UTAH GEOLOGICAL AND MINERALOGICAL SURVEY

AFFILIATED WITH

THE COLLEGE OF MINES AND MINERAL INDUSTRIES

UNIVERSITY OF UTAH

SALT LAKE CITY, UTAH

Lower Ordovician Detailed Stratigraphic Sections For Western Utah

Of Particular Interest to Geologists Concerned With Petroleum Possibilities of the Great Basin

BY

LEHI F. HINTZE

Bulletin 39

May 1951

Price $1.50

UTAH GEOLOGICAL AND MINERALOGICAL SURVEY

The Utah Geological and Mineralogical Survey was authorized by act of the Utah State Legislature in 1931; however, no funds were made available for its establishment until 1941 when the State Government was reorganized and the Utah Geological and Mineralogical Survey was placed within the new State Departement of Publicity and Industrial Development where the Survey functioned until July 1, 1949. Effective as of that date, the Survey was transferred by law to the College of Mines and Mineral Industries, University of Utah.

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2. "The survey of the geological formations of the State with special reference to their economic contents, values and uses, such as: the ores of the various metals, coal, oil-shale, hydro-carbons, oil, gas, industrial clays, cement materials, mineral waters and other surface and underground water supplies, mineral fertilizers, asphalt, bitumen, structural materials, road-making materials, their kind and availability; and the promotion of the marketing of the mineral products of the State.

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4. "The consideration of such other scientific and economic problems as, in the judgment of the Board of Regents, should come within the field of the Survey.

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MAPS AND ILLUSTRATIONS

MAPS:

ILLUSTRATIONS:

FOREWARD

Geologists concerned with the petroleum possibilities of the Great Basin have been sorely in need of detailed studies of key areas. In the following pages Dr. Lehi F. Hintze has given the results of one such study. A companion investigation to that here reported will appear in a later bulletin of this series under the authorship of Gregory W. Webb, on The Ordovician Quartzites of West Central Utah. These belong to a series of detailed studies undertaken by Ph D. candidates at Columbia University under the sponsorship of the Utah Geological and Mineralogical Survey, while the Survey was still a branch of the Raw Materials Division of the Utah State Department of Publicity and Industrial Development.

At that time, the survey was gathering data for the symposium volume later published (1949) on the Oil and Gas Possibilities of Utah. The dearth of basic geologic information on the Basin Range province was at once apparent. To supply such data the Survey entered into contracts by which it sponsored respective projects on specific areas by candidates for advanced degrees from several universities both within and without the state.

The first contract entered into was with Richard W. Rush for a study of the Burbank Hills of Western Millard County. Part of the data gathered by Rush has been published as Bulletin 38 of the Utah Geological and Mineralogical Survey. A special supplementary study by Rush of the Silurian Rocks of the Basin Range province will be published in a subsequent bulletin.

Not only is "The Lower Ordovician Detailed Stratigraphic Sections for Western Utah," detailed; it is comprehensive. Dr. Hintze has amassed a wealth of information the full significance of which will be apparent only with the publication of his monograph (also to appear as a bulletin of the Utah Geological and Mineralogical Survey) on the Ordovician Trilobites of Utah. This will contain approximately 30 beautiful plates each showing 30 specimens (900 figures in all). Many species and several genera are new to science. The author, Dr. Lehi F. Hintze, now Professor of Geology, Oregon State College, is a native Utahn, the youngest son of the Professor Emeritus of Paleontology, University of Utah, Dr. F. F. Hintze who himself is an authority on the Paleozoic stratigraphy of Utah. Dr. F. F. Hintze is the proud father of two other sons who have also followed the profession of his choice and each of whom has made significant contributions to the science of geology.

Arthur L. Crawford, Director

Utah Geological and Mineralogical Survey

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ABSTRACT

Stratigraphy of the Ordovician Pogonip - Eureka sequence is traced from the Ibex area, west central Utah, eastward to central Utah and northward to the nearly equivalent Garden City - Swan Peak sequence of northeastern Utah. Pogonip limestone thins by convergence from about 3000 feet at Ibex to about 1700 feet near Scipio, central Utah, near the eastern margin of the Ordovician miogeosyncline. Thinning, partly by convergence and partly by pre-Upper Ordovician erosion is indicated along the miogeosynclinal margin in north central Utah. Middle Ordovician shallow seas persisted slightly later in west central Utah than in marginal areas to the east and north.

Six new lithologic units and fifteen faunal zones are recognized within the Pogonip group of western Utah: the Canadian House (new), Fillmore (new), and Wahwah (new) limestones; and the Chazyan Juab (new) limestone, Kanosh (new) shale and Lehman (new) formation. Two Middle Ordovician quartzites overlie the Pogonip group in western Utah. In this sequence the lower (Swan Peak) quartzite, 390 feet in central Utah, thins in western Utah to disappear in eastern Nevada, grading into successively younger Pogonip zones westward; the upper (Eureka) quartzite persists to the west, halfway across Nevada. Quartzite deposition in medial Ordovician time culminated in widespread erosion prior to the deposition of Upper Ordovician dolomites as a sheet over the area.

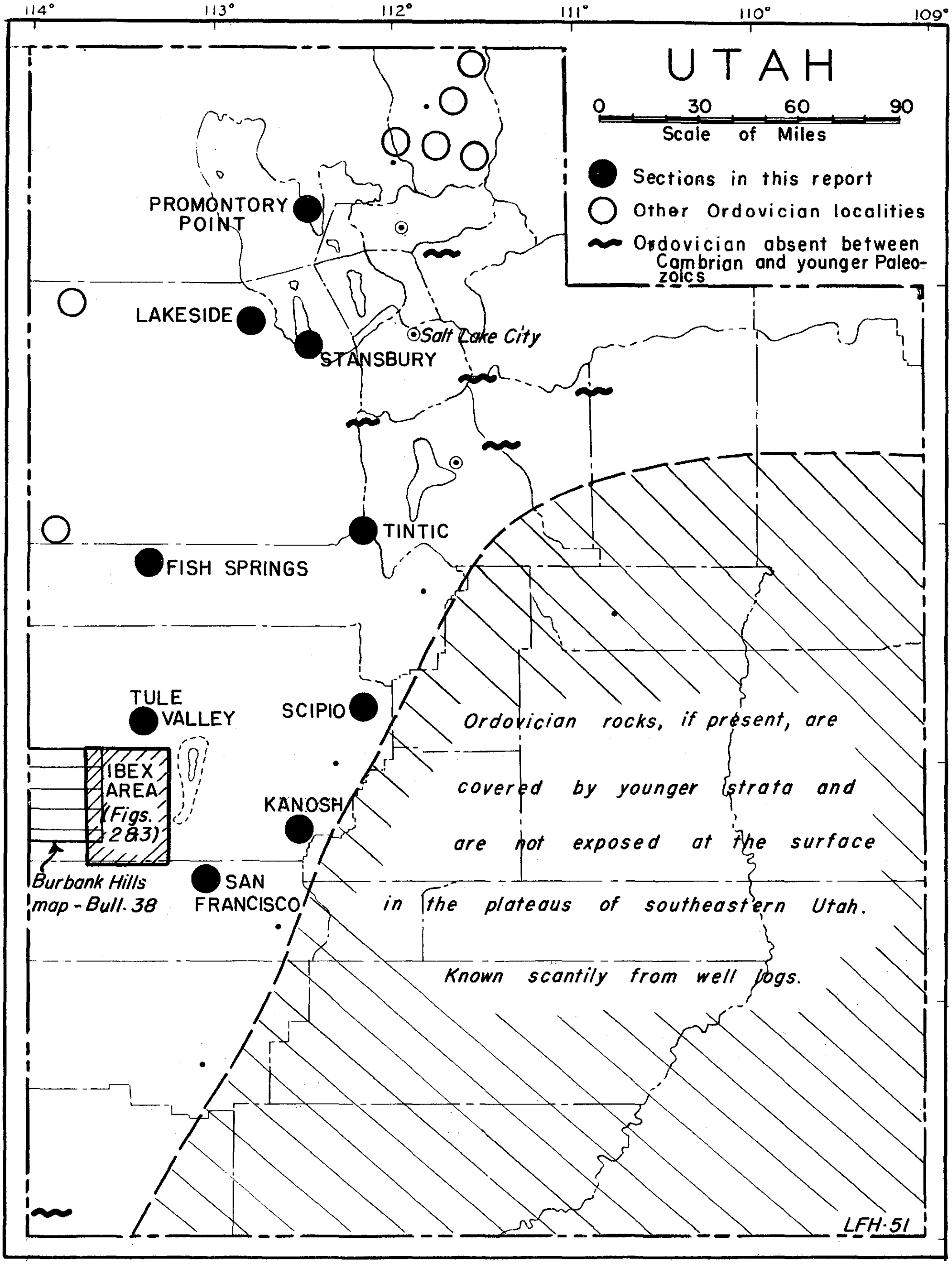


Fig. 1.- Index Map of Utah showing Ordovician localities.

LOWER ORDOVICIAN DETAILED STRATIGRAPHIC SECTIONS FOR WESTERN UTAH

Of Interest to Geologists Concerned With Petroleum Possibilities of the Great Basin

INTRODUCTION

Since the summer of 1947 the writer has been making a study of the Pogonip limestones of Ordovician age in western Utah and Nevada in order to gain a detailed understanding of the miogeosynclinal deposition there during the early Paleozoic. In the course of the investigation many stratigraphic sections have been examined in the fault block ranges of the Great Basin and much new data gathered. In order to clarify the stratigraphic relations within the thick series of Pogonip limestones it appeared desirable to subdivide these rocks on lithologic and faunal bases. The Ibex area of southwestern Millard County, Utah (see Fig. 1) was found to have the best exposed and most continously fossiliferous Ordovician section in western Utah and was selected as the type area for the establishment of six new formations within the Pogonip group. In this paper these new formations are defined for the first time and their exposures in the Ibex type area described in detail. In addition, Ordovician sections from several other localities are presented herein. Some of these localities lie between the Pogonip exposures in the Ibex area and the lower Ordovocian Garden City formation exposures in northeastern Utah and may serve as connecting links between these two areas.

Fifteen faunal zones are recognized within the Pogonip of western Utah. Faunal lists for these zones accompany the formation descriptions. For the most part these zones correspond with those in the Garden City and Swan Peak formations of northeastern Utah as recognized by Ross (1949, 1951) but the uppermost Pogonip zones are younger than any faunas reported from the Swan Peak formation of northeastern Utah and thus marine deposition appears to have persisted later in the Ibex area than in the northeastern corner of the state. A complete discussion of these Pogonip faunal zones in western Utah will accompany the description of the new trilobite genera and species found there (designated in this report by "n. sp. a" etc.) to be published in a forthcoming bulletin of the Utah Geological and Mineralogical Survey. Another paper will trace the Ordovician stratigraphy from central Utah into central Nevada (abstract, Hintze and Webb, 1949).

Although the primary purpose of this report is to present detailed stratigraphic notes in the belief that they will be of value to other workers, a secondary accomplishment of this study is a contribution to the knowledge of the areal geology of Utah. For example, the existence of Ordovician rocks in central Utah as far east as the edge of the high plateaus near Scipio and Kanosh is newly recognized. Most of the sections are entirely new to geologic literature, and the others considerably amplify existing information. The sections have been located as specifically as possible with the existing maps. Pertinent structural data as to dip of beds and local faults are given within the section descriptions. The recently published geologic map of Utah (Andrews, 1948) and the index to geologic mapping of Utah (Boardman, 1948) show the sparsity of published information in western Utah except for mining localities. Earlier reconnaissance geologic mapping of portions of Utah (Butler, 1920; Wheeler, 1876; King, 1876) is inadequate and in many places inaccurate, for it represents geology sketched in from long range observations from a limited series of traverses. An obstacle to the areal mapping of western Utah and eastern Nevada is the lack of suitable, or in most instances any, topographic maps. Nor are aerial photographs available for some of the region, although Jack Ammann Company in 1949 photographed much of western Utah. There remain then Forest Service maps, where available, and township and section plats which are useful if any of the mapped roads or section corners can be located. Grazing Service range maps compiled from land plats show the location of modern graded Grazing Service roads. Standard highway maps show the gross relations but the positions of desert roads and ranges on them are unreliable. Fortunately, the desert area between ranges is covered with an extensive network of passable roads and trails so that access to any part is fairly easy. Most of the area could be mapped readily, were there a suitable topographic base, as bedrock exposures are not masked by vegetation and block faulting has revealed the entire stratigraphic column.

Tracing of stratigraphic horizons is important in mining districts because of the localization of ores in certain strata. As a result of a regional stratigraphic study such as this one it becomes possible to recognize zones within mining districts in their true stratigraphic position and to make interpretations regarding apparent excess thicknesses caused by faulting, or the disappearance of beds by faulting or erosion. Such interpretations are impossible or can be made only with difficulty from such data as can be secured from disturbed strata within the limited area of the mining district itself. The present zonation of the Pogonip has clarified the status of the Opohonga limestone of the Tintic district, Utah, the Tank Hill and Yellow Hill formations in the Pioche district, Nevada, and the Morehouse quartzite of the San Francisco district, Utah.

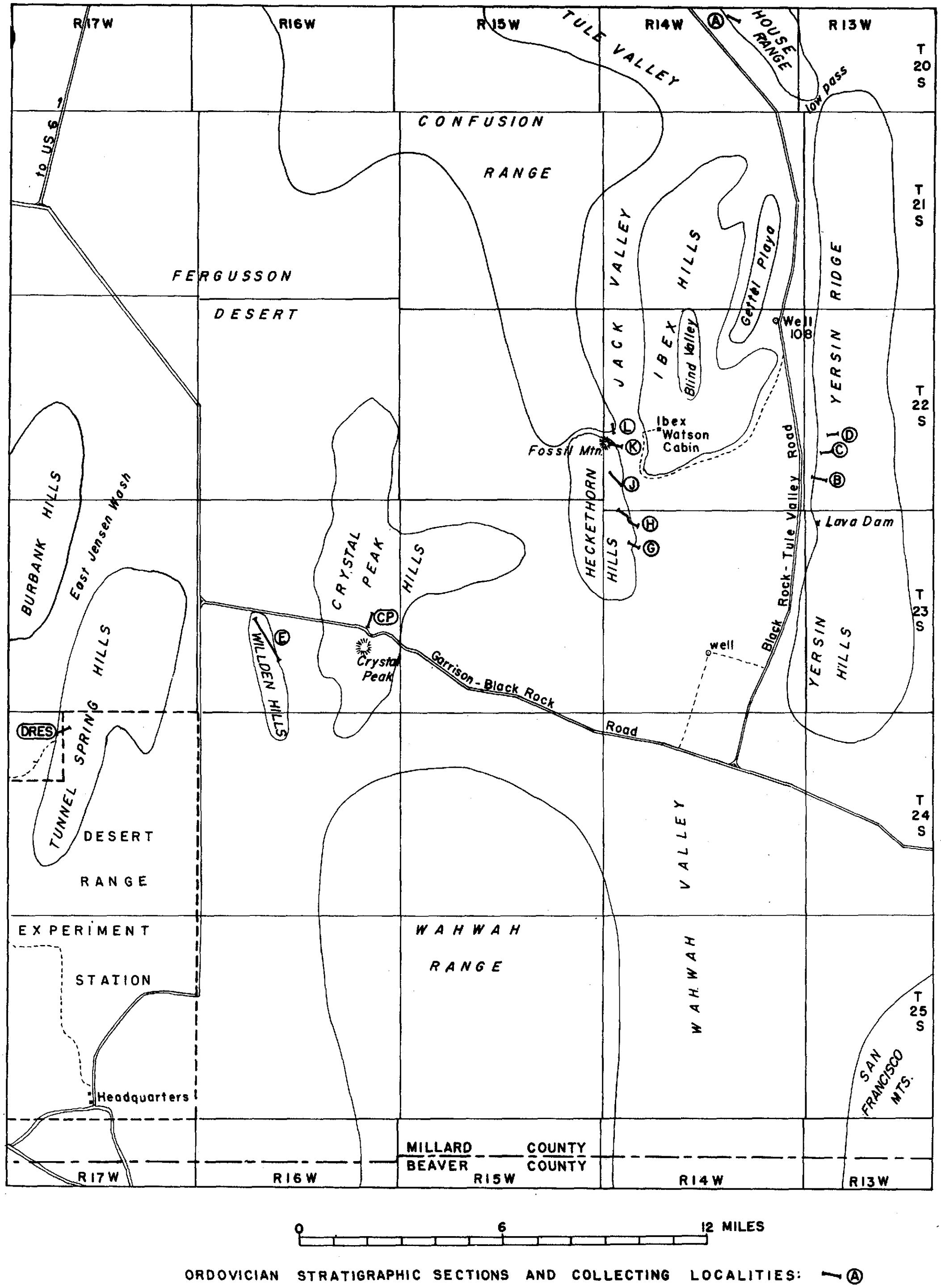


FIG. 2. LOCALITY MAP OF IBEX AREA, MILLARD COUNTY, UTAH.

ACKNOWLEDGEMENTS

In the course of this study friendly assistance has been received from many sources. Among those to whom I am particularly indebted are my father, F. F. Hintze, who first introduced me to the Ordovician of Utah; Prof. Marshall Kay of Columbia University for his constant interest and guidance; Gregory W. Webb, my field companion and co-worker; Ronald Willden and Robert Bright for assistance in the field; F. W. Christiansen, F. F. Hintze, T. S. Lovering, A. J. Eardley, and J. S. Williams for aid in locating sections; R. J. Ross Jr. for aid in the faunal studies; D. S. Hutchins of the Desert Range Experiment Station, Utah and Max Wainwright of the Lehman Caves National Monument, Nevada for hospitality and field information, and many other residents of the desert region for their advice as to local conditions and other courtesies; my wife, Ione, for her help and understanding in all phases of the work. It is a pleasure to acknowledge all of this friendly help but the writer alone must assume the responsibility for any shortcoming or mistakes. The study was made possible by financial support from the government under the veterans education program, by financial assistance from the Utah State Department of Publicity and Industrial Development, and by grants from the Kemp Memorial Fund of Columbia University, and from the General Research fund of Oregon State College.

STRATIGRAPHIC UNITS

Pogonip Group

"Pogonip limestone" is a name that has had several usages. It was defined originally to include all limestones between the Cambrian Dunderberg shale and the Ordovician Eureka quartzite in the White Pine mining district of eastern Nevada. Use of the name, subsequently, spread throughout Nevada and parts of California and Utah as a general term applied to carbonate rocks beneath the Eureka quartzite. Usage tended, however, to restrict Pogonip to the Ordovician (see Sharp, 1942, p. 657 for a resume and bibliography of use of the term). Parts of the Pogonip limestone have been found within other mining areas and in a few instances have been given names. It is not thought advisable to use these formational names outside each local district as their limits are based not on stratigraphic considerations but rather on local exposure and structural conditions.

