to 10,200 feet. Sevier Valley is a northeast-trending structural trough; the Pavant Range is one of the high plateaus of central Utah.

Three groups of rocks comprise the Pavant Range: marine Paleozoic and continental Mesozoic formations (western front), Upper Cretaceous and Tertiary fluviatile and lacustrine beds (crest and eastern front), and Tertiary lava flows (southern part). Units exposed in the area are: Cambrian Tintic Quartzite; Middle Cambrian Ophir Formation, Teutonic, Dagmar and Herkimer Limestones, and Bluebird and Cole Canyon Dolomites; Upper Cambrian Opex Dolomite; Jurassic (?) Navajo Sandstone; Upper Cretaceous Price River Formation; Upper Cretaceous (?) - Paleocene North Horn Formation; upper Paleocene - lower Eocene Flagstaff Formation; upper Eocene Green River Formation; fluviatile upper Eocene Crazy Hollow Formation; Bald Knoll Formation; Gray Gulch (?) Formation; Oligocene Bullion Canyon volcanic beds; upper Pliocene or lower Pleistocene Axtell Formation. One stage of Pleistocene glaciation is evident in the Pavant Range.

Both complex folding and faulting (typical of basin ranges) and simpler normal and reverse faulting (common in plateau areas) occur in the Pavant Range. Cambrian and Ordovician formations have been thrust over Jurassic and older beds along the Pavant thrust fault. Relative movement of overthrust block was eastward, and displacement is at least 11 miles. The Pavant Range is bordered on the east and west by normal faults of great displacement; associated with these are two groups of small faults -- parallel and normal to the mountain front. A group of synthetic faults accounts largely for the abrupt rise of of the Pavant Range above the Sevier Valley to the east. Tilting of Axtell beds and faulted alluvial fans suggests repeated movement during Pleistocene and Recent. *Abstract revised (B. Y. S. and B. C.)*

302. LEAMER, RICHARD JAMES, 1960, Petrology of some freshwater limestones from the Intermountain area: Univ. of Utah M. S. thesis, 123 p.

One hundred representative samples of various freshwater limestones were studied by means of thin sections, acetate peels, insoluble residues and etched surfaces in an attempt to apply existing carbonate classifications to lacustrine carbonate rocks. The limestone classification proposed by R.L. Folk in 1959 proved to be the most satisfactory for classifying freshwater carbonates. The term "altered," to be applied to limestones containing more than 1 percent authigenic SiO_2, is suggested as a modifier to be used in conjunction with the rock names proposed by Folk.

No invertebrate fecal pellets were definitely identified during this study, indicating that pellet-forming organisms are not common inhabitants of environments of deposition of freshwater limestones. Microcrystalline limestone types apparently are more common in lacustrine carbonate deposits than in marine carbonate deposits. It is suggested that precipitation of calcium carbonate through the photosynthetic activities of green algae, blue-green algae and aquatic vascular green plants is important in the formation of lacustrine limestone deposits. The most common fossil remains in freshwater limestones, arranged in order of decreasing abundance are: ostracods, charophytes, gastropods and pelecypods. *Author abstract*

303. LEE, KWANG-YUAN, 1950, Petrography of the Price River Formation in the Sanpete Valley district [Sanpete County], Utah: Ohio State Univ. M. S. thesis, 50 p.

The Price River Formation belongs to the post-orogenic piedmont facies, and consists chiefly of quartzite conglomerate with grit matrix bound by calcareous cement. It grades upward into North Horn Formation with intertonguing relationship, and overlies the Indianola Group and older rocks in a pronounced angular unconformity. Deposition in water is indicated by well-worn character of fragments, stratification of sandstone lenses and imbricate structure of gravels.

Zircon, tourmaline and dolomite comprise 97 percent of heavy minerals; garnet, rutile, sillimanite, glauconite, fluorite, biotite, apatite, staurolite, diopside, magnetite and iron oxides comprise 3 percent. Tourmaline overgrowths are nearly colorless, and are attached to the negative poles of brown, blue and green crystals. The heavy mineral suite varies regionally, stratigraphically and even within one horizon, in relative percent of constituent minerals. The great variation is probably due to fluctuation in hydraulic ratios and to lack of variety in the heavy mineral suites of reworked sediments. Detrital constituents of the Price River Formation are largely derived from Mesozoic (especially the Indianola Group) and Paleozoic rocks to west and north, and to a minor extent from Precambrian metamorphic rocks in the Wasatch Mountain region.

Basal member of North Horn seems barren of tourmaline, and much poorer in heavy mineral assemblages than Price River Formation.

Summary and conclusions revised (B. C.)

304. LEE, KWANG-YUAN, 1953, A petrographic study of the latest Cretaceous and earliest Tertiary formations of central Utah: Ohio State Univ. Ph. D. thesis.
(Abs.): Dissert. Abs., v. 19, No. 12, p. 3276-3277, 1959; Geol. Soc. America Bull., v. 69, No. 12, pt. 2, 1734-1735, 1958.

The present petrographical study of latest Cretaceous and earliest Tertiary sediments of central Utah has aimed (1) to determine the value of mineralogical composition of the sediments as a basis for differentiating the North Horn Formation from the Price River Formation as well as the overlying member of the Paleocene Flagstaff Limestone, (2) to determine the mineralogical and lithological variations regionally and stratigraphically, and (3) to decipher the processes of sedimentation of the North Horn sediments. The North Horn sediments contain more mineral assemblages than the Price River Formation and the basal part of the Flagstaff Limestone. On the basis of allogenic mineral association, five mineral zones are tentatively proposed for the purpose of correlation. The regional and stratigraphic variation of the heavy mineral assemblages is probably due to fluctuation in hydraulic ratios or to the fact that there were no great variations of heavy minerals to begin with in the reworded mesozoic and Paleozoic sediments, rather than to intrastratal solution.

The different rock types of the latest Cretaceous and earliest Tertiary sediments are the mechanical mixture of the three end members: (1) coarse detritus, (2) a wide open depression located in the vicinity of North Horn Mountain, and (3) piedmont slopes, and intermontane basin-like depressions. Two fluvial cycles and two lacustrine cycles are recognized in the formation of those sediments. Each of these cycles was directly controlled by space and supply relations in association with the diastrophic movements. No tectonic break exists between Price River and North Horn Formations in this area.

From author abstracts

305. LEFEBVRE, RICHARD H., 1961, Joint patterns in the central part of the Hurricane fault zone, Washington County, Utah: Univ. of Kansas M. S. thesis, 35 p.

Joints along a part of the Hurricane fault zone in Washington County, Utah, were mapped on aerial photographs with a scale of 1:62,500. Criteria used for mapping were incised fractures, vegetation alignments, soil tonal changes, straight line stream segments, positive weathered fractures and straight scarps. Approximately 3,000 joints were measured and plotted on radial histograms. The histograms show three main joint maxima: N. 20° - 30° W., north-south, and N. 20° - 30° E., and some lesser maxima that were not consistent throughout the area.

Comparison of the joint maxima to the local structure indicated no apparent relationship between the joints and the Virgin anticline but did show that the joints parallel normal faults. In addition, it was found that joints do not cut the lava flows, but partially controlled their extrusion.

A genetic relationship of the joints to folding of the Laramide revolution is rejected on the basis that the joint patterns mapped are dissimilar to the joint patterns that would be expected to occur with the Virgin anticline which was formed during the Laramide orogeny. Upward propagation of old lines of weakness and Tertiary epeirogenic uplift are other possible causes of the jointing. The best explanation for the joint development, however, is the relaxation of Laramide compression. The dominant joint pattern resulting from this study makes an obtuse angle to the west, the orientation that would be expected by the relaxation of a compressive force.

Author abstract

306. LEWIS, ARTHUR EDWARD, 1958, Geology and mineralization connected with the intrusion of a quartz monzonite porphyry, Iron Mountain, Iron Springs district [Iron County], Utah: California Inst. Technology Ph. D. thesis, 75 p., geol. map.

Iron Mountain is one of three intrusive bodies exposed in the Iron Springs district approximately 15 miles west of Cedar City, Utah. It is the erosional remnant of a quartz monzonite porphyry intruded into Mesozoic limestone and clastic rocks probably at a depth of less than one mile. The quartz monzonite was intruded in large part along the base of the Carmel Formation and has pushed aside the overlying sedimentary rocks as if they were a trapdoor hinged on the southeast.

Metamorphism is very weak and is confined for the most part to the Sandy Member at the base of the Carmel Formation. The Homestake Limestone Member of the Carmel Formation is locally replaced by massive bodies of iron ore, consisting chiefly of magnetite, specularite, carbonates and phlogopite. The mineralization is associated with the quartz monzonite but was not necessarily derived from it. Chemical analyses and the mineralogy of the limestone and the ore show that Ca and CO_2 have been removed and important amounts of Fe, Si, Mg, Al and K have been added with no change in volume during replacement of the limestone.

A high temperature and a low confining pressure during mineralization may have permitted the transport of iron halide in a gas phase, but the addition of some of the other constituents and the removal of Ca are not easily accounted for by such a mechanism. *Author abstract*

307. LIESE, HOMER C., 1957, Geology of the northern Mineral Range, Millard and Beaver Counties, Utah: Univ. of Utah M. S. thesis, 88 p., geol. map.

The area mapped constitutes the northernmost 10 miles of the Mineral Range, Basin and Range Province. Sedimentary exposures, confined to the north, include Cambrian Prospect Mountain Quartzite, Pioche Shale and undifferentiated limestones; Cambrian (?) undifferentiated limestones; and Cretaceous (?) Indianola (?) conglomerate. Glossopleura producta was collected from Pioche Shale.

Igneous rocks in the southern two-thirds of the area are granite (20 square miles in the mapped area) and a granodiorite body (2 square miles). These Early (?) and/or Middle (?) Tertiary rocks are of magmatic origin. Quartz latite dikes and two rhyolite volcanoes of Late (?) Tertiary age are within the plutonic rocks. Numerous aplitic, basic and pegmatitic dikes exist. Metamorphic zones include a marble-hornfels zone, tremolitized zones and a basic zone (possibly Precambrian). The first two result from contact metamorphism of Cambrian shales and carbonates. In the last, granitization was an active process.

A thrust plate of older Cambrian Prospect Mountain Quartzite, Pioche Shale and limestones overrides limestones of younger Cambrian (?) age. The time of thrusting is Late Jurassic (?) to Early Cretaceous. The sedimentary area has been domed, possibly by a subjacent igneous body. Transverse normal faults may be Laramide; longitudinal interior normal faults are younger, probably Basin and Range. Eastern and western border faults are postulated.

Abstract revised (B. Y. S.)

308. LIESE, HOMER C., 1962, Indirect geothermometric mineral studies of silicic igneous rocks: Univ. of Utah Ph. D. thesis, 93 p.

_____ 1964, A correlative geothermometric mineral study: Am. Jour. Sci., v. 262, No. 2, p. 223-230.

Four geothermometric methods are employed in conjunction to estimate relative temperatures of formation of some hypabyssal and small plutonic bodies, of silicic composition, Cretaceous and Tertiary age, located in the Basin and Range Province. The four methods are: (a) variation of titanium content in magnetite (spectrographic analysis), (b) variation of tetrahedral aluminum in biotite (infrared analysis), (c) order-disorder in potash feldspars (infrared analysis), and (d) order-disorder in sodic plagioclases (universal stage measurements). Temperature interpretations are made for each method and rocks are listed with respect to relative ranges of formation temperatures.

A comparatively high degree of concordance is found between titanium content in magnetite and order-disorder in potash feldspars. They are of sufficient geothermometric value to warrant more extensive and quantitative study. Temperature interpretations concerning order-disorder in sodic plagioclases show only fair agreement with the two preceding methods, perhaps due to difficulty in locating all extinction positions during universal stage measurements. Those for tetrahedral aluminum in biotite are generally discordant with the other methods, so that the amount of tetrahedral aluminum does not seem to be primarily a function of temperature but of composition and/or pressure.

Concordance between progressive decrease in relative ranges of formation temperatures and increase in silica content is compatible with the Reaction Series, supports a magmatic origin for the rocks, and emphasizes the influence of slight composition changes in geothermometric studies.

Silicic porphyries do not suggest temperatures of formation which are consistently higher (or lower) than granitoid rocks of similar composition, except perhaps throughout a single area within which both types occur. *Abstract revised (B. Y. S.)*

309. LINSCOTT, ROBERT O., 1962, Petrography of the upper member of the Paradox Formation (Pennsylvanian) in the Four Corners region: Univ. of Colorado M. S. thesis, 71 p.

Subsurface petrographic study reveals the sedimentary history and environmental relationships of the upper member, Paradox Formation, during invasion of the Paradox Basin by Desmoinesian epicontinental seas. This suite of rocks -- subdivided into a normal marine facies (limestone), a transitional facies (replacement dolomites), and an evaporite facies (primary dolomite, anhydrite and siltstone) -- is transitional between an older dominant evaporite environment and a younger dominant normal marine environment.

Distinct textural and mineralogic gradients characterize these rocks. The size and size distribution of carbonate particles varies with water depth. Gradation from anhydrite to dolomite to calcite was related to basin control over biochemical and physiochemical precipitation. High porosities are common in some rock types such as algal bio-sparrudites, which are quantitatively important. The normal marine facies probably was deposited in shallow waters (less than 70 feet). The organic structures (called bioclastic mounds) may not be in growth position.

Abstract revised (B. Y. S.)

310. LIVINGSTON, DONALD E., 1961, Structural and economic geology of the Beaver Lake Mountains, Beaver County, Utah: Univ. of Arizona M. S. thesis, 68 p.

The Beaver Lake Range, located in southwestern Utah, consists of Paleozoic and possible Mesozoic sedimentary rocks which were uplifted and eroded prior to the deposition of a thick sequence of volcanic rocks. These rocks have been intruded by two quartz monzonite stocks which have acted as stable buttresses against the following major tectonic movements affecting the range. The major deformation was a compressional stress oriented NNW which caused the formation of an overthrust or high-angle reverse fault and an overturned syncline both of which strike ENE. This folding and faulting was accompanied by the development of complementary sets of steep tear faults which strike northerly to northwesterly. These faults have offset portions of the quartz monzonite intrusives and have served as the locus of several small acidic and basic dikes. Mineralization, succeeding the major tectonic movements formed the chalcopyrite-molybdenite-pyrite deposits of the Copper Ranch mine. At the same time several areas of quartz-sericite and marble alteration were developed. *Author abstract*

311. LIVINGSTON, VAUGHN EDWARD, Jr., 1955, Sedimentation and stratigraphy of the Humbug Formation in central Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 2, No. 6, 60 p.

The Humbug Formation outcrops in many localities throughout central Utah. It has been recognized as far east as Duchesne County, as far south as the Tintic mining district, and as far north and west as the Lakeside Mountains. It is over 2,100 feet thick on Stansbury Island and thins rapidly to the south and east. The Humbug Formation consists of intercalated limestone, orthoquartzite, sandstone and dolomite. Many of the limestones and dolomites were deposited as clastics. Most of the carbonate clastic material was supplied by sessile benthonic organisms. Siliceous clastics probably originated west of the Brazer Basin. Several types of epigenetic and syngenetic sedimentary structures are present in the formation. Faunal studies indicate that the formation is Upper Mississippian, probably Meramecian in age. All of the fossils in the formation are probably benthonic. *Author abstract*

312. LOFGREN, BEN E., 1947, The Quaternary geology of southeastern Jordan Valley [Salt Lake County], Utah: Univ. of Utah M. S. thesis, 52 p., geol. map.

An area in southeastern Jordan Valley, 15 miles south and extending from the Jordan River eastward to the the Wasatch Mountain front was studied and mapped in connection with this thesis. Field evidence here observed adds new information as to the recent history of the valley and the nature of the unconsolidated sediments that comprise the valley-fill of the basin.

Lake Bonneville represents the last of a long series of Pleistocene lakes that have occupied Great Salt Lake Basin, and due to the shortness of its stay, is of relative unimportance in Quaternary history. Prior to Bonneville time the surface of the land appeared much as it does today, with terraces and deltas marking the shorelines of earlier lakes, and canyon streams entering the valley excavated to much their present level. Stream gravels, alluvial fans and glacial debris extended far into the valley and overlapped with the fine silts and clays of ancient lake deposition. Then, after a long period of dessication, the waters of Lake Bonneville appeared, remaining for a relatively short period of time and masking beneath a thin cover of re-worked material the complex structure of the earlier surface. The entire range of Bonneville lake stages are represented in this area, and are portrayed on the surface maps in the report. *Author abstract*

313. LOHMAN, KENNETH E., 1957, Cenozoic nonmarine diatoms from the Great Basin: California Inst. Technology Ph. D. thesis, 190 p.

The wide distribution in the Great Basin area of the western United States, both geographically and geologically, of the Cenozoic nonmarine diatoms would make them particularly useful for stratigraphic correlation and age determination if their geologic ranges were better known. For this reason, diatoms were collected from some well-known vertebrate collecting localities in Nevada, Idaho and Utah (Provo Formation, late Pleistocene age, central Utah) and the geologic ranges of the individual species established.

Of the 353 different species and varieties of nonmarine diatoms identified from the six stratigraphic units chosen, ranging from late middle Miocene to late Pleistocene in age, 85 have been described and illustrated as new, 40 have been known previously only as fossils, and 228 have been recorded previously from living assemblages elsewhere.

Paleoecological interpretations of the environmental conditions which obtained during the deposition of the sediments studied were made on the basis of the 228 species and varieties of diatoms in the last category.

The investigation has shown that many of the fossil nonmarine diatoms have satisfactorily short ranges in geologic time, and therefore are valuable guides for stratigraphic correlation and age determination of the sediments in which they occur. Furthermore, the Recent species in each assemblage have been shown to supply much useful data on which to base paleoecological interpretations, limited principally by published ecologic data on the living organisms.

Author abstract

314. LORING, WILLIAM BĀCHELLER, 1959, Geology and ore deposits of the northern part of the Big Indian district, San Juan County, Utah: Univ. of Arizona Ph. D. thesis, 75 p., geol. map.
(Abs.): Arizona Geol. Soc. Digest, v. 3, p. 174-175, 1960; Dissert. Abs., v. 19, p. 2912, 1959.

The Big Indian uranium district lies in northern San Juan County, 33 miles southeast of Moab. Following Permian and Pennsylvanian deposition of "Rico" and Cutler Formations, doming about a salt plug resulted in a 3° unconformity with overlying Triassic Chinle sand and shale beds. Younger strata include Wingate Formation; Jurassic Kayenta, Navajo, Entrada and Morrison Formations; and Cretaceous Burro Canyon-Dakota Sandstone and Mancos Shale.

Most of the structures are post-Mancos -- probably Laramide. An anticline, trending northwest, was localized by the earlier dome. Upward forces resulted in the Lisbon Valley fault along the axis of the anticline, with uplifting of the southwest, footwall block. This block was subdivided by a series of radial and concentric fractures, faults and joints, centering on a point near the Lisbon Valley fault. In the hanging-wall block at this point, there is a a copper deposit in the Dakota-Burro Canyon sandstone.

Uranium ore deposits were formed during the early Tertiary. In the foot-wall block, acid, reducing fluids moved out and up, along the fractures, removing calcite cement and bleaching the hematite; affecting in particular sandstone and arkose immediately above and below the Cutler-Chinle contact. Ore-bearing solutions followed the bleaching ones; pyrite, in sparse amounts, was deposited first, then pitchblende and calcite. The pitchblende is scattered throughout the calcite cement, and coats and replaces quartz grains; the calcite is colored pink from disseminated hematite. The bleaching may have been effected by a sulphur acid; and the ore emplacement by a carbonate solution, with a ferrous precipitant. Most of the ore is in Chinle sand laid down by braided streams, which flowed westerly from the Uncompahgre highland, and is found where these sands overlie the paleo-outcrop of a Cutler arkose bed. Where the Chinle sand is missing, ore may occur in Chinle siltstone, or in the top of the Cutler. *Abstract revised (B. C.)*

315. LUEDKE, ROBERT G., 1953, Stratigraphy and structure of the Miners Mountain area, Wayne County, Utah: Univ. of Colorado M. S. thesis, 86 p., geol. map.
U.S. Geol. Survey open-file report.

The Miners Mountain area includes about 85 square miles in south central Utah, characterized by cliffs and deep, steep-walled canyons.

The exposed sedimentary rocks are about 3,500 feet thick. At the base are the (Permian) buff Coconino Sandstone and overlying white, lime, chert-containing Kaibab Limestone. Unconformably over the Kaibab is the (Lower Triassic) Moenkopi Formation of reddish-brown and yellow mudstone, siltstone and sandstone; the lower part contains the "Sinbad Limestone Member." Thin, lenticular Shinarump Conglomerate unconformably overlies the Moenkopi, but grades upward into the (Upper Triassic) Chinle Formation of variegated mudstone with some interbedded sandstone and limestone lenses. Unconformably overlying the Chinle are the Wingate Sandstone, Kayenta Formation and Navajo Sandstone of the Jurassic (?) Glen Canyon Group, which consist of red to white sandstones. At the top is the lower part of the Carmel Formation (Upper Jurassic) consisting of variegated siltstone, sandstone, limestone and gypsum.

The major structure is the Teasdale anticline which trends northwest. It is limited on the north and east by the Capitol Reef monocline (northern part of Waterpocket fold) and on the south and southwest by the Teasdale (normal) fault. Maximum displacement on this fault exceeds 1,000 feet.

From author abstract

316. LUFKIN, JOHN L., 1965, Geology of the Stockton stock and related intrusives, Tooele County, Utah: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 12, p. 149-164.

The Stockton stock and related intrusives were mapped in an area approximately 6 square miles, along the north wall of Soldier Canyon, in the west central part of the Oquirrh Mountains, Tooele County, Utah. Samples were collected to determine mineralogy, method of emplacement and metamorphic effects on intruded formations.

The Stockton stock is a porphyritic adamellite intrusive that has invaded the lower Oquirrh Formation. Related intrusives include hypabyssal dikes and sills that are hypocrystalline and intermediate in composition.

A bleached metamorphic aureole surrounds the stock and includes, in part, two facies of contact metamorphism: albite-epidote hornfels and hornblende-hornfels.

Mining activity flourished in nearby areas during the late 1800's and early 1900's, but how much ore was obtained from mines in this area is not known.

Rush Valley district, adjacent to the mapped area, probably did not exceed $10,000,000 in total production. The economic future of the district does not appear to be great, due to the shallow nature of intrusives, low rank metamorphism and past history of mining production. *Author abstract*

317. LUM, DANIEL, 1957, Regional gravity survey of the north central Wasatch Mountains and vicinity, Utah: Univ. of Utah M. S. thesis, 27 p.

A regional gravity survey was made in the north central Wasatch Mountains to ascertain regional structures, particularly Basin-and-Range type, and to obtain information on potential ground-water problems. Three hundred and sixty-eight gravimeter stations were established in 1,000 square miles. Gravity data were reduced to a Bouguer anomaly map with contour interval of 2 milligals. Three observed gravity profiles were evaluated to present interpretive geologic cross sections across major anomalies.

The results outline the major Basin-and-Range structures and several Laramide structures. Graben with steep faults along their sides have maximum depths of from 8,000 to 10,000 feet and occur on both sides of mountain blocks. Most faults dip about 60° toward the valley, and some very steep faults occur. General trend of regional structures is about N. 10° W. In Morgan Valley, alternate interpretations of the residual gravity profile are given.

Some of the largest gravity gradients in the United States are found in the surveyed area. Within 11 miles there is a negative anomaly of 66.1 milligals toward the east in the Salt Lake Valley west of the frontal Wasatch Mountains, which may be a manifestation of low-density rock beneath the Wasatch Mountain System. *Abstract revised (B. Y. S.)*

318. McCARTHY, WILLIAM R., 1959, Stratigraphy and structure of the Gunlock-Motoqua area, Washington County, Utah: Univ. of Washington M. S. thesis, 41 p., geol. map.

The Gunlock-Motoqua area lies on south slope of Bull Valley Mountains in southwestern Utah. About 13,000 feet of strata are exposed, as follows: Pennsylvanian Callville Limestone (?); Permian Coconino Sandstone (100 feet or less) and Kaibab Limestone (1,100 feet of limestone and chert, alternating with gypsum and fine clastics); Triassic Moenkopi Formation (1,800 feet of sandstone, shale and gypsiferous redbeds and marine limestone) and Shinarump Formation (100 to 200 feet of sandstone which thins to west and contains coarse conglomerate and petrified wood); Upper Triassic-Jurassic Chinle Formation (1,975 feet of red-brown siltstone, sandstone and shale); Jurassic Navajo Sandstone (3,420 feet of red cross-bedded sandstone) and Carmel Formation (1,600 feet, divided into three members with gypsiferous Temple Cap Member at base); Cretaceous Iron Springs Formation (3,900 feet of variegated sandstone and shale); Upper Cretaceous-Eocene Claron Formation (1,000 feet mainly coarse conglomerate); Eocene-Oliogocene Quichapa Formation (700 feet, Leach Canyon Tuff at base, two ignimbrites separated by limestone in middle and Harmony Hills Tuff at top).

Major structure is homoclinal with dip averaging about 25° NE. Structural history includes Laramide thrusting of Paleozoic rocks eastward, post-volcanic homoclinal tilting and associated N. 60° W. faulting, and later displacement of earlier structures along north-south faults. *B. C.*

319. McCUBBIN, DONALD G., 1961, Basal Cretaceous of southwestern Colorado and southeastern Utah: Harvard Univ. Ph. D. thesis, 172 p.

A thin sequence of sandstone, shale and conglomerate underlain by nonmarine Jurassic strata and overlain by thick marine Cretaceous shales comprises the basal Cretaceous, which is widespread in western interior, and in area of report is referred to Burro Canyon Formation of Early Cretaceous age and to Dakota Sandstone of Early (?) and Late Cretaceous age. Regional depositional pattern during Dakota time was a broad deltaic plain bordered on east by a shallow delta-front marine environment. Lower Dakota facies consists of elongate lenticular bodies of cross-stratified sandstone, partly conglomeratic, and associated carbonaceous mudstone and coal beds (valley-fill and deltaic-plain deposits). Upper Dakota facies, which thins westward by interfingering with Lower Dakota deposits, consists of horizontally bedded sandstone and associated fine-grained deposits (marine delta-front deposits). Mancos-like clay shales in Upper Dakota probably represent marine tongues extending from east.

Cross-stratification directions in stream-channel sandstones and channel trends indicate regional transport direction was northeast to east and southeast. Regional stratigraphic relations indicate north-south average shoreline trend. Orthoquartzitic composition of sandstones, second-cycle quartz grains in some sandstones, predominance of chert and sedimentary quartzite pebbles in conglomerates, and scarcity of feldspar and heavy minerals typically derived from igneous and metamorphic terranes indicate that the source area consisted largely of sedimentary rocks. Homogeneity in composition of detrital constituents suggests single source or thorough mixing of detritus from multiple sources. Eastward decrease in abundance of detrital clay and feldspar supports east and northeast regional transport direction. The most likely source lay to southwest. Two probable sources are Mogollon highland in southern New Mexico and Arizona and Cordilleran geanticline in western Utah and farther south.

B. Y. S. and B. C.
(based on author introduction and summary and interpretation)

320. McDOUGALD, WILLIAM D., 1953, Geology of Beaver Creek and adjacent areas [Summit County], Utah: Univ. of Utah M. S. thesis, 54 p., geol. map.

The Beaver Creek area, southwestern Uinta Mountains, Utah, includes upper Precambrian, Cambrian, Mississippian, Pennsylvanian, Permian and Triassic formations, and unconsolidated Quaternary glacial, alluvial and landslide deposits. Igneous rocks include extensive Oligocene andesite flows, agglomerates and tuffs, and a small feldspathoid-bearing dike of uncertain age.

Structurally, the area is located at the westward plunging nose and southern limb of the Uinta arch. The "Hoyt Canyon" high-angle normal fault trends eastward, increasing in throw from west to east. Two major unconformities are present: (1) basal Cambrian unconformity, (2) Late Devonian - Early Mississippian unconformity.

During late Precambrian, the site of the Uinta Mountains was a deep trough of deposition which was elevated by gentle arching prior to Cambrian time. Cambrian strata were deposited on the beveled edges of Precambrian strata. Ordovician and Silurian rocks are not present. Devonian strata were removed before the Mississippian. The remaining pre-Laramide history was largely one of sedimentation. Rock units younger than Triassic are absent in the area. The Uinta Range was modified by extensive glacial and weathering processes during Pleistocene and Recent. *Abstract revised (B. Y. S.)*

321. McDOWELL, JOHN P., 1955, Early Tertiary geology of northeastern Utah, northwestern Colorado and southwestern Wyoming: Dartmouth College M. A. thesis, 44 p.

All readily available Early Tertiary literature on the Uinta, Piceance Creek and Green River Basins was analyzed with reference to thickness, distribution, depositional environment, age equivalence and degree of unconformity with the pre-Tertiary rocks. The data permitted the construction of an isopach map of the Wasatch Formation, an isometric lithologic fence diagram of the Wasatch and Green River Formations, and a map showing the degree of unconformity of the Tertiary with the underlying rocks.

The isopach map shows an increase in thickness of the Wasatch Formation in the Uinta Basin towards the west indicating a western source. The lithologic fence diagram confirms this by showing a considerable increase in amount of coarse sediments to the west. Other minor positive elements are indicated by the two diagrams.

The degree of unconformity map is interesting in that it shows what elements were positive at the start of the Tertiary period. It illustrates the west-to-east migration of the Nevadian-Laramide orogenic activity. A structure map of the region has also been compiled.

The data were insufficient to construct a lithologic facies map based on a sand-shale ratio, and for isopach analyses of formations other than Wasatch.
Author abstract

322. McFALL, CLINTON CAREW, 1955, Geology of the Escalante-Boulder area [Garfield County], south central Utah: Yale Univ. Ph. D. thesis, 180 p., geol. map.

The Escalante-Boulder area comprises 583 square miles on the southern slopes of the 11,000-foot, lava-capped Aquarius Plateau. Jurassic, Upper Cretaceous and Tertiary strata totaling 12,000 feet are exposed. Pre-Tertiary beds have been involved in monoclinal folding and are overlain in angular unconformity by nearly horizontal Tertiary strata. A few relatively small, normal faults cut both the Tertiary and older rocks. The Jurassic formations, totaling 3,800 feet, are (ascending): Kayenta Formation and Navajo Sandstone (Glen Canyon Group); Carmel Formation, Entrada Sandstone and Summerville Formation (San Rafael Group); and Morrison Formation.

The Carmel Formation of the San Rafael Swell region is correlated with beds presently called Carmel, Entrada and Curtis Formations in Bryce and Zion Canyon areas; the Entrada Sandstone of the San Rafael Swell region is correlated with the Windsor Formation of southwestern Utah.

Upper Cretaceous formations are marine or deltaic and total more than 2,500 feet. They are Dakota (?) Sandstone, Tropic Shale, Straight Cliffs and Wahweap Sandstones and Kaiparowits Formation. Tertiary strata, about 2,500 feet thick, are mainly lake beds. The lowest (orange pink) Tertiary beds are correlative with the Flagstaff Limestone rather than with the Wasatch Formation. The upper (white) beds are called Brian Head Formation and are believed to be of Eocene age. Pyroclastic material in the upper part of the Brian Head is closely related to the porphyritic olivine basalt lava which caps the Aquarius Plateau. *Abstract revised (B. C.)*

323. McFARLAND, CARL R., 1955, Geology of the West Canyon area, northwestern Utah County, Utah: Brigham Young Univ.

(M. S. thesis) Research Studies, Geol. Ser., v. 2, No. 3, 21 p.

Approximately 35 square miles were mapped for this report. The area is located in the south central part of the Oquirrh Mountains, about 25 miles south of Salt Lake City and 11 miles west of Lehi, Utah. It is in the extreme northwestern corner of Utah County and is bounded on the west by the Tooele-Utah County line and on the north by the Utah-Salt Lake County line.

The Mississippian System is represented in the area by the upper part of the Deseret Limestone, the Humbug Formation, the Great Blue Limestone and the lower half of the Manning Canyon Shale. The combined thickness of the Mississippian rocks is 5,467 feet, and this is overlain by the upper Manning Canyon Shale (Springeran) and 3,842 feet of Pennsylvanian Oquirrh Formation, divided into the Morrow, Atoka and Desmoines Series in this report. Several small moraines and cirques are present in the area.

The major structural feature of the West Canyon area is a large asymmetrical northwest plunging anticline. Folds and possible faults within the area formed during the Cedar Hills orogeny (?) and various phases of the Laramide orogeny. Folding was followed by Tertiary volcanism and erosion.

Author abstract

324. McFARLANE, JAMES J., 1955, Silurian strata of the eastern Great Basin: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 2, No. 5, 53 p.

Silurian strata of the Great Basin have a western dominantly clastic facies and an eastern carbonate (principally dolomite) facies. The eastern facies is widespread and uniform, a typical miogeosynclinal stable shelf deposit. Three poorly defined units are: a dark-gray, finely crystalline, commonly cherty unit; a light-gray medium to coarsely crystalline unit; and a medium to dark-gray finely crystalline unit. The last, uppermost, unit is not everywhere present. Fossils are generally confined to the darker-colored beds.

Dolomites are secondary, formed by penecontemporaneous replacement of calcite (or aragonite). Size distribution of the clastic quartz fraction in insoluble residues indicates a northeastern or eastern provenance.

Silurian rocks of the Great Basin have been interpreted to be Middle Silurian (Niagaran) but recent evidence suggests that Upper Silurian and Lower Silurian may also be present. The faunal succession of the Great Basin Silurian is relatively unknown. It is proposed that the name Laketown Dolomite, first used in northeastern Utah, be extended over the entire eastern Great Basin. The Laketown Dolomite has little economic value but it is a relatively pure dolomite in certain areas.

Abstract revised (B. Y. S.)

325. McGOOKEY, DONALD PAUL, 1958, Geology of the northern portion of the Fish Lake Plateau [Sevier County], Utah: Ohio State Univ. Ph. D. thesis, geol. map.
(Abs.): Dissert. Abs., v. 19, No. 12, p. 3277-3278, June 1959.

Northern Fish Lake Plateau, central High Plateaus Province, includes the area east of Sevier Valley and south from the Wasatch Plateau to the northern edge of the great lava fields of the southern part of the High Plateaus. Jurassic to Recent rocks are exposed, but this study is mainly of the Late Cretaceous and Tertiary.

The Late Cretaceous Price River Sandstone and North Horn Shale record Piedmont and succeeding lowland environments during contemporaneous orogenic activity farther west. The Early Tertiary Uinta Lake covered this area continuously while the upper shale sequence of the North Horn Formation, Flagstaff Limestone, Colton Shale and Green River Shale and Limestone were deposited. The lake withdrew because of post-Green River positive movements, and erosion preceded deposition of the fluvial Crazy Hollow Shale and Sandstone. The area was again inundated in late Eocene time by the Gray Gulch lake. Volcanic activity to the south or southwest at this time caused a fairly steady rain of fine pyroclastic material during the shale deposition of the Bald Knoll Member; increased activity provided coarser debris for the Dipping Vat Member (new name). The lake withdrew and mudflows and volcanic conglomerate (lower Bullion Canyon Series) were deposited from erosion of nearby volcanoes. They represent the last of a nearly continous sedimentary succession from Jurassic to Middle Tertiary.

Structurally, early Middle Tertiary monoclinal folding caused development of the Wasatch and Gates Creek monoclines and related structures. Late Tertiary normal faulting developed linear north-south graben and complex fault zones with no relation to previous structures. Subsequent erosion has caused the fault zones to stand out as physiographic features. The main faulting was followed by two cycles of stream erosion and valley filling by alluvium. The deposits of two separate Wisconsin glaciations can be differentiated locally in valleys at high elevations. *Abstract revised (B. Y. S.)*

326. McKELVEY, VINCENT E., 1946, Stratigraphy of the Phosphatic Shale Member of the Phosphoria Formation in western

Wyoming, southeastern Idaho and northern Utah: Univ. of Wisconsin Ph. D. thesis, 152 p.

The marine Phosphoria Formation is noteworthy for its vanadium and phosphate reserves. It has a lower Phosphatic Shale Member (object of this study), overlain by the Rex Member (cherty limestone). Its aggregate thickness of 226 to 500 feet represents much of Permian time.

The Phosphatic Shale Member consists of soft, black, carbonaceous, fine-grained, phosphatic siltstone and shale with layers of harder, dark-gray, phosphatic oolite, limestone or dolomite, cherty limestone and cherty siltstone. It is composed largely of colophane, francolite, and calcite or dolomite, with clay minerals, quartz and mica, and organic matter. It is divided into a lower and an upper part, each consisting of a phosphatic and calcareous sequence overlain by clastic or siliceous rocks.

The lower part thickens westward and southward. It consists of calcareous siltstone or dolomite, 3-5 feet of phosphate, and alternating beds of siltstone and shale. The vanadiferous zone is thicker (8 to 12 feet) and more phosphatic in southeastern Idaho than in western Wyoming or Crawford Mountains, Utah. The upper part of the member thickens southward to about 100 feet in the Crawford Mountains. Its lower half is alternating beds of phosphatic oolite and calcareous or dolomitic siltstone. The upper phosphate beds, a thin oolite and a limestone (top of the vanadiferous zone) extend over much of the region.

Areal variations in thickness are caused by variations in thickness of the phosphate (which increases westward, as does the fluorine content), carbonate (increases southward), and cherty rocks found in east and south); vanadium content of the entire phosphatic shale ranges from 0.1 to over 1.0 percent V_2O_5 and, like the phosphate and carbonate, parallels the vanadiferous zone.

The phosphate, vanadium and trace elements are syngenetic. The Phosphoria Sea, given sufficient time, normal contributions from chemical denudation, and normal oceanic circulation, might have been an adequate source for these tremendous volumes of phosphate and vanadium if other sediments were deposited abnormally slowly. Lateral variations in precipitated concentrates were controlled by unknown factors. *Abstract revised (B. Y. S.)*

327. McMINN, PAUL MELOY, 1948, The Pennsylvanian stratigraphy of Daggett County, Utah: Univ. of Wisconsin M. S. thesis, 45 p.

Area studied lies largely in western end of Daggett County, partly in eastern Summit County, along northeast flank of Uinta Mountains. Belden, Youghall and Weber Formations (ascending) comprise the Pennsylvanian System. A thick section of clastics with intercalated limestones of Late Mississippian (?) age overlies the Madison Limestone and underlies the Belden in eastern part of area. From east to west the most conspicuous lithologic variations in the Belden are introduction and thickening of dolomite and increased clastic content of upper Beldon. Fauna of Belden resembles Morrowan faunas of Rocky Mountains.

The Youghall Formation decreases in limestone content from western Colorado into eastern Uintas and becomes entirely a sandstone section in most of area studied. It is generally darker and more thinly bedded than the Weber, but the contact is so gradational where measured that a combined thickness is reported. The Weber is a uniform sandstone, locally quite soft. Upper contact of Weber is uncertain due to obscurity of unconformity at its top, and to variable lithology at base of overlying Permian Park City Formation. *Abstract revised (B. C.)*

328. MacNISH, ROBERT D., 1962, Geomorphology of the western Sanpete Valley [Sanpete County], Utah: Univ. of Michigan M. S. thesis, 64 p.

Sanpete Valley, central Utah, is a structural trough in Mesozoic and Tertiary formations, partially filled with Late Tertiary and Quaternary alluvium. Normal faulting along a zone which bounds the Gunnison Range on the east began in late middle Miocene time and continued to the present, creating a series of faulted pediments and alluvial fans along the mountain front.

Periods of faulting divide alluvial deposits into three units. The oldest body, Alluvium I, was deposited on pediment surfaces formed after Tertiary uplift of main mountain block. Deposits in Wales Canyon indicate that the canyon reached grade and alluviated. Early Pleistocene (?) faulting uplifted blocks in northern Sanpete Valley. The Early San Pitch River, enlarged due to pluvial climate of late Pleistocene, eroded edges of some fans and deposited channel sands. Subsequent faulting in southern part of valley uplifted blocks which dammed the Early San Pitch River creating a lake which developed into a marsh. Recent faulting created fresh scarps and truncated spurs along the Range front, after which Alluvium III was deposited on top of the fans of Alluvium II. *Abstract revised (B. C.)*

329. MADSEN, JACK WILLIAM, 1952, Geology and ore deposits of the Spring Canyon area, Long Ridge [Juab and Utah Counties], Utah: Brigham Young Univ. M. S. thesis, 92 p., geol. map.

Long Ridge is a structurally complex, low range at eastern edge of Basin and Range Province composed of (ascending) Cambrian Tintic Quartzite, Ophir Formation, Teutonic, Dagmar and Herkimer Limestones, Bluebird, Cole Canyon and Opex Dolomites; Ordovician Ajax and Opohonga Limestones; Mississippin Gardner Dolomite, Pine Canyon Limestone and Humbug Formation; Cretaceous - Tertiary Price River-North Horn conglomerates; Tertiary volcanic rocks, and Quaternary Lake Bonneville sediments.

Severe deformation during early "Laramide" orogeny produced a north-south anticlinal fold. Normal faulting followed the folding and recurred during Basin-and-Range faulting. Ascending hydrothermal solutions deposited manganese-bearing hypogene minerals in faults and fissures. Later, the water table lowered and meteoric water oxidized the primary minerals and concentrated them as supergene minerals psilomelane, pyrolusite, wad, hematite and limonite. No hypogene ores are found, but rhodochrosite occurs in surrounding areas, and boxwork pattern found in mines in the area studied suggests rhodochrosite and pyrite as hypogene minerals. Ore is confined to faults and fault zones of the oxidized zone, and is very irregular, pockety and lens-like. Three deep shafts have produced 1,947 tons of ore, averaging 11.1 percent manganese, since 1924. Silicification and argillic alteration have occurred adjacent to the veins.

Abstract revised (B. C.)

330. MADSEN, JAMES H., Jr., 1959, Geology of the Lost Creek-Echo Canyon area, Morgan and Summit Counties, Utah: Univ. of Utah M. S. thesis, 60 p., geol. map.

Williams, N.C. and J.H. Madsen, Jr., 1959, Late Cretaceous stratigraphy of the Coalville area, Utah: Intermtn. Assoc. Petroleum Geologists Guidebook, 10th Ann. Field Conf., p. 122-125.

Rocks of Mesozoic and Cenozoic age are exposed in the Lost Creek-Echo Canyon area. The Jurassic System is represented in ascending order by the Nugget, Twin Creek, Preuss, Stump and Morrison Formations. The Cretaceous System is represented by the lower Kelvin, Frontier and Wanship Formations, and a conglomerate. The lower Eocene Knight Formation was the only Tertiary formation recognized.

Fossil marine pelecypods collected from thin sands within 400 feet of the base of the formation indicate that the conglomerate sequence for which the name Echo Canyon Conglomerate is proposed is Late Cretaceous, although considered Tertiary by previous workers. This sequence rests conformably upon the Wanship Formation (Cretaceous-Coloradoan), and is unconformably overlain by nearly horizontal Tertiary beds.

Redefinition of the Cretaceous - Tertiary boundary emphasizes the great time indicated by the basal Tertiary unconformity which truncates rocks of late Montanan (?) and older age. The most significant pulse of the Laramide orogeny occurred during this time and is recorded in folds of the pre-Eocene formations.

Abstract revised (B. Y. S.)

331. MADSEN, RUSSEL A., 1952, Geology of the Beverly Hills area [Utah County], Utah: Brigham Young Univ. M. S. thesis, geol. map.

The geology of an area of approximately 9 square miles in northern Utah County was mapped. The formations which were investigated are: the Mississippian Great Blue Limestone, the Mississippian-Pennsylvanian Manning Canyon Shale, the Pennsylvanian Oquirrh Formation, and more than 200 feet of Tertiary latite flows and breccias. Deposits of economic value are largely restricted to clay deposits in the Clinton clay pits.

From author abstract

332. MANCUSO, JAMES D., 1954, Geology of Topliff Hill and the Thorpe Hills, Tooele and Utah Counties, Utah: South Dakota School of Mines and Technology M. S. thesis, 33 p., geol. map.

The area mapped lies in the extreme eastern part of the Basin and Range Province, and has topographic features such as linear mountain ranges and broad, alluvium-filled valleys which are typical of the Province. The climate is arid, and outcrops are plentiful.

Rocks exposed range in age from Mississippian to Quaternary and include the Deseret Limestone, Humbug Formation and Great Blue Limestone of Mississippian age; the Manning Canyon Shale of Mississippian and Pennsylvanian age; the Oquirrh Formation of Pennsylvanian age; and sediments of Pleistocene and Recent age. The only complete section measured was of the Humbug Formation, 813 feet thick.

The rocks of Topliff Hill define an anticlinorium, the axis of which trends N. 25° W. and plunges to the north. The northern part of the axis has been displaced eastward, probably by a hidden tear fault. The Thorpe Hills are essentially synclinal in structure. The axis trends approximately N. 30° W. and plunges to the south. Both Topliff Hill and Thorpe Hills are broken by high-angle normal faults, and a block fault separates the two areas.

Abstract revised (B. C.)

333. MANN, CHRISTIAN J., 1961, Pennsylvanian stratigraphy of southwestern Wyoming, northwestern Colorado and northeastern Utah: Univ. of Wisconsin Ph. D. thesis.
(Abs.): Dissert. Abs., v. 22, No. 2, p. 540, 1961.

Paleontologic, lithologic and stratigraphic features of Pennsylvanian strata in southwestern Wyoming, northwestern Colorado and northeastern Utah have been investigated to determine more accurately the age and interrelationships of the various sedimentary facies, the depositional environment, the source of the sediments, and tectonic features existing during the Pennsylvanian Period.

Almost continuous deposition during the Pennsylvanian Period is recorded. The Late Mississippian-Early Pennsylvanian Darwin Sandstone of central Wyoming is the nearshore facies of a black shale and limestone unit of northeastern Utah. These basal beds are conformably overlain by the fossiliferous Amsden and Morgan Formations (Morrowan, Atokan and early Desmoinesian age) in very stable shallow water. They grade upward into neritic sandstones of the Tensleep and Weber Formations (late Atokan, Desmoinesian, Missourian, Virgilian and Wolfcampian age). The sandstones are not equivalent in age everywhere. The Belden Shale of probable Morrowan and Atokan age, the Desmoinesian Minturn Formation and the Maroon Formation of late Desmoinesian to Virgilian age in central Colorado are equivalent to and even interfinger westward with the Morgan Formation and Weber Sandstone.

The LaBarge Platform, western Wyoming, was stable throughout the Pennsylvanian. The Uinta and Maroon Basins began slow subsidence in the Morrowan. Ancestral Front Range and Uncompahgre Mountains were rising, positive features from Desmoinesian until Permian; Great Divide Basin was formed during the Desmoinesian. The Wyoming arch began in late Desmoinesian as an extension of the Ancestral Front Range.

The probable source of the clastic material is either the cratonic area or the Ancestral Rocky Mountains; southeastern Wyoming source was important during deposition of the Darwin Sandstone. The Ancestral Front Range and Uncompahgre Range supplied coarse clastic material locally to the Maroon Basin and areas bordering the late Pennsylvanian uplifts.

Abstract revised (B. Y. S.)

334. MARINE, IRA WENDELL, 1960, Geology and ground-water resources of Jordan Valley [Salt Lake County], Utah: Univ. of Utah Ph. D. thesis, 275 p.

_____ and Don Price, 1964, Geology and ground-water resources of the Jordan Valley, Utah: Utah Geol. and Mineralog. Survey, Water-Resources Bull. 7, 67 p.

The modern landscape was formed by: (1) lake deposition and erosion, (2) stream erosion and deposition, (3) faulting, (4) pedimentation, (5) wind deposition, (6) mudrock flow deposition, and (7) glacial deposition. The valley is divided into six major and several minor areal units, based on subsurface geology and water-bearing characteristics. Each unit has a characteristic range of specific gravity: highest being 30-750 gpm per foot drawdown; lowest, below 3.

Recharge sources are seepage from irrigation and precipitation, underflow of creek channels and the Jordan River, channel loss of the Wasatch creeks and irrigation canals, and subsurface bedrock springs. Ground water is discharged by evapotranspiration, springs and seeps, and by wells (estimated to be 91,000 acre-feet in 1957), drains and tunnels. Total ground-water discharge was about 274,000 acre-feet in 1957. Potentiometric surface and flowing-well areas in 1956-58 were very similar to those of 1931. Water-level trends are generally horizontal, but have risen on the west because of irrigation water. Ground water ranges from 50° to 60° F, with warmer waters in the southeast and northwest.

Ground water on the east is of satisfactory chemical quality for most uses. On the west it is suitable for most uses, but seepage from irrigated fields locally deteriorates the quality. In the northwest, ground-water uses are limited.

Units of ground-water storage are delimited and storage is estimated. Geologic, hydraulic and chemical methods of aquifer delimitation were tried and evaluated. Geologic methods involve use of peg models, cross sections, gravel percentage maps, mechanical analysis of drilling samples, analysis of source lithologies and qualitative evaluation of drillers' logs. Hydraulic methods involve graphs of depths of small-diameter wells, graphs of relation of water level to well depth, changes in potentiometric surface, Au Current Meter investigations, well-interference tests and a specific capacity map.

Abstract revised (B. Y. S.)

335. MARKLAND, THOMAS R., 1964, Subsurface water geology of Spanish Fork quadrangle, Utah County, Utah: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 11, p. 37-65.

Coarse sediments of pre-Lake Bonneville deposits and Lake Bonneville Group comprise the aquifers. Hydrostatic pressures vary from 1 to 44 feet above the surface. The piezometric surface is not of uniform gradient; subsurface water flows toward Utah Lake. Water of best quality comes from deeper aquifers. Chloride, sodium and potassium show most variation along the fault zone. Warm water flowing from Benjamin fault near Arrowhead Resort has a hydrothermal gradient of 10.6 degrees per hundred feet. Coarse sediments on the east, placed against finer sediments of the upthrown block, form a ground-water dam. Most water is used for culinary and stock purposes, some for irrigation. Prospects for development of water supplies are fair north of Santaquin and on the Spanish Fork floodplain and delta.

Abstract revised (B. Y. S.)

336. MARSELL, RAY EVERETT, 1932, Geology of the Jordan Narrows region, Traverse Mountains [Salt Lake and Utah Counties], Utah: Univ. of Utah M. S. thesis, 117 p., geol. map.

The Traverse Mountains lie at the boundary of two major provinces, the Great Basin and Western Rocky Mountains. Very thick Upper Pennsylvanian quartzites and intercalated limestones form the core of the range. These are overlain by early Miocene andesite flows, Pliocene lake beds, and Pleistocene fanglomerates, terrace travertines and Lake Bonneville sediments. Structure includes parts of two anticlines and an intervening syncline. Both the east-west trend and the external form of the Traverse Mountains are due to close topographic adjustment to the folded structures. The eastern and western halves of the mountains are a single geologic unit. The Traverse Mountains are part of the Oquirrh crustal block. They are separated from the Wasatch Mountains by the Wasatch fault and constitute part of the downthrown block of the Wasatch fault.

The Wasatch Mountain region possessed considerable relief when Basin-Range faulting began, probably in late Pliocene. Total throw of the Wasatch fault is probably about 5,000 feet.

Abstract revised (B. Y. S. and B. C.)

337. MARTNER, SAMUEL T., 1948, Geology of the Manila-Linwood area, Sweetwater County, Wyoming and Daggett County, Utah: California Inst. Technology Ph. D. thesis, 119 p., geol. map.

The Manila-Linwood area consists of about 200 square miles lying on the Wyoming-Utah border. A brief review of the records of early geological and geographical exploration by such men as Clarence King, S.F. Emmons and Ferdinand V. Hayden is presented.

One of the most completely exposed stratigraphic sections, representing a span of geologic time as long as or longer than that seen in any area of comparable size in the United States, characterizes the area, and contains rocks representing the Archean (?) and Algonkian eras, as well as all later periods except possibly the Cambrian, Ordovician, Silurian and Devonian. The character, thickness, age and correlation of the 23 mapping units are briefly discussed. The only plutonic igneous bodies were those intruded into formations of Archean (?) age. Minor extrusive accumulations consist chiefly of tuffs interbedded in shales and sandstones.

Structurally part of the Rocky Mountain Province, the southern portion is a segment of the great, east-west-oriented, Uinta Mountain arch and the northern half is a sector of Bridger Basin (southwestern Wyoming). Superimposed on the northward regional dip are minor, transverse flexures. Part of the Uinta fault and other rather complex faulting are found in the district.

Abstract revised (B. Y. S.)

338. MASE, RUSSELL EDWIN, 1957, Geology of the Indianola embayment, Sanpete and Utah Counties, Utah: Ohio State Univ. M. S. thesis, 96 p., geol. map.

Rocks of marine, lacustrine, fluviatile and volcanic origin are exposed in the Indianola embayment. Their ages range from late Jurassic to Quaternary. The finer sediments, especially varicolored shale and siltstone, are common in the Jurassic and Early Tertiary formations. Brown sandstone and coarse conglomerate are typical of the Cretaceous formations. The limestones are chiefly Tertiary in age and the pyroclastics are entirely so.

The Indianola embayment is structurally divisible into (1) the central and southern parts which exhibit generally simple block-fault structure controlled by a few major faults, and (2) the northern and northeastern parts in which rocks have been complexly folded and faulted by thrust from the west.

The embayment embraces a variety of land forms: deeply dissected plateau country with erosion remnants left as peaks, cuestas held up by resistant sandstones, broad wide valleys cut in formations made up chiefly of shales, and steep-sided box canyons where the dissected rocks are conglomerates and sandstones. Topography is youthful. Valley floors are thickly alluviated.

Evidence for 17 distinct Late Jurassic to Pleistocene crustal movements has been recognized in central Utah. Only six or seven are recorded in rocks exposed in the Indianola embayment.

Excerpts from thesis

339. MATTHEWS, ASA A. LEE, 1924, Marine Lower Triassic beds of [Wasatch Range] Utah: Stanford Univ. M. A. thesis. (Abs.): Geol. Soc. America Bull., v. 36, p. 200, 1925.

This paper calls attention to the Anasibirites bed of the Wasatch Range, Utah. It compares the species with those of similar beds described in the Salt Range, India, and also those of Timor. The paper states that the Anasibirites bed represents a horizon near the top of the Lower Triassic and fills in a gap between the Meekoceras and Columbites zones which occur in the type section in the Aspin Mountains, Idaho, and also in the Inyo Range, California.

The general conclusion reached is that, with the exception of the lowermost bed, America possesses complete faunas representing the Lower Triassic. *Published abstract*

340. MATTHEWS, ASA A. LEE, 1929, Lower Triassic cephalopod fauna of the Fort Douglas area [Wasatch Range], Utah: Univ. of Chicago Ph. D. thesis.

______ 1929, The Lower Triassic cephalopod fauna of the Fort Douglas area, Utah: Chicago Univ. Walker Museum Memoirs, v. 1, No. 1, 74 p.

The Lower Triassic rocks outcrop in the Fort Douglas area in two localities: on the north limb of a syncline between Red Butte and Dry Canyons and on the south limb of the same structure near Mill Canyon. They comprise the lower division of the Thaynes Group and are referred to here as the Pinecrest Formation. This formation is named after Pinecrest Ridge which lies between the north and south fork of Red Butte Creek.

The Pinecrest Formation contains a very rich marine fauna consisting primarily of pelecypods and cephalopods. The principal element of the pelecypods belongs to the Pectinidae or its close allies; the cephalopods belong to the Ammonoidea.

The cephalopod facies of the fauna is essentially new for North America. It consists of 13 genera and 68 species, of which 2 genera and 60 species are new. There are over 1,000 specimens of cephalopods in the collection, most of which have been obtained from the Anasibirites zone in the Pinecrest Formation.

The Anasibitires zone is younger than the Meekoceras and older than the Tirolites and Columbites zones of the Aspen Ridge, Idaho. It more nearly corresponds to the lower part of the Hungarites shale in the Kashmir Range, Asia. It occurs just above the Hedenstroemia beds in the Himalaya Mountains, and is considered equivalent to the lower part of the Upper Ceratite limestone in the Salt Range, India.

The description of the new species is based upon a system of measurements and ratios in addition to the generally accepted characteristics used in determining new species. *From published introduction*

341. MAXEY, GEORGE BURKE, 1941, Cambrian strata in northern Wasatch region [Cache County]: Utah State Univ. M. S. thesis.

Williams, J.S., and G.B. Maxey, 1941, The Cambrian section in the Logan quadrangle, Utah and vicinity: Am. Jour. Sci., v. 239, No. 4, p. 276-285.

Two new, complete, and better-exposed sections of Middle and Upper Cambrian rocks, near the well-known Blacksmith Fork section, have been studied in detail. Numerous other exposures of the lower part of the section have been examined. The famous Spence Shale is found to be a member low in the Langston Formation, not the basal member of the Ute Formation. The relative positions of the Ptarmigania and Spence Shale faunas have been determined. Other facts bearing on the faunal sequence in the Middle Cambrian rocks of the Cordilleran trough have been discovered. There is evidence that the Nounan Formation is of Upper Cambrian age. The Brigham Formation is probably of Lower Cambrian age. *Published abstract*

342. MAXEY, GEORGE BURKE, 1951, Lower and Middle Cambrian stratigraphy in western Utah and southeastern Idaho: Princeton Univ. Ph. D. thesis.
(Abs.): Dissert. Abs., v. 15, No. 4, p. 558, 1955.

______1958, Lower and Middle Cambrian stratigraphy in northern Utah and southeastern Idaho: Geol. Soc. America Bull., v. 69, p. 647-688.

The lower and Middle Cambrian deposits of Utah and southeastern Idaho include the basal medium-to coarse-grained Prospect Mountain Quartzite overlain by interbedded fine- and coarse-grained clastic rocks (Pioche Formation) that in turn are overlain by several hundred to a few thousand feet of carbonate rocks with a few thinly interbedded layers of fine clastics. In central and northern Utah and southeastern Idaho the carbonate sequence includes (upward) the Langston Formation, Ute Limestone, Blacksmith Dolomite, and Bloomington Formation. The Nounan Dolomite (Upper Cambrian) overlies the Bloomington. In the House Range, western Utah, the carbonate sequence consists (upward) of the Langston Formation; Millard, Burrows, Burnt Canyon, Dome, and Swasey Limestones; "Wheeler Formation"; and "Marjum Formation." Uppermost "Marjum Formation" beds are Late Cambrian.

All known occurrences of fossil genera and species are listed, and many newly described faunal horizons are defined. Forty-nine faunal groups are given, and a revised sequence of faunizones is recommended (oldest to youngest): "Olenellus zone," Antagmus-Onchocephalus zone, Glossopleura-Zacanthoides zone (Albertella-Kochaspis, Anoria and Glossopleura-Solenopleurella subzones), Bolaspis-Glyphaspis zone, Elrathiella-Triplagnostus-Asaphiscus zone, Palella-Thompsonaspis zone, Eteraspis-Orria zone (Deissella and Brookscodia "subzones").

Cambrian deposits may be separated into (1) orthoquartzite, (2) greenish-brown, micaceous and arenaceous shale, (3) brown-weathering calcareous sandstone, (4) rusty-brown-weathering dolomite, (5) green and buff fissile shale, (6) calcareous black shale, (7) mottled, silty, aphanitic, thinly bedded limestone, (8) Girvanella limestone, (9) intraformational conglomerate, (10) oolitic limestone, (11) "undifferentiated limestone," and (12) "undifferentiated dolomite" facies.

These sediments probably were deposited in a shallow, oscillating sea, which transgressed a low-lying but mature topography eastward to western Utah by earliest Cambrian (pre-Olenellus ?) time and to eastern Utah by the end of Early Cambrian time. The area remained submerged during Medial Cambrian and much of late Cambrian time.

Abstract revised (B. Y. S. and B. C.)

343. MAXFIELD, E. BLAIR, 1957, Sedimentation and stratigraphy of the (Pennsylvanian) Morrowan Series in central Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 4, No. 1, 46 p.

The area covered by this study of the Morrowan Series of the Oquirrh Formation is approximately 18 townships. The entire area is located in Utah County except the most westerly portion, which extends into Tooele County. Portions of two major physiographic provinces are included, the eastern part of the Basin and Range Province and part of the south central Wasatch Range of the Middle Rocky Mountain Province.

Six sections were measured and studied. They average nearly 1,000 feet thick and are divisible into five mappable lithologic units, an upper, lower, and middle limestone lithotope separated by two sandstone lithotopes. The limestone lithotopes consist of clastic units ranging from relatively pure limestone to calcareous sandstone. The sandstone lithotopes are well-sorted calcareous sandstone beds.