Both Cambrian and Ordovician rocks were included originally within the Pogonip limestone because in this region there is no obvious break between the Upper Cambrian and the Lower Ordovician. Although detailed study now enables recognition and several lithologic units within the Pogonip, the lithologic changes between these subdivisions are not as striking as the early recognized contrast between the Pogonip limestone and the Eureka quartzite or the Dunderberg shale. The entire sequence from Upper Cambrian through Lower Ordovician is apparently conformable in most localities. Thus determination of which part is Cambrian and which Ordovician is solely a faunal problem. As yet paleontologists have not agreed upon the exact position of the Cambrian - Ordovician boundary in the Great Basin. Upper Cambrian rocks especially have received little attention, possibly because they are not so conspicuously fossiliferous as the formations above and below them. More extensive collecting is necessary before the Upper Cambrian history of the Basin and Range province can be well known and its upper boundary definitely set.

For the purposes of this report, however, it was necessary to define a boundary at or near the base of the Ordovician which could be recognized from place to place. The most natural lower limit and one which approximates the Cambrian - Ordovician boundary, is the lithologic change below the Symphysurina faunal zone. This was defined as the lower limit of the House limestone (new) and used as the lower boundary of the rocks studied. Lithologies below this are quite distinct from those above. In western Utah the underlying strata form massive cliffs (Notch Peak formation, restricted) of unfossiliferous limestone, but in central Utah and several Nevada localities underlying rocks are dolomitic. The lower limit of the House limestone is, as far as can be determined, the same as the lower limit of the Garden City formation of northeastern Utah. The lowermost faunas are equivalent, and the Garden City formation also rests on a dolomite, the uppermost beds of the Cambrian St. Charles formation.

The Pogonip group in western Utah and eastern Nevada comprises the House limestone (new), the Fillmore limestone (new), the Wahwah limestone (new), the Juab limestone (new), the Kanosh shale (new), and the Lehman formation (new). In central Nevada Merriam (unpublished manuscript) has subdivided the Pogonip group into three formations.

Two broad faunal zones have long been recognized by paleontologists in the Ordovician Pogonip. Both are of early Ordovician age; the lower has been compared with the Beekmantownian and the higher with the Chazyan of the eastern United States. In western Nevada the Ordovician is represented by a thick series of little studied argillites. This western shaly facies is correlated with the Pogonip. Graptolite faunas found in these shales and slates are compared to those of the Deepskill and the Normanskill of the eastern United States. Graptolites occur rarely in the Pogonip group but are more common in interbedded shales in the Garden City formation of northeastern Utah.

House Limestone

This name is proposed for the lowest formation within the Pogonip group as restricted. Ibex section A at the south end of the House Range (see Fig. 2 for location) is designated the type locality for the House limestone. There the entire formation is exposed above the more massive Notch Peak limestone. Southward from its type section the House limestone disappears below overlying strata in the Yersin Ridge syncline; the upper beds reappear on the south limb in Ibex section B. At the type locality the House limestone consists of 475 feet of typically medium gray, medium to thin bedded, cherty, silty calcilutite. Included within the limestone is much more fine quartz detritus than one would suspect from examination of fresh or weathered samples. In fact, the fine sand and silt content of some samples is enough to make the digestion of the carbonate cement by hydrochloric acid an extremely slow process, more than half of the rock consisting of fine detrital particles, principally quartz. Chert nodules and stringers are most common in the middle third of the formation, becoming less prominent upwards.

In the Ibex area two faunal zones are present in the House limestone, the lower zone extending through over 300 feet of beds from about 100 feet above the base of the formation upwards. This lower zone corresponds to Ross' (1949, 1951) zone B and at Ibex contains the following fauna:

Bellefontia n. sp. a
Bellefontia cf. *B. chamberlaini* Clark
Clelandia utahensis Ross
Hystricurus genalatus Ross
Hystricurus paragenalatus Ross
Hystricurus politus Ross
Hystricurus n. sp. a
Bellefontia-like n. gen. n. sp. a
Pseudokainella ? sp. A
Remopleuridiella caudalimbata Ross
Symphysurina cf. *S. elegans* Poulsen
Symphysurina n. sp. a and n. sp. b
Xenostegium franklinense Ross
Xenostegium sp. A

Apheoorthis cf. A. melita (Hall and Whitfield)
Lingulella cf. L. pogonipensis Walcott

Ophileta sp.

The upper zone corresponding to Ross' zone C, consists of a few thin layers of silty limestone crowded with the remains of unsilicified brachiopods of the genus Syntrophina and partially silicified trilobites of the genus Paraplethopeltis. This zone is found within ten to twenty feet of the top of the House limestone in the Ibex area and bears the following fossils:

Hystricurus cf. H. genalatus Ross
Hystricurus cf. H. politus Ross
Hystricurus n. sp. b
Paraplethopeltis n. sp. a and n. sp. b
Pseudokainella ? n. sp. b
Symphysurina n. sp. c

Syntrophina cf. S. campbelli (Walcott)

Fillmore Limestone

Intraformational conglomerate beds are found almost throughout the Pogonip group in western Utah but they are especially abundant in the Fillmore limestone, which is named for the town of Fillmore, Utah. This formation is characteristically a comples of thin bedded interbeds of intraformational conglomerate, limy siltstone, muddy limestone, and limy shales, with occasional thin layers of calcilutite. Attempts to trace even the most resistant-appearing beds from one locality to another have met with failure as the individual beds thin and lens out, or grade into other beds, within short distances.

The shallow water clastic origin of the Fillmore limestone is attested not only by the intraformational conglomerate itself, but also by occasional ripple-marks and cross-laminations, and by the abundance of beds of size-sorted silicified trilobite "hash" mostly water-worn beyond even generic recognition. Much quartz silt and fine sand is included in the limestone. This predominatly intraformationally conglomeratic character of the beds just above the base of the Lower Ordovician of Utah has been noted also in the Garden City formation of northeastern Utah, and in the Opohonga limestone of the Tintic district, Utah.

Although individual beds are not recognizable from one locality to the next, certain lithologic sequences can be recognized within the Fillmore limestone of the Ibex area. This is fortunate as the entire thickness of the Fillmore limestone is not exposed in any one section. The lowest part is represented only in Yersin Ridge (Ibex section C and D) and in the Willden Hills (Ibex section E); the middle and upper parts appear in the southern end of the Heckethorn Hills (Ibex section G and H). The Yersin Ridge and the Heckethorn Hills sections overlap considerably. Sequences of lithologies and faunal zones can be traced from one section to the other, and a composite section constructed, the thickness of which is more than 1500 feet. The formation is defined to comprise all beds between the top of the House limestone and the base of the Wahwah limestone; Ibex sections D, G, and H are designated as the type localities for the various portions as listed in the section descriptions.

The Fillmore limestone thins eastward and at Scipio, Utah, is about half as thick as at Ibex. Westward from Ibex in Nevada the thickness changes little but the lithology changes considerably. Intraformational conglomerates become less prominent westward, and quartz detritus is less conspicuous in the limestone. Chert becomes more prominent and several thick bedded, resistant beds appear.

Seven faunal zones are recognized in the Fillmore limestone at Ibex, Utah, corresponding approximately to Ross' (1949, 1951) faunal zones D, E, F, G-1, G-2, H, and I. The faunules from western Utah for these zones are as follows:

D. - This lowest zone occurs within 50 feet of the base of the Fillmore limestone intraformational conglomerate and contains a few rather poorly preserved trilobites of which only Kainella has been positively identified. Kainella is not reported by Ross from the Leiostegium manitouensis bearing zone D in northeastern Utah but inasmuch as the writer has found Leiostegium manitouensis and Kainella associated together at Sunnyside, Nevada the Kainella bearing zone D of Ibex is believed to correspond with the Leiostegium bearing zone D of northeastern Utah.

E. - This zone of western Utah differs from Ross' zone E in relative abundance of certain forms (Ross personal communication) and in the fact that some trilobite genera such as Hyperbolochilus, reported by Ross only from zone F, are found in western Utah in this lower zone as well. In the Ibex area this zone extends through about 75 feet of beds and contains the following forms:

Amblycranium variabile Ross
Hyperbolochilus sp.
Hystricurus sp. C Ross 1951 pl. 10
Hystricurus cf. H. oculilunatus Ross
Leiostegium n. sp. a
Pseudoclelandia cf. P. lenisora Ross
Pseudohystricurus sp.
Tesselecauda cf. T. depressa Ross
Pilekia ? sp. Ross 1951 pl. 35

Syntrophina ? sp.

F. - About one-third of the species listed by Ross for this zone in northeastern Utah have been found in the Fillmore limestone and in addition a new species of Parahystricurus. In the Ibex area the zone occurs through about 80 feet of intraformational conglomerate beds in which most of the trilobite remains have been broken beyond recognition during deposition. The following forms have been recovered:

Amblycranium cornutum Ross
Goniophrys prima Ross
Hyperbolochilus cf. H. marginauctum Ross
Hystricurus contractus Ross
Hystricurus oculilunatus Ross
Licnocephala sp.
Parahystricurus cf. P. fraudator Ross
Parahystricurus n. sp. a
Protopliomerops superciliosa Ross

G-1. - This zone is about 240 feet thick in the Ibex area and the most abundant fossil is a new species of the genus Megalaspidiella.

Jeffersonia ? sp.
Megalaspidiella n. sp. a
Asaphellus ? eudocia (Walcott)
Menoparia genalunata Ross
Parahystricurus sp.
Nileus-like sp. A
Protopliomerops celsaora Ross
Protopliomerops n. sp. a and n. sp. b
Psalikilus n. sp. a

Dictyonema sp.

Hormotoma-like gastropod impressions.

G-2. - As in the preceding zone a representative of the genus Megalaspidiella is the most abundant fossil in this zone in western Utah where the zone extends through over 400 feet of beds in the middle part of the fillmore limestone intraformational conglomerates.

Carolinites sp. A
Jeffersonia ? sp. A
Kirkella n. sp. f.
Licnocephala bicornuta Ross
Megalaspidiella n. sp. b
Menoparia genalunata Ross
Niobe ? n. sp. a
Protopliomerops cf. P. celsaora Ross
Protopliomerops contracta Ross
Protopliomerops n. sp. c
Psalikilus typicum Ross
Psalikilus n. sp. a
Nileus-like n. gen. n. sp. a
Rananasus sp.

Nanorthis ? sp.
Syntrophina ? sp.

Endoceras sp.

Dictyonema sp.
Didymograptus ? sp.

H. - This zone is characterized by its most abundant trilobite, _Trigonocerca_, a prominent guide fossil found in almost every section examined in Utah and eastern Nevada. This zone extends through over 225 feet of beds in the Ibex area where it also contains the many other fossils listed below in addition to Trigonocerca.

Carolinites cf. _C. genacinaca_ Ross
Dimeropygiella n. sp. a and n. sp. b
Goniotelus sp.
Jeffersonia ? sp.
Kirkella n. sp. a
Nileus-like n. gen. n. sp. b
Psalikilus sp. A
Pseudocybele n. sp. a and n. sp. b
Protopliomerops n. sp. c
Trigonocerca typica Ross

Diparalasma sp.
Hesperonomia ? sp.
Trematorthis sp.

Bellerophon-like steinkerns
Euomphalus ? sp.

Catoraphiceras sp.
Endoceras sp.

sponge ? elongate hollow form

I. - This uppermost zone of the Fillmore limestone is best exposed in section H at Ibex, Utah where it is at least 135 feet thick. This zone occupies the same stratigraphic position as Ross' zone I in northeastern Utah but they have only _Hesperonomia_ sp. and _Goniotelus_ sp. in common. A list of the ibex faunule from this zone follows:

Bathyurellus ? sp.
Carolinites genacinaca Ross
Goniotelus ? sp.
Isoteloides n. sp. a
Kirkella n. sp. a and n. sp. b
Nileus-like n. gen. n. sp. c
Pseudocybele n. sp. a and n. sp. b

Hesperonomia sp.
Syntrophina ? sp.

Bellerophon-like steinkerns

Endoceras sp.

Phyllograptus sp.

Wahwah Limestone

The Wahwah limestone, named from the Wahwah valley (see Fig. 2), is a ledge-forming quartz silty calcisiltite that contrasts topographically with the underlying slope-forming Fillmore limestone. Wahwah ledges are especially apparent in the type section, Ibex section H, as the lowest four of the five prominent ledges traceable northward to Ibex section J. The formation is resistant because of its high content of silty and fine sandy detritus so that its more massive beds stand as ledges or hogbacks wherever exposed from central Utah into east central Nevada, but in central Nevada equivalent beds are more shaly and less resistant. The Wahwah limestone is 227 feet thick in the type section at Ibex, Utah.

The Wahwah limestone is proliferously fossiliferous in the lower half, bearing perhaps the most widely reported Candadian fauna in the Great Basin, that designated by Ross (1949, 1951) as zone J. The following is a list of the fauna from this zone in western Utah:

"Barrandia ? sp." Walcott
Carolinites genacinaca Ross
Cybelopsis cf. C. speciosa Poulsen
Dimeropygiella caudanodosa Ross
Goniotelus, sp. A, sp. B, sp. C, sp. D
Isoteloides cf. I. polaris Poulsen
Isoteloides ? n. sp. b
Kawina sexapugia Ross
Kawina n. sp. a
Kirkella declivita Ross
Lachnostoma latucelsum Ross
Nileus-like n. gen. n. sp. d
Pliomerops cf. P. insolita Poulsen
Pseudocybele nasuta Ross
Illaenus-like n. gen. n. sp. a
Trigonocerca ? n. sp. a

Diparalasma sp.
Hesperonomia cf. H. dinorthoides Ulrich and Cooper
Tritoechia cf. T. sinuata Ulrich and Cooper

Lesuerilla ? sp.
Raphistomina sp.
Bellerophon-like sp.

Campbelloceras ? sp.
Catoraphiceras sp.

Zittelella cf. Z. clarae Howell
sponge ? bryozoan ? impressions
cystid plates

Near the top of the Wahwah limestone in the Ibex area a one-foot bed, crowded with valves of the brachiopod Hesperonomiella minor (Walcott), serves as a useful marker horizon. The only other fossils common in this bed are gastropod steinkerns of Lophospira-like and Lytospira-like aspect. This bed has yielded none of the forms noted by Ross (1949, 1951) from his faunal zone K but it occupies a similar stratigraphic position and is probably nearly equivalent.

Juab Limestone

This name, from Juab County, Utah, is proposed for the fine sandy calcisiltite lithologically distinctive from the Wahwah limestone below and the Kanosh shale above by its lack of shaly detritus and its characteristic medium gray, slabby appearance. Nodules of limonite pseudomorphs up to 1-1/2 inches in diameter weather from the Juab limestone. The thickness of the Juab in its type locality, Ibex section J, is 139 feet.

Fossils are not abundant and are but poorly preserved in the Juab in contrast to the formations above and below. The brachiopod genus Orthis makes its first appearance in the species O. subalata Ulrich and Cooper and suggests assignment of this unit to the Chazyan. Thus the Canadian - Chazyan time boundry is probably near the Wahwah - Juab contact. Other fossils tentatively indentified from the poorly preserved material of the Juab include the trilobites Pliomerops, Eleutherocentrus, and Parapilekia. This Juab limestone fauna correlates with Ross' (1949, 1951) faunal zone L of the uppermost Garden City formation of northeastern Utah.

Kanosh Shale

The Kanosh shale, named for a village in central Utah near which there is an exposure of the formation, appears abruptly above the Juab limestone. Though predominantly a yellowish-brown, olive, gray, or pink fissile shale, intercalated throughout are many thin-bedded limestone beds; in the upper part several thin bedded, orange weathering siltstone and fine sandstone also occur. The formation is very fossiliferous. Certain of the interbedded limestones are comprised largely of the valves of the brachiopods Orthis michaelis Clark and Anomalorthis utahensis Ulrich and Cooper, and others of the ostracods Macronotella sp. and Leperditia sp., the last-named, however, is even more abundant in the overlying Lehman formation. Trilobites, gastropods, orthocones, receptaculites, bryozoans, and cystid fragments are common in the formation; fossils are well preserved but rarely silicified. Lower beds of the Kanosh shales are exposed at Ibex section J; the entire formation is exposed at the type locality, Ibex section K, on the flank of Fossil Mountain; the upper beds are well exposed in Smooth Canyon, at Ibex section L, and at Crystal Peak, Utah.

In the Ibex area the Kanosh shale measures about 500 feet but estward from there it thins markedly. At the Scipio, Utah, section little of the formation is actually exposed but it is not more than 370 feet thick. It is even thinner in the Kanosh section some 35 miles southwestward from Scipio, although the exact thickness there is unknown because of structural complications. The Kanosh shale is found to the west as far as the Snake Range in eastern Nevada where limited exposures north of Big Spring reveal its typical lithology. Fifty miles farther westward, at Sunnyside, Nevada, equivalent beds lack the fissile shales and are predominantly limestone and limy siltstone.

Two faunal zones are recognized in the Kanosh shale. The lower zone, corresponding to Ross' (1949, 1951) highest zone, M, from the Swan Peak formation of northeastern Utah, occurs from the base of the Kanosh shale upwards through about 300 feet of beds in the Ibex area and contains the following fossils:

Bathyurellus cf. B. feitleri (Holliday)
Carolinites cf. C. killaryensis (Stubblefield)
Cybelopsis sp. (large)
Eleutherocentrus cf. E. petersoni Clark.
Pliomerops n. sp. a
Pliomerops n. sp. b (large)
n. gen. P, n. sp. a and n. sp. b

Leperditia sp.
Macronotella ? sp.

Acrotreta ? sp. (large)
Anomalorthis utahensis Ulrich and Cooper
Lingula sp
Orthis michaelis Clark

Bellerophon-like sp.
n. gen. gastropod near Maclurites
Endoceras large and small species
Receptaculites mammillaris Walcott
bryozoa, spherical and branching
cystid plates and calcite balls

The upper zone, here given a letter designation, N, is found in the upper part of the Kanosh shale and in the overlying Lehman formation and contains the following:

Barrandia ? sp.
Cybelopsis sp. (large)
Illaenus n. sp. a
Nieszkowskia ? n. sp. a
Pseudosphaeroexochus sp.
n. gen. P, n. sp. c

Anomalorthis sp.
Lingula sp.
Orthis ? sp.
Kirkina millardensis Salmon

Modiolopsis ? sp.

Hormotoma-like sp.
Lecanospira-like sp.
Maclurites sp.
Raphistoma sp.

Endoceras sp.
Trocholites ? sp.

bryozoans, spherical and branching

Lehman Formation

As typical of the Ordovician of western Utah and eastern Nevada as the quartzite below which it occurs is the thin to thick bedded, fossiliferous, blue gray calcilutite here given the name Lehman formation, after exposures in the Snake Range near the Lehman Caves, Nevada. A few beds of sandstone and quartzite alternate with the calcilutite. In the Ibex area the base of the Lehman formation is the base of the lowest interbedded sandstone ledge, and the upper limit of the formation is the top of the highest calcilutite beneath the Swan Peak? quartzite ledges. The most abundant fossil is Leperditia cf. L. bivia White, which occurs also in the Kanosh shale. The Lehman formation of western Utah carries the same fauna as the uppermost Kanosh shale. Uppermost Lehman beds to the west in Nevada carry a younger fauna than any recognized in the Lehman formation in Utah, the Eofletcheria zone fauna. In its type locality, Ibex section L, the Lehman formation is almost 200 feet thick.

Eastward from Ibex the Lehman thins to dissappearance. It was not recognized at Scipio, Utah, and at Kanosh, Utah only a few feet of limestone above the Kanosh shale have been tentatively assigned to the Lehman formation. Westward from Ibex the Lehman more than doubles in thickness by the overlying Swan Peak? quartzite grading into the Lehman lithology westward.

Garden City Formation

The Garden City formation of northeastern Utah and its trilobite faunas has recently been the subject of an excellent study by Reuben J. Ross (1949, 1951) and the reader is referred to Ross' papers for a discussion of that formation and the Swan Peak formation in their type localities. However, comparison of Garden City and Pogonip lithologies and an explanation of the usage of the Garden City as a formational name in the present report would seem to be in order here.

Lithologies of the lower Garden City formation of northeastern Utah and the lower Pogonip group of the Ibex area are similar; the lower 300 feet or so of Garden City contains a scattering of light colored chert stringers similar to those in the House limestone; also, the lower two-thirds of the Garden City formation is of predominantly intraformational limestone conglomerate as is the thickest Pogonip unit, the Fillmore limestone, the conditions of deposition of which are believed to be substantially the same as described by Ross (1951, p. 33) for this lithology. However, the upper parts of the Pogonip and Garden City differ; lithologically the cherty upper member of the Garden City formation is very different from the approximately equivalent Wahwah and Juab limestones; furthermore, higher faunal zones (M and N) are found in the Pogonip group than are present in the Garden City formation. Inasmuch as the Garden City formation represents only a part of the Pogonip group it was felt desirable to use the Garden City as a formational name only in the northern Utah sections in this report (Stansbury, Lakeside, Promontory Point) where the lithologies and faunas in the upper third of the formation more closely agree with the Garden City than with the Pogonip group of western Utah. The Utah Pogonip lithologies and faunas can be traced westward, through some transitions, to the limestones first designated as Pogonip some seventy years ago by Hague and King after Pogonip Mountain in the White Pine mining district of east central Nevada.

Swan Peak ? Quartzite

As defined in northeastern Utah (see Ross, 1949, p. 478) the Swan Peak formation comprises all beds above the typical Garden City limestone and below the Upper Ordovician dolomite and consists of two main lithologies, the lower half a shaly fossiliferous sequence, the upper a vitreous quartzite member. This same relation obtains in central Utah where the Kanosh shale appears to be almost identical in fauna as well as in lithology with the lower Swan Peak of northeastern Utah. The Swan Peak ? quartzite of central Utah is also almost identical lithologically with the upper quartzite member of the Swan Peak formation of northeastern Utah. However, the intervening Lehman formation of central Utah has no counterpart, either in lithology or fauna, in the northeastern Utah sections. It is impossible to trace the upper quartzite member of the Swan Peak formation southward from the type area as it thins to disappear, probably by erosion, in the central Wasatch, Lakeside, Stansbury, and Tintic ranges, although the lower shaly member persists at Lakeside and Stansbury. Two alternatives are considered; first, that the Lehman formation of central Utah is equivalent to the upper quartzite member of the Swan Peak formation of northeastern Utah, in which case the Swan Peak ? quartzite of central Utah would have no counterpart in northeastern Utah and should have a new name; and second, that the Lehman formation is represented within the Swan Peak formation of northeastern Utah, albeit unrecognizable, and that the Swan Peak ? quartzite of central Utah is equivalent to the upper quartzite member of the Swan Peak formation of northeastern Utah. The latter view has been taken by Webb (1949) in his study of the Ordovician quartzites. At Ibex the Swan Peak ? quartzite consists of about 250 feet of quartzites and sandstones at Ibex section L. It is overlain by the Middle Ordovician Delomite member. Webb has shown that both the Swan Peak ? quartzite of central Utah and the Swan Peak formation of northeastern Utah are older than the Eureka quartzite of Nevada. The Swan Peak ? quartzite is regressive, according to Webb, thinning in western Utah to disappear in eastern Nevada, grading into successively younger Pogonip zones westward.

Dolomite Member

The Dolomite member, 85 feet thick and as yet unnamed, occurs between the Swan Peak ? and Eureka quartzites in the Ibex area. This dolomite, heretofore undifferentiated from the Poponip limestones, also underlies the Eureka quartzite in eastern Nevada. Webb (1949) has correlated the Dolomite member with an as yet unnamed calcareous shale, which bears a late Chazyan to medial Trentonian fauna, and underlies the Eureka quartzite in central Nevada. Limestone lenses within the Dolomite have yielded some brachiopods which are under study by Webb, but the most conspicuous fossil in the member is the coral Eofletcheria which forms biostrome in western Utah about three feet thick. This Eofletcheria-bearing horizon is here designated as faunal zone O.

Twenhofel (1932, p. 350) states, "..that most, if not all, dolomites were formed in shallow water..." Direct evidence for the depth of water during deposition of the Dolomite member has not been observed, but as it occurs at the top of a thick series of clastic limestones and shales and just beneath an orthoquartzite, the shallow waters of an epicontinental sea would seem to be indicated. The question naturally arises; of what significance is the fact that the dolomite persistantly underlies the Ordovician quartzite? Is it a blanket deposit laid at one time as a sheet over the area, or is it connected in some way with environmental conditions just preceding quartzite deposition? Certain observations suggest the latter view. First, a similar dolomite - quartzite relationship of somewhat earlier age occurs in northeastern Utah where the lower part of the Swan Peak quartzite rests on a dolomite at the top of the Garden City formation (Ross, 1949, p. 477; Williams, 1948, p. 1135). Secondly, Ross notes that this dolomite, in certain instances, has formed by replacement of limestone. Such would appear to be also the case for the Dolomite member, which at Sunnyside, Nevada, is seen to pass into limestone in a short distance along the strike. The widespread areal distribution of the dolomite - quartzite sequence tends to indicate that such replacement was probably penecontemporaneous rather than a much later secondary replacement; the fact that dolomites occur beneath both the Swan Peak (in northern Utah) quartzite and the younger Eureka quartzite (in western Utah and Nevada) suggests environmental control.

Thickness of the Dolomite member is less than 100 feet in western Utah and Nevada. The upper Garden City dolomite unit in northern Utah attains somewhat greater thickness. On the west side of Promontory Point it measures about 200 feet; in the east limb of the Stansbury Island anticline on the south end of the "island" (now land-bridged) almost 400 feet of dolomite underlie 250 feet of interbedded dolomite and ripple-marked sandstone, which in turn underlie more than 700 feet of magnacross-bedded sandstone and quartzite. Whether this maximum development of the dolomite bears any genetic relationship to this maximum development of the dune-like cross bedding in the Ordovician sands there, and whether this occurrence could thus be regarded as indirect data bearing on the shallowness of dolomite-forming seas is questionable, but the coincidence is noteworthy.

Eureka Quartzite

At Ibex the massive cliff forming quartzite overlying the Dolomite member and underlying the Upper Ordovician cherty dolomite has been correlated with the Eureka quartzite of central Nevada by Webb (1949) in his concurrent study of the Ordovician quartzites of the Great Basin. The maximum thickness yet found for the Eureka is at Ibex where the quartzite measures 537 feet. While in many western Utah and eastern Nevada sections this quartzite regularly overlies the Dolomite member, its relation to underlying rocks in central Nevada as noted by Merriam and Anderson (1942, p. 1684) is by no means so simple. Whereas the Eureka quartzite lies on Middle Ordovician shaly beds in central Nevada in the Antelope and Monitor Ranges, in nearby localities it is found to rest with no angular discordance upon older rocks. At lone Mountain, 28 miles to the north, and at Bellevue Peak, 20 miles to the northeast in the Eureka district, the quartzite lies on the Chazyan limestone. In the Roberts Mountains at Pete Hanson Creek some 20 miles north of Lone Mountain, and in the Cortez mining district 20 miles farther northward, the Eureka quartzite rests on unfossiliferous dolomites which are lithologically like uppermost Cambrian dolomites elsewhere in the region. Eureka quartzite in central Nevada thus rests with regional unconformity on strata varying in age from Upper Cambrian (?) to Middle Ordovician from Cortez southward to the Antelope Valley.

According to Webb, deposition of the quartzite was followed by a period of erosion prior to the deposition of the Upper Ordovician dolomite. A forthcoming bulletin of the Utah Geological and Mineralogical Survey by Webb will elucidate Eureka quartzite relationships.

Upper Ordovician

The Upper Ordovician, typically a dolomite only a few hundred feet thick, is one of the most persistent stratigraphic units in the Great Basin. Commonly the dolomite is dark gray and cherty; the most common fossils are dolomitized outlines of the long-ranging corals, Streptelasma and Halysites, consequently in some localities lacking other fossils they have not been distinguished from the similar dolomites of the overlying Silurian. A few localities, however, have yielded a more diagnostic brachiopod fauna, some elements of which are rather uniformly present also in correlative formations of the central United States. Many older publications list this fauna as Richmondian; later Kirk (1930, p. 464-465) suggested that "this horizon was of Cincinnatian age, and in the sense of being pre-Richmond, post-Trenton"; Kay (1935, p. 589) suggested assignment of the unit to the late Trentonian, Cincinnatian, or both. Mr. Richard W. Rush is currently working on the Upper Ordovician and Silurian dolomites in western Utah, and his results will be published in a forthcoming bulletin of the Utah Geological and Mineralogical Survey.

The Upper Ordovician has been separately mapped as the Fish Haven dolomite in northeastern Utah (Richardson, 1941, Williams, 1948) and at Gold Hill (Nolan, 1935), as the Ely Springs dolomite at Pioche, Nevada (Westgate, 1932) and at Death Valley (Hazzard, 1938), and as the argillaceous and limy Hanson Creek formation in central Nevada (Merriam and Anderson, 1942). The Bluebell dolomite of the Tintic district, Utah (Loughlin, 1919; Lovering, 1949) is probably an equivalent. At no locality has the Upper Ordovician been reported to lie with an angular unconformity upon the Eureka quartzite, but thin dolomitic sands at the top of the Eureka are said to represent reworking of the exposed sand by the transgressing late Ordovician sea. An erosional unconformity seems indicated, for at Tintic, Gold Hill, and Lakeside, Utah the Middle Ordovician deposits are absent. Upper Ordovician deposits represent the most widespread invasion of any Paleozoic sea in North America, and the marine carbonate sheet deposited at that time sealed off the underlying Ordovician and Cambrian sands as well as some of the pre-Cambrian crystalline areas from thenceforth being sources of quartz detritus.

POSSIBLE PETROLEUM SOURCE BEDS AND RESERVOIR ROCKS

The lower four formations of the Pogonip group in western Utah, the House, Fillmore, Wahwah, and Juab limestones are not regarded by the writer as favorable petroleum source or reservoir beds. Although these beds are largely detrital with considerable amounts of quartz fine sand and silt intermixed with carbonate detritus, the carbonate cementing material renders them compact and unporous. Digestion of many samples of these formations with hydrochloric acid has shown that they do not contain any hydrocarbon residue and can hardly be regarded as source beds for petroleum.

The succeeding Ordovician formations are more favorable. Both the Kanosh shale and the Lehman formation are abundantly fossiliferous. Upon leaching with acid certain beds of these formations yield an oily residue. The overlying quartzites are possible reservoir rocks. Some of the horizons, especially in the lower part of the Swan Peak quartzite and the upper part of the Eureka are incompletely cemented and somewhat porous. Joint fractures are abundant in the quartzites in most localities. Apparently the quartzites have yielded to deformation by fracturing and in consequence the jointing planes are much more prominent in the quartzites than in the underlying and overlying rocks. Such fractures should considerably increase the permeability of the Ordovician quartzites as possible reservoir rocks. In suitable structures such as apparently exist in the Burbank Hills of western Utah the Ordovician quartzites should not be overlooked as possible oil bearers.

CLASSIFICATION

Cloud and Barnes (1946) have recognized three major faunal-facies groups in the Lower Ordovician of North America; first, a shale-graptolite facies; second, a limestone-brachioped facies; and third, a cherty carbonate-molluscan facies. Comparison of faunas (and time standards) between these different facies is difficult for they appear to have few fossils in common. Trilobites are apparently of limited importance in the cherty carbonate-molluscan facies in the lower Ordovician of the Ozarks, the Ellenburger of Texas, and most of the lower Ordovician of the Appalachians. And gastropods are certainly of limited importance in the trilobite-brachiopod faunas of the Pogonip group, consisting of poorly preserved steinkerns wherever the trilobites are well preserved and abundant only in the Palliseria zone of central Nevada, in the facies lacking trilobites.

It seems inadvisable, therefore, to refer the magnificent trilobite sequence of the western Lower Ordovician to another North American standard, such as the Ozarks or the Appalachian, in which that sequence is only scantily known. Certain correlations can be made however. The faunas of the House limestone compare with the lower Ordovician faunas in the Tribes Hill, Stonehenge, Gasconade and Manitou formations. Succeeding Pogonip fromations record an unbroken history of sedimentation and faunal change well into Chazyan time. Faunas in the Juab limestone and Kanosh shale resemble those found in the Joins formation of Oklahoma; the Lehman formation of central Utah may be provisionally correlated with the Oil Creek. The Pogonip faunal-facies as a whole is best compared to the Arbuckle group of Oklahoma and the El Paso formation of west Texas. Faunas found in the Antelope Valley area of central Nevada indicate a late Chazyan to medial Trentonian age for the shaly carbonates just beneath the Eureka quartzite. The dolomite overlying the Eureka quartzite is late Trentonian, Cincinnatian, or both.

STRUCTURAL CONSIDERATIONS

To appreciate the present distribution of the Ordovician in the Basin and Range province it is advantageous to review the structural history of the region. Nolan (1943, p. 142) has summarized this as follows:

> "The geosynclinal sea which in the early part of the Paleozoic era covered most of the province and in which many thousands of feet of sediments were deposited was divided in late Devonian time by a rising arch or geanticline in western Nevada. Locally there was moderate deformation during the uplift, but by Permian time elevation had ceased and most of the positive area had been covered by marine sediments. Coincidentally with the degradation of this geanticline during the Permain epoch similar uplift began in eastern Nevada, and a land mass between two seas persisted there, until early Jurassic time, when, instead of subsiding as the earlier one did, it became the site of intense diastrophism, marked particularly by large overthrust faults. To judge from the relatively meager evidence available, recurrent epochs of similar deformation continued into early Tertiary time, affecting an area that considerably exceeded that of the Basin and Range province . . . The Mesozoic and early Tertiary folding and overthrusting were succeeded closely by the initiation of the block faulting that has been the chief cause directly or indirectly of the present relief of the province. The faulting appears to have started at least by early Oligocene and to have continued up to the present day."

The block faulting has served to afford fine exposures of the Paleozoic column in various ranges throughout the province. The distribution of Ordovician exposures thus provided is admirably suited to stratigraphic studies. Thrust faulting, however, may have served to dislocate the sections from their original depositional site. Structural studies of the Great Basin have not proceeded far enouch to determine the amount of the displacement or even the locus of the thrust plates except in a few instances. In central Nevada Merriam and Anderson (1942) have postulated a thrust which has brought the western shaly facies (Vinini) of the Ordovician into juxtaposition with the Pogonip limestone facies. Thrust faulting is known in several localities in south central Nevada, and there appears to be a belt of thrusts in a line slightly east of north through central Nevada. Longwell (1949) and Hewett (1931) in their studies of the Muddy Mountains and Goodsprings areas of southern Nevada show extensive thrusting, and other thrusts have been found in a belt connecting this southern Nevada region with the thrusts in the Wasatch Mountains near Ogden, Utah (Eardley, 1944). Intermediate areas in this belt where thrusting is recognized are Pioche, Nevada (Westgate and Knopf, 1932), San Francisco, Utah (Hintze, 1949) Pavant Range, Utah (Maxey, 1946), Canyon Range, Utah (Christiansen, 1950) Gold Hill, Utah (Nolan, 1935), Sheeprock Range, Utah (Loughlin in Butler, 1920), Southern Wasatch Range, Utah (Eardley, 1934), and Oquirrh Range, Utah (Gilluly, 1932).

Realizing the widespread occurrence of thrust dislocations in the Basin and Range province, nonetheless it has not been possible

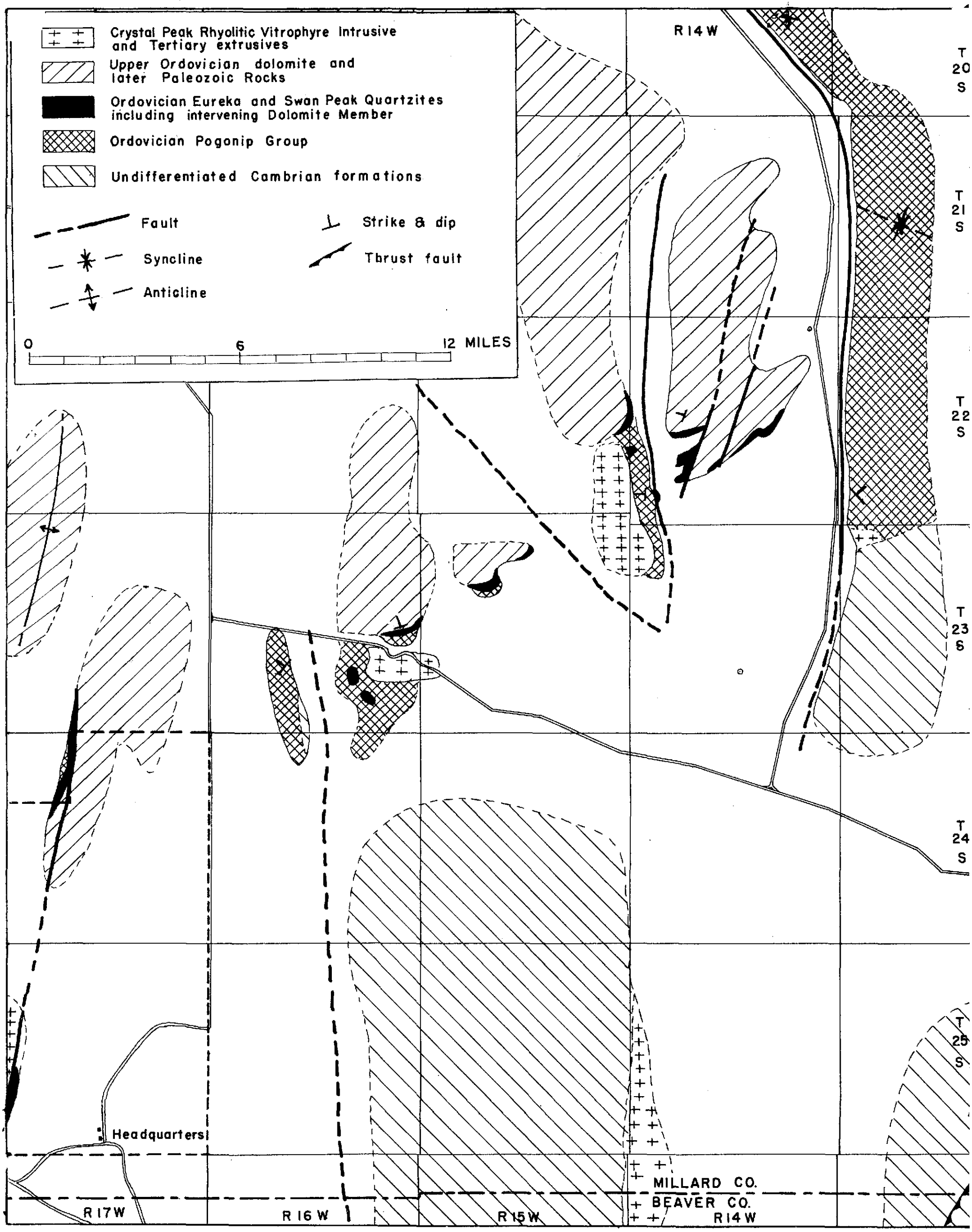


FIG. 3. GEOLOGIC SKETCH MAP OF IBEX AREA, MILLARD COUNTY, UTAH.

to determine whether any of the stratigraphic sections studied in this report are allochthonous. The stratigraphy itself shows no anomalies that might be the result of gross displacement and it is thus assumed for purposes of interpreting paleogeography that the various stratigraphic sections of this report have not been greatly, if at all, displaced by the thrust faults of the Great Basin.