The sedimentary environment apparently was a rapidly sinking miogeosynclinal area in a shallow epicontinental sea. The source areas of the sediments lay to the west and north, which during sedimentation was far enough from the area of deposition to allow the material to be well sorted.

Author abstract

344. MECHAN, DERRAL F., 1948, The structure of Little Rock Canyon, central Wasatch Mountains [Utah County], Utah: Brigham Young Univ. M. A. thesis, 59 p., geol. map.

Little Rock Canyon is in the south central Wasatch Mountains between Provo and Springville. Only Mississippian formations are exposed in the canyon itself, with Cambrian and Devonian formations nearby. Cambrian strata include: Tintic Quartzite, Ophir Shale, Maxfield Limestone (with distinctive mudstone partings), and Lynch (?) Dolomite (with peculiar chilled steel appearance). The Devonian Jefferson (?) Dolomite characteristically weathers light gray. Mississippian formations are: Madison Limestone (with abundant black and brown chert), Deseret Formation (many members weather red) and Humbug Formation.

Little Rock Canyon area is the crest of a partly overturned faulted anticline. Numerous joints, fractures and faults occur in the highly folded crestal beds. Drag folds are present. The Wasatch fault strikes N. 20° W. A series of minor faults parallels it, and some minor faults strike at an angle to it.

Economically the area is unimportant, although lime and gravel have been produced commercially and an ornamental aragonite called "Mexican Onyx" occurs in limited quantities. *B. Y. S.*

345. MERRELL, HARVEY W., 1957, Petrology and sedimentation of significant Paradox shales: Univ. of Utah M. S. thesis, 40 p.

_____ D.J. Jones and L.B. Sand, 1957, Sedimentation features in Paradox shales, southeastern Utah (abs.): Geol. Soc. America Bull., v. 68, No. 12, pt. 2, p. 1766.

Petrological and sedimentological studies were made of subsurface samples of Pennsylvanian Paradox shales from seven wells in the southwestern part of the Paradox Basin, southeastern Utah. Sediment properties examined included grain size, carbonate content, clay minerals, and heavy mineral content.

The section of the Paradox shales selected for study lies at or near the top of the evaporite sequence and consists of highly calcareous, gray to black carbonaceous siltstones, shales and mudstones, and localized micaceous zones. Composition of the shales is uniform throughout the area; average bulk mineral composition is as follows: quartz, 40-60 percent; calcite, 15-40 percent; dolomite, 10-35 percent; and clay minerals, 5-10 percent.

Size analyses show a decrease in median diameter northwesterly toward the center of the basin. The heavy mineral and carbonate content of the shales also decreases in this direction.

There is an anomaly in the general sedimentary pattern in a small northwest-trending area characterized by abnormally high concentration of heavy minerals, low dolomite content, high chlorite content, and markedly poor sorting compared to the nearshore and offshore areas.

A progressive change in the clay minerals from near shore to the basin was noted as follows: montmorillonite with illite, chlorite and illite with montmorillonite, and chlorite and illite.

Abstracts revised (B. C.)

346. METTER, RAYMOND EARL, 1955, The geology of a part of the southern Wasatch Mountains [Utah County], Utah: Ohio State Univ. Ph. D. thesis, 262 p., geol. map.
(Abs.): Dissert. Abs., v. 15, No. 6, p. 1047, 1955.

The southern Wasatch Mountains and northern Cedar Hills are bounded by Spanish Fork Canyon, Utah Valley, Santaquin Canyon, Gardner Hollow and Thistle Creek. Sedimentary rocks range from Precambrian (?) to Recent, with the older rocks to the west, and include: Precambrian (?) quartzites and shales; Tintic Quartzite, Ophir Formation, Teutonic Limestone, Dagmar Limestone, Herkimer Limestone, Bluebird Dolomite, Cole Canyon Dolomite and Opex Dolomite (all Cambrian age); Mississippian Madison Limestone, Deseret Limestone, Humbug Formation and Great Blue Formation (all mainly carbonate rocks); poorly exposed Manning Canyon Shale; thick Oquirrh Formation (ranging from Springeran, or possibly Chesteran, to Wolfcampian); Permian Kirkman Limestone, Diamond Creek Sandstone and Park City Formation; portions of Triassic Thaynes and Ankareh Formations; Jurassic Nugget Sandstone and Twin Creek Formations; North Horn Formation; Tertiary Flagstaff and Colton Formations. A piedmont deposit is herein called the Crab Creek Formation. Pyroclastics (Oligocene ?) lie on a Tertiary surface of considerable relief.

Crystalline rocks include the basal complex on Dry Mountain, a diabase body in the Tintic Quartzite, and one or more sills.

The southern Wasatch Range is the eastern limb of a former north-trending anticlinal structure. Dry Mountain is an east-dipping homocline. Shurtz Canyon anticline and Pole Canyon syncline are on the northeastern side, and the Loafer Canyon anticline on the southwestern side of Loafer Mountain. Strata in the northern Cedar Hills are gently warped.

Two episodes of thrusting are evidenced by: The pre-North Horn Santaquin overthrust and Dry Mountain thrust, which involved strip-thrusting from the west; and the post-Flagstaff Bear Canyon thrust, representing compression from the north. Normal faults are: Wasatch frontal fault and Thistle Canyon fault. Some areas are complexly faulted. Transverse tear and normal faulting accompanied folding. *Published abstract revised (B. Y. S.)*

347. MILLER, DONALD S., 1960, The isotopic geochemistry of uranium, lead and sulfur in the Colorado Plateau uranium ores: Columbia Univ. Ph. D. thesis.
(Abs.): Dissert. Abs., v. 24, No. 1, p. 250, 1963.

_____ 1960, Uranium, lead and sulfur isotopic data and the origin of the Colorado Plateau uranium ores (abs.): Geol. Soc. America Bull., v. 71, No. 12, pt. 2, p. 1930.

A comprehensive investigation of the isotopic relations of uranium, lead and sulfur in the minerals of the Colorado Plateau uranium ores has been made. Samples include unoxidized-primary pitchblendes from typical Colorado Plateau sandstone-type deposits and the intimately associated galena. The results indicate that the uranium mineralization probably occurred at more than one period of time depending on the area and the host rock. The Plateau mineralization does not appear related to the formation of the Colorado Front Range pitchblende deposits at 65 m.y. ago.

Combining all the isotopic evidence it is felt that the uranium mineralization history was as follows: The uranium entered the present host rocks in ground water, probably as complex uranyl carbonates in very dilute solution. In the presently mineralized zones the organic material within the sediments was being used as an energy source for sulfur bacteria. These bacteria were actively reducing sulfate to hydrogen sulfide thus producing a highly reducing environment within and around most concentrations of organic material. In the immediate vicinity of organic material the water probably became saturated with H_2S. The uranium, reduced to the +4 valence state, would be immediately precipitated as pitchblende. This precipitation occurred, in most cases, soon after or during the accumulation of the host rocks (Lisbon Valley). There are other occurrences such as Cane Creek where deposition at intermediate times is suggested. In geologically recent times, alteration has occurred which caused loss of lead from the uranium mineral. Variable amounts of lead were lost and in some cases the lead that was lost had a lower Pb^{207}/Pb^{206} ratio than the total lead of the uranium mineral before the alteration took place.

With the low temperature indications and low concentrations of uranium needed it seems quite adequate to have derived the uranium ions from somewhere within the sedimentary column.

From author abstract

348. MILLER, GERALD MATTHEW, 1958, Post-Paleozoic structure and stratigraphy of Blue Mountain area [Beaver County], southwest Utah: Univ. of Washington M. S. thesis, 59 p., geol. map.

Dominant feature of the Blue Mountain area in southern Wah Wah Mountains is a large overthrust in which Middle and Upper Cambrian carbonate rocks, 3,000 or more feet thick, have overridden Lower Triassic to Upper Jurassic clastic sedimentary rocks, about 3,600 feet thick. The latter are correlated with (ascending) Triassic Moenkopi Formation, Shinarump Conglomerate, Chinle Formation and lower Glen Canyon Group; and Jurassic Navajo Sandstone, San Rafael Group and Winsor Formation. Tertiary volcanic rocks with boulder conglomerate at base overlie mainly Cambrian strata.

Evidence for age of large-scale block faulting is lacking. Pre-thrust doming due to compression or intrusion is postulated. Moderate deformation occurred in Triassic and Jurassic rocks beneath thrust plane, but few faults can be demonstrated to be older than and unrelated to thrusting.

The Blue Mountain thrust plane appears concordant with bedding of upper and lower plates. During thrusting, folds and minor thrusts were generated within upper plate. The thrust is correlated with Laramide thrusting in eastern part of this section of Great Basin. Compressional folding and/or uplift caused by intrusion are postulated to explain the post-thrust uplift which has brought the rocks of Blue Mountain into their present high structural and topographic position. *B. C.*

349. MILLER, GERALD MATTHEW, 1960, The pre-Tertiary structure and stratigraphy of the southern portion of the Wah Wah Mountains [Beaver County], southwest Utah: Univ. of Washington Ph. D. thesis, 143 p.
(Abs.): Dissert. Abs., v. 20, No. 12, p. 4634-4635, 1960.

The southern Wah Wah Mountains (southwest Utah) contain two large thrusts which divide the area into three distinct units: an "autochthon," the Blue Mountain thrust plate, and the Wah Wah thrust plate.

The lower, or Blue Mountain thrust brings Middle Cambrian through Lower Pennsylvanian rocks over the Lower Triassic-Upper Triassic continental clastic "autochthon." Some of the Triassic units are partially hornfelsed by local contact metamorphism from a postulated intrusive body. The "autochthon" is exposed at Blue Mountain and in windows in the south central portion. The Blue Mountain thrust, probably Laramide in age, is 12 miles long and has a minimum horizontal displacement of 9 miles.

Rocks of the Blue Mountain thrust plate are an easterly facies of the eastern Great Basin Paleozoic. The main facies difference noted is thinning and omission of units, but the Mississippian sequence displays a distinct facies, with a fauna typical of the Brazer Limestone. Mississippian rocks lie disconformably on the Simonson Dolomite. Several imbricate thrusts are present within the Blue Mountain thrust plate and overfolding indicates an east-southeasterly direction of yielding.

The upper thrust (Wah Wah) has brought late Precambrian to Middle Cambrian rocks over the Paleozoic rocks of the Blue Mountain Thrust plate. The main part of the Wah Wah Mountains is composed of this upper-plate Cambrian sequence which continues northward into the House Range. The Paleozoic sequence of the Wah Wah thrust plate continues unbroken to the northwest into the Confusion Range. Thus the Wah Wah, House and Confusion Ranges are assigned to the same major thrust plate. The Wah Wah thrust is a frontal breakthrough of the Snake Range décollement. A large part of the area is covered by Tertiary volcanic rocks which have been moderately faulted, tilted, and in part folded.
Abstract revised (B. C.)

350. MILLER, W. D., 1959, The general geology of Moab Valley, Moab [Grand County], Utah: Texas Technolog. College M. S. thesis, 121 p., geol. map.

This thesis provides a geologic map of Moab Valley and a detailed description of the Pennsylvanian, Permian, Triassic and Jurassic rocks exposed in the area. The units consist, in ascending order, of the Paradox, Hermosa, Rico-Cutler, Moenkopi, Chinle, Wingate, Kayenta, Navajo, Carmel and Entrada Formations.

Moab anticline has been uplifted and eroded three times: (1) in the Late Permian, (2) in the Early Triassic, and (3) in the Late Cretaceous or Tertiary. At least two periods of salt intrusion have occurred and the secondary folds and faults on the limbs of the anticline are due to salt intrusion and collapse.
Author abstract

351. MITCHELL, HAROLD G., 1925, A geological report on the Dry Canyon division of the Ophir mining district [Tooele County], Utah: Stanford Univ. M. A. thesis, 69 p., geol. map.

This report concerns a 2-mile-square area in the central, or Dry Canyon division, of the Ophir mining district on west side of Oquirrh Range. Exposed rocks include quartzite (Lower Cambrian ?); Ophir, Teutonic, Dagmar, Herkimer, Blue Bird, Cole Canyon and Opex Formations (Cambrian); Ajax (Ordovician); Pine Canyon, Humbug and Great Blue Formations (Mississippian); and a rhyolite porphyry occurring in dikes thought to be earlier than ore. Ophir mining district lies along major (northwest-dipping) axis of a northwest, southeast elongated quaquaversal anticline. Folding and associated thrusting were due to compressional stresses at close of Mesozoic.

The Dry Canyon division has produced generally a high-grade ore. Deposits are found in Ophir, Ajax, Pine Canyon, Humbug and Great Blue Formations. Ores occurring as replacement deposits are the most important. They consist of the sulfides galena, chalcopyrite, pyrite and sphalerite. Pipe and vein deposits also occur. Hypogene high- to intermediate-temperature solutions coming in along northeast-trending fissures accomplished the ore deposition. Cold meteoric solutions have partially altered the primary minerals.

Productive portion of area is complexly faulted, and many rich ore bodies terminate against faults. Development based upon maximum geological interpretation and minimum expense should result in production exceeding that in past. *B. C.*

352. MOLLAZAL, YAZDAN, 1961, Petrology and petrography of Ely Limestone in part of eastern Great Basin: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 8, p. 3-35.

Ely Limestone of Early to Medial Pennsylvanian age was studied in terms of carbonate petrology and petrography in three areas in the eastern Great Basin. Results are as follows: (1) At Moorman Ranch area, White Pine County, Nevada, reference section for Ely Limestone, the formation is approximately 1,700 feet thick and consists of limestones of these types: matrix, detrital-in-matrix, skeletal and combinations. These are unstable-shelf to miogeosynclinal varieties of relatively shallow water origin. (2) In the central Pequop Mountains of Elko County, Nevada, the Ely Limestone is 1,600 feet of argillaceous, silty, sandy matrix limestones and bioclastic limestones. Some chert-pebble conglomerates are present, and gypsiferous limestones are abundant. (3) The west side of Conger Mountain in the Confusion Range of western Utah contains a superb section of Ely Limestones, 2,000 feet thick and consisting largely of bioclastic and sandy limestones. A new classification of carbonate rocks is proposed.

Carbonates of Ely in these localities are micritic, aphanitic to finely crystalline, silty and sandy, and fine to coarsely bioclastic. Calcarenites are common, and pelletoid grains are abundant in some matrix limestones. Material that was swept into the Ely Basin came from the Antler orogenic belt, western Utah highland, and northern Nevada high. Numerous units within the Ely contain carbonates which have high interskeletal, intercrystalline, and interparticle porosity. Some rocks when broken emit hydrocarbon odors. Some sequences display repetitive intercalations of lithoclastic and bioclastic strata; many possibly accumulated on unstable shelves and within a miogeosyncline. *Author abstract*

353. MOLLOY, MARTIN WILLIAM, 1960, Tertiary volcanism in the Tushar Range [Piute County], Utah: (1) X-ray spectrochemical analysis: an application to certain light elements in clay minerals and volcanic glass. (2) Diffractometer patterns of A. P. I. reference clay minerals. (3) The Tushar uranium area, Marysvale, Utah: Columbia Univ. Ph. D. thesis.
(Abs.): Dissert. Abs., v. 21, No. 11, p. 3422, 1961.

A thick sequence of late Tertiary volcanic tuff covers large portions of the Tushar Plateau in south central Utah, while rhyolite of similar age fills parts of the Sevier River Valley to the east. Mines along the valley are producing uranium ore from deposits genetically related to the tuff and rhyolite. The threefold relationship of mountain tuff, valley rhyolite and uranium mineralization has been investigated by field mapping and laboratory study of the Mt. Belknap volcanic series.

In the field, changes in volcanic stratigraphy of the units and the interfingering of regional tuff with local valley rhyolites between the 12,000-foot crests of the Tushar Range and 6,000-foot Sevier River Valley below are shown. In the laboratory, X-ray spectrochemical (fluorescence) analyses of the rhyolite, glass and tuff emphasize the limited compositional range and indicate that these units were derived from a uniform magma. Differences in potassium and calcium content support the distinction between Mountain and valley units and provide information on the glassy dikes which are associated with uranium ore in the Marysvale mines. Iron, titanium, aluminum and calcium are enriched in clay alteration zones, while phosphorus and silica are removed.

Thin section and clay mineral investigations yield additional insight into the primary structures of volcanic units and their chemical and mineralogical reaction to alteration. Compaction, intergradation and flow-folding suggest unusual modes of air-fall aggregation and gravity slumping for the emplacement of some of the volcanic units. Zeolites, silica and feldspar represent primary alteration features. Variations in kaolinite, montmorillonite, illite, and mixed-layer clay alteration suite are responsive to the intensity of alteration along fracture zones.
Part 3 of author abstract

354. MORIN, WILBUR JOSEPH, 1963, Foundation conditions, Cart Creek Bridge, Daggett County, Utah: Univ. of Utah M. S. thesis, 55 p., geol. map.

Thrust loads imposed by the 550-foot arch bridge spanning Cart Creek one mile southwest of Flaming Gorge Dam required thorough foundation investigation of abutment areas. Exposed rocks are highly fractured quartzitic sandstone with interbedded shale (Precambrian Uinta Mountain Group) and sandstone and conglomerate (Tertiary Browns Park Formation).

Exploratory holes were drilled to determine rock types and extent of fracturing at depth. In west abutment blocks of quartzitic sandstone were loosened by weathering and partial removal of underlying shale. Rock in the east was highly fractured to depths of 70 feet. Selected core sections were tested for unconfined compressive strength. Maximum compression of each abutment due to structure load was estimated as 0.02 inches. To prevent movement along or perpendicular to open fractures, four drilled-in columns were provided extending 50 feet beyond base of each footing along bearing and inclination of thrust reaction.

Excavation confirmed predictions in west abutment. In east, a one-foot fracture, east of spring line necessitated deepening north footing. Three additional drilled-in columns (total of seven) were provided for each footing in east abutment because of the highly fractured rock. *Abstract revised (B. Y. S.)*

355. MORRIS, ELLIOT C., 1953, Geology of the Big Piney area, Summit County, Utah: Univ. of Utah M. S. thesis, 66 p., geol. map.

The Big Piney Mountain area (Coalville quadrangle) contains the following sedimentary rocks: Woodside Shale, Thaynes Formation, Ankareh Shale, Shinarump Conglomerate, and Chinle Formation of Triassic age; Nugget Sandstone, Twin Creek, Preuss, Stump and Morrison Formations of Jurassic age; Kelvin Formation, Aspen Shale, Frontier and Wanship Formations of Cretaceous age; and Almy and Knight Formations of Tertiary age. Igneous rocks include andesite flows and a small intrusive dike which contains about 40 percent nepheline, 28 percent augite, and 25 percent phlopite, with accessory apatite, aegerine, and calcite. This is the first feldspathoid-bearing feldspar-free rock reported in the Uinta Mountains.

Cross folds of northeast trend (Wasatch Mountains) and east trend (Uinta Mountains) intersect in the area. The following history is inferred from the stratigraphy and structure: (1) Montanan stage: cross-folding of the Wasatch Mountains and reverse faulting, erosion of highlands and deposition of Wanship Formation. (2) Paleocene epoch: Initial arching of Uinta Mountains and tilting of previously formed structures, erosion of highlands and deposition of Almy Formation, continued uplift of Uinta Mountains causing overturning and thrusting along north flank, erosion of highlands and deposition of Knight Formation. (3) Eocene epoch: gentle folding of Knight Formation. *Abstract revised (B. Y. S.)*

356. MORRIS, HAL T., 1947, The igneous rocks of the East Tintic mining district [Tooele and Juab Counties]: Univ. of Utah M. S. thesis, 30 p.

Three distinct periods of volcanic activity are evident in the East Tintic district. The sequence of events in the igneous history of the area was: first, extrusion of latite upon a deeply dissected surface of Paleozoic strata; second, an erosion interval followed by extrusion of a quartz-latite series; third, extrusion of latites and trachyandesites following a second intravolcanic erosional period. Intrusive monzonites, latites and pebble breccias were contemporaneous with the latite extrusions. Structural and stratigraphic evidence indicates a Miocene age for the igneous activity. *Author abstract*

357. MOULTON, FLOYD C., 1951, Ground-water geology of Cedar Valley and western Utah Valley [Utah County]: Brigham Young Univ. M. S. thesis.

Boyden, T.A. and F.C. Moulton, Ground-water geology of southern and western Utah Valley, pt. 2, Western Utah Valley: Compass, v. 29, No. 1, p. 15-20.

This brief report contains a generalized fence diagram of sediments mainly of Lake Bonneville origin, prepared from well log data. It is the opinion of the writer that deep test wells, not necessarily exceeding 1,200 feet in depth, will penetrate untapped aquifers, some of which should have artesian flows. *B. C.*

358. MOUNT, DONALD LEE, 1952, Geology of the Wanship-Park City region [Summit County], Utah: Univ. of Utah M. S. thesis, 35 p., geol. map.

Study of the flanking sediments near Park City and sedimentary windows within volcanic rocks indicates a complex geologic history for the transition area between the Uinta and Wasatch Mountains. First stage of early Laramide orogeny (Montana phase) was represented by development of northeasterly-trending folding and thrusting, normal faulting (Dry Canyon fault), and deposition of "Wanship Formation." Second stage of early Laramide orogeny (Montana phase) caused initial arching of Uinta Mountains, high-angle reverse faulting (Cherry Canyon fault), and Silver Creek chaos (formed by thrusting or major landsliding after considerable erosion). During the middle Laramide orogeny (Paleocene) the Wasatch Group was deposited on highly contorted beds. During the late Laramide orogeny (Eocene) the Wasatch Group was gently folded and the main uplift of the Uinta Mountains occurred, accompanied by normal faulting along the flanks. The Absarokan orogeny was represented by vulcanism of regional and local extent and, subsequently, gentle folding of the volcanic rocks.

These events were followed by development of the Gilbert Peak and Herd Mountain surfaces. After epeirogenic uplift, the Weber Valley surface was formed by pedimentation. Finally block faulting to the west caused a minute regional tilt to the east. *Abstract revised (B. Y. S.)*

359. MOUSSA, MOHAMED MOUNIR TAWKIK, 1965, Geology of the Soldier Summit quadrangle [Carbon, Utah and Wasatch Counties], Utah: Univ. of Utah Ph. D. thesis, 192 p., geol. map.
(Abs.): Dissert. Abs., v. 26, No. 4, p. 2136, 1965.

In the 250-square-mile Soldier Summit quadrangle, central Utah, the Upper Cretaceous-lower Cenozoic nonmarine sequence is about 12,000 feet thick. The northern section, representative of Uinta Basin, includes (ascending) Colton, Green River and Uinta Formations. In the southern sequence, representative of Wasatch Plateau, two sections are differentiated. The eastern includes (ascending) Blackhawk, Castlegate, Price River, North Horn and Flagstaff Formations; the western contains a thick conglomerate between the Price River and North Horn Formations, here called the "Bennion Creek" Formation. Previously this conglomerate was considered a facies equivalent of the Price River Formation and Castlegate Sandstone.

Structurally the rocks are folded into northeast-plunging Clear Creek anticline, with Beaver Creek syncline on the southeast, and Tie Fork syncline on the northwest. Most important faults are the Pleasant Valley and Starvation Creek fault zones. A disconformity occurs between Price River and Bennion Creek Formations. In the area south of U.S. Highway 6-50, between Soldier Summit and Colton, secondary structures are developed in Flagstaff rocks by gliding of upper part of formation under influence of gravity. Crustal movements occurred during early Laramide orogeny and late Eocene to Miocene period of folding and normal faulting.

The area was a floodplain from Blackhawk through Bennion time. Lacustrine conditions encroached over the area in North Horn time and became widespread during Flagstaff time. In Colton time, the area was a floodplain with lacustrine conditons in the west. The area was part of Uinta Lake from Green River until probably Duchesne River time, except for time of deposition of fluviatile facies. Geomorphically, the area is divided into Flagstaff cuesta; Pleasant Valley, Dry Valley and Starvation Valley graben; Dry Valley horst ridge; west Starvation fault scarp; southeast Starvation ridge; the Green River hogbacks, and six canyons.
Abstract revised (B. Y. S. and B. C.)

360. MOYLE, RICHARD W., 1958, Paleoecology of the Manning Canyon Shale in central Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 5, No. 7, 86 p.

Five sections of Upper Mississippian and Lower Pennsylvanian Manning Canyon Shale range from 1,000-2,600 feet in thickness and average 1,500-1,600 feet. Shales predominate throughout: clay shales characterize lower 600 feet and silty shales and shaly limestones typify upper 900-1,000 feet. Lake Mountain section is the exception; quartzites, arkoses and subgraywackes comprise one-third of formation. Typical marine fossil assemblages, pelecypod and gastropod faunas, and plant remains suggest that fresh, brackish and shallow, warm, marine water conditions existed in central Utah during Manning Canyon time.

The sponges Talpaspongia clavata, Wewokella contorta, Wewokella solida, and Wewokella n. sp. are present in West Canyon, Soldier Canyon and Ophir Pass.

Study of Manning Canyon indicates three regressions, two transgressions, and many minor climatic and depositional changes. Formation thickens and size of clastics increases to east. Conclusive evidence of Mississippian-Pennsylvanian boundary was not found; however, it is tentatively placed above a fossiliferous limestone zone about 575 feet above the base of formation and below a plant zone within the interbedded shales and quartzites 700 feet above the base.
Abstract revised (B. C.)

361. MUDGETT, PHILIP MICHAEL, 1964, Regional gravity survey of parts of Beaver and Millard Counties, Utah: Univ. of Utah M. S. thesis (copyright 1968).

During June through September 1962, a regional gravity survey was made in parts of Beaver and Millard Counties, Utah. A total of 197 gravity stations as established in an area of approximately 1,400 square miles. The results were compiled on a Bouquer gravity anomaly map with a contour interval of 2 milligals, and on an interpretive geologic cross section across the surveyed region.

A broad regional gravity high with a northeastward-trending axis essentially coincides with the Sevier arch of late Mesozoic age.

The gravity data confirm the Basin-and-Range structures in the surveyed area. Four northward-trending grabens were delineated by gravity anomalies. From west to east, they are designated, respectively, the Pine Valley, Wah Wah Valley, Big Wash, and Milford Valley grabens. The valley fill in these grabens, of Cenozoic age, has an indicated maximum depth of 5,500 feet, for an assumed density contrast of 0.5 gm/cc between the valley fill and the underlying bedrock of Mesozoic and Paleozoic age. This maximum depth is indicated on the east side of the Milford Valley graben.
Author abstract

362. MUESSIG, SIEGFRIED JOSEPH, 1951, Geology of a part of Long Ridge [Utah and Juab Counties], Utah: Ohio State Univ. Ph. D. thesis, 213 p., geol. map.

Long Ridge is an isolated linear north-south range in Utah and Juab Counties. At least 25,000 feet of bedrock from Precambrian (?) to middle (?) Tertiary is exposed: Precambrian (?) Cottonwood slates, Cambrian Tintic Quartzite, Ophir Formation, Teutonic Limestone, Dagmar Limestone, Herkimer Limestone, Bluebird Dolomite, Cole Canyon Dolomite, Opex Dolomite; Ordovician Ajax Dolomite (including Emerald Dolomite Member), Opohonga Limestone; Ordovician and Silurian Bluebell Dolomite; Devonian Victoria Quartzite; Devonian and Mississippian Gardner Dolomite (containing Lower Mississippian fauna); Mississippian Pine Canyon Limestone, Humbug Formation; Pennsylvanian and Permian Oquirrh Formation; Permian Diamond Creek Sandstone, Park City Formation; covered interval; Triassic Ankareh Shale; Jurassic Nugget Sandstone; covered interval (unconformity); Cretaceous (?) and Tertiary North Horn Formation; Tertiary Flagstaff Formation, Green River Formation (middle Eocene), and Golden's Ranch Formation (volcanic conglomerate, tuff, bentonite, and sandstone with several interbedded flows) which contains middle Eocene flora in the Sage Valley Limestone Member. Wide Canyon Conglomerate overlies the North Horn and Flagstaff Formations with angular unconformity, and is probably post-Eocene. North Horn is gradational with Flagstaff, and Golden's Ranch is gradational with Green River, but to west of area of exposure of Green River Formation, volcanic sediments overlie all older formations unconformably.

The Laguna Latite Series (volcanic breccia with interbedded andesite flows) unconformably overlies Paleozoic strata north of Dog Valley Pass. A small exposure reveals Packard Quartz Latite beneath it.

The range consists of complexly folded and faulted pre-Laramide (Precambrian ? to Jurassic) rocks which are overlain by relatively unfolded but considerably faulted late Upper Cretaceous and Tertiary strata. Basin-Range faults outline the western and northwestern side; Juab Valley, a structural valley, outlines the eastern side. A normal fault is probably present along the eastern side of Long Ridge from Haycock Canyon area southward to Lamson Canyon area. Southward from Levan Pass, Long Ridge consists of two hogbacks of homoclinally eastward-dipping Tertiary rocks. *B. C.*

363. MURANY, ERNEST ELMER, 1963, Subsurface stratigraphy of the Wasatch Formation of the Uinta Basin, Utah: Univ. of Utah Ph. D. thesis, 121 p.
(Abs.): Dissert. Abs., v. 24, No. 4, p. 1576-1577.

The upper portion of the Wasatch Formation interfingers with the black shale facies, Green River Formation; the lower portion, with the North Horn and Tuschar Formations. To the west (Red Narrows-Thistle-Soldier Summit area) the correlation of the Wasatch is in doubt. In the north and east, the Wasatch (less than 1,000 feet thick) is unconformably overlain by Green River Formation, and underlain by Mesaverde Group (Late Cretaceous). The Wasatch thins southward to 75 feet of sandstones and shales in the San Arroyo area.

The "Colton Formation" should be reduced to the Colton Tongue of the Wasatch Formation, and the Tuscher Formation (not recognizable in subsurface) should be considered the basal member of the Wasatch. The lacustrine ostracodal and oolitic limestones near the top of the Wasatch should be considered part of black shale facies of Green River Formation. The Wasatch is considered to be an accumulation of continental fluviatile sediments up to nearly 3,000 feet thick in center of basin, and consisting dominantly of red-brown shale and fine-grained subgraywacke sandstone, with great lateral variation. It can be divided roughly into upper shale, Chapita, and lower shale zones.

Area now occupied by Uinta Mountains and Uncompahgre high, and possibly Wasatch Mountains, acted as source area for sediments of Wasatch Formation. Source of Colton sediments was perhaps to the east, due to westward thinning and interfingering with Green River Formation.

Green River Lake may have had inception with rise of Douglas Creek arch in post-Wasatch, early Green River time, when climate was thought to have been subtropical.

Oil and gas in the Wasatch is thought to be indigenous. Gas is produced in commercial quantities from the Chapita Wells, Ute-Trail, Rock House, Island, and Uinta units. *B. Y. S. and B. C.*

364. MURPHY, DON R., 1954, Fauna of the Morrowan rocks of central Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 1, No. 3, 64 p.

This report concerns the invertebrate fossils found in the rocks of Morrowan age in central Utah. Forty-five species, which are divided into five phyla, are described. A sixth phylum, echinodermata, is present in the form of crinoid stem fragments but no specific identifications are made. Forty-two species have been photographed and are presented on plates I to IV.

The central Utah fauna is compared with faunas of known equivalent age in the Rocky Mountains, Great Basin, and midwestern United States. When compared with other Rocky Mountain and Great Basin faunas, the brachiopods appear to maintain the greatest stratigraphic value. When compared with faunas of Morrowan age in midwestern United States a difference in depositional conditions between the Midwest area and the Rocky Mountain-Great Basin area is suggested.

A discussion of each measured section is presented with mention made of the characteristic fossil assemblages which occur.

Several biofacies are discussed and it is concluded that several different biocoenoses and thanatocoenoses are responsible for the deposition of the Morrowan rocks. *Author abstract*

365. MYERS, RICHARD LEE, 1955, Magnetic profiles in the central Wasatch region, Utah: Univ. of Utah M. S. thesis, 40 p.

Magnetic traverses totaling 46 miles were taken through the Cottonwood mining district and across Jordan Valley. Contact magnetite deposits, which are only indirectly related to ore deposits, are believed responsible for magnetic anomalies up to 1,700 gammas in the area of Little Cottonwood and Alta stocks. Noticeable anomalies of several hundred gammas are observed over hematite-stained fracture zones in areas of mining concentration. Regional drop in readings observed adjacent to Alta stock may indicate shallow intrusive; a negative anomaly of 500 gammas observed near center of Little Cottonwood stock may be due to lack of magnetic susceptibility or to inverse remnant magnetism. Granitic outwash is responsible for readings of about 75 gammas above the normal in the center of the Jordan Valley, 5 miles west of the mouth of Little Cottonwood Canyon.

A traverse in Farmington Canyon and Jordan Valley revealed a negative tendency of several hundred gammas over the Farmington Complex. The cause is unknown, but it may be due to metamorphic rocks or an underlying intrusive. Dikes in the Farmington Complex caused larger anomalies than did dikes in Cottonwood district. A negative tendency was observed along Wasatch front as opposed to normal readings of valley. *Abstract revised (B. C.)*

366. NAGEL, FRITZ G., 1952, Regional stratigraphic analysis of Upper Cretaceous rocks of Rocky Mountain region and adjacent areas: Northwestern Univ. M. S. thesis, 122 p.

_____ and W.C. Krumbein, 1953, Regional stratigraphic analysis of "Upper Cretaceous" rocks of Rocky Mountain region: Am. Assoc. Petroleum Geologists Bull., v. 37, No. 5, p. 940-960.

Lithologic and thickness data on the "Upper Cretaceous" rocks of the western states were collected in the field and from the literature. The data were arranged into isopach-lithofacies maps showing average lithology of the total interval, and of the Dakota-Colorado and Montana-Laramie Groups. Vertical variability maps of the number of sandstones in the units were also prepared.

The isopach-lithofacies maps indicate a general thickening and increasing sand content in all units from east to west. The facies lines are roughly parallel with the isopachs, and suggest a general westerly source for most of the sediments, although local sources were operative at times. The number of sandstone beds is greatest along an intermediate belt, indicating a major intertonguing of sand and shale in the general area of the average shoreline trend.

Detailed study of sand and shale lithology in sections from Arizona, New Mexico, and southwestern Colorado indicates that most of the sands are relarively clean subgraywackes, decreasing in angular components northeastward. The shales are mainly silty, and the association of lithologic types suggests unstable shelf conditions over most of the area. *Published abstract*

367. NARANS, HARRY DONALD, Jr., 1959, Sub-basement seismic reflections in northern Utah: Univ. of Utah M. S. thesis, 71 p.

_____ J.W. Berg, Jr., and K.L. Cook, 1961, Subbasement seismic reflections in northern Utah: Jour. Geophys. Research, v. 66, No. 2, p. 599-603.

In September 1958, seismic experiments were conducted in the Rozel Hills area of northern Utah near the shore of the Great Salt Lake to determine the possibility of obtaining sub-basement reflections at normal incidence with small charges. A conventional multiple-trace seismograph was used to record the energy from 15 charges ranging from 59 lb. to 300 lb. Various instrument settings, geophones, and spreads were used to determine the optimum recording technique. Low signal-to-noise ratios in the resulting records necessitated the application of a method of statistics to differentiate between reflections and noise.

On December 20, 1958, a record of reflections at normal incidence was obtained from a quarry blast of 490,500 lb of explosive at Promontory, Utah. This site was located 20 miles southeast of the Rozel Hills site. Similar instrumentation was employed at this site.

Although the interpretation was hampered by low signal-to-noise ratios and the presence of multiple reflections, reflected events, yielding depths of approximately 8.5 km and 26.3 km, were obtained at both sites. The depths computed for the horizons found in this thesis were in agreement with depths derived from the Promontory refraction project of the University of Utah Geophysics Department. *Author abstract*

368. NEFF, THOMAS RODNEY, 1963, Petrology and structure of

the Little Willow Series, Wasatch Mountains, Utah: Univ. of Utah M. S. thesis, 83 p., geol. map.

Little Willow Series is a Middle (?) Precambrian metamorphic complex consisting of mica schist, quartzo-feldspathic schist, banded gneiss meta-conglomerate, quartzite and amphibolite produced dynamo-thermal metamorphism of the epidote-amphibolite facies from fluvial shales, quartzo-feldspathic sandstones, conglomerates and impure dolomites or basic dikes. Foliation strikes northeast and dips steeply northwest. Small (1-3 feet long by 2-6 inches wide) lenticular quartz pegmatites are scattered throughout the Little Willow Series and larger (5-10 feet long by 2-3 feet wide) partially zoned quartz-feldspar-mica pegmatites are present in the southeast part of area. Unconformably overlying the Little Willow Series are massive quartzites of the Big Cottonwood Series, correlated with the Upper Precambrian Uinta Mountain Group.

Late Cretaceous folding was followed by latest Cretaceous and early Paleocene thrusting along the unconformity separating Big Cottonwood and Little Willow Series. During Middle Eocene time, quartz monzonite was intruded into the Little Willow metasediments and the Big Cottonwood quartzites. Heat derived from the magma produced andalusite at the expense of muscovite. Later potassium- and sodium-bearing solutions derived from the magma produced feldspars at the expense of andalusite and muscovite. Mineralized veins, pegmatites and an aplite dike that cut the Little Willow metasediments probably represent differentiates derived from the quartz monzonite magma. *Abstract revised (B. C.)*

369. NELSON, ROBERT B., 1959, The stratigraphy and structure of the northernmost part of the northern Snake Range and the Kern Mountains in eastern Nevada and the southern Deep Creek Range in western Utah: Univ. of Washington Ph. D. thesis, 165 p., geol. map.
(Abs.): Dissert. Abs., v. 20, No. 3, p. 996-997, 1959.

This area is in a north-south-trending mountainous belt which lies near the middle of the Great Basin. This paper deals principally with the pre-Mesozoic stratigraphic section in this, a central segment of the avolcanic eastern portion of the Cordilleran geosyncline, and the orogenic features developed from these rocks during the late Mesozoic and possibly also the earliest Tertiary.

The main orogeny in this part of the Great Basin is marked by large-scale thrust masses moving toward the southeast which have pushed the thick sedimentary cover over the underlying metamorphic basement complex. In the area studied, the décollement plane between these is well exposed. The lower plane has locally been intensely deformed, and many thousands of feet of the metasedimentary section has apparently been tectonically removed during thrusting. This was accompanied by a mineralogical retrogression of those metasediments near the thrust plane. Parallel to this décollement plane, a sheet of schistose, mylonitic marble was developed that is discordant to both the rocks below and above. In a later stage this marble was plastically folded and intruded by small stringers of granitic magma. The upper plate of the décollement thrust contains characteristic deformational patterns such as imbricate slicing, thrusting, tear faulting, and development of an east-northerly trending, large-scale transverse fold.

After the main orogeny, and after a subsequent period of erosion, a thick sequence of probably Early Tertiary sediments and "ignimbrites" was deposited, with minor accompanying deformation. The series was then turned nearly on end, possibly accompanied by emplacement of large quartz-monzonitic masses. Two are exposed in the area mapped, at center of Kern Mountains and Deep Creek Range, and are aligned parallel to the north-northeasterly structural trend. They are both bordered on the north by faults that are perpendicular to this trend. *Abstract revised (B. C.)*

370. NELSON, WILLIS HOWARD, 1950, Petrology of early Tertiary volcanic rocks in the Iron Springs district [Iron County], Utah: Univ. of Washington M. S. thesis, 42 p.

Iron Springs district lies in Great Basin just west of Hurricane fault. Cretaceous (?) Iron Springs Formation was deposited disconformably upon Jurassic Homestake and "Entrada" Formations. Strong deformation occurred in a narrow belt trending N. 30° E., and the Claron Formation (Late Cretaceous or early Eocene) was deposited unconformably upon truncated Iron Springs strata. Following volcanism, laccolithic intrusions were emplaced within belt of pre-Claron deformation, concordant at base of Homestake. Magnetite-hematite ore bodies have replaced the Homestake in places.

Volcanic sequence, base to top, consists of lower rhyolite tuff, quartz latite lava, middle rhyolite tuff, upper rhyolite tuff, biotite dacite tuff and undifferentiated tuffs. Conformity with Claron and occurrence of Claron-like gravels between higher units indicates a late Claron (probable early Eocene) age for the volcanics.

All the volcanic units except the quartz latite lava are tuffs deposited from nuée ardente-type volcanic eruptions. The tuffs were erupted from several different vents, and the individual eruptions occurred in rapid succession. Some tuffaceous material was lithified by compaction and devitrification some time after it was laid down, while some was welded by its own heat at the time of deposition. These welded deposits could properly be called welded tuffs or "ignimbrites."

B. C. (in part from summary of conclusions)

371. NIELSEN, MERRILL L., 1950, Mississippian cephalopods from [Confusion Range, Millard County] western Utah: Idaho Coll. of Mines (Moscow) M. S. thesis, 39 p.

About 400 cephalopods were collected from a shale zone in the Mississippian rocks in the Confusion Range of western Utah during the summer of 1949. This cephalopod fauna includes specimens referable to the genera Mooreoceras, Pseudorthoceras, Bactrities, Goniatites, Lyrogoniatites, Neoglyphioceras, Girtyoceras, Dimorphoceras and Epicanites. Two new species referable respectively to Lyrogoniatites and Epicanites are described and illustrated along with representative specimens of the other genera. A small collection of pelecypods associated with the cephalopods are also considered in the present report. On the basis of the fossil evidence the containing beds are regarded as of about middle Meramec age and approximately equivalent to the cephalopod-bearing beds of the Heath Formation of Montana; the White Pine Shale of Nevada (and California), the Helms and Barnett Formations of Texas, the Caney Shale of Oklahoma, Moorefield, Ruddell, Batesville, and Fayetteville beds of Arkansas, "Meramec" beds of Kentucky, and the Floyd Shale of Georgia. With relation to the well-known Carboniferous section of Europe, our fauna seems to be most nearly like that of the upper Visean.

Author abstract

372. NIELSEN, MITCHELL, F., 1957, Some late Mississippian pleurotomarian gastropods from Nevada and Utah: Univ. of Nebraska M. S. thesis, 43 p.

Statistical methods were used to compare the ornamental features, number of whorls, and other diagnostic changes which occur during ontogenetic development. The most intensive quantitative study was made on pleurotomarian gastropods, including two new species of Glabrocingulum, G. binodum and G. ferebimun, and a new species of Neilsonia N. costatus. Also identified were Neilsonia sp. a new form too poorly preserved to be a type, Worthenia tenuilineata Girty, Soleniscus (Soleniscus) typicus Meek and Worthen, and Trepospira depressa? Cox.

The gastropods studied were collected from various stratigraphic positions of the Chainman Formation, about 1,800 feet of dark-gray to black shale, exposed in western Utah and eastern Nevada. The study indicates that gastropods can be successfully used as guide fossils. The new forms of Neilsonia appear in the Goniatites zone of the lower Chainman Formation. Glabrocingulum ferebinum replaces G. grayvillense (Norwood and Pratton) as the oldest known glabrocingulid in North America, and it is limited to the upper Chainman Formation with Eumorphoceras bisulcatum. Glabrocingulum and Neilsonia occur later in the geologic column in Utah and Nevada than in Scotland.

Author summary and introduction revised (B. C.)

373. NIKRAVESH, RASHEL, 1963, The microfauna of the type Allen Valley Shale (Upper Cretaceous), Sanpete County, Utah: Ohio State Univ. M. S. thesis, 54 p.

Twenty-one foraminiferal and one ostracodal species are described and illustrated from the type Allen Valley Shale (Upper Cretaceous) of Utah. These species show similarities with faunas of the Frontier Formation of southwestern Wyoming and northeastern Utah and with those of the upper Greenhorn Limestone and Carlile Shale of the Great Plains.

The faunal assemblages yield data in regard to depth, salinity, pH, and temperature of the Mancos sea in which the Allen Valley Shale was deposited. Distribution of the foraminifers is not uniform throughout the formation; ostracodes are found only in the lower 75 feet of the formation. *Author abstract*

374. NOHARA, TOMOHIDE, 1966, Microfauna of the upper Mississippian Great Blue Limestone near Morgan [Morgan County], Utah: Univ. of Utah M. S. thesis, 84 p.

The Great Blue Limestone north of U.S. Highway 30 South, about $1\frac{1}{2}$ miles northeast of Morgan, Utah, consists of about 900 feet of dark-gray to bluish-gray limestone which includes a bluish-gray shale unit 85 feet thick. Forty species of Ostracoda belonging to 26 genera (1 new), 3 species of Foraminifera belonging to 3 genera, and 1 species of Bryozoa are figured and described. Fossil specimens are poorly preserved, and most were collected about 400 feet above the base of the formation. Paleoecologic study indicates that the fauna is marine benthonic, representing littoral to shallow neritic environment.

Ostracod assemblage is dominated by genus Bythocypris. Species of Aechminella, Amphissites, Healdia, Monoceratina, ? Perprimitia, and Polytylites are less abundant. Chesterella ? exuta Croneis and Gutke, C.? fissurata Croneis and Gutke, and Beyrichiopsis spinosa (Croneis and Bristol) are known elsewhere only from the upper Chesteran. The ostracod assemblage is closely related in age and morphology to the Chester fauna of Illinois.

This study indicates that Perprimitia (?) morganensis n. sp. is sexually dimorphic.

Abstract revised (B. C.)

375. NOKES, CHARLES MORMON, Jr., 1912, The igneous rocks of Utah: Univ. of Utah M. S. thesis, 43 p.

In Utah the chief feldspars are orthoclase, sanadine, anorthoclase and microcline; the feldspathoids -- nephelite, sodalite and leucite. Glasses here are very common and are represented in the Iron County obsidian, the Millard County scoria, and the basaltic flows at the northern part of Utah. Rhyolites are very numerous and occur chiefly as dykes and in connection with other igneous intrusions. The rhyolites of Bingham, Tintic, Ophir and Little Cottonwood Canyon are the important formations. The granites represent by far the most important igneous rocks of Utah. The great intrusions of the Wasatch Range stand out as headliners in the petrographical column. Trachytes too are common but less so than the granites. Beaver, Wasatch, Eureka, Traverse Mountains, Park City and Bingham contribute the trachyte type. Syenites are very scarce, one being known in Millard County. Typical phonolites and nephelite syenites are unknown. The dacite group, which is rich in the plagioclase minerals and containing quartz is wanting. Quartz diorites are rare. Andesites are well represented in Eureka, Traverse Mountains, Ophir, Wasatch County, Park City and the Uinta Range. Diorites are not few in number. Basalts are represented in the flows at northern Utah and gabbros are not found within the province.

From author conclusion

376. NOLAN, GRACE MARGARET, 1950, Sedimentation of the (Pennsylvanian) Oquirrh Formation, West Mountain [Utah County], Utah: Brigham Young Univ. M. A. thesis, 39 p.

West Mountain is a north-south-trending ridge about 8 miles long by $2\frac{1}{2}$ miles wide in southern Utah Valley composed of nearly vertical sedimentary strata which strike N. 25° E. The Oquirrh Formation, which makes up most of West Mountain, consists of about 11,040 feet of beds which are mostly limestones of various types. Age of the formation has been determined on the basis of the fusulinid fauna and includes representatives of the Atokan, Desmoinesian, Missourian, Virgilian and Wolfcampian stages. *B. C.*

377. NOVOTNY, ROBERT THOMAS, 1958, A gravity and magnetic study of Antelope Island, Great Salt Lake, Davis County, Utah: Univ. of Utah M. S. thesis, 24 p.

About 160 square miles were the subject of a survey which included 146 gravity stations and 9 magnetic traverses; a Bouguer anomaly map with 2 milligal contour interval was constructed from the gravity data. Highest and lowest Bouguer gravity values are -128 and -166 milligals, respectively. Two principal areas of anomaly occupy most of the region surveyed. The Antelope Island gravity high extends northward to Fremont Island and is believed to be caused by Precambrian crystalline rocks which form part of the northern Utah highland. A gravity low occurs east of the island. Two theoretical gravity profiles were computed across the latter area using a two-dimensional graticule and an assumed density contrast of 0.4 between bedrock and Tertiary-Quaternary rocks. A graben is inferred which has an average depth of 8,000 feet and is bounded on both sides by high-angle step faults. Trending slightly west of north, it terminates southward beyond the surveyed area and northward in the vicinity of Seagull Point. A minor high indicates a probable raised bedrock surface lying east of the inferred graben at a depth of about 1,000 feet.

The magnetic investigation was confined principally to the east side of the island and supports conclusions drawn from gravity data.

Abstract revised (B. C.)

378. NYGREEN, PAUL W., 1955, Stratigraphy of the lower Oquirrh Formation in the type area and near Logan, Utah: Univ. of Nebraska M. S. thesis, 79 p.

_____ 1958, The Oquirrh Formation -- stratigraphy of the lower portion in the type area and near Logan, Utah: Utah Geol. and Mineralog. Survey Bull. 61, 67 p.

Detailed descriptions of the thick (26,000 feet) Pennsylvanian-Permian Oquirrh Formation are lacking. Detailed study of the lowermost portion reveals the formation is divisible into at least two members. The lower limestone member (West Canyon Member) is 1,456 feet thick in the type area and 510 feet thick near Logan. The "sandy" member constitutes the upper part of the formation. Studied in detail were 3,663 feet of this upper member in the Oquirrh Mountains and 1,121 feet near Logan.

Despite a very limited number of lithologic types, the formation is far from monotonous in sedimentary character. Remarkable bipartite cycles and various rhythmic patterns characterize the "sandy" member and are described in detail. Fusulinid occurrences indicate a preferred placement within the sedimentary cycles. Other sedimentary features include cross-bedding, pseudobreccias, ripple marks, slump structures, and graded bedding.

An important lower Pennsylvanian Chaetetes zone is present and an age zonation, based on fusulinids, is presented. Morrow and lower Desmoines (Krebs Group) age rocks are present. No Atokan fusulinids were found although rocks of this age are probably present.

Near Logan, the presence of the Desmoines fusulinid Wedekindellina in beds previously dated as

Morrow corrects this error. Correlations are made with lower Pennsylvanian formations of the Rocky Mountains. *Published abstract*

379. ODEKIRK, JERRY RAY, 1963, Lead-alpha age determinations of five Utah rocks: Univ. of Utah M. S. thesis, 31 p.

Zircons from five rocks in Utah were dated by the lead-alpha method with the following results:

Location	Rock-Type	Age (m.y.)	Geologic Age
Ogden Canyon	Granite Gneiss	1582	Precambrian
Weber Canyon	Granite Gneiss	674	Precambrian
Desert Mountain	Leuco-granite	36	Oligocene
Desert Mountain	Hornblende Biotite Granite	41	Oligocene
Sheeprock Mountains	Granite	13	Miocene

Details of the procedures used are described.

The age of the zircons in the gneisses may represent the age of zircons in the Precambrian rock which was metamorphosed, the age of metamorphism, or some intermediate age.

Considering the precision and accuracy of the lead-alpha method, the two intrusions of Desert Mountain must be considered contemporaneous. However, field evidence and petrographic data indicate that the dark hornblende biotite granite represents inclusions in the magma which formed the leucogranite.

The Sheeprock granite was dated by the U.S. Geological Survey by the lead-alpha method and gave dates of 15 and 20 m.y. The date of 13 m.y. obtained by the writer is within the precision and accuracy of this method. *Author abstract*

380. OGDEN, LAWRENCE, 1950, Mississippian and Pennsylvanian stratigraphy, Confusion Range [Millard County], west central Utah: Univ. of Wisconsin M. S. thesis.

______ 1951, Mississippian and Pennsylvanian stratigraphy, Confusion Range, west central Utah: Am. Assoc. Petroleum Geologists Bull., v. 35, No. 1, p. 62-82.

The stratigraphic column in the Confusion Range extends from Ordovician (?) through Triassic. Mississippian and Pennsylvanian strata were studied in detail and one composite section was diagrammed.

Slightly more than 6,000 feet of Devonian strata were recognized. They consist for the most part of massive, black limestone beds containing an Upper Devonian fauna. The massive limestone beds are overlain by shaly limestone beds that contain a Cyrtospirifer fauna.

The Mississippian System is represented by only 260 feet of strata, assigned to the Midridge Formation, that appear to be correlative with some part of the Mission Canyon Formation of Montana. No rocks of Burlington, Keokuk, Meramec, and Chester ages were found in the area.

The Pennsylvanian System consists of slightly more than 3,700 feet of sediments that contain an abundant, well-preserved fauna of Morrow age. The Pennsylvanian sediments are cyclic and are interpreted to indicate gradual submergence of the area. Beds in the lower part of the Morrow sequence have heretofore been assigned to the Mississippian. *Published abstract*

381. OKERLUND, MAESER D., 1951, A study of the calcite-aragonite deposits of Lake Mountain, Utah County, Utah: Brigham Young Univ. M. S. thesis.

______ 1951, Geology of the calcite-aragonite deposits of Lake Mountain, Utah: Compass, v. 29, No. 1, p. 64-72, geol. map.

This report is based upon a study of a portion of the Pelican Hills about 4 square miles in area, lying immediately west of Utah Lake. The exposed rocks are sedimentary in origin and have a total thickness of about 4,000 feet or more. They are divided into the Deseret Limestone, Humbug Formation, Great Blue Limestone and Manning Canyon Shale of Upper Mississippian age, and Quaternary sediments.

Mineralization of calcite and aragonite occurs in veins associated with normal and reverse faults, some associated with folding and thrusting, and some with Basin-Range block faulting. Seven mineral veins were mapped, of which three have been mined. Hydrothermal deposition of calcite followed the faulting. Secondary faulting occurred, and the resulting fissures were partially filled with aragonite. Openings formed by secondary faulting provided a channel for ground water and allowed the formation of solution cavities, elongated parallel to and along the zone of secondary faulting. Calcite and aragonite were identified by cleavage and interference figures, and partial paramorphism was found in some fragments studied. This is explained by the extremely slow rate of transformation of aragonite to calcite under ordinary dry conditions. *Abstract of published article (B. C.)*

382. OLSEN, BEN L., 1955, Geology of the Baldy area, west slope of Mount Timpanogos, Utah County, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 2, No. 2, 30 p., geol. map.

The stratigraphic sequence in this area totals approximately 8,435 feet, and consists of parts of three marine Paleozoic formations. The Great Blue Limestone and lower Manning Canyon Shale are Mississippian, the upper Manning Canyon Shale and Oquirrh Formation being Pennsylvanian. Tertiary (?) and Quaternary fanglomerates and landslide debris, Pleistocene lacustrine deposits, and Recent alluvium lie upon or overlap older rocks.

Structurally the Baldy area is situated on an allochthon of the Deer Creek thrust plate, which moved eastward during the early Laramide orogeny. The folds and thrust faults in the mapped area are minor structures that formed on the eastward-moving plate. Post-thrusting normal faults along the western margin of the area have displaced strata thousands of feet. The lower escarpment along the Wasatch front has resulted from continued movements along these normal faults since Eocene time.

The area contains few materials of economic value. Water constitutes the most valuable resource in the area. Springs not only provide water for irrigation and culinary purposes in cities adjacent to the area, but also supply water power for a powerhouse. No mining is being carried on, nor is there promise of future development. *From author abstract*

383. OLSEN, DONALD R., 1951, A differential thermal, X-ray, and optical analysis of some chlorites: Univ. of Utah M. S. thesis, 26 p.

Of the ten chlorites analyzed in this report, specimen No. 1, jefferisite, is from the Doctor claim, Clifton district, Utah. *B. C.*

384. OLSON, RICHARD HUBBELL, 1960, Geology of the Promontory Range, Box Elder County, Utah: Univ. of Utah Ph. D. thesis, geol. map.
(Abs.): Dissert. Abs., v. 21, No. 9, p. 2676, 1961.

_____ 1956, Geology of the Promontory Range: Utah Geol. Soc. Guidebook to the geology of Utah, No. 11, p. 41-75, geol. map.

The Promontory Range consists of Precambrian phyllite, shale, mafic extrusives, quartzite (7,443+ feet); Cambrian quartzite, calcareous siltstone, limestone, dolomite (10,762+ feet); Ordovician limestone, shale, quartzite, dolomite (2,992+ feet); Silurian dolomite (757 feet); Devonian (predominantly) dolomite (1,576+ feet); Mississippian limestone, calcareous orthoquartzite, sandstone, shale (2,619+ feet); Mississippian-Pennsylvanian quartzite, shale (1,088+ feet); Pennsylvanian - Permian limestone, calcareous orthoquartzite, shale (3,213+ feet); and Pleistocene gravel, sand, silt, clay (1,000+ feet). Major unconformities occur at the base of Upper Ordovician, Lower Mississippian and Pleistocene.

Metamorphism of higher grade than that of the greenschist facies has not been recognized. The Precambrian stratigraphic sequence, the carbonate strata in the lower plate of an overthrust fault, and the argillaceous Mississippian-Pennsylvanian strata in the northern part of the range have been subjected to pervasive low-grade metamorphism, but on the whole metamorphism is relatively unimportant in the rocks of the Promontory Range.

A northeast-southwest high-angle fault divides the Promontory Range into northern and southern structural blocks. The characteristic structural features are large fault blocks bounded by high-angle faults. Folding is minor, except in the northern portion of the range. One overthrust fault has been recognized in the west central portion of the area. It is the oldest structural feature in the Promontory Range.

The Laramide orogeny is represented by (1) evidences of overthrusting, presumably from the west, by (2) tight, locally overturned folds which trend approximately north-south, and by (3) minor high-angle reverse faults and major high-angle normal faults. This later faulting has an approximate north-south and east-west pattern and has formed large tilted fault blocks, mostly without strong topographic expression. Gravity surveys indicate that border faults exist below the alluvium along the western and eastern sides of the range. *Abstract revised (B. C.)*

385. ORNELAS, RICHARD HENRY, 1953, Clay deposits of Utah County, Utah: Brigham Young Univ. M. S. thesis, 80 p., geol. map.

The clay deposits of Utah County are divided into four general groups, namely: Manning Canyon Shale deposits, Great Blue Limestone deposits, alteration deposits, and miscellaneous deposits. Samples from most of the deposits were collected and fired to various temperatures, and the results are tabulated.

Extensive outcrops of the Mississippian-Pennsylvanian Manning Canyon Shale are found in the Wasatch, Lake and Oquirrh Mountains. The formation, approximately 80 percent shale, is the most important clay-producing geologic unit in Utah County. Sixteen claims in the Manning Canyon are described. There are no commercial clay workings in this formation in the Wasatch Mountains, on the west side of Lake Mountain, and in parts of the Oquirrh Mountains. Further prospecting should be done in these areas.

The Mississippian Great Blue Limestone is also exposed in the Wasatch, Lake and Oquirrh Mountains. The black, carbonaceous Long Trail Shale Member is worked commercially in four deposits along the west flank of the Wasatch Mountains.

There are many small pocket or lens halloysite occurrences in Utah County. The halloysite is usually the result of alteration of volcanic and sedimentary rocks by hydrothermal solutions. It occurs extensively in the Eureka (Utah) district in association with Tertiary volcanic rocks. Several clay and shale occurrences of no economic significance are included in the "miscellaneous" section.
From author abstract

386. O'TOOLE, WALTER L., 1951, Geology of the Keetley-Kamas volcanic area [Wasatch and Summit Counties]: Univ. of Utah M. S. thesis, 38 p., geol. map.

Investigation of sedimentary windows exposed in the volcanic area between the towns of Keetley and Kamas, Utah, combined with magnetic susceptibility measurement, gives information on the subvolcanic geology and topography.

The volcanics were deposited upon a surface composed of folded Paleozoic and Mesozoic strata on which there existed a relief of approximately 1,500 feet.

The subvolcanic structure is shown to be synclinal in an east-west direction and anticlinal in a north-south direction, forming a structural "saddle." This feature is modified by minor folds and faults and has been locally intruded by diorite porphyry.

The formations are mapped where exposed and their positions under the volcanic cover are predicted by virtue of geologic projections and magnetic measurements.

The geologic history and physiography are discussed, and new evidence of the date of the Park City-Uinta uplift is offered. *Author abstract*

387. OTT, HENRY LOUIS, 1958, Stratigraphic distribution of Charophyta in the Morrison Formation of Colorado and Utah: Univ. of Missouri M. A. thesis, 135 p.