Certain relations in the Ibex area suggest the possibility of thrusting there. Eureka quartzite boulders are found resting on Fillmore limestones on top of Yersin Ridge. Present topography is such that these boulders could not have come from adjacent hills. Further, the Eureka quartzite of Ibex is not a durable rock and is not found as talus away from the immediate base of its cliffs, nor does it persist as boulders in the desert stream washes. Yersin Ridge was neither glaciated nor submerged beneath Lake Bonneville during the Pleistocene. The presence of the Eureka quartzite boulders is thus a difficult thing to explain. Possibly they are the remnant of an overthrust sheet of Ordovician quartzite.

Cambrain beds dip southward from Notch Peak in the House Range and are concealed beneath the lower Ordovician beds in the Yersin Ridge syncline (see Fig. 3), reappearing south of Lava Dam in the Yersin Hills. Southward, beds of Cambrain age comprise most of the San Francisco and Wahwah Ranges. Butting against this linear trend of older Paleozoic rocks from the Nevada line to the Ibex Hills is a heterogeneous assemblage of Ordovician and later Paleozoic rocks in small, much faulted blocks. Orodovician quartzite cliffs are strikingly distributed in echelon from the Ibex Hills southwestward to the Halfway Hills. North-south anticlinal folding in the Burbank Hills suggests east-west compressional forces. The above considerations make it clear that the possibility of thrusting having dislocated the Ordovician in the Ibex area from its site of deposition cannot be entirely disregarded.

PALEOGEOGRAPHIC INTERPRETATIONS

Throughout the Great Basin the Pogonip group lies on the Cambrain and reflects a continuation of the conditions that prevailed in late Cambrian time. Studies of the Lower and Middle Cambrian stratigraphy by Wheeler (1944, 1948) disclose a widespread faunal and lithologic continuity over most of the Great Basin, the lithogenetic units having a tendency to become younger eastward. McKee (1945) presents evidence for an eastern source of clastics deposited in the southern part of the Cambrian geosyncline. The Upper Cambrian limestones have not been studied sufficiently to show details of their pattern of distribution but in several Great Basin localities they are reported to be 2000 to 3000 feet thick. The Cambrian thins rapidly near the eastern border of the miogeosyncline and is thin on the craton in eastern Utah, Wyoming, and Colorado, in places locally absent.

The Pogonip limestone thickens from about 1700 feet at Scipio near the miogeosynclinal margin to a rather constant 3000 feet in western Utah and eastern Nevada, the broad area of the miogeosyncline having subsided as a plate. Additional subsidence is recorded in central Nevada. In eastern Utah, well records show the Ordovician to be thin or absent (see Hintze, 1949, p. 49). In central Colorado the Manitou limestone, bearing only the lowermost Ordovician faunas lies in places on Upper Cambrian sands and in places directly on the pre-Cambrian (Maher, 1950). Though thinning of the lower Pogonip units from western to central Utah is by convergence, part of the thinning of upper units, just preceding or following the quartzite, may be erosional truncation. Middle Ordovician erosion is certainly indicated for marginal areas to the north by the truncation of the earlier Ordovician rocks of the Tintic district, Utah, where the Upper Ordovician Bluebell dolomite rests directly on Lower Ordovician Opohonga limestone, the Middle Ordovician limestones and sands being absent probably by erosion rather than non-deposition. The entire Ordovician section is notably absent on the flanks of the Uinta Mountains (see Fig. 1) whether by erosion or non-deposition is indeterminable but it is noteworthy that this east-west Uinta trend was a positive area even in Ordovician time. (The Cambrian, too, is much thinner in this vicinity than in northeastern Utah or the basin ranges of western Utah). In the Wasatch Mountains near Salt Lake City a white quartzite about 150 feet thick occurs at Becks Spur and in Neffs Canyon between Cambrian and Devonian limestones, but it is absent from the same interval a few miles farther south in Big Cottonwood Canyon. On Stansbury Island the Ordovician Swan Peak formation includes over 600 feet of dune-crossbedded sand evidencing the approximate locus of the Ordovician beach. Just a few miles to the southwest, however, in the Stansbury Mountains, the quartzite is absent; a few miles farther to the west and north in the Lakeside Mountains a one foot quartzite bed is found directly beneath the Upper Ordovician carbonates. Ross (1949, p. 490) notes the possibility of erosional bevelling as an explanation of the thinning of the Swan Peak quartzite to the southwest within the Logan quadrangle. Therefore, evidence seems to indicate a period of erosion (and possibly local upwarps in the Ogden-Salt Lake-Provo region) in Middle Ordovician time prior to the deposition of the Upper Ordovician carbonate. On the cratonal area to the east in central Colorado the Middle Ordovician Harding sandstone rests variously on Pre-Cambrian to lowermost Ordovician (Manitou) strata.

Presence of large amounts of fine quartz arenaceous material in the Pogonip group in central Utah, combined with shallow water features such as intraformational conglomerates, ripplemarks, cross laminations, and beds of worn and sorted trilobite fragments indicate that the area lay near the eastern shore of the epeiric sea. The fact that texture of this included quartz detritus decreases westward and that the Kanosh shale passes westward into limestones indicates an eastern source for the terrigenous material.

No special efforts have been made to record the orientation of pebbles, fossils, or crossbedding, nor are these features so obvious in the Pogonip group that any preferred orientation is noticeable. As nothing coarser than fine sand (the intraformational conglomerate forming locally) has been found in the Ordovician of the Great Basin, the source area was low lying, distant, or both. During Pogonip deposition relative increase in the proportion of terrigenous detritus to carbonate occurs in the Wahwah limestone but the succeeding Juab limestone is less silty. Influx of greater amounts of fine terrigenous materials began again with the deposition

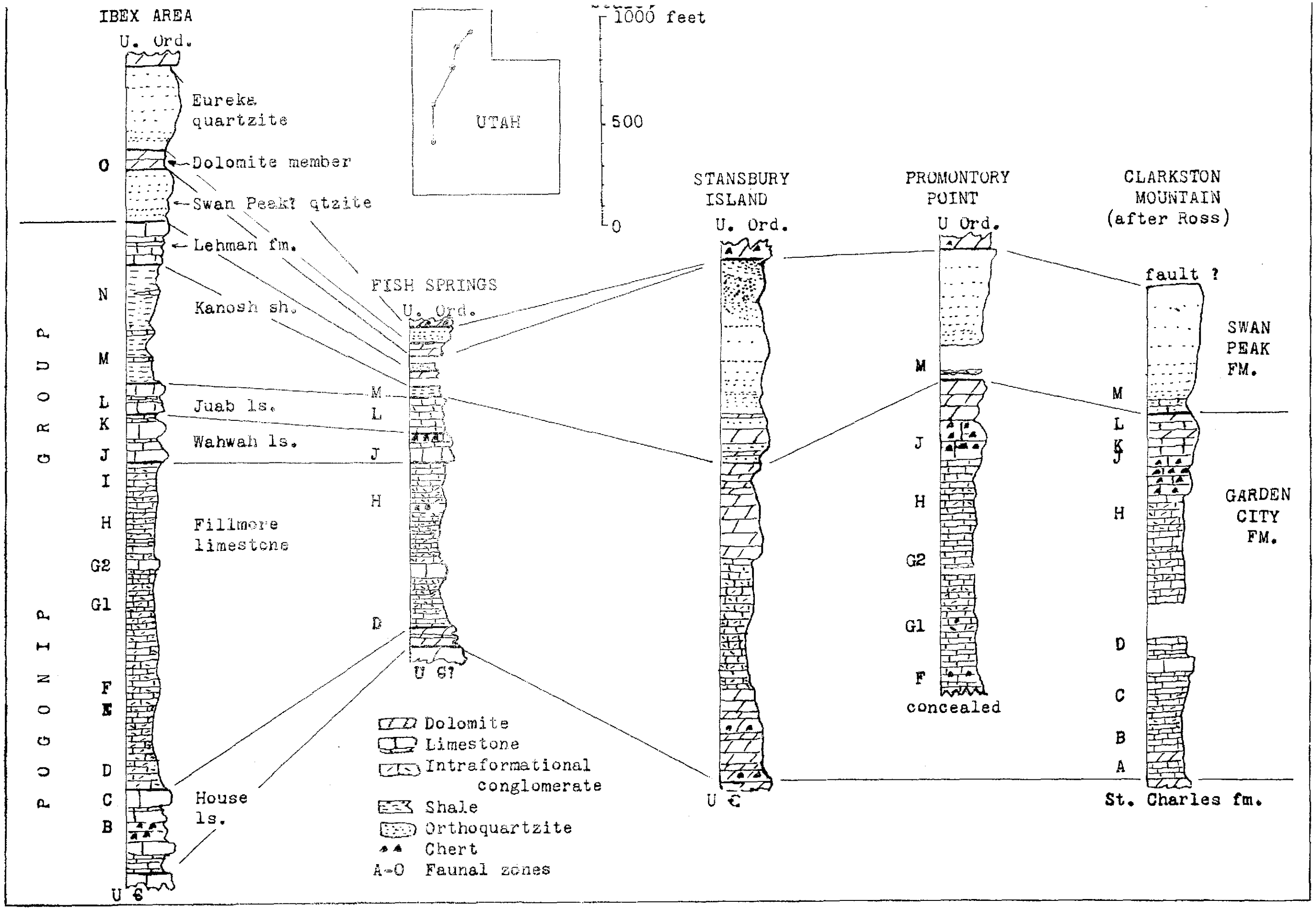


Fig. 4.- Generalized diagrammatic stratigraphic sections of Ordovician formations from several Utah localities.

of the Kanosh shales in Utah, and was climaxed by the deposition of the Swan Peak ? quartzite. This quartzite thins markedly to the west and is represented in the Snake Range only by a thin calcareous sand in the equivalent Lehman beds. Shallowing of the seas may be indicated by the thin Dolomite member which preceded the deposition of the Eureka quartzite in Utah and eastern Nevada. As already noted, a period of erosion probably marked the end of quartz deposition although it is possible that some areas continued to receive sand while others were being eroded. However, in late Trentonian or Cincinnatian time the entire Great Basin was again submerged and the upper Ordovician dolomite (Fish Haven, Ely Springs, Bluebell, etc.) deposited as a sheet over not only the geosynclinal belt but most of the cratonal source area as well, sealing many areas from ever again being sources of quartz detritus.

STRATIGRAPHIC SECTIONS

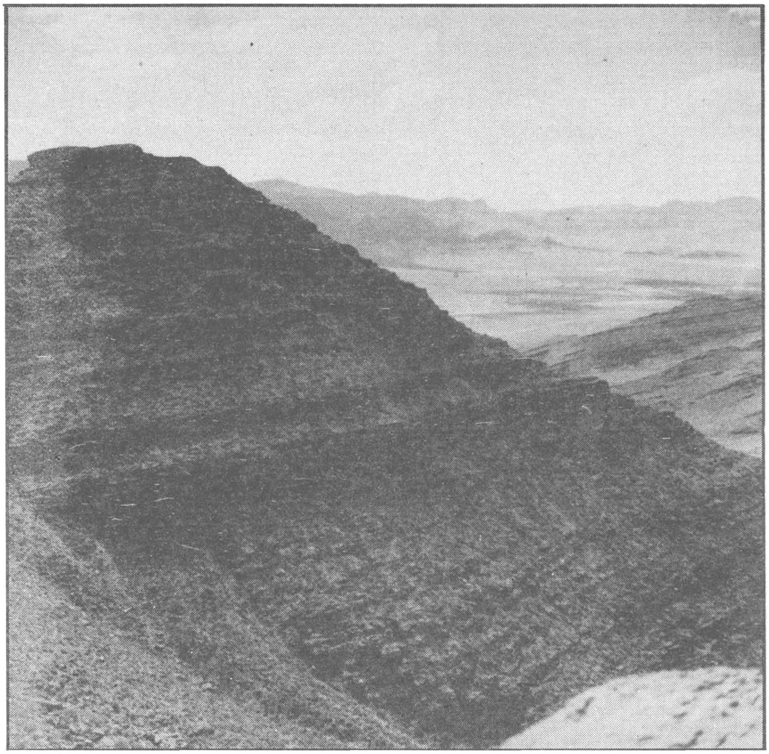
The following stratigraphic sections are arranged successively, the Ibex area northward. The figures in column I are the thicknesses (in feet) of the individual described units; those in column II are cumulative thicknesses from the base of the formation or exposure as the case may be. Measurements were made with Abney hand level or steel tape and Brunton compass as convenient. Descriptive color terminology is that of the National Reserach Council Rock Color Chart (1948), a copy of which was carried in the field. Detrital calcite rocks (calcitites) of sand texture (calcarenites), silt texture (calcisiltites), and clay texture (calcilutites) were distinguished in the field. Several samples of Pogonip limestones from Ibex were tested in the laboratory and found to be entirely lacking in magnesium. Dolomites were recognized in the field by their weathered brownish gray color and their failure to effervesce in dilute hydrochloric acid.

The following bedding thickness usage is employed: thick bedded, over 24 inches; medium bedded, 4 to 24 inches; thin bedded, 2 to 4 inches; very thin bedded, 1/2 to inches; shaly, under 1/2 inch thick. Estimates of the relative abundance of fossil forms was somewhat subjective but the three categories used were as follows: abundant (a) forms are those which comprise considerable parts of certain strata as noted in the field or in silicified samples upon leaching, the individuals being too numerous to count ordinarily; common (c) forms are those, several individuals of which have been noted in the field or in silicified residues; the rare (r) category is reserved for less than three individuals of a form in a sample.

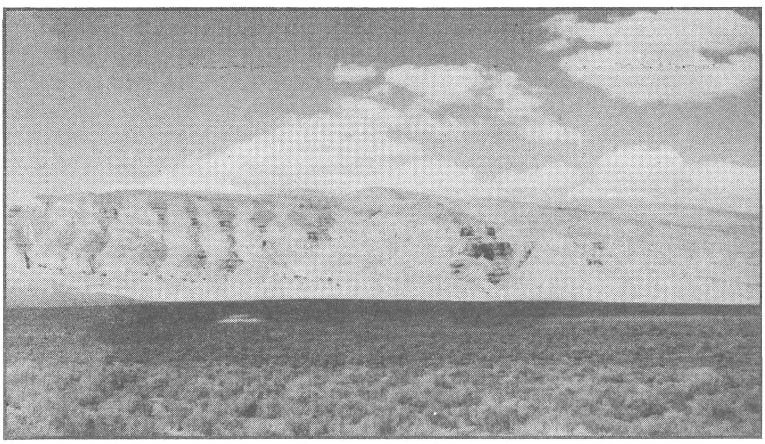
IBEX SECTION A: Located on north side of small butte near mouth of westward flowing wash, about 1/2 mile east of Tule Valley Grazing Service road, and approximately in Sec. 23, T. 20 S., R. 14 W. at south end of the House Range where Ordovician beds, dipping from Notch Peak, approach valley level. Beds dip 12°, S. 10° W.

Top of butte, end of section. To the east on the next hill about 200 feet of intraformational conglomerate (Fillmore ls.) overlie the House limestone, separated from Section A by a minor fault.

House Limestone:	I	II
Calcisiltite, medium gray, silty, thin bedded indistinct bedding planes, forms 8' ledge capping hilltop. Fossils abundant in re-entrant under ledge.	9'	475'
Calcisiltite, brownish gray, thin bedded, slope forming with slabby talus. (A-10) at 466'.	16	466
Calcilutite and calcisiltite, medium gray to brownish gray, mostly thin bedded, slope forming, but with occasional one or two foot ledges. Slope covered with platy talus with abundant fossils, (A-9) at 450'. Occasional small chert nodules in float slabs.	50	450
Calcisiltite, medium gray, thin bedded, chert nodules fairly common, slope forming with platy talus, (A-8) at 400'.	30	400
Calcilutite, light to medium gray, thin bedded, slope forming. (A-7) at 370'.	15	370
Calcisiltite and calcilutite, medium gray, thin bedded to massive, cliff and ledge forming, cherty, chert in thin bedding plane layers up to 1" thick and in larger irregular nodules up to 4" thick, mostly unfossiliferous. (A-6) at top of cliff forming ledges at 355'.	65	355
Calcitites, silty to fine sandy, thin bedded slope forming.	23	290
Calcilutite, medium gray, ledge forming, cherty in nodular lenses along bedding up to 1-1/2" thick.	10	267
Covered, cherty calcilutite float covers slope.	17	257
Calcitites, weathering brownish gray, thin bedded, quartz silty, occasional cross laminations up to 6", chert in thin bedding plane layers up to 2" thick, cliff and ledge forming. (A-5) at 238'.	75	240
Calcilutite, medium to light gray, thin to medium bedded, with occasional thin beds of intraformational conglomerate and calcisiltite, at 121' a one foot bed of intraformational conflomerate with pebbles up to 3" diameter. (A-4) at 160', (A-3) at 155', (A-2) at 123', (A-1) at 112'. At 100' moved eastward from creek bed to follow ledges.	65	165
Calcilutite, medium gray, medium to thin bedded, cherty.	25	100
Calcilutite, medium gray, medium bedded, cherty in bedding plane nodules.	10	75
Covered.	8	65
Calcilutite, medium gray, cherty, forms 2' ledge.	2	57



View westward toward Tule Valley at Ibex section A. Upper beds of House limestone are shown on hill in foreground.



View eastward from Tule Valley Grazing Service road toward Ibex measured section A at south end of House Range.

Fig. 5

Covered, cherty, calcilutite float.	15	55
Calcilutite, medium gray, medium bedded, cherty, chert in layers up to 2". Forms ledges 2-5' high.	40	40

Note: Base of measured section A is the top of massive calcilutite cliff above the cedar tree nearest to the Tule Valley road. A reconnaissance further up the wash down-section from these massive limestones did not reveal any fossil zones. However, 14 air miles to the south of section A in the Yersin Ridge about 1/2 mile southwest of the Lava Dam (Sec. 6, T. 23 S., R. 13 W.) an uppermost Cambrian silicified Euptychaspis, Stenopilus, and Eurekia trilobite fauna was found at an horizon in limestone at about the level of the top of Lava Dam. Several hundred feet of unfossiliferous Notch Peak limestone above the upper Cambrian fossils was lithologically dissimilar to the House limestone. The exact thickness of strata between this Upper Cambrian fossil horizon and the Lower Ordovician Symphysurina-Bellefontia zone was not determined but it seems to be at least several hundred feet.

IBEX SECTION A FAUNULES: (a), abundant; (c), common; (r), rare.

A-1 Symphysurina sp. indet. (r).

A-2 Symphysurina n. sp. a (c), Hystricurus n. sp. a (r), Pseudokainella ? sp. indet. (r).

A-3 Symphysurina sp. indet. (r).

A-4 Bellefontia sp. indet. (r).

A-5 Schizambon ? sp. (r).

A-6 Symphysurina cf. S. elegans Poulsen (c), Hystricurus genalatus Ross (a).

A-7 Symphysurina cf. S. elegans Poulsen (r), Hystricurus genalatus Ross (a), Xenostegium franklinense Ross (a), Pseudokainella ? sp. (r).

A-8 Hystricurus politus Ross (a), Bellefontia n. sp. a (a).

A-9 Hystricurus politus Ross (a), Bellefontia n. sp. a (c), Hystricurus genalatus Ross (a), Symphysurina c. sp. c (r).

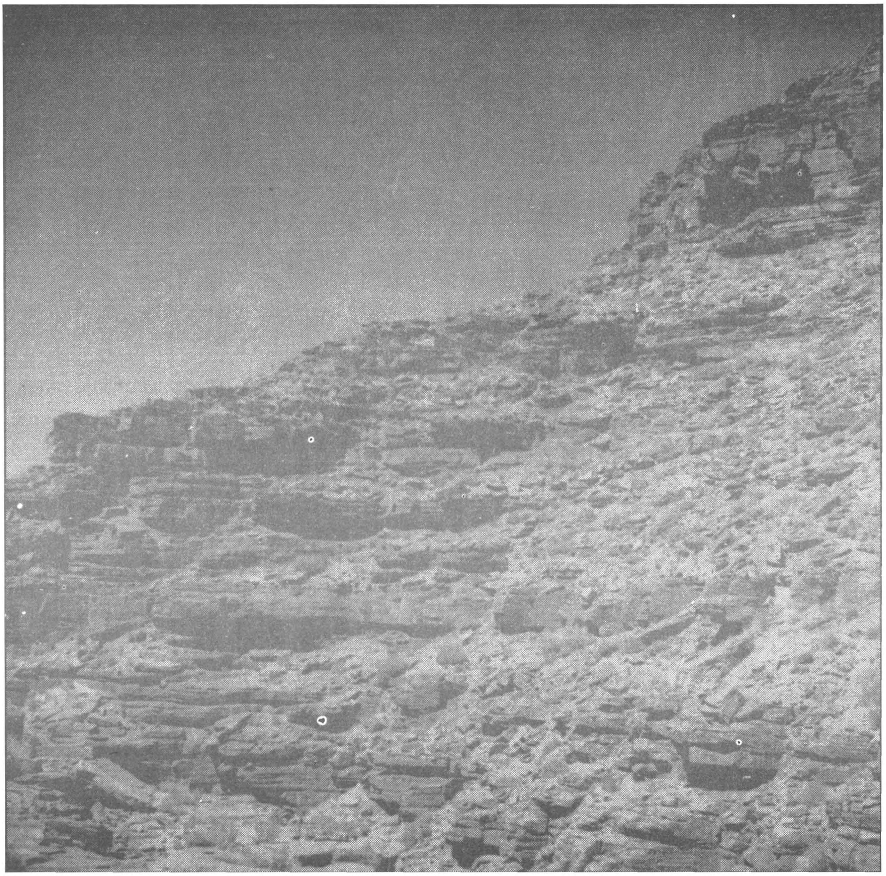
A-10 Paraplethopeltis n. sp. a (a), Paraplethopeltis n. sp. b (a), Hystricurus genalatus Ross (c), Syntrophina cf. S. campbelli Walcott (a).

IBEX SECTION B: Located 4.3 air miles south of Government Well No. 108 Pump house, which is on the Tule Valley - Black Rock Grazing Service road in Sec. 1, T. 22 S., R. 14 W. Also about 1-1/2 air miles north of Yersin Ridge Lava Dam; may be seen on Jack Ammann Co. aerial photo 44U-10, September 1949, in the upper central part of photo. Measured section B bottoms at the mouth of the largest of several small canyons on the west face of Yersin Ridge (See Fig. 2), and proceeds eastward up the canyon bottom, beginning about 1/2 mile east of the Grazing Service graded road. Beds dip 4°, N. 50° E.

Fillmore Limestone:

Undetermined thickness. Prominent marker bed at top of House Limestone was traced northward 0.5 miles to measured section C where the Fillmore Limestone was better exposed.

House Limestone:	I	II
Calcisiltite, medium dark gray, silty, very thick bedded, weathering to prominent ledge which is very persistent in the House Range-Ibex - Willden Hills area. Fossil beds immediately under the ledge further serve to identify the horizon. The top of this ledge marks the top of the House limestone as defined.	15'	343'
Siltstone, light gray, calcareous, very thin bedded, fossils very abundant in some of the thin beds, (B-14) at 328'.	3	328
Calcitites, calcilutites, fine grained calcarenites, and flat pebble conglomerates, interbedded, medium dark to medium light gray, weathering to light brownish gray step ledges. Trilobites common in float blocks, (B-13) at 318'.	65	325
Calcilutite, medium gray, thin bedded, chert nodules rare, weathers light medium gray, forms step ledges up to 4' high. (B-12) at 252' to 256'.	18	260
Calcitites, medium dark to medium light gray, calcilutites, calcisiltites, and fine grained calcarenites, very thin bedded to thin bedded, flat bedded, chert in bedding plane layers and nodules but less abundant than in beds below, beds weather to step ledges generally pale yellowish brown aspect. (B-8) at 188', (B-9) at 194', (B-10) at 204', (B-11) at 240'.	58	242
Calcilutite, medium gray, shaly in a few beds, thin bedded, black chert in stringers and small nodules comprises about 5% of rock; forms step ledges up to 5' high weathering light medium gray. (B-7) at 100'. This is a more resistant ledge forming horizon than the beds above or below.	24	184
Calcilutite, medium gray, quartz silty in some beds, very thin to thin bedded, flat bedded, black chert comprises about 5% of rock in bedding plane layers up to 1-1/2" thick and in irregular nodules cutting across bedding. Weathers to light medium gray steep slope forming step ledges.	63	160



Uppermost beds of House limestone at Ibex section B. The *Paraplethopeltis* - *Syntrophina* horizon is at the base of the ten to fifteen foot ledge shown in the upper right corner of this picture.

Fig. 6

Silicified trilobites abundant in some layers but rare in most of rock. (B-3) at 110', (B-4) at 140', (B-5) at 145', (B-6) at 160'.		
Calcitite, medium gray, quartz silty and cherty, gray to black chert comprising about one-third of rock in irregular bedding masses, and etching into relief. This is the lowest prominent brown weathering ledge which is obvious from the valley road.	17	97
Calcilutite, medium gray, thin bedded, quartz silty, a small amount of bedding plane chert up to 1" thick, a few thin intraformational conglomerate beds.	5	80
Siltstone, light brownish gray weathering moderate brown, cherty, ledge forming.	3	75
Calcilutite, medium gray, very thin bedded, silty, some small cross-laminated layers, slope forming except on gully walls.	25	72
Calcisiltite, light brownish gray, fine quartz sandy, ledge forming, fossils uncommon, poorly preserved.	8	47
Calcilutite, medium gray, very thin bedded, weathers light medium gray, slope forming.	4	39
Siltstone, light brownish gray, very thin bedded, flat to uneven bedding planes, calcareous, occasional black chert nodules, slope forming weathers yellowish orange.	4	35
Calcitites, medium gray, calcilutites, calcisiltites, with a few intraformational conglomerates, fine quartz sandy to silty, gnarly to flat bedded, silicified trilobites fairly common, slope forming, weathers light medium gray. (B-2) at 29', (B-1) at 7'.	31	31

Base covered by valley alluvium. For lowest beds of House limestone see Ibex Section A.

IBEX SECTION B FAUNULES: (a), abundant; (c), common; (r), rare.

B-1 Apeoorthis cf. A. melita (Hall and Whitfield) (c), Lingulella cf. L. pogonipensis Walcott (c), Ophileta sp. indet. (c), Hystricurus n. sp. a (c), Symphysurina n. sp. a (a), Symphysurina cf. S. elegans Poulsen (a).

B-2 Symphysurina sp. indet. (r).

B-3 Symphysurina n. sp. b (c).

B-4 no ident. fossil remains.

B-5 Bellefontia sp. indet. (r), Hystricurus sp. indet. (c).

B-6 Symphysurina cf. S. spicata Walcott (a), Clelandia utahensis Ross (c), Hystricurus sp. indet. (r), Pseudokainella ? sp. (r), Lingulella cf. L. pogonipensis Walcott (r).

B-7 *Symphysurina* cf. *S. spicata* Walcott (c), *Hystricurus* sp. indet. (c), *Clelandia utahensis* Ross (c).

B-8 *Xenostegium* sp. indet. (r), *Symphysurina* sp. indet. (r), *Hystricurus genalatus* Ross (c).

B-9 no indentifiable fossils

B-10 *Hystricurus genalatus* Ross (c), *Symphysurina* sp. indet. (r).

B-11 Worm borings?

B-12 *Clelandia utahensis* Ross (c), *Hystricurus genalatus* Ross (a), *Xenostegium franklinense* Ross (a), *Bellefontia* cf. *B. chamberlaini* Clark (a), *Bellefontia*-like n. gen. (c).

B-13 *Bellefontia* cf. *B. chamberlaini* Clark (c), *Xenostegium* sp. indet. (r), *Hystricurus genalatus* Ross (c), *Pseudokainella* ? sp.

B-14 *Paraplethopeltis* n. sp. a (a), *Paraplethopeltis* n. sp. b (a), *Syntrophina* cf. *S. campbelli* Walcott (a).

IBEX SECTION C: 3.8 air miles south-southeast of Government Well No. 108 which is located in Sec. 1, T. 22 S., R. 14 W. Measured section C is on west face of Yersin Ridge (See Fig. 2) about 1/2 mile east of Grazing Service graded road and about 1/2 mile north of measured section B. The base of section C is the same horizon as the top of section B. Beds dip 4^{o}, N. 50^{o} E.

Fillmore Limestone:

Top of hill, top of section. For beds above see Section D.

	I	II
Siltstone and intraformational conglomerate alternating, siltstone light gray, calcareous, fossiliferous, the intraformational conglomerate medium dark gray, quartz silty. Slope forming, thin bedded, outcrop mainly float covered with few step ledges of intraformational conglomerate. (C-13) at 595', (C-12) at 472', (C-11) at 434', (C-10) at 430'.	93'	603'
Intraformational conglomerate, coarse, medium gray, fine quartz sandy, thin bedded, quartz sandy pebbles up to 6" in medium grained calcarenitic matrix. Unfossiliferous for the most part, slope forming, prominent from a distance for its brownish weathered color. (C-9) at 510', (C-8) at 430', (C-7) at 400'.	116	510
Calcilutite, light medium gray, massive, forms prominent marker ledge at base of brownish weathering beds above. (C-6) at 390'.	9	394
Covered, calcarenite and intraformational conglomerate float, (C-4) at 366', (C-5) at 380'.	25	385

Intraformational conglomerate, medium gray, with inter-bedded silty limestone, thin bedded, slope forming. (C-3F) at 330'.	50	360
Calcilutite, medium gray, thick bedded, forms ledge.	7	310
Siltstone, shaly, reentrant under ledge.	3	303
Interbedded intraformational conglomerate, medium light gray, and calcareous shaly siltstone, thin bedded, low step ledges, fossils rare, (C-2) at 286'.	20	300
Covered, intraformational conglomerate float, probably interbedded with shaly siltstone in thin beds.	65	280
Intraformational conglomerate, medium to light gray, thin bedded, slope forming, subrounded silty pebbles up to 3" but of various sizes in calcarenite to calcilutite matrix.	19	215
Calcilutite, medium gray, thick bedded, ledge forming.	5	196
Siltstone, light gray, calcareous, thin bedded, reentrant.	5	191
Intraformational conglomerate, medium gray, massive, ledge.	3	186
Covered.	5	183
Calcilutite, medium gray, thick bedded, forms ledge.	10	178
Siltstone, medium light gray, shaly, reentrant.	4	168
Intraformational conglomerate, medium light gray, quartz silty pebbles up to 2" but average 1" in calcisiltite matrix, very thin bedded, rubbly slope forming.	54	164
Covered, intraformational conglomerate float.	12	110
Intraformational conglomerate, medium gray, silty limestone pebbles up to 2" in calcarenite matrix.	3	98
Covered, thin bedded limestone float.	22	95
Calcilutite, medium gray, thick bedded, ledge forming, few chert nodules.	3	73
Interbedded fine grained light medium gray calcarenite, and intraformational conglomerate with silty pebbles up to 2" in limestone matrix. Thin bedded, slope forming, unfossiliferous.	35	70
Limestones, light medium gray fine grained calcarenite, weathers dark medium gray, thick bedded, ledge.	6	35
Covered.	4	29
Calcilutite, medium dark gray, silty, thick bedded, forms brownish gray weathering ledge.	4	25
Calcisiltite, medium light gray, silty, thin bedded, reentrant (C-1) at 19'.	4	21
Calcilutite, medium dark gray, ledge.	2	17
Limestones, medium dark gray, thin bedded, mostly calcilutite with few interbedded calcarenite and intraformational conglomerate beds, weathers to brownish gray slope.	15	15

House Limestone: See measured section B.

IBEX SECTION C FAUNULES: (c), common; (a), abundant; (r), rare.

C-1 Acrotreta sp. (a).

C-2 Endoceras sp. (r), Syntrophina-like brachiopod (r).

C-3F Hystricurus sp. (r).

C-4 Tesselecauda cf. T. depressa Ross (r), Hystricurus sp. C Ross (c), Leiostegium n. sp a (c), Hyperbolochilus sp. (r), Syntrophina ? sp. (c).

C-5 Tesselecauda cf. T. depressa Ross (r), Hystricurus sp. C Ross (c) Pseudoclelandia cf. P. lenisora Ross (c), Hystricurus cf. H. oculilunatus Ross (r), Hyperbolochilus sp. (a).

C-6 Tesselecauda cf. T. depressa Ross (c), Leiostegium n. sp. a (c), Hyperbolochilus sp. (c), Pilekia ? sp. Ross 1951 pl. 35 (r), two undet. pygidia, Syntrophina ? sp. (c).

C-7 Syntrophina - like brachiopod

C-8 Parahystricurus sp. (c).

C-9 Megalaspidiella n. sp. a (a), Endoceras sp. indet. (r).

C-10 Megalaspidiella n. sp a (a).

C-11 Megalaspidiella n. sp a (a), Menoparia genalunata Ross (c), Psalikilus n. sp a (r), Dictyonema sp. (r).

C-12 Megalaspidiella n. sp a (a), Menoparia genalunata Ross (c).

C-13 Megalaspidiella n. sp a (a), Menoparia genalunata Ross (r), Protopliomerops n. sp. a (c), Psalikilus sp. (c), Parahystricurus sp. (r), Hormotoma-like gastropod impression (r).

IBEX SECTION D: Located about 1/2 mile northward from section C, section D is an upward continuation of measured section C. Marker horizon, section C 385' - 394' traced for datum, provides 210' of overlap between sections. Footage in column II for section D is cumulative from base of Fillmore limestone from section C.

Fillmore Limestone:	I	II
Top of section, top of hill where stands a 6' rock cairn.		
Intraformational conglomerate, dark gray, coarse, with some fine quartz sandy beds, pebbles, subrounded, up to 6" long but average about 1", in a quartz fine sandy matrix, some siliceous beds up to 6" thick. Forms step ledges capping top of hill. (D-13) at 969', (D-12) at 924'.	60'	969'
Calcisiltite, medium gray, shaly to silty, very thin bedded, interbedded with intraformational conglomerate beds up to 2" thick.	100	909

Shaly calcisiltite beds up to 6' thick, forming cliffs and step ledges near top of hill, weathering light yellowish gray. Occasional beds of pinkish gray fine quartz sandstone, calcareous, up to 1' thick. (D-11) at 829'.		
Intraformational conglomerate, medium gray, silty calcisiltite pebbles in fine to coarse grained calcarenite matrix. Interbeds of silty to shaly calcisiltite. (D-10) at 749'. Abundant silicified trilobites.	61	809
Calcisiltite and intraformational conglomerate ledge. Above here the intraformational conglomerate beds predominate projecting as step ledges while the calcisiltite is less resistant forming reentrants.	9	748
Calcisiltite, medium dark gray, silty to shaly, very thin bedded, weathers yellowish gray, interbeds of intraformational conglomerate 4" to 6" thick and spaced from 2' to 6' apart forming step ledges beneath which the weaker calcisiltite crops out. Trilobites common in the calcisiltite, (D-9) at 734', (D-8) at 719', (D-7) at 694', (D-6) at 684, (D-5) at 634', (D-4) at 604'.	135	739
Siltstone and intraformational conglomerate, conglomerate medium gray, coarse, quartz silty pebbles. Siltstone light brownish gray with silicified trilobites. Some calcisiltite float shows mud cracks and current ripple marks with crests 2" apart. (D-2) at 580', (D-3) at 594'.	95	604
Intraformational conglomerate, coarse, medium gray, weathering brownish gray, slope forming. Measurement began at top of light medium gray calcilutite ledge 385' to 394' of measured section C, and footage is cumulative from the base of the Fillmore limestone from section C. (D-1) at 394'.	115	509
	0	394

IBEX SECTION D FAUNULES: (a), abundant, (c), common; (r), rare.

D-1 Leiostegium n. sp. a (c).

D-2 Protopliomerops n. sp. a (c), Megalaspidiella n. sp. a (c).

D-3 Protopliomerops n. sp. b (a), Megalaspidiella n. sp. a (a), Menoparia genalunata Ross (c), Psalikilus n. sp. a (c), undet. pygidia (r).

D-4 Protopliomerops n. sp. b (c), Megalaspidiella n. sp. a (a).

D-5 Megalaspidiella n. sp. a (c).

D-6 Megalaspidiella n. sp. b (a), Protopliomerops contracta Ross (r).

D-7 Megalaspidiella n. sp. b (a), Protopliomerops cf. P. celsaora Ross (c), unassigned pygidia.

D-8 Megalaspidiella n. sp. b (a), Protopliomerops contracta n. var. (r).

D-9 Megalaspidiella n. sp. b (a), Protopliomerops contracta Ross (c), Psalikilus sp. indet. (r), unassigned pygidia, Syntrophina ? sp. (r), Endoceras ? sp. (r).

D-10 Megalaspidiella n. sp. b (a), Protopliomerops contracta Ross (c), Psalikilus typicum Ross (r), Menoparia genalunata Ross (r).