Charophyte assemblages of the Salt Wash and Brushy Basin Members of the Upper Jurassic Morrison of the Colorado Plateau are sufficiently diagnostic to justify extension of the "western" lithologic boundary eastward into the undifferentiated Morrison of the Colorado Front Range. "Typical" Brushy Basin charophytes include representatives of <u>Aclistochara obovata</u> Peck, <u>Stellatochara arguta</u> Peck, and <u>Latochara latitruncata</u> (Peck), and the more common Salt Wash species are <u>Aclistochara bransoni</u> Peck, <u>Latochara concinna</u> Peck, <u>Obtusochara madleri</u> Peck, and <u>Echinochara spinosa</u> Peck. <u>Aclistochara obovata</u>, <u>Latochara concinna</u>, and <u>Obtusochara madleri</u> are confined to the member indicated on the Colorado Plateau. Outside of the Colorado Plateau <u>Latochara concinna</u> and <u>Obtusochara madleri</u> cannot be successfully used for correlation and here <u>Aclistochara obovata</u> apparently is the only species limited to the upper horizons of the undifferentiated Morrison of the Colorado Front Range. The ratio of sample percentages of <u>Aclistochara jonesi</u> Peck/<u>Aclistochara bransoni</u> Peck is of some stratigraphic value; the general trend being an increase in the percentage of representatives of <u>A. jonesi</u> in higher beds. Approximate unity of the <u>A. jonesi</u>/<u>A. bransoni</u> ratio parallels the lithologic separation of the "western" Morrison and the paleobotanical division of the Morrison of the Colorado Front Range. *From author abstract*

388. OWEN, JOHN WALLACE, 1931, The distribution, relationship, and character of the Swan Peak quartzite within the Logan quadrangle [Cache County], Utah: Univ. of Missouri M. A. thesis.

The Swan Peak has not yielded sufficient fossil evidence to allow definite correlation. It is composed entirely of fine-textured quartzite, essentially uniform in character. Within the area under investigation the Swan Peak ranges from 80 to 320 feet in thickness. The massive quartzite member is present only in the northern half of the area and never at any place does it make up the total thickness of the formation. The Swan Peak lenses out to the southward and is apparently lacking in the central and southern Wasatch. This rapid thinning of the quartzite formation is strongly suggestive of erosion previous to the deposition of the overlying Fish Haven. The evidence at hand indicates an uplift of the region south of the Logan quadrangle during Middle Ordovician times. Maps, structural cross-sections, columnar sections, and various tables are included in the report. *Author abstract*

389. PACK, FRED JAMES, 1905, Farmington gneiss: Columbia Univ. M. A. thesis.

390. PADDOCK, ROBERT EDWARDS, 1956, Geology of the Newfoundland Mountains, Box Elder County, Utah: Univ. of Utah M. S. thesis, 101 p., geol. map.

The Newfoundland Mountains consist of a single north-south trending range, located in the midst of the Great Salt Lake Desert, west of Great Salt Lake. A well-exposed section of Paleozoic rocks in excess of 15,700 feet thick is present. This includes 2000+ feet of Upper ? Cambrian, 5,500+ feet of Ordovician, 1,313± feet of Silurian, 4,200+ feet of Devonian, and 2,900+ feet of Permian.

Deposits of Mississippian and Pennsylvanian age are absent, and rocks of Permian age lie on Upper Devonian beds with profound unconformity. Precambrian, Mesozoic and Tertiary rocks are not exposed in the range.

A basal conglomerate of Leonardian age is present, and suggests a period of uplift and erosion in the Newfoundland Mountains region.

Structurally, the range consists of a westward inclined homoclinal block. High-angle normal faults are the dominant structural features in the area, and two prominent fault systems are recognized: one trends east-west and represents two periods of movement; the other trends north-south, with movement between the two periods of east-west faulting.

The northern part of the region was intruded by a quartz monzonite pluton presumably in Late Laramide time, and metamorphism and mineralization of the sediments occurred. *Author abstract*

391. PARIS, OLIVER L., 1935, A study of Precambrian rocks between Big Cottonwood and Little Willow Canyons in the central Wasatch Mountains: Univ. of Utah M. S. thesis, 45 p.

The purpose of this study was to show the homologous nature of the slates in Big Cottonwood Canyon and the more highly metamorphosed schists in the vicinity of Little Willow Canyon through correlation of the macroscopic and microscopic nature of the various rocks concerned and through consideration of the metamorphic processes involved. *From author introduction*

392. PARKER, RAYMOND L., 1949, Mineralogy of the alunitized volcanic rocks near Marysvale [Piute County], Utah: Indiana Univ. M. A. thesis, 46 p.

Analyzed samples from the alunite deposits near Marysvale, Utah, have been examined by petrographic methods, X-ray diffraction, differential thermal analysis and the electron microscope. Alunite, quartz, opal, kaolinite, halloysite and hematite have been distinguished by these techniques. The application of these methods of identification as well as the distinguishing criteria for the individual minerals are discussed.

The presence of kaolinite and halloysite further supports the belief that alunite is formed in an acidic environment. *Author abstract*

393. PARKER, RAYMOND L., 1954, Alunitic alteration at Marysvale [Piute County], Utah: Columbia Univ. Ph. D. thesis, 116 p.
(Abs.): Dissert. Abs., v. 14, No. 9, p. 1360, 1954.

The alunite deposits in the Marysvale region, Utah, are of two types, vein and replacement bodies. The wall rock alteration that borders the alunite veins has been divided into the feeble, moderate and intense phases respectively in order of their zonal distribution toward the veins. Feeble phase alteration is characterized by the formation of illite-montmorillionite mixed lattice clay, kaolinite and minor quartz. The moderate phase is represented by the assemblage, alunite, kaolinite and quartz. Strongly alunitized and silicified rock adjacent to the vein represents the intense phase of alteration.

Alteration in the replacement deposits consists of the feeble and moderate phases. The alunite bodies represent the moderate phase and those bodies that are sharply defined, are surrounded by an envelope of feeble phase alteration.

Results from the study of the alunite deposits suggest the following conclusions: (1) Alteration and alunite deposition resulted from the same solutions and were contemporaneous processes. (2) Solutions transported K_2O, Al_2O_3, SO_3, H_2S and probably SiO_2 to the site of the vein deposits. (3) Solutions transported at least SO_3 to the site of the replacement deposits. (4) The alunite depositing solutions were acid at the level of deposition. (5) The solutions became progressively less acid with increasing distance from the channelway, a fact which largely accounts for the zonal distribution of wall rock alteration. (6) The temperature of the solution at the time and level of alunite deposition was probably below 350° C. (7) The alunite veins are largely fillings of solution channelways and the associated wall rock alteration is due to lateral solution migration from the channelway. (8) The replacement bodies are the result of alunite replacement of originally porous horizons in the volcanics which became permeated by sulfate-bearing solutions.

(Author also reports studies of isomorphous substitution -- sodium for potassium -- and thermal behavior of alunite.) *From author abstract*

394. PARKS, JAMES M., Jr., 1949, Stratigraphy and coral zonation of the Brazer Limestone (Mississippian) of northern Wasatch Mountains, Utah: Univ. of Wisconsin M. S. thesis, 76 p.

______ 1951, Corals from the Brazer Formation (Mississippian) of northern Utah: Jour. Paleontology, v. 25, No. 2, p. 171-186.

Three new genera and eight new species of corals from the Brazer Limestone are described. Five coral zones are recognized (bottom to top): Ekvasophyllum inclinatum zone; Faberophyllum occultum - F. araneosum zone; Lithostrotion whitneyi - Faberophyllum leathamense zone; Triplophyllites zone; and Caninia zone. Neither stratigraphic section contains all five zones. At Leatham Hollow in Bear River Range the Brazer Formation is 2,240 feet thick. It lies on Madison Limestone without angular discordance and is overlain by Wells Formation (Pennsylvanian). Near Dry Lake in the Pigsah Hills the lower arenaceous members and part of limestones above are not exposed, but a considerably thicker section of limestone (2,000+ feet) is exposed here than at Leatham Hollow. Absence from Leatham Hollow section of the Caninia zone and of the several hundred feet of cherty limestone associated with it in the Dry Lake section is evidence of a profound erosional unconformity between Brazer Limestone and Wells Formation.

An evolutionary sequence for the morphologically similar Brazer corals based principally upon morphologic comparison of adult growth stages and stratigraphic order of occurrence is: (1) general increase in size, (2) general increase in number of septa, (3) change in axial structure, and (4) change in general trend of tabulae.

Abstract of published article (B. C.)

395. PARR, CLAYTON JOSEPH, 1965, A study of primary sedimentary structures around the Moab anticline, Grand County, Utah: Univ. of Utah M. S. thesis, 102 p., photogeol. map.

This study, undertaken to describe the structural development of the Moab salt anticline, involved detailed plotting of current directions in the Cutler Formation (Permian); Moenkopi Formation (Lower and Middle Triassic); Chinle Formation (Upper Triassic ?); Kayenta Formation (Upper Triassic ?); and Salt Wash Member of Morrison Formation (Upper Jurassic).

The site of the Moab anticline was probably determined in Pennsylvanian time by faulting that took place during the initial stages of uplift of the ancestral Uncompahgre Range either just previous to or during the initial stages of deposition of the Paradox Member of the Hermosa Formation. A thick sequence of evaporites accumulated in a structural trough adjacent to the fault. The time of the first salt flowage is uncertain, but the most active period of movement was during the period from Cutler time through Chinle time. Salt movement had ceased or had become very minor by Kayenta time, and the structure was covered by the Jurassic sediments. The present anticlinal structure was formed along the ancient trend probably during a phase of the Laramide orogeny. Two stages of faulting later occurred. The first resulted in a large normal fault, the Moab fault. The second resulted in collapse features around Moab Valley. *From author abstract*

396. PARRY, WILLIAM THOMAS, 1959, Trace elements in pyrite from the U. S. and Lark mines [Bingham district], Utah: Univ. of Utah M. S. thesis, 45 p.

Samples were collected from three levels of the U.S. section of the mine in and near a particular ore body. On two levels ore was apparent. On the lower level no ore was visible.

Polished sections were made of the samples and the mineral relationships were studied. Pyrite was separated and analyzed spectrochemically for its copper, lead, and arsenic content. Qualitative data were obtained for all other elements which could be detected with the methods used. The analyses were made on a 1.5 meter, 24,000-line-per-inch grating, Abney mount spectrograph. Iron contained in the pyrite was used as an internal standard.

Two types of pyrite were observed in the polished sections: a fractured pyrite which contained no inclusions of lead or zinc sulfide, and euhedral pyrite which occasionally did contain inclusions of sphalerite and galena.

The trace element content of pyrite shows some promise of indicating the channelways along which the ore forming solutions passed. Copper and lead values increase slightly as this channel is approached. Arsenic values vary erratically as the channel is approached. No significant changes in the qualitative trace element content of the pyrite with relation to the ore shoot are apparent.

From author abstract

397. PARRY, WILLIAM THOMAS, 1961, Cation substitutions in biotites from Basin and Range quartz monzonites: Univ. of Utah Ph. D. thesis, 121 p.

_____ and M.P. Nackowski, 1963, Copper, lead and zinc in biotites from Basin and Range quartz monzonites: Econ. Geol., v. 58, No. 7, p. 1126-1144.

Biotites from several Basin and Range monzonitic stocks have been analyzed for copper, lead and zinc. Copper, lead and zinc data have been compiled for biotites from the Tintic mining district, the Bingham mining district, the Park City-Little Cottonwood area, the Iron Springs mining district, the San Francisco and related mining districts, the Gold Hill mining district, the Mineral Range stock, and the Ibapah stock in Utah, and the Ely district and the Whitehorse Pass stock in Nevada. The biotites were analyzed spectrochemically on an Applied Research Laboratories, 1.5 meter, 24,400-line-per-inch grating spectrograph. Indium was used as an internal standard. The F test was used to test the equivalence of the variances of base metal concentration in biotites from groups of individual stocks or districts. A graphical comparison of geometric means and standard deviations of the base metal content of biotites from the individual stocks and districts was examined and visual estimates of differences and similarities were noted.

The results of the comparisons show the following: (1) Each stock or district belongs to its individual trace base metal concentration population. (2) A correlation exists between base metal concentration of biotite and base metal production in the area where the biotite was found. High copper content was associated with copper production, whereas low lead and zinc content is associated with lead and zinc production. (3) Biotites from hydrothermally altered stocks contain higher copper values and lower lead and zinc values than unaltered stocks. (4) The partitioning of lead between biotite and coexisting potassium feldspar suggests that the biotite and feldspar are near equilibrium with respect to lead content, that the biotites and feldspars formed at or near the same temperature, and that lead does occupy the potassium position in the two minerals. (5) Trace base metal content of biotite is an indicator of base metal mining districts in the Basin and Range Province.

Author abstract

398. PASHLEY, EMIL FREDERICK, Jr., 1956, The geology of the western slope of the Wasatch Plateau between Spring City and Fairview [Sanpete County], Utah: Ohio State Univ. M. S. thesis, 115 p., geol. map.

The Spring City-Fairview area, in northern Sanpete County, includes about 128 square miles of northwestern Wasatch Plateau and northeastern Sanpete Valley. Bedrock exposed ranges in age from medial Montana (Cretaceous) to Eocene, and includes the Blackhawk, Price River (with Castlegate Sandstone Member in lower part), North Horn, Flagstaff, Colton and Green River Formations, and a loosely consolidated conglomerate assigned to the Moroni Formation (Oligocene ?). The conglomerates, sandstones, shales and limestones represent inland floodplain, channel, lake and lowland-swamp environments. Eight basic igneous dikes of post-North Horn age occur east of Mount Pleasant, and are intermediate in composition between kersantites and spessartites.

The Wasatch monocline is less prominent than to the south. Displacement exceeding 1,320 feet characterizes the long "frontal fault" of the Wasatch Plateau. Beds to east of fault scarp are essentially horizontal; beds to west dip westward on limb of monocline. The limb is broken by four antithetic faults. A graben occurs in beds east of frontal fault in Pleasant Creek district. Elsewhere the beds are cut by high-angle faults of minor displacement. All faults in area trend north.

Several small, north-facing cirques are present.

Abstract revised (B. C.)

399. PATTERSON, BEN ARNOLD,, 1957, A study of the basal member of the Chinle Formation in the Inter-River area, Grand and San Juan Counties, Utah: Univ. of Illinois M. S. thesis, 54 p.

The Shinarump (?) Formation which is exposed in the Inter-River area only partly resembles the Shinarump Conglomerate described by Gregory in southern Utah. Both consist of ledge-forming, conglomeratic sandstone, deposited in streams and in lenticular bodies. Both occur as blanket-type deposits upon a mid-Triassic unconformity and grade upward into sandy shales of the Chinle Formation. The principal difference between them is the character of the pebbles. Well-rounded pebbles of durable siliceous rocks and vein quartz apparently derived from igneous and metamorphic rocks are found in the conglomerate of the type locality. Well-rounded pebbles of limestone, siltstone, mudstone, shale and some quartz and quartzite are found in the conglomerate of the Inter-River area. If the name, "Shinarump Conglomerate," is to apply only to a conglomerate of mainly siliceous pebbles occurring above an unconformity of mid-Triassic age, the Shinarump (?) of the Inter-River area is either a basal conglomeratic sandstone of the Chinle Formation, or a facies variation of the Shinarump Conglomerate.

From author abstract

400. PAYNE, ANTHONY, 1950, Hydrothermal dolomitization of Cambrian sediments, Tintic District, Utah: Univ. of Utah M. S. thesis, 48 p.

In the Tintic mining district, Utah, three Cambrian formations: the Dagmar Limestone, Bluebird Dolomite and Cole Canyon Dolomite, exhibit marked lithologic changes toward the north away from the center of mineralization and intrusive activity. Three miles to the north, a fault cuts perpendicularly across this section. North of this fault the above formations, ordinarily thought of as dolomites, are composed of limestone which is only slightly dolomitized. These limestones bear remarkable resemblances to their dolomitized counterparts to the south of the fault. The position of this dolomitization is found to be controlled to a very large extent by bedding planes, which may have been the loci for bedding plane movement during faulting and folding, facilitating the entry of the dolomitizing solutions.

A second period of dolomitization, which is intimately associated with faulting and jointing, has converted limestone to dolomite locally along fractures.

The solutions which accomplished this conversion are thought to have been hot, dilute solutions of mixed chlorides ($MgCl_2$ and $CaCl_2$) with some CO_2, and are distinctly related to the intrusive and mineralization activity.

Author abstract

401. PAYNE, ANTHONY L., 1962, Geology and uranium deposits of the Colorado Plateau: Stanford Univ. Ph. D. thesis. (Abs.): Dissert. Abs., v. 23, No. 5, p. 1326-1327, 1962.

Uranium ore deposits are found in practically all of the sedimentary formations of the Colorado Plateau. Most significant deposits occur in fluvial members of two formations: the Chinle Formation of Triassic age, and the Morrison Formation of Jurassic age. Most large deposits show a pronounced tendency to be spatially distributed around Tertiary igneous centers, and where numerous ore deposits are developed in large mining districts, sedimentary units not usually known to contain mineralization show appreciable concentrations of uranium and other metals. Anomalous concentrations of uranium have been found in igneous rocks, diatremes, breccia pipes, faults, and other structures of Tertiary age. Absolute age determinations strongly indicate an epigenetic origin and Tertiary age for all of the uranium deposits of commercial significance. Isotopic studies point to an epigenetic, probable hypogene origin for the lead in the deposits.

Many of the primary sedimentary features control ore deposition to a degree not heretofore suspected in hypogene ore deposits, and a thorough treatment of these features is necessary to show that they are not really of primary importance in explaining the ultimate origin of the mineralization. Most important of the primary sedimentary controls of uranium mineralization are the peculiar paleostream deposits contained in fluvial units.

It is theorized that uranium emanating from magmatic sources travelled upward and outward great distances from Tertiary igneous centers and final movement may have been mostly lateral along permeable beds. The solutions were essentially in equilibrium with the nonreactive wall rock through which they passed, and uranium was usually precipitated from solutions when the reducing environment of the carbon-rich paleostream deposits was encountered. Some intermising of the hydrothermal solutions with ground water probably took place, and a telethermal classification of the resulting ore deposits is proposed. *From author abstract*

402. PEACOCK, C. HERSCHEL, 1953, Geology of the Government hill area, a part of Long Ridge [Utah and Juab Counties], Utah: Brigham Young Univ. M. S. thesis, 96 p.

The Government Hill area is a small part of Long Ridge, Basin and Range Province, central Utah. The following sedimentary formations, totaling 4,000 feet, are discussed: Herkimer Limestone, Bluebird Dolomite, Cole Canyon Dolomite, and Opex Dolomite (Cambrian); Ajax Limestone (Ordovician); Victoria Quartzite and Pinyon Peak Limestone (Devonian); Gardner Dolomite, Pine Canyon Limestone, Humbug Formation and Great Blue Limestone (Mississippian); Price River - North Horn (Tertiary); and Lake Bonneville sediments (Quaternary).

The Government Hill area is the east limb of an anticline. It is one of a series of anticlines and synclines which merge in this vicinity in southward virgation and plunge. The present structure is a result of folding and thrusting of Laramide type in mid-Montana time and faulting of Basin-and-Range type which is post-Laramide.

A small outcrop of volcanic material is present in the area; it was deposited as a volcanic conglomerate and has the same composition as the Laguna Latite series of other localities in Long Ridge to the south.

The economic potential of the area consists of carbonate rocks for flux, and possibilities of ore at depth along or near fault zones, although surface evidence has justified only two shafts and a few adits and prospect pits. *Abstract revised (B. Y. S.)*

403. PEIRCE, HOWARD WESLEY, 1963, Stratigraphy of the DeChelly Sandstone of Arizona and Utah: Univ. of Arizona Ph. D. thesis, 208 p.
(Abs.): Dissert. Abs., v. 23, No. 12, p. 4659, 1963.

_____ 1964, Internal correlation of the Permian DeChelly Sandstone, Defiance Plateau, Arizona: Mus. Northern Arizona Bull. 40, p. 15-32.

The Permian DeChelly Sandstone of Gregory can be subdivided, on the basis of contrasting depositional environments, into five members no one of which is coextensive with the DeChelly Sandstone as a whole. The distribution of these members reflects instability in part of the area formerly occupied by the earlier Paleozoic Defiance positive element. The various members of the DeChelly are believed to correlate with: (1) the uppermost evaporitic and dark detrital sediments of the Supai Formation found in the subsurface to the south of the Defiance Plateau, (2) the Coconino Sandstone of the Grand Canyon region, and (3) the San Andres Formation of the Zuni area in New Mexico. Emphasis is placed on: (1) the distribution and nature of sedimentary structural types such as cross stratification, stratification, channels and ripple marks, and (2) modification of sandstone characteristics by secondary solution and cementation processes. *Author abstract*

404. PERKINS, RICHARD F., 1955, Structure and stratigraphy of the lower American Fork-Mahogany Mountain area, Utah County, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 2, No. 1, 38 p.

An area of approximately 18 square miles between lower American Fork Canyon and Grove Creek Canyon in the south central Wasatch Mountains was mapped in detail for this thesis. The Timpanogos Cave National Monument is located in the north part of the area.

Sedimentary rocks of the Cambrian, Mississippian and Pennsylvanian Systems are well exposed in the mountains and canyons. Lake Bonneville sediments occur in the west part of the area. The Paleozoic rocks are dominantly limestone, although considerable dolomite, shale and orthosiltite are present. The lacustrine deposits are gravel, sand, silt and clay.

Three episodes of diastrophism have disturbed the rocks in the area: Mid-Cretaceous, Late Cretaceous - Early Tertiary, and Mid-Tertiary. Thrust faults have displaced rocks eastward. Basin-and-Range type normal faults, some with displacements of several thousand feet, produced high relief blocks out of which the Wasatch Range has been sculptured.

Only a few materials in the area are of economic value. Construction materials of gravel, sand, silt and clay are being exploited locally but additional development is remote. *Author abstract*

405. PETERSEN, HERBERT NEIL, 1953, Structure and Paleozoic stratigraphy of the Currant Creek area near Goshen [Utah County], Utah: Brigham Young Univ. M. S. thesis, 61 p., geol. map.

The geology of a 10-square-mile area on the northern end of Long Ridge is presented. Strata from Ordovician through lower Upper Mississippian are present in the mapped area, along with Late Tertiary volcanic flows and Quaternary Lake Bonneville sediments. A detailed stratigraphic section of all Paleozoic formations includes: Ajax Dolomite and Opohonga Limestone (Ordovician), Blue Bell Dolomite (Silurian), Victoria Quartzite and Pinyon Peak Limestone (Devonian), and Gardner Dolomite, Pine Canyon Limestone and Humbug Formation (Mississippian).

The map represents a complexly faulted area located on the southeast flank of the Long Ridge anticline. All of the faults which are mapped are of the normal type, probably caused by relaxation of regional compressional forces. *Abstract revised (B. Y. S.)*

406. PETERSEN, MORRIS S., 1956, Devonian strata of central Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 3, No. 3, 38 p.

The area studied extends from the Lakeside Mountains to the South Tintic Range. It includes the eastern margin of the Devonian miogeosyncline. The Devonian System of central Utah consists dominantly of carbonate rocks with minor sandstones, and is considered to contain parts of the Lower, Middle and Upper Series. It includes the following formations from base to top: Sevy Dolomite, Simonson Dolomite, Guilmette Formation (mostly dolomite), Victoria Quartzite, and Pinyon Peak Limestone. Aggregate thickness in central Utah varies from 142 to 1,620 feet, thinning to a "feather edge" a short distance to the east. Microstructures and lithologic associations indicate that the entire Devonian System was deposited in very shallow water, probably the shallow epineritic zone, on a stable to slightly unstable shelf. Thin-section analysis suggests that the dolomites are secondary and represent penecontemporaneous replacement of calcite (or aragonite) by dolomite. *Abstract revised (B. C.)*

407. PETERSON, DALLAS O., 1953, Structure and stratigraphy of the Little Valley area, Long Ridge [Utah and Juab Counties], Utah: Brigham Young Univ. M. S. thesis, 96 p., geol. map.

Little Valley is located almost due east of Goshen, Utah, on the northeastern prong of "Y-shaped" Long Ridge, eastern Basin and Range. The 18 mappable units, with a total thickness of about 4,000 feet, are: Tintic Quartzite, Ophir Formation, Teutonic Limestone, Dagmar Limestone, Herkimer Limestone, Bluebird Dolomite, Cole Canyon Dolomite and Opex Dolomite (Cambrian); Ajax Limestone (Ordovician); Victoria Quartzite and Pinyon Peak Limestone (Devonian); Gardner Dolomite, Pine Canyon Limestone and Humbug Formation (Mississippian); Price River-North Horn (Cretaceous-Tertiary); Lake Bonneville sediments (Quaternary).

Structurally, the area is moderately complex. It is part of an east-dipping limb of a south-plunging, north-south trending anticlinal fold which has been highly faulted. Major deformation occurred in the early "Laramide" orogeny. Post-orogenic conglomeratic materials overlie these upturned and faulted strata in angular unconformity, and Tertiary volcanics post-date this material.

Sand- and gravel-quarrying by the Utah State Road Commission and one water well drilled for irrigational purposes constitute the economic operations in the area. *Abstract revised (B. Y. S.)*

408. PETERSON, DALLAS O., 1959, Regional stratigraphy of the Pennsylvanian System in northeastern Utah, western Wyoming, northwestern Colorado, and southeastern Idaho: Washington State Univ. Ph. D. thesis.
(Abs.): Dissert. Abs., v. 20, No. 7, p. 2757, 1960.

Among the nomenclatural changes recommended by the author are the following: the Oquirrh Formation be raised to group status and carried into the Wells Formation area, Round Valley Limestone be applied to what was formerly known as lower Morgan, upper tan and buff portion of Youghall Formation be redefined as upper member of Morgan, the balance of Youghall be designated the "Red Morgan" Member and the Hells Canyon Formation be designated the lower member of Morgan Formation in the Uinta Mountains.

The Uncompahgre highlands appear to have extended at least as far as the Wasatch and Uinta Mountains junction based on the isopachous pattern and regional stratigraphic relationships. Projection of this structural feature beyond its heretofore recognized northwestern limit severs as a possible explanation for: (1) absence of Morgan south of type area, (2) thick Oquirrh facies on south and west opposing the Weber-Morgan-Round valley facies on north and east along the line of projection, and (3) facies change eastward in Morgan Formation.

Sources of sands deposited on Wyoming shelf and in Uinta trough area are believed to be positive areas situated west and northwest of area under study. Red clastics in Amsden and Morgan Formations are believed to be eroded and redistributed portions of Molas and Sacajawea Formations which are lithogenetic units, but not time-stratigraphic.

Future petroleum fields may be found in the northern part of the Paradox basin area where stratigraphic traps may occur as pinch outs up-dip against the positive elements or result from changes in porosity-permeability. Similar possibilities exist in the southern part of the Uinta Basin and the transitional interface between the Uinta trough and the central Colorado basin sediments, as well as possible stratigraphic traps westward where the sands of the Weber become tight. *Abstract revised (B. C.)*

409. PETERSON, DEVERL J., 1956, Stratigraphy and structure of the west Loafer Mountain-Upper Payson Canyon area, Utah County, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 3, No. 4, 41 p.

An area of approximately 12 square miles in the southern Wasatch Mountains near Payson, Utah was mapped in detail for this thesis.

Rocks of the Cambrian, Mississippian, Pennsylvanian, Cretaceous and Tertiary Systems are found in the mapped area, as well as Recent alluvium, colluvium and related products of mass wasting.

Structurally the area contains two major thrust faults, a large wrench fault and numerous normal faults associated with the Laramide orogeny. The Wasatch fault and other normal faults of the Basin-and-Range System are also found in the mapped area.

Water is the most important economic resource. However, the area has a clay of potential value. *Author abstract*

410. PETERSON, HAROLD, 1929, A comparison of the lithologic units in Utah, southeastern Idaho and western Wyoming: Utah State Univ. M. S. thesis, 39 p.

The aim of the writer is to point out units of corresponding age, and by depicting their lithologic characteristics and stratigraphic position, show their general relationship. The thesis represents a summary or compilation of the sources listed in the bibliography section. *B. C.*

411. PETERSON, PARLEY ROYAL, 1952, Geology of the Thistle area [Utah County], Utah: Brigham Young Univ. M. A. thesis, 72 p., geol. map.

An area of approximately 10 square miles in the southern part of Utah County, Utah, was mapped in detail. Sedimentary rocks of Upper Permian, Triassic, Jurassic, Cretaceous and Tertiary ages are exposed in canyons and mountains. Quaternary and Recent deposits are present as alluvial fans, slope wash, and stream and valley fill. The rocks consist mainly of conglomerates, sandstones, shales and limestones representing widely varied sedimentary environments. A minor amount of Tertiary pyroclastic material overlies older sedimentary formations. The mapped area reflects to a lesser extent the profound diastrophism which has affected the surrounding region. Several phases of the Laramide orogeny and later epeirogenic adjustments have resulted in varied folding and faulting and in rejuvenation of the drainage system.

Only building materials of minor economic value are being produced from the area at present. A potential asphalt deposit is not currently exploited. *Author abstract*

412. PETERSON, REED H., 1950, Microfossils and correlation of part of the Frontier Formation, Coalville [Summit County], Utah: Univ. of Utah M. S. thesis, 54 p.

_____ D.J. Gauger and R.R. Lankford, 1953, Microfossils of the Upper Cretaceous of northeastern Utah and southwestern Wyoming: Utah Geol. and Mineralog. Survey Bull. 47, 158 p.

Twenty species and 2 varieties of Foraminifera (belonging to 10 genera) and 6 species of Ostracoda (belonging to 5 genera) from a black shale bed of the Frontier Formation (Wegemann's Unit 10) of Late Cretaceous age are figured and discussed. Nine species and 1 variety of Foraminifera are probably new or are too poorly preserved for identification, and one species of Ostracoda seems new.

The Foraminifera and Ostracoda are shallow, warm water types with Gulf Coastal affinities. The fauna indicates an upper Austin and/or lower Taylor age when compared with Gulf Coastal microfaunas, but it cannot be used for direct correlation with Upper Cretaceous formations of the continental interior.

Microfossil evidence indicates that this shale, which is generally considered to be of Colorado age, is of Montana age, and that the Colorado-Montana boundary must be placed lower in the Cretaceous section exposed at Coalville.

Abstract revised (B. C.)

413. PETERSON, VICTOR E., 1936, The geology of a part of the Bear River Range [Cache County], and some relationships that it bears with the rest of the range: Utah State Univ. M. S. thesis, 73 p.

The area studied is about 13 square miles lying between Providence and Logan Canyons, including parts of Cache Valley and the western flank of the Bear River Range. Rocks ranging in age from Ordovician to Carboniferous are unconformably overlain by Quaternary (Lake Bonneville) sediments. *B. C.*

414. PETERSON, VICTOR E., 1941, A study of the geology and ore deposits of the Ashbrook silver mining district [northwestern Box Elder County], Utah: Univ. of Chicago Ph. D. thesis.

_____ 1942, A study of the geology and ore deposits of the Ashbrook silver mining district, Utah: Econ. Geol., v. 37, p. 466-502.

The ore of the Ashbrook district occurs as irregular patchy replacement deposits in fractured and folded limestone, whose structure has strongly influenced distribution of the orebodies. The distribution is controlled by small crenulations within the limestone, the apical portions of which are usually marked by a strong development of secondary calcite, which is generally more susceptible to replacement by mineralizing solutions. Due to two episodes of minor fracturing, the sequence of primary mineralization can be divided into three periods of deposition: (1) rhodochrosite to the exclusion of other minerals, (2) quartz, pyrite, arsenopyrite, sphalerite, and minor amounts of chalcopyrite, and (3) galena, aragyodite, pyrargyrite, pearceite, tennantite, and an unidentified mineral. The second phase seems to be responsible for the minor gold values in the ores. Processes of enrichment and oxidation have produced a large group of secondary minerals. Alteration of the primary silver minerals has been mainly to argentite and native silver which together account for the main values found in the ores. *Published abstract*

415. PHILLIPS, KENNETH A., 1940, The mining geology of the Mount Nebo district [Juab County], Utah: Iowa State Univ. (Ames) M. S. thesis, 79 p., geol. map.

The Mount Nebo mining district is located in the western front of the southern Wasatch Range. Stratigraphic column includes Algonkian shales, phyllites and quartzites; unconformity; Cambrian Tintic Quartzite, Ophir Formation; Cambro-Ordovician (?) limestone and dolomite; Devonian (?) dolomite; unconformity; Mississippian Madison Series (Victoria Quartzite, Gardner Dolomite, Pine Canyon Limestone) and Brazer Series (Deseret Limestone, Humbug Formation, Great Blue Limestone, Manning Canyon Shale); Pennsylvanian thick intercalated series of limestones and sandstones.

Beds in northern half of district are homoclinal, strike northeast-southwest, and dip nearly 40° to the southeast. Beds in southern half have been folded into an anticline; distortion is extreme near mouths of Bear and Pole Canyons. Several large faults of post-mineral age occur in the district.

Lead, zinc and silver ore deposits occur in a zone 5 miles long and $\frac{1}{2}$ mile wide which has been intruded by many lamprophyr dikes and sills. Largest deposits have been bedded replacements of Mississippian limestones. The lamprophyrs were emplaced first. Mineralizing solutions followed identical fissures used by lamprophyrs only in traversing relatively impervious strata. Where fissures are numerous, the solutions produced smaller and more numerous ore bodies. Copper deposits associated with a thick sill of red felsite are economically unimportant. *B. C.*

416. PIERCE, JACK WARREN, 1950, Structural history of the Uinta Mountains, Utah: Univ. of Illinois M. S. thesis, 70 p.

Trough which occupied site of Present Unita Mountains and caused thick accumulation of Permian sediments did not greatly affect post-Permian sedimentation. During late Sierra Nevada orogeny, western portion of region was elevated causing final regression of sea. Marine conditions continued in central and eastern portions, with deposition of clastics derived from Mesocordilleran geanticline. Deep-seated forces from south initiated Uinta flexure about Aspen time. Climax of Uinta uplift in form of normal faulting along flanks probably occurred during early Montana time.

Shallow forces from west initiated deformation to north and south of Uintas during late Montana time. Flysch deposits of early stages (Pulpit Rock and Henefer Formations) were later folded and thrust. Strata to north of range moved eastward as folding and thrusting progressed, causing change in trend of north-south structures. Imbricate thrusting occurred along generally westward-dipping planes. Thrusting toward west is improbable, although portions of planes dipped eastward.

Uinta structural trends formed before north-south structures; the range was relatively unaffected by east-west compressional forces. Wasatch Group was folded during last stages of Laramide. Release caused normal faults along vertical portions of thrust planes, which imparted 7-20° dip to Wasatch strata. *Author conclusions revised (B. C.)*

417. PINNEY, ROBERT IVAN, 1965, A preliminary study of Mississippian biostratigraphy (Conodonts) in the Oquirrh Basin of central Utah: Univ. of Wisconsin Ph. D. thesis. (Abs.): Dissert. Abs., v. 26, No. 7, p. 3868, 1966.

The conodont faunas from eight localities in the Oquirrh basin of central Utah were studied for the purpose of determining more precise series and stage time boundaries in one of the world's most complete Mississippian sections. The stratigraphic units studied include (in ascending order) the Kinderhookian Fitchville Formation, the Valmeyeran Gardison Limestone, Deseret Limestone, Humbug Formation and lower Great Blue Limestone and the Chesterian upper Great Blue Limestone and lower Manning Canyon Shale. Previous studies in the type area of the Mississippian enabled students there to recognize 22 conodont assemblage zones and to accurately define series and stage boundaries. Only 8 conodont assemblage zones could be recognized in central Utah, 4 of which are modifications or combinations of formerly recognized zones. The Kinderhookian of central Utah is characterized by conodonts belonging to the Gnathodus n. sp. A, Gnathodus n. sp. B - G. kockeli-Apatognathus Transition, Siphonodella quadruplicata-S. cooperi Assemblage Zones and the lower part of a lower interval of few conodonts. The Valmeyeran is characterized by the upper part of the lower interval of few conodonts, the Pseudopolygnathus multistriata-Polygnathus communis Assemblage Zone, a middle interval of few conodonts, the Gnathodus texanus-Taphrognathus Assemblage Zone, the Taphrognathus varians-Cavusgnathus Assemblage Zone, an upper interval of few conodonts and the Apatognathus-Spathognathodus scitulus Assemblage Zone. Although distinctive, conodonts were not present in sufficient numbers for the recognition of assemblage zones in the upper Great Blue Limestone and lower Manning Canyon Shale and the entire interval is referred to as the Chesterian.

From author abstract

418. PITCHER, GRANT G., 1957, Geology of the Jordan Narrows quadrangle [Salt Lake and Utah Counties], Utah: Brigham Young Univ. (M. S. thesis Research Studies, Geol. Ser., v. 4, No. 4, 46 p., geol. map.

The Jordan Narrows quadrangle, named for the water gap made by the Jordan River through the Traverse Range, lies between west longitudes 112° and 111°52'30" and north latitudes 40°22'30" and 40°30'.

Paleozoic sediments exposed include 800+ feet of Great Blue Limestone, 1,200± feet of Manning Canyon Shale, and more than 3,767 feet of Oquirrh Formation of which 854 feet are Morrowan, 1,913± feet Atokan, and more than 1,000 feet Desmoines. Tertiary latite flows up to 255 feet thick overlie the deformed Paleozoic sediments with angular unconformity.

Paleozoic rocks in the West Traverse Range lie on the northeast limb of the northwesterly trending anticline. The Paleozoic rocks in the East Traverse Range, which are greatly brecciated, do not form a recognizable structure. Block faults separate the East and West Traverse Ranges. Salt Lake and Jordan Valleys on the north and Utah Valley on the south are graben of large magnitude, making the Traverse Range a structural horst.

Prominent terraces around Steep Mountain in the East Traverse Range are the result of erosion and deposition along the shores of Lake Bonneville while it was at the Alpine, Bonneville and Provo levels.

From author abstract

419. PLEBUCH, RAYMOND OTTO, 1957, Tectonics of the Mississippian System of western United States: Univ. of Illinois M. S. thesis, 97 p.

The following remarks and conclusions are derived from the discussion: (1) The isopachous map illustrates the trends and magnitudes of the primary and secondary basins of deposition and the areal extent of shelf areas. (2) The lithofacies map demonstrates in a broad fashion that western United States was characterized by carbonate deposition throughout Mississippian time except for certain areas within the primary geosyncline, certain secondary basins and areas adjacent to low-lying land masses. (3) The Williston basin represents the only known occurrence of Mississippian evaporites in western United States. (4) A similar study dividing the Mississippian into two units of pre-Meramec and post-Osage, and limited to the area between the Cordilleran miogeosyncline and the Mississippi River, may provide valuable information on paleogeographic relationships which are obscured by a study of the system as a single unit. (5) A study of the insoluble residues and detrital quartz content of the Lower Mississippian limestones flanking the transcontinental arch may give some hint as to the degree to which this feature was positive during Kinderhook and Osage time. *Author conclusions*

420. PLILER, RICHARD, 1959, The distribution of thorium, uranium and potassium in a Pennsylvanian weathering profile and the Mancos Shale: Rice Institute Ph. D. thesis, 95 p.

A weathering profile representing the decomposition of the Boulder Creek granodiorite underlying the Pennsylvanian Fountain Formation near Boulder, Colorado, and the Upper Cretaceous Mancos Shale in Utah, Colorado, New Mexico and Arizona were studied to determine the manner in which thorium and uranium may occur in source rocks and in sediments, especially shales, and to relate the variations in the distribution of thorium and uranium in a shale to the fundamental geological processes. Major conclusions are: (1) One kilogram of the most weathered material in the pre-Fountain weathering profile represents at least 4 kilograms of original granodiorite. (2) In the weathering profile uranium is present largely in the primary resistates, and thorium occurs mainly in the secondary resistates, probably hydrolyzates or clays. As much as 90 percent of the thorium and 60 percent of the uranium present in the fresh granodiorite are leachable in 2N hydrochloric acid. (3) Average concentrations found in the 124 Mancos Shale samples are 10.2 ppm thorium, 3.7 ppm uranium and 1.9 percent potassium. Average Th/U ratio is 3:1. Uranium and thorium values were checked by both radiometric and chemical methods; average error was less than 10 percent. (4) Variations in concentration of thorium, uranium and potassium within Mancos Shale are mainly gradual and take place over large distances. (5) The K/Th ratio is about 2,200 in the shale (and sandy intertongues) showing remarkably little variation, particularly on a regional basis. (6) Thorium, Th/U ratio, and potassium tend to decrease and uranium tends to increase with distance from Upper Cretaceous shoreline. (7) Uranium in Mancos Shale may be present largely in the fine-grained primary resistates, and thorium may occur in the fine-grained secondary resistates or fixed on clays. (8) Bentonitic zones may provide useful marker horizons in Mancos Shale.

Conclusions revised (B. C.)

421. POBORSKI, STANISLAW JOZEF, 1952, The Virgin Formation of the St. George area [Washington County], southwestern Utah: Johns Hopkins Univ. M. A. thesis, 160 p.

______ 1954, Virgin Formation (Triassic) of the St. George, Utah, area: Geol. Soc. America Bull., v. 65, No. 10, p. 971-1006.

Marine sediments which have been designated the Virgin Limestone Member of the Moenkopi Formation constitute an easily mappable lithologic unit that unconformably overlies the continental strata of the lower red member of the Moenkopi Formation and is, in turn, conformably overlain by the continental middle red member of the Moenkopi. It is recommended that the Virgin be made a formation and the Moenkopi a group; the term "limestone" is not applicable to the Virgin in the area studied.

The Virgin Formation was deposited in a near-shore, shallow-water, marine environment. Cyclic sedimentation characterizes the lower part of the formation, the cycles consisting of basal limestones overlain by siltstones. In the southeastern portion of the area studied, strata of the upper part were deposited in lagoons under a restricted arid environment, while marine conditions persisted in the northern portion.

Ammonites, identified by Prof. S. W. Muller as Tirolites spinosus Mojs. s. l., ?Cordillerites, and ?Hungarites establish the stratigraphic position as near the top of the Lower Triassic sequence.

Abstract revised (B. C.)

422. POWELL, DEAN KEITH, 1959, The geology of southern House Range, Millard County, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 6, No. 1, 49 p., geol. map.

The stratigraphic sequence of the southern House Range is composed of rock units of the lower Paleozoic and Cenozoic Eras. The Paleozoic rock units are approximately 6,800 feet thick and are Middle and Upper Cambrian, and Lower Ordovician in age. The Cambrian system is represented by the Marjum Limestone, Weeks and Orr Formations, Dunderberg Shale, and Notch Peak Limestone. The House Limestone and Fillmore Limestone comprise the units of the Lower Ordovician System. The Cenozoic Era is represented by Tertiary alluvium, Quaternary and Recent sediments.

The Paleozoic beds were slightly folded and faulted during Mesozoic and early Cenozoic time. During this time, the Notch Peak intrusive invaded the Paleozoic rocks causing slight doming, fracturing and extensive metamorphism of the surrounding sedimentary rock. Later block faulting produced the Basin-and-Range structure of the region. This block faulting caused a displacement of approximately 10,000 feet along the White Valley fault on the western side of the House Range.

Mining is of little commercial importance in the area except for small deposits of tungsten ore around the periphery of the Notch Peak Limestone.

Author abstract

423. PRAETORIUS, HERMAN W., 1956, Stratigraphy of the Phosphoria Formation of northwestern Colorado and northeastern Utah: Univ. of Colorado M. S. thesis, 96 p.

The Permian Phosphoria Formation of the eastern Uinta Mountains contains two members: an upper, Rex Member, dominantly dolomite with large amounts of bedded and nodular chert; and a lower, Phosphatic Shale Member, chiefly phosphatic shales with interbedded phosphate rock. The Phosphatic Shale Member rests on Pennsylvanian Weber Sandstone in most places, but at Dry Fork on south flank of Uinta Mountains, a thin dolomitic sandstone probably belonging to the lower Park City Formation overlies the unconformity and is overlain by the Phosphatic Shale Member. Nearest reported occurrence of lower Park City rocks in 40 miles to the west, so pre-Phosphoria erosion may have removed this unit from a more extensive area.

The Rex Member extends further south and east than the phosphatic member, and is contemporaneous with Woodside siltstones and shales on its south and east margins. Abundant fine clastics forced the northwestward retreat of depositional conditions typical of the Rex Member, and caused deposition of rocks intermediate in character between Rex and Woodside strata. Depositional conditions typical of Rex Member returned for a short period while extensive carbonate deposits formed, but were permanently displaced by a recurrent influx of fine clastics. *Abstract revised (B. C.)*

424. PRAMMANI, PRAPATH, 1957, Geology of the east central part of the Malad Range (Utah and) Idaho: Utah State Univ. M. S. thesis, 60 p., geol. map.

The mapped area lies in the northeast corner of the Basin and Range Province, northern Utah and southern Idaho. It includes rugged mountains of Paleozoic rocks, smooth hills underlain by the Salt Lake Group, and a flat (bottom) area floored by Quaternary alluvial depostis. Rocks of the mapped area range in age from Cambrian to Recent, and consist of the Brigham Quartzite and Langston Formation of Middle Cambrian age, the Nounan Formation and St. Charles Formation of Upper Cambrian age, the Garden City Limestone of Lower Ordovician age, the Swan Peak Quartzite of Upper Ordovician age, the Salt Lake Group, lava flow(s?), and boulder gravel (?) of Tertiary age, and alluvium of Quaternary age. *B. C.*

425. PRESCOTT, MAX W., 1958, Geology of the northwest quarter of the Soldier Summit quadrangle [Utah County], Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 5, No. 2, 44 p., geol. map.

An area of 54 square miles near the head of Soldier Creek was mapped in detail. The exposed stratigraphic sequence is 7,000 feet thick, and consists (from base to top) of the Cretaceous-Tertiary North Horn Formation, Tertiary Flagstaff Limestone, Colton Formation and Green River Formation. The Colton Formation grades laterally and vertically into the underlying Flagstaff and overlying Green River Formations.

Two major normal faults, the West Soldier and East Soldier faults, form a graben averaging about $3\frac{1}{2}$ miles in width, and extending southward beyond the area mapped. Displacement ranges from zero in the north to about 1,200 feet in southern part of area. Water is probably the most important mineral resource. Oil shale of low quality and limited quantity is present. Fault traps may occur in underlying formations, but no oil or gas wells have been drilled in area. *Abstract revised (B. C.)*

426. PRICE, JACK R., 1951, Structure and stratigraphy of the Slate Jack Canyon area, Long Ridge [Utah County], Utah: Brigham Young Univ. M. S. thesis.

______ 1951, Stratigraphy and structure of the Slate Jack Canyon area, Long Ridge, Utah: Compass, v. 29, No. 1, p. 73-81, geol. map.

Oldest rocks in the 9-square-mile area studied are 2,300 feet of Proterozoic metaquartzite and slate belonging to the Big Cottonwood Formation. Cambrian rocks include Tintic Quartzite (about the upper 1,500 feet exposed in fault contact), Ophir Shale (305 feet), Teutonic Limestone, Dagmar Limestone (40 feet), Herkimer Limestone and Bluebird Dolomite. Mesozoic-Cenozoic rocks include isolated exposures of Price River-North Horn Conglomerate lying unconformably upon Paleozoic rocks, Lake Bonneville sediments and Tertiary andesites. A diabasic flow less than 50 feet thick occurs locally 160 feet above the base of the Tintic Quartzite.

Precambrian and Cambrian rocks have been displaced to the east along the Slate Jack Canyon thrust fault. This thrust is considered to be low-angle, and of the break-thrust type, having developed on the west limb of the Long Ridge anticline (east limb of the Tintic syncline). The sheet rode eastward in the form of a lobe-like plate. Beds in the overriding block increase in dip eastward until attitudes that are overturned to recumbent characterize the frontal edge of the thrust.

Normal faults of the area are mainly a series of en echelon faults that are low-angle and transverse. *Abstract of published article (B. C.)*

427. PRINCE, DONALD, 1963, Mississippian coal cyclothems in the Manning Canyon Shale of central Utah: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 10, p. 83-103.

Late Mississippian coal cyclothems of Chesteran and Springeran age occur in the middle third of the Manning Canyon Shale of Soldier Canyon, 5 miles southeast of Stockton, Tooele County, Utah. A lower marine limestone-shale sequence, a lower coal cyclothem, an upper coal cyclothem and an upper partial cycle occur within a 285-foot section. The cyclothems are highly asymmetrical with marine strata dominating, indicating generally transgressive seas with alternating short regressive stages. The two cyclothems are comparable to mid-continent cyclothems.

The lower cyclothem, 63 feet thick, consists of a resistant basal quartzite, thin sandy shale and underclay, coal and roof shale. The coal is lenticular, highly weathered lignite, 1 to 2 inches thick. The upper cyclothem, 26 feet thick, contains the 5 units of the lower cyclothem with an overlying black, fossiliferous limestone and upper shale sequence. The coal is lenticular, brown, banded lignite, up to 5 inches thick. Gypsum is associated with the coal and overlying 13 inches of roof shale. The upper partial cycle consists of a 4-foot resistant quartzite and overlying black shales. A thin sandy shale is present immediately above the quartzite, but clay and coal are absent.

Abstract revised (B. C.)

428. PROBANDT, WILLIAM TAYLOR, 1959, Regional geologic aspects of the Moab Valley area, Grand County, Utah: Texas Technolog. College M. S. thesis.

_____ 1960, Reconnaissance investigation - Paradox Basin salt structures and Moab Valley, Utah: Compass, v. 37, No. 4, p. 250-268.

A series of parallel-trending collapsed anticlines, underlain by a thick evaporite section, are located in the Paradox Basin region of Utah and Colorado. Similar structural and sedimentary relationships, and the evidence of tectonic influence from a zone of major folding and faulting, indicate a common, localized mode of origin for these salt structures. A deep-seated belt of parallel folds probably controlled the linearity of the structures and the mobile front of the monoclinal Uncompahgre Uplift probably transmitted deformational pulses into the Paradox Basin.

A detailed review of theories and conclusions gained from previous investigations is presented in conjunction with a reconnaissance study of Moab Valley, a typical Paradox Basin salt structure. The conclusions of this study are deemed broadly applicable to any of the companion Paradox Basin salt structures. *Published abstract*

429. PROCTOR, PAUL DEAN, 1943, The geology of the Bulley Boy mine, Piute County, Utah: Cornell Univ. M. A. thesis, 26 p., geol. map.

The Bulley Boy vein has been traced 3,200 feet along the surface and 2,000 feet underground. Width ranges from 20-50 feet. Known downward extent is 2,800 feet.

The structural, textural and mineralogical characteristics of the ore together with the occurrence of some of the veins in the Tertiary volcanics suggest that the mineral deposition took place at relatively shallow depth or under epithermal conditions. Recurrent faulting during the period of mineralization repeatedly interrupted mineral deposition and the ore was as a consequence deposited in three or perhaps four stages. The base metals apparently were introduced during the third, the gold during the fourth stage. The tenor of the ore, particularly in the upper and intermediate parts of the mine, has been considerably increased by supergene enrichment.

The primary ore shows a distinct zonal distribution. The precious metals are more abundant above (only in part perhaps because of supergene enrichment) and diminish in quantity with increasing depth. The lead ore increases in abundance in the intermediate levels of the mine and becomes less abundant both above and below. The copper increases with depth. Ore has been localized in shoots by vein intersections and also by changes in strike.

Mainly author summary and conclusions

430. PROCTOR, PAUL DEAN, 1949, Geology of the Harrisburg (Silver Reef) mining district, Washington County, Utah: Indiana Univ. Ph. D. thesis.

_____ 1953, Geology of the Silver Reef (Harrisburg) mining district, Washington County, Utah: Utah Geol. and Mineralog. Survey, Bull. 44, 169 p.

The Silver Reef mining area in southwestern Utah contains the only known occurrence in the United States of commercial bodies of silver ore with minor copper-uranium-vanadium minerals in sandstone. The ore bodies are restricted to the Silver Reef Sandstone Member of the upper Triassic Chinle Formation and occur on the limbs and nose of a major anticline and a subsidiary anticline and syncline. A newly recognized north-trending normal fault and a thrust fault with a minimum eastward displacement of 1,500 feet repeat the ore horizon three times. No constant relationship exists between the mineralization and the folds or faults.

Silver, copper and minor gold values in a bentonite 300 feet below the ore-bearing horizon, minerals of these metals and lense-like bentonitic shales in the Silver Reef Sandstone, and other known occurrences of notable metal content in volcanic tuffs suggest a new theory of origin for these unusual deposits. It is concluded that the metals were primary constituents of original volcanic tuffs in Triassic time, that these metals were dissolved and/or mechanically transported by streams eroding the tuffaceous sediments, that they were later deposited with the sandstone and shales of the Silver Reef area, that further concentration of the metals in the Silver Reef Sandstone was by (1) solution in circulating ground water and (2) precipitation through contact with entombed plant debris and associated bacteria in more permeable buried Triassic stream channels. Folding, erosion and exposure of the ore horizon is assumed to have resulted in secondary enrichment of the ore deposits by meteoric waters. *Published abstract*

431. PURCELL, FRANCIS A., Jr., 1961, The geology of the western half of the Hurricane quadrangle [Washington County], Utah: Univ. of Southern California M. A. thesis, 143 p., geol. map.

The mapped area is in a zone of structural transition between the Colorado Plateau and Basin and Range Physiographic Provinces, and constitutes a portion of the hanging wall block of the Hurricane fault which parallels the eastern border of the mapped area less than 4 miles to the east. Nine formations ranging in age from Permian to Recent are exposed. Except for Quaternary basalts, the stratigraphic sequence is sedimentary, and consists mainly of nonmarine Mesozoic sediments.

Tectonic features are Laramide, the dominant one being the Virgin anticline. A variety of fault types occur. Due to intermittent uplift, topography is youthful and has marked surface relief. It is characterized by hogbacks dominating contiguous erosional valleys.

Archeological discoveries indicate human occupation of the area as early as and probably prior to Basketmaker time (300 A. D.-700 A. D.). Petroglyphs generally indicate the time necessary for development of desert varnish.

Former extensive production of silver from a sandstone member of the Chinle Formation has long ceased. Petroleum exploration has had negative results. Presence of a high-grade uranium claim and current geophysical explorations nearby are hopeful signs for future economic development.
Abstract revised (B. C.)

432. QUITZAU, ROBERT PETER, 1961, A regional gravity survey of the back valleys of the Wasatch Mountains and adjacent areas in Utah, Idaho and Wyoming: Univ. of Utah M. S. thesis.

A total of 407 new gravity stations was established with Worden gravimeter in an area where 120+ stations had been previously located. The purpose was to investigate the eastern margin of the north and central parts of the Wasatch Mountains and the "back valleys." Bear Lake Valley, Bear River Valley, Morgan Valley, Rhodes Valley and the valley of the Weber River near Henefer, Utah, are probably graben. The northern part of the Wasatch Range throughout the region between Heber City and Ogden Canyon is shown to be a horst.

Gravity data indicate location and amount of vertical displacement of East Canyon fault, Crawford Mountains fault, Morgan fault, newly discovered St. Charles and Milton fault zones, and newly proposed Lincoln Creek fault. The major structural trends are oriented generally north-south. The Milton fault zone, which may be one of the major eastern boundary faults of the Wasatch horst, is probably continuous in the region west of Ogden Valley and Morgan Valley for a distance of about 25-30 miles.

A trend at least 100 miles long extends along East Canyon fault zone, Toone Canyon fault, Lincoln Creek fault and Crawford Mountains fault and is thought to be the locus of structural movements from Laramide time to present. *From author abstract*

433. RANDALL, ARTHUR G., 1952, Areal geology of the Pinecliff area, Chalk Creek, Summit County, Utah: Univ. of Utah M. S. thesis, 43 p., geol. map.

In the Pinecliff area, Chalk Creek Valley, northeastern Utah, 4,500 feet of Cretaceous and 3,000+ feet of Tertiary rocks are exposed. Lower Cretaceous rocks include the Kelvin and Aspen Formations; upper Cretaceous rocks are represented only by the Frontier Formation. Tertiary rocks are represented by the Wasatch Group which in ascending order, consists of the Almy, Fowkes and Knight Formations.

Although Tertiary sediments largely obscure pre-Tertiary strata, the study indicates that Laramide and later periods of deformation have developed major folds and faults in the area between the Uinta Mountains and the Bridger Basin. In late Cretaceous compressional forces formed a northwest-trending anticline and syncline. Two periods of faulting, one in post-Coloradoan and one in post-Eocene time, affected the area. *Author abstract*

434. RATTÉ, CHARLES A., 1963, Rock alteration and ore genesis in the Iron Spring-Pinto mining district, Iron County, Utah: Univ. of Arizona Ph. D. thesis, 149 p.
(Abs.): Dissert. Abs., v. 24, No. 5, p. 1981-1982, 1963.

The Iron Springs-Pinto mining district is about 20 miles west of Cedar City in southwestern Utah. Mesozoic and Cenozoic sedimentary rocks have been intruded by quartz monzonite porphyry intrusives, of which Iron Mountain, Granite Mountain and Three Peaks have been exposed to erosion. Emplacement of the intrusives was accomplished by roof stoping and assimilation of the Navajo and older formations, and later by doming and upfaulting of the younger sedimentary rocks. Lithology of the Mesozoic strata in immediate vicinity of ore bodies is described. Homestake and Entrada Formations are correlated with Carmel and Entrada Formations of Colorado Plateau.

Iron ore occurs as limestone replacement deposits, fissure fillings and as open-space fillings in breccias. Special attention is given to iron ore occurrences in breccia zones and breccia pipe structures, not previously described in this district. Introduction of significant amounts of Si, Al, Fe, Mg and F early in the intrusive history produced fine-grained contact metasomatic skarn rock in the limestone and siltstone members of the Homestake Formation. Minerals developed include diopside, tremolite-actionolite, phlogopite, wollastonite, vesuvianite and calcite. Garnet is the predominant mineral developed in contact metasomatized limestone. The skarn zone increased the permeability of the limestone, and as mineralization progressed, the skarn minerals were replaced by magnetite while silica and lime were removed from the area by hot solutions.

The iron is believed to have been present in fluids residual from magmatic crystallization, which were released during the contact metasomatic and iron ore mineralization phases. Iron was also leached from the wall rock during the hydrothermal activity.

Abstract revised (B. C.)

435. RAWSON, RICHARD RAY, 1957, Geology of the southern part of the Spanish Fork Peak quadrangle [Utah County], Utah: Brigham Young Univ. M. S. thesis, 33 p., geol. map.

Rocks of Pennsylvanian, Permian, Triassic, Jurassic, Tertiary and Quaternary Systems were mapped over an area of 23 square miles located south of Spanish Fork Canyon in the southern Wasatch Mountains. Paleozoic and Mesozoic beds were folded during the Laramide orogeny, developing a sharp anticline and syncline exposed in Pole Canyon. Tertiary formations, where present, lie upon Paleozoic and Mesozoic formations with marked angular unconformity. The Wasatch Fault and other normal faults of the Basin-and-Range type are found near the mouth of Spanish Fork Canyon. Water is the most important economic resource developed in the area. Although extensive prospecting has taken place in and around the Dream mine, no ore has been produced.

Author abstract

436. REBER, SPENCER J., 1951, Stratigraphy and structure of the south central and northern Beaver Dam Mountains, Washington County, Utah: Brigham Young Univ. M. S. thesis.

______ 1951, Stratigraphy and structure of the south central and northern Beaver Dam Mountains, Utah: Compass, v. 29, No. 1, p. 81-88, geol. map; Intermountain Assoc. Petroleum Geologists, Guidebook to the geology of Utah, No. 7, p. 101-108.

Area of this report is about 120 square miles, lying 40 miles west of the boundary between the Great Basin and Colorado Plateaus Provinces. Precambrian granite, gneiss and schistose rocks crop out extensively in southwest corner of the area. The overlying sedimentary sequence includes Cambrian Prospect Mountain Quartzite (520 feet) and Pioche Shale (220 feet); lower Paleozoic undifferentiated carbonate rocks aggregating nearly 2,200 feet in thickness, exposed along a northwest-southeast-trending ridge on west side of area; Mississippian Redwall Limestone (1,100 feet) with a disconformity at base; Pennsylvanian Callville Limestone (1,560 feet); Pennsylvanian-Permian Supai-Coconino, massive, tan, yellow and white, fine-grained, cross-bedded sandstones (1,800 feet); Permian Kaibab Limestone (1,000 feet); Triassic Moenkopi Formation (2,100 feet) lying unconformably upon Kaibab, Shinarump Conglomerate (170 feet), and Chinle Formation (1,030 feet); and Jurassic Navajo Sandstone (2,200 feet). Younger rocks consist of Tertiary and Quaternary unconsolidated sediments and local Quaternary basalt flows.