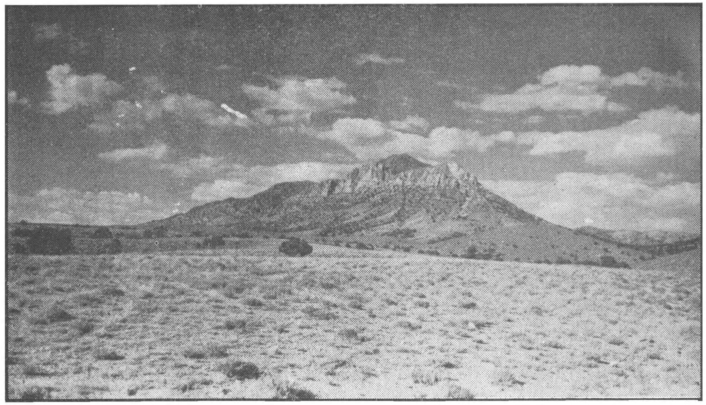
D-11 Protopliomerops contracta Ross (c), Protopliomerops ? sp. A (r), Carolinites sp. A Hintze (r), unassigned pygidium, Nanorthis ? sp. (a).

D-12 Protopliomerops contracta Ross (r), Kirkella n. sp. f. (r) Licnocephala bicornuta ? Ross (r), Nileus-like sp. (r).

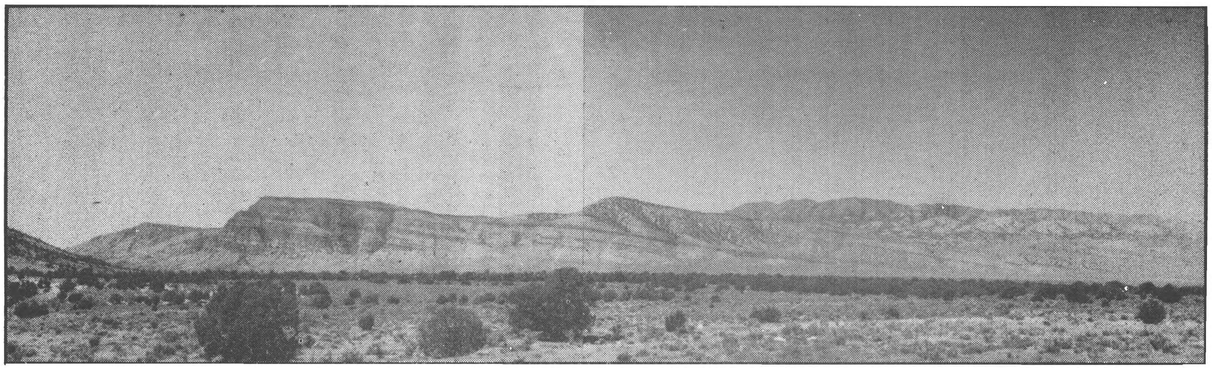
D-13 Megalaspidiella sp. cf. "Xenostegium" taurus Walcott (c), Protopliomerops sp. (c), Nileus-like sp. (r).

IBEX SECTION E (Willden Hills): In Sections 20, 21, 28, and 29, T. 23 S., R. 16 W., and about three miles westward from Crystal Peak is a low range here called the Willden Hills. (See fig. 2) The east side of the Willden Hills is a gently dipping homocline of lower Ordovician strata, the oldest rock being exposed to the south. The section was measured upward beginning at the bedrock outcrops at the top of the alluvial fan of the largest wash about one and one-half miles south of where the Garrison - Black Rock road crosses the northern end of the Willden Hills, and the traverse offset northward on various of the continuous ledges in order to measure the successively younger beds. The beds dip 9° N. 50° W.

	I	II
Fillmore Limestone: The entire thickness of this formation is not exposed in the Willden Hills, but about 800 feet more than is described below is represented in the extreme north end of the hills.		
Intraformational conglomerate and calcisiltite interbedded, thin bedded, slope forming, top of hill.	45'	314'
Intraformational conglomerate and calcisiltite, thin bedded, but forming a fairly continuour ledge about 5' high at top. Cairn at 269'.	15	269
Limestones and intraformational conglomerate interbedded, thin bedded, slope forming.	35	254
Covered, intraformational conglomerate float.	20	219
Interbedded intraformational conglomerate and calcisiltite in about equal amounts, thick bedded, forms the most prominent ledges found above those at base of	32	199



View northeastward toward Tunnel Spring Mountain at Desert Range Experiment Station, Utah. Ordovician quartzites forming the cliffs have been shattered by faulting along the crest of the Tunnel Spring Hills.



View southwestward toward homoclinal Willden Hills from a point near Crystal Peak. Top of massive Notch Peak limestone exposed at base of higher ridge on left side of photo.

Fig. 7

Fillmore limestone, ledges here are about 3' high alternating with slopes of 6'.		
Intraformational conglomerate and silty calcilutite with some cherty beds, thick bedded, ledge forming. (E-17) at 167'.	6	167
Covered, intraformational conglomerate slabby talus, underlying rock probably thin bedded calcisiltite and intraformational conglomerate.	65	161
Intraformational conglomerate ledge.	2	96
Covered.	3	94
Intraformational conglomerate ledge.	2	91
Covered, intraformational conglomerate talus.	17	89
Intraformational conglomerate, medium gray, siliceous, ledge forming.	3	72
Covered, intraformational conglomerate float, with occasional low ledges of same cropping out.	47	69
Calcisiltite, medium dark gray, silty, some chert nodules, forms massive ledge, conspicuous marker horizon. (E-16) at 9'.	22	22
House Limestone:		
Calcisiltite, medium dark gray, silty cherty, forms a ledge separated from that above by a reentrant.	6	421
Siltstone, light medium gray, fossiliferous marker horizon. (E-15) at 415'.	2	415
Calcisiltite, brownsih gray, cherty ledge forming. (E-14) at 413'.	3	413
Calcilutite, medium gray, thick bedded, some bedded nodular chert, (D-11) at 395', (D-10) at 370'.	45	410
Calcisiltite, medium light gray, thin bedded, occasional chert nodules, forms step ledges, *Hystricurus* sp. abundant on the dip slope exposure at the top. This is the top of the north wall of the gully up which the traverse started. (E-9) at 365', (E-8) at 355', (E-7) at 315'.	65	365
Calcilutite, medium gray, replacement chert masses in irregular cross cutting masses and along bedding, in places comprising 30% of rock, thick bedded forming ledges. (E-6) at 290', (E-5) at 285', (E-4) at 260'.	65	300
Calcisiltite, medium light gray, cherty, thin bedded.	20	235
Siltstone, light medium gray, calcareous, replacement chert and siliceous masses comprising 30% to 50% of rock. Forms a prominent series of three ledges at 175-185, at 195-200 and at 210-215, (E-3) at 200'.	50	215

Calcisiltite, medium dark gray to medium light gray, silty, very thin to thin bedded, forming platy talus. (E-2) at 155', (E-1) at 120'.	70	165
Calcisiltite, medium dark gray, little chert, thick bedded, ledgy, unfossiliferous.	25	95
Calcisiltite, medium dark gray, bedded chert comprising 25% to 50% of rock, very thick bedded cliff forming.	70	70
Cambrian ? Limestone:		
Calcisiltite, medium gray, very thick bedded, cliff forming, unfossiliferous. Cairn erected at start of section in mouth of gully.	95	95

IBEX SECTION E (Willden Hills) FAUNULES: (A), abundant; (c), common; (r), rare.

E-1 Symphysurina sp. indet. (c), Hystricurus genalatus Ross (r).

E-2 Pseudokainella ? sp. (r).

E-3 Symphysurina n. sp. a (c), Clelandia utahensis Ross (c), Xenostegium cf. X. franklinense Ross (c).

E-3A Symphysurina n. sp. b (c), Bellefontia cf. B. chamberlaini Clark (c).

E-4 Bellefontia sp. indet. (c), Hystricurus genalatus Ross (a).

E-5 Hystricurus politus Ross (c).

E-6 Hystricurus genalatus Ross (a), Clelandia utahensis (r), Bellefontia sp. indet. (r).

E-7 Hystricurus genalatus Ross (a), Hystricurus politus Ross (a), Clelandia utahensis Ross (c), Symphysurina n. sp a. (r), Xenostegium franklinense Ross (c), Bellefontia sp. cf. B. chamberlaini Clark (a), Pseudokainella ? sp. A (r).

E-8 Hystricurus politus Ross (a), Remopleuridiella caudalimbata Ross (r), Xenostegium sp. indet. (r).

E-9 Hystricurus politus Ross (a), Hystricurus genalatus Ross (c), Bellefontia n. sp. a (r).

E-10 Hystricurus politus Ross (a), Hystricurus genalatus Ross (a) Hystricurus paragenalatus Ross (r), Bellefontia n. sp. a (c), Xenostegium sp. indet. (r), Remopleuridiella caudalimbata Ross (c).

E-11 Hystricurus politus Ross (a), Hystricurus genalatus Ross (c), Hystricurus paragenalatus Ross (r), Bellefontia n. sp. a (c), Remopleuridiella caudalimbata Ross (c).

E-12 Hystricurus politus Ross (c), Hystricurus genalatus Ross (c), Remopleuridiella caudalimbata Ross (r), Xenostegium sp. indet. (r), Bellefontia sp. indet. (r).

E-13 Symphysurina n. sp. c (c), Hystricurus ? n. sp. b (a), Hystricurus cf. H. genalatus Ross (c), Bellefontia cf. B. chamberlaini Clark (r), Pseudokainella ? n. sp. a (r).

E-14 Paraplethopeltis n. sp. a (a), Paraplethopeltis n. sp. b (c), Syntrophina ? cf. S. campbelli Walcott (a).

E-15 Same fauna as E-14.

E-16 Acrotreta sp. (a), Schizambon sp. (r).

E-17 Hystricurus robustus Ross (c), Amblycranium variabile Ross (r), Pilekia ? sp. Ross, 1951, plate 35 (r).

IBEX SECTION G: Located in NW-1/4, Sec. 8, T. 23 S., R 14 W., these are the oldest rocks on the west side of Wahwah Valley north of Crystal Peak, and they crop out in a low hill about 1/2 mile southeast of a very prominent lava capped butte. Measured section G runs from the lowest outcrops northwestward toward the lava capped butte. Beds dip 5° westward.

Fillmore Limestone: The Fillmore limestone comprises all beds between the uppermost House limestone as defined in measured section B and the ledge in measured section H which defines the bottom of the Wahwah limestone. Within the Fillmore limestone, ledge 762' - 766' in section G is correlated with ledge 162' - 166.6' of section H 0.7 miles to the north. The 1329' of Fillmore limestone here exposed represents all but the lower 212' of the formation which are exposed only on the east side of Wahwah Valley in sections B and C. The correlation between sections on the east and west side of Wahwah Valley, six miles apart, is based mainly on the distinctive fauna which is found in section G at 537' (G-13), and in section D at 749' (D-10). The lithologies and faunas above and below this reference are compatible with this correlation. Unfortunately then, there is no unbroken sequence of Fillmore limestone known to the author in the Ibex area, although section G-H represents most of the formation and is considered the type section of the Fillmore limestone for all but the lower beds not exposed here. It is possible that this thick formation should be further subdivided, but at present it does not appear useful to do so.

Fillmore Limestone:	I	II
Top of hill.		
Intraformational conglomerate, medium gray, thin bedded, with interbeds of siliceous fine sandy calcarenite, medium gray, weathering light gray with small solution cavities. Hill capped by 8" intraformational conglomerate bed. (G-21) at 858'.	28'	864'
Calcilutite, ledge forming, 2" bed of bluish chert in middle of ledge.	3	836
Intraformational conglomerate and sandy calcarenite interbedded, thin bedded, slope forming.	19	833
Calcilutite, medium gray, thick bedded, forms prominent ledge near top of hill.	4	814

Intraformational conglomerate, medium gray interbedded with about 20% calcisiltite beds and 20% fine quartz sandy calcarenite. (G-20) at 790'.	21.8	810
Intraformational conglomerate, medium gray, ledge.	1.2	788.2
Interbedded thin bedded intraformational conglomerate and calcisiltite.	7	787
Calcarenite, light brownish gray, quartz sandy, ripple marked, thin bedded, weathers yellowish orange.	2	780
Intraformational conglomerate and calcisiltite interbedded, the platy quartz sandy thin bedded calcisiltite forming step ledges.	12	778
Calcilutite, medium gray, massive, ledge forming.	4	766
Interbedded intraformational conglomerate, calcisiltite, and fine quartz sandy calcarenite, thin bedded, slope forming, slabby talus. (G-19) at 758' undetermined silicified trilobite fragments.	19	762
Calcilutite, medium gray, massive, ledge forming.	2	743
Calcisiltite, light gray, reentrant.	3	741
Intraformational conglomerate, ledge.	2	738
Interbedded intraformational conglomerate, and calcisiltite, (G-18) at 735' trilobite silicified hash.	20.5	736
Intraformational conglomerate, gray, ledge forming.	4.5	715.5
Interbedded intraformational conglomerate and calcisiltite, thin bedded, slope forming.	11	710
Intraformational conglomerate, gray, ledge forming.	4	699
Interbedded intraformational conglomerate and calcisiltite, medium gray, thin bedded, step ledge forming individual ledges mostly under 1' but few up to 3'. (G-17) at 690' and (G-16) at 675'.	69.1	695
Intraformational conglomerate, gray, ledge. (G-15) at 625'.	2.9	625.9
Calcisiltite, medium gray weathering light yellowish gray, thin bedded, reentrant forming.	7	623
Calcilutite, medium gray, gnarly, ledge forming.	3.5	616
Calcisiltite, medium gray, thin bedded, nobby.	9.5	612.5
Calcilutite, medium dark gray, weathers medium light gray, gnarly, forms prominent continuous ledge.	7	603
Interbedded intraformational conglomerate and calcisiltite, thin bedded, slope forming.	8.3	596

Intraformational conglomerate, ledge.	2.7	587.7
Calcisiltite, medium light gray, thin bedded, slabby, with about 10% thin bedded calcarenite. (G-14) at 585'.	7	585
Calcisiltite, massive, quartz silty, ledge capping.	3	578
Intraformational conglomerate, forms lower part of ledge.	4	575
Calcisiltite, medium gray weathering light yellowish gray, thin bedded, with intraformational conglomerate interbeds from 2" to 10" thick comprising 20% of rock.	30.5	571
Calcisiltite, medium gray, thin bedded, reentrant forming, weathers light yellowish gray, very fossiliferous, float from this horizon easily recognized further down the slope, as it falls over the prominent ledge just below this outcrop. (G-13) at 537'.	4.5	540.5
Calcisiltite, medium gray, thick bedded, forms lowest most prominent and continuous ledge, calcarenite in bottom 1' of ledge. (G-12) at 529' abundant silicified trilobite fragments.	8	536
Calcisiltite, medium gray weathering, silty, shaly, very thin bedded, reentrant forming, with interbeds of thin bedded intraformational conglomerate comprising about one-third of the rock forming low step ledges.	38	528
Calcisiltite, medium gray, weathering, silty, very thin bedded, with interbeds of thin bedded intraformational conglomerate comprising about one-fifth of rock. (G-11) at 490' and (G-10A) at 462'.	16.2	490
Intraformational conglomerate, medium gray, thin bedded, forms slope at the base of the ledge forming outcrops which begin at 473.8'. (G-10F) at 453'.	32.6	473.8
Intraformational conglomerate, medium gray, thin bedded, subrounded pebbles up to 2" in quartz sandy coarse calcarenite matrix, unfossiliferous. Forms base of highest hill. (G-9) at 407'.	114.2	441.2
Intraformational conglomerate, medium gray, fine quartz sandy, thin bedded, with 25% interbeds of quartz silty calcisiltite.	20.5	327
Intraformational conglomerate, ledge. (G-8).	0.5	306.5
Covered.	4.8	306
Intraformational conglomerate ledge.	0.5	301.2
Covered.	69.3	300.2
Interbedded intraformational conglomerate, medium dark gray weathering brownish gray, and calcisiltite, medium gray	102.0	231.4

weathering medium gray, silty. These beds thin bedded, slope forming back slope of first hill. Beds dip 16°. (G-7) at 194', (G-6) at 183', (G-5) at 140'.		
Intraformational conglomerate, medium gray, thin bedded, fine quartz sandy calcareous pebbles up to 2" in calcarenite and calcisiltite matrix. Interbeds of calcisiltite and calcarenite occasionally, rocks quite siliceous but chert rare. (G-4) at 125', (G-3) at 90'. Cairn erected at 129.4' which is on top of first hill.	35	129.4
Covered.	27.6	94.4
Intraformational conglomerate ledge. (G-2)	1.3	66.8
Covered, intraformational conglomerate float, occasional thin bed of same crops out.	25.7	65.5
Intraformational conglomerate, medium gray, thin bedded, subrounded silty calcisiltite pebbles in calcarenite matrix.	3.8	39.8
Covered, intraformational conglomerate float.	9	36
Intraformational conglomerate ledge.	0.4	27
Covered, intraformational conglomerate float.	10.4	26.6
Intraformational conglomerate ledge. (G-1) No chert.	0.7	16.2
Covered, intraformational conglomerate float.	15	15.5
Intraformational conglomerate, medium gray, fine quartz sandy, about 10% black chert, ledge.	0.5	0.5

IBEX SECTION G FAUNULES: (a), abundant; (c), common; (r), rare.

G-0 *Amblycranium* ? sp. (r).

G-1 *Amblycranium* sp. (c), unassigned pygidium (r).

G-2 *Hyperbolochilus* sp. (c), *Hystricurus* sp. indet. (r).

G-3 *Tesselecauda* sp. (r), *Pseudohystricurus* sp. (r), *Hystricurus* sp. C. Ross (c), undet. pygidium (r).

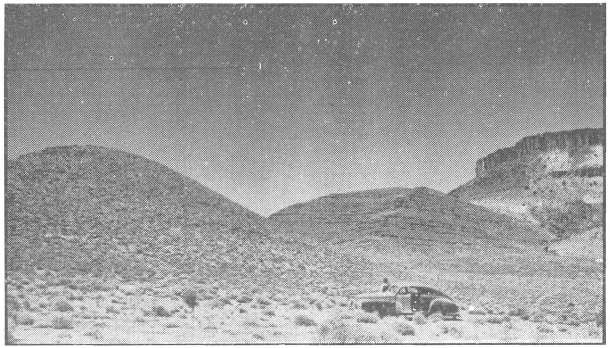
G-4 Nothing identifiable

G-5 *Goniophrys prima* Ross (r), *Hyperbolochilus* cf. *H. marginauctum* Ross (c), *Hystricurus oculilunatus* Ross (c), *Hystricurus contractus* Ross (r), *Parahystricurus fraudator* Ross (r), *Parahystricurus* n. sp. a (r), *Protopliomerops* cf. *P. superciliosa* Ross (r), undet. pygidium (r), *Licnocephala* sp. (r).

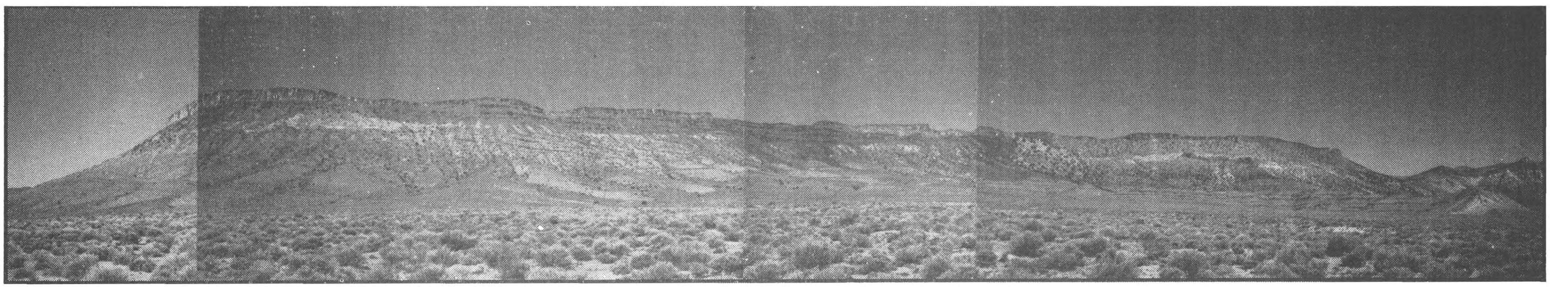
G-6 *Megalaspidiella* n. sp. a (c).

G-7 *Megalaspidiella* sp. cf. Ross undet. O (a).

G-8 *Megalaspidiella* n. sp. a (a), *Protopliomerops celsaora* Ross (c), *Menoparia genalunata* Ross (c), *Psalikilus* n. sp. a (a), *Jeffersonia* sp. (r), *Nileus*-like sp. A (r), *Hormotoma*-like gastropod impressions (r), undet. pygidium (r).



View westward toward Fillmore limestone beds at Ibex section G in the Heckethorn Hills. Lava capped butte at right is same as on left side in picture below. Note that beds near the middle of the Fillmore limestone, as exposed in center of picture, are somewhat more ledgy than those beneath.



Panorama of Heckethorn Hills from south to west showing Ibex sections H and J. Ibex limestone ledges can be traced from one section to the other. Tertiary lavas cap the beveled Ordovician strata.

Fig. 8

G-9 Protopliomerops celsaora Ross (c), Nileus-like ? sp. A (c), undet. pygidium (r).

G-10A Protopliomerops contracta Ross (c), Megalaspidiella sp. indet. (r), Psalikilus n. sp. a. (c).

G-10F Protopliomerops sp. indet. (c), Psalikilus sp. (r), Rananasus sp. (r).

G-11 Megalaspidiella sp. indet.

G-12 Psalikilus typicum Ross (c), Jeffersonia ? sp. A Hintze (a), Niobe? sp. (c), undet. sp. S (c), undet. pygidium (r), Endoceras ? sp. (r), Dictyonema sp.. (r), Didymograptus ? sp. (r).

G-13 Psalikilus typicum Ross (r), Protopliomerops cf. P contracta Ross (r), Menoparia genalunata Ross (c), Megalaspidiella n. (a), undet. sp. T. (r).

G-14 Psalikilus typicum Ross (c), undet. sp. (c), undet. sp. S (c), Protopliomerops n. sp. c (c), Protopliomerops sp. indet. (5 pairs of pygidial spines) (r), undet. pliomerid pygidium with 3 pairs of spines (r), two other undet. pygidia (r), Nanorthis ? sp. (a).

G-15 Nanorthis ? sp. (r), undet. sp. S (r).

G-16 Nothing identifiable.

G-17 Protopliomerops contracta Ross (a), Psalikilus n. sp. a (c), Psalikilus ? sp. (r), Megalaspidiella n. sp. b (c), Nileus-like n. sp a (r), Kirkella n. sp. f (c), Niobe? n. sp a (a).

G-18 Niobe ? n. sp. a (a), Protopliomerops contracta Ross (c).

G-19 Protopliomerops contracta Ross (c), Niobe ? n. sp. a (a), Kirkella n. sp. f (c), Menoparia genalunata Ross (c) Nileus-like n. sp. a (r).

G-20 Protopliomerops sp. indet. (c).

G-21 Psalikilus sp. indet. (c).

IBEX SECTION H: Base of section H located 0.7 miles north of section G and on the east slope of lava capped butte approximately at 1/4 Cor., Sec. 5, Sec. 6, T. 23 S., R. 14 W. Beds cannot be walked out between sections G and H because a space of about 200 feet is covered by lava talus from the butte above. Section H begins in a gully at the base of the east slope of lava capped butte and 30' below a huge quartzite boulder prominent on the slope. At this point there is a large pink volcanic rock with a large chair-like cavity about 10' in diameter and facing southeastward. Measured section H, follows the outcrop, offsetting northwestward along the strike on certain prominent ledges for about a mile. By this means an almost continuour exposure of about 1000 feet of stratigraphic section can be measured, this being the thickest single exposure of lower Ordovician limestones in the Ibex area. Section H is the type section of the upper part of the Fillmore limestone and the Wahwah limestone. At the base of the section the beds dip 13°, N. 85° W., but throughout most of the section the beds dip about 6° due West.

Juab Limestone: For description of this formation see measured section J.

	I	II
Wahwah Limestone:		
Calcisiltite, medium gray weathering medium dark gray, alternately thin and thick bedded, step ledge and slope forming.	16.1'	227.0'
Calcisiltite, medium gray, siliceous, unfossiliferous, forming fourth prominent ledge.	8.0	210.9
Calcisiltite, medium gray, thin bedded, weathers to step ledges and slopes.	13.1	202.9
Brachiopod shell rock, a matte of valves of <u>Hesperonomiella</u> <u>minor</u> with several gastropods species in limited numbers, <u>Loxoplocus</u> sp. etc.	1.0	189.9
Calcisiltite, medium gray, thin bedded, shaly, step ledge and slope forming.	43.0	188.9
Calcisiltite, medium gray, silty, platy, forming third ledge.	5.	145.9
Calcisiltite, medium gray, thin bedded, shaly, with some thin beds of calcarenite and intraformational conglomerate, forms series of low step ledges and slopes.	47.5	140.9
Calcisiltite, medium gray, siliceous, forms second prominent ledge.	5.4	93.4
Calcisiltite, medium gray, thin bedded, quartz silty, weathers light yellowish gray, slope forming. (H-33) at 41'.	56.0	88.0
Calcisiltite ledge.	1.6	32.0
Calcisiltite, medium gray, slabby, silty, reentrant forming.	5.4	30.4
Calcisiltite, medium gray, siliceous, thick bedded, gnarly, forms the lowest conspicuous ledge of a group of five promient ledges on this hillside. (H-32) at 15'.	12.0	25.0
Calcisiltite, medium gray weathering light yellowish gray, fine quartz sandy, thin bedded, rubbly slopes, interbeds of intraformational conglomerate and calcareous shales.	11.0	13.0
Calcarenite, medium dark gray, ledge forming. (H-31).	2.0	2.0
Fillmore Limestone:		
Calcisiltite, medium gray, thin bedded, slope forming.	25.0	730.0

Calcisiltite, light gray weathering light yellowish gray, thin bedded, fine quartz sandy, with 2" to 4", interbeds of intraformational conglomerate comprising about one-third of the rock as more resistant beds. Gastropod steinkerns numerous. (H-30) at 705'.	27.2	705.0
Calcisiltite, light gray weathering light yellowish gray, thin knobby bedded, slope forming but capped by a 1' resistant calcarenite ledge. (H-29) at 670'.	31.0	677.8
Intraformational conglomerate, calcisiltite pebbles, light brown weathering same, ledge forming.	4.8	646.8
Siltstone, light gray weathering light yellowish gray, shaly, thin bedded slope forming, contains beautifully preserved silicified trilobites. (H-28) at 630' to 642'.	15.2	642.0
Intraformational conglomerate, thin bedded, platy, slope forming.	15.0	626.8
Calcarenite, coarse, low ledge forming, with interbeds of intraformational conglomerate and calcisiltite forming reentrants. (H-27) at 610'.	39.1	611.8
Calcisiltite capped by resistant 2' ledge of coarse calcarenite. Offset northward along this ledge to continue measurement upward. (H-26) at 572' silicified trilobite hash, no recognizable fragments.	4.7	572.7
Calcisiltite, medium gray weathering light medium gray, very abundant forms resembling Receptaculites elongatus Walcott in this ledge.	3.0	568.0
Covered, slabby calcarenite float.	20.0	565.0
Calcarenite, coarse, dark medium gray weathering brownish gray, (H-25) at 545'.	12.4	545.0
Intraformational conglomerate, thin bedded, slope forming, here capped by 8' of thick bedded coarse calcarenite, (H-24) at 525'.	32.6	532.6
Interbedded calcarenites, calcisiltites, and intraformational conglomerates, thin bedded, quartz silty, weathering moderate brown, few fossils.	17.0	500.0
Calcarenites, with interbedded calcisiltites, thin bedded, quartz silty, gray weathering moderate brown, fossil trilobite fragments abundant. (H-23) at 483', (H-22) at 460', (H-21) at 450'.	48.2	483.0
Calcarenite, medium gray weathering moderate brown, quartz sandy, thin bedded, slope forming, fossiliferous, (H-20) at 434'.	16.8	434.8

Intraformational conglomerate, thin bedded, slabby, slope forming, and calcarenite, coarse to fine grained, fossiliferous in the coarse beds. (H-19) at 416', (H-18) at 412', and (H-17) at 410'.	28.8	418.0
Interbedded intraformational conglomerate and calcisiltite, thin bedded, step ledge and slope forming. (H-16) at 380'.	12.2	389.2
Calcisiltite, medium gray weathering very light gray, very thin bedded forming reentrant in creek bed beneath a 4" intraformational conglomerate bed.	3.0	377.0
Calcarenite, coarse, thin bedded, slabby slope forming.	3.6	374.0
Calcisiltite, medium gray, ledge forming.	1.8	370.4
Calcarenite, fine to coarse, thin bedded, slope forming.	5.6	368.6
Calcarenite, fine, slope forming capped by a 1-1/2' coarse calcarenite ledge.	6.0	363.0
Calcarenite, coarse, light gray, ledge forming. (H-15) at 357'.	2.0	357.0
Covered.	16.1	355.0
Calcarenite, coarse, thick bedded, ledge forming with interbedded calcarenite, fine, silty, weak, and intraformational conglomerate, thin bedded, slabby and weak. (H-14) at 338.9' silicified broken trilobite fragments probably broken and reworked by wave action.	19.5	338.0
Calcisiltite, light medium gray, quartz silty, siliceous nodules transect bedding, capped by a 4" coarse intraformational conglomerate bed.	1.4	319.4
Calcarenite and intraformational conglomerate interbedded, step ledges and covered slopes.	17.6	318.0
Intraformational conglomerate, medium gray, elongated pebbles in a calcarenite matrix (H-13) broken silicified trilobite fragments.	1.4	300.4
Calcarenite, medium gray, fine quartz sandy, motheaten appearing, reentrant forming.	5.1	299.0
Intraformational conglomerate, coarse, subrounded pebbles in calcarenite matrix, ledge forming.	1.9	293.9
Calcarenite, fine, medium gray, quartz silty, motheaten, reentrant forming.	2.0	292.0
Calcarenite, light olive gray, coarse, massive ledge forming, large pararipples 2" troughs and 15" between crests strike N 30° W. (H-12) shows cystid fragments.	1.5	290.0

Calcarenite, medium gray, fine grained, quartz sandy, slopes.	8.3	288.5
Calcarenite, coarse grained, ledge forming.	1.2	280.2
Calcisiltite, medium gray, thin bedded, with thin intraformational conglomerate layers.	3.0	279.0
Calcarenite, coarse grained, medium gray, ledge forming. (H-11)	1.0	276.0
Covered.	2.0	275.0
Intraformational conglomerate, calcisiltite pebbles in a calcarenite matrix, with interbeds of calcarenite, coarse. At 103.4 to 103.9 at 6" bed of blue replacement chert. (H-10) at 268'.	18.2	273.0
Calcilutite, medium gray, siliceous, ledge forming, the lower 6" of ledge are of coarse calcarenite of crinoid and trilobite fragments.	1.8	254.8
Covered, but platy intraformational conglomerate slabs and occasional low ledges show this to be underlying rock. Fragments of bedded bluish gray chert in float. (H-9) at 250', (H-8) at 228', and (H-7) at 190'.	67.0	253.0
Intraformational conglomerate, calcisiltite pebbles in a coarse calcarenite matrix. (H-6) at 186'.	1.5	186.0
Covered, slabby intraformational conglomerate float.	7.5	184.5
Intraformational conglomerate, medium gray, thick bedded, calcisiltite pebbles in coarse calcarenite matrix, ledge forming. (H-5) at 177'.	3.5	177.0
Covered, slabby intraformational conglomerate float.	6.9	173.5
Calcilutite, medium gray, massive ledge forming. "166.6" painted on ledge.	4.6	166.6
Interbedded thin bedded intraformational conglomerate and calcarenite. (H-3) at 160'.	4.4	162.0
Intraformational conglomerate ledge.	1.6	157.6
Covered.	4.0	156.0
Calcilutite, medium gray, massive, ledge forming.	4.0	152.0
Interbedded intraformational conglomerates, quartz sandy calcarenites, and calcisiltites. At 144' at 6" sandy calcarenite bed has large bluish gray chert replacement nodules.	38.5	148.0
Intraformational conglomerate ledge.	3.0	109.5
Intraformational conglomerate and calcisiltite interbedded. (H-2)	14.5	106.5
Calcilutite, medium gray, massive ledge forming.	3.5	92.0
Intraformational conglomerate with some fine sandy calcarenite beds, thick bedded ledge forming. (H-1) at 82'.	11.4	88.5

Covered.	45.6	77.1
Interbedded intraformational conglomerate' and calcisiltite, thin bedded. This is near the base of huge quartzite boulder.	4.0	31.5
Covered.	15.5	27.5
Calcilutite ledge in gully bottom.	2.0	12.0
Covered. The base of measured section H is on the top of the calcilutite ledge which corresponds to 603' in measured section G as determined by tracing the beds in the field.	10.0	10.0

BEX SECTION H FAUNULES: (a), abundant; (c), common; (r), rare.

H-1 Niobe ? n. sp. a (a), Nileus-like n. sp. a (c).

H-2 Protopliomerops contracta Ross (c), Kirkella n. sp. f (c), Nileus-like sp. (r).

H-3 Protopliomerops contracta Ross (r), Nileus-like n. sp. a (c).

H-4 Protopliomerops sp. (r).

H-5 undet. sp. S (r).

H-6 Protopliomerops contracta Ross (r), Psalikilus sp. (c). undet. sp. T (r).

H-7 Protopliomerops sp. (r), Psalikilus typicum Ross (c), Psalikilus ? sp. (r), Nileus-like ? sp. (r), free cheek cf. Hystricurus oculilunatus (r).

H-8 Nothing identifiable.

H-9F Protopliomerops contracta Ross (c).

H-10 Nothing identifiable.

H-11 Psalikilus sp. (r), Dimerophygiella free cheek (r), Nileus-like sp. (r), Maclurites - like gastropod impression.

H-12 Nothing identifiable.

H-13 Trigonocerca sp. (r), bryozoan ? sp. indet.

H-14 Nothing identifiable.

H-15 Trigonocerca sp. (c), Dimeropygiella n. sp. b. (r).

H-16 Trigonocerca typica Ross (c), Protopliomerops ? sp. (4-spined pygidia) (c), Pseudocybele n. sp. a. (r).

H-17 Trigonocerca typica Ross (c).

H-18 Trigonocerca typica Ross (a), Pseudocybele n. sp. b. (c), Pseudocybele n. sp. a (r), Dimeropygiella n. sp. b (r) Psalikilus sp. A (r), two unidentified pygidia.

H-19 Trigonocerca typica Ross (c), Pseudocybele n. sp. b (r), Endoceras sp. (r), sponge ? (c).

H-20 Trigonocerca typica Ross (a), Pseudocybele n. sp. b (c), Pseudocybele n. sp. a (r), Protopliomerops ? sp. (4-spined pygidium)(r), Protopliomerops n. sp. c (r), Nileus-like n. sp. b (c), Kirkella n. sp. a (c), Dimeropygiella n. sp. b (a), Dimeropygiella n. sp. a (a), Dimeropygiella sp. A (r), Goniotelus 2 sp. pygidia (c), Jeffersonia ? sp. (c), unassigned sp. S ? (r), unassigned cranidium (r), undet. gen. and sp. (r), undet. pygidium (c), Trematorthis ? sp. (c), Diparalasma sp. (c), Catoraphiceras sp. (r), Euomphalus ? sp. (c), Bellerophon-like steinkerns (c).

H-21 Trigonocerca typica Ross (a), Diparalasma ? sp. (r), Bellerophon-like gastropod steinkerns.

H-22 Trigonocerca typica Ross (a).

H-23 Trigonocerca typica Ross (a), Pseudocybele n. sp b (c), Kirkella n. sp. a (r), Dimeropygiella sp. (r), Carolinites cf. C. genacinaca Ross (c), Protopliomerops ? sp. (4-spined pygidium)(r).

H-24 Trigonocerca typica Ross (c), Pseudocybele n. sp. b (c), Kirkella n. sp a (c), Dimeropygiella sp. (r), Carolinites cf. C. genacinaca Ross (c), Protopliomerops ? sp. (4-spined pygidium)(r), Nileus-like n. sp. b. (c).

H-25 Pseudocybele n. sp b (a), Kirkella n. sp a (r), Carolinites genacinaca Ross (c), Isoteloides n. sp a (c), Nileus-like n. sp. c (c), Hesperonomia ? sp. (c), elongate sponge-like form cf. Receptaculites elongatus Walcott (a).

H-26 Pseudocybele n. sp. b (c), Nileus-like sp. (c).

H-27 Pseudocybele n. sp. b (a), Nileus-like n. sp. c (c), Kirkella sp. (r), Dimeropygiella sp. (c), Carolinites sp. (r).

H-28 Nileus-like n. sp. c (a), Isoteloides n. sp. a. (c), Kirkella n. sp. b (a), Pseudocybele n. sp. b. (a), Carolinites genacinaca Ross (c), Bathyurellus ? sp. (r), Goniotelus ? sp. (r), Endoceras sp. (r).

H-29 Nileus-like n. sp. c (c), Pseudocybele n. sp. b (c), Pseudocybele n. sp. a (r), Kirkella n. sp. b (a), Carolinites genacinaca Ross (r), Goniotelus ? sp. (r), Syntrophina ? sp. (r), Bellerophon-like gastropod steinkerns (r).

H-30 Pseudocybele nasuta Ross (c), Isoteloides cf. I. polaris Poulsen (c), Kirkella cf. K. declivita Ross (a), unassigned cranidium and hypostoma.

H-31 Pseudocybele nasuta Ross (c), Cybelopsis cf. C. speciosa Poulsen (c).

H-32 Pseudocybele nasuta Ross (c), Lachnostoma latucelaum Ross (c), Goniotelus sp. B Hintze (r), Hesperonomia sp. (c).

IBEX SECTION J: Located in NE 1/4, Section 31, T. 22 S., R. 14 W. is a fault block of Ordovician quartzite and dolomite which stands as a small isolated hill east of the main Ordovician limestone ledges. Measured section J begins at the lowest outcrop exposed in the second small gulch west of this quartzite hill. A rock cairn was erected at the base of this section and the lower ledge marked with yellow paint. The measured section proceeds up this gulch through an excellent exposure of most of the fossiliferous Wahwah limestone, and onto the crest of a spur capped by Juab limestone beds. It continues westward up the spur into the Kanosh shales, the lower part of which are well exposed here and very fossiliferous. The beds dip 6°, N. 80° W.