Laramide orogeny initiated with local open folding along north-south trends. Thick deposits of conglomerate, shale and clays accumulated, perhaps in Miocene or Pliocene. Mississippian beds were thrust over Precambrian and Miocene beds in southwest part of area. Displacements up to nearly a mile long occur along major normal faults. Folding is generally less intense than in areas to the west. Overall structural pattern is slightly asymmetrical to the east.

Abstract of Guidebook article (B. C.)

437. REISER, ALLAN R., 1934, Occurrence, paragenesis and microscopic features of certain ores of the San Francisco mining district [Beaver County], Utah: Univ. of Utah M. S. thesis, 59 p.

Unaltered limestone is country rock in vicinity of Buckhorn orebody. Minerals present in order of paragenesis are quartz, pyrite, galena, anglesite, limonite and soluble iron sulfates. Galena was attacked by ferric sulfates and acid ferrous sulfates to produce lead sulfate which, under certain conditions, may be transported to zone of secondary enrichment.

Tremolite-diopside contact zone contains numerous small ore bodies of which the Double Barrell Tunnel bedded deposit is typical. This consists of an exposure about 2,000 feet from the limestone-monzonite contact. Paragenetic series (for this zone and garnet zone, below) is garnet, diopside, tremolite-wollastonite, quartz, pyrite, sphalerite, galena-chalcopyrite and supergene calcite.

The garnet zone is limited to a belt having maximum width about 200 feet at the contact with quartz monzonite.

The intrusive is a quartz monzonite.

A silicified lava outcrop, 1 mile north of the Horn Silver mine and just east of the monzonite, has been intensely altered by hypogene pyritization, sericitization, and silicification followed by supergene alunitization with minor deposition of secondary quartz. *Abstract revised (B. C.)*

438. REMINGTON, NEWELL CHRISTY, 1959, A history of the gilsonite industry: Univ. of Utah M. S. thesis.

This thesis is primarily an historical account of the Uinta Basin, Utah, and the development of the gilsonite industry. Various mines, veins and operations, and the importance of transportation are discussed. Report ends with characteristics, origin and uses of gilsonite. *B. C.*

439. RENZETTI, BERT LIONEL, 1952, Geology of the Scranton mine area, Tooele County, Utah: Indiana Univ. M. A. thesis, 32 p., geol. map.

_____ 1956, Geology of the Scranton mine area, Tooele County, Utah: Compass, v. 33, No. 3, p. 174-193, geol. sketch map.

Formations exposed in the Scranton mine area range in age from the Ordovician Ajax Dolomite to the Mississippian Great Blue Limestone. The lower Paleozoic formations are dominantly dolomites and the middle and upper Paleozoic formations are mainly argillaceous to pure limestones, quartzites and sandstones.

The Scranton mine area is located on the west flank of the asymmetrical, north-plunging Broad Canyon anticline. Drag folds generally trend roughly parallel to the major structure. Normal and tear faults cut the folds. Most conspicuous is the Scranton fissure zone, a series of closely spaced normal faults, which strikes northward and dips steeply to the west. Folding of the Broad Canyon anticline probably took place in Late Cretaceous.

Hydrothermal alteration and lead-zinc mineralization are genetically and spatially related to the Scranton fissure. Although the hydrothermal alteration is most intense near the fissure zone, it followed more routes and penetrated farther than the later ore mineralization which is confined to a narrow belt parallel to the Scranton fissure.

Galena and zinc blende mineralization occurred along the Scranton fissure zone and replaced adjacent, favorable limestone beds in the Pine Canyon and Gardner Formations. Subsequent oxidation resulted in the formation of lead carbonate and zinc carbonates and silicates. Possible bedded replacements may be below the known ore bodies. *Author abstract*

440. RHODES, JAMES A., 1955, Stratigraphy and structural geology of the Buckley Mountain area, south central Wasatch Mountains [Utah County], Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. ser., v. 2, No. 4, 57 p., geol. map.

The Buckley Mountain area occupies about 12 square miles of western margin of south central Wasatch Mountains to east of U. S. Highway 91 between Provo and Springville in central Utah County. Exposed sedimentary rocks totaling about 9,000 feet thickness have been divided into 12 formations: 2 Precambrian, 3 Cambrian, 5 Mississippian, 1 Mississippian-Pennsylvanian, and 1 Pennsylvanian. Other mapped units are a thin Cambrian diabase flow and unconsolidated Pleistocene lake sediments which lie unconformably against older rocks adjacent to the range front.

The area is dominated structurally by two distinct lines of Laramide folding which intersect at near right angles, a thrust fault of probably the same age, and Quaternary and older normal faults. Economic potential appears to be limited to sand and gravel excavation from Lake Bonneville sediments. *Abstract revised (B. C.)*

441. RICHMOND, GERALD M., 1955, Quaternary stratigraphy of the La Sal Mountains [Grand and San Juan Counties], Utah: Univ. of Colorado Ph. D. thesis, 207 p.
(Abs.): Dissert. Abs., v. 16, No. 6, p. 1127-1128, 1956.

_____ 1962, Quaternary stratigraphy of the La Sal Mountains, Utah: U. S. Geol. Survey Prof. Paper 324, 135 p.

The La Sal Mountains comprise three groups of laccolithic mountains on eastern margin of Colorado Plateau.

The area contains an unusually complete stratigraphic record of Quaternary sedimentation, erosion, and soil development, which yields evidence for at least nine glacial episodes and intervening interglacial intervals. The Quaternary deposits are subdivided into four formations, on each of which is a stratigraphically distinct soil profile whose degree of development characterizes that formation. Younger formations overlap older formations, or lie on erosion surfaces that dissect them. Formations are subdivisible into members, on each of which is a soil profile whose degree of development does not characterize a particular member. Members comprise several genetically distinct lithofacies having mutually gradational or interfingering relations.

Each stratigraphically distinct soil grades from higher to lower altitudes through four soil facies or Great Soil Groups, without change in relative development. This coincidence in relative development and relative stratigraphic position of soils is one of several criteria for correlating the Quaternary deposits of the La Sal Mountains with those of the San Juan Mountains, the Front Range, the Wind River Mountains, the High Plains of Kansas and Nebraska, and questionably with the drift sheets of the mid-continent region. A time-stratigraphic standard for the Rocky Mountain region is proposed.

The Quaternary stratigraphy of the La Sal Mountains demonstrates that a specific succession of geologic processes, presumably controlled by climate, dominated each glacial-interglacial cycle. During glacial intervals, widespread frost action, solifluction and glaciation caused stream regimen to change from erosion to coarse-grained alluviation. Eolian activity and fine-grained alluviation changing gradually to arroyo-cutting dominated late glacial and early interglacial time. Soil formation under conditions of essential slope stability followed. In late interglacial time stream erosion deepened and widened valley floors prior to the onset of the next glaciation. *From author abstract*

442. RIDD, MERRIL KAY, 1960, A new landform map for Utah: Univ. of Utah M. S. thesis, 66 p.

The first part of the written report concerns all significant original maps of Utah, and the second part concerns procedures of drawing the map. In order to show detail, the landform map and a horizontal scale of 1:500,000 were selected. A vertical scale index is used as a guide for displacing a given peak northward in accordance with its elevation above its local base, which permits the portrayal of each landform feature in proportion to its actual local relief. The result is a "Proportional relief landform map." *Abstract revised (B. C.)*

443. RIGBY, J. KEITH, 1949, Stratigraphy and structure of the paleozoic rocks in the Selma Hills, Utah County, Utah: Brigham Young Univ. M. S. thesis.

______ 1952, Geology of the Selma Hills, Utah County, Utah: Utah Geol. and Mineralog. Survey, Bull. 45, 107 p., geol. map.

The Selma Hills are a structural continuation of the East Tintic Range and are contiguous on the north to the Tintic mining district. They are in the eastern part of the Basin and Range Province and are characteristic of its structure.

About 3,500 feet of Paleozoic limestone, dolomite and sandstone are well exposed. The section, from base to top, consists of (Cambrian) Opex Dolomite, (Ordovician) Ajax Dolomite and Opohonga Limestone, (Silurian) Bluebell Dolomite, (Devonian) Victoria Quartzite and Pinyon Peak Formation, and (Mississippian) Gardner, Pine Canyon and Humbug Formations. These rocks show a marked thinning from the Tintic district due to inter-formational and intersystemic erosion. It is concluded that bank or shelf conditions existed in the area during middle Paloezoic time while the sedimentary rocks were mainly fine-grained carbonates. Geosynclinal sediments occur in the lower and upper Paleozoic and are characterized by coarse, and oftentimes terrigenous, detritus. Younger rocks are andesite tuffs and basaltic flow of Tertiary age and Quaternary alluvial and lacustrine deposits.

Three systems of faults are differentiated. The first are compressional, the second are transverse normal, and the third are longitudinal normal. Three imbricate thrust blocks are mapped and related to regional structure.

Abstract (Utah Geol. Survey Bull.) revised (B. C.)

444. ROBERTS, DAVID B., 1953, Relationships between lithology and microfossils in the Lower Tertiary [Green River Formation] of northeastern Utah: Univ. of Minnesota M. S. thesis, 51 p.

Ostracodes of the Green River Formation are of the family Cypridae, which is primarily fresh-water in habitat. Many species tend to occur in particular lithologies, but the disappearance of species upward through the formation is unexplained.

Heterocypris watsonensis and Cyprois marginata occur in limestones, dolomites, claystones and oil shales with no apparent ecologic control. Cypris pagei, Potamocypris williamsi, and Erpetocypris sp. occur most commonly in limestone. Cypris pagei may occur with large amounts of organic material. Candona, Erpetocypris and Potamocypris are rare. Cypridea bisulcata occurs both in carbonate rocks and in very bituminous, argillaceous rocks, favoring those with high calcite to dolomite ratios. Cyprois ravenridgensis occurs mainly in dark bituminous shales, always in rocks very low in calcite, but in some exceeding 20 percent dolomite.

Rocks high in calcite have relatively low pH and high Eh. Rocks high in sodium are low in carbonate minerals, have high pH and low Eh. The content of lipoid material varies directly as the darkness in color. *From author summary*

445. ROBERTS, PHILIP KENNETH, 1964, Stratigraphy of the Green River Formation, Uinta Basin, Utah: Univ. of Utah Ph. D. thesis, 212 p.
(Abs.): Dissert. Abs., v. 25, No. 4, p. 2450, 1964.

The Green River Formation is a dominantly lacustrine unit of Eocene age which occurs in parts of Wyoming, Colorado and Utah. This study concerns the Green River Formation deposited in Uinta Lake in the Uinta Basin of northeastern Utah. The Uinta Basin is a large asymmetrical syncline bounded by anticlinal features: Uinta Mountains (north), Douglas Creek arch (east), Uncompahgre uplift (southeast), San Rafael Swell (southwest) and Wasatch Mountains (west). The Green River Formation consists of marlstone, dolomite, oil shale, limestone, claystone, and sandstone (and siltstone), of which marlstone is the typical lithology. Shale, although present, is not listed because the term is structural-textural.

The formation is divided into four "intervals." These are, in ascending order, the Willow Creek (new term), Douglas Creek, Parachute Creek and Evacuation Creek intervals. The Willow Creek interval is characterized by ostracod, pelecypod and gastropod limestone and has a maximum thickness of 1,250 feet. The Douglas Creek interval is characterized by abundance of sandstone, and reaches a maximum thickness of 2,000 feet. Algal reefs, a few feet in thickness, are common. The Parachute Creek interval is characterized by oil shale and organic marlstone, and reaches a maximum thickness of about 1,200 feet. The Evacuation Creek interval is characterized by organic marlstone throughout most of the basin, and reaches a maximum thickness of about 600 feet. The lake level fluctuated continuously throughout Green River time, reaching its highest level in late Parachute Creek time, and becoming nearly dry at the close of Evacuation Creek time.

In the northern Uinta Basin, the Green River Formation consists of conglomerate, sandstone and shale, representing debris eroded from the Uinta Mountains and deposited along the northern shore of Uinta Lake. Numerous intraformational unconformities are present, but the intervals described above cannot be differentiated. *Abstract revised (B. C.)*

446. ROBISON, RICHARD ASHBY, 1958, Upper Cambrian trilobites of western Utah: Brigham Young Univ. M. S. thesis.

_____ 1960, Some Dresbachian and Franconian trilobites of western Utah: Brigham Young Univ. Research Studies, Geol. Ser., v. 7, No. 3, 59 p.

Fossils were collected from ten measured sections in western Utah. In the vicinity of the House Range, where the thickest section is found, the Upper Cambrian is comprised of the Weeks, Orr, Dunderberg, and Notch Peak Formations. Upper Cambrian rocks of central Utah have been subdivided into three units known as the Opex, Dunderberg, and Ajax Formations.

Representatives of six of the seven standard Upper Cambrian trilobite zones have been recognized. They are, from oldest to youngest: Cedaria, Crepicephalus, Aphelaspis, Elvinia, Ptychaspis-Prosaukia, and Saukia. The Cedaria, Crepicephalus and Elvinia zones are the most prolific in numbers of trilobite species preserved, but the Aphelaspis zone is by far the most abundantly fossiliferous zone encountered. Fifty-two trilobite species have been identified and most of them are described.

Faunal evidence indicates that the Weeks and Orr Formations are equivalent to the Lamb and Hicks Formations in western Utah, and to the Opex Dolomite in central Utah. The name, Dunderberg Shale, has been extended from central Nevada into western Utah for the widespread shale unit which marks the base of the Franconian. The Notch Peak Limestone of western Utah is equivalent to the Ajax Limestone of central Utah. *From published abstract*

447. ROBISON, RICHARD ASHBY, 1962, Late Middle Cambrian faunas from the Wheeler and Marjum Formations of western Utah: Univ. of Texas Ph. D. thesis, 304 p.
(Abs.): Dissert. Abs., v. 23, No. 5, p. 1661, 1962.

_____ 1964, Late Middle Cambrian faunas from western Utah: Jour. Paleontology, v. 38, No. 3, p. 510-566.

The Wheeler and Marjum Formations of western Utah contain from 1,400 to 1,800 feet of limestone and shale in one of the thickest, best exposed, and most fossiliferous successions of upper Middle Cambrian strata in North America. During the present study, seven stratigraphic sections were measured in the House Range and Drum Mountains, fossils were systematically collected, and the stratigraphic positions of all collections were recorded. From the fossils that were collected, 43 species of trilobites, 8 species of brachiopods, 1 species of ecocrinoid, 4 species of molluscs, and 2 species of porifera are described. Three general and 21 species of trilobites are new. The new genera are Trymataspis, Utagnostus and Utaspis; the new species are Baltagnostus eurypyx, Bathyuriscus fimbriatus, Bolaspidella contracta, Bolaspidella drumensis, Brachyaspidion sulcatum, Cotalagnostus laevus, Elrathia alapyge, Elrathia marjumi, Goniagnostus akanthodes, Hemirhodon amplipyge, Homagnostus incertus, Lejopyge calva, Linguagnostus perplexus, Modocia brevispina, Modocia laevinucha, Modocia nuchaspina, Peronopsis segmenta, Trymataspis depressa, Trymataspis lomaleie, Trymataspis pristina, and Utagnostus trispinulus. Abundant silicified specimens have provided new information concerning the morphology and ontogeny of agnostid trilobites.

Trilobites from the Wheeler and Marjum Formations belong to the Bolaspidella Assemblage Zone of the "standard" Cambrian biostratigraphic column for North America. Three local assemblage subzones are defined, which from oldest to youngest are named for the index species Bathyuriscus fimbriatus, Bolaspidella contracta, and Lejopyge calva. It is proposed here that stratigraphers should continue to place the Middle-Upper Cambrian boundary in North America between rocks that contain faunas of the Bolaspidella and Cedaria Zones.

From author abstract

448. RODRIGUEZ, ENRIQUE LEVY, 1960, Economic geology of the sulphur deposits at Sulphurdale [Millard and Beaver Counties], Utah: Univ. of Utah M. S. thesis, 74 p., geol. map.

An 18-square-mile area in Millard and Beaver Counties was mapped. Normal faults are important structural features. A horst bounded by Tertiary faults has a stratigraphic sequence 2,600 feet thick, consisting of Pennsylvanian Oquirrh Limestone; Permian Pakoon Limestone, Coconino Sandstone and Kaibab Limestone. Graben to east is composed mainly of Tertiary volcanic flows and Cretaceous Price River conglomerate. Flows are porphyritic quartz latites, latites and andesites; pyroclastics are mainly andesitic lapilli tuffs. Basalt flows were extruded and cinder cones rose from valley floor during Pleistocene and Recent times. Stratified beds of tuff were deposited in shallow lakes created by damming of streams by flows.

Three main types of sulphur deposits are found: sulphur deposits in water-laid tuffs, in conglomerate and in recent breccia talus slopes. Present in the deposits are the ore minerals-sulphur and iron sulphides, and the gangue minerals-siliceous sinter, gypsum and quartz. A composite mineralogical zoning is proposed for the predominant minerals from top to bottom: gypsum; gypsum and sulphur; sulphur; sulphur, pyrite and marcasite; pyrite and marcasite; pyrite. The deposits are undoubtably associated with solfataric thermal springs. Low-temperature, silica-bearing solutions rich in hydrogen sulphide have permeated favorable beds depositing sulphur near the water table.

Abstract revised (B. C.)

449. ROGERS, ALLEN STUART, 1954, The physical behavior and geologic control of radon in mountain streams: Univ. of Utah Ph. D. thesis.

The distribution of radon in stream waters and related springs was investigated in the Wasatch Mountains adjacent to Salt Lake City, Utah, and in a part of the Weber River near Ogden, Utah. The radon distribution in the stream waters studied forms a definite pattern which is dependent upon the local influx of relatively large amounts of radon-bearing ground water into the stream, and, in turn, the ability of the stream to lose its radon to the atmosphere through turbulence. Radon content of streams varied from 1 to 450 micro-microcuries per liter; content of spring waters was generally higher. High-radon anomalies can usually be related to definite stratigraphic horizons or structural features. Amount of ground water being added to stream can be estimated in some cases by radon measurements of stream waters and related springs. Almost complete disequilibrium occurs between radon and its parent radium in stream and spring waters in this area. *From author abstract*

450. ROOT, ROBERT L., 1952, Geology of the Smith and Morehouse-Hayden Fork area [Summit County], Utah: Univ. of Utah M. S. thesis, 58 p., geol. map.

The Smith and Morehouse-Hayden Fork area is located in the drainages of the upper Weber River and the western portion of the Bear River near their source in the north flank of the Uinta Mountains.

Rocks present in the area include formations of Precambrian, Paleozoic, Mesozoic and Cenozoic ages.

The structural history of the Uinta Mountains is considered to be divisible into three phases: (1) Uinta Arch, consisting of Laramide, (2) Main Uinta Uplift, consisting of vertical uplift in Eocene time and (3) Regional Uplift, affecting a large area of the West. The Uinta Arch phases is divided into three episodes: (1) Post Frontier-Pre "Wanship" episode, a precursor of the Laramide orogeny, (2) Moffit thrust episode, a culmination of the Laramide orogeny, producing overturning of folds and development of thrust faults locally along the north flank of the Uinta Mountains and (3) Wasatch episode, representing the termination of the Laramide.

Physiographic development of the Uinta Mountains is treated briefly, and the significance of landslides as an important factor in the Recent erosional cycle is stressed. *Author abstract*

451. ROSE, ARTHUR W., 1958, Trace elements in sulfide minerals from the central mining district, New Mexico, and the Bingham district, Utah: California Inst. Technology Ph. D. thesis, 264 p.
(Abs.): Econ. Geol., v. 54, No. 7, p. 1355, 1959; Geol. Soc. America Bull., v. 70, No. 12, pt. 2, p. 1664, 1959.

One hundred forty-three samples of chalcopyrite, 230 samples of sphalerite, and a few samples of other hydrothermal minerals from the Central and Pinos Altos mining districts of New Mexico, and the Bingham mining district of Utah, were analyzed spectrographically for trace element content. Most of the sphalerites were also analyzed for iron content by an X-ray fluorescence method.

In the chalcopyrite and sphalerite from both districts the trace element contents are found to fall readily into two or more groups, which can generally be distinguished geographically, and also show geologic and mineralogic differences.

Variability in trace element content of chalcopyrite and sphalerite within mining districts indicates that four or more properly selected samples are necessary to obtain a valid mining district average for use in regional studies.

The large variability of iron content of sphalerite within districts, mines, and even veins and single crystals is believed to result in part from variations in temperature, in part from lack of equilibrium between the sphalerite and the adjacent minerals and fluid during deposition, and in part from equilibrium with pyrite rather than pyrrhotite. It is suggested that the iron content of sphalerite is most correctly interpreted to give a minimum temperature of deposition; that is, the temperature of deposition was at least as high as the value indicated by the iron content on the solvus of the FeS-ZnS system.

Abstract revised (B. C.)

452. ROSS, REUBEN J., Jr., 1948, The stratigraphy of the Garden City Formation of northeastern Utah and its trilobite faunas: Yale Univ. Ph. D. thesis, 367 p.

In northeastern Utah the Garden City Formation varies in thickness from 1,200 to nearly 1,800 feet. It is easily distinguished from the dolomite of the underlying St. Charles Formation and from the shales, siltstones and quartzites of the overlying Swan Peak Formation. The Garden City beds can be divided lithologically into two members, the lower composed predominantly of intraformational conglomerate and the upper of irregularly laminated, very cherty limestone.

Widespread faunal zones indicate that its lower and upper boundaries vary little, if at all in age. A sequence of 12 of these zones, distributed throughout the formation, prove it to be mostly Canadian in age and contemporaneous with at least a part of the Pogonip Formation of Nevada. The upper 30-50 feet are faunally allied with the overlying Swan Peak Formation and are of Chazyan age.

On the basis of trilobites the lower 60-150 feet are correlated with the Tribes Hill and Stonehenge Formations of the East. Sparsity of published information on the trilobite faunas of the standard North American section for the Lower Ordovician prevents detailed correlation of the middle portion of the Garden City Formation

Its prolific trilobite fauna includes more than 80 species; 43 of these are described and represent 24 genera, of which 15 are new. The remaining 37 species are illustrated; their description will be undertaken in the near future.

A discussion of the evolutionary trends illustrated by five species of Pliomerid trilobites is presented with a record of the ontogeny of <u>Protoliomerops supercilius</u> Ross, n. sp.

Evidence is presented for a northwesterly source of the clastics of the Swan Peak Formation.

Author abstract

453. RUSH, RICHARD W., 1954, Silurian rocks of western Millard County, Utah: Columbia Univ. Ph. D. thesis.

_____ 1956, Silurian rocks of western Millard County, Utah: Utah Geol. and Mineralog. Survey, Bull. 53, 66 p.

More than 1,000 feet of Silurian dolomitic strata, 650 feet of which are asphaltic, occur in western Millard County, Utah. The paleontological evidence supports the establishment of a definite Ordovician-Silurian boundary in this area. The Siluro-Devonian boundary is still questionable because of the scarcity of fossils. The evidence supports subdivision of Silurian strata into three lithic units--Roberts Mountain, Jack Valley and Decathon Formations in ascending order.

Jack Valley and Decathon are new names, and the Jack Valley is a newly recognized lithic unit. Kings Canyon is a new term for questionable Devonian dolomites above the Decathon. These new names apply to the Garrison area only.

Upper Ordovician (Fish Haven) beds and Silurian (Roberts Mountain) are divided into lithic sub-units. Only four of the seven sub-units of the Roberts Mountain Formation at Big Spring, Nevada, are present 50 miles eastward in the Ibex Hills-Kings Canyon area of the Confusion Range, east of Garrison, Utah. The lowest units (Nos. 1 and 2) and a middle unit (No. 4) are absent in the Confusion Range. Regional age relationships are somewhat dependent on unit 4 because this unit contains a pentamerid fauna which is a guide to Silurian rocks.

The Garrison area is the transition zone of two Silurian rock types. West of the Garrison area certain Silurian units yield a pentamerid fauna and eastward into Utah, Silurian rocks are asphaltic dolomite containing cephalopods, which, although uncommon, can be used to identify the rock.

Published abstract

454. SADLICK, WALTER, 1955, The Mississippian-Pennsylvanian boundary in northeastern Utah: Univ. of Utah M. S. thesis, 77 p.

_____ 1955, Carboniferous formations of northeastern Uinta Mountains: Wyoming Geol. Assoc. Guidebook, 10th Ann. Field Conf., Green River Basin, p. 49-59.

_____ 1959, Illustrated sections of strata adjustment adjacent to the Mississippian-Pennsylvanian boundary, western Uinta Mountains: Intermountain

Assoc. Petroleum Geologists Guidebook, 10th Ann. Field Conf., p. 75-81.

Stratigraphic paleontologic investigation of the Mississippian "black shale unit" and the overlying lower lime member of the Pennsylvanian Morgan Formation of the Uinta Mountains has yielded evidence concerning the position of the Mississippian-Pennsylvanian boundary in Utah. The black shale unit contains typical Chester forms. Rhipodomella nevadensis (Meek) overlies this fauna in the upper beds of the Manning Canyon Shale of the Great Basin but has not been found in the black shale unit. However, a Rhipodomella nevadensis assemblage occurs in the basal beds of the lower lime member of the Morgan Formation. Present evidence indicates a correlation of the black shale unit with the Manning Canyon black shale of the Great Basin.

The presence of a mixed typical Chester and Lower Pennsylvanian assemblage with abundant specimens of Rhipodomella nevadensis (Meek) and Schizophoria texana Girty arbitrarily define the Springer Series in Utah. The lower lime member which contains such an assemblage in the lower portions, has been traced to the type section of the Morgan Formation and is found to underlie it; furthermore, it has been included as a part of the Brazer Formation by previous geologists. Since this lower lime member is a distinct lithologic unit, a new name, Round Valley Limestone, is proposed. *From author abstract*

455. SADLICK, WALTER, 1965, Biostratigraphy of the Chainman Formation (Carboniferous), eastern Nevada and western Utah: Univ. of Utah Ph. D. thesis, 227 p.
(Abs.): Dissert. Abs., v. 26, No. 10, p. 5978, 1966.

The Chainman Formation was deposited in the Cordilleran geosyncline and was derived from early Paleozoic eugeosynclinal rocks that were thrust over miogeosynclinal strata during the Antler orogeny. The formation contains a classical regressive facies, and is, therefore, a clastic wedge deposited in an exogeosyncline.

The Chainman (about 2,000 feet thick along the Utah-Nevada boundary) is divided into 6 intertonguing members: basal 500-foot siltstone, 15-foot limestone marker bed, 500- to 1,800-foot dark (fondothem) shale unit with an upper deltaic meiorogenic facies, 250-foot molasse conglomerate and coarsely clastic unit which thins eastward, 300-foot limestone unit formed as carbonate banks, and upper 450-foot alluvial coastal plain and neritic facies.

Seven faunal zones are useful in interpretation. Lower part of dark shale unit contains three cosmopolitan goniatite zones of Visean age (Valmeyeran and early to middle Chesterian): Goniatites cf. crenistria Zone, Goniatites multiliratus Zone, and Goniatites granosus Zone. Namurian (middle Chesterian) Cravenoceras hesperium Zone occurs in thick neritic facies indicating that the Antler belt was being actively eroded. Spirifer brazerianus Zone (middle late Chesterian) occurs within C. hesperium Zone in upper limestone and Caninia cf. nevadensis and Caninia cf. excentrica, which locally formed biostromes, are common in upper beds of this limestone. Lower part of the uppermost unit contains a Namurian "Zone" of "Tumulites" Eumorphoceras varians (late Chesterian) in which Cravenoceras hesperium is prolific. Uppermost Chainman and basal Ely Limestone contain Rhipodomella nevadensis Zone; Eumorphoceras cf. bisulcatum helps date zone as late Chesterian.

Hierarchy of two dalmanellid brachiopods is refined and Rhipodomella nevadensis is redescribed. Genus Orthotichia is placed in synonymy with Schizophoria. Specimens formerly identified as Schizophoria texana (Early Pennsylvanian) are described as a new subspecies.

Worthenia tenuilineata (Gastropoda) is designated type species of a new subgenus, thus supporting Mississippian age of highest Chainman strata. *Abstract revised (B. Y. S. and B. C.)*

456. SALTER, ROBERT JOEL, 1966, Primary sedimentary structures, petrography and paleoenvironments of the Gartra Member of the Chinle Formation in northern Utah: Univ. of Utah M. S. thesis, 91 p.

The Gartra Member of the Chinle Formation of Triassic age is a cross-bedded, gray to yellow to pink, locally conglomeratic sandstone of fluvial origin which crops out mainly along the southern flank of the Uinta Mountains and in the central Wasatch Mountains of northern Utah. Thickness is variable, averaging about 40 feet. Grains are mainly quartz (95 percent) with accessory orthoclase, microcline, plagioclase and traces of muscovite. Cross-strata orientations, gravel fabric, and the lineation of channel lenses indicate that the Gartra was derived from a source in west central Colorado and deposited by a westerly flowing stream. Various factors indicate the old Uncompahgre uplift and the late Paleozoic sedimentary rocks surrounding it as sources of detrital material.

The Gartra Member is relatively unfossiliferous. On the basis of stratigraphic position, it is considered to be of early Late Triassic age. The Gartra does not correlate with the Shinarump nor with any specific rock unit in Wyoming. The Higham Grit in southeastern Idaho probably occupies a very slightly higher stratigraphic position, but is correlative in other respects. It is proposed that the term "grit" is not valid when referring to the Gartra Member in northern Utah. *Abstract revised (B. C.)*

457. SANDERS, DAVID T., 1962, The mineral resources of the Sevier River Drainage, central Utah: Utah State Univ. M. S. thesis.

Although mining and exploration have ceased in most mining districts due to low prices and high costs, the Main Tintic, West Tintic, Erickson and Detroit districts would warrant development under favorable market conditions. Marysvale district is most active. Significant beryllium occurrences have been discovered in the western part of the Sevier drainage.

Alunite, fluorspar, gypsum, halloysite, bentonite, Fuller's earth, salt, sand and gravel are the most important nonmetallic mineral and rock products. The area contains the largest known fluorspar reserves in Utah, but present market conditions prevent their production. The alunite deposits near Marysvale are the most extensive economic mineral occurrence in the area. Although currently being mined for use as fertilizer, the full development of these deposits is dependent upon the discovery of an economical process for the extraction of alumina and potash. Volcanic rock products, calcite, aragonite, sulfur and building stone also occur in quantities sufficient to sustain current and expanded development.

Further development of groundwater reservoirs is possible, but due to the present state of equilibrium between surface water and groundwater in the eastern part, development would depend upon the cooperation between the present users in entire drainage area.

Although favorable stratigraphic and structural situation exists, no commercial accumulations of oil and gas have been discovered.

Abstract revised (B. C.)

458. SARGENT, ROBERT EDWARD, 1953, Geology of the new Bullion mine area, Tooele County, Utah: Indiana Univ. M. A. thesis, 49 p., geol. map.

The new Bullion mine area lies on the fringe of the major mining district of Tintic, Utah. Sedimentary rocks exposed in the area range in age from the lower Ordovician Opohonga Limestone to the upper Mississippian Great Blue (?) Formation. Quaternary alluvium covers much of Rush Valley, to the west.

The major structure of the area is represented by the west limb of the north-trending Broad Canyon anticline. Minor folds are superimposed on this major fold. All folds in the area plunge to the northwest. Two sets of faults cut the fold. One set strikes northeast, the other set strikes northwest and has a larger apparent horizontal displacement.

Hydrothermal alteration and mineralization within the area include the following types: (a) dolomite and rhombohedral calcite, (b) jasperiod, (c) ferruginous calcite and (d) ore sulphides. Though paragenetic relationships could not be established for all types, they generally appear to follow the sequence suggested by Lovering for the East Tintic district. Mineralization shows a preference for northeast-trending fault structures.

Geochemical prospecting offers a new tool for detailed exploration in the area. A proposed sample grid for soil samples to be analyzed for possible heavy metal content is included. *Author abstract*

459. SAUER, FRANK J., 1956, The Springdale Sandstone in the Zion Canyon region in southwestern Utah [Iron and Washington Counties]: Univ. of Nebraska M. S. thesis, 41 p.

The Springdale Sandstone of the Moenave Formation is a consistent, easily recognized unit, and will probably be an excellent marker bed. At the type locality, Springdale, Utah, it is a light gray to light red lenticular sandstone with minor mud-pebble conglomerate, varying in thickness from 110 to 150 feet. It has been traced to its northern exposure near Cedar City, where it is 180 feet thick.

During Laramide compression the Kanarra fold was initiated, but was broken by the Taylor Creek thrust fault at an early stage of folding. Continued folding culminated in an asymmetrical fold. Later relaxation resulted in the Hurricane fault, and local readjustment resulted in some of the minor faults (Cougar Mountain and the Black Wash fault).

Author abstract

460. SAYYAH, TAHA AHMED, 1965, Geochronological studies of the Kinsley stock, Nevada, and the Raft River Range [Box Elder County], Utah: Univ. of Utah Ph. D. thesis, 99 p. (Abs.): Dissert. Abs., v. 26, No. 1, p. 403, 1965.

Five Pb-α radioactive and two Rb-Sr isotopic age determinations were made on the igneous rocks of the Kinsley stock in east central Nevada, together with two Rb-Sr determinations on crystalline rocks of the Raft River Range of northwestern Utah. An age of 60 ± 5 m.y. for the Kinsley quartz monzonite was obtained by both the Pb-α and the Rb-Sr (using biotite) methods. An age of 40 ± 2 m.y. by both Pb-α and Rb-Sr methods has been obtained for the quartz latite porphyry dikes intruding the Kinsley stock.

A semiquantitative analysis of the heavy accessory minerals indicates that the heavy mineral suite of the Kinsley stock consists of: magnetite, sphene, apatite and zircon in a decreasing order of relative abundance. This assemblage is characteristic of a CaO-rich rock. The pluton contains about 3.4 percent CaO.

A qualitative spectrochemical analysis of the trace elements in the heavy accessory minerals of the Kinsley stock shows that: magnetite contains Al, Cr, Co, Cu, Ga, Mn, Mo, Ni, Ti, V and Zn; sphene contains Al, Ce, La, Nd, Sm, Tm, Yb and Y; apatite contains Ce, La, Mn, Nd, Sm, Sc, Yb and Y; and zircon contains Hf, Nd, Sm, Th, U, Yb and Y in their lattices. This analysis indicates that the quartz monzonite and latite porphyry dike of the Kinsley stock have been formed from the same source magma.

An age of 2,430 m.y. has been obtained for the massive granite of the Raft River Range by a whole rock Rb/Sr determination, indicating that the igneous rocks of that area represent the oldest rock so far known in Utah. An age of 3,732 m.y. was obtained for the granite gneiss of this Range, but this age is very doubtful because it is based only on one whole rock Rb/Sr determination and this age is greater than any previously reported on this continent. The isotopic ages of the Raft River Range obtained here were correlated with ages obtained on the older Precambrian basement complex of the Rocky Mountains by other investigators.

From author abstract

461. SCHAEFFER, FREDERICK ERNST, Jr., 1961, Geology of the central and southern Silver Island Mountains, Tooele County, Utah, and Elko County, Nevada: Univ. of Utah Ph. D. thesis.
(Abs.): Dissert. Abs., v. 22, p. 2361.

_____ and W.L. Anderson, 1960, Geology of the Silver Island Mountains, Box Elder and Tooele Counties, Utah, and Elko County, Nevada: Utah Geol. Soc., Guidebook to the Geology of Utah, No. 15, 185 p., geol. map.

The Silver Island Mountains lie in the northeastern Basin and Range Province. Approximately 23,600 feet of predominantly miogeosynclinal strata are exposed as follows (maximum thickness in feet). Cambrian--Prospect Mountain Quartzite (1,405), Pioche Shale (285), Busby Quartzite (570?), undifferentiated Millard, Burrows? and Burnt Canyon? Limestones (1,708?), Dome Formation? (355), Condor Formation (265), restricted Swasey Limestone (305), Wheeler Shale (280), Marjum Limestone (290), Weeks Formation (310), Notch Peak Formation (1,865); Ordovician--Garden City Formation (3,130), Kanosh Shale (165), Lehman Formation (770), Swan Peak Quartzite tongue (5), Crystal Peak Dolomite (120), Eureka Quartzite (370), Fish Haven Dolomite including Floride Dolomite Member (505); Silurian--Laketown Dolomite (1,140); Devonian--Simonson Formation (1,270), Guilmette Limestone (2,230) and Pilot Shale (425).

These strata are unconformably overlain by the Mississippian Joana Limestone (270) which is, in turn, unconformably overlain by the Chainman and Diamond Peak Formations undivided (1,140). The latter are overlain by 1,740 feet of Morrowan-lower Desmoinesian beds and 2,550+ feet of middle Virgilian-lower Guadalupian beds, the eastern facies of which is referred to as Oquirrh Formation.

Five paraconformities are indicated in lower Paleozoic rocks. Unconformities indicate Late Devonian-Early Mississippian westward tilting of strata, Middle Mississippian folding and erosion (Wendover phase of Antler orogeny) and Pennsylvanian tilting and/or folding (northeast Nevada high). North- to northeast-trending folds of Antler orogeny were intensified during Nevadan and/or Laramide orogeny.

Early Tertiary normal faults probably created basins in which the early volcanics, the probable Early Tertiary sediments, and the Salt Lake Group (2,800+) accumulated. Disparity in strike of these major internal normal faults with Late Tertiary Basin-and-Range block faulting is 45°-90°. Granitic bodies and subsequent early volcanic rocks were intruded by porphyry stocks and dikes. Basin-and-Range faulting along the southeastern margin of the range is post-Salt Lake Group and pre-late volcanics.

Abstract revised (B. C.)

462. SCHICK, ROBERT BRYANT, 1955, Geology of the Morgan-Henefer area, Morgan and Summit Counties, Utah: Univ. of Utah M. S. thesis, 54 p., geol. map.

The sequence of rocks exposed in the Morgan-Henefer area, 25 miles northeast of Salt Lake City, includes Cambrian, Devonian, Mississippian, Pennsylvanian, Permian, Triassic, Jurassic, Tertiary and Quaternary strata. Round Valley Limestone (Pennsylvanian) and Huntsville Fanglomerate (Pliocene) have been newly recognized. Triassic rocks have been reclassified into Moenkopi Group, Shinarump (?) Formation and Chinle Formation.

The area shows evidence of five or more orogenic impulses. The Durst Mountain thrusting of the Cedar Hills orogeny in early (?) Cretaceous was followed by reverse faulting in the Paleocene, and uplift and reverse faulting in the Eocene (East Canyon fault initiated). During Oligocene and Miocene time volcanism resulted in deposition of the Norwood tuff followed by folding (Morgan Valley syncline), normal faulting (Morgan fault initiated), and then by erosion which attained greatest development in Miocene time. During this erosion interval the Herd Mountain erosion surface was formed. Normal faulting in Pliocene time gave rise to the Huntsville Fanglomerate, and subsequent erosion created the Weber Valley surface in late Pliocene and early Pleistocene (?) time. The Weber Valley surface was later dissected, probably because of faulting and lowering of the base level west of the Wasatch Mountains. *Abstract revised (B. C.)*

463. SCHINDLER, STANLEY FRED, 1952, Geology of the White Lake Hills [Utah County], Utah: Brigham Young Univ. M. S. thesis, 66 p., geol. map.

The mapped area embraces approximately $4\frac{1}{2}$ square miles between West Mountain and Long Ridge, eastern Basin and Range Province. Nearly 7,000 stratigraphic feet of sedimentary strata is divided into 14 bedrock formations as follows: 8 Cambrian (2,468 feet thick), 1 Devonian (129 feet thick) and 1 Permian (thickness undetermined). Lake Bonneville sediments and later alluvial deposits are conspicuous in some of the lower slopes.

Crustal movements of the early Laramide orogeny caused thrust and associated tear faulting which resulted in complex structural pattern. The general direction of thrusting was from west to east.

Limestones and dolomites having chemical compositions suitable for use in manufacture of steel appear to be most valuable resource. Prospecting for metalliferous ores has not been successful.
Abstract revised (B. Y. S.)

464. SCHLEH, EDWARD E., 1963, Upper Devonian to Middle Pennsylvanian discontinuity-bounded sequences in a part of the Cordilleran region: Univ. of Washington Ph. D. thesis. (Abs.): Dissert. Abs., v. 24, No. 11, p. 4636, 1964.

Regional integration of stratigraphic data dealing with Upper Devonian to Middle Pennsylvanian rocks in eastern Nevada, northern Utah, southeastern Idaho, western Montana, Wyoming and Colorado, leads to the recognition of three regional unconformities (discontinuities) that divide this part of the stratigraphic record into natural rock units. Included in the present study are three named sequences: the Tamaroa, Crow (new name) and Absaroka (restricted).

The base of the Tamaroa sequence is marked by one or more unconformities under Cyrtospirifer-bearing Upper Devonian to lower Kinderhookian rocks. The Upper Devonian to Chesteran Tamaroa sequence contains a lower widespread crinoidal limestone lithosome (Leadville, Madison, Deseret, Gardner, Joana, etc.); an upper eastern limestone (Great Blue and "Brazer"), and an upper western shale, sandstone and conglomerate (Chainman - Diamond Peak, Woodman, Humbug, etc.).

The subCrow discontinuity is developed under rocks of about post-Chesteran and pre-Morrowan to Morrowan age and is well documented in the eastern part of the region. Rocks of the Crow sequence range in age from post-Chesteran and pre-Morrowan to Atokan. Included in the eastern part of the region are the Kerber, Glen Eyrie, Belden, Amsden, Soapstone, Round Valley, etc. In Idaho, central Utah and Nevada, limestone predominates.

The Absaroka sequence is restricted to rocks above the sub-Desmoinesian discontinuity. Evidence points to the existence of the discontinuity in Montana, Wyoming, Colorado, Idaho and eastern Utah, but farther west its presence cannot be demonstrated conclusively. In the eastern part of the region the basal Absaroka (restricted) is predominantly sandstone (Fountain, Minturn, Tensleep, Casper, Quadrant, Weber, Wells, Wood River, Morgan, etc.), but progressively more carbonates are encountered in the western sections.

Local effects of late Paleozoic orogenic belts (Antler and "Ancestral Rocky Mountains") are superimposed upon regional sequences. *Abstract revised (B. C.)*

465. SCHMITT, LEONARD J., Jr., 1964, A lithic description of the Cutler Formation in the Big Indian Wash [San Juan County], Utah: Columbia Univ. M. A. thesis, 64 p.

The Cutler Formation underlies the Chinle in Big Indian Wash. A detailed lithic differentiation of the Cutler is described and investigation of the nature and extent of iron distribution, calcite and silica mineralization, and alteration of biotite and plagioclase was undertaken using microscopic and X-ray spectrographic techniques. Data establishes the removal and redistribution of iron in the Cutler, at least two periods of silica mineralization, attack and replacement of detrital minerals by calcite, but reveals no relationship between "bleaching" and the degree of alteration of detrital grains. The cause of bleaching was not fully determined.
Author abstract

466. SCHOFF, STUART L., 1931, Oolites in the Manti Formation of [Sanpete County] central Utah: Ohio State Univ. M. A. thesis, 54 p.

The Manti Formation consists of gray, platy limestone, cream-colored, platy, oolitic limestone, gray and blue shales, and some sandstone, with a total thickness of about 300 feet. It lies above the Wasatch Formation in Sanpete Valley, and is roughly equivalent to the Green River Formation.

Thin and polished sections of Manti Formation oolites and thin-sections of oolitic grains from the Great Salt Lake were examined under petrographic and binocular microscope.

The oolites of the Manti Formation developed in an environment unlike the Great Salt Lake, probably in fresh water. They are probably of inorganic origin. The grains are generally equally developed on all sides and show no sign of movement or abrasion. Many lack definite nuclei, although some crystallized about two centers. Silicification begins in the matrix, but recrystallization begins in the grains, generally destroying their internal structure. Oolitic grains are closely spaced but crystals outside grains are not oriented, indicating compaction during formation of grains, but not during recrystallization. Oolitic grains probably have not grown during recrystallization by addition of material from the matrix. *B. C.*

467. SCHOFF, STUART L., 1937, Geology of the Cedar Hills [Sanpete, Utah and Juab Counties], Utah: Ohio State Univ. Ph. D. thesis.
(Abs.): Geol. Soc. America Bull., v. 52, No. 12, pt. 2, p. 1931-1932, 1941.

_____ 1951, Geology of the Cedar Hills, Utah: Geol. Soc. America Bull., v. 62, No. 6, p. 619-646, geol. map.

The Cedar Hills occupy an area of about 320 square miles in central Utah between the northern end of the Wasatch Plateau and the southern end of the Wasatch Mountains, in the boundary zone between the Colorado Plateaus and the Great Basin. The oldest exposed rocks are of Carboniferous age, but most of the area is underlain by Upper Cretaceous and Tertiary continental sediments many thousands of feet thick. The Indianola Group alone is about 15,000 feet thick. It consists principally of coarse conglomerates and sandstones indicative of nearby orogeny but also contains a tongue of fossiliferous marine sandstones that show that it is of Colorado age. This group is overlain unconformably by a thick series of fluviatile and lacustrine deposits ranging from Montana to Eocene in age (Price River, North Horn, Flagstaff, Wasatch and Green River Formations), which in turn are overlain unconformably by pyroclastic rocks of probably late Tertiary age. The area was subjected to compressive orogenic disturbances in middle Cretaceous, upper Cretaceous (Montana) and probably middle Tertiary time, and to the normal faulting of the Basin-Range disturbance in late Tertiary time.

Published abstract (1941)

468. SCHREIBER, JOSEPH FREDERICK, Jr., 1958, Sedimentary record in Great Salt Lake, Utah: Univ. of Utah Ph. D. thesis, 99 p.
(Abs.): Dissert. Abs., v. 19, No. 4, p. 773-774, 1958.

A total of 111 feet of relatively undisturbed sedimentary core was recovered from six coring stations occupied in the southern part of Great Salt Lake. Additional samples and sedimentation records were studied from the area adjoining the lake. Very calcareous silt and clay with oolites and abundant faecal pellets (type I lithology) occur in Great Salt Lake today as well as in the upper intervals of the lake cores. High carbonate content, pellets, brine shrimp egg capsules and oolites indicate a very saline environment. Deeper core intervals contained calcareous, clayey silt, slightly sandy, with quartz the dominant clastic (type II lithology). Deposited in a freshwater to slightly brackish lake, the sediments contained an abundant ostracod fauna and lesser numbers of gastropods and Chara oogonia. A calcareous, very silty sand, predominantly composed of quartz (type III lithology), was observed in the bottom of core 4 only, and is believed to represent a low lake stage of 2-3 percent salinity.

Illite is the dominant clay mineral. The association of calcite, dolomite, gypsum and organic matter indicates that the diagenetic environment has high pH and negative Eh values. Sediments of the Green River Lakes are similar to saline sediments (type I lithology) of Great Salt Lake, however the Green River sediments have a very high organic content, and a suite of unusual carbonates, mixed carbonates, silicates and borosilicates not found in Great Salt Lake. The Great Salt Lake environment is too saline to support a large biota.

The last freshwater lake stage, the Stansbury, was determined by C^{14} analyses to have lasted from about 23,000 years B.P. to 13,500 years B.P. Sediments of type II lithology were deposited during this stage. Type III sediments were probably deposited during the pre-Stansbury interpluvial, a low lake stage possibly near the Gilbert level.

Abstract revised (B. C.)

469. SCOTT, GERALD L., 1960, Permian sedimentary framework of the Four Corners region: Univ. of Wisconsin Ph. D. thesis.
(Abs.): Dissert. Abs., v. 20, No. 11, p. 4370-4371, 1960.

The Four Corners region contains rocks of Wolfcampian-Leonardian age. Arkosic redbed facies in southwestern Colorado and northwestern New Mexico grade into light-colored, cross-bedded sandstone facies in southeastern Utah and northeastern Arizona. Fossiliferous carbonates locally occur in the lower and uppermost parts of the Permian interval.

The White Rim Sandstone of Utah is physically continuous with the sandstone of the eastern phase of the Toroweap Formation. Furthermore, the White Rim in western Monument Valley, Utah, gradationally overlaps the DeChelly Sandstone. The White Rim, which is partly an eastern facies equivalent of the marine Kaibab Limestone, may be a beach deposit.

The aeolian Arizona Coconino Sandstone and so-called Utah "Coconino" are not physically continuous in the subsurface. The Utah "Coconino" may be marine on the basis of the marine or marginal marine origin postulated for its two tongues, the White Rim and the Cedar Mesa. The Cedar Mesa Sandstone is inferred to be a spit-like bar deposit because of spacial considerations, subaqueous (?) structures, locally persistent horizontal bedding, and rare marine microfossils.

The Cedar Mesa Sandstone changes abruptly to the southeast into the gypsiferous and red clastic "Cedar Mesa evaporite." Lenticular configuration suggests deposition in a confined, elongate basin. Proximity to the Cedar Mesa Sandstone and rare foraminifera imply replenishment of saline water from westerly seas.

Some upper Cutler Sandstones of the so-called "non-marine" redbed facies bear significant numbers of marine microfossils and shell fragments in the Big Indian Wash locality, Utah.

High brown tourmaline content and low zircon:tourmaline ratio in light-colored, cross-bedded sandstones as contrasted with Uncompahgre-derived arkosic facies sandstones confirm earlier cross-bed references which indicate a northern quartz sand source distinct from the Uncompahgre. The source of the light-colored sand possibly was in central Utah. *From author abstract*

470. SCOTT, WILLARD FRANK, 1954, Regional physical stratigraphy of the Triassic in a part of the eastern Cordillera: Univ. of Washington Ph. D. thesis.
(Abs.): Dissert. Abs., v. 14, No. 8, p. 1199-1200, 1954.

The Triassic strata of the Eastern Cordillera may be divided areally by the Wasatch Line into an eastern, shelf facies and a western, miogeosynclinal facies. Rock units in the shelf facies are the Moenkopi, Shinarump and Chinle Formations, aggregating about 1,000 feet in thickness. The units in the miogeosynclinal facies are the Dinwoody, Woodside, Thaynes and Timothy Formations, which together form the Moenkopi Group, and the Shinarump and Chinle Formations, averaging 4,000 to 6,000 feet.

Isopach-lithofacies studies show an increase in limestones and finer clastics westward which is primarily due to the presence of the marine Thaynes Formation.

Thaynes deposition west of the Wasatch line was miogeosynclinal whereas all other Triassic units indicate deposition on a mildly unstable to stable shelf. Two moderately positive source areas in the region are indicated, one in Montana and Canada, the other in western Colorado.

Two Lower Triassic seas covered parts of the region; one, the Dinwoody Sea, was largely confined to the area west of the Wasatch line, while the more extensive Thaynes Sea reached eastward to the southeastern Uinta Mountains and the San Rafael Swell. *Published abstract*

471. SETTY, M. G. ANANTHA PADMANABHA, 1963, Paleontology and paleoecology of diatoms of Lake Bonneville, Utah: Univ. of Utah Ph. D. thesis, 128 p.
(Abs.): Dissert. Abs., v. 24, No. 4, p. 1578-1579, 1963.

Thirty-one samples of diatomite and diatom-bearing sediments were collected from the lake sediments at several differing elevations around the basin. Preparation of strewn slides and use of England finder are explained and a classification of diatoms is included.

A total of 126 species and varieties of diatoms are identified, and some of them are illustrated. Twelve new species are described and illustrated. These are: Coscinodiscus disciformis, Coscinodiscus oculiformis, Navicula ellipsis, Stauroneis inclinatus, Gomphonema lalithaea, Gomphonema navicularis, Cymbella bonnevillensis, Surirella rostrata, Surirella rhombus, Surirella roburii, Campylodiscus alaetus and Nitzschia obtusifida. Discus porcelaineous Stodder is reassigned as Coscinodiscus porcelaineous (Stodder) Setty. Many of the species identified are living today, whereas some are reported to have come from Pliocene and probably earlier Tertiary deposits.

Two types of sedimentary environments are recognized in the lake sediments and these are: (1) high-energy, nearshore environment characterized by coarse-grained sediment, agitation of the water, transportation by currents, mixing of faunas, and scarce and poor state of preservation, (2) low-energy, quiet-water environment in protected shore areas of the lake such as bays and lagoons, and characterized by abundance of diatoms, excellent state of preservations, and little clastic sediment.

The percentage distribution of planktonic and benthonic forms and associated pollen and spores, spicules, and desmids indicate that the diatom accumulations sampled are shallow water, nearshore deposits. The faunal assemblage indicates coexistence of diatoms with ostracods (especially thin-shelled ostracods) and complete disappearance in any gastropod or pelecypod remains.

Finally, it is concluded that, the lake, as represented by the samples collected, was oligohalob-indifferent (freshwater) between levels of 5,150$^{\pm}$ and 4,840 feet, mesohalobien (brackish water) at 4,800-foot elevation, and was euhalobien (similar to marine water) at 4,500-foot level.
From author abstract

472. SHARP, BYRON J., 1949, The mineralogy of the Fox Clay deposit [Utah County], Utah: Univ. of Utah M. A. thesis, 21 p.

The Fox Clay deposit, one of the largest in Utah, is located about 50 miles south of Salt Lake City, and 15 miles west of Provo. The clay occurs as a sedimentary bed which lenses out and becomes more impure toward its extremities. Tertiary (?) limestones lie conformably below and above this bed and all dip gently to the southwest. Flat lying Tertiary basalt flows overlie the southern half of the area.

Mineralogical investigations show that the mineral of the Fox Clay falls in the series of endellite-halloysite. Refractive index and differential thermal analysis indicated the Fox Clay is a hydrous sample. X-ray powder pictures, however, show it to be halloysite. The apparent hydrous nature of the Fox Clay, therefore, is due only to water of absorption. *Author abstract*

473. SHARP, BYRON J., 1955, Mineralization in Little Cottonwood Canyon [Salt Lake County], Utah: Univ. of Utah Ph. D. thesis, 79 p.

_____ 1958, Mineralization in the intrusive rocks in Little Cottonwood Canyon, Utah: Geol. Soc. America Bull., v. 69, No. 11, p. 1415-1430.

The mapped area is about 25 miles southeast of Salt Lake City, and about 2 miles west of Alta, Utah. Eastward-dipping Precambrian quartzites and argillites have been intruded by a Tertiary pluton called the Little Cottonwood quartz monzonite. Another major intrusive is exposed within the borders of the extensive Little Cottonwood intrusive. Widespread scheelite mineralization was found, and previously reported molybdenite mineralization of possible commercial value has been correlated.

In general, the minerals present are those associated with medium- and high-temperature hydrothermal deposits. Mineralized structures in the intrusive rocks consist of zones of jointing and fracturing which form a concentric pattern around an intensely fractured central zone. The more intense fracture zones are mainly within the exposures of the later and smaller intrusive body. Three stages of mineralization have been recognized: (1) deposition of widespread scheelite, pyrite and sericite on joint surfaces of intrusive rocks, (2) molybdenite, pyrite, quartz sericite galena, sphalerite and small amounts of scheelite and calcite deposited in the more intensely fractured zones, (3) fluorite and sericite in local sericite zones in the intrusive rocks.

A sample, possibly representative of much of the 6-square-mile area, contained 0.02 percent WO_3. Published assays on the molybdenite mineralized area indicated 0.24, 0.66 and 2.14 percent of MoS_2. The tungsten mineralization is relatively uniform in distribution, but the molybdenite distribution is very erratic. Intensive sampling is recommended to determine the economic value of known mineralization; the sampling project may also expose other minerals associated with high-temperature deposition. Prospecting for tungsten minerals in all other igneous intrusive bodies is also recommended. *Abstract revised (B. C.)*

474. SHENKEL, CLAUDE W., Jr., 1952, A lithologic definition of the Hermosa Formation: Univ. of Colorado Ph. D. thesis. (Abs.): Colorado Univ. Studies, Gen. Ser., v. 29, p. 59-60, 1953.

The Hermosa Formation lies within a sedimentary basin in southwestern Colorado, northwestern New Mexico, northeastern Arizona and southeastern Utah. The Hermosa Formation of this thesis includes, in descending order, the Upper Hermosa, Paradox Member and Lower Hermosa. Sediments usually assigned to the Rico division are included within the Hermosa. Above the Hermosa are red, arkosic and conglomeratic sandstones and shales of the Cutler Formation (which interfingers with the Hermosa); beneath the Hermosa are cherty, conglomeratic red shales of the Molas Formation.

Sandstones of the Hermosa are generally arkosic with oligoclase the most common detrital fragment. Presence of this unstable sodic plagioclase as well as extreme angularity of grains indicates rapid deposition. The basin in which the Hermosa was deposited was deepest (or had greatest subsidance) adjacent to the Uncompahgre uplift. The Uncompahgre-San Juan and Ft. Defiance areas experienced recurrent uplift and provided source areas for sediments of the Hermosa Basin.

Evaporites and shales of the Paradox Member were deposited in the interior of the basin while alternating marine limestones and nonmarine sandstones and shales were deposited around the periphery. Increasing crustal movement toward the end of Hermosa time may have invoked salt flowage within the Paradox Member which in turn produced structural features now obscured by overlying sediments. This uplift brought Paradox deposition to a close, and the alternating sandstones and limestones of the Upper Hermosa spread across the basin. Eventually uplift was so great that coarse, Cutler-like sediments that had been deposited continuously along the flanks of surrounding highlands following deposition of Leadville Limestone now spread across the Hermosa Basin and marine conditions were eliminated.

Lithofacies map indicates areas of lithologic associations similar to those that are now productive of petroleum, and zones in which subsurface reefing might be expected. *Published abstract revised (B. C.)*

475. SIEGFRIED, JOSHUA FLOYD, 1927, Geology of the Colorado River from Moab, Utah, to the inflow of the Green River [Grand and San Juan Counties]: Univ. of Utah M. S. thesis, 74 p.

The region studied is a typical portion of the Colorado Plateau. Pennsylvanian, Triassic and Jurassic strata form the canyon walls. Salt has shifted to form great thicknesses in the anticlinal structures of Late Cretaceous or Early Tertiary age. It is improbable that oil will be produced at a profit in the vicinity of Moab due to the depth at which it would occur in the well and the high costs due to inaccessibility and remoteness of the region. *B. C.*

476. SIEGFUS, STANLEY SPENCER, 1924, A reconnaissance of the Promontory Point mining district [Box Elder County], Utah: Univ. of Utah M. S. thesis, 191 p.

_____ 1925, A reconnaissance of the Promontory Point mining district, Utah: Utah Univ. Bull., v. 15, No. 2 (Eng. Exper. Sta. Bull. No. 15), p. 57-72.

The Promontory Point mining district was an important zinc producer before 1917, but has produced no ore since 1919. The district is divided into three fault blocks which consist mainly of Paleozoic sedimentary rocks dipping generally to northeast, and a fourth area which borders the lake. Rocks ranging in age from Precambrian to Mississippian, igneous rocks, and Quaternary alluvium occur in the district.

Except for the properties of the Lakeview, Big Pine and Sunshine mining companies, the ore deposits do not appear to extend deeply. Ore deposits of the Lakeview are remnants of deposits which have been mostly eroded from an upthrown fault block close to major faults. Workable deposits may be found on the downthrown side of these faults, and there is suggestive evidence for deposits in the lower workings of Lead Hill. *B. C.*

477. SIKICH, STEVE W., 1960, Stratigraphy of the Upper Triassic Stanaker Formation of the eastern Uinta Mountain area, northeastern Utah and northwestern Colorado: Univ. of Wyoming M. A. thesis, 119 p.

Usage of a local terminology, Stanaker Formation with the basal Gartra Member, is preferable in the Uinta Mountains because of uncertainty of correlation with Upper Triassic strata in adjoining areas. It also combats the tendency to refer to any medial Triassic conglomerate in the western interior as Shinarump.

The Stanaker Formation consists of a fluvial basal conglomeratic sandstone which grades upward into fluvial and lacustrine redbeds. The basal unconformity is believed to have formed in Middle Triassic time prior to, but not coevally with, deposition of the Gartra Member which is considered the introductory Upper Triassic deposit. Granitic uplifts to the southeast and east furnished the bulk of the detritus with local highs contributing additional sediment.

Future petroleum production from the Gartra Member is thought likely, but the presence of other economic deposits is doubtful. *From author abstract*

478. SIRRINE, GEORGE KEITH, 1953, Geology of Warm Springs Mountain, Goshen [Utah County], Utah: Brigham Young Univ. M. S. thesis, 83 p., geol. map.