Kanosh Shale: Top not exposed, masked by Tertiary volcanic talus.

	I	II
Siltstone, yellowish gray, weathers dark yellowish orange, calcareous, forms cap to prominent ledge.	1.5'	381.0'
Shales, dark gray.	3.0	379.5
Siltstone, dark yellowish orange weathering, ledge.	1.5	376.5
Shales, dark gray, fissile.	0.5	375.0
Siltstone, medium gray, weathers yellowish orange, ledge forming, <u>Orthis michaelis</u> impressions.	1.0	374.5
Covered, shaly float.	18.0	373.5
Shales, olive gray, fissile, barren, with about 50% interbeds of thin bedded fossiliferous gray calcarenite which weathers to medium brown slabby talus, abundant <u>Orthis michaelis</u> Clark, <u>Anomalorthis utahensis</u> Ulrich and Cooper, <u>Macronotella</u> sp.	42.5	355.5
Shales, as above but with only 30% interbedded calcarenite.	24.1	313.0
Calcarenite, medium gray, weathers medium brown, shell rock, <u>Orthis michaelis</u>, <u>Macronotella</u> n. sp.	0.9	288.9
Shales, olive gray, fissile barren, form fine talus masking the bedrock outcrop.	24.0	288.0
Shales, light olive gray, fissile, barren, with about 30% interbedded calcarenite, coarse, medium dark gray, weathering medium brown, thin bedded, fossiliferous. The lower 100 feet has a brownish overall color when viewed from a distance while the upper part is more grayish. Above 264' the beds on this spur are masked by fine shaly float and fine volcanic float from above so that it is necessary	264.0'	264.0'

	I	II
to walk out a bed northward to continue the traverse up a gully where the overlying beds described above are exposed. (J-18) at 5', (J-19) at 44', (J-20) at 60', (J-21) at 66', (J-22) at 99', (J-23) at 110', (J-24) at 126', (J-25) at 137', (J-26) at 148', (J-27) at 154', (J-28) at 160', (J-29) at 171', (J-30) at 243', and (J-31) at 260'.		

Juab Limestone: This is the type section of this formation. The lithology is distinctive from the beds above and below for its lack of shaly detritus and its characteristic medium gray slabby appearance. Small nodules of limonite pseudomorphs after pyrite up to 1 1/2 inches diameter are common on the weathered limestone surfaces.

Calcisiltite, medium gray weathering same, fine quartz sandy, thin bedded, forms low step ledges on nose of spur capped by a 1' resistant calcisiltite ledge which forms a backslope on the spur.	45.2	139.0
Calcisiltite, medium gray weathering same, alternately thin and thick bedded, forms step ledges up nose of spur capped by a resistant bed at 93.8'.	29.8	93.8
Calcisiltite, thin bedded, slope forming, with 1' caprock.	16.4	64.0
Calcisiltite, medium gray, fine sandy, forms rubbly slope capped by a 2' yellowish orange weathering calcisiltite ledge.	9.6	47.6
Calcisiltite, ledge, medium gray, weathers moderate brown. (J-17).	1.4	38.0
Calcisiltite, rubbly slope no outcrop.	17.6	36.6
Calcisiltite, medium gray, weathering yellowish gray and dark yellowish orange, fine sandy, thin bedded, capped by a 4' ledge of siliceous calcisiltite which forms the 5th very prominent ledge in a series from the bottom of this gulch, _Orthis_ cf. _subalata_ Ulrich and Cooper common.	19.0	19.0

Wahwah Limestone:

Calcisiltite, gray, alternately thin and thick bedded, quartz silty, silty material weathers yellowish gray, step ledge and slope forming.	23.4	192.5

	I	II
Calcisiltite, medium gray, weathering dark medium gray, siliceous material on gnarly parting planes, forms 4th prominent ledge in a series from the bottom of this gulch, unfossiliferous.	4.1	169.1
Calcisiltite, thin bedded, low ledge and slope forming.	9.7	165.0
Hesperonomiella minor (Walcott) shell rock bed. (J-16A).	0.8'	155.3'
Calcisiltite, gray, shaly, thin bedded, low ledges and slopes.	20.0	154.5
Calcisiltite, silty, massive ledge forming. (J-16) at 127'.	9.0	134.5
Calcisiltite, thin bedded, low ledge and slope forming. (J-15) at 118'.	11.0	125.5
Calcisiltite, ledge (J-14) at 114'.	2.0	114.5
Calcisiltite, thin bedded, low ledges and slopes.	3.0	112.5
Calcisiltite, silty, 1 1/2 foot ledge capping 3 1/2 feet thin bedded float.	5.0	109.5
Calcisiltite, medium gray, weathering same with yellowish gray silty partings, thin bedded, low ledges and slopes.	8.4	104.5
Calcisiltite, thin bedded, silty, shaly reentrant capped by a 2' siliceous calcisiltite ledge, forming the third prominent ledge in the series up this gulch.	7.1	96.1
Calcisiltite, medium gray, weathering yellowish gray, shaly reentrant capped by 1 1/2' ledge.	4.5	89.0
Calcarenite, gray, ledge.	2.0	84.5
Calcisiltite, medium gray, silty, shaly reentrant under ledge, (J-13) at 80'.	8.4	82.5
Calcarenite, medium gray, coarse, includes some pebbles of fine calcisiltite, massive, ledge forming. (J-12) at 70'.	4.0	74.1
Calcisiltite, medium light gray, fine quartz sandy, thin bedded, gnarly, slope forming. (J-10) at 61', (J-11) at 66'.	19.0	70.1
Calcisiltite, siliceous, ledge forming capped by 6" coarse calcarenite bed which forms ledge in creek bottom. (J-9) at 51'.	2.4	51.1
Calcisiltite, medium gray, weathering light yellowish gray, find quartz sandy, thin bedded, reentrant.	2.2	48.7
Calcisiltite, medium gray, massive, siliceous, forms second prominent ledge in gully, this ledge offset about 7 1/2' by a minor cross fault in the gully.	5.2	46.5

	I	II
Calcisiltite, medium gray, thin bedded intraformational conglomeratic in thin beds, very fossiliferous. (J-8) at 38'.	12.7	41.3
Calcisiltite, medium gray, quartz silty, thin bedded forming low ledges capped by massive 18" ledge. (J-6) at 26', (J-7) at 28'.	5.6	28.6
Calcisiltite, medium gray, weathers light yellowish gray, quartz sandy, thin bedded slope forming. (J-4) at 20', (J-5) at 21'.	11.0	23.0
Intraformational conglomerate, medium gray, quartz silty calcisiltite, thick bedded ledge.	2.0	12.0
Calcisiltite, medium gray, weathering pale yellowish brown, fine quartz sandy, thin bedded, slope forming, with some thin beds of calcarenite and intraformational conglomerate. This is the lowest Wahwah limestone exposure in this gully and immediate vicinity. (J-1) at 0', (J-2) at 5', and (J-3) at 8.5'.	10.0	10.0

IBEX SECTION J FAUNULES: (a), abundant; (c), common; (r), rare.

J-1 *Pseudocybele nasuta* Ross (c), *Kirkella declivita* Ross (c), *Trigonocerca* ? n. sp. a (r), *Raphistomina* ? sp. (r), Nileus-like n. sp. d.

J-2 *Pseudocybele nasuta* Ross (c), *Kirkella declivita* Ross (a), *Lachnostoma latucelsum* Ross (a), Isoteloides cf. *I. polaris* Poulsen (c), *Carolinites genacinaca* Ross (r), *Trigonocerca* ? n. sp. a (c).

J-3 Nothing identifiable

J-4 *Pseudocybele nasuta* Ross (c), *Lachnostoma latucelsum* Ross (c), *Dimeropygiella caudanodosa* Ross (r).

J-5 *Pseudocybele nasuta* Ross (c), *Lachnostoma latucelsum* Ross (c).

J-6 *Pseudocybele nasuta* Ross (c), *Lachnostoma latucelsum* Ross (a), *Cybelopsis* cf. *C. speciosa* Poulsen (c), *Kirkella declivita* Ross (c), *Goniotelus* sp. A (c), *Catoraphiceras* sp. (r), *Hesperonomia* sp. (c).

J-7 *Kirkella* sp. (c).

J-8 Pseudocybele nasuta Ross (a), Lachnostoma latucelsum Ross (a), Cybelopsis cf. C. speciosa Poulsen (c), Pliomerops cf. P. insolita Poulsen (r), Kirkella declivita Ross (c), Goniotelus sp. A (a), Goniotelus sp. B (c), Dimeropygiella caudanodosa Ross (a), Carolinites genacinaca Ross (c), Illaenus-like n. gen. (c), Nileus-like n. sp. d (r), Hesperonomia sp. (c), Catoraphiceras sp. (r), Raphistomina sp. (c), Bellerophon-like gastropod steinkerns (r), bryozoa ? (c). "Barrandia ? sp." Walcott (r), Kawina sexapugia Ross (r), Diparalasma sp. (r), Tritoechia sinuata Ulrich and Cooper (r).

J-9 Cybelopsis cf. C. speciosa Poulsen (r), Pliomerops cf. P. insolita Poulsen (c), Lachnostoma latucelsum Ross (c), Goniotelus sp. A (c), Dimeropygiella caudanodosa Ross (c), Illaenus-like n. gen. (r).

J-10 Cybelopsis cf. C. speciosa Poulsen (c), Pliomerops cf. P. insolita Poulsen (r), Lachnostoma latucelsum Ross (a), Goniotelus sp. A (c), Dimeropygiella caudanodosa Ross (a) Carolinites genacinaca Ross (c), Kirkella declivita Ross (r), Raphistomina sp. (c), Catoraphiceras sp. (r).

J-11 Cybelopsis cf. C. speciosa Poulsen (r), Kirkella declivita Ross (c), Pliomerops cf. P. insolita Poulsen (c), Lachnostoma latucelsum Ross (a), Goniotelus sp. (c).

J-12 Pseudocybele nasuta Ross (c), Lachnostoma latucelsum Ross (c), Dimeropygiella caudanodosa Ross (a), Goniotelus sp. C (c), Goniotelus sp. D (r).

J-13 Lachnostoma latucelsum Ross (a), Kirkella declivita Ross (c), Isoteloides ? n. sp. b (c), Nileus-like sp., Carolinites genacinaca Ross (c), Kawina n. sp. a (r), unassigned pygidium, Zittelella cf. Z. clarae Howell (sponge) (r).

J-14 Campbelloceras ? sp. (r), Goniotelus ? sp. indet. (r), cystid plates (r).

J-15 Pseudocybele nasuta Ross (c), Cybelopsis cf. C. speciosa Poulsen (r), Pliomerops cf. P. insolita Poulsen (c), Goniotelus sp. B (c), Dimeropygiella caudanodosa Ross (c), Lesuerilla ? sp. (c).

J-16 Pliomerops sp. (c), Goniotelus sp. A (c), Endoceras ? sp. (c), Zittelella ? sp. indet. (r).

J-16A Hesperonomiella minor Walcott (a), Loxoplocus sp. (r).

J-17 Pliomerops sp. indet. (r), Parapilekia ? sp. (r), Orthis subalata Ulrich and Cooper. Eleutherocentrus ? sp. (r).

J-18 Pliomerops n. sp. a (r), n. gen. P, n. sp. b (c), Anomalorthis sp. (r), bryozoa (c), cystid balls (c), Macronotella sp. (c).

J-19 Eleutherocentrus cf. E. petersoni Clark (a), Pliomerops n. sp. a (c), Macronotella sp. (a), Orthis sp. (c).

J-20 Pliomerops n. sp. a (c), n. gen. P, n. sp. a (c), Eleutherocentrus sp. (r), Macronotella sp. (a).

J-21 Pliomerops n. sp. a (c), Eleutherocentrus sp. (c).

J-22 N. gen. P, n. sp. a (a), Pliomerops n. sp. a (r), Bathyurellus cf. B. feitleri (Holliday) (a), Eleutherocentrus sp. (r), Receptaculites mammillaris Walcott (c), Leperditia sp. (c), cystid plates (r).

J-23 N. gen. P, n. sp. a (c), Pliomerops n. sp. a (c), Bathyurellus cf. B. feitleri (Holliday) (a), Leperditia sp. (a), Orthis michaelis Clark (c), gastropod n. gen. and n. sp. near Maclurites carinatus Walcott (r), large Acrotreta ? sp. (c).

J-24 Bathyurells cf. B. feitleri (Holliday) (c), Leperditia sp. (a), Macronotella sp. (a).

J-25 Pliomerops n. sp. a (c), n. gen. P, n. sp. a (c), Bathyurellus cf. B. feitleri (Holliday) (c), Endoceras sp. (c), Leperditia sp. (c), Macronotella sp. (c).

J-26 Pliomerops n. sp. a (c), n. gen. P, n. sp. a (r), Bathyurellus cf. B. feitleri (Holliday) (c), Pliomerops n. sp. b (broad pygidial spines) (r), Eleutherocentrus sp. (r), Orthis michaelis Clark (a), Anomalorthis utahensis Ulrich and Cooper (r), Lingula sp.(35 mm. long) (r), gastropod n. gen. and n. sp. near Maclurites carinatus Walcott (r), Bellerphon-like steinkerns (r), Endoceras sp. (r), cystid balls and plates (c).

J-27 Pliomerops n. sp. a (c), n. gen. P, n. sp. a (c).

J-28 Pliomerops n. sp. a (c), Bathyurellus cf. B. feitleri (Holliday) (c), Orthis michaelis Clark (c), Anomalorthis utahensis Ulrich and Cooper (r), Endoceras sp. (c), gastropod n. gen. and sp. near Maclurites carinatus Walcott (c).

J-29 Bathyurellus cf. B. feitleri (Holliday) (c), Eleutherocentrus sp. (c), n. gen. P, n. sp. a (c), Leperditia sp. (c).

J-30 Bathyurellus cf. B. feitleri (Holliday (a), n. gen. P, n. sp. a (c), Leperditia sp. (c).

J-31 Bathyurellus cf. B. feitleri (Holliday) (c), n. gen. P, n. sp. a (c), Eleutherocentrus (r), Leperditia sp. (c).

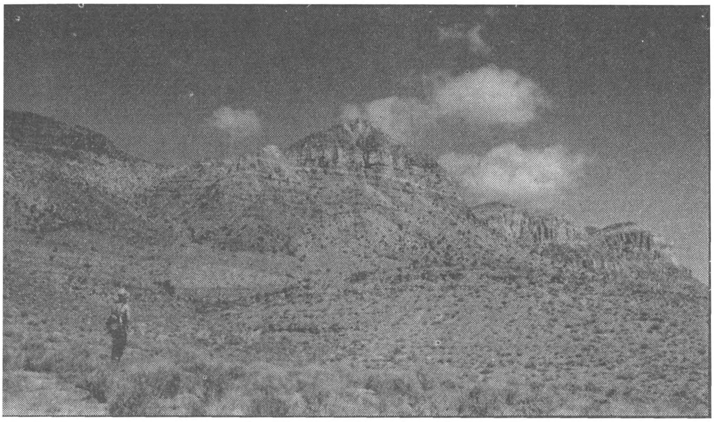
IBEX SECTION K: Westward 1 1/2 miles across the valley from the Jack Watson shack at Ibex are two prominent quartzite-capped bluffs which flank both sides of the largest canyon in that vicinity, known locally as Smooth Canyon. The south bluff is called Fossil Mountain and is located just west of 1/4 cor., Sec. 19-30, T. 22 S., R. 14 W. Strata on the east face of Fossil Mountain are cut by a series of vertical faults of small displacement, but the central part of the west face is unfaulted from the foothills upwards. This is the type section of the Kanosh shale and is the only place in the Ibex area where the entire formation is exposed in one section. Fossil Mountain is capped by lower beds of the Eureka quartzite beneath which the Dolomite member forms a dark band near the top of the mountain. Below the Dolomite member the Swan Peak? quartzite and Lehman formation are well exposed, but these upper beds are cut by minor east-west trending vertical faults on Fossil Mountain; a north-south fault of much larger displacement cuts just west of the top of Fossil Mountain, thus the Eureka-Upper Ordovician contact is not shown here. A description of these upper beds above the Lehman formation is included under Section L, located on the bluff 1/4 mile northward across Smooth Canyon. There these upper beds are exposed in an unfaulted sequence from the upper Kanosh shales to the top of the Eureka quartzite. Beds dip 3°, N. 80° W.

Swan Peak? Quartzite: 249' thick, for description see measured section L.

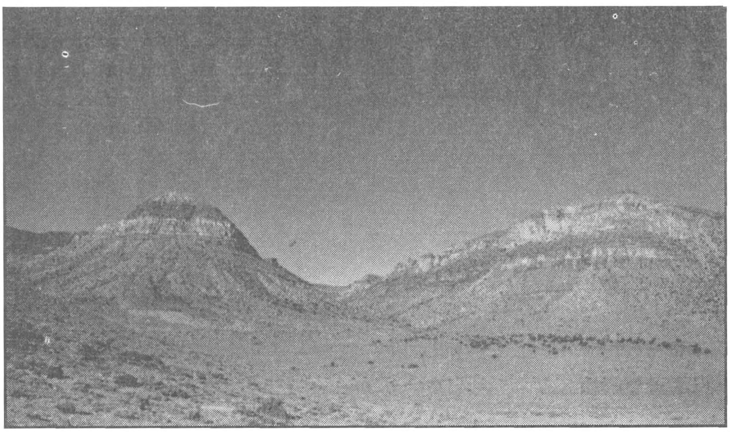
Lehman Formation:

	I	II
Calcisiltite, medium dark gray, weathering light brownish gray, chippy slope beneath quartzite.	20'	195.0'
Quartzite, white, weathering reddish, ledge forming.	22	175.0
Calcilutite, dark gray, weathering medium bluish gray, shaly, thin bedded, even bedded, forms part of bluff capped by quartzite above.	17	153.0
Calcilutite, medium dark gray, weathering medium bluish gray, silty, gnarly, rubbly slopes, Leperditia sp., abundant.	18'	136.0'
Calcilutite, weathers medium bluish gray, thin bedded, even bedded, forms step ledges.	72	118.0
Calcilutite, medium gray, weathering medium bluish gray, thin bedded and alternating with thin beds of shaly calcisiltite. Leperditia sp. very abundant in some beds. (K-6) at 25', (K-7) at 40'.	37.3	46.0

	I	II
Calcarenite, fine, medium gray weathering medium dark gray, quartz sandy, siliceous, ledge forming.	2.8	8.7
Sandstone, grayish orange weathering light brown, fine, cross laminated beds up to 4" thick, forms prominent ledge.	5.9	5.9
KANOSH SHALE:		
Limestone, calcisiltite, calcarenite, and some calcilutite, gray, thin bedded, with interbedded shales, slope forming. (K-5) at 490'.	77	550
Calcisiltite, medium gray, weathering brownish gray, thin bedded, gnarly, shaly. (K-4) at 473' *Anomalorthis utahensis* and *Orthis* cf. *O. swanensis* Ulrich and Cooper abundant in thin beds of calcarenite.	33	473
Calcisiltite, medium gray, weathers brownish gray, thin bedded