Warm Springs Mountain, Goshen, Utah, is on the northern end of Long Ridge. A detailed study of the rocks and the structure of the area was made, including a limited investigation of the thermal springs. Formations of the marine Paleozoic sequence are: Cambrian Herkimer Limestone, Bluebird Dolomite, Cole Canyon Dolomite and Opex Formation; Ordovician Ajax Formation; Devonian Victoria Quartzite and Pinyon Peak Limestone; Mississippian Gardner Dolomite, Pine Canyon Limestone, Humbug Formation, and Great Blue Limestone. Price River-North Horn Conglomerate undivided represent the Cretaceous and Tertiary Systems. Tertiary volcanic gravels and a flow are also present. Quaternary alluvium, fans, and Lake Bonneville deposits are present.

The structure is complex. Warm Springs Mountain and Long Ridge comprise the east limb of an anticline with the Tintic district syncline. Folding and thrust faulting of the strata occurred probably during "Laramide" time. As a result of these orogenic forces, tear faults have offset large blocks. Tertiary volcanism followed. The last major movement was the Goshen fault that downdropped the valley and caused the present west-facing escarpment. Economically, only the thermal springs and silt, sand and gravel are being exploited.

Abstract revised (B. Y. S.)

479. SLENTZ, LOREN WILLIAM, 1955, Tertiary Salt Lake Group in the Great Salt Lake Basin: Univ. of Utah Ph. D. thesis, 59 p.
(Abs.): Utah Univ. Bull., v. 50, No. 15, p. 162-163, 1959.

"Salt Lake Group" is used to designate rocks that are post-Wasatch (Paleocene and Eocene) and pre-Pleistocene in age. It has been divided into Traverse volcanics and Jordan Narrows units (oldest), Camp Williams unit, Travertine unit, and Harkers Fanglomerate unit (youngest). The freshwater lacustrine deposits of the Jordan Narrows consist predominantly of white marlstone with oolitic, argillaceous, and cherty limestones, sandstones, clays and rhyolitic tuffs, and were derived from and deposited almost contemporaneously with the Traverse volcanics, which consist of reddish to purple andesites and andesite breccias, augite and biotite-hornblende latites and latite flows, and lesser amounts of rhyolite and basalt. The fluvial Camp Williams unit consists of poorly consolidated red to tan mudstones and siltstones and a basal conglomerate of igneous detritus. The Travertine unit consists of a white, dense, massive travertine which contains some small lens-like accumulations of manganese dioxide. The Harkers Fanglomerate is a light-colored, poorly consolidated, torrential stream deposit containing Paleozoic quartzites and limestones with minor igneous fragments. Several mudrock flows occur in the Salt Lake Group.

The units listed above occur in Jordan Valley and Oquirrh Mountains, and are compared with similar sequences in Tooele Valley, Stansbury Mountains and Rozel Hills. Variations are due to presence of lakes, intermittent rejuvenation of isolated block fault mountains, and widespread, spasmodic volcanic activity characteristic of Basin and Range Province.

The following sequence of events is proposed: (1) early Oligocene (?) to mid-Miocene (?) deposition of Traverse volcanics and Jordan Narrows units; (2) late Miocene (?) disappearance of lake, some deformation and erosion, deposition of fluvial Camp Williams unit; (3) early (?) Pliocene block faulting along east flank Oquirrh Mountains and deposition of Harkers Fanglomerate; (4) pedimentation of alluvial fans composed of Harkers Fanglomerate culminating in late Pliocene; (5) Pleistocene incision of pediment. *Abstract revised (B. C.)*

480. SMITH, CLEON VERL, 1956, Geology of the North Canyon area, southern Wasatch Mountains, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 3, No. 7, 33 p., geol. map.

This thesis is a detailed study of the geology of the North Canyon area, about 15 square miles. Rocks representing at least parts of Precambrian, Cambrian, Ordovician (?) and Mississippian Systems were mapped. Unconsolidated sediments of Quaternary age were mapped as fans, landslides and alluvium. Major structures include east-west faults, Laramide folds, Nebo overthrust and Basin-and-Range faults. Only one mining operation has been successful. The main economic value is the exceptionally good water supply from canyons and drilled water wells.

Abstract revised

481. SMITH, GRANT McKAY, 1951, Geology of southwest Lake Mountain [Utah County], Utah: Brigham Young Univ. M. S. thesis, 41 p., geol. map.

An area of approximately 6 square miles on the southwest flank of Lake Mountain has the following stratigraphic sequence: Great Blue Limestone (1,191 feet), Manning Canyon Shale (1,130 feet) and the lower part of Oquirrh Formation (2,993 feet). The Humbug Formation and Gardner Dolomite are present as a result of thrust faulting.

Thrust faults and tear faults occur in the lower elevations. Two thrust faults which probably occurred simultaneously are present: one responsible for presence of the Gardner Dolomite, and the other, for the Humbug Formation. Both formations are resting unconformably on the Great Blue Limestone. One large tear fault has a northwest to southeast strike. This strike and the position of the Humbug Formation and Gardner Dolomite in relation to the other beds suggest movement from northwest to southeast.

Tertiary (probably Eocene) volcanic activity has resulted in a deposit of latite breccia that is being quarried as an aggregate in the manufacture of cinder bricks. Clay deposits, manganese deposits, and very limited iron deposits have not been commercially valuable. Pumice deposits are being commercially operated. *Abstract revised (B. Y. S.)*

482. SMITH, JAMES A., 1957, Insoluble residue study of Pennsylvanian strata exposed in San Juan Canyon, San Juan County, Utah: Univ. of New Mexico M. A. thesis, 84 p.

Distinctive zones which are present in the Pennsylvanian strata exposed in the canyon of the San Juan River can be correlated on the basis of similar residue percentages, average residue suites, and replaced organic remains in the residues. Rare sedimentary minerals are not common to the three sections studied.

Insoluble residues will probably not be valuable in correlating zones within the Rico Formation, due to variable suites present; chert, nondetrital quartz, and minute bryozoa which have been replaced by green, nondetrital quartz are found in the basal Rico. Distinctive zones of red and orange chert and nondetrital quartz are interbedded with detrital residue zones in the upper Hermosa. The lower Hermosa contains correlative zones of detrital residues and silica residues which are less colorful.

Near the base of the Hermosa and in the Paradox Formation are zones containing gray chert and white and light-gray nondetrital quartz interbedded with zones containing correlative clay and detrital quartz. Two unconformable contacts in the Honaker Trail section have been correlated with gypsum zones at Raplee anticline. Both are overlain by beds containing very small percentages of residues which are predominantly free clay with minor detrital grains and nondetrital quartz.

Author conclusions revised (B. C.)

483. SMITH, ROBERT B., 1965, Geology of the Monte Cristo area, Bear River Range [Cache, Rich and Weber Counties], Utah: Utah State Univ. M. S. thesis, 77 p., geol. map.

The Monte Cristo area is a $7\frac{1}{2}$-minute quadrangle in southeastern Bear River Range, Middle Rocky Mountains Province. Sedimentary rocks exposed in the area include: Prospect Mountain Quartzite (Lower Cambrian), St. Charles and Nounan Formations (Upper Cambrian), Garden City Limestone and Fish Haven Dolomite (Ordovician), Laketown Dolomite (Silurian), Water Canyon and Jefferson Formations (Devonian), Lodgepole Limestone (Lower Mississippian), Wasatch Formation and Salt Lake Group (Tertiary).

Major structural features are the Strawberry Valley anticline of Laramide age in the western portion and major north-trending normal faults of Basin-and-Range (late Miocene - Pleistocene) origin in the east. *B. Y. S.*

484. SMITH, THEODORE L., 1957, Geology of the Antimony Canyon area, Garfield and Piute Counties, Utah: Univ. of Utah M. S. thesis, 39 p., geol. map.

In the Antimony Canyon area strata below the Tertiary volcanic cover are exposed in gorges cut into the Aquarius Plateau of south central Utah. The stratigraphy was revised extensively and the structure was mapped in detail. Formations exposed are (ascending) Chinle (?) Formation, Navajo Sandstone, Carmel Formation and Flagstaff (?) Formation. Late Paleocene (?) freshwater gastropods were found in a concordant sequence which is believed related in age to the Flagstaff Limestone of the Wasatch Plateau. This sequence had previously been called (ascending) Entrada, Curtis-Winsor, Dakota and Tropic Formations. Unconformities occur at base of Tertiary sediments and at base of Tertiary volcanic rocks.

The Paunsaugunt fault trends generally north-south through the area. The eastern upthrown block is cut by canyons that expose the overturned east limb of a north-south-trending anticline in Mesozoic beds. *Abstract revised (B. C.)*

485. SMITH, WALTER L., 1951, Stratigraphic correlation of southeastern Utah: Brigham Young Univ. M. S. thesis.

______ 1951, Subsurface stratigraphic correlation of southeastern Utah: Compass, v. 29, No. 1, p. 89-96.

A portion of the Colorado Plateau lying south of the Book Cliffs and east of the High Plateau escarpments was studied to determine the subsurface geology. All available logs of wells were studied. At the time of this writing, 314 wells have been drilled for oil in the area studied. The resulting correlation diagram and the full geologic report are on file in the geology department at Brigham Young University. *From published article*

486. SONTAG, RICHARD JOSEPH, 1965, Regional gravity survey of parts of Beaver, Millard, Piute and Sevier Counties, Utah: Univ. of Utah M. S. thesis. (Copyright 1968).

During June 1963, a regional gravity survey was made in parts of Beaver, Millard, Piute and Sevier Counties, Utah, over an area of approximately 1,400 square miles. The complete Bouguer anamaly map, based on a total of 285 gravity stations, indicates a complex area with considerable gravity relief. Gravity values range from a high of -164.8 mgal in the Pavant Range to a low of -251.4 mgal in the Marysvale Valley. Pronounced gravity lows follow the outline of the alluviated valleys. A gravity high corresponds with the exposed pre-Tertiary sediments in the Pavant Range, and a broad gravity low corresponds with the volcanic Tushar Mountains. Three major grabens, trending generally northward, are indicated by the gravity data. The Beaver Valley graben has an interpreted maximum depth of valley fill of approximately 2,500 feet. The Sevier Valley graben has an interpreted depth of valley fill of approximately 10,000 feet. The Marysvale Valley graben has an interpreted depth of valley fill of approximately 1,500 feet, based on sparse gravity data. A steep gradient of approximately 70 mgal, over a horizontal distance of 8 miles, which occurs between the Pavant overthrust and the Sevier Valley graben, is assumed to be due partly to a density contrast within the basement complex, and partly due to the density contrast between the sediments of pre-Tertiary age and the valley fill of Quaternary and Tertiary age in the Sevier Valley graben. *Author abstract*

487. STACY, ROBERT R., 1957, A study of the Winsor Formation of Upper Jurassic age near the type section (southwestern Utah) [Kane County]: Univ. of Nebraska M. S. thesis, 44 p.

The Winsor Formation in the vicinity of the type area at Winsor Cove, Kane County, Utah, is a fine-grained angular quartz sandstone about 300 feet thick. The lower part is predominantly red and grades upward into predominantly white sandstone. It overlies the Curtis Formation with apparent conformity. A prominant unconformity and abrupt lithologic change characterize the upper contact with the Dakota (?) Conglomerate and Sandstone. The Winsor Formation can be traced eastward across the Skutumpah Terrace, and can be observed to increase steadily in thickness to 600 feet in the eastern part of the terrace, a distance of 30 miles.

Equivalent exposures a few miles to the east, on the east side of Paria Valley, have been variously correlated with the Entrada and Carmel Formations, due to the introduction of a sequence of purplish beds in the lower part. About 100 feet of sandstone is overlain by about 110 feet of purplish interbedded sandstone and shale, which is in turn overlain by about 25 feet of greenish sandstone and shale with many 1/4-inch-thick layers of gypsum.

Without detailed mapping to the east of the Paunsaugunt Plateau across the Kaiparowits Plateau, to tie in with areas in which the stratigraphy is better known, and without adequate paleontological evidence, the writer believes that the entire sequence (about 800 feet thick) in Paria Valley should be designated Winsor Formation. *B. C.*

488. STAGNER, WILBUR LOWELL, 1939, Paleogeography of the Uinta Basin during Uinta B time (Eocene): Univ. of Colorado M. S. thesis.
(Abs.): Univ. of Colorado Studies, v. 26, No. 2, p. 117-118, 1939.

_____ 1941, The paleogeography of the eastern part of the Uinta Basin during Uinta B (Eocene) time: Carnegie Mus. Annals, v. 28, art. 14, p. 273-308.

The problem of the paleogeography of the Uinta Basin during late Eocene has been the subject of considerable controversy. The Uinta B Formation outcrops in an east-west direction in the synclinal Uinta Basin, which is located south of Uinta Mountains in northeastern Utah. Cross-bedded massive sandstone ledges intermixed with shales and clays give definite indication of the fluviatile origin of the formation.

The investigation revealed that during Uinta B time, the direction of the main drainage pattern in the Uinta Basin was at right angles to the trend of modern Green River. Aggrading streams flowed from the east, and not from the north as was formerly supposed. Several lines of evidence supporting this condition are: (1) orientation of stream channel deposits and westward decrease in grain size of the sediments, (2) floodplain deposits along the northern margin of the zone of channel fills, (3) occurrence in the channel deposits of igneous pebbles, and an abundance of heavy minerals, and large feldspars whose source was foreign to the Uinta Mountains, (4) deposition of sediment derived from the Uinta Mountains after Uinta B time. The faunal content and green-colored sands in the channel deposits indicate warm, equable, moist climatic conditions.

This condition was terminated near the close of Uinta B time by orogenic movements in the Uinta Mountains. That this uplift progressed from east to west is evidenced by the progressive westward deposition of sediments derived from the slowly rising northern land mass. The major disturbance that formed the present Uinta Mountains occurred after post-basal Oligocene time. *Author abstract*

489. STANLEY, DONALD ALVORA, 1966, A preliminary investigation of the low-sodium portion of the system $BeO-Na_2O-SiO_2-H_2O$: Univ. of Utah Ph. D. thesis, 65 p.
(Abs.): Dissert. Abs., sec. B., v. 27, No. 4, p. 1194B, 1966.

A study of the phase relationships of the system $BeO-SiO_2-H_2O$ is of particular interest since the large deposit of hydrated bertrandite at Spor Mountain, Utah, contains a mineral which has significantly different physical and chemical properties than normal bertrandite. *From author summary*

490. STARK, NORMAN P., 1953, Areal geology of the Upton region, Summit County, Utah: Univ. of Utah M. S. thesis, 39 p.

Cretaceous and Tertiary formations are exposed in the Upton region, about 12 miles east of Coalville, Utah, which is part of the structural transition zone between the Wasatch Mountains (west), Uinta Mountains (south), and Green River Basin (north). The north-trending Clark Canyon syncline was produced by folding of the Cretaceous and older strata in late Laramide time. The Knight Formation of Tertiary age has been folded along north-south axes independently of the structural attitudes of the underlying Cretaceous formations. The East Flank and Clark Canyon faults are high-angle reverse faults which cut Cretaceous strata. Three unconformities are present: (1) the basal Wanship unconformity represented by a basal conglomerate and slight angularity between the Wanship and Frontier Formations, (2) the basal Knight unconformity on which the Tertiary Knight Formation rests with angular discordance on Cretaceous beds, (3) the basal Norwood unconformity in which the Norwood Tuff (?) rests with angularity on older beds.

Evidence of several episodes of Laramide orogeny are recorded in early Montanan folding of Frontier Formation, late Paleocene folding of Almy Formation and late Eocene folding of Knight Formation. Epeirogenic uplift and erosion has followed the Oligocene Absarokan orogeny. *Abstract revised (B. C.)*

491. STEELE, GRANT, 1959, Stratigraphic interpretation of the Pennsylvanian-Permian Systems of the eastern Great Basin: Univ. of Washington Ph. D. thesis.
(Abs.): Dissert. Abs., v. 20, No. 12, p. 4635-4636, 1960.

_____ 1960, Pennsylvanian-Permian stratigraphy of east central Nevada and adjacent Utah: Intermtn.

Assoc. Petroleum Geologists Guidebook, 11th Ann. Field Conf., p. 91-113.

The three facies of the lower portion of the Pennsylvanian System (Springeran to Desmoinesian) in the eastern Great Basin are clearly defined by their proximity to tectonically active lands formed by the Antler orogeny in late Mississippian to earliest Pennsylvanian time. The western facies is characterized by large amounts of chert clastics shed from these lands (Diamond Peak, Moleen and Tomera Formations). The sediments characterizing the eastern and southern facies (Ely, Oquirrh, Bird Spring, Callville and Topache Formations) being less effected by the Antler positives, were deposited in a limestone, dolomite and silt province. In middle Desmoinesian time the entire eastern Great Basin was gently elevated, permitting erosion and/or nondeposition until at least middle Missourian time. During Virgilian to earliest Wolfcampian time partial relaxation of positive forces again permitted the seas to invade most of eastern Nevada and adjacent Utah depositing the Strathearn, Jakes Creek (new name), Carbon Ridge, Oquirrh, Ferguson Springs (new name) and Pakoon Formations. In late Wolfcampian time the seas retreated depositing the limestones, silts and dolomites of the Rib Hill and Supai Formations.

Leonardian to earliest Guadalupian marine limestone and dolomite sedimentation, modified by two episodes of evaporited precipitation, is represented by the Moorman Ranch (new name) Formation, the unnamed Summit Springs evaporite succession, and the Hermit and Toroweap Formations.

Subsidence continued, accompanied by the deposition of the Kaibab, Butte Mountain (new name), Phosphoria and Gerster Formations, until latest Guadalupian time when westerly positives once again fed minor amounts of chert clastics east and south into the western portion of the Phosphoria-Gerster deposition basin in Nevada.

From author abstract

492. STEPHENS, JAMES D., 1960, Hydrothermal alteration at the United States mine, West Mountain (Bingham) district, Utah: Univ. of Utah Ph. D. thesis, 83 p.
(Abs.): Dissert. Abs., v. 21, No. 4, p. 920, 1960.

A study was made of the hydrothermal alteration associated with ore deposits of four mining districts. In each case the ore minerals occur as bedding replacements of limestone host rocks. Samples were collected along the strike of the formations, beginning in sulfide mineralization and proceeding to apparently unaltered rock. The samples were studied by X-ray diffraction analysis, differential thermal analysis, spectrographic analysis, chemical analysis, and hydrothermal experimentation.

In only one case, at the United States mine, West Mountain (Bingham) district, Utah, was a correlation between alteration and sulfide mineralization established. Samples taken in and near ore were dark green (nearly black), while those at a distance of approximately 40 feet from ore were nearly white. Talc occurs in and adjacent to ore, followed outward by phlogopite and K-feldspar, then by montmorillonite which is zoned compositionally with an iron-aluminum variety toward ore, a magnesium-aluminum variety intermediate, and a high aluminum variety outermost. Analysis of ten samples taken at 5-foot intervals showed a distinct enrichment in Fe_2O_3, FeO, Al_2O_3, and K_2O near the sulfides, and a less definite enrichment of Na_2O away from them. Spectrographic analysis of selected samples showed that trace amounts of molybdenum, copper, and silver increase as ore is approached, and trace amounts of zirconium increase away from ore.

Study of the mineral phases formed led to the conclusion that the hydrothermal solutions transported an alumino-silicate sol which replaced the host limestone to form montmorillonite. The montmorillonite was further altered to talc and phlogopite. The high magnesium content of the alteration minerals -- up to 20 percent MgO by weight -- indicates that the solutions were rich in that element. Examination of the hydrothermal stability fields of the alteration minerals leads to the conclusion that the temperature of the solutions was between 800° C and 250° C. *Abstract revised (B. C.)*

493. STEPHENSON, DAVID A., 1961, Stratigraphy of the Entrada-Preuss and Curtis-Stump Formations in southwestern Wyoming and the Uinta Mountains of Utah: Washington State Univ. M. S. thesis, 96 p.

Jurassic strata of upper Callovian and Oxfordian ages occur throughout the area of investigation and crop out extensively along the northeastern flank of the Uinta Mountain uplift and within the Wyoming Range along the Idaho-Wyoming border.

Two facies are present in the upper Callovian strata: (1) the Preuss Formation, a restricted marine, red-bed sequence deposited in a shelf and intercratonic basin environment, and (2) toward the east, the Entrada Formation, a clean sandstone sequence deposited in a continental to nearshore environment. The Oxfordian strata also include two facies: (1) the Stump Formation, a glauconitic sandstone and siltstone sequence deposited in a shelf to unstable shelf environment, and (2) toward the east, the Curtis Formation, a glauconitic sandstone and oolitic limestone sequence deposited in a shelf environment.

The facies change from the Preuss to the Entrada is suggested, on the basis of field study, to lie in the

region between Manila, Utah, and Vermilion Creek, Colorado. This region of change is farther east than presently recognized. The facies change from the Stump to the Curtis is within the region between Church Buttes and LaBarge, Wyoming. The Preuss and overlying Stump were deposited in the Utah trough, and represent the last sedimentation in the formerly extensive Cordilleran miogeosyncline.
Author abstract

494. STEPP, JESSE CARL, 1961, Regional gravity survey of parts of Tooele and Box Elder Counties, Utah, and Elko County, Nevada: Univ. of Utah M. S. thesis, 40 p.

The writer occupied 155 of the 510 gravity stations established over an area of about 3,000 square miles. Gravity data were reduced to Bouguer anomaly values and contoured on a 2-mgal interval. A two-dimensional Jung graticule was used to evaluate four residual gravity profiles in terms of geologic structure.

Gravity data indicate the following structures of Basin-and-Range type. Faulting is confirmed along east and west sides of Newfoundland Mountains and Silver Island Mountains, and along east side of Pilot Mountains. The Little Pigeon fault zone, about 40 miles long, probably extends along west edge of Little Pigeon Mountains, and southward along northwest side of Silver Island Mountains. Wendover fault zone separates Silver Island Mountains from northeast-trending Wendover graben (to southeast). Northward-trending Pilot Valley graben lies between Pilot Mountains (west) and Lemay Mountain and Silver Island Mountains (east). Lucin graben lies between Lemay Mountain gravity high (west) and Little Pigeon Mountains (east). Elongate northward-trending gravity anomalies between Little Pigeon Mountains and Newfoundland Mountains indicate structures buried by Cenozoic deposits: Little Pigeon graben, Jackson syncline, and Westfoundland graben. Normal faults along margins of these graben have total displacements up to at least 5,000 feet.
Abstract revised (B. C.)

495. STEVENS, CALVIN HOWES, 1963, Paleoecology and stratigraphy of pre-Kaibab Permian rocks in the Ely Basin, Nevada and Utah: Univ. of Southern Calif. Ph. D. thesis.
(Abs.): Dissert. Abs., v. 24, No. 9, p. 3693-3694, 1964.

All pre-Kaibab Permian rocks in the Ely Basin between Confusion Range, Millard County, Utah, and Dry Mountain, White Pine County, Nevada, may be referred to five formations. Near the margins of the basin (Confusion Range, Butte Mountains, Ely area of the east; Dry Mountain on the west) the stratigraphic succession from older to younger comprises Reipe Spring Limestone, Reipetown Formation and Arcturus Formation. In the central part of the basin in the Illipah quadrangle, the Reipe Spring Limestone and Reipetown Formation are recognizable, but the Arcturus Formation is represented laterally by the Pequop and Loray Formations.

The Reipe Spring Limestone is rather uniform in its physical characteristics. The fauna indicates that water depth decreased westward from 100 feet in the Confusion Range to only about 20 feet at Dry Mountain.

The Reipetown Formation consists mainly of siltstone and very fine-grained sandstone in the eastern and southern parts of the Ely Basin. The fauna indicates that the water depth was a very shallow 0 - 15 feet. Molds of evaporitic minerals indicate that at times the salinity reached saturation. The source of silt and sand in the Reipetown and Lower Arcturus Formations was to the east.

In the eastern part of the Ely Basin, the Lower and Middle Arcturus sandstones and limestones were deposited in about 15 feet of water. Water depth increased westward. Red and yellow sandstones and thin, dark-gray limestones of the Upper Arcturus were deposited in very shallow water, the salinity of which ranged from very low to very high.

Extremely varied Permian faunas of the Ely Basin have been divided into eight recognizable groups or populations which occupied different environments and presumably had different depth, energy and salinity requirements: textulariid, fusulinid, coral, productid-bryozoan, chonetid, Heteralosia, Nuculana, and Euphemites faunal groups.
Abstract revised (B. C.)

496. STEWART, DONALD G., 1956, General geology, channeling and uranium mineralization, Triassic Shinarump Conglomerate, Circle Cliffs area [Garfield County], Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 3, No. 6, 38 p., geol. map.

The Circle Cliffs anticlinal upwarp lies just west of Henry Mountains in Garfield County, Utah. It is an asymmetrical fold, breached by erosion, the east limb passing into a major monocline, the Water Pocket fold. Oldest formation in area is Permian Coconino Sandstone, youngest is Jurassic Navajo Sandstone.

Stream channel deposits of Triassic Shinarump Conglomerate contain the only known commercial concentrations of uranium minerals in this area. An erosional unconformity at its base is evidenced by stream channels incised into underlying Moenkopi Formation. Three general types of channels are recognized: shallow, wide "floodplain" type, 15 to 60 feet thick and over 1 mile wide; wide, deeply incised "trunk" type, 60 to 245 feet thick and from 1/2 to 1 mile wide; and converging and diverging type, 60 to 100 feet thick and 500 feet to 1/2 mile wide.

Uranium occurs as fillings and replacement bodies in wood fragments and is concentrated in channel sands saturated with hydrocarbons; in structural traps such as channel lows, slumps, and fault traps; and in stratigraphic traps formed by interfingering of sands, siltstones and shales. Uranium minerals present are torbernite, uraninite, autunite, with minor amounts of uranophane and carnotite. Other minerals present are pyrite, arsenopyrite, gypsum, and the copper minerals, azurite, malachite, chalcopyrite, and chryscola. *Abstract revised (B. C.)*

497. STEWART, JOHN HARRIS, 1961, Stratigraphy and origin of the Chinle Formation (Upper Triassic) on the Colorado Plateau: Stanford Univ. Ph. D. thesis.
(Abs.): Dissert. Abs., v. 22, No. 2, p. 543, 1961.

The Chinle Formation, 0-1,700 feet thick, consists of nonmarine conglomerate, sandstone, siltstone, claystone and limestone. Thin units or lenses of siltstone (in some places, sandstone and conglomerate) mottled red, purple and gray, are interpreted as remnants of a soil. The mottled strata are widely distributed along an unconformity at the base of the Chinle.

The lower part of the Chinle Formation is a vast alluvial plain deposit which extends over the southern part of the Colorado Plateau and into adjacent regions. It is divided into (1) Shinarump and related members, (2) Monitor Butte and related members, (3) Moss Back Member and related units, and (4) Petrified Forest Member. Thin widespread sandstone and conglomerate units, such as the Shinarump and Moss Back Members, are probably braided stream deposits. The claystone, clayey siltstone and clayey sandstone of the Monitor Butte and Petrified Forest Members are probably deposits of large meandering streams and of lakes. Stream directions were north to northwest, the source being the predominantly volcanic terrain of the Mogollan highland, in southern Arizona and adjacent states.

The upper part of the Chinle is a large deltaic deposit spread out into a lake. It extends throughout most of northeastern Arizona, northwestern New Mexico, eastern Utah, and western Colorado. It is divided into two parts, (1) Owl Rock Member, and (2) Church Rock Member and related units. The Owl Rock Member is composed of reddish-brown siltstone with thin beds of limestone. The Church Rock Member is composed of reddish - brown siltstone and minor amounts of cross-stratified sandstone. This sandstone is abundant in a narrow belt extending from southwestern Colorado to central Utah, and is probably the delta deposit of a large river which formed the delta. Stream directions are dominantly northwest; Uncompahgre and Front Range igneous and metamorphic terrain were main source areas. *Abstract revised (B. C.)*

498. STEWART, MOYLE DUANNE, 1950, Stratigraphy and paleontology of the lower Oquirrh Formation of Provo Canyon in the south central Wasatch Mountains, Utah: Brigham Young Univ. M. S. thesis.

499. STEWART, SAMUEL W., 1956, Gravity survey of Ogden Valley, Weber County, Utah: Univ. of Utah M. S. thesis, 23 p.

_____ 1958, Gravity survey of Ogden Valley in the Wasatch Mountains, north central Utah: Am. Geophys. Union Trans., v. 39, No. 6, p. 1151-1157.

Ogden Valley is a northwest-trending valley within the Wasatch Mountains of north central Utah. On the basis of geological evidence Ogden Valley is believed to be structurally controlled by normal faults along both the east and west margins. Gravity measurements in the valley definitely indicate a fault with at least 2,000 feet of vertical displacement along the west margin of the valley. A fault with at least 1,000 feet of vertical displacement is postulated along the east margin of the valley, together with three smaller, buried faults within the valley. The maximum depth of Quaternary alluvium and Tertiary sediments within the valley is about 6,000 feet. *Author abstract*

500. STIFEL, PETER BEEKMAN, 1964, Geology of the Terrace and Hogup Mountains, Box Elder County, Utah: Univ. of Utah Ph. D. thesis, 173 p., geol. map.
(Abs.): Dissert. Abs., v. 25, No. 4, p. 2453, 1964.

Strata which aggregate about 22,200 feet are assigned to the following systems and formations: Pennsylvanian - Oquirrh Formation, Virgilian Series (3,000+); Permian - Oquirrh Formation, Wolfcampian Series (6,718+), Diamond Creek Sandstone (2,852), Loray ? Formation (3,420), Park City Formation, Grandeur Member (1,838), Phosphoria Formation, Meade Peak Phosphatic (404), Rex Chert Member (1,157), Gerster Formation (903); Triassic - Dinwoody Formation (1,647), and Thaynes Formation (329+). Triassic strata are paraconformable above Permian strata. The Dinwoody and Thaynes Formations were deposited in shallow water in a subsiding basin.

The Terrace Mountains are structurally similar to neighboring ranges except for the apparent absence of high-angle reverse and large scale thrust faults. The Big Pass graben divides the Terrace Mountains into eastern and western structural blocks, each characterized by long, high-angle, north-south trending boundary faults and minor east-west normal faults. A system of arcuate rotational faults is present in the western block. Folds are broad and of large scale except for those at the north end of the eastern Terrace Mountains, in the Hogup Mountains and at the south end of Crocodile Mountain. Two groups of folds formed in late Mesozoic or early Cenozoic. Folding was followed by block faulting and tilting of blocks to northwest.

Topography ancestral to that of the present developed during late Cenozoic time, previous to deposition of strata of the Salt Lake Group. Rocks of Pliocene age include the Salt Lake Group and diabasic and basaltic dikes, basalt flows and a welded tuff deposit. Angular unconformities are recognized at base of Pliocene and Pleistocene sediments. Faulting of Pliocene and Pleistocene age is recognized. Shoreline features of Lake Bonneville are well developed. Elevations of three major terraces in the Hogup Mountains are: Bonneville-5,248 feet, Provo-4,833 feet and Stansbury-4,518 feet. Shorelines are as much as 50 feet higher in the southern Terrace Mountains. *Abstract revised (B. C.)*

501. STILLMAN, FRANCIS BENEDICT, 1927, Reconnaissance of the Wasatch Front between Alpine and American Fork Canyons, Utah County, Utah: Cornell Univ. M. S. thesis.

_____ 1928, A reconnaissance of the Wasatch Front between Alpine and American Fork Canyons, Utah: Jour. Geology, v. 36, No. 1, p. 44-55.

During the Laramide revolution compressive stresses acting tangentially from the southwest produced the major structure. Thrust faulting was associated with the folding, but normal faulting was caused by later vertical stresses exerted by the Cottonwood igneous intrusion. These normal faults occurred along planes of weakness already initiated by the previous folding. *Published abstract*

502. STOKES, WILLIAM LEE, 1938, Lithology and stratigraphy of the Red Plateau, Emery County, Utah: Brigham Young Univ. M. S. thesis, 50 p.

The Red Plateau in itself presents no complicated problems in structure or stratigraphy. The fossil content and petrographic make-up of the prominent Buckhorn Conglomerate Member of the Morrison reveal the place of origin of the sediments as being upper Paleozoic strata toward the west. These fragments indicate a long period of erosion and transportation from their place of formation. Incidental studies of the gastroliths has tended to substantiate their dinosaur origin. Several igneous rocks in the series have shown that volcanic activity was not confined to the Cenozoic but was present during or before Morrison times. Jasperization of sediments in the Great Basin is also indicated to have taken place at an earlier date than previously supposed. Several problems of correlation between the Dakota and Morrison are pointed out and some suggestions offered. *Author abstract*

503. STOKES, WILLIAM LEE, 1941, Stratigraphy of the Morrison Formation and related deposits in and adjacent to the Colorado Plateau: Princeton Univ. Ph. D. thesis.

_____ 1944, Morrison Formation and related deposits in and adjacent to the Colorado Plateau: Geol. Soc. Am. Bull., v. 55, No. 8, p. 951-992.

The Morrison Formation in and adjacent to the Colorado Plateau currently includes diverse lithic units, many of which cannot properly be included if the limitations of the type section and relationships to other formations are considered. The Todilto Limestone, Bluff Sandstone, Wanakah Marl, Pony Express Limestone and Bilk Creek Sandstone can be correlated with the San Rafael Group and dated as Upper Jurassic by the marine beds in the group. The Salt Wash Sandstone, Brushy Basin Shale, Recapture Creek Sandstone and Westwater Creek Sandstone are considered equivalent to the type Morrison and have yielded vertebrate remains and are almost certainly Jurassic. Succeeding these are two new formations, the Buckhorn Conglomerate and Cedar Mountain Shale, which have yielded no fossils but are tentatively classed as Lower Cretaceous, mainly by analogy with similar deposits in adjacent areas.

Lithology, distribution and paleogeography of all units are discussed, and changes in nomenclature and correlation are recommended.

Published abstract

504. STOTT, GEORGE F., 1916, Mining and milling of complex lead and zinc ores in the Park City district, Utah: Univ. of Utah M. S. thesis, 64 p.

A summary of mining and milling practices in the Park City district together with a short geological review. *B. C.*

505. STOUFFER, STEPHEN GERALD, 1964, Landslides in the Coal Hill area, Kane County, Utah: Univ. of Utah M. S. thesis, 102 p.

The Coal Hill area consists of about 4 square miles along State Highway 15, about halfway between Mt. Carmel Junction and Zion National Park. Principal drainages are Meadow Creek and Little Meadow Creek. Sedimentary rocks having a regional northeast dip of 1° to 2° include Jurassic Carmel and Winsor Formations which comprise the San Rafael Group and Cretaceous Dakota-Cedar Mountain and Tropic Formations.

The active "Coal Hill Slide" is of the composite slump-block type, composed of several stages of backward rotational movement along sliding surfaces which are concave upward. Bentonitic shales of the basal Tropic Formation receive water primarily from a fault zone and associated fracture system along the east flank of the slide area. At the head of a larger slide, marked by a conspicuous "slump scar", blocks of lower Tropic shale, coal and sandstone have slumped and collapsed along local fractures. This movement has been "triggered" by extensive burning in coal beds.

Age relationships of slide debris to alluvium of Meadow Creek indicate that most of the instability of slopes has developed within the past 1,300 years. Unstable conditions arise from favorable stratigraphy of lower Tropic Formation supplemented by local structural control, effects of ground water, climate, and Recent geomorphological history of Meadow Creek. *Abstract revised (B. C.)*

506. STRINGHAM, BRONSON F., 1942, Mineralization in the West Tintic mining district (Utah): Columbia Univ. Ph. D. thesis.

_____ 1942, Mineralization in the West Tintic mining district, Utah: Geol. Soc. Am. Bull., v. 53, No. 2, p. 267-290.

In the West Tintic mining district Proterozoic quartzites and slates have been thrust over folded Paleozoic limestones and dolomites. Five types of igneous rocks have been intruded in sequence of four stages: (1) monzonite stock simultaneous with monzonite porphyry dikes, (2) granite porphyry stocks with (3) granite cores, (4) aplite dikes.

Contact metamorphism is prominent adjacent to the larger intrusions and is considered to have been accomplished by end-stage liquids with little addition. Pyrometasomatic veins and mesothermal deposits were next formed and were followed by the formation of low-temperature quartz-barite veins and replacements. The entire sequence of events is established by field and laboratory evidence.

It is believed that here is represented the history of a cooling differentiating magma and the deposition of hydrothermal minerals of progressively lower temperature of formation. *Published abstract*

507. SWANSON, JAMES W., 1952, Geology of the southern portion of West Mountain [Utah County], Utah: Brigham Young Univ. M. S. thesis, 69 p., geol. map.

The problem concerns the detailed study and mapping of the rocks in an area of approximately 8 square miles located in the southern one-third portion of West Mountain, Utah.

The Cambrian, Devonian, Mississippian, Pennsylvanian and Permian Systems are represented in the bed rock of the area. Of the 18 formations found in the area, 8 are Cambrian, 1 is Devonian, 4 are Mississippian, 1 is Pennsylvanian and Permian, and 1 is Permian. The formations aggregate a total thickness of 12,000 feet, of which 4,981 feet were measured and described in detail. The sedimentary rocks are predominantly orthoquartzites, sandstones, limestones and dolomites with many other lithotopes represented.

The strata of the area have been highly disturbed by orogenic forces in the form of large open folding and thrust faulting during "Laramide" time. The associated tear faults have offset large blocks within the individual thrusts.

The economic aspects of the area are of little significance at the present time. The limestones and dolomites may be used later for the nearby steel furnaces and the gravels and sands may also be exploited in the future. *Author abstract*

508. SWENSEN, A. JAREN, 1962, Anisoceratidae and Hamitidae (Ammonoidea) from the Cretaceous of Texas and Utah: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 9, pt. 2, p. 53-82.

A systematic study of the Texas and southern Utah heteromorph ammonite families Anisoceratidae and Hamitidae indicates the occurrence of one species of Hamites, three of Stomohamites, six of Anisoceras, three of Idiohamites and six (?) of Allocrioceras. Several European species not previously reported from Texas, and two Texas species that are junior synonyms of previously described European species, are recorded. Members of the Anisoceratidae and Hamitidae families occur in Texas in nine formations which range from upper Middle Albian to Lower Turonian. Certain Anisoceratidae occur in rocks of Early Turonian age in Utah.

A biostratigraphic study of a portion of the Utah Tropic Formation and a correlation of the Tropic with the Texas Britton Formation was made on the basis of Anisoceratidae and other ammonites. The occurrence, in both the Tropic Formation and the Britton Formation of conspecific forms of the Anisoceratidae Allocrioceras and species of Metoicoceras, Kanabiceras, Proplacenticeras and others, establishes a definite correlation between the Utah and Texas rocks. Based on the occurrence of ammonites, most authorities would date the Tropic and the Britton as Early Turonian, although some regard their age as Late Cenomanian. *Author abstract*

509. TANNER, VASCO M., 1920, Deltas of Lake Bonneville: Univ. of Utah M. A. thesis, 44 p.

City Creek delta is a characteristic fossil delta as described by Gilbert. It resembles an alluvial fan and is strewn with alluvial debris. The stream which built it has cut it into two parts, exposing pre-deltaic deposits at its base. Contemporaneous erosion, unconformities and poorly sorted strata show that there were seasonal variations, times of flood and changes in stream course. Deposits of deep quiet-water sediments are encountered up City Creek, which in some places are overlain by gravel near-shore deposits and in others overlie shallow-water deposits, thus demonstrating that there have been transgressive and regressive movements of the lake. Although the size of the deposits at the different halts tells us much about the time involved, most, if not all, of the Bonneville delta material was removed and built into Provo deltas. Deposition of calcium carbonate in great amounts at both the Bonneville and Provo levels suggests that a long halt was made in both cases and that the waters became saturated with $CaCO_3$.

(This report also describes the transporting power of running water, the structure of a typical delta, the important streams which flowed into Lake Bonneville and the important deltas of the ancient lake.) *Author conclusions revised (B. C.)*

510. TAYLOR, DOROTHY ANN, 1948, The geology of the Gunnison Plateau Front in the vicinity of Wales [Sanpete County], Utah: Ohio State Univ. M. S. thesis.

The 24-square-mile area mapped lies along the eastern front of the Gunnison Plateau in Sanpete County. The bedrock is all sedimentary and ranges from Upper Jurassic to Lower Tertiary. Sequence, from base to top, consists of Arapien Shale (Twist Gulch Member), with maximum thickness 1,200 feet; Indianola Group, with maximum thickness 1,000 feet; unconformity; Price River Formation, with maximum thickness of 600 feet; North Horn Formation, with maximum thickness 2,600 feet; and the Flagstaff Limestone, about 300 feet thick.

The Gunnison Plateau is carved out of a broad, shallow syncline with part of the eastern limb overturned. The general trend in the vicinity of Wales is north-south, and the dip (of the North Horn Formation) is generally 20° W. Along the base of the Plateau the strata vary in attitude and are mostly overturned, the dip varying between 20°W to (overturned) 34°E. Most folding occurred in the Arapien and Indianola. At least two episodes of folding have taken place: post-Indianola and post-Flagstaff. The latter resulted in the asymmetrical syncline of the Gunnison Plateau. *B. C.*

511. TAYLOR, MICHAEL E., 1963, The Lower Devonian Water Canyon Formation of northeastern Utah: Utah State Univ. M. S. thesis, 63 p.

Williams, J. S. and M.E. Taylor, 1964, The Lower Devonian Water Canyon Formation of northern Utah: Wyoming Univ. Contr. Geology, v. 3, No. 2, p. 38-53.

The Early Devonian Water Canyon Formation is disconformably underlain by the Middle Silurian Laketown Dolostone and overlain by the Late Devonian Hyrum Dolostone Member of the Jefferson Formation. The Water Canyon is divided into two members. The lower, Card Member, consists of argillaceous dolostone. The Card Member weathers light gray forms resistant ledges. The upper, Grassy Flat Member, is characterized by interbedded sandstone, arenaceous dolostone and argillaceous dolostone. The Grassy Flat Member weathers light brown and forms smooth slopes. Both members are recognized throughout the type area, northeastern Utah.

Fossils, collected by the author, were restricted to the lower 10 feet of the Grassy Flat Member. The fossiliferous zone contains a notable fish fauna as well as pelecypods, Lingula sp. and unidentified plants.

The Card Member with its lesser clastic content appears to have been deposited during a transgressive phase of the Early Devonian sea. The Grassy Flat Member was probably deposited during a regressive phase.

The Sevy Dolostone of east central Nevada, the Water Canyon Formation of northeastern Utah, and the Beartooth Butte Formation of northwestern Wyoming and southwestern Montana, are recognized as correlatives. The formations represent miogeosynclinal facies to the southwest and nearshore facies to the northeast. *Author summary*

512. TEICHERT, JOHN A., 1958, Geology of the southern Stansbury Range, Tooele County, Utah: Univ. of Utah M. S. thesis, 79 p., geol. map.

_____ 1959, Geology of the southern Stansbury Range, Tooele County, Utah: Utah Geol. and Mineralog. Survey Bull. 65, 75 p., geol. map.

About 70 square miles of southern Stansbury Range was studied. Paleozoic rocks in excess of 27,000 feet include: 4,800+ feet Cambrian (not including several thousand feet of Tintic Quartzite), 1,600+ feet Ordovician, 600+ feet Silurian, 600+ feet Devonian, 3,400+ feet Mississippian (not including 1,200+ feet unmeasured Manning Canyon Shale), and 14,000+ feet Pennsylvanian. Quaternary deposits include pre-Lake Bonneville fan gravels, Lake Bonneville beds, creep and glacial deposits, Recent sand dune deposits and alluvium.

Due to pre-Mississippian uplift, Ordovician, Silurian and Devonian rocks are absent in central part of Range. Basal Mississippian rocks rest unconformably on Cambrian beds. A coarse Upper Devonian conglomerate referred to as the Stansbury Conglomerate is hundreds of feet thick at the north end of the Range and thins to a few tens of feet at the south end.

The Range consists of a north-south anticline of which the west limb (at the south end) has been removed by Laramide thrusting. Other structures include high-angle northwest-southeast normal faults (Laramide) and normal faults of Basin-Range type which roughly parallel the Laramide structures.

Abstract revised (B. C.)

513. THOMAS, GERALD W., 1958, Stratigraphic paleontology of the Morgan Formation, Uinta Mountains and vicinity: Washington State Univ. M. S. thesis, 137 p.

The Morgan Formation is a sequence of Early Pennsylvanian strata that occur in the Uinta and Wasatch Mountains of northeastern Utah and at Cross Mountain, Colorado. At several localities the Morgan is divisible into a lower limestone member, a middle red member and an upper limestone-sandstone member.

Fossils collected and described from the Morgan Formation include 41 species. Only the foraminifera are useful for intraformational zonation.

The lower member is essentially Morrowan in age and is readily recognizable by the appearance of abundant species of Millerella. However at one locality the lower contact is Mississippian. The middle member contains fossils which occur in both Atokan and Desmoinesian series, but the writer concludes that at least the lower portion of the member is Atokan. (Although the fusulinid population in the middle member is small, Fusulinella is usually indicative of that horizon). Wedekindellina and Fusulina indicate that the upper member is lower Desmoinesian in age.

The Morgan Formation is equivalent in age to the Amsden and lower Tensleep Formations in Wyoming, the lower Hermosa and McCoy in southern Utah and western Colorado, and to the lower 1,500 feet of Oquirrh near Provo, Utah. The lower Morgan is the same age as the Beldon of Colorado, and the lowermost Morgan at Soapstone Basin, Duchesne County, Utah, is equivalent to a part of the Brazer Formation.

From author abstract and text

514. THOMAS, GILBERT E., 1960, The South Flat and related formations in the northern part of the Gunnison Plateau [Sanpete County], Utah: Ohio State Univ. M. S. thesis, 137 p., geol. map.

About 10,650 feet of sedimentary rocks ranging in age from Upper Jurassic to Lower Tertiary (lower Eocene) are exposed in the South Flat area. They are divided into the Twist Gulch Formation (base), Indianola Group, South Flat Formation, Price River Formation, North Horn Formation and Flagstaff Limestone (top). Certain units previously placed in the South Flat Formation have been placed in the Indianola Group, consisting of gray or red conglomerate with minor shale, sandstone and freshwater limestone.

The South Flat Formation of sandstones with minor shales overlies the Indianola group (of middle Montana age) with angular unconformity. The Price River Formation of sandstone with minor conglomerate lenses (probably middle to late Montana in age) overlies the South Flat Formation with a marked disconformity. Instead of one main early Laramide pulse of orogeny, the stratigraphic relations indicate two pulses, a pre-South Flat pulse and a post-South Flat, pre-Price River pulse.

The Gunnison Plateau is underlain by a northeast-southwest trending synclinal structure consisting of an older syncline of Indianola rocks folded before South Flat deposition, and an upper syncline composed of beds of the South Flat, Price River, North Horn and Flagstaff Formations. The east Gunnison fault is a major west-dipping normal fault of probable Middle to Late Tertiary age which bounds the Gunnison Plateau on the east. *B. C.*

515. THOMAS, GLENN H., 1958, Geology of the Indian Springs quadrangle, Tooele and Juab Counties, Utah: Brigham Young Univ. M. S. thesis, Research Studies, Geol. Ser., v. 5, No. 4, 35 p., geol. map.

The Indian Springs quadrangle treated in this geologic report lies in the southern Simpson Mountains in western Utah, within the Basin and Range Province.

The Precambrian sediments, the Sheeprock Series, occupy over half of the bedrock exposure, having a total measured thickness of 9,400 feet. They consist mainly of dark quartzite and slate with an occasional light-colored quartzite.

Paleozoic formations mapped include the Cambrian Tintic Quartzite, Pioche Shale, Cambrian carbonates undifferentiated; Ordovician Pogonip Formation, Kanosh Shale, Swan Peak Quartzite; Ordovician-Silurian Fish Haven-Laketown Dolomite; Devonian Sevy and Simonson Dolomite.

This Paleozoic section is exposed in a large $2\frac{1}{2}$ mile wide graben with Precambrian strata on either side. East trending fault zones bounding the graben extend across the entire Simpson Mountains, a total length of about 7 miles.

Small intrusives which occur in the Simpson Mountains have evidently controlled the migration of ore-bearing fluids as certain intrusives contain moderate amounts of metal sulfides. Fault structures also have localized small ore deposits where such structures cross favorable calcareous slates in the Sheeprock Series. The writer recommends drilling and geophysical surveying in favorable areas to develop the economic potential of the area.

Author abstract

516. THOMAS, HAROLD E., 1947, Geology of Cedar City and Parowan Valleys, Iron County, Utah: Univ. of Chicago Ph. D. thesis.

_____ and G. H. Taylor, 1946, Geology and ground-water resources of Cedar City and Parowan Valleys, Iron County, Utah: U.S. Geol. Survey Water Supply Paper 993, 210 p., geol. map.

Cedar City and Parowan Valleys lie in eastern Iron County, in eastern part of Great Basin. Parowan Valley is bordered on east by High Plateaus; Cedar City Valley lies to west and south. Present drainage is interior. During more humid climates in past, drainage was northeasterly toward Escalante Valley.

Exposed rocks range in age from Permian to Recent. Permian and Triassic rocks crop out only along base of plateau on east side of Cedar City Valley. Jurassic rocks occur principally in the same locality. Cretaceous rocks are widespread in mountains and plateaus. Tertiary and Pleistocene rocks, mostly of volcanic origin, cap plateaus and ranges, and also crop out in valleys. Since mid-Tertiary (?) time highland erosion and lowland aggradation has led to an unknown but great thickness of torrential deposits in valleys.

Persistent zones of coarser detritus below surface of alluvial fans, shoreline features above limits of present playa lakes, and drainage channels developed as outlets to both valleys are probably the result of humid climate which caused creation of Lake Bonneville.

Post-Mesozoic folding accompanied by thrust faulting occurred in the southern part of the region, probably contemporaneously with the forming of the Virgin anticline and similar structures farther south, in Washington County. Sometime during the Tertiary Period, perhaps contemporaneous with the volcanic eruptions that were prevalent during the period, andesitic intrusions in the form of laccoliths caused considerable warping of the sediments in the Iron Springs area, west of Cedar City Valley.

Physiography is dominated by normal faults, most striking effect of which is difference in elevation between High Plateaus and Great Basin. Normal faulting probably began early in Tertiary and accelerated the accumulation of debris in valleys. Scarps in alluvium are evidence of recent faulting. Valleys are evidently graben and adjacent highlands are horsts.

Published abstract revised (B. C.)

517. THOMAS, WAYNE B., 1940, The structural geology of lower Ogden Canyon [Weber County], Utah: Univ. of Utah M. S. thesis, 44 p.

The geologic structure of the Ogden Canyon area is the result of folding and thrust faulting during the Laramide orogeny and of normal faulting in post-Eocene time. Normal faulting initiated with or just prior to the Wasatch fault caused repetition of the Cambrian formations. East-west (transverse) faults offset the older north-south faults slightly. The Carboniferous limestones rest conformably upon lower Paleozoic rocks and the postulated Hermitage overthrust does not exist.

From author conclusions

518. THORPE, MALCOLM R., 1916, Geology of Abajo Mountains, San Juan County, Utah: Yale Univ. Ph. D. thesis.

_____ 1919, Structural features of Abajo Mountains, Utah: Am. Jour. Sci., 4th ser., v. 48, p. 379-389, geol. map.

The Sierra Abajo of San Juan County which occupy an area of about 150 square miles in the Canyon Lands consist of a group of laccoliths with associated sheets and dikes. The intrusive bodies, composed chiefly of hornblende-latite prophyry, show a remarkable similarity in mineral content.

The floor is probably uneven although data are not conclusive. The roof of the laccolith, composed of McElmo (Jurassic), Dakota, probably Mesaverde Sandstone and possibly Mancos Shale as well, must have been no less than 1,200 feet deep and was probably at least 2,750 feet deep in the Shay Mountain area.

The theory of laccolithic origin is substantiated by 4 factors concerned with the igneous mass itself, 6 in the associated sediments and 2 general factors. Effects of contact metamorphism are minor, possibly because of a lack of mineralizing agents in the magma. The intrusion probably occurred in the Early Tertiary during the Laramide Revolution.

Abstract of published article (B. Y. S.)

519. THREET, RICHARD L., 1952, Geology of the Red Hills area, Iron County, Utah: Univ. of Washington Ph. D. thesis, 107 p., geol. map.

The Red Hills area comprises a small basin-range block in the Colorado Plateau - Basin-and-Range transition zone. It is aligned with the northerly-trending Hurricane Cliffs, but lies just west of Markagunt Plateau margin. Plateau-like stratigraphic section of 6,000 to 8,000 feet sedimentary and volcanic rocks includes Jurassic Navajo Sandstone, Carmel Limestone, Entrada, Curtis and Winsor Formations; Upper Cretaceous Iron Springs Sandstone; Early to Middle Tertiary Claron (Pink Cliffs Wasatch) Formation and a sequence of volcanic-derived sediments and acidic welded tuffs and lavas; Late Tertiary-Early Quaternary pediment gravels; and Quaternary olivine basalts.

In Late Cretaceous, Iron Springs Sandstone and older rocks were uplifted in an isolated welt, with northerly trend along site of Red Hills and Hurricane Cliffs and thrust eastward toward site of plateaus. This fold was bevelled and covered by Early to Middle Tertiary rocks.

In Middle Tertiary, the present arrangement of structural elements largely came into existence; the Hurricane fault zone, which was developed approximately coincident with the old buried fold axis south of Red Hills area, is replaced northward by eastward-trending Summit monocline which transfers the plateau margin abruptly eastward to the Paragonah fault zone at margin of Markagunt Plateau. As a result, the Red Hills area and its segment of the Laramide fold lie several miles west of the plateau margin.

During mid-Tertiary the Red Hills area was broadly upwarped and bevelled at its southern end. In Late Tertiary-Early Quaternary the Red Hills area was upfaulted between subsiding blocks of Parowan and Cedar City Valleys. Quaternary basalt sheets locally erupted onto lower flanks of rising block were broken by latest phases of uplift. Winn and Parowan Creeks maintained their antecedent positions and cut transverse gaps through the rising block. Further uplift defeated Parowan Creek, causing gap to be abandoned. *Abstract revised (B. C.)*

520. TIDWELL, WILLIAM D., 1962, Early Pennsylvanian flora from Manning Canyon Shale [Utah County], Utah: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 9, pt. 2, p. 83-101.

The Manning Canyon Shale on the eastern slope of Lake Mountain, located within T. 7 S., R. 1 W. (S.L.B.M.), contains an Early Pennsylvanian flora within its upper shales. The most abundant plant specimens are those which are more readily preserved, stems, portions of fronds, detached pinnules and bits of wood with a few isolated seeds scattered throughout. Alethopteris is the most abundant form with Neuropteris second and Calamites third.

The flora consists of three species of Neuropteris, five species of Alethopteris, one species of Sphenopteris, one species of Cordaites, two species of Calamites, two species of Pterispermostrobus and one possible Cardiocarpus.

The Manning Canyon Formation is composed of shales with quartzites, sandstones and limestones which appear to have been deposited in an embayment with transgressive-regressive cycles alternating between lagoonal and paludal environments.

The plants have been deposited near their place of growth as suggested by their random distribution and orientation on the bedding planes of several large slabs of shale that were sectioned and mapped. The flora and rock types indicate a fresh or brackish swamp environment. *Author abstract*

521. TINT, MAUNG THAW, 1963, Microfossils and petrology of Mississippian Limestones, northern Stansbury Range, Tooele County, Utah: Univ. of Utah M. S. thesis, 103 p.

The Mississippian System in the northern Stansbury Range is divided into five faunal zones on basis of endothyroid foraminifera: (bottom to top). Granuliferella granulosa zone, Plectogyra tumula zone, Plectogyra turgida zone, Endothyra spiroides zone, and Endothyra symmetrica zone. Due to overlap of Granuliferella granulosa and Plectogyra tumula zones, the former may be a subzone of the latter. Endothyra spiroides and Endothyra symmetrica zones also overlap. Lower 2 zones are Kinderhookian-Osagian; upper 3 zones are tentatively considered as Meramecian-Chesteran. Upper Meramecian endothyroid Foraminifera and ostracodes are strikingly similar to those of mid-continent region. Glomospira and Ammodiscus are suggested as phylogenetic ancestors of Endothyra and Plectogyra.

Micropetrologic examination of all samples was carried out so as to establish bio-litho-ecological relationships and to find evidence bearing on the theories of the origin of chert and dolomite.

Abstract revised (B. C.)

522. TREXLER, DAVID W., 1955, Stratigraphy and structure of the Coalville area [Summit County], northeastern Utah: Johns Hopkins Univ. Ph. D. thesis, 143 p., geol. map.

The Coalville area includes approximately 215 square miles of the area where the north central Wasatch Mountains joins the northwestern flank of the Uinta Mountains.

The stratigraphic section has an aggregate thickness of about 12,500 feet. Less than one-fourth of this sequence is of marine origin, the remaining three-fourths is fluviatile or terrestrial. The formations recognized are the Kelvin (?) (Early Cretaceous), the Frontier (Late Cretaceous), the Henefer (Late Cretaceous), the Pulpit (Late Cretaceous ?) and the Knight (Eocene). Quaternary drift and alluvium (Pleistocene and Recent) lie on older rocks. Mappable units within the Cretaceous formations are designated members. The following nine members are recognized within the Frontier formation: (oldest to youngest) Skunk Point sandstone member, Chalk Creek member, Grass Valley shale member, Oyster Ridge sandstone member, Coalville conglomerate member, Dry Hollow sandstone member, Meadow Creek sandstone member, Judd shale member and the Upton sandstone member. All of these, except the Oyster Ridge sandstone member, are new names.

The structural units within the Coalville area consist of folds (some of which are plunging and overturned) and normal faults. The folds and early normal faults are genetically related to the folds and thrusts of the Wasatch Mountains. They were formed during the early Laramide orogeny of Late Cretaceous time. The influence of the Uinta anticline upon these structures at the time of folding is shown by the northeast-southwest orientation of the Coalville fold axes as compared to the north-south trends of the Wasatch structures. Late normal faults (post-Knight in age) are related to a second period of uplift in the Uinta Mountains.

Author abstract

523. TUCKER, LeROY M., 1954, Geology of the Scipio quadrangle [Millard County], Utah: Ohio State Univ. Ph. D. thesis, 360 p., geol. map.

The Scipio quadrangle consists of about 300 square miles largely along eastern edge of Millard County, central Utah. It includes significant portions of the Pavant Range, Valley Mountains and Upper and Lower Round Valleys. Ordovician strata, previously unknown in this part of Utah, were mapped in northern part of Pavant Range. Lower members were correlated with Lower Ordovician sections in Great Basin by Lehi F. Hintze. A higher unit of probable Upper Ordovician age, 1,200+ feet thick, was defined and named the Wild Goose Formation. A 1,500-foot Upper Cambrian (?) sequence on Coffee Peak, Pavant Range, which is conformable upon Upper Cambrian strata and lies below Ordovician beds has been divided into a lower limestone designated Jumpoff Limestone and an upper dolomite designated Coffee Peak Dolomite.

Lithology of the Paleozoic sequence was studied in detail, and the great thickness of unfossiliferous but conformable carbonate strata was measured, described and pictured in order to correlate it with similar Great Basin strata. Thickness and general character of Cambrian and Ordovician sequences in Pavant Range were similar to those of sequences in Gold Hill district, Utah, and Pioche and Ely districts, Nevada. Tintic and Oquirrh districts, Utah, were less closely related in lithology.

Abstract revised (B. C.)

524. TURNER, FRANK PAUL, 1952, Stratigraphy and structure of Provo Canyon between Bridal Veil Falls and South Fork [Utah County]: Brigham Young Univ. M. S. thesis, 46 p., geol. map.

The rocks exposed in Provo Canyon are sedimentary and are mostly horizontal. The 26,000-foot Oquirrh Formation (Pennsylvanian-Permian) is interbedded limestones, shales and orthoquartzites. Only the lower 3,554 feet was studied. The lower interbedded limestones, shales, orthoquartzites and shaly limestones have been assigned to the Ardian Series (Springeran and Morrowan Stages). These beds accumulated on a stable to unstable shelf under infraneritic to epineritic conditions. The upper facies consists of orthoquartzites with a few interbedded cherty limestones assigned to the Oklan Series (Atokan and Desmoinesian stages). Atokan strata indicate an unstable shelf; Desmoinesian rocks indicate stable to mildly unstable shelf conditions.

Thrust faulting and folding occurred in Late Cretaceous time; normal and reverse faulting, in latest Cretaceous and Early Tertiary time. A large graben with downdrop of about 1,145 feet is bounded by the Aspen Grove fault on the west and Vivian Park fault on the east.

Abstract revised (B. Y. S.)

525. TWENTER, FLOYD R., 1956, Relation of texture and mineral composition to the topographic expression of some Colorado Plateau sandstones: Univ. of Missouri M. A. thesis, 85 p.

Various Permian, Triassic and Jurassic sandstones from the Colorado Plateau were studied to determine if the texture and mineral composition affects the distinct topographic expression of those sandstones. This paper includes a general discussion of the stratigraphy, the location of the areas sampled, the procedures used in performing various analyses, along with the results of those analyses, and the final conclusions.

The data obtained indicates that porosity, sphericity of grains, and cementing material are directly related to the topographic expression of those sandstones on the Colorado Plateau. The fraction of the grain surfaces in contact with other grains or cement, when related to the number and type of grain contacts, indicates a direct correlation with the topographic expressions of the sandstones. Although grain size and mineral composition have probably had an indirect influence upon the weathering of the Permian, Triassic and Jurassic sandstones, no direct correlation can be made between them.

Author abstract

526. VAN DE GRAAFF, FREDRIC R., 1962, Upper Cretaceous stratigraphy of the central part of Utah: Utah State Univ. M. S. thesis, 107 p. plus appendix (index of published stratigraphic sections).

Hale, L.A. and F.R. Van de Graaff, 1964, Cretaceous stratigraphy and facies patterns - northeastern Utah and adjacent area: Intermountain Assoc. Petroleum Geologists Guidebook, 13th Ann. Field Conf., p. 115-138.

Rocks of Late Cretaceous age in central Utah are dominantly clastic, with conglomerate and sandstone of nonmarine origin to the west, sandstone and shale of marine origin to the east. These rocks were deposited at or near the western shore of a sea which extended from the Arctic to the Gulf of Mexico, the strand line of which was generally north-south through Utah.

Outcrops of Upper Cretaceous rocks are widespread except in west central and northwestern Utah. The Upper Cretaceous section varies greatly in thickness. It is nearly complete only in east central Utah where the section aggregates about 9,400 feet.

The Cretaceous sea transgressed westward into Utah during latest Early Cretaceous and earliest Late Cretaceous. From early Colorado to late Montana time, the sea tended to regress eastward. The regression was interrupted by transgressions which caused an intertonguing relationship in rocks of Late Cretaceous age.

The writer believes it is possible to discern two different sequences of facies, from west to east: (1) (exemplified by the Castlegate Sandstone) piedmont, inland, littoral marine, to offshore marine, with lagoonal sediments absent; (2) inland, lagoonal, littoral marine and offshore marine, with piedmont sediments absent. *B. C.*

527. VLAM, HEBER ADOLF ARIEN, 1963, Petrology of Lake Bonneville gravels, Salt Lake County, Utah: Univ. of Utah M. S. thesis, 58 p.

A study of sand and gravel deposits associated with Pleistocene Lake Bonneville was made from October 1961 to July 1962 in lower Jordan Valley, Salt Lake County, Utah. The sand and gravel deposits were mapped, and existing and potential reserves of sand and gravel were estimated. Pebble counts were taken to determine the mineralogical composition and geologic origin of the different deposits. Representative samples of the deposits were tested in the laboratory for grading, liquid limit and plasticity index, absorption, optimum moisture and dry density, and abrasion.

The sand and gravel deposits of lower Jordan Valley are derived almost entirely from the rocks that make up the mountains surrounding the valley and include: (1) deposits associated with the Alpine, Provo and post-Provo stages of Lake Bonneville; (2) stream terraces, formed by streams breaching and redepositing the shore gravels of the lake; (3) sand dunes associated with some of the Provo spits; and (4) mudrock flow deposits and alluvial fans.
Author abstract

528. VOGEL, JAMES WILLIAM, 1957, Geology of the southernmost Juab Valley and adjacent highlands, Juab County, Utah: Ohio State Univ. M. S. thesis, 152 p., geol. map.

Area of report lies in southeastern Juab County. Exposed bedrock ranges in age from Middle Jurassic to late Eocene and includes Jurassic marine Arapien Shale (380+ feet), Paleocene nonmarine Flagstaff Limestone (998 feet), Eocene lacustrine Green River Formation (859 feet), fluviatile and lacustrine "Tawny beds" (about 769 feet), and pyroclastic Golden's ranch Formation (748+ feet) which was traced from Long Ridge across Juab Valley into western edge of Gunnison Plateau.

Both the Golden's Ranch and the "Tawny beds" overlie the Arapien in places in angular unconformity on an early Laramide erosion surface of considerable relief. The Golden's Ranch strata overlie the "Tawny beds" in a conformable relationship on the Gunnison Plateau front, and in the area of southern Long Ridge the same holds true for the Golden's Ranch - Green River contact. Eocene age for Golen's Ranch Formation is supported by transitional conformable relationship to "Tawny beds." Fossils suggest that "Tawny beds" are a facies of upper Green River Formation.

Juab Valley and the western outcropping hogbacks of the Gunnison Plateau appear to comprise a shallow synclinal structure modified by high-angle faults of small stratigraphic throw. Homoclinal Tertiary strata forming two rows of cuestas comprise southern Long Ridge. *B. C.*

529. WAGNER, OSCAR E., Jr., 1932, The paleontology and stratigraphy of the Kaibab Limestone: Univ. of Illinois Ph. D. thesis, 110 p.
(Abs.): Univ. of Illinois Abstracts of Theses, 9 p.

The Kaibab Limestone, which forms the rim rock of the Grand Canyon of the Colorado River, also occurs in southern Utah. The Kaibab in most places passes by gradation down into the Coconino Sandstone below and is overlain disconformably by the Moenkopi Formation of Triassic age. At the type locality in Kaibab Gulch, Utah, the limestone is 717 feet thick. It thickens to the west and thins eastward, northward and southward and evidently was deposited in a sea which advanced from the west.

The fauna of the Kaibab Limestone as here described consists of 74 species belonging to 55 genera. The genus Phylloporella is here described for the first time. Twenty-five new species of invertebrates are described. The fauna is divided into two faunal facies or faunules, the Productus ivesi faunule below and the Schizodus verdensis faunule above. The latter term is proposed for the part of the fauna hitherto designated as the "Bellerophon fauna."

The Kaibab Limestone is correlated with the Word Formation of the Glass Mountains of Texas, and with the upper part of the Naco Limestone of the Chiricahua Mountains of southeastern Arizona and is upper Middle Permian in age.

From author summary

530. WALLACE, RONALD G., 1964, Late Cenozoic mass movement along part of the west edge of the Wasatch Plateau [Sanpete County], Utah: Ohio State Univ. M. S. thesis, 92 p.

The bouldery deposit now occurring as terraces in lower Six Mile Canyon and as a large bouldery fan in Sanpete Valley is believed to be the result of mass movement. A large mudflow moved from the upper portion of the Wasatch Plateau when the floor of Six Mile Canyon was higher. It filled lower Six Mile Canyon due to confinement of the valley walls; remnants now form terraces. As it spread out into a large fan in Sanpete Valley, damming San Pitch River, a lake was formed in which lacustrine sediments accumulated.

Uplift of the underlying Arapien Shale and Green River Formation caused arching and tilting of the bouldery deposit and lake sediments. A stream was diverted and deposited stream gravels on the lake sediments. Later a mud flow moved from Funks Cove into lower Six Mile Canyon. It blocked a small tributary on the north side of the valley, where Funks Lake now exists, and produced a large lobate fan at the mouth of Six Mile Canyon, causing fragmental debris to overlie the older bouldery deposit.

Slow debris flows, slump, earthflows, mudflows, protalus ramparts and talus tongues are conspicuous forms of mass movement in upper Six Mile Canyon, Manti Canyon and Twelve Mile Canyon.

Author summary revised (B. C.)

531. WALTON, PAUL TALMADGE, 1942, Geology of the Cretaceous of the Uinta Basin, Utah: Massachusetts Institute of Technology Ph. D. thesis.

_____ 1944, Geology of the Cretaceous of the Uinta Basin, Utah: Geol. Soc. Am. Bull., v. 55, p. 91-130.

The Cretaceous rocks of the Uinta Basin, Utah, are exposed along south flank of Uinta Mountain anticline and are overlain unconformably by Tertiary sediments. The Dakota (?) sandstone disconformably overlies Jurassic Morrison and is overlain conformably by Mancos shale. It probably represents rocks of both Upper and Lower Cretaceous. The Mancos shale, as mapped and studied, comprises only a lithologic unit since in Vernal vicinity it is equivalent in age and stratigraphic position to Mesaverde group sandstones of Tabby Mountain region to west. The Mancos is divided into the following members: lower shale, Aspen shale, middle shale, Frontier sandstone and upper shale.

The Mesaverde group refers only to a lithologic facies since at the west end of the area it is predominantly Niobrara in age, whereas at the east it is completely post-Niobrara. In the Vernal region it is divided into three members: the Asphalt Ridge sandstone, the Rim Rock sandstone and the Williams Fork Formation (contains more than type Williams Fork). The lower members of the Mesaverde group intertongue with the upper portion of the Mancos shale and wedge out toward the east.

The name Currant Creek is proposed for a sequence of conglomerate beds unconformably overlying the Mesaverde group in the Tabby Mountain region. This new formation is tentatively referred to the Upper Cretaceous but it probably represents the transitional strata deposited from late Upper Cretaceous to Eocene during the early phases of the Laramide folding.

The Uinta Basin is an asymmetrical syncline with its steep side along the flank of the Uinta Mountain anticline to the north from which numerous small noses and supplementary folds plunge southward.

From published abstract

532. WARING, ROBERT G., 1952, Geology of the phosphatic shale member of the Park City Formation in central and north central Utah: Brigham Young Univ. M. S. thesis, 34 p.

The phosphate mineral occurs in rounded grains (oolites) ranging from minute to $\frac{1}{2}$ inch in diameter. The grains are cemented usually by calcite. The rock is gray to black and has a very fetid odor when freshly broken. The rock has a higher than average specific gravity. Origin was sedimentary. Both chemical precipitation and mechanical accretion likely played a part in the origin and formation of the phosphorite.

The Park City Formation of the south central Wasatch Mountains, the Phosphoria of the Confusion Range and the thin shelf facies of the Park City Formation in the Uinta Mountains are correlatives. Apparently during Park City time a similar depositional environment existed throughout west central Utah, as far east as the central Wasatch region. The Uinta Mountains area was a shelf. Thrusting has resulted in the juxtaposition of the thick miogeosynclinal rocks from the west against thin stable shelf facies in the Uinta Mountain region to the east. Thus the abrupt facies changes present today are due to structural adjustments and are not normal lateral sedimentary facies changes. *B. Y. S.*

533. WARNER, MAURICE ARMOND, 1956, The origin of the Rex chert: Univ. of Wisconsin Ph. D. thesis, 84 p.
(Abs.): Dissert. Abs., v. 16, No. 5, p. 947-948, 1956.

Stratigraphic, petrographic and geochemical studies of the Rex chert member of the Phosphoria Formation lead to the conclusion that the bulk of the bedded chert was deposited as a finely divided chemical precipitate. A smaller amount of chert resulted from the silicification of bioclastic limestones through the action of silica bearing solutions migrating up-dip from the deeper part of the basin along the more permeable beds.

Most of the chert was deposited in an east-west trending trough surrounded on three sides, at least, by more stable platform areas. The scarcity of clastics, and the greater amount of pyrite and organic matter in the chert show that these rocks were deposited under deeper, quieter waters than those that prevailed over the platform areas where the sediments are characterized by an abundance of terrigenous and bioclastic particles and a low content of organic matter and pyrite. Around the periphery of the area of silica deposition the chert grades into and is interbedded with carbonate rocks which are largely of a bioclastic nature.

The petrologic and geochemical features of most of the chert show that it was probably deposited as a finely divided chemical precipitate along with calcium carbonate in an area of minimum clastic deposition. The chemical conditions in the deeper part of the basin led to the resolution of most of the calcium carbonate and the dolomitization of much of the remainder. The good crystal form and the zonation of the dolomite rhombs present in the chert, the nature of the silicified fossil fragments, the small amount of alumina in the chert and limestone and the similarity of the trace element ratios in adjacent samples of chert and carbonate rock support this conclusion. *From author abstract*

534. WARNER, MONT MARCELLUS, 1949, Correlation study of the Mesozoic stratigraphy of Utah and the adjacent portions of surrounding states: Brigham Young Univ. M. A. thesis.

Six cross-section diagrams illustrate the stratigraphic sequence of Mesozoic strata of Utah and adjacent states. Correlation of local formational units with the major units of each system are given. Triassic is present throughout area, but is thicker in southeastern Idaho and southwestern Wyoming, more sandy and gypsiferous elsewhere. Major units are Moenkopi, Shinarump and Chinle Formations. Jurassic Glen Canyon Group consists of (ascending) Wingate Sandstone, Kayenta Formation and Navajo Sandstone. This group is thickest in southeastern Nevada, southwestern Utah and northwestern Arizona. Jurassic San Rafael Group overlies Glen Canyon and consists of (ascending) Carmel, Entrada, Curtis and Summerville Formations. The greatest thickness of San Rafael Group is in southeastern Idaho, southwestern Wyoming and northern Utah. Strata are more calcareous in north and northeast, more gypsiferous and arenaceous in south and southwest. The distinctive Morrison Formation contains the youngest Jurassic beds.

Common names applied to Cretaceous rocks are Dakota Sandstone (base), Mancos Shale, Mesaverde Formation and Price River Formation. The Cretaceous is relatively thick throughout but is thickest in the northern, northeastern and central parts where it is typically marine; it grades into coarser sandstone and conglomerates in the south and southwest. *Abstract revised (B. Y. S.)*

535. WARNER, MONT MARCELLUS, 1963, Sedimentation of the Duchesne River Formation, Uinta Basin, Utah: State Univ. of Iowa (Iowa City) Ph. D. thesis.
(Abs.): Dissert. Abs., v. 24, No. 6, p. 2425-2427, 1963.

The Duchesne River Formation is located in the Uinta Basin south of the Uinta Mountains in northeastern Utah. The formation is nonmarine and consists mainly of fluviatile sandstones and mudstones, and contains some bentonitic clay beds. Its age is Eocene-?Oligocene. The environment of deposition of the Duchesne River Formation may have changed from one of subaqueous to one of subaerial conditions between early and late Duchesne River time.

With the exception of several bentonitic clay beds, the sediments which make up the Duchesne River Formation were derived from older Cenozoic, Mesozoic, Paleozoic and Precambrian rocks of the Uinta Mountains. The Precambrian source was more influential on the Duchesne River Formation of the western half of the basin, and the younger sedimentary source was of greater influence in the eastern half.

The Duchesne River Formation is divided into two facies on the basis of the sandstone/mudstone ratio. There is from four to six times as much sand in the western half of the formation as there is in the eastern half. The Duchesne River Formation is divided into two members on the basis of bentonite content, which represents at least seven volcanic eruptions during Duchesne River time.

An increase in the rate of uplift of the Uinta Mountains progressed from west to east during Duchesne River time. The basin was being deformed by the Uinta uplift as the Tertiary formations were being deposited from Wasatch to Duchesne River time. This is indicated by the gradual northward shift of the synclinal axis and the angular unconformities along the northern edge of the basin.

Solid hydrocarbon (gilsonite) veins are closely associated with fine-textured rocks, the concentration of surface fractures, the areas where Tertiary formations are thinnest, concentrations of gypsum in surface formations, and low relief areas.

From author abstract

536. WARNER, ROBERT O., 1951, Groundwater geology of the Provo-Orem, Utah area [Utah County]: Brigham Young Univ. M. S. thesis.

Gates, R.W. and R.O. Warner, 1951, Groundwater geology of east Utah Valley, Utah: Compass, v. 29, No. 1, p. 39-47.

Utah Valley is an intermont situated along the eastern edge of the Basin and Range Province and is bounded on the east by the western escarpment of the south central Wasatch Mountains. This short (published) report, which summarizes the findings of both authors theses, concerns the groundwater geology of the east side of Utah Valley from Orem (north) to Spanish Fork (south), about 125 square miles. Data was obtained mainly from logs of water wells; other sources include unpublished data from files of the geology department and its faculty.

Numerous aquifers are present above a depth of 1,200 feet throughout eastern Utah Valley which can provide pure water for culinary and commercial purposes. Most water needs can be met with wells drilled to depths not exceeding 600 feet. A panel diagram (scale 1:12,000) illustrating the nature, depth, thickness and extent of each producing aquifer is on file in the geology department, along with appendices. *B. C.*

537. WASHBURN, GEORGE R., 1948, Geology of the Manti Canyon area [Sanpete County], central Utah: Ohio State Univ. M. S. thesis, 67 p., geol. map.

The Manti Canyon area, about 51 square miles, lies near the town of Manti, in Sanpete County, Utah, and includes parts of Sanpete Valley and the Wasatch Plateau. The exposed formations have a total thickness in excess of 3,274 feet, and consist of the North Horn Formation, Flagstaff Limestone, Colton Formation, Green River Formation and Crazy Hollow Formation. They range in age from Upper Cretaceous to Lower Tertiary, and are of freshwater origin, consisting predominantly of fine clastics and limestones. Pleistocene deposits include a rockslide moraine (?) and terrace gravel.

The major regional structural feature is the Wasatch monocline, marking the western border of the Wasatch Plateau. Here about $5\frac{1}{2}$ miles wide, it is a broad flexure broken by normal faults, transverse and parallel to the structural trend, the latter downthrown generally to the east. A graben occurs at the shoulder of the monocline, separating the flexure from the flat-lying rocks of the plateau. *B. C.*

538. WEBB, GREGORY W., 1949, Stratigraphy of the Ordovician quartzites of the Great Basin: Columbia Univ. M. A. thesis, 42 p.

The Middle Ordovician Eureka Quartzite of Nevada has been tentatively correlated with the Swan Peak Quartzite of northern Utah. New field evidence, however, has shown that these units cannot be correlated directly, although both formations are delimited by the same Ordovician time rock units.

The Swan Peak Formation, recognized in northern and western Utah, is calcareous at the base, with a Chazyan fauna, and grades upward into a pure quartzite. This quartzite can be traced only with difficulty into Nevada. The Eureka Formation, which in the type locality also consists of a carbonate and quartzite suite, could easily be taken for a time rock equivalent of the Swan Peak. However an inferred disconformity at the base of the massive quartzite member of the Eureka restricts the use of "Eureka" to this upper member alone. In a newly described section at Ibex, Utah, this same massive member of the Eureka is separated by a dolomite from the underlying Swan Peak sequence. In central Nevada a calcareous unit with a Bolarian fauna seems to be the rock equivalent of this dolomite, thus suggesting that the quartzite of Nevada is considerably younger than the Swan Peak Quartzite.

From author abstract

539. WEBB, GREGORY W., 1954, Middle Ordovician stratigraphy in eastern Nevada and western Utah: Columbia Univ. Ph. D. thesis.

______ 1958, Middle Ordovician stratigraphy in eastern Nevada and western Utah: Am. Assoc. Petroleum Geologists Bull., v. 42, No. 10, p. 2335-2377.

Stratigraphy of Middle Ordovician quartz arenites and related rocks is traced from central Nevada to central Utah, and correlations with northern Utah rocks are suggested. Following accumulation of thick, fossiliferous Pogonip carbonate rocks, miogeosynclinal regressive Kanosh argillites and the Watson Ranch tongue of the Swan Peak quartzite were deposited in west central Utah and along the southwest flank of the Tooele arch, a Middle Ordovician emergent element west of Provo, synchronous with Chazyan Swan Peak argillite and quartzite deposition in northern Utah. After subsequent accumulation of the Crystal Peak dolomite, the basal regressive phase of the Eureka quartzite was spread westward from central Utah, culminating in the fossiliferous undaform edge Copenhagen Formation in central Nevada. Continued emergence caused deep erosion in part of north central Nevada and moderate to slight erosion elsewhere.

Transgressive Trentonian Eureka Quartzites, with several distinct members of approximate time-rock value, were deposited in thickness over much of Nevada and western Utah, and probably into central Utah. At least sporadically developed in northern Utah, the Eureka Quartzite may be thickly developed there, represented by rocks now considered as type Swan Peak and close correlatives. Continued transgression forming latest Trentonian and early Cincinnatian carbonates was interrupted, probably by widespread emergence, so that Richmondian dolomites lie on Eureka Quartzite and other Middle Ordovician and Lower Ordovician rocks.

Published abstract

540. WEGG, DAVID S., Jr., 1915, Bingham mining district, Utah: Univ. of Utah M. S. thesis, 224 p.

An inclusive coverage of the history of early mining in Utah, in Salt Lake County and in the Bingham district, together with a description of the various mines and plants, and summary of the geology of the ores. *B. C.*

541. WEINTRAUB, JUDY, 1957, Mineral paragenesis and wall rock alteration at the Ophir mine, Tooele County, Utah: Univ. of Utah M. S. thesis, 44 p.

A study was made of a drift on a lower level of the Ophir mine. A total of 75 samples was examined. The contact metamorphic minerals, such as epidote and garnet, were pre-ore and developed mainly along bedding faults. A near-vertical sanidine-quartz dike striking north-south also was found to be pre-ore. Ore deposition, which was restricted to the limestone beds, was related to north-south fissures approximately normal to the bedding. Order of deposition of the ore minerals was pyrite and scheelite, galena and chalcopyrite (minor bismuth minerals and tennantite), sphalerite and pyrrhotite.

The extent of alteration of the Ophir Shale was noted as a function of the proximity to the ore bodies. By plotting the relative intensities of the X-ray diffraction peaks of the micas, changes could be noted in the sericite up to 100 feet along the bedding approaching ore, and over 10 feet normal to the bedding. Alteration of the sericite to chlorite and phlogopite occurred within approximately 15 feet of ore. A generalized sequence of mineral change approaching ore is sericite, modified sericite, modified sericite and 7Å chlorite, 14Å chlorite and phlogopite, and phlogopite. This sequence was not found in areas barren of ore minerals.

From author abstract

542. WELLS, RICHARD B., 1963, Orthoquartzites of the Oquirrh Formation: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 10, p. 51-81.

The Oquirrh Formation (Pennsylvanian and Wolfcampian) of northwest central Utah consists mainly of calcareous and siliceous clastic sedimentary rocks. A 15,540-foot section of sandstone with minor cherty limestone and calcarenite was measured at South Mountain west of Stockton in Tooele County. A 7,250-foot section (Wolfcampian) of similar lithology was measured in Hobble Creek Canyon, east of Springville. A 714-foot interval (Wolfcampian) of Weber Formation, Weber Canyon, is comprised mainly (80 percent) of noncalcareous orthoquartzite.

Oquirrh orthoquartzites were deposited in shallow water in a large marine basin which was subject to irregular instability and great subsidence. Clastic sediments were derived from surrounding local positive areas. Grains were fairly well sorted and generally subrounded to subangular, equant and anhedral. Much of the quartz was derived from sedimentary rocks.

No similar examples of calcarenaceous orthoquartzite were found during a study of about 30 other formations in the United States. Orthoquartzites generally are nonporous light-colored rocks consisting of anhedral quartz grains (95 percent or more) in which silica cementation has taken place through pressure solution or by addition of new silica, or both. *Abstract revised (B. C.)*

543. WHEELWRIGHT, MONA VYONNE, 1958, Preliminary palynology of some Utah and Wyoming coals: Univ. of Utah M. S. thesis, 110 p.

Spore and pollen content of 11 coal samples from Late Cretaceous Blackhawk, Adaville and "Wanship" Formations and from Early Tertiary Knight (?) Formation was studied. Coal from "Wanship" Formation had no identifiable forms. Forms were infrequent in samples from Knight (?) Formation, but common to abundant in samples from Adaville and Blackhawk Formations.

Bituminous samples were treated with dry potassium chlorate, concentrated nitric acid and a 10 percent solution of potassium hydroxide. Coals of lower rank were treated with Schulze's solution and 10 percent solution of potassium hydroxide. Eighty-four kinds of fossil spores and pollen are described and 104 forms are photomicrographed. Classification was based on Mesozoic genera in palynological literature, paleozoic form genera of Schopf, Wilson and Bentall, and pollen form groups of Faegri and Iverson.

Statistical comparison of spore and pollen populations (200 specimens from each sample) indicates the following: pollen spectra of the various formations are different; there is greater similarity between populations of same coal seam than between populations of different coal seams; variations in length of hydroxide treatment introduce slight errors in percentages; in geologically younger coals, percentages of alete spores and inaperturate pollen grains increase and percentage of triporate pollen grains decrease. *Abstract revised (B. C.)*

544. WHIPPLE, ROSS W., 1949, Radioactivity correlations in an ore deposit near Park City, Utah: Univ. of Utah M. S. thesis, 40 p.

An attempt was essayed to determine the nature of radioactivity within a mineral deposit near Park City, Utah. A beta-ray analysis of samples taken across a known fissure deposit was made in order to discover if surface prospecting in the region would locate similar deposits.

It was discovered that quantities of uranium as small as 1×10^{-6} grams per gram of rock can be identified with a beta-ray counting device. Potassium, however, contributed appreciably to the activity of the rock samples, masking the effect of more diagnostic uranium and thorium minerals. It is suggested that a chemical analysis for potassium be made in conjunction with beta-ray analysis for future work; a correction for the activity due to potassium could thus be made. *Author abstract*

545. WHITE, BOB O., 1953, Geology of the West Mountain and northern portion of Long Ridge, Utah County, Utah: Brigham Young Univ. M. S. thesis.

The area mapped includes about 85 square miles in south central Utah County. It lies near the eastern boundary of the Basin and Range Province and near the base of the southern Wasatch Mountains. About 24,000 feet of sedimentary strata are exposed, divided into 18 formations: eight Cambrian (2,982 feet), one Devonian (108 feet), four Mississippian (3,591 feet exposed), one Pennsylvanian-Permian (about 16,200 feet), two Permian (1,170-1,270 feet incomplete exposed thickness), and two Cretaceous-Tertiary (estimated thickness of 250-300 feet). Lake Bonneville lacustrine sediments and later lacustrine and alluvial deposits cover slopes and valley areas.

Structural pattern is complex and consists of overfolds and thrusts cut by a system of tear and normal faults. Movement along the thrust sheets appears to be from west to east. Crustal deformations occurred during the early stages of the Laramide orogeny and have continued intermittently until the present. *Abstract revised (B. C.)*

546. WILCKEN, PHYLLIS D., 1936, The Brazer Formation in the Beck Spur area, central Wasatch Mountains: Univ. of Utah M. S. thesis, 55 p.

This report records the results of a detailed stratigraphic study of a portion of the Upper Paleozoic rocks in the central Wasatch Mountains exposed in a bold salient referred to locally as the Beck Spur.

The specific problem undertaken in this investigation involved: (1) the determination of the presence or absence of rocks of Brazer age (Upper Mississippian) in the Beck Spur region by means of a lithologic and stratigraphic correlation of Mississippian Formations with sections of Mississippian rocks in neighboring parts of northern Utah and southeastern Idaho; (2) the preparation of a geologic map showing the areal distribution of Mississippian Formations within the area, (3) the detailed description and measurement of the Paleozoic rocks younger than the known Devonian "Beck Limestone", (4) a summary of the published descriptions of Mississippian sections in adjoining regions including the preparation of a faunal correlation table of Mississippian fossils.

The results of this investigation indicate that the upper Paleozoic section in the Beck Spur area closely resembles both the Madison and Brazer Formations of southeastern Idaho, and the Madison, Deseret, Humbug, and "Great Blue" Limestones in the Mercur district, Oquirrh Range. *Author abstract*

547. WILEY, MICHAEL ALAN, 1963, Stratigraphy and structure of the Jackson Mountain-Tobin Wash area, southwest Utah: Univ. of Texas at Austin M. A. thesis, 94 p., geol. map.

Jackson Mountain-Tobin Wash area is located in transition zone between Colorado Plateau and Basin-Range Province on eastern edge of major Laramide thrusting in the Cordillera. Area is bounded on east and west by major north-trending Basin-Range faults. About 2,000 feet of Upper Cretaceous (?) and Lower Tertiary (?) fanglomerate and sandstone of Grapevine Wash Formation was derived from plate of Laramide surface thrust which carried Pennsylvanian and Permian limestone and sandstone over 8,000+ feet of Jurassic and Upper Cretaceous rocks. Thrust advanced over fan developed in front of it in latest Cretaceous and Eocene time but movement had ceased by late Eocene or early Oligocene time. Thrust is overlain by limestone of Claron Formation with interbedded welded tuff of Needles Range Formation. A potassium-argon determination on biotite from tuff indicates Oligocene age.

About 2,500 feet of Oligocene and Miocene extrusive rocks, chiefly ignimbrites, overlie Claron Formation. High-angle faulting which may have begun in Eocene time culminated in latest Miocene time with extensive northeast tilting and contemporaneous antithetic and strike faulting and marks the time of fracturing of transition zone in southwest Utah. In Pliocene (?) and Pleistocene time thick fill accumulated in structural basins, extensive pediments were cut, and basalt was extruded over eastern part of area. *From author abstract*

548. WILLARD, ALLEN D., 1959, Surficial geology of Bear Lake Valley [Rich County], Utah: Utah State Univ. M. S. thesis.

Williams, J. S., A. D. Willard and Verlyn Parker, 1961, Recent geologic history of the Bear Lake Valley, Utah-Idaho: Friends of the Pleistocene, Rocky Mountain Section, Guidebook, 7th Ann. Field Conf., 18 p.

_____ 1962, Recent history of Bear Lake Valley, Utah-Idaho: Am. Jour. Sci., v. 260, p. 24-36.

Bear Lake Valley, 30 miles east of the Bonneville Basin in northern Utah and lying across the Utah-Idaho line, is partly the result of downfaulting along the Bear Lake fault at its eastern margin. Scarplets in alluvium are almost continuous along the trace of the fault. Bear River flows obliquely across the northern end of the valley. The valley is marked by abandoned shorelines of Bear Lake at elevations 6, 15 and 25 feet above present lake level. Radiocarbon dating of the shorelines indicates that these high stages existed about 8,000 years B.P. The highest stage apparently was due to downward movement of the valley, ponding the river. The intermediate stage can be explained by slowed downcutting of the outlet, or perhaps landsliding. The 6-foot stage is believed due to regrowth of the alluvial fan of Bear River. *Published abstract (Am. Jour. Sci.)*

549. WILLDEN, CHARLES R., 1952, The nature of the igneous-sediment contact in the U. S. mine, Bingham, Utah: Univ. of Utah M. S. thesis, 41 p.

The Last Chance stock in the U.S. mine, Bingham, Utah, has metamorphosed the quartzitic and calcareous (to dolomitic quartzitic) sedimentary rocks that it intrudes to a considerable extent in the lower levels of the mine, but to a lesser extent in the upper levels. This suggests bedding-plane control for the migration of the fluids that served as a heat source for the contact metamorphism and possibly aided in the recrystallization of the sedimentary materials.

Minor assimilation of the sedimentary material by the magma resulted in an increase in grain size particularily of plagioclase and augite near the contact with the sediments. This increase in grain size in a magma upon assimilation of sedimentary material is to be expected when acidic magmas intrude and assimilate calcareous and dolomitic sediments.

Granitic dikes which resemble rocks from the Bingham stock cut the Last Chance stock and suggest that the Bingham stock post-dates the Last Chance stock. *Abstract revised (B. C.)*

550. WILLES, SIDNEY B., 1962, The mineral alteration products of Keetley-Kamas area [Wasatch and Summit Counties], Utah: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 9, pt. 2, p. 3-28.

Types and areal extent of the hydrothermal alteration products in the volcanic rocks of the Keetley-Kamas area were determined by differential thermal analysis and thin section study. Chloritization was widespread whereas silicification, alunitization, kaolinization and montmorillonization were localized in a few square miles around a diorite porphyry intrusion.

Quantitative spectrochemical analysis confirmed the introduction of moderate amounts of manganese in the alteration but failed to show any consistent major addition of lead, zinc, gold, copper or silver. Copper and silver, however, were observed in local areas to be present in unusually large amounts. *Author abstract*

551. WILLIAMS, EDMUND J., 1964, Geomorphic features and history of the lower part of Logan Canyon [Cache County], Utah: Utah State Univ. M. S. thesis, 64 p.

The lower part of Logan Canyon is that section from the mouth upstream 23 miles to Tony Grove Canyon. Several tributary canyons have been included in this investigation. More than 20,000 feet of Paleozoic rocks are exposed in Logan Canyon. Cenozoic deposits are widespread in and near the Canyon. The crest of the Bear River Range near Naomi Peak was the center of glacial activity during the Pleistocene. During the glaciations of Tony Grove, Lake Bonneville extended into Logan Canyon.

CORRELATION OF EVENTS IN LOGAN CANYON

Age		Erosion and deposition	Lake Bonneville	Glaciation
Recent		Alluvial fans Mudrock flows		Temple Lake (?)
Pleistocene	Late Wisconsin	Continued terrace-building	4,777±	
Pleistocene	Middle Wisconsin	Spring Hollow terraces Mill Hollow terraces	4,807± 5,142	Bull Lake II
Pleistocene	Early Wisconsin	Tony Grove Canyon (U-shaped cross profile)	5,107±	Bull Lake I
Pleistocene		Beirdneau Hollow terraces		Buffalo (?)
Pre-Pleistocene		Canyon cutting		

Author correlation chart and part of abstract

552. WILLIAMS, FLOYD ELMER, 1951, Geology of the north Selma Hills area, Utah County, Utah: Brigham Young Univ. M. S. thesis.

_____ 1051, Geology of the north Selma Hills area, Utah: Compass, v. 29, No. 1, p. 96-108, geol. map.

The mapped area lies on a northward extension of the East Tintic Range characterized by low relief and excellent bedrock exposures. Sedimentary rocks of Silurian, Devonian and Mississippian age aggregate 2,783 feet in thickness. Tertiary volcanic rocks and Quaternary strata are also present. The area has been profoundly affected by thrust faulting and later normal faulting. Some mineralization has occurred.

Abstract from published introduction

553. WILLIAMS, NORMAN C., 1952, Wall rock alteration, Mayflower mine, Park City, Utah: Columbia Univ. Ph. D. thesis, 58 p.
(Abs.): Dissert. Abs., v. 13, No. 3, p. 373, 1953.

At the Mayflower mine, Park City district, Utah, unoxidized sulfide ores of the mesothermal type occur essentially as vein deposits in two east-trending fissures. The fissures are largely within a diorite intrusion of Tertiary age, but one of the fissures crosses the intrusive contact and transects limestone and shale beds of Carboniferous age.

Three distinct stages are present and are defined as: (1) early sulfide, (2) carbonate-quartz, and (3) late sulfide. Structural relationships of the veins, together with paragenetic studies of the vein minerals, indicate a directional growth of the fissure system contemporaneously with progressive change in the nature of the vein solutions. All three vein stages are present in the west end of the main fissure, stages 2 and 3 are present in the central part of the main fissure and in the smaller fissure.

In the diorite wall rock several alteration zones of limited extent developed in conjunction with vein mineralization. The alteration zones, identified by mineral content, are: (1) host, (2) chloritic, (3) argillic, (4a) quartz-sericite (local), and (4b) quartz-sericite (migratory). Zone 1 is outermost from the vein and is followed successively veinward by zones 2, 3 and 4a. Stage 4b is superposed on all previous vein deposits and alteration stages in a system of branching fractures.

In the diorite wall rock, all alteration zones accompany all vein stages, whether the vein stages are individually isolated in parts of the country rock or are present in combination. Where the veins transect the sedimentary rocks, the alteration effects of the several vein stages were not separately observed, and only a single complex alteration in the diorite is noted.

Vein solutions acting upon the diorite wall rock appear to have produced mineralogically identical alteration products during each of the three recognizable stages of changing vein mineral deposition. Identical vein solutions produced a different assemblage of alteration products in the diorite and in the sediments. *Published abstract*

554. WILLIS, JOSEPH P., Jr., 1961, Geology of the eastern portion of the Hurricane quadrangle [Washington County], Utah: Univ. of Southern California M. A. thesis, 79 p., geol. map.

The Hurricane Cliffs form the western margin of the Colorado Plateaus Province, and comprise an upthrown block along a narrow north - south zone of normal faulting over 200 miles long. Maximum displacement in area mapped is 4,750 feet. Faulting is post-Eocene and has continued intermittenly during Tertiary and Quaternary, accompanied by basalt flows.

Oldest exposed rocks are Kaibab marine limestones and sandstones. Overlying the Permo-Triassic erosional unconformity is Lower Triassic Moenkopi Formation. Shinarump Conglomerate overlies erosion surface developed on Moenkopi strata, and is basal to floodplain deposits of Chinle Formation. Upper part of Chinle was deposited under increasingly arid conditions and grades upward into Navajo Sandstone. Triassic-Jurassic boundary is not distinct. Toward close of Jurassic, Carmel limestones were deposited unconformably upon Navajo in shallow seas. Following deposition of Cretaceous rocks, Laramide upwarping of post-Cretaceous age removed all but minor amounts of the Cretaceous deposits.

East of the Hurricane Cliffs, flat-lying sediments have been capped by basalts, limestones and conglomerates to form mesas, buttes and benches. To the west, in the transition zone between Colorado Plateaus and Basin and Range Provinces, rocks have been folded and faulted to form cuestas, hogbacks and tilted blocks. *Abstract revised (B. C.)*

555. WILSON, JOHN C., 1961, Geology of the Alta stock [Salt Lake County]: California Inst. Technology Ph. D. thesis, 236 p., geol. map.

The Alta stock of granodiorite is closely associated with many Pb, Zn and Ag ore deposits in the Park City-Cottonwood mining area in the central Wasatch Mountains. The Alta magma was intruded in two pulses into pre-Triassic sedimentary rocks at a depth of about 21,000 feet and a temperature in excess of 720° C. The first phase of magma solidified with a nonporphyritic texture. At a late stage in crystallization history the Alta stock had an essentially solid shell of nonporphyritic granodiorite at least 1,200 feet thick that surrounded a semirigid crystal mush. Structural adjustments resulted in close-space jointing and emplacement of aplite-pegmatite dikes in the shell. The crystal mush and solid shell were subsequently intruded by a second pulse of magma. Strongly porphyritic texture indicates a loss of volatiles through fractures in the overlying material. The Flagstaff-Emma ore zone in the Little Cottonwood district is on the trend of a westward dike-like projection of the porphyritic granodiorite.

Seventy-six mineral separates of orthoclase, plagioclase, biotite, hornblende, magnetite, sphene, quartz and chlorite were analyzed by emission spectrograph for Cu, Pb, Zn, Ag, Co, Ni and Sn. Comparison between samples of the same mineral shows that Co and Ni are slightly less abundant and Cu, Pb and Sn are more abundant in the later phases of the Alta igneous suite. No trend is apparent for Ag and Zn.

The release of volatiles associated with the late-stage intrusion of porphyritic granodiorite, the structural relation of the adjacent ore deposits to this porphyritic granodiorite, and the trend in trace element abundances suggest that an ore-forming fluid may have been produced at a late stage in the crystallization of the Alta stock.

Abstract revised (B. C.)

556. WILSON, MARK D., 1949, The geology of the upper Six Mile Canyon area [Sanpete County], central Utah: Ohio State Univ. M. S. thesis, 106 p., geol. map.

The Six Mile Canyon area lies mainly within the 6-mile-wide Wasatch monocline which forms the front of the Wasatch Plateau. Elevations range from 6,000 to 10,000 feet, west to east. Exposed formations ranging in age from Upper Cretaceous to Paleocene (?) are of floodplain and lacustrine origin. They are (base to top): Six Mile Canyon Formation (2,800 feet), Price River Formation (541 feet), North Horn Formation ? (600-1,300 feet) and Flagstaff Limestone (540 feet). Unconformities occur above the Six Mile Canyon and North Horn Formations. Pleistocene glacial deposits reach a maximum thickness of 40 feet and are composed mainly of ground moraine and some lateral moraines with minor amounts of finely laminated glacial lake deposits. Large amounts of glacial material occur in the upper part of the canyon and on the lower part of the south wall.

The Wasatch monocline is a regular structure of uniform (5,000-foot) displacement, and is probably of Oligocene age. The Flagstaff Limestone shows a total displacement of about 4,000 feet within the area mapped. Other major structures are several longitudinal faults parallel to the monocline, mainly normal with east sides down. There are numerous minor east-dipping parallel faults, and a graben.

B. C.

557. WILSON, RICHARD FAIRFIELD, 1959, The stratigraphy and sedimentology of the Kayenta and Moenave Formations, Vermilion Cliffs region [Kane County], Utah and Arizona: Stanford Univ. Ph. D. thesis.
(Abs.): Dissert. Abs., v. 19, No. 11, p. 2918-2919, 1959.

The Vermilion Cliffs of northern Arizona and southern Utah are composed of strata of Glen Canyon Group of Triassic (?), Jurassic (?), and Jurassic age which overlie the Upper Triassic Chinle Formation. The Glen Canyon Group consists of, ascending, the Moenave Formation, Kayenta Formation and Navajo Sandstone. Wingate Sandstone is absent. The Chinle Formation is redefined to include all strata between top of underlying Shinarump Conglomerate and an erosion surface from 150 to 250 feet below the base of the Springdale Sandstone Member of the Moenave Formation.

The Moenave Formation is equivalent to the upper part of the Petrified Forest Member and to the Springdale Sandstone Member of Gregory's Chinle Formation, and is subdivided into, ascending, Dinosaur Canyon, Whitmore Point and Springdale Sandstone Members. Dinosaur Canyon consists of 140-230 feet reddish-brown sandstone, siltstone and claystone. Eastward along Vermilion Cliffs, grayish to reddish siltstone and claystone of Whitmore Point tongues into basal Springdale. Springdale consists of 116-225 feet of reddish fine-grained sandstone and minor clay pellet conglomerate.

The Kayenta Formation is redefined to include all strata between top of Springdale Sandstone and base of Navajo Sandstone, and embraces the upper sandstones of Chinle, the Kayenta Formation and Wingate Sandstone of Gregory for the western Vermilion Cliffs. It is composed predominantly of reddish sandstone in east, and siltstone and claystone in west. The Kayenta thickens from 100-200 feet in east to over 1,100 feet to the west of Zion. Top of Kayenta intertongues with and pinches out into aeolian Navajo Sandstone in a northeast direction. In vicinity of Kanab and eastern part of Zion Canyon, the Lamb Point Tongue of Navajo (Wingate Sandstone of Gregory) is overlain by Tenney Canyon Tongue of Kayenta Formation (Kayenta Formation of Gregory).

Westward decrease in grain size and similar mineral assemblages suggest same eastern source for Kayenta, Moenave and basal Navajo.

Abstract revised (B. C.)

558. WOOD, WILLIAM JAMES, 1953, Areal geology of the Coalville vicinity, Summit County, Utah: Univ. of Utah M. S. thesis, 81 p., geol. map.

About 100 square miles in northeastern Utah were mapped. Lower Cretaceous Kelvin and Aspen Formations are exposed only in core of Coalville anticline. Alternating sandstones and shales of Upper Cretaceous Frontier and Wanship Formations are well exposed on northwest flank of Coalville anticline. Both formations contain marine and nonmarine beds; a slight unconformity occurs between Frontier and Wanship. Tertiary nonmarine red and gray conglomerates of Wasatch Group are divided into Almy and Knight Formations. The Knight, which has been removed from most of Coalville anticline, truncates the Almy and all older rocks which form the anticline.

Structure of the Coalville area is transitional between east-trending structures of Uinta Mountains to southeast and north-trending structures of Wasatch Mountains to west. It consists generally of a series of folds and faults, the major elements of which trend northeasterly. Dominant structure is Coalville anticline, which has been superposed on a gentle post-Frontier, pre-Wanship structure. Most details of structure are pre-Eocene Knight Formation. Later modification is due to normal faulting, broad arching and regional uplift.

Weber River and Chalk Creek are superposed streams. Their channels were established across the Coalville anticline when it was covered by Knight Formation. *B. C.*

559. WOODLAND, ROLAND BERT, 1957, Stratigraphic significance of Mississippian endothyroid foraminifera in central Utah: Brigham Young Univ. M. S. thesis, 74 p.

Study of thin sections from samples of the Mississippian sequence in central Utah has yielded biostratigraphic data on the occurrence of endothyroid Foraminifera. Distribution of these foraminifers in the Provo Rock Canyon section suggests three faunal zones and one subzone.

Eight new species belonging to the genera Granuliferella, Plectogyra, and Endothyra are described.

Comparative phylogeny of central Utah and Mississippi Valley endothyroids shows striking similarity of Upper Mississippian forms but very little similarity in Lower Mississippian forms. Upper Mississippian strata in central Utah can be correlated with Mississippi Valley strata using comparative phylogeny.

A vagrant benthonic habit of endothyroids during life is indicated by limited lithologic association with echinoderm fragments, irregularity of form, and granular wall of individuals. Flood occurrence is attributed to biological and ecological agents which periodically destroyed and preserved sensitive populations en masse. Presence of angular calcarenite grains of calcite in the groundmass indicates sedimentary sorting did not affect flood occurrence. Endothyroid sensitivity to environment is indicated by their diminished abundance or complete absence in rocks of noncalcareous composition and nonencrinitic texture. *From author abstract*

560. WOOLARD, LOUIS EUGENE, 1955, Late Tertiary rhyolitic eruptions and uranium mineralization, Marysvale [Piute County], Utah: Columbia Univ. Ph. D. thesis, 201 p. (Abs.): Dissert. Abs., v. 15, No. 8, p. 1373, 1955.

After the intrusion of the Early Tertiary Bullion Canyon flows by quartz monzonite and granite and the subsequent alteration of both the intrusives and extrusives, there was extensive erosion. Following this quiescent interval the more localized late Tertiary Mount Belknap rhyolites were emplaced. In part, the extrusion of the rhyolite took place within the Antelope Range. Glassy and porphyritic rhyolite erupted in domes and from vents 1,000 to 3,500 feet in diameter. Related rhyolite glass dikes, which are accompanied in some cases by radioactive anomalies, have been recognized at widely scattered points throughout the area. The greatest concentration occurs in and near the Bullion Monarch and Prospector mines, however, where the dikes are associated with the ore-bearing veins.

In contrast to the intense alteration of the earlier volcanics there has been only limited alteration of the overlying rhyolites. In some cases major alteration channels terminate against the basal rhyolite, indicating that the hydrothermal activity which accompanied alunitic mineralization predated the Mount Belknap. In those channels which do cut the rhyolite the flows are bleached, devitrified, and silicified. The rhyolite glasses, which form the base of the principal flows as well as the dikes exposed in the mines, are completely altered to montmorillonite and illite locally. Inasmuch as there is evidence that the principal period of uranium mineralization occurred after the emplacement of the rhyolite, these effects are significant indications of possible mineralization in compositionally favorable rocks at depth.

Comparison of the effects observed in the andesite, latite, quartz monzonite, granite and rhyolite leads to the conclusion that the successive stages of alteration did not result from periodic changes in the fundamental composition of the hydrothermal solutions, but from a systematic variation produced in the solutions through reaction with the wall rock as they moved outward from the conduit.

From author abstract

561. WRIGHT, PHILLIP MICHAEL, 1966, Geothermal gradient and regional heat flow in Utah: Univ. of Utah Ph. D. thesis, 181 p. (Abs.): Dissert. Abs., sec. B, v. 27, No. 4, p. 1196B, 1966.

More than 50 drill holes in Utah were evaluated for possible use in this study. Temperatures were measured and geothermal gradients were determined in 19 of these holes using a platinum resistance thermometer. These 19 holes were located in five areas of Utah: Spor Mountain, Enterprise, La Sal, Monticello and Jordan Valley. Thirteen of the 19 holes are believed to be disturbed by shallow effects (Spor Mountain, Enterprise, Monticello and Jordan Valley). The remaining six holes are believed to be free from such effects (La Sal). The measured temperatures ranged from 10.79° C to 21.14° C, and gradients ranged from -38° C/km to +90° C/km.

Thermal conductivity was measured for 40 rock discs from two areas (Spor Mountain and La Sal) using the divided-bar apparatus. The rock discs were machined from drill core and from bulk rock specimens, which were collected from these two areas. Thermal conductivity values ranging from 3.78 mcal/cm-sec-° C to 12.19 mcal/cm-sec-° C were measured.

Heat flow values were determined for three areas in Utah. A tentative heat flow value of 2.8 μcal/cm^2-sec was indicated at Spor Mountain, Juab County. This value may be subject to revision because of probable circulation of warm ground water in the area. A heat flow value of 1.8 μcal/cm^2-sec was estimated in Jordan Valley, Salt Lake County. No thermal conductivity measurements were made for Jordan Valley, and the hole in which temperatures were measured is possibly in an area of warm groundwater flow. A heat flow value of 1.2 ± 0.2 μcal/cm^2-sec was found at La Sal, San Juan County. This value is probably representative for that area. Terrain corrections calculated for La Sal were found to be about 3 percent of the gradient, and were, therefore, negligible. *From author abstract*

562. WRIGHT, RICHARD E., 1961, Stratigraphic and tectonic interpretation of Oquirrh Formation, Stansbury Mountains [Tooele County], Utah: Brigham Young Univ. (M. S. thesis) Geol. Studies, v. 8, p. 147-166.

Detailed measurement of seven stratigraphic sections within the Oquirrh Formation, Stansbury Mountains, Utah, revealed a maximum of 14,214 feet of Morrowan to Wolfcampian strata. Fusulinids were successfully used to delineate time units. Lateral lithological facies variations were seen to be extremely complex, but were simplified by fusulinid time unit delineation, making general lithologic correlation possible. Documentation of a time structural unconformity between Oquirrh Formation and subjacent Manning Canyon Shale was obtained. The Stansbury area was seen to have constituted a marginal portion of the "Oquirrh Basin" and to have been an area of local source for sediments of Morrowan and Derryan age. Studies strongly infer that the "Oquirrh Basin" was not a repository of continuous sedimentation; but represents a series of small (areally) taphrogenic, autocannibalistic troughs and contiguous highs. Tectonic instability throughout Pennsylvanian and Lower Permian-Wolfcampian time was prevalent as indicated by diverse Oquirrh lithologies. *Author abstract*

563. YEATS, VESTAL L., 1961, The areal geology of the Moab 4 NW quadrangle, Grand County, Utah: Texas Technolog. College M. S. thesis, 96 p., geol. map.

Extreme dissection in an arid climate has laid bare sediments from Permian to Lower Cretaceous in age. These sediments represent an example of continental deposition under arid conditions during most of this time. Continental deposition leaves a poor fossil record, and the age of many of the exposed sediments is still in doubt. Much revision of formations has been done in the past and is continuing.

Uranium, oil and potash contribute to the local economy. Uranium exploration is not going on at the present time, but oil and potash exploration is very active. Present oil production is confined to the Big Flat area. Potash is not now in production, but should begin with the completion of a railroad spur to Thompson, Utah. *Author abstract*

564. YOLTON, JAMES S., 1943, The Dry Lake section of the Brazer Formation, Logan Quadrangle [Cache County], Utah: Utah State Univ. M. S. thesis, 29 p.

The Dry Lake section of the Brazer Formation, totaling 3,100 feet in thickness, is an excellent exposure containing an abundance of fossils many of which are well preserved. The fauna indicates that the formation is to be correlated with the Upper Iowan and Chester Series of the type Mississippian System in the Mississippi Valley section. Generalized sequence, ascending, is B Member-300 feet, slightly calcareous sandstone; C-400 feet, thick-bedded limestone; D-470 feet, limestone; E-950 feet, limestone with chert; F-950 feet, silty limestone and calcareous siltstone. Substantial fossil evidence indicates the following correlation for the Brazer Members. C unit represents western equivalent of middle Meramec Group, i.e., the Salem and St. Louis Limestones. D Member is decidedly Ste. Genevieve in general faunal aspects but, because of the presence of some Chester fauna, it must be considered as a transition between Meramec and New Design Groups. F Member is, in most respects, typically equivalent of the Chester Series. There are also relationships to the fauna of Batesville and Moorefield deposits of Arkansas, lower Caney Shale of Oklahoma, and Paradise Formation of southeastern Arizona. (Faunal list includes numerous brachiopods, molluscs, corals and echinoderms.) *Abstract revised (B. C.)*

565. YOUNG, J. LLEWELLYN, 1939, Glaciation in Logan quadrangle [Cache County], Utah: Utah State Univ. M. S. thesis, 79 p.

Evidences for 15 glaciers and 2 distinct glacial episodes are present in the Logan quadrangle (northeast Utah). The glaciers were developed on the east side of the Front Ridge of the southern Bear River

Range. Most cachement basins are above 8,500 feet in elevation, and the lowest glacial features lie at 6,100 feet elevation. The early (outer) moraines are more extensive and have been more deeply eroded and weathered. *B. C.*

566. YOUNG, JOHN C., 1953, Geology of the southern Lakeside Mountains [Tooele County], Utah: Univ. of Utah M. S. thesis, 90 p., geol. map.

_____ 1955, Geology of the southern Lakeside Mountains, Utah: Utah Geol. and Mineralog. Survey, Bull. 56, 110 p.

The Lakeside Mountains are a north-northwest-trending range on the southwestern side of Great Salt Lake. Marine strata of every Paleozoic period are well exposed, and consist of 5,495+ feet of Cambrian-Tintic Quartzite, Ophir Shale, Hartmann (?) Limestone, Bowman (?) Limestone, Lynch (?) Dolomite; 1,666 feet of Ordovician-Garden City Limestone, Swan Peak Formation, Fish Haven Dolomite; 546 feet of Silurian-Laketown Dolomite; 1,711 feet of Devonian-Water Canyon Formation, Jefferson Dolomite; 3,458 feet of Mississippian-Madison Limestone, Deseret Limestone, Humbug Formation, Great Blue Limestone, Manning Canyon Formation; and an estimated 5,000+ feet of Pennsylvanian-Permian (?)-Oquirrh Formation.

Bordering the range on its southwestern side is the large, high-angle Lakeside fault with maximum stratigraphic displacement over 9,000 feet. Other faults of smaller displacement cut the range longitudinally and transversely. Folding is predominantly gentle. The Lakeside fault may be related to a proposed major east-west basement-controlled fracture zone which developed during regional compression to accommodate differential shortening between relatively rigid northern Utah Highland (north) and relatively pliable Oquirrh Basin (south). Displacement on Lakeside fault initiated during early Cretaceous or late Cretaceous-early Tertiary; but renewed movement occurred following mid-Tertiary erosion, and pedimented surfaces have been offset by later pre-Lake Bonneville movement.

Abstract revised

567. YOUNG, ROBERT G., 1952, Stratigraphic relations in the Upper Cretaceous of the Book Cliffs, Utah-Colorado: Ohio State Univ. Ph. D. thesis, 147 p.
(Abs.): Dissert. Abs., v. 18, No. 3, p. 1014-1016, 1958.

_____ 1955, Sedimentary facies and intertonguing in the Upper Cretaceous of the Book Cliffs, Utah-Colorado: Geol. Soc. America Bull., v. 66, No. 2, p. 177-202.

The Upper Cretaceous of the Book Cliffs in central Utah and western Colorado exhibits intricate lateral and vertical intertonguing of marine and nonmarine facies. Excellent exposures permit detailed observations and facilitate tracing of individual units. Dominantly continental deposits of the Star Point, Blackhawk and Price River Formations pass eastward into lagoonal deposits formed behind offshore bar sandstones, which interfinger eastward with the marine Mancos Shale.

The Star Point Sandstone consists of two littoral marine sandstone tongues. Overlying the Star Point is the Blackhawk Formation consisting of six members separated by thin tongues of Mancos Shale, which grade upward into the overlying littoral marine sandstones. Each marine shale tongue rests with a slight disconformity on the underlying member. Where the littoral marine sandstones are absent the rocks cannot be so subdivided. The Price River Formation which rests disconformably on the Blackhawk consists of two facies -- the Farrer or barren facies and the Neslen or coal-bearing facies which is divided into five cyclic members similar to those of the Blackhawk.

The intricate intertonguing of these deposits is interpreted to be the result of deposition in a shallow basin in which there were long periods of relative stability separated by sharp pulses of subsidence. Thick peat beds formed during periods of quiet coincide with the tops of offshore bars. Sharp subsidences preceded formation of the basal sandstone tongues; lesser pulses preceded formation of the offshore bars.

A generalized cycle of four units can be recognized in these deposits: (1) basal marine shale, (2) littoral marine sandstone, (3) lagoonal rocks, (4) coal.

Published abstract (Geol. Soc. America Bull.)

568. ZELLER, HOWARD DAVIS, 1949, The geology of the west central portion of the Gunnison Plateau, Utah: Ohio State Univ. M. S. thesis.

Hardy, C.T. and H.D. Zeller, 1953, Geology of the west central part of the Gunnison Plateau, Utah: Geol. Soc. America Bull., v. 64, p. 1261-1278, geol. map.

Bedrock ranges in age from Late Jurassic (Arapien Shale) to Eocene (Green River Formation). The North Horn (Cretaceous-Tertiary), Flagstaff (Paleocene ?) and Green River Formations successively overlap older rocks truncated by an early Laramide erosion surface. Considerable relief on the surface has greatly affected the distribution and thickness of Price River, North Horn and Flagstaff strata, and has caused different facies within the Flagstaff Limestone. The North Horn Formation is derived in part from material of Twist Gulch Member of Arapien Shale. Abundant plant fossils and some oil shale are found in the upper or tawny facies of the Green

River Formation, which is mapped and described for the first time. Numerous small intrusive masses of monzonite porphyry occur in the Arapien Shale.

The North Horn and overlying Flagstaff oppose the Arapien Shale across a high-angle fault. Green River Formation extends across fault and overlaps Arapien, substantiating a period of normal faulting between Flagstaff and Green River time. This part of the Gunnison Plateau is a monocline extensively modified by normal faulting. The age of this structure is thought to correspond with the Wasatch monocline (late Eocene-Miocene).

Abstract revised (B. C.)

569. ZELLER, RONALD P., 1958, Paleocology of the Long Trail Shale Member of the Great Blue Limestone, Oquirrh Range, Utah: Brigham Young Univ. (M. S. thesis) Research Studies, Geol. Ser., v. 5, No. 8, 36 p.

The Long Trail Shale is composed of different varieties of limestone and shale rock types. Six of these limestones and five of the shale varieties predominate. Recognition of three of the predominating carbonates is facilitated by their distinctive biofacies.

The Long Trail Shale dwarfed fauna has been examined in detail and it is suggested that this assemblage consists of sorted, normally small-sized, and dwarfed fossils. It is believed that this biofacies is the result of both sorting by bottom currents and fouled bottom environment partially inaccessible to these currents.

Depositional environments of this unit apparently underwent considerable lateral variation, but certain Paleoecologic generalizations are suggested: (1) Waters were shallow in depth (600 ft and less) and probably rather warm. (2) Turbidity during most of the Long Trail's deposition was high, but periodic cessation of turbidity is indicated by a few biofacies. Lithofacies generally indicate slight agitation. *Author abstract*

570. ZIMBECK, DONALD ALLEN, 1965, Gravity survey along northward-trending profiles across the boundary between the Basin and Range Province and Colorado Plateau: Univ. of Utah M. S. thesis. (Copyright 1968).

A gravity-profile study of central Utah and central Arizona was made. Three northward-trending Bouguer-gravity profiles, each of which crosses the boundary between the Basin and Range Province and either the western or southwestern margin of the Colorado Plateau, were analyzed. About two-thirds of the total of 2,500 km of profile, consisting of 914 observations, was taken during the fall of 1964, and the remaining one-third was compiled from results of previous workers at the University of Utah.

The detailed Bouguer gravity profiles were smoothed for obvious geological contributions, and crustal models were constructed for those portions of the Colorado Plateau and Basin and Range Province lying along the profiles. A zero Bouguer anomaly was assumed for an interface depth of 30 km and the method of Talwani (1959) was used to recompute the Bouguer gravity of the model.

In order for the Bouguer gravity anomaly to be consistent with previous seismic crustal investigations, it was necessary to introduce beneath the 30 km interface of the Basin and Range Province a 30- to 50-km-thick layer whose density is smaller than that usually used for the upper-mantle density. This layer, though not necessarily a unique solution, would account for the observed gravity, whereas a lack of sufficient Bouguer gravity change (between the Basin and Range Province and the Colorado Plateau) exists when considering only the seismic depths and velocity distributions down to the 30-km interface.

An anomalous density distribution, corresponding to the anomalous P_n velocity distribution of Herrin and Taggert (1962) was not indicated by the gravity data. Therefore, the present paper agrees more with the less extreme variations of the P_n velocity in the Utah and Arizona area which was proposed by Stuart and others (1964) and by Pakiser and Steinhart (1964).

571. ZIMMERMAN, JAMES THOMAS, 1961, Geology of the Cove Creek area, Millard and Beaver Counties, Utah: Univ. of Utah M. S. thesis, 91 p., geol. map.

The Cove Creek area is near the eastern border of Basin and Range Province in southeastern Millard County. Sedimentary rocks consist of Ordovician Pogonip Group (112 feet), Eureka Quartzite (104 feet), and Fish Haven Dolomite (583 feet); Devonian Sevy Dolomite (183 feet), and Guilmette (?) Formation (137 feet); Mississippian Deseret Limestone (234 feet); Pennsylvanian Oquirrh Formation (441 feet); Permian Kaibab Limestone (271 feet); Pliocene to early (?) Pleistocene Sevier River Formation (262 feet); and Quaternary gypsum sands, gravels and alluvium.

During Late Tertiary, extrusion of hornblende rhyolite was followed by extrusion of augite andesite. The latter was accompanied by alteration of Paleozoic and extrusive rocks along faults, joints and fractures by iron-bearing solutions. Pliocene to early (?) Pleistocene Sevier River Formation was deposited in an Early to Medial Tertiary (?) tectonic basin. Its upper portion is interbedded with and underlies pre-Lake Bonneville basalts. Following dessication of Pleistocene Lake Bonneville, gypsum sands accumulated through evaporation of playa lakes and wind deposition. Volcanism followed, resulting in building of Cove Fort volcano and extrusion of basalt. Erosion of older rocks and development of post-Bonneville basalts and alluvial deposits in southern portions of area continued from Late Tertiary to present. *Abstract revised (B. C.)*

572. HOWARD, JAMES D., 1966, The Upper Cretaceous Panther Sandstone Tongue of east central Utah–Description of sedimentary facies and interpretation of depositional environments: Brigham Young Univ. Ph. D. thesis.

_____ 1966, Sedimentation of the Panther Sandstone Tongue: Utah Geol. and Mineralog. Survey Bull. 80, p. 23-33.

This discussion of the Panther Sandstone Tongue [of the Star Point Formation] is two-fold. First it is a summary of the fine-grained clastic facies of the Panther Tongue, and secondly it is a re-evaluation of the writer's previous interpretation of the conditions of deposition.

The five facies of the Panther Tongue represent a composite deltaic sequence. Highly mottled, gray siltstones which make up the bottomset beds grade into very fine-grained, matrix-rich, foreset sandstones. Delta-front deposits and fluvial-channel sandstones make up the topset beds. Capping most of the foregoing deposits is a wedge-shaped sandstone and siltstone body representing a small-scale repeat of the Panther Tongue. *Published abstract*

AUTHOR AND TITLE INDEX

Abbott, Ward Owen, 1951
Cambrian diabase flow in central Utah: Brigham Young Univ. M.S. thesis.

Abdel-Gawad, Abdel-Moneim M., 1960
Alteration features associated with some basal Chinle uranium deposits: Columbia Univ. Ph.D.

Acosta, Alvaro, 1961
Upper Cretaceous paleobotany of northeastern Utah: Univ. of Utah M.S. thesis.

Adams, O. Clair, 1962
Geology of the Summer Ranch and North Promontory Mountains, Utah: Utah State Univ. M.S. thesis.

Adamson, Robert D., 1955
Salt Lake Group in Cache Valley, Utah and Idaho: Utah State Univ. M.S. thesis.

Addison, Carl C., 1929
Stratigraphy and correlation of some Carboniferous sections of Nevada and adjacent states: Stanford Univ. M.A. thesis.

Akers, J.P., 1960
The Chinle Formation of the Paria Plateau area, Arizona and Utah: Univ. of Arizona M.S. thesis.

Allen, Jim E., 1961
Wall rock alteration, Ontario mine, Keetley, Utah: Univ. of Utah M.S. thesis.

Ames, Roger Lyman, 1963
Sulfur isotopic study of the Tintic mining districts, Utah: Yale Univ. Ph.D. thesis.

Amin, Surendra R., 1950
Heavy mineral study of the intrusive rocks of the Antelope Range, Piute County, Utah: Univ. of Utah M.S. thesis.

Anderman, George Gibbs, 1955
Geology of a portion of the north flank of the Uinta Mountains in the vicinity of Manila, Summit and Daggett Counties, Utah, and Sweetwater County, Wyoming: Princeton Univ. Ph.D. thesis.

Anderson, Barbara J., 1959
Nickel-zinc mineralization in the southern Oquirrh Mountains, Utah: Univ. of Utah M.S. thesis.

Anderson, Christian Donald, 1966
Telluric current surveys in Utah: Univ. of Utah Ph.D. thesis.

Anderson, Darrell John, 1966
Marls in Salt Lake County and low-fired marl brick: Univ. of Utah M.S. thesis.

Anderson, John J., 1965
Geology of northern Markagunt Plateau, Utah: Univ. of Texas Ph.D. thesis.

Anderson, Paul Leon, 1960
Bloating clays, shales and slates for lightweight aggregate, Salt Lake City and vicinity, Utah: Univ. of Utah M.S. thesis.

Anderson, Warren L., 1957
Geology of the northern Silver Island Mountains, Box Elder and Tooele Counties, Utah: Univ. of Utah M.S. thesis.

Apple, Florence Olive, 1929
The relation of rock alteration to mineralization at East Tintic, Utah: Northwestern Univ. M.S. thesis.

Armstrong, Richard L., 1964
Geochronology and geology of the eastern Great Basin in Nevada and Utah: Yale Univ. Ph.D. thesis.

Arnold, Dwight Ellsworth, 1956
Geology of the northern Stansbury Range, Tooele County, Utah: Univ. of Utah M.S. thesis.

Atwood, Wallace W., 1903
Glaciation of the Uinta and Wasatch Mountains: Univ. of Chicago Ph.D. thesis.

Austin, Carl Fulton, 1955
Geochemical prospecting as applied to replacement ores in limestones: Univ. of Utah M.S. thesis.

Axenfeld, Sheldon, 1952
Geology of the North Scranton area, Tooele County, Utah: Indiana Univ. M.A. thesis.

Baars, Donald Lee, 1965
Pre-Pennsylvanian paleotectonics of southwestern Colorado and east central Utah: Univ. of Colorado Ph.D. thesis.

Babisak, Julius, 1949
The geology of the southeastern portion of the Gunnison Plateau, Utah: Ohio State Univ. M.S. thesis.

Bachman, Mattias E., 1959
Geology of the Water Hollow fault zone, Sevier and Sanpete Counties, Utah: Ohio State Univ. M.S. thesis.

Baddley, Elmer R., 1924
A study of the Tintic Standard ore deposit, Dividend, Utah: Stanford Univ. M.A. thesis.

Baer, James L., 1962
Geology of the Star Range, Beaver County, Utah: Brigham Young Univ. M.S. thesis.

Bailey, James S., 1955
A stratigraphic analysis of Rico strata in the Four Corners region: Univ. of Arizona Ph.D. thesis.

Bailey, Reed W., 1927
A contribution to the geology of the Bear River Range, Utah: Univ. of Chicago M.S. thesis.

Baker, Arthur A., 1931
Geology of the Moab district, Grand and San Juan Counties, Utah: Yale Univ. Ph.D. thesis.

Baker, Walker Holcombe, 1959
Geologic setting and origin of the Grouse Creek pluton, Box Elder County, Utah: Univ. of Utah Ph.D. thesis.

Bamberger, Clarence G., 1908
Report on the property of the Daly West Mining Co., Park City, Utah: Cornell Univ. M.E. thesis.

Bardsley, Stanford Ronald, 1962
Evaluating oil shale by log analysis: Univ. of Utah M.S. thesis.

Barnett, Jack Arnold, 1966
Ground-water hydrology of Emigration Canyon, Salt Lake County, Utah: Univ. of Utah M.S. thesis.

Barosh, Patrick James, 1959
Geology of the Beaver Lake Mountains, Utah: Univ. of California (Los Angeles) M.A. thesis.

Bauer, Herman Louis, Jr., 1952
Fluorspar deposits, north end of Spor Mountain, Thomas Range, Juab County, Utah: Univ. of Utah M.S. thesis.

Baughman, Russell Leroy, 1959
The geology of the Musinia graben area, Sevier and Sanpete Counties, Utah: Ohio State Univ. M.S. thesis.

Bayley, Richard W., 1950
A heavy mineral study of the Morrison Formation of south central Utah: Ohio State Univ. M.S. thesis.

Beach, Gary A., 1961
Late Devonian and Early Mississippian biostratigraphy of central Utah: Brigham Young Univ. M.S. thesis.

Beard, John Harvey, 1959
Microfauna of the Upper Cretaceous-Lower Tertiary rocks of the western Book Cliffs, Carbon County, Utah: Univ. of Utah M.S. thesis.

Becker, Joseph Henry, 1959
Upper Devonian conodonts from the eastern Great Basin: Southern Methodist Univ. M.S. thesis.

Beckmann, Marian C., 1959
Saline facies of recent sediments in Great Salt Lake, Utah: Columbia Univ. M.A. thesis.

Behrendt, John C., 1957
Regional magnetic study of Uinta Mountains, Utah: Univ. of Wisconsin M.S. thesis.

Bell, Gordon L., 1951
Geology of the Precambrian metamorphic terrane, Farmington Mountains, Utah: Univ. of Utah Ph.D. thesis.

Bentley, Craig B., 1958
Upper Cambrian stratigraphy of western Utah: Brigham Young Univ. M.A. thesis.

Benvegnu, Carl Jerome, 1963
Stratigraphy and structure of the Croyden-Henefer-Grass Valley area, Morgan and Summit Counties, Utah: Univ. of Utah M.S. thesis.

Berge, Charles William, 1960
Heavy minerals study of the intrusive bodies of the central Wasatch Range, Utah: Brigham Young Univ. M.S. thesis.

Bethke, Philip Martin, 1957
The sulfo-selenides of mercury and their occurrence at Marysvale, Utah: Columbia Univ. Ph.D. thesis.

Beus, Stanley Spencer, 1958
Geology of the northern part of Wellsville Mountain, northern Wasatch Range, Utah: Utah State Univ. M.S. thesis.

Beus, Stanley Spencer, 1963
Geology of the central Blue Spring Hills, Utah-Idaho: Univ. of California (Los Angeles) Ph.D. thesis.

Bick, Kenneth Fletcher, 1958
Geology of the Deep Creek quadrangle, western Utah: Yale Univ. Ph.D. thesis.

Birch, Rondo O., 1940
The geology of the Little Willow district, Wasatch Mountains: Univ. of Utah M.S. thesis.

Bissell, Harold Joseph, 1936
Pennsylvanian and Lower Permian stratigraphy in the southern Wasatch Mountains, Utah: State Univ. of Iowa (Iowa City) M.S. thesis.

Bissell, Harold Joseph, 1948
Pleistocene sedimentation in southern Utah Valley, Utah: State Univ. of Iowa (Iowa City) Ph.D. thesis.

Black, B. Allen, 1965
Nebo overthrust, southern Wasatch Mountains, Utah: Brigham Young Univ. M.S. thesis.

Blank, Horace Richard, Jr., 1959
Geology of the Bull Valley district, Washington County, Utah: Univ. of Washington Ph.D. thesis.

Blue, Donald McCoy, 1960
Geology and ore deposits of the Lucin mining district, Box Elder County, Utah, and Elko County, Nevada: Univ. of Utah M.S. thesis.

Bodine, Marc W., Jr., 1956
Alteration of Triassic sediments, Temple Mountain, Utah: Columbia Univ. Ph.D. thesis.

Bonar, Chester M., 1948
Geology of the Ephraim area, Utah: Ohio State Univ. M.S. thesis.

Bordine, Burton W., 1965
Paleoecologic implications of strontium, calcium and magnesium in Jurassic rocks near Thistle, Utah: Brigham Young Univ. M.S. thesis.

Botbol, Joseph Moses, 1961
Geochemical exploration for gilsonite: Univ. of Utah M.S. thesis.

Bowes, William A., 1952
Distribution and thickness of phosphate ore zones in the Phosphoria Formation: Univ. of Utah M.S. thesis.

Boyden, Thomas A., 1951
Ground-water geology of Payson-Benjamin, Utah: Brigham Young Univ. M.S. thesis.

Bradley, Whitney Allen, 1952
Jurassic and pre-Mancos Cretaceous stratigraphy of the eastern Uinta Mountains, Colorado-Utah: Univ. of Colorado M.S. thesis.

Bradley, Wilmot H., 1927
Origin and microfossils of the oil shale in the Green River Formation of Colorado and Utah: Yale Univ. Ph.D. thesis.

Brady, Michael J., 1965
Thrusting in the southern Wasatch Mountains, Utah: Brigham Young Univ. M.S. thesis.

Branson, Carl C., 1930
Paleontology and stratigraphy of the Phosphoria Formation: Univ. of Missouri Ph.D. thesis.

Brimhall, Willis H., 1951
Stratigraphy and structural geology of the northern Deer Creek Reservoir area, Provo Canyon, Utah: Univ. of Arizona M.S. thesis.

Brodsky, Harold, 1960
The Mesaverde Group at Sunnyside, Utah: Univ. of Colorado M.S. thesis.

Brooke, John P., 1959
Trace elements in pyrite from Bingham, Utah: Univ. of Utah M.S. thesis.

Brooke, John P., 1964
Alteration and trace elements of volcanics in the San Francisco Mountains: Univ. of Utah Ph.D. thesis.

Brooks, James Elwood, 1954
Regional Devonian stratigraphy in central and western Utah: Univ. of Washington Ph.D. thesis.

Brophy, Gerald P., 1953
Geology and hydrothermal alteration: Papsy's Hope prospect, Marysvale, Utah: Columbia Univ. M.A. thesis.

Brophy, Gerald P., 1954
Hydrothermal alteration and uranium mineralization in the Silica Hills area, Marysvale District, Utah: Columbia Univ. Ph.D. thesis.

Brown, Ralph Sherman, 1950
Geology of the Payson Canyon-Piccayune Canyon area, southern Wasatch Mountains, Utah: Brigham Young Univ. M.S. thesis.

Brox, George Stanley, 1961
The geology and erosional development of northern Bryce Canyon National Park: Univ. of Utah M.S. thesis.

Bryan, G. Gregory, 1935
Mineragraphy and paragenesis of the ore of the Park City Consolidated Mine, Park City, Utah: Univ. of Utah M.S. thesis.

Budge, David R., 1966
Stratigraphy of the Laketown Dolostone, north central Utah: Utah State Univ. M.S. thesis.

Bullock, Kenneth C., 1942
A study of the geology of the Timpanogos Caves, Utah: Brigham Young Univ. M.S. thesis.

Bullock, Kenneth C., 1949
Geomorphology of Lake Mountain, Utah: Univ. of Wisconsin Ph.D. thesis.

Bullock, Ladell R., 1965
Paleoecology of the Twin Creek Limestone in the Thistle Utah area: Brigham Young Univ. M.S. thesis.

Bullock, Nedra D., 1940
A summary of the Pennsylvanian sedimentation of Utah: Univ. of Utah M.A. thesis.

Bullock, Reuben Lynn, 1958
The geology of the Lehi quadrangle, Utah: Brigham Young Univ. M.S. thesis.

Burge, Donald Lockwood, 1959
Intrusive and metamorphic rocks of the Silver Lake Flat area, American Fork Canyon, Utah: Brigham Young Univ. M.S. thesis.

Burger, John Allen, 1959
Mesaverde Group in adjoining areas of Utah, Colorado and Wyoming: Yale Univ. Ph.D. thesis.

Burnham, C. Wayne, 1955
Metallogenic provinces of the southwestern United States and northern Mexico: California Inst. Technology Ph.D. thesis.

Buss, Fred Earle, 1924
Physiography of the southern Wasatch Mountains and adjacent valley lands, with especial reference to the origin of topographic forms: Stanford Univ. M.A. thesis.

Buss, Walter R., 1933
A preliminary study of the physiographic types of Utah: Brigham Young Univ. M.S. thesis.

Cadigan, Robert Allen, 1952
The correlation of the Jurassic Bluff and Junction Creek Sandstones in southeastern Utah and southwestern Colorado: Pennsylvania State Univ. M.S. thesis.

Calderwood, Keith W., 1951
Geology of the Cedar Valley Hills area, Utah: Brigham Young Univ. M.S. thesis.

Cardone, Anthony Thomas, 1966
A statistical forecasting of engineering properties and compression index of soils, Salt Lake City, Utah: Univ. of Utah M.S. thesis.

Cargo, David Niels, 1966
Polygonal strain systems in the Cordilleran foreland, western United States: Univ. of Utah Ph.D. thesis.

Carnahan, Thomas S., 1905
The development of the Little Bell Mine, Park City, Utah: Columbia Univ. M.A. thesis.

Chapman, John S., 1958
Conodonts from the _Manticoceras_ zone (Devonian), Confusion Range, Millard County, Utah: Univ. of Kansas M.S. thesis.

Childs, Orlo E., 1938
A physiographic study of Morgan Valley, Utah: Univ. of Utah M.S. thesis.

Chorney, Raymond, 1943
Scheelite and mineral association at the Reaper mine, Gold Hill, Utah: Univ. of Utah M.S. thesis.

Christensen, A. Lee, 1928
Geology and physiography of Deer Creek and Silver Fork tributaries of American Fork Canyon, Wasatch Mountains, Utah: Stanford Univ. M.A. thesis.

Christiansen, Francis Wyman, 1937
The geology and economic possibilities of the alunite deposits in Sevier and Piute Counties, Utah: Univ. of Utah M.S. thesis.

Christiansen, Francis Wyman, 1948
Geology of the Canyon Range, Utah: Princeton Univ. Ph.D. thesis.

Church, Clifford C., 1925
A laboratory study of certain Tertiary formations of the northern Wasatch Mountains, Utah: Stanford Univ. M.A. thesis.

Clark, A.F., 1924
Utah hydrocarbons: Univ. of Utah M. S. thesis.

Clark, David L., 1954
Stratigraphy and sedimentation of the Gardner Formation in central Utah: Brigham Young Univ. M.S. thesis.

Clark, David L., 1957
Marine Triassic stratigraphy in the eastern Great Basin: State Univ. of Iowa (Iowa City) Ph.D. thesis.

Clark, John, 1932
New turtle from the Uinta Basin, northeastern Utah: Univ. of Pittsburgh M.S. thesis.

Clark, Robert S., 1953
The structure and stratigraphy of Government Ridge, Utah: Brigham Young Univ. M.S. thesis.

Coffman, W. Elmo, 1932
A progress report of metals in Utah: Brigham Young Univ. M.A. thesis.

Cohen, Caxel Lodewijk David, 1959
Preliminary study of coccoliths and discoasterids from the Mancos Shale of eastern Utah and western Colorado: Univ. of Utah M.S. thesis.

Cohenour, Robert E., 1952
Some techniques for sampling the bottom sediments of Great Salt Lake: Univ. of Utah M.S. thesis.

Cohenour, Robert E., 1957
Geology of the Sheeprock Mountains, Tooele and Juab Counties, Utah: Univ. of Utah Ph.D. thesis.

Condie, Kent C., 1960
Petrogenesis of the Mineral Range Pluton, southwestern Utah: Univ. of Utah M.A. thesis.

Condie, Kent C., 1965
Petrology and geochemistry of the Late Precambrian rocks of the northeastern Great Basin: Univ. of California (San Diego) Ph.D. thesis.

Condon, David D., 1935
A preliminary study of the social and economic geography of Utah with special emphasis on the Tintic Mining district: Brigham Young Univ. M.S. thesis.

Coody, Gilbert L., 1957
Geology of the Durst Mountain-Huntsville area, Morgan and Weber Counties, Utah: Univ. of Utah M.S. thesis.

Cook, Earl F., 1954
Geology of the Pine Valley Mountains, Utah: Univ. of Washington Ph. D. thesis.

Cooley, I. LaVell, 1928
The Devonian of the Bear River Range, Utah: Utah State Univ. M.S. thesis.

Cooper, John E., Jr., 1956
Petrography of the Moroni Formation, southern Cedar Hills, Utah: Ohio State Univ. M.S. thesis.

Costain, John Kendall, 1960
Geology of the Gilson Mountains and vicinity, Juab County, Utah: Univ. of Utah Ph.D. thesis.

Coulter, Henry W., Jr., 1954
Geology of the southeast portion of the Preston quadrangle, Idaho-Utah: Yale Univ. Ph.D. thesis.

Cramer, Howard R., 1950
Tertiary freshwater ostracoda from the Uinta Basin, Utah: Univ. of Illinois M.S. thesis.

Cramer, Howard R., 1954
Coral zones in the Mississippian of the Great Basin area: Northwestern Univ. Ph.D. thesis.

Croft, Mack G., 1956
Geology of the northern Onaqui Mountains, Tooele County, Utah: Brigham Young Univ. M.S. thesis.

Cronkhite, George, 1936
The analytical composition of the calcareous oolite of the Great Salt Lake: Univ. of Utah M.S. thesis.

Crosby, Gary Wayne, 1959
Geology of the south Pavant Range, Millard and Sevier Counties, Utah: Brigham Young Univ. M.S. thesis.

Crosson, Robert Scott, 1964
Regional gravity survey of parts of western Millard and Juab Counties, Utah: Univ. of Utah M.S. thesis.

Curtis, Bruce F., 1949
Structure and stratigraphy of Linwood-Spring Creek area, Utah-Wyoming: Harvard Univ. Ph.D. thesis.

Dahl, Charles Laurence, 1959
Trace ferrides in iron ores from the Iron Springs district, Cedar City, Utah: Univ. of Utah M.S. thesis.

Dahl, Harry M., 1954
Alteration in the central uranium area, Marysvale, Utah: Columbia Univ. Ph.D. thesis.

Dane, Carle H., 1932
Geology of Salt Valley anticline and the northwest flank of the Uncompahgre Plateau, Utah: Yale Univ. Ph.D. thesis.

Davidson, David M., Jr., 1963
The nature and origin of silica occurrences in the Mount Peale quadrangle, Grand and San Juan Counties, Utah: Columbia Univ. M.A. thesis.

Davis, Briant LeRoy, 1959
Petrology and petrography of the igneous rocks of the Stansbury Mountains, Tooele County, Utah: Brigham Young Univ. M.S. thesis.

Davis, Del E., 1956
A taxonomic study of the Mississippian corals of central Utah: Brigham Young Univ. M.S. thesis.

Davis, H. Clyde, 1952
Geology of the Culmer gilsonite vein of Duchesne County, Utah: Brigham Young Univ. M.S. thesis.

Davis, Leland M., 1951
Characteristics, occurrence and uses of the solid bitumens of the Uinta Basin, Utah: Brigham Young Univ. M.S. thesis.

Dearden, Melvin O., 1954
Geology of the central Boulter Mountains area, Utah: Brigham Young Univ. M.S. thesis.

Demars, Lorenzo C., 1956
Geology of the northern part of Dry Mountain, southern Wasatch Mountains, Utah: Brigham Young Univ. M.S. thesis.

Dennan, William L., 1920
Yampa vein of Bingham, Utah: Massachusetts Inst. Technology M.S. thesis.

Dennis, Eldon, 1931
A preliminary survey of Utah nonmetallic minerals: Brigham Young Univ. M.A. thesis.

Denson, Norman M., 1942
Late Middle Cambrian trilobite faunas and stratig-

raphy of Alberta, Montana, Wyoming and Utah: Princeton Univ. Ph.D. thesis.

DeVries, Neal H., 1959
Contact between the North Horn and Price River Formations, east front of the Gunnison Plateau, Sanpete County, Utah: Michigan State Univ. M.S. thesis.

Dixon, Howard B., 1938
The building and monumental stones of the State of Utah: Brigham Young Univ. M.A. thesis.

Doelling, Hellmut H., 1964
Geology of the northern Lakeside Mountains and the Grassy Mountains and vicinity, Tooele and Box Elder Counties, Utah: Univ. of Utah Ph.D. thesis.

Dolan, William M., 1957
Location of geological features by radio ground wave measurements in mountainous terrane: Univ. of Utah M.S. thesis.

Duke, David Allen, 1959
Jasperoid and ore deposits in the East Tintic mining district: Univ. of Utah M.S. thesis.

Duke, Walter Clifford, 1965
Turonian (Cretaceous) stratigraphy and micropaleontology, Cumberland Gap, Wyoming - Woodside, Utah: Univ. of Colorado M.S. thesis.

Dunn, David Evan, 1959
Geology of the Crystal Peak area, Millard County, Utah: Southern Methodist Univ. M.S. thesis.

Eardley, Armand J., 1930
Structure and stratigraphy and physiography of the southern Wasatch Mountains, Utah: Princeton Univ. Ph.D. thesis.

Earll, Fred Nelson, 1957
Geology of the central Mineral Range, Beaver County, Utah: Univ. of Utah Ph.D. thesis.

East, Edwin H., 1956
Geology of the San Francisco Mountains of western Utah: Univ. of Washington M.S. thesis.

Edmisten, Neil, 1952
Micropaleontology of the Salt Lake Group, Jordan Narrows, Utah: Univ. of Utah M.S. thesis.

Edvalson, Fredrick M., 1947
Stratigraphy and correlation of the Devonian in the central Wasatch Mountains, Utah: Univ. of Utah M.S. thesis.

Egbert, Robert L., 1954
Geology of the East Canyon area, Morgan County, Utah: Univ. of Utah M.S. thesis.

Ehlmann, Arthur J., 1958
Pyrophyllite in shales of north central Utah: Univ. of Utah Ph.D. thesis.

Eicher, Don Lauren, 1955
Stratigraphy and micropaleontology of the Curtis Formation, northwestern Colorado and northeastern Utah: Univ. of Colorado M.S. thesis.

Elison, James H., 1952
Geology of the Keigley quarries and the Genola Hills area, Utah: Brigham Young Univ. M.S. thesis.

El-Mahdy, Omar Rasheed, 1966
Origin of ore and alteration in the Freedom No. 2 and adjacent mines at Marysvale, Utah: Univ. of Utah Ph.D. thesis.

Emigh, George D., 1956
The petrography, mineralogy and origin of phosphate pellets in the western Permian formation and other sedimentary formations: Univ. of Arizona Ph. D. thesis.

Erickson, Max P., 1940
Thermal metamorphism of the ancient tillite of the Alta region, Utah: Univ. of Utah M.S. thesis.

Eriksson, Yves, 1960
Geology of the upper Ogden Canyon, Weber County, Utah: Univ. of Utah M.S. thesis.

Eskelsen, Quinn M., 1953
Geology of the Soapstone Basin and vicinity, Wasatch, Summit and Duchesne Counties, Utah: Univ. of Utah M.S. thesis.

Evans, Max Thomas, 1951
Geology and ore deposits of the Great Western mine, Marysvale region, Utah: Brigham Young Univ. M.S. thesis.

Evensen, Charles G., 1953
A comparison of the Shinarump Conglomerate on Hoskinnini Mesa with that in other selected areas in Arizona and Utah: Univ. of Arizona M.S. thesis.

Everett, Kaye R., 1958
Geology and ground water of Skull Valley, Tooele County, Utah: Univ. of Utah M.S. thesis.

Ezell, Robert L., 1953
Geology of the Rendezvous Peak area, Cache and Box Elder Counties, Utah: Utah State Univ. M.S. thesis.

Fagadau, Sanford Payne, 1949
An investigation of the Flagstaff Limestone between Manti and Willow Creek Canyons in the Wasatch Plateau, central Utah: Ohio State Univ. M.S. thesis.

Faulk, Niles Richard, 1948
The Green River Formation in the Manti-Spring City area of central Utah: Ohio State Univ. M.S. thesis.

Fetzner, Richard W., 1959
Pennsylvanian paleotectonics of the Colorado Plateau: Univ. of Wisconsin Ph.D. thesis.

Fiero, G.W., Jr., 1958
Geology of Upheaval Dome, San Juan County, Utah: Univ. of Wyoming M.S. thesis.

Finch, Warren Irvin, 1954
Geology of the Shinarump No. 1 mine, Grand County, Utah, with a general account of uranium deposits in Triassic rocks of the Colorado Plateau: Univ. of California (Berkeley) M.S. thesis.

Fograscher, Arthur Carl, 1956
The stratigraphy of the Green River and Crazy Hollow Formations of part of the Cedar Hills, central Utah: Ohio State Univ. M.S. thesis.

Forrester, James D., 1935
Structure of the Uinta Mountains: Cornell Univ. Ph.D. thesis.

Foster, John M., 1959
Geology of the Bismark Peak area, North Tintic district, Utah County, Utah: Brigham Young Univ. M.S. thesis.

Foutz, Dell R., 1960
Geology of the Wash Canyon area, southern Wasatch Mountains, Utah: Brigham Young Univ. M.S. thesis.

Fowkes, Elliott J., 1964
Pegmatites of Granite Peak Mountains, Tooele County, Utah: Brigham Young Univ. M.S. thesis.

Fox, Feramorz, 1906
General features of the Wasatch Mountains: Univ. of Utah M.S. thesis.

Franson, Oral M., 1950
Sedimentation of the basal Oquirrh Formation, Provo Canyon, Utah: Brigham Young Univ. M.S. thesis.

Frazier, Noah A., 1951
Heavy mineral study of the Morrison (?) Formation and the Indianola Group of southern Sanpete and northern Sevier Counties, Utah: Ohio State Univ. M.S. thesis.

Gaines, Patric W., 1950
Stratigraphy and structure of the Provo Canyon-Rock Canyon area, south central Wasatch Mountains, Utah: Brigham Young Univ. M.S. thesis.

Gardner, Weston Clive, 1954
Geology of the West Tintic mining district and vicinity, Juab County, Utah: Univ. of Utah M.S. thesis.

Garmoe, Walter J., 1958
A preliminary study of the Mississippian and Lower Pennsylvanian formations in the Park City district, Utah: Univ. of Minnesota M.S. thesis.

Gates, Joseph Spencer, 1960
Hydrology of Middle Canyon, Oquirrh Mountains, Tooele County, Utah: Univ. of Utah M.S. thesis.

Gates, Robert W., 1951
Groundwater geology of the Spanish Fork-Springville area: Brigham Young Univ. M.S. thesis.

Gehman, Harry Merrill, Jr., 1954
Geology of the Notch Peak intrusive, Millard County, Utah: Cornell Univ. M.S. thesis.

Gelnett, Ronald H., 1958
Geology of southern part of Wellsville Mountain, Wasatch Range, Utah: Utah State Univ. M.S. thesis.

Gill, James R., 1950
Flagstaff Limestone of the Spring City-Manti area, Sanpete County, Utah: Ohio State Univ. M.S. thesis.

Gilliland, William N., 1948
Geology of the Gunnison quadrangle, Utah: Ohio State Univ. Ph.D. thesis.

Gilluly, James, 1926
Geology of part of San Rafael Swell, Utah: Yale Univ. Ph.D. thesis.

Glissmeyer, Carl Howard, 1959
Microfauna of the Funk Valley Formation of Indianola Group, central Utah: Univ. of Utah M.S. thesis.

Goode, Harry D., 1959
Surficial deposits, geomorphology, and Cenozoic history of the Eureka quadrangle, Utah: Univ. of Colorado Ph.D. thesis.

Gould, Laurence M., 1925
Geology of the La Sal Mountains of Utah: Univ. of Michigan Ph.D. thesis.

Gould, Wilburn James, 1959
Geology of the northern Needle Range, Millard County, Utah: Brigham Young Univ. M. S. thesis.

Granger, Arthur Earle, 1939
Geologic aspects of torrential floods in northern Utah: Univ. of Washington M.S. thesis.

Grant, Sheldon Kerry, 1966
Metallization and paragenesis in the Park City district, Utah: Univ. of Utah Ph.D. thesis.

Gray, Irving B., 1961
Nature and origin of the Moenkopi-Shinarump hiatus in Monument Valley, Arizona and Utah: Univ. of Arizona Ph.D. thesis.

Gray, Ralph S., 1925
A study of the Wasatch Mountains: Univ. of Utah M.S. thesis.

Gray, Robert Charles, 1966
Crustal structure from the Nevada test site to Kansas as determined by a gravity profile: Univ. of Utah M.S. thesis.

Green, Jack, 1954
The Marysvale Canyon area, Marysvale, Utah: Columbia Univ. Ph.D. thesis.

Green, Paul Reed, 1959
Microfauna of the Allen Valley Shale of Indianola Group, central Utah: Univ. of Utah M.S. thesis.

Groenewold, Bernard Cyrus, 1960
Subsurface geology of the Mesozoic formations overlying the Uncompahgre uplift in Grand County, Utah: Univ. of Utah M.S. thesis.

Groff, Sidney Lavern, 1959
Geology of the West Tintic Range and vicinity, Tooele and Juab Counties, Utah: Univ. of Utah Ph.D. thesis.

Gross, Larry Thomas, 1961
Stratigraphic analysis of the Mesaverde Group, Uinta Basin, Utah: Univ. of Utah M.S. thesis.

Groth, Frederick A., 1955
Stratigraphy of the Chinle Formation in the San Rafael Swell, Utah: Univ. of Wyoming M.A. thesis.

Grundy, Wilbur D., 1953
Geology and uranium deposits of the Shinarump Conglomerate of Nokai Mesa, Arizona and Utah: Univ. of Arizona M.S. thesis.

Gunderson, Wayne, 1961
An isopach and lithofacies study of the (Upper Cretaceous) Price River, (Upper Cretaceous-Paleocene) North Horn, and (Eocene) Flagstaff Formations of central Utah: Univ. of Nebraska M.S. thesis.

Gunnell, Francis H., 1930
Telotremata of Brazer Limestone of northern Utah: Univ. of Missouri M.A. thesis.

Gwynn, Thomas Andrew, 1948
Geology of the Provo Slate Canyon in the southern Wasatch Mountains, Utah: Brigham Young Univ. M.S. thesis.

Haenggi, Walter T., 1957
Geology of the Cowboy Pass area, Confusion Range, Millard County, Utah: Univ. of Texas M.A. thesis.

Hafen, Preston Lon, 1961
Geology of the Sharp Mountain area, southern part of the Bear River Range, Utah: Utah State Univ. M.S. thesis.

Halverson, Mark Olson, 1960
Regional gravity survey of northwestern Utah and part of southern Idaho: Univ. of Utah M.S. thesis.

Hamblin, William K., 1954
Geology and groundwater of northern Davis County, Utah: Brigham Young Univ. M.S. thesis.

Hamilton, Edward Alricks, 1949
The sedimentology of the Upper Jurassic formations in the vicinity of Escalante, Utah: Johns Hopkins Univ. Ph.D. thesis.

Hamilton, Richard P., 1955
Small nonmarine gastropods from the Paleocene of Wyoming and Utah: Univ. of Missouri M.A. thesis.

Hammond, Weldon Woolf, 1930
The Spiriferidae of the Madison Formation of the Logan quadrangle, Utah: Univ. of Missouri M.S. thesis.

Hampton, O. Winston, 1955
Methods and costs of uranium exploration and mining on the Colorado Plateau: Univ. of Colorado M.S. thesis.

Hanks, Keith L., 1962
Geology of the central House Range area, Millard County, Utah: Brigham Young Univ. M.S. thesis.

Hansen, Alan R., 1952
Regional stratigraphic analysis of the Uinta Basin, Utah and Colorado: Northwestern Univ. M.S. thesis.

Hansen, Othello T., 1930
Productidae of the Madison Formation of the Logan quadrangle, Utah: Univ. of Missouri M.A. thesis.

Hansen, Steven C., 1964
Geology of the southwestern part of the Randolph quadrangle, Utah-Wyoming: Utah State Univ. M.S. thesis.

Hanson, Alvin Maddison, 1942
Phosphate deposits in western Summit, Wasatch, Salt Lake, Morgan, and Weber Counties, Utah: Utah State Univ. M.S. thesis.

Hanson, Alvin Maddison, 1949
Geology of the southern Malad Range and vicinity in northern Utah: Univ. of Wisconsin Ph.D. thesis.

Hardman, Elwood, 1964
Regional gravity survey of central Iron and Washington Counties, Utah: Univ. of Utah M.S. thesis.

Hardy, Clyde Thomas, 1948
Stratigraphy and structure of a portion of the western margin of the Gunnison Plateau, Utah: Ohio State Univ. M.S. thesis.

Hardy, Clyde Thomas, 1949
Stratigraphy and structure of the Arapien Shale and the Twist Gulch Formation in Sevier Valley, Utah: Ohio State Univ. Ph.D. thesis.

Harper, M.L., 1960
The areal geology of Castle Creek Valley, Utah: Texas Technolog. College M.S. thesis.

Harrill, James Reece, 1962
Geology of the Davis Knolls and northern Big Davis Mountain area, Tooele County, Utah: Univ. of Utah M.S. thesis.

Harris, A. Wayne, 1936
Structural interpretations in the Rock Canyon area of southern Wasatch Mountains, Utah: Brigham Young Univ. M.S. thesis.

Harris, DeVerle, 1958
The geology of the Dutch Peak area, Sheeprock Range, Tooele County, Utah: Brigham Young Univ. M.S. thesis.

Harris, Harold Duane, 1953
Geology of the Birdseye area, Thistle Creek Canyon, Utah: Brigham Young Univ. M.S. thesis.

Hatch, Robert A., 1938
Precambrian crystalline rocks of the Wasatch Mountains, Utah: Univ. of Michigan M.S. thesis.

Haynie, Anthony V., Jr., 1957
The Worm Creek Quartzite Member of the St. Charles Formation, Utah-Idaho: Utah State Univ. M.S. thesis.

Hays, James Douglas, 1960
Study of the South Flat and related formations of central Utah (I-Petrology; II-Palynology): Ohio State Univ. M.S. thesis.

Hebertson, Keith M., 1950
Origin and composition of the Manning Canyon Formation in central Utah: Brigham Young Univ. M.A. thesis.

Hebrew, Quey Chester, 1950
Groundwater geology of the Lehi, Utah, area: Brigham Young Univ. M.S. thesis.

Hedden, Albert H., Jr., 1948
The geology of the Pinyon Peak area, East Tintic Mountains, Utah: California Inst. Technology M.S. thesis.

Henderson, Gerald V., 1958
Geology of the northeast quarter of the Soldier Summit quadrangle, Utah: Brigham Young Univ. M.S. thesis.

Hepworth, Richard Cundiff, 1963
Heaving in the subgrade of highways constructed on the Mancos Shale: Univ. of Utah M.S. thesis.

Heylmun, Edgar B., 1966
Systematic rock joints in parts of Utah, Colorado and Wyoming, and an hypothesis on their origin: Univ. of Utah Ph.D. thesis.

Hightower, Charles Henry, Jr., 1959
Middle Cambrian stratigraphy of the Wah Wah Range, Beaver County, Utah: Southern Methodist Univ. M.S. thesis.

Hinds, Jim S., 1960
Controls on Paradox salt deposition in the area of Comb monocline, San Juan County, Utah: Univ. of New Mexico M.S. thesis.

Hinman, Eugene E., 1954
Jurassic Carmel-Twin Creek facies of northern Utah: Washington State Univ. M.S. thesis.

Hintze, Ferdinand Friis, Jr., 1913
A contribution to the geology of the Wasatch Mountains, Utah: Columbia Univ. Ph.D. thesis.

Hintze, Lehi F., 1948
An Ordovician section in Millard County, Utah: Columbia Univ. M.A. thesis.

Hintze, Lehi F., 1950
Ordovician stratigraphy from central Utah to central Nevada: Columbia Univ. Ph.D. thesis.

Hodgkinson, Kenneth A., 1961
Permian stratigraphy of northeastern Nevada and northwestern Utah: Brigham Young Univ. M.A. thesis.

Hodgson, Robert A., 1951
Geology of the Wasatch Mountain front in the vicinity of Spanish Fork Canyon, Utah: Brigham Young Univ. M.S. thesis.

Hodgson, Robert A., 1959
Regional study of jointing in Comb Ridge-Navajo Mountain area, Arizona and Utah: Yale Univ. Ph.D. thesis.

Hodgson, Russell B., 1925
Reconnaissance of the Crescent Eagle structure and its connection with the Salt Valley anticline: Univ. of Utah M.S. thesis.

Hoffman, Floyd H., 1951
Geology of the Mosida Hills area, Utah: Brigham Young Univ. M.S. thesis.

Holland, Frank Delno, Jr., 1950
Stratigraphic details of lower Mississippian rocks of northeastern Utah and southwestern Montana: Univ. of Missouri M.A. thesis.

Holmes, Allen W., Jr., 1954
Upper Cretaceous stratigraphy of northeastern Arizona and south central Utah: Univ. of Colorado M.S. thesis.

Holt, Robert E., 1953
Structure and petrology of the diorite on the 800 level, Mayflower mine, Park City, Utah: Univ. of Utah M.S. thesis.

Hooper, Warren G., 1951
Geology of the Smith and Morehouse-South Fork area, Utah: Univ. of Utah M.S. thesis.

Hosford, Gregory F., 1950
Groundwater geology of Pleasant Grove, Utah, and vicinity: Brigham Young Univ. M.S. thesis.

Howard, James D., 1966
The Upper Cretaceous Panther Sandstone Tongue of east central Utah: Description of sedimentary facies and interpretation of depositional environments: Brigham Young Univ. Ph.D. thesis.

Hunt, John Prior, 1957
Rock alteration, mica, and clay minerals in certain areas in the United States and Lark mine, Bingham, Utah: Univ. of California (Berkeley) Ph.D. thesis.

Hunt, Robert Elton, 1948
The geology of the Dry Canyon region, Gunnison Plateau, Utah: Ohio State Univ. M.S. thesis.

Hunt, Robert Elton, 1950
Geology of the northern part of the Gunnison Plateau, Utah: Ohio State Univ. Ph.D. thesis.

Jacobs, Marian B., 1963
Alteration studies and uranium emplacement near Moab, Utah: Columbia Univ. Ph.D. thesis.

Jacobson, A. Thurl, 1941
Geology of the North Fork and upper Duchesne River region: Univ. of Utah M.A. thesis.

John, Edward C., 1964
Petrology and petrography of the intrusive igneous rocks of the Levan area, Juab County, Utah: Brigham Young Univ. M.S. thesis.

Johns, Kenneth Herbert, 1950
Geology of the Twelve Mile Pass area, Utah County, Utah: Brigham Young Univ. M.S. thesis.

Johnson, John Burlin, Jr., 1956
Regional gravity survey of parts of Tooele, Juab and Millard Counties, Utah: Univ. of Utah Ph.D. thesis.

Johnson, Kenneth Dee, 1959
Structure and stratigraphy of the Mount Nebo-Salt Creek area, southern Wasatch Mountains, Utah: Brigham Young Univ. M.S. thesis.

Johnson, Melvin Coatany, 1952
Areal geology of the Wanship-Coalville area: Univ. of Utah M.S. thesis.

Johnson, Mike Sam, 1949
Geology of the Twelve Mile Canyon area, central Utah: Ohio State Univ. M.S. thesis.

Johnson, William W., 1958
Regional gravity survey of part of Tooele County, Utah: Univ. of Utah M.S. thesis.

Jones, Ray S., 1924
The manner of occurrence of gold in the jarosite from Marysvale, Utah: Columbia Univ. M.A. thesis.

Jordan, Jack G., 1957
Correlation of reef calcarenites of the Pennsylvanian Paradox Formation, San Juan Canyon, Utah: Univ. of New Mexico M.S. thesis.

Katherman, Vance Edward, 1948
The Flagstaff Limestone on the east front of the Gunnison Plateau of central Utah: Ohio State Univ. M.S. thesis.

Katich, Philip J., Jr., 1951
Stratigraphy and paleontology of the pre-Niobrara Upper Cretaceous rocks of Castel Valley, Utah: Ohio State Univ. Ph.D. thesis.

Kayser, Robert Benham, 1964
Sedimentary petrology of the Nugget Sandstone, northern Utah, western Wyoming and eastern Idaho: Univ. of Utah M.S. thesis.

Keller, George H., 1956
Sedimentary features of the "White Quartzite" in the western Uinta Mountains, Utah: Univ. of Utah M.S. thesis.

Keller, Kenneth F., 1942
Contact metamorphism near Alta, Utah: Univ. of Utah M.S. thesis.

Kelley, Dana R., 1959
Urano-organic ore at Temple Mountain, Utah; clay alteration and ore, Temple Mountain, Utah: Columbia Univ. Ph.D. thesis.

Kemmerer, John L., Jr., 1934
Gilsonite: Univ. of Utah M.S. thesis.

Kemmerer, Mahlon S., 1935
Rock alteration at the Tintic Prince mine, North Tintic district, Utah: Univ. of Utah M.S. thesis.

Kennedy, Richard R., 1960
Geology between Pine (Bullion) Creek and Ten Mile Creek, eastern Tushar Range, Piute County, Utah: Brigham Young Univ. M.S. thesis.

Kennedy, Richard R., 1963
Geology of Piute County, Utah: Univ. of Arizona Ph.D. thesis.

Kennedy, Vance C., 1961
Geochemical studies of mineral deposits in the Lisbon Valley area, San Juan County, Utah: Univ. of Colorado Ph.D. thesis.

Kepper, Jack C., 1960
Stratigraphy and structure of the southern half of the Fish Springs Range, Juab County, Utah: Univ. of Washington M.S. thesis.

Khin, Maung Aung, 1956
Geology of the district north of Indianola, Utah County, Utah: Ohio State Univ. M.S. thesis.

Kildale, Malcolm Brus, 1938
Structure and ore deposits in the Tintic district, Utah: Stanford Univ. Ph.D. thesis.

King, Harley D., 1965
Paleozoic stratigraphy of the James Peak quadrangle, Utah: Utah State Univ. M.S. thesis.

King, Norman J., 1953
Physical properties contributing to the relative erosional resistance of sandstone and shale-derived sediments: Univ. of Utah M.S. thesis.

Kinney, Douglas M., 1950
Geology of the Uinta River-Brush Creek area, Duchesne and Uintah Counties, Utah: Yale Univ. Ph.D. thesis.

Kirkland, Peggy L., 1962
Permian stratigraphy and stratigraphic paleontology of the Colorado Plateau: Univ. of New Mexico M.S. thesis.

Kleweno, Walter P., Jr., 1958
Permian stratigraphy of northern Utah, southeastern Idaho and southwestern Wyoming: Washington State Univ. M.S. thesis.

Knight, Lester L., 1954
A preliminary heavy mineral study of the Ferron Sandstone: Brigham Young Univ. M.S. thesis.

Kothavala, Rüstum Zal, 1959
A study of the remnant magnetism of Granite Mountain, Iron Springs district, Utah: Univ. of Arizona M.S. thesis.

Kraetsch, Ralph B., Jr., 1950
Stratigraphy of the Pennsylvanian-Lower Permian interval in southern Idaho and adjacent area: Northwestern Univ. M.S. thesis.

Kransdorff, David, 1934
The geology of the Eureka Standard mine, Tintic, Utah: Harvard Univ. Ph.D. thesis.

Kucera, Richard Edward, 1954
Geology of the Joes Valley and north Dragon area, central Utah: Ohio State Univ. M.S. thesis.

Lambert, Hubert C., 1941
Structure and stratigraphy in the southern Stansbury Mountains, Tooele County, Utah: Univ. of Utah M.S. thesis.

Lankford, Robert R., 1952
Micropaleontology of the Cretaceous-Paleocene, northeastern Utah: Univ. of Utah M.S. thesis.

Lapham, D.M., 1955
A preliminary study of ore samples from Temple Mountain, Utah: Columbia Univ. M.S. thesis.

Laraway, William H., 1958
Geology of the south fork of the Ogden River area, Weber County, Utah: Univ. of Utah M.S. thesis.

Larsen, Esper S., III, 1940
The mineralogy and paragenesis of the variscite nodules from the vicinity of Fairfield, Utah: Harvard Univ. Ph.D. thesis.

Larsen, Norbert W., 1960
Geology and groundwater resources of northern Cedar Valley, Utah County, Utah: Brigham Young Univ. M.A. thesis.

Larsen, Willard, N., 1954
Precambrian geology of the western Uinta Mountains, Utah: Univ. of Utah M.S. thesis.

Larsen, Willard N., 1957
Petrology and structure of Antelope Island, Davis County, Utah: Univ. of Utah Ph.D. thesis.

Larson, Kenneth W., 1951
The areal geology of the Rockport-Wanship area: Univ. of Utah M.S. thesis.

Lautenschlager, Herman Kenneth, 1952
The geology of the central part of the Pavant Range, Utah: Ohio State Univ. Ph.D. thesis.

Leamer, Richard James, 1960
Petrology of some freshwater limestones from the Intermountain area: Univ. of Utah M.S. thesis.

Lee, Kwang-Yuan, 1950
Petrography of the Price River Formation in the Sanpete Valley district, Utah: Ohio State Univ. M.S. thesis.

Lee, Kwang-Yuan, 1953
A petrographic study of the latest Cretaceous and earliest Tertiary formations of central Utah: Ohio State Univ. Ph.D. thesis.

Lefebvre, Richard H., 1961
Joint patterns in the central part of the Hurricane fault zone, Washington County, Utah: Univ. of Kansas M.S. thesis.

Lewis, Arthur Edward, 1958
Geology and mineralization connected with the intrusion of a quartz monzonite porphyry, Iron Mountain, Iron Springs district, Utah: California Inst. Technology Ph.D. thesis.

Liese, Homer C., 1957
Geology of the northern Mineral Range, Millard and Beaver Counties, Utah: Univ. of Utah M.S. thesis.

Liese, Homer C., 1962
Indirect geothermometric mineral studies of silicic igneous rocks: Univ. of Utah Ph.D. thesis

Linscott, Robert O., 1962
Petrography of the upper member of the Paradox Formation (Pennsylvanian) in the Four Corners region: Univ. of Colorado M.S. thesis.

Livingston, Donald E., 1961
Structural and economic geology of the Beaver Lake Mountains, Beaver County, Utah: Univ. of Arizona M.S. thesis.

Livingston, Vaughn Edward, Jr., 1955
Sedimentation and stratigraphy of the Humbug Formation in central Utah: Brigham Young Univ. M.S. thesis.

Lofgren, Ben E., 1947
The Quaternary geology of southeastern Jordan Valley, Utah: Univ. of Utah M.S. thesis.

Lohman, Kenneth E., 1957
Cenozoic nonmarine diatoms from the Great Basin: California Inst. Technology Ph.D. thesis.

Loring, William Bacheller, 1959
Geology and ore deposits of the northern part of the Big Indian district, San Juan County, Utah: Univ. of Arizona Ph.D. thesis.

Luedke, Robert G., 1953
Stratigraphy and structure of the Miners Mountain area, Wayne County, Utah: Univ. of Colorado M.S. thesis.

Lufkin, John L., 1965
Geology of the Stockton stock and related intrusives, Tooele County, Utah: Brigham Young Univ. M.S. thesis.

Lum, Daniel, 1957
Regional gravity survey of the north central Wasatch Mountains and vicinity, Utah: Univ. of Utah M.S. thesis.

McCarthy, William R., 1959
Stratigraphy and structure of the Gunlock-Motoqua area, Washington County, Utah: Univ. of Washington M.S. thesis.

McCubbin, Donald G., 1961
Basal Cretaceous of southwestern Colorado and southeastern Utah: Harvard Univ. Ph.D. thesis.

McDougald, William D., 1953
Geology of Beaver Creek and adjacent areas, Utah: Univ. of Utah M.S. thesis.

McDowell, John P., 1955
Early Tertiary geology of northeastern Utah, northwestern Colorado and southwestern Wyoming: Dartmouth College M.A. thesis.

McFall, Clinton Carew, 1955
Geology of the Escalante-Boulder area, south central Utah: Yale Univ. Ph.D. thesis.

McFarland, Carl R., 1955
Geology of the West Canyon area, northwestern Utah County, Utah: Brigham Young Univ. M.S. thesis.

McFarlane, James J., 1955
Silurian strata of the eastern Great Basin: Brigham Young Univ. M.S. thesis.

McGookey, Donald Paul, 1958
Geology of the northern portion of the Fish Lake Plateau, Utah: Ohio State Univ. Ph.D. thesis.

McKelvey, Vincent E., 1946
Stratigraphy of the Phosphatic Shale Member of the Phosphoria Formation in western Wyoming, southeastern Idaho and northern Utah: Univ. of Wisconsin Ph.D. thesis.

McMinn, Paul Meloy, 1948
The Pennsylvanian stratigraphy of Daggett County, Utah: Univ. of Wisconsin M.S. thesis.

MacNish, Robert D., 1962
Geomorphology of the western Sanpete Valley, Utah: Univ. of Michigan M.S. thesis.

Madsen, Jack William, 1952
Geology and ore deposits of the Spring Canyon area, Long Ridge, Utah: Brigham Young Univ. M.S. thesis.

Madsen, James H., Jr., 1959
Geology of the Lost Creek-Echo Canyon area, Morgan and Summit Counties, Utah: Univ. of Utah M.S. thesis.

Madsen, Russel A., 1952
Geology of the Beverly Hills area, Utah: Brigham Young Univ. M.S. thesis.

Mancuso, James D., 1954
Geology of Topliff Hill and the Thorpe Hills, Tooele and Utah Counties, Utah: South Dakota School of Mines and Technology M.S. thesis.

Mann, Christian J., 1961
Pennsylvanian stratigraphy of southwestern Wyoming, northwestern Colorado and northeastern Utah: Univ. of Wisconsin Ph.D. thesis.

Marine, Ira Wendell, 1960
Geology and groundwater resources of Jordan Valley, Utah: Univ. of Utah Ph.D. thesis.

Markland, Thomas R., 1964
Subsurface water geology of Spanish Fork quadrangle, Utah County, Utah: Brigham Young Univ. M.S. thesis.

Marsell, Ray Everett, 1932
Geology of the Jordan Narrows region, Traverse Mountains, Utah: Univ. of Utah M.S. thesis.

Martner, Samuel T., 1948
Geology of the Manila-Linwood area, Sweetwater County, Wyoming, and Daggett County, Utah: California Inst. Technology Ph.D. thesis.

Mase, Russell Edwin, 1957
Geology of the Indianola embayment, Sanpete and Utah Counties, Utah: Ohio State Univ. M.S. thesis.

Matthews, Asa A. Lee, 1924
Marine Lower Triassic beds of Utah: Stanford Univ. M.A. thesis.

Matthews, Asa A. Lee, 1929
Lower Triassic Cephalopod fauna of the Fort Douglas area, Utah: Univ. of Chicago Ph.D. thesis.

Maxey, George Burke, 1941
Cambrian strata in northern Wasatch region: Utah State Univ. M.S. thesis.

Maxey, George Burke, 1951
Lower and Middle Cambrian stratigraphy in western Utah and southeastern Idaho: Princeton Univ. Ph.D. thesis.

Maxfield, E. Blair, 1957
Sedimentation and stratigraphy of the (Pennsylvanian) Morrowan Series in central Utah: Brigham Young Univ. M.S. thesis.

Mecham, Derral F., 1948
The structure of Little Rock Canyon, central Wasatch Mountains, Utah: Brigham Young Univ. M.A. thesis.

Merrell, Harvey W., 1957
Petrology and sedimentation of significant Paradox shales: Univ. of Utah M.S. thesis.

Metter, Raymond Earl, 1955
The geology of a part of the southern Wasatch Mountains, Utah: Ohio State Univ. Ph.D. thesis.

Miller, Donald S., 1960
The isotopic geochemistry of uranium, lead and sulfur in the Colorado Plateau uranium ores: Columbia Univ. Ph.D. thesis.

Miller, Gerald Matthew, 1958
Post-Paleozoic structure and stratigraphy of Blue Mountain area, southwest Utah: Univ. of Washington M.S. thesis.

Miller, Gerald Matthew, 1960
The pre-Tertiary structure and stratigraphy of the southern portion of the Wah Wah Mountains, southwest Utah: Univ. of Washington Ph.D. thesis.

Miller, W.D., 1959
The general geology of Moab Valley, Moab, Utah: Texas Technolog. College M.S. thesis.

Mitchell, Harold G., 1925
A geological report on the Dry Canyon division of the Ophir mining district, Utah: Stanford Univ. M.A. thesis.

Mollazal, Yazdan, 1961
Petrology and petrography of Ely Limestone in part of eastern Great Basin: Brigham Young Univ. M.S. thesis.

Molloy, Martin William, 1960
Tertiary volcanism in the Tushar Range, Utah: Columbia Univ. Ph.D. thesis.

Morin, Wilbur Joseph, 1963
Foundation conditions, Cart Creek Bridge, Daggett County, Utah: Univ. of Utah M.S. thesis.

Morris, Elliot C., 1953
Geology of the Big Piney area, Summit County, Utah: Univ. of Utah M.S. thesis.

Morris, Hal T., 1947
The igneous rocks of the East Tintic mining district: Univ. of Utah M.S. thesis.

Moulton, Floyd C., 1951
Groundwater geology of Cedar Valley and western Utah Valley: Brigham Young Univ. M.S. thesis.

Mount, Donald Lee, 1952
Geology of the Wanship - Park City region, Utah: Univ. of Utah M.S. thesis.

Moussa, Mohamed Mounir Tawkik, 1965
Geology of the Soldier Summit quadrangle, Utah: Univ. of Utah Ph.D. thesis.

Moyle, Richard W., 1958
Paleoecology of the Manning Canyon Shale in central Utah: Brigham Young Univ. M.S. thesis.

Mudgett, Philip Michael, 1964
Regional gravity survey of parts of Beaver and Millard Counties, Utah: Univ. of Utah M.S. thesis.

Muessig, Siegfried Joseph, 1951
Geology of a part of Long Ridge, Utah: Ohio State Univ. Ph.D. thesis.

Murany, Ernest Elmer, 1963
Subsurface stratigraphy of the Wasatch Formation of the Uinta Basin, Utah: Univ. of Utah Ph.D. thesis.

Murphy, Don R., 1954
Fauna of the Morrowan rocks of central Utah: Brigham Young Univ. M.S. thesis.

Myers, Richard Lee, 1955
Magnetic profiles in the central Wasatch region, Utah: Univ. of Utah M.S. thesis.

Nagel, Fritz G., 1952
Regional stratigraphic analysis of Upper Cretaceous rocks of Rocky Mountain region and adjacent areas: Northwestern Univ. M.S. thesis.

Narans, Harry Donald, Jr., 1959
Sub-basement seismic reflections in northern Utah: Univ. of Utah M.S. thesis.

Neff, Thomas Rodney, 1963
Petrology and structure of the Little Willow Series, Wasatch Mountains, Utah: Univ. of Utah M.S. thesis.

Nelson, Robert B., 1959
The stratigraphy and structure of the northernmost part of the northern Snake Range and the Kern Mountains in eastern Nevada and the southern Deep Creek Range in western Utah: Univ. of Washington Ph.D. thesis.

Nelson, Willis Howard, 1950
Petrology of early Tertiary volcanic rocks in the Iron Springs district, Utah: Univ. of Washington M.S. thesis.

Nielsen, Merrill L., 1950
Mississippian cephalopods from western Utah: Idaho Coll. of Mines (Moscow) M.S. thesis.

Nielsen, Mitchell F., 1957
Some late Mississippian pleurotomarian gastropods from Nevada and Utah: Univ. of Nebraska M.S. thesis.

Nikravesh, Rashel, 1963
The microfauna of the type Allen Valley Shale (Upper Cretaceous), Sanpete County, Utah: Ohio State Univ. M.S. thesis.

Nohara, Tomohide, 1966
Microfauna of Upper Mississippian Great Blue Limestone near Morgan, Utah: Univ. of Utah M.S. thesis.

Nokes, Charles Mormon, Jr., 1912
The igneous rocks of Utah: Univ. of Utah M.S. thesis.

Nolan, Grace Margaret, 1950
Sedimentation of the (Pennsylvanian) Oquirrh Formation, West Mountain, Utah: Brigham Young Univ. M.A. thesis.

Novotny, Robert Thomas, 1958
A gravity and magnetic study of Antelope Island, Great Salt Lake, Davis County, Utah: Univ. of Utah M.S. thesis.

Nygreen, Paul W., 1955
Stratigraphy of the lower Oquirrh Formation in the type area and near Logan, Utah: Univ. of Nebraska M.S. thesis.

Odekirk, Jerry Ray, 1963
Lead-alpha age determinations of five Utah rocks: Univ. of Utah M.S. thesis.

Ogden, Lawrence, 1950
Mississippian and Pennsylvanian stratigraphy Confusion Range, west central Utah: Univ. of Wisconsin M.S. thesis.

Okerlund, Maeser D., 1951
A study of the calcite - aragonite deposits of Lake Mountain, Utah County, Utah: Brigham Young Univ. M.S. thesis.

Olsen, Ben L., 1955
Geology of the Baldy area, west slope of Mount Timpanogos, Utah County, Utah: Brigham Young Univ. M.S. thesis.

Olsen, Donald R., 1951
A differential thermal X-ray, and optical analysis of some chlorites: Univ. of Utah M.S. thesis.

Olson, Richard Hubbell, 1960
Geology of the Promontory Range, Box Elder County, Utah: Univ. of Utah Ph.D. thesis.

Ornelas, Richard Henry, 1953
Clay deposits of Utah County, Utah: Brigham Young Univ. M.S. thesis.

O'Toole, Walter L., 1951
Geology of the Keetley-Kamas volcanic area: Univ. of Utah M.S. thesis.

Ott, Henry Louis, 1958
Stratigraphic distribution of Charophyta in the Morrison Formation of Colorado and Utah: Univ. of Missouri M.A. thesis.

Owen, John Wallace, 1931
The distribution, relationship, and character of the Swan Peak quartzite within the Logan quadrangle, Utah: Univ. of Missouri M.A. thesis.

Pack, Fred James, 1905
Farmington gneiss: Columbia Univ. M.A. thesis.

Paddock, Robert Edwards, 1956
Geology of the Newfoundland Mountains, Box Elder County, Utah: Univ. of Utah M.S. thesis.

Paris, Oliver L., 1935
A study of Precambrian rocks between Big Cottonwood and Little Willow Canyons in the central Wasatch Mountains: Univ. of Utah M.S. thesis.

Parker, Raymond L., 1949
Mineralogy of the alunitized volcanic rocks near Marysvale, Utah: Indiana Univ. M.A. thesis.

Parker, Raymond L., 1954
Alunitic alteration at Marysvale, Utah: Columbia Univ. Ph.D. thesis.

Parks, James M., Jr., 1949
Stratigraphy and coral zonation of the Brazer Limestone (Mississippian) of northern Wasatch Mountains, Utah: Univ. of Wisconsin M.S. thesis.

Parr, Clayton Joseph, 1965
A study of primary sedimentary structures around the Moab anticline, Grand County, Utah: Univ. of Utah M.S. thesis.

Parry, William Thomas, 1959
Trace elements in pyrite from the U.S. and Lark mine, Utah: Univ. of Utah M.S. thesis.

Parry, William Thomas, 1961
Cation substitutions in biotites from Basin and Range quartz monzonites: Univ. of Utah Ph.D. thesis.

Pashley, Emil Frederick, Jr., 1956
The geology of the western slope of the Wasatch Plateau between Spring City and Fairview, Utah: Ohio State Univ. M.S. thesis.

Patterson, Ben Arnold, 1957
A study of the basal member of the Chinle Formation in the Inter-River area, Grand and San Juan Counties, Utah: Univ. of Illinois M.S. thesis.

Payne, Anthony, 1950
Hydrothermal dolomitization of Cambrian sediments, Tintic District, Utah: Univ. of Utah M.S. thesis.

Payne, Anthony L., 1962
Geology and uranium deposits of the Colorado Plateau: Stanford Univ. Ph.D. thesis.

Peacock, C. Herschel, 1953
Geology of the Government Hill area, a part of Long Ridge, Utah: Brigham Young Univ. M. S. thesis.

Peirce, Howard Wesley, 1963
Stratigraphy of the DeChelly Sandstone of Arizona and Utah: Univ. of Arizona Ph.D. thesis.

Perkins, Richard F., 1955
Structure and stratigraphy of the lower American Fork-Mahogany Mountain area, Utah County, Utah: Brigham Young Univ. M.S. thesis.

Petersen, Herbert Neil, 1953
Structure and Paleozoic stratigraphy of the Currant Creek area near Goshen, Utah: Brigham Young Univ. M.S. thesis.

Petersen, Morris S., 1956
Devonian strata of central Utah: Brigham Young Univ. M.S. thesis.

Peterson, Dallas O., 1953
Structure and stratigraphy of the Little Valley area, Long Ridge, Utah and Juab Counties, Utah: Brigham Young Univ. M.S. thesis.

Peterson, Dallas O., 1959
Regional stratigraphy of the Pennsylvanian System in northeastern Utah, western Wyoming, northwestern Colorado, and southeastern Idaho: Washington State Univ. Ph.D. thesis.

Peterson, Deverl J., 1956
Stratigraphy and structure of the west Loafer Mountain-Upper Payson Canyon area, Utah County, Utah: Brigham Young Univ. M.S. thesis.

Peterson, Harold, 1929
A comparison of the lithologic units in Utah, southeastern Idaho and western Wyoming: Utah State Univ. M.S. thesis.

Peterson, Parley Royal, 1952
Geology of the Thistle area, Utah: Brigham Young Univ. M.A. thesis.

Peterson, Reed H., 1950
Microfossils and correlation of part of the Frontier Formation, Coalville, Utah: Univ. of Utah M.S. thesis.

Peterson, Victor E., 1936
The geology of a part of the Bear River Range, and some relationships that it bears with the rest of the Range: Utah State Univ. M.S. thesis.

Peterson, Victor E., 1941
A study of the geology and ore deposits of the Ashbrook silver mining district, Utah: Univ. of Chicago Ph.D. thesis.

Phillips, Kenneth A., 1940
The mining geology of the Mount Nebo district, Utah: Iowa State Univ. (Ames) M.S. thesis.

Pierce, Jack Warren, 1950
Structural history of the Uinta Mountains, Utah: Univ. of Illinois M.S. thesis.

Pinney, Robert Ivan, 1965
A preliminary study of Mississippian biostratigraphy (Conodonts) in the Oquirrh Basin of central Utah: Univ. of Wisconsin Ph.D. thesis.

Pitcher, Grant G., 1957
Geology of the Jordan Narrows quadrangle, Utah: Brigham Young Univ. M.S. thesis.

Plebuch, Raymond Otto, 1957
Tectonics of the Mississippian System of western United States: Univ. of Illinois M.S. thesis.

Pliler, Richard, 1959
The distribution of thorium, uranium and potassium in a Pennsylvanian weathering profile and the Mancos Shale: Rice Institute Ph.D. thesis.

Poborski, Stanislaw Jozef, 1952
The Virgin Formation of the St. George area, southwestern Utah: Johns Hopkins Univ. M.A. thesis.

Powell, Dean Keith, 1959
The geology of southern House Range, Millard County, Utah: Brigham Young Univ. M.S. thesis.

Praetorius, Herman W., 1956
Stratigraphy of the Phosphoria Formation of northwestern Colorado and northeastern Utah: Univ. of Colorado M.S. thesis.

Prammani, Prapath, 1957
Geology of the east central part of the Malad Range, (Utah and) Idaho: Utah State Univ. M.S. thesis.

Prescott, Max W., 1958
Geology of the northwest quarter of the Soldier Summit quadrangle, Utah: Brigham Young Univ. M.S. thesis.

Price, Jack R., 1951
Structure and stratigraphy of the Slate Jack Canyon area, Long Ridge, Utah: Brigham Young Univ. M.S. thesis.

Prince, Donald, 1963
Mississippian coal cyclothems in the Manning Canyon Shale of central Utah: Brigham Young Univ. M.S. thesis.

Probandt, William Taylor, 1959
Regional geologic aspects of the Moab Valley area, Grand County, Utah: Texas Technolog. College M.S. thesis.

Proctor, Paul Dean, 1943
The geology of the Bulley Boy mine, Piute County, Utah: Cornell Univ. M.A. thesis.

Proctor, Paul Dean, 1949
Geology of the Harrisburg (Silver Reef) mining district, Washington County, Utah: Indiana Univ. Ph.D. thesis.

Purcell, Francis A., Jr., 1961
The geology of the western half of the Hurricane quadrangle, Utah: Univ. of Southern California M.A. thesis.

Quitzau, Robert Peter, 1961
A regional gravity survey of the back valleys of the Wasatch Mountains and adjacent areas in Utah, Idaho and Wyoming: Univ. of Utah M.S. thesis.

Randall, Arthur G., 1952
Aerial geology of the Pinecliff area, Chalk Creek Summit County, Utah: Univ. of Utah M.S. thesis.

Ratté, Charles A., 1963
Rock alteration and ore genesis in the Iron Springs-Pinto mining district, Iron County, Utah: Univ. of Arizona Ph.D. thesis.

Rawson, Richard Ray, 1957
Geology of the southern part of the Spanish Fork Peak quadrangle, Utah: Brigham Young Univ. M.S. thesis.

Reber, Spencer J., 1951
Stratigraphy and structure of the south central and northern Beaver Dam Mountains, Washington County, Utah: Brigham Young Univ. M.S. thesis.

Reiser, Allan R., 1934
Occurrence, paragenesis and microscopic features of certain ores of the San Francisco mining district, Utah: Univ. of Utah M.S. thesis.

Remington, Newell Christy, 1959
A history of the gilsonite industry: Univ. of Utah M.S. thesis.

Renzetti, Bert Lionel, 1952
Geology of the Scranton mine area, Tooele County, Utah: Indiana Univ. M.A. thesis.

Rhodes, James A., 1955
Stratigraphy and structural geology of the Buckley Mountain area, south central Wasatch Mountains, Utah: Brigham Young Univ. M.S. thesis.

Richmond, Gerald M., 1955
Quaternary stratigraphy of the La Sal Mountains, Utah: Univ. of Colorado Ph.D. thesis.

Ridd, Merril Kay, 1960
A new landform map for Utah: Univ. of Utah M.S. thesis.

Rigby, J. Keith, 1949
Stratigraphy and structure of the Paleozoic rocks in the Selma Hills, Utah County, Utah: Brigham Young Univ. M.S. thesis.

Roberts, David B., 1953
Relationships between lithology and microfossils in the Lower Tertiary of northeastern Utah: Univ. of Minnesota M.S. thesis.

Roberts, Philip Kenneth, 1964
Stratigraphy of the Green River Formation, Uinta Basin, Utah: Univ. of Utah Ph.D. thesis.

Robison, Richard Ashby, 1958
Upper Cambrian trilobites of western Utah: Brigham Young Univ. M.S. thesis.

Robison, Richard Ashby, 1962
Late Middle Cambrian faunas from the Wheeler and Marjum Formations of western Utah: Univ. of Texas Ph.D. thesis.

Rodriguez, Enrique Levy, 1960
Economic geology of the sulphur deposits at Sulphurdale, Utah: Univ. of Utah M.S. thesis.

Rogers, Allen Stuart, 1954
The physical behavior and geologic control of radon in mountain streams: Univ. of Utah Ph.D. thesis.

Root, Robert L., 1952
Geology of the Smith and Morehouse-Hayden Fork area, Utah: Univ. of Utah M.S. thesis.

Rose, Arthur W., 1958
Trace elements in sulfide minerals from the central mining district, New Mexico, and the Bingham district, Utah: California Inst. Technology Ph.D. thesis.

Ross, Reuben J., Jr., 1948
The stratigraphy of the Garden City Formation of northeastern Utah and its trilobite faunas: Yale Univ. Ph.D. thesis.

Rush, Richard W., 1954
Silurian rocks of western Millard County, Utah: Columbia Univ. Ph.D. thesis.

Sadlick, Walter, 1955
The Mississippian-Pennsylvanian boundary in northeastern Utah: Univ. of Utah M.S. thesis.

Sadlick, Walter, 1965
Biostratigraphy of the Chainman Formation (Carboniferous), eastern Nevada and western Utah: Univ. of Utah Ph.D. thesis.

Salter, Robert Joel, 1966
Primary sedimentary structures, petrography and paleoenvironments of the Gartra Member of the Chinle Formation in northern Utah: Univ. of Utah M.S. thesis.

Sanders, David T., 1962
The mineral resources of the Sevier River Drainage, central Utah: Utah State Univ. M.S. thesis.

Sargent, Robert Edward, 1953
Geology of the new Bullion mine area, Tooele County, Utah: Indiana Univ. M.A. thesis.

Sauer, Frank J., 1956
The Springdale Sandstone in the Zion Canyon region in southwestern Utah: Univ. of Nebraska M.S. thesis.

Sayyah, Taha Ahmed, 1965
Geochronological studies of the Kensley stock, Ne-

vada, and the Raft River Range, Utah: Univ. of Utah Ph.D. thesis.

Schaeffer, Frederick Ernst, Jr., 1961
Geology of the central and southern Silver Island Mountains, Tooele County, Utah, and Elko County, Nevada: Univ. of Utah Ph.D. thesis.

Schick, Robert Bryant, 1955
Geology of the Morgan - Henefer area, Morgan and Summit Counties, Utah: Univ. of Utah M.S. thesis.

Schindler, Stanley Fred, 1952
Geology of the White Lake Hills, Utah: Brigham Young Univ. M.S. thesis.

Schleh, Edward E., 1963
Upper Devonian to Middle Pennsylvanian discontinuity-bounded sequences in a part of the Cordilleran region: Univ. of Washington Ph.D. thesis.

Schmitt, Leonard J., Jr., 1964
A lithic description of the Cutler Formation in the Big Indian Wash, Utah: Columbia Univ. M.A. thesis.

Schoff, Stuart L., 1931
Oolites in the Manti Formation of central Utah: Ohio State Univ. M.A. thesis.

Schoff, Stuart L., 1937
Geology of the Cedar Hills, Utah: Ohio State Univ. Ph.D. thesis.

Schreiber, Joseph Frederick, Jr., 1958
Sedimentary record in Great Salt Lake, Utah: Univ. of Utah Ph.D. thesis.

Scott, Gerald L., 1960
Permian sedimentary framework of the Four Corners region: Univ. of Wisconsin Ph.D. thesis.

Scott, Willard Frank, 1954
Regional physical stratigraphy of the Triassic in a part of the eastern Cordillera: Univ. of Washington Ph.D. thesis.

Setty, M.G. Anantha Padmanabha, 1963
Paleontology and paleoecology of diatoms of Lake Bonneville, Utah: Univ. of Utah Ph.D. thesis.

Sharp, Byron J., 1949
The mineralogy of the Fox Clay deposit, Utah: Univ. of Utah M.A. thesis.

Sharp, Byron J., 1955
Mineralization in Little Cottonwood Canyon, Utah: Univ. of Utah Ph.D. thesis.

Shenkel, Claude W., Jr., 1952
A lithologic definition of the Hermosa Formation: Univ. of Colorado Ph.D. thesis.

Siegfried, Joshua Floyd, 1927
Geology of the Colorado River from Moab, Utah, to the inflow of the Green River: Univ. of Utah M.S. thesis.

Siegfus, Stanley Spencer, 1924
A reconnaissance of the Promontory Point mining district, Utah: Univ. of Utah M.S. thesis.

Sikich, Steve W., 1960
Stratigraphy of the Upper Triassic Stanaker Formation of the eastern Uinta Mountain area, northeastern Utah and northwestern Colorado: Univ. of Wyoming M.A. thesis.

Sirrine, George Keith, 1953
Geology of Warm Springs Mountain, Goshen, Utah: Brigham Young Univ. M.S. thesis.

Slentz, Loren William, 1955
Tertiary Salt Lake Group in the Great Salt Lake Basin: Univ. of Utah Ph.D. thesis.

Smith, Cleon Verl, 1956
Geology of the North Canyon area, southern Wasatch Mountains, Utah: Brigham Young Univ. M.S. thesis.

Smith, Grant McKay, 1951
Geology of southwest Lake Mountain, Utah: Brigham Young Univ. M.S. thesis.

Smith, James A., 1957
Insoluble residue study of Pennsylvanian strata exposed in San Juan Canyon, San Juan County, Utah: Univ. of New Mexico M.A. thesis.

Smith, Robert B., 1965
Geology of the Monte Cristo area, Bear River Range, Utah: Utah State Univ. M.S. thesis.

Smith, Theodore L., 1957
Geology of the Antimony Canyon area, Garfield and Piute Counties, Utah: Univ. of Utah M.S. thesis.

Smith, Walter L., 1951
Stratigraphic correlation of southeastern Utah: Brigham Young Univ. M.S. thesis.

Sontag, Richard Joseph, 1965
Regional gravity survey of parts of Beaver, Millard, Piute and Sevier Counties, Utah: Univ. of Utah M.S. thesis.

Stacy, Robert R., 1957
A study of the Winsor Formation of Upper Jurassic age near the type section: Univ. of Nebraska M.S. thesis.

Stagner, Wilbur Lowell, 1939
Paleogeography of the Uinta Basin during Uinta B time (Eocene): Univ. of Colorado M.S. thesis.

Stanley, Donald Alvora, 1966
A preliminary investigation of the low-sodium portion of the system $BeO-Na_2O-SiO_2-H_2O$: Univ. of Utah Ph.D. thesis.

Stark, Norman P., 1953
Areal geology of the Upton region, Summit County, Utah: Univ. of Utah M.S. thesis.

Steele, Grant, 1959
Stratigraphic interpretation of the Pennsylvanian-Permian Systems of the eastern Great Basin: Univ. of Washington Ph.D. thesis.

Stephens, James D., 1960
Hydrothermal alteration at the United States mine, West Mountain (Bingham) district, Utah: Univ. of Utah Ph.D. thesis.

Stephenson, David A., 1961
Stratigraphy of the Entrada-Preuss and Curtis-Stump Formations in southwestern Wyoming and the Uinta Mountains of Utah: Washington State Univ. M.S. thesis.

Stepp, Jesse Carl, 1961
Regional gravity survey of parts of Tooele and Box Elder Counties, Utah, and Elko County, Nevada: Univ. of Utah M.S. thesis.

Stevens, Calvin Howes, 1963
Paleoecology and stratigraphy of pre-Kaibab Permian rocks in the Ely Basin, Nevada and Utah: Univ. of Southern Calif. Ph.D. thesis.

Stewart, Donald G., 1956
General geology, channeling and uranium mineralization, Triassic Shinarump Conglomerate, Circle Cliffs area, Utah: Brigham Young Univ. M.S. thesis.

Stewart, John Harris, 1961
Stratigraphy and origin of the Chinle Formation (Upper Triassic) on the Colorado Plateau: Stanford Univ. Ph.D. thesis.

Stewart, Moyle Duanne, 1950
Stratigraphy and paleontology of the lower Oquirrh Formation of Provo Canyon in the south central Wasatch Mountains, Utah: Brigham Young Univ. M.S. thesis.

Stewart, Samuel W., 1956
Gravity survey of Ogden Valley, Weber County, Utah: Univ. of Utah M.S. thesis.

Stifel, Peter Beekman, 1964
Geology of the Terrace and Hogup Mountains, Box Elder County, Utah: Univ. of Utah Ph.D. thesis.

Stillman, Francis Benedict, 1927
Reconnaissance of the Wasatch Front between Alpine and American Fork Canyons, Utah County, Utah: Cornell Univ. M.S. thesis.

Stokes, William Lee, 1938
Lithology and stratigraphy of the Red Plateau, Emery County, Utah: Brigham Young Univ. M.S. thesis.

Stokes, William Lee, 1941
Stratigraphy of the Morrison Formation and related deposits in and adjacent to the Colorado Plateau: Princeton Univ. Ph.D. thesis.

Stott, George F., 1916
Mining and milling of a complex lead and zinc ores in the Park City district, Utah: Univ. of Utah M.S. thesis.

Stouffer, Stephen Gerald, 1964
Landslides in the Coal Hill area, Kane County, Utah: Univ. of Utah M.S. thesis.

Stringham, Bronson F., 1942
Mineralization in the West Tintic mining district: Columbia Univ. Ph.D. thesis.

Swanson, James W., 1952
Geology of the southern portion of West Mountain, Utah: Brigham Young Univ. M.S. thesis.

Swensen, A. Jaren, 1962
Anisoceratidae and Hamitidae (Ammonoidea) from the Cretaceous of Texas and Utah: Brigham Young Univ. M.S. thesis.

Tanner, Vasco M., 1920
Deltas of Lake Bonneville: Univ. of Utah M.A. thesis.

Taylor, Dorothy Ann, 1948
The geology of the Gunnison Plateau front in the vicinity of Wales, Utah: Ohio State Univ. M.S. thesis.

Taylor, Michael E., 1963
The Lower Devonian Water Canyon Formation of northeastern Utah: Utah State Univ. M.S. thesis.

Teichert, John A., 1958
Geology of the southern Stansbury Range, Tooele County, Utah: Univ. of Utah M.S. thesis.

Thomas, Gerald W., 1958
Stratigraphic paleontology of the Morgan Formation, Uinta Mountains and vicinity: Washington State Univ. M.S. thesis.

Thomas, Gilbert E., 1960
The South Flat and related formations in the northern

part of the Gunnison Plateau, Utah: Ohio State Univ. M.S. thesis.

Thomas, Glenn H., 1958
Geology of the Indian Springs quadrangle, Tooele and Juab Counties, Utah: Brigham Young Univ. M.S. thesis.

Thomas, Harold E., 1947
Geology of Cedar City and Parowan Valleys, Iron County, Utah: Univ. of Chicago Ph.D. thesis.

Thomas, Wayne B., 1940
The structural geology of lower Ogden Canyon Utah: Univ. of Utah M.S. thesis.

Thorpe, Malcolm R., 1916
Geology of Abajo Mountains, San Juan County, Utah: Yale Univ. Ph.D. thesis.

Threet, Richard L., 1952
Geology of the Red Hills area, Iron County, Utah: Univ. of Washington Ph.D. thesis.

Tidwell, William D., 1962
Early Pennsylvanian flora from Manning Canyon Shale, Utah: Brigham Young Univ. M.S. thesis.

Tint, Maung Thaw, 1963
Microfossils and petrology of Mississippian Limestones, northern Stansbury Range, Tooele County, Utah: Univ. of Utah M.S. thesis.

Trexler, David W., 1955
Stratigraphy and structure of the Coalville area, northeastern Utah: Johns Hopkins Univ. Ph.D. thesis.

Tucker, Leroy M., 1954
Geology of the Scipio quadrangle, Utah: Ohio State Univ. Ph.D. thesis.

Turner, Frank Paul, 1952
Stratigraphy and structure of Provo Canyon between Bridal Veil Falls and South Fork: Brigham Young Univ. M.S. thesis.

Twenter, Floyd R., 1956
Relation of texture and mineral composition to the topographic expression of some Colorado Plateau sandstones: Univ. of Missouri M.A. thesis.

Van de Graaff, Fredric R., 1962
Upper Cretaceous stratigraphy of the central part of Utah: Utah State Univ. M.S. thesis.

Vlam, Heber Adolf Arien, 1963
Petrology of Lake Bonneville gravels, Salt Lake County, Utah: Univ. of Utah M.S. thesis.

Vogel, James William, 1957
Geology of the southernmost Juab Valley and adjacent highlands, Juab County, Utah: Ohio State Univ. M.S. thesis.

Wagner, Oscar E., Jr., 1932
The paleontology and stratigraphy of the Kaibab Limestone: Univ. of Illinois Ph.D. thesis.

Wallace, Ronald G., 1964
Late Cenozoic mass movement along part of the west edge of the Wasatch Plateau, Sanpete County, Utah: Ohio State Univ. M.S. thesis.

Walton, Paul Talmadge, 1942
Geology of the Cretaceous of the Uinta Basin, Utah: Massachusetts Inst. Technology Ph.D. thesis.

Waring, Robert G., 1952
Geology of the Phosphatic shale member of the Park City Formation in central and north central Utah: Brigham Young Univ. M.S. thesis.

Warner, Maurice Armond, 1956
The origin of the Rex chert: Univ. of Wisconsin Ph.D. thesis.

Warner, Mont Marcellus, 1949
Correlation study of the Mesozoic stratigraphy of Utah and the adjacent portions of surrounding states: Brigham Young Univ. M.A. thesis.

Warner, Mont Marcellus, 1963
Sedimentation of the Duchesne River Formation, Uinta Basin, Utah: State Univ. of Iowa (Iowa City) Ph.D. thesis.

Warner, Robert O., 1951
Groundwater geology of the Provo-Orem, Utah area, Utah County: Brigham Young Univ. M.S. thesis.

Washburn, George R., 1948
Geology of the Manti Canyon area, Sanpete County, central Utah: Ohio State Univ. M.S. thesis.

Webb, Gregory W., 1949
Stratigraphy of the Ordovician quartzites of the Great Basin: Columbia Univ. M.A. thesis.

Webb, Gregory W., 1954
Middle Ordovician stratigraphy in eastern Nevada and western Utah: Columbia Univ. Ph.D. thesis.

Wegg, David S., Jr., 1915
Bingham mining district, Utah: Univ. of Utah M.S. thesis.

Weintraub, Judy, 1957
Mineral paragenesis and wall rock alteration at the Ophir mine, Tooele County, Utah: Univ. of Utah M.S. thesis.

Wells, Richard B., 1963
Orthoquartzites of the Oquirrh Formation: Brigham Young Univ. M.S. thesis.

Wheelwright, Mona Vyonne, 1958
Preliminary palynology of some Utah and Wyoming coals: Univ. of Utah M.S. thesis.

Whipple, Ross W., 1949
Radioactivity correlations in an ore deposit near Park City, Utah: Univ. of Utah M.S. thesis.

White, Bob O., 1953
Geology of the West Mountain and northern portion of Long Ridge, Utah County, Utah: Brigham Young Univ. M.S. thesis.

Wilcken, Phyllis D., 1936
The Brazer Formation in the Beck Spur area, central Wasatch Mountains: Univ. of Utah M.S. thesis.

Wiley, Michael Alan, 1963
Stratigraphy and structure of the Jackson Mountain-Tobin Wash area, southwest Utah: Univ. of Texas at Austin M.A. thesis.

Willard, Allen D., 1959
Surficial geology of Bear Lake Valley, Rich County, Utah: Utah State Univ. M.S. thesis.

Willden, Charles R., 1952
The nature of the igneous - sediment contact in the U.S. mine, Bingham, Utah: Univ. of Utah M.S. thesis.

Willes, Sidney B., 1962
The mineral alteration products of Keetley-Kamas area, Wasatch and Summit Counties, Utah: Brigham Young Univ. M.S. thesis.

Williams, Edmund J., 1964
Geomorphic features and history of the lower part of Logan Canyon, Cache County, Utah: Utah State Univ. M.S. thesis.

Williams, Floyd Elmer, 1951
Geology of the north Selma Hills area, Utah County, Utah: Brigham Young Univ. M.S. thesis.

Williams, Norman C., 1952
Wall rock alteration, Mayflower mine, Park City, Utah: Columbia Univ. Ph.D. thesis.

Willis, Joseph P., Jr., 1961
Geology of the eastern portion of the Hurricane quadrangle, Washington County, Utah: Univ. of Southern California M.A. thesis.

Wilson, John C., 1961
Geology of the Alta stock, Salt Lake County: California Inst. Technology Ph.D. thesis.

Wilson, Mark D., 1949
The geology of the upper Six Mile Canyon area, Sanpete County, central Utah: Ohio State Univ. M.S. thesis.

Wilson, Richard Fairfield, 1959
The stratigraphy and sedimentology of the Kayenta and Moenave Formations, Vermilion Cliffs region, Kane County, Utah and Arizona: Stanford Univ. Ph.D. thesis.

Wood, William James, 1953
Areal geology of the Coalville vicinity, Summit County, Utah: Univ. of Utah M.S. thesis.

Woodland, Roland Bert, 1957
Stratigraphic significance of Mississippian endothyroid Foraminifera in central Utah: Brigham Young Univ. M.S. thesis.

Woolard, Louis Eugene, 1955
Late Tertiary rhyolitic eruptions and uranium mineralization, Marysvale, Piute County, Utah: Columbia Univ. Ph.D. thesis.

Wright, Phillip Michael, 1966
Geothermal gradient and regional heat flow in Utah: Univ. of Utah Ph.D. thesis.

Wright, Richard E., 1961
Stratigraphic and tectonic interpretation of Oquirrh Formation, Stansbury Mountains, Tooele County, Utah: Brigham Young Univ. M.S. thesis.

Yeats, Vestal L., 1961
The areal geology of the Moab 4 NW quadrangle, Grand County, Utah: Texas Technolog. College M.S. thesis.

Yolton, James S., 1943
The Dry Lake section of the Brazer Formation, Logan quadrangle, Cache County, Utah: Utah State Univ. M.S. thesis.

Young, J. Llewellyn, 1939
Glaciation in Logan quadrangle, Cache County, Utah: Utah State Univ. M.S. thesis.

Young, John C., 1953
Geology of the southern Lakeside Mountains, Tooele County, Utah: Univ. of Utah M.S. thesis.

Young, Robert G., 1952
Stratigraphic relations in the Upper Cretaceous of the Book Cliffs, Utah-Colorado: Ohio State Univ. Ph.D. thesis.

Zeller, Howard Davis, 1949
The geology of the west central portion of the Gunnison Plateau, Utah: Ohio State Univ. M.S. thesis.

Zeller, Ronald P., 1958
Paleoecology of the Long Trail Shale Member of the Great Blue Limestone, Oquirrh Range, Utah: Brigham Young Univ. M.S. thesis.

Zimbeck, Donald Allen, 1965
Gravity survey along northward - trending profiles across the boundary between the Basin and Range Province and Colorado Plateau: Univ. of Utah M.S. thesis.

Zimmerman, James Thomas, 1961
Geology of the Cove Creek area, Millard and Beaver Counties, Utah: Univ. of Utah M.S. thesis.

SUBJECT INDEX

1. Geophysical, hydrogeologic, geomorphological and areal (general, or mapping) theses are indexed by county. Mining and economic geological, mineralogical and geochemical theses are more commonly indexed by mining district. Most theses are also indexed by prominent physiographic features such as basins, plateaus, valleys and mountains. Stratigraphic theses may be indexed by physiographic features, but are not indexed by county.

2. Formations are generally listed as they appear in the "Lexicon of Geologic Names of the United States for 1953-1960", Bulletin 1200 of the U.S. Geological Survey. Information in brackets indicates age of rock unit and its distribution in Utah, and is largely derived from the Lexicon. Publication in this volume does not imply approval by either the U.S. Geological Survey or the Utah Geological and Mineralogical Survey.

3. Rock units named in thesis abstracts have been completely indexed. Abstract numbers printed in bold type are the more important references to the rock types.

STRATIGRAPHY (con't)

STRATIGRAPHY (con't)

UNIVERSITY INDEX

UNIVERSITY OF ARIZONA
Tuscon, Arizona

1951 Brimhall, Willis H. (M.S.)
1953 Evensen, Charles G. (M.S.)
Grundy, Wilbur D. (M.S.)
1955 Bailey, James S. (Ph.D.)
1956 Emigh, George D. (Ph.D.)
1959 Kothavala, Rüstum Zal (M.S.)
1960 Loring, William Bacheller (Ph.D.)
Akers, J.P. (M.S.)
1961 Gray, Irving B. (Ph.D.)
Livingston, Donald E. (M.S.)
1963 Kennedy, Richard R. (Ph.D.)
Peirce, Howard Wesley (Ph.D.)
Ratté, Charles A. (Ph.D.)

BRIGHAM YOUNG UNIVERSITY
Provo, Utah

1931 Dennis, Eldon (M.A.)
1932 Coffman, W. Elmo (M.A.)
1933 Buss, Walter R. (M.S.)
1935 Condon, David D. (M.S.)
1936 Harris, A. Wayne (M.S.)
1938 Dixon, Howard B. (M.A.)
Stokes, William Lee (M.S.)
1942 Bullock, Kenneth C. (M.S.)
1948 Gwynn, Thomas Andrew (M.S.)
Mecham, Derral F. (M.A.)
1949 Rigby, J. Keith (M.S.)
Warner, Mont Marcellus (M.A.)
1950 Brown, Ralph Sherman (M.S.)
Franson, Oral M. (M.S.)
Gaines, Patric W. (M.S.)
Hebertson, Keith M. (M.A.)
Hebrew, Quey Chester (M.S.)
Hosford, Gregory F. (M.S.)
Johns, Kenneth Herbert (M.S.)
Nolan, Grace Margaret (M.A.)
Stewart, Moyle Duane (M.S.)
1951 Abbott, Ward Owen (M.S.)
Boyden, Thomas A. (M.S.)
Calderwood, Keith W. (M.S.)
Davis, Leland M. (M.S.)
Evans, Max Thomas (M.S.)
Gates, Robert W. (M.S.)
Hodgson, Robert A. (M.S.)
Hoffman, Floyd H. (M.S.)
Moulton, Floyd C. (M.S.)
Okerlund, Maeser D. (M.S.)
Price, Jack R. (M.S.)
Reber, Spencer J. (M.S.)
Smith, Grant McKay (M.S.)
Smith, Walter L. (M.S.)
Warner, Robert O. (M.S.)
Williams, Floyd Elmer (M.S.)
1952 Davis, H. Clyde (M.S.)
Elison, James H. (M.S.)
Madsen, Jack William (M.S.)
Madsen, Russel A. (M.S.)
Peterson, Parley Royal (M.A.)
Schindler, Stanley Fred (M.S.)
Swanson, James W. (M.S.)
Turner, Frank Paul (M.S.)
Waring, Robert G. (M.S.)
1953 Clark, Robert S. (M.S.)
Harris, Harold Duane (M.S.)
Ornelas, Richard Henry (M.S.)
Peacock, C. Herschel (M.S.)
Petersen, Herbert Neil (M.S.)
Peterson, Dallas O. (M.S.)
Sirrine, George Keith (M.S.)
White, Bob O. (M.S.)
1954 Clark, David L. (M.S.)
Dearden, Melvin O. (M.S.)
Hamblin, William K. (M.S.)
Knight, Lester L. (M.S.)
Murphy, Don R. (M.S.)
1955 Livingston, Vaughn Edward, Jr. (M.S.)
McFarland, Carl R. (M.S.)
McFarlane, James J. (M.S.)
Olsen, Ben L. (M.S.)
Perkins, Richard F. (M.S.)
Rhodes, James A. (M.S.)
1956 Croft, Mack G. (M.S.)
Davis, Del E. (M.S.)
Demars, Lorenzo C. (M.S.)
Petersen, Morris S. (M.S.)
Peterson, Deverl J. (M.S.)
Smith, Cleon Verl (M.S.)
Stewart, Donald G. (M.S.)
1957 Maxfield, E. Blair (M.S.)
Pitcher, Grant G. (M.S.)
Rawson, Richard Ray (M.S.)
Woodland, Roland Bert (M.S.)
1958 Bentley, Craig B. (M.A.)
Bullock, Reuben Lynn (M.S.)
Harris, DeVerle (M.S.)
Henderson, Gerald V. (M.S.)
Moyle, Richard W. (M.S.)
Prescott, Max W. (M.S.)
Robison, Richard Ashby (M.S.)
Thomas, Glenn H. (M.S.)
Zeller, Ronald P. (M.S.)
1959 Burge, Donald Lockwood (M.S.)
Crosby, Gary Wayne (M.S.)
Davis, Briant LeRoy (M.S.)
Foster, John M. (M.S.)
Gould, Wilburn James (M.S.)
Johnson, Kenneth Dee (M.S.)
Powell, Dean Keith (M.S.)
1960 Berge, Charles William (M.S.)
Foutz, Dell R. (M.S.)

Kennedy, Richard R. (M.S.)
Larsen, Norbert W. (M.A.)
1961 Beach, Gary A. (M.S.)
Hodgkinson, Kenneth A. (M.A.)
Mollazal, Yazdan (M.S.)
Wright, Richard E. (M.S.)
1962 Baer, James L. (M.S.)
Hanks, Keith L. (M.S.)
Swensen, A. Jaren (M.S.)
Tidwell, William D. (M.S.)
Willes, Sidney B. (M.S.)
1963 Prince, Donald (M.S.)
Wells, Richard B. (M.S.)
1964 Fowkes, Elliott J. (M.S.)
John, Edward C. (M.S.)
Markland, Thomas R. (M.S.)
1965 Black, B. Allen (M.S.)
Bordine, Burton W. (M.S.)
Brady, Michael J. (M.S.)
Bullock, Ladell R. (M.S.)
Lufkin, John L. (M.S.)
1966 Howard, James D. (Ph.D.)

UNIVERSITY OF CALIFORNIA (BERKELEY)
Berkeley, California

1954 Finch, Warren Irvin (M.S.)
1957 Hunt, John Prior (Ph.D.)

UNIVERSITY OF CALIFORNIA (LOS ANGELES)
Los Angeles, California

1959 Barosh, Patrick James (M.A.)
1963 Beus, Stanley Spencer (Ph.D.)

UNIVERSITY OF CALIFORNIA (SAN DIEGO)
La Jolla, California

1965 Condie, Kent C. (Ph.D.)

CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena, California

1948 Martner, Samuel T. (Ph.D.)
Hedden, Albert H., Jr. (M.S.)
1955 Burnham, C. Wayne (Ph.D.)
1957 Lohman, Kenneth E. (Ph.D.)
1958 Lewis, Arthur Edward (Ph.D.)
Rose, Arthur W. (Ph.D.)
1961 Wilson, John C. (Ph.D.)

UNIVERSITY OF CHICAGO
Chicago, Illinois

1903 Atwood, Wallace W. (Ph.D.)
1927 Bailey, Reed W. (M.S.)
1929 Matthews, Asa A. Lee (Ph.D.)
1941 Peterson, Victor E. (Ph.D.)
1947 Thomas, Harold E. (Ph.D.)

UNIVERSITY OF COLORADO
Boulder, Colorado

1939 Stagner, Wilbur Lowell (M.S.)
1952 Shenkel, Claude W., Jr. (Ph.D.)
Bradley, Whitney Allen (M.S.)
1953 Luedke, Robert G. (M.S.)
1954 Holmes, Allen W., Jr. (M.S.)
1955 Richmond, Gerald M. (Ph.D.)
Eicher, Don Lauren (M.S.)
Hampton, O. Winston (M.S.)
1956 Praetorius, Herman W. (M.S.)
1959 Goode, Harry D. (Ph.D.)
1960 Brodsky, Harold (M.S.)
1961 Kennedy, Vance C. (Ph.D.)
1962 Linscott, Robert O. (M.S.)
1965 Baars, Donald Lee (Ph.D.)
Duke, Walter Clifford (M.S.)

COLUMBIA UNIVERSITY
New York, New York

1905 Carnahan, Thomas S. (M.A.)
Pack, Fred James (M.A.)
1913 Hintze, Ferdinand Friis, Jr. (Ph.D.)
1924 Jones, Ray S. (M.A.)
1942 Stringham, Bronson F. (Ph.D.)
1948 Hintze, Lehi F. (M.A.)
1949 Webb, Gregory W. (M.A.)
1950 Hintze, Lehi F. (Ph.D.)
1952 Williams, Norman C. (Ph.D.)
1953 Brophy, Gerald P. (M.A.)
1954 Brophy, Gerald P. (Ph.D.)
Dahl, Harry M. (Ph.D.)
Green, Jack (Ph.D.)
Parker, Raymond L. (Ph.D.)
Rush, Richard W. (Ph.D.)
Webb, Gregory W. (Ph.D.)
1955 Woolard, Louis Eugene (Ph.D.)
Lapham, D.M. (M.S.)
1956 Bodine, Marc W., Jr. (Ph.D.)
1957 Bethke, Philip Martin (Ph.D.)
1959 Kelley, Dana R. (Ph.D.)
Beckmann, Marian C. (M.A.)
1960 Abdel-Gawad, Abdel-Moneim M. (Ph.D.)
Miller, Donald S. (Ph.D.)
Molloy, Martin William (Ph.D.)
1963 Jacobs, Marian B. (Ph.D.)
Davidson, David M., Jr. (M.A.)
1964 Schmitt, Leonard J., Jr. (M.A.)

CORNELL UNIVERSITY
Ithaca, New York

1908 Bamberger, Clarence G. (M.E.)
1927 Stillman, Francis Benedict (M.S.)
1935 Forrester, James D. (Ph.D.)
1943 Proctor, Paul Dean (M.A.)
1954 Gehman, Harry Merrill, Jr. (M.S.)

DARTMOUTH COLLEGE
Hanover, New Hampshire

1955 McDowell, John P. (M.A.)

HARVARD UNIVERSITY
Cambridge, Massachusetts

1934 Kransdorff, David (Ph.D.)
1940 Larsen, Esper S., III (Ph.D.)
1949 Curtis, Bruce F. (Ph.D.)
1961 McCubbin, Donald G. (Ph.D.)

UNIVERSITY OF IDAHO
Moscow, Idaho

1950 Nielsen, Merrill L. (M.S.)

UNIVERSITY OF ILLINOIS
Urbana, Illinois

1932 Wagner, Oscar E., Jr. (Ph.D.)
1950 Cramer, Howard R. (M.S.)
Pierce, Jack Warren (M.S.)
1957 Patterson, Ben Arnold (M.S.)
Plebuch, Raymond Otto (M.S.)

INDIANA UNIVERSITY
Bloomington, Indiana

1949 Proctor, Paul Dean (Ph.D.)
Parker, Raymond L. (M.A.)
1952 Axenfeld, Sheldon (M.A.)
Renzetti, Bert Lionel (M.A.)
1953 Sargent, Robert Edward (M.A.)

STATE UNIVERSITY OF IOWA
Iowa City, Iowa

1936 Bissell, Harold Joseph (M.S.)
1948 Bissell, Harold Joseph (Ph.D.)
1957 Clark, David L. (Ph.D.)
1963 Warner, Mont Marcellus (Ph.D.)

IOWA STATE UNIVERSITY
Ames, Iowa

1940 Phillips, Kenneth A. (M.S.)

JOHNS HOPKINS UNIVERSITY
Baltimore, Maryland

1949 Hamilton, Edward Alricks (Ph.D.)
1952 Poborski, Stanislaw Jozef (M.A.)
1955 Trexler, David W. (Ph.D.)

UNIVERSITY OF KANSAS
Lawrence, Kansas

1958 Chapman, John S. (M.S.)
1961 Lefebvre, Richard H. (M.S.)

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge, Massachusetts

1920 Dennan, William L. (M.S.)
1942 Walton, Paul Talmadge (Ph.D.)

UNIVERSITY OF MICHIGAN
Ann Arbor, Michigan

1925 Gould, Laurence M. (Ph.D.)
1938 Hatch, Robert A. (M.S.)
1962 MacNish, Robert D. (M.S.)

MICHIGAN STATE UNIVERSITY
East Lansing, Michigan

1959 DeVries, Neal H. (M.S.)

UNIVERSITY OF MINNESOTA
Minneapolis, Minnesota

1953 Roberts, David B. (M.S.)
1958 Garmoe, Walter J. (M.S.)

UNIVERSITY OF MISSOURI
Columbia, Missouri

1930 Branson, Carl C. (Ph.D.)
Gunnell, Francis H. (M.A.)
Hammond, Weldon Woolf (M.S.)
Hansen, Othello T. (M.A.)
1931 Owen, John Wallace (M.A.)
1950 Holland, Frank Delno, Jr. (M.A.)
1955 Hamilton, Richard P. (M.A.)
1956 Twenter, Floyd R. (M.A.)
1958 Ott, Henry Louis (M.A.)

UNIVERSITY OF NEBRASKA
Lincoln, Nebraska

1955 Nygreen, Paul W. (M.S.)
1956 Sauer, Frank J. (M.S.)
1957 Stacy, Robert R. (M.S.)
Nielsen, Mitchell F. (M.S.)
1961 Gunderson, Wayne (M.S.)

UNIVERSITY OF NEW MEXICO
Albuquerque, New Mexico

1957 Jordan, Jack G. (M.S.)
Smith, James A. (M.A.)
1960 Hinds, Jim S. (M.S.)
1962 Kirkland, Peggy L. (M.S.)

NORTHWESTERN UNIVERSITY
Evanston, Illinois

1929 Apple, Florence Olive (M.S.)
1950 Kraetsch, Ralph B., Jr. (M.S.)
1952 Hansen, Alan R. (M.S.)
Nagel, Fritz G. (M.S.)
1954 Cramer, Howard R. (Ph.D.)

OHIO STATE UNIVERSITY
Columbus, Ohio

1931 Schoff, Stuart L. (M.A.)
1937 Schoff, Stuart L. (Ph.D.)
1948 Gilliland, William N. (Ph.D.)
Bonar, Chester M. (M.S.)
Faulk, Niles Richard (M.S.)
Hardy, Clyde Thomas (M.S.)
Hunt, Robert Elton (M.S.)
Katherman, Vance Edward (M.S.)
Taylor, Dorothy Ann (M.S.)
Washburn, George R. (M.S.)
1949 Hardy, Clyde Thomas (Ph.D.)
Babisak, Julius (M.S.)
Fagadau, Sanford Payne (M.S.)
Johnson, Mike Sam (M.S.)
Wilson, Mark D. (M.S.)
Zeller, Howard Davis (M.S.)
1950 Hunt, Robert Elton (Ph.D.)
Bayley, Richard W. (M.S.)
Gill, James R. (M.S.)
Lee, Kwang-Yuan (M.S.)
1951 Katich, Philip J., Jr. (Ph.D.)
Muessig, Siegfried Joseph (Ph.D.)
Frazier, Noah A. (M.S.)
1952 Lautenschlager, Herman Kenneth (Ph.D.)
Young, Robert G. (Ph.D.)
1953 Lee, Kwang-Yuan (Ph.D.)
1954 Tucker, Leroy M. (Ph.D.)
Kucera, Richard Edward (M.S.)
1955 Metter, Raymond Earl (Ph.D.)
1956 Cooper, John E., Jr. (M.S.)
Fograscher, Arthur Carl (M.S.)
Khin, Maung Aung (M.S.)
Pashley, Emil Frederick, Jr. (M.S.)
1957 Mase, Russell Edwin (M.S.)
Vogel, James William (M.S.)
1958 McGookey, Donald Paul (Ph.D.)
1959 Bachman, Mattias E. (M.S.)
Baughman, Russell Leroy (M.S.)
1960 Hays, James Douglas (M.S.)
Thomas, Gilbert E. (M.S.)
1963 Nikravesh, Rashel (M.S.)
1964 Wallace, Ronald G. (M.S.)

PENNSYLVANIA STATE UNIVERSITY
University Park, Pennsylvania

1952 Cadigan, Robert Allen (M.S.)

UNIVERSITY OF PITTSBURGH
Pittsburgh, Pennsylvania

1932 Clark, John (M.S.)

PRINCETON UNIVERSITY
Princeton, New Jersey

1930 Eardley, Armand J. (Ph.D.)
1941 Stokes, William Lee (Ph.D.)
1942 Denson, Norman M. (Ph.D.)
1948 Christiansen, Francis Wyman (Ph.D.)
1951 Maxey, George Burke (Ph.D.)
1955 Anderman, George Gibbs (Ph.D.)

RICE INSTITUTE
Houston, Texas

1959 Pliler, Richard (Ph.D.)

SOUTH DAKOTA SCHOOL
OF MINES AND TECHNOLOGY
Rapid City, South Dakota

1954 Mancuso, James D. (M.S.)

UNIVERSITY OF SOUTHERN CALIFORNIA
Los Angeles, California

1961 Purcell, Francis A., Jr. (M.A.)
Willis, Joseph P., Jr. (M.A.)
1963 Stevens, Calvin Howes (Ph.D.)

SOUTHERN METHODIST UNIVERSITY
Dallas, Texas

1959 Becker, Joseph Henry (M.S.)
Dunn, David Evan (M.S.)
Hightower, Charles Henry, Jr. (M.S.)

STANFORD UNIVERSITY
Stanford, California

1924 Baddley, Elmer R. (M.A.)
Buss, Fred Earle (M.A.)
Matthews, Asa A. Lee (M.A.)
1925 Church, Clifford C. (M.A.)
Mitchell, Harold G. (M.A.)
1928 Christensen, A. Lee (M.A.)
1929 Addison, Carl C. (M.A.)
1938 Kildale, Malcolm Brus (Ph.D.)
1959 Wilson, Richard Fairfield (Ph.D.)
1961 Stewart, John Harris (Ph.D.)
1962 Payne, Anthony L. (Ph.D.)

UNIVERSITY OF TEXAS AT AUSTIN
Austin, Texas

1957 Haenggi, Walter T. (M.A.)
1962 Robison, Richard Ashby (Ph.D.)
1963 Wiley, Michael Alan (M.A.)
1965 Anderson, John J. (Ph.D.)

TEXAS TECHNOLOGICAL COLLEGE
Lubbock, Texas

1959 Miller, W.D. (M.S.)
Probandt, William Taylor (M.S.)
1960 Harper, M.L. (M.S.)
1961 Yeats, Vestal L. (M.S.)

UNIVERSITY OF UTAH
Salt Lake City, Utah

1906 Fox, Feramorz (M.S.)
1912 Nokes, Charles Mormon, Jr. (M.S.)
1915 Wegg, David S., Jr. (M.S.)
1916 Stott, George F. (M.S.)
1920 Tanner, Vasco M. (M.A.)
1924 Clark, A.F. (M.S.)
Siegfus, Stanley Spencer (M.S.)
1925 Gray, Ralph S. (M.S.)
Hodgson, Russell B. (M.S.)
1927 Siegfried, Joshua Floyd (M.S.)
1932 Marsell, Ray Everett (M.S.)
1934 Kemmerer, John L., Jr. (M.S.)
Reiser, Allan R. (M.S.)
1935 Bryan, G. Gregory (M.S.)
Kemmerer, Mahlon S. (M.S.)
Paris, Oliver L. (M.S.)
1936 Cronkhite, George (M.S.)
Wilcken, Phyllis D. (M.S.)
1937 Christiansen, Francis Wyman (M.S.)
1938 Childs, Orlo E. (M.S.)
1940 Birch, Rondo O. (M.S.)
Bullock, Nedra D. (M.A.)
Erickson, Max P. (M.S.)
Thomas, Wayne B. (M.S.)
1941 Jacobson, A. Thurl (M.A.)
Lambert, Hubert C. (M.S.)
1942 Keller, Kenneth F. (M.S.)
1943 Chorney, Raymond (M.S.)
1947 Edvalson, Fredrick M. (M.S.)
Lofgren, Ben E. (M.S.)
Morris, Hal T. (M.S.)
1949 Sharp, Byron J. (M.A.)
Whipple, Ross W. (M.S.)
1950 Amin, Surendra R. (M.S.)
Payne, Anthony (M.S.)
Peterson, Reed H. (M.S.)
1951 Bell, Gordon L. (Ph.D.)
Hooper, Warren G. (M.S.)
Larson, Kenneth W. (M.S.)
Olsen, Donald R. (M.S.)
O'Toole, Walter L. (M.S.)
1952 Bauer, Herman Louis, Jr. (M.S.)
Bowes, William A. (M.S.)
Cohenour, Robert E. (M.S.)
Edmisten, Neil (M.S.)
Johnson, Melvin Coatany (M.S.)
Lankford, Robert R. (M.S.)
Mount, Donald Lee (M.S.)
Randall, Arthur G. (M.S.)
Root, Robert E. (M.S.)
Willden, Charles R. (M.S.)
1953 Eskelson, Quinn M. (M.S.)
Holt, Robert E. (M.S.)
King, Norman J. (M.S.)
McDougald, William D. (M.S.)
Morris, Elliot C. (M.S.)
Stark, Norman P. (M.S.)
Wood, William James (M.S.)
Young, John C. (M.S.)
1954 Rogers, Allen Stuart (Ph.D.)
Egbert, Robert L. (M.S.)
Gardner, Weston Clive (M.S.)
Larsen, Willard N. (M.S.)
1955 Sharp, Byron J. (Ph.D.)
Slentz, Loren William (Ph.D.)
Austin, Carl Fulton (M.S.)
Myers, Richard Lee (M.S.)
Sadlick, Walter (M.S.)
Schick, Robert Bryant (M.S.)
1956 Johnson, John Burlin, Jr. (Ph.D.)
Arnold, Dwight Ellsworth (M.S.)
Keller, George H. (M.S.)
Paddock, Robert Edwards (M.S.)
Stewart, Samuel W. (M.S.)
1957 Cohenour, Robert E. (Ph.D.)
Earll, Fred Nelson (Ph.D.)
Larsen, Willard N. (Ph.D.)
Anderson, Warren L. (M.S.)
Coody, Gilbert L. (M.S.)
Dolan, William M. (M.S.)
Liese, Homer C. (M.S.)
Lum, Daniel (M.S.)
Merrell, Harvey W. (M.S.)
Smith, Theodore L. (M.S.)
Weintraub, Judy (M.S.)
1958 Ehlmann, Arthur J. (Ph.D.)
Schreiber, Joseph Frederick, Jr. (Ph.D.)
Everett, Kaye R. (M.S.)
Gelnett, Ronald H. (M.S.)
Johnson, William W. (M.S.)
Laraway, William H. (M.S.)
Novotny, Robert Thomas (M.S.)
Teichert, John A. (M.S.)
Wheelwright, Mona Vyonne (M.S.)
1959 Baker, Walker Holcombe (Ph.D.)
Groff, Sidney Lavern (Ph.D.)
Anderson, Barbara J. (M.S.)
Beard, John Harvey (M.S.)
Brooke, John P. (M.S.)
Cohen, Caxel Lodewijk David (M.S.)
Dahl, Charles Laurence (M.S.)
Duke, David Allen (M.S.)
Glissmeyer, Carl Howard (M.S.)
Green, Paul Reed (M.S.)
Madsen, James H., Jr. (M.S.)
Narans, Harry Donald, Jr. (M.S.)
Parry, William Thomas (M.S.)
Remington, Newell Christy (M.S.)
1960 Costain, John Kendall (Ph.D.)
Marine, Ira Wendell (Ph.D.)
Olson, Richard Hubbell (Ph.D.)
Stephens, James D. (Ph.D.)
Anderson, Paul Leon (M.S.)
Blue, Donald McCoy (M.S.)
Condie, Kent C. (M.A.)
Eriksson, Yves (M.S.)
Gates, Joseph Spencer (M.S.)
Groenewold, Bernard Cyrus (M.S.)
Halverson, Mark Olson (M.S.)
Leamer, Richard James (M.S.)
Ridd, Merril Kay (M.S.)

Rodriguez, Enrique Levy (M.S.)
1961 Parry, William Thomas (Ph.D.)
Schaeffer, Frederick Ernst, Jr. (Ph.D.)
Acosta, Alvaro (M.S.)
Allen, Jim E. (M.S.)
Botbol, Joseph Moses (M.S.)
Brox, George Stanley (M.S.)
Gross, Larry Thomas (M.S.)
Quitzau, Robert Peter (M.S.)
Stepp, Jesse Carl (M.S.)
Zimmerman, James Thomas (M.S.)
1962 Liese, Homer C. (Ph.D.)
Bardsley, Stanford Ronald (M.S.)
Harrill, James Reece (M.S.)
1963 Murany, Ernest Elmer (Ph.D.)
Setty, M.G. Anantha Padmanabha (Ph.D.)
Benvegnu, Carl Jerome (M.S.)
Hepworth, Richard Cundiff (M.S.)
Morin, Wilbur Joseph (M.S.)
Neff, Thomas Rodney (M.S.)
Odekirk, Jerry Ray (M.S.)
Tint, Maung Thaw (M.S.)
Vlam, Heber Adolf Arien (M.S.)
1964 Brooke, John P. (Ph.D.)
Doelling, Hellmut H. (Ph.D.)
Roberts, Philip Kenneth (Ph.D.)
Stifel, Peter Beekman (Ph.D.)
Crosson, Robert Scott (M.S.)
Hardman, Elwood (M.S.)
Kayser, Robert Benham (M.S.)
Mudgett, Philip Michael (M.S.)
Stouffer, Stephen Gerald (M.S.)
1965 Moussa, Mohamed Mounir Tawkik (Ph.D.)
Sadlick, Walter (Ph.D.)
Sayyah, Taha Ahmed (Ph.D.)
Parr, Clayton Joseph (M.S.)
Sontag, Richard Joseph (M.S.)
Zimbeck, Donald Allen (M.S.)
1966 Anderson, Christian Donald (Ph.D.)
Cargo, David Niels (Ph.D.)
El-Mahdy, Omar Rasheed (Ph.D.)
Grant, Sheldon Kerry (Ph.D.)
Heylmun, Edgar B. (Ph.D.)
Stanley, Donald Alvora (Ph.D.)
Wright, Phillip Michael (Ph.D.)
Anderson, Darrell John (M.S.)
Barnett, Jack Arnold (M.S.)
Cardone, Anthony Thomas (M.S.)
Gray, Robert Charles (M.S.)
Nohara, Tomohide (M.S.)
Salter, Robert Joel (M.S.)

UTAH STATE UNIVERSITY
Logan, Utah

1928 Cooley, I. LaVell (M.S.)
1929 Peterson, Harold (M.S.)
1936 Peterson, Victor E. (M.S.)
1939 Young, J. Llewellyn (M.S.)
1941 Maxey, George Burke (M.S.)
1942 Hanson, Alvin Maddison (M.S.)
1943 Yolton, James S. (M.S.)
1953 Ezell, Robert L. (M.S.)
1955 Adamson, Robert D. (M.S.)
1957 Haynie, Anthony V., Jr. (M.S.)
Prammani, Prapath (M.S.)
1958 Beus, Stanley Spencer (M.S.)
1959 Willard, Allen D. (M.S.)
1961 Hafen, Preston Lon (M.S.)
1962 Adams, O. Clair (M.S.)
Sanders, David T. (M.S.)
Van de Graaff, Fredrick R. (M.S.)
1963 Taylor, Michael E. (M.S.)
1964 Hansen, Steven C. (M.S.)
Williams, Edmund J. (M.S.)
1965 King, Harley D. (M.S.)
Smith, Robert B. (M.S.)
1966 Budge, David R. (M.S.)

UNIVERSITY OF WASHINGTON
Seattle, Washington

1939 Granger, Arthur Earle (M.S.)
1950 Nelson, Willis Howard (M.S.)
1952 Threet, Richard L. (Ph.D.)
1954 Brooks, James Elwood (Ph.D.)
Cook, Earl F. (Ph.D.)
Scott, Willard Frank (Ph.D.)
1956 East, Edwin H. (M.S.)
1958 Miller, Gerald Matthew (M.S.)
1959 Blank, Horace Richard, Jr. (Ph.D.)
Nelson, Robert B. (Ph.D.)
Steele, Grant (Ph.D.)
McCarthy, William R. (M.S.)
1960 Miller, Gerald Matthew (Ph.D.)
Kepper, Jack C. (M.S.)
1963 Schleh, Edward E. (Ph.D.)

WASHINGTON STATE UNIVERSITY
Pullman, Washington

1954 Hinman, Eugene E. (M.S.)
1958 Kleweno, Walter P., Jr. (M.S.)
Thomas, Gerald W. (M.S.)
1959 Peterson, Dallas O. (Ph.D.)
1961 Stephenson, David A. (M.S.)

UNIVERSITY OF WISCONSIN
Madison, Wisconsin

1946 McKelvey, Vincent E. (Ph.D.)
1948 McMinn, Paul Meloy (M.S.)
1949 Bullock, Kenneth C. (Ph.D.)
Hanson, Alvin Maddison (Ph.D.)
Parks, James M., Jr. (M.S.)
1950 Ogden, Lawrence (M.S.)
1956 Warner, Maurice Armond (Ph.D.)
1957 Behrendt, John C. (M.S.)
1959 Fetzner, Richard W. (Ph.D.)
1960 Scott, Gerald L. (Ph.D.)
1961 Mann, Christian J. (Ph.D.)
1965 Pinney, Robert Ivan (Ph.D.)

UNIVERSITY OF WYOMING
Laramie, Wyoming

1955 Groth, Frederick A. (M.A.)
1958 Fiero, G.W., Jr. (M.S.)
1960 Sikich, Steve W. (M.A.)

YALE UNIVERSITY
New Haven, Connecticut

1916 Thorpe, Malcolm R. (Ph.D.)
1926 Gilluly, James (Ph.D.)
1927 Bradley, Wilmot H. (Ph.D.)
1931 Baker, Arthur A. (Ph.D.)
1932 Dane, Carle H. (Ph.D.)
1948 Ross, Reuben J., Jr. (Ph.D.)
1950 Kinney, Douglas M. (Ph.D.)
1954 Coulter, Henry W., Jr. (Ph.D.)
1955 McFall, Clinton Carew (Ph.D.)
1958 Bick, Kenneth Fletcher (Ph.D.)
1959 Burger, John Allen (Ph.D.)
Hodgson, Robert A. (Ph.D.)
1963 Ames, Roger Lyman (Ph.D.)
1964 Armstrong, Richard L. (Ph.D.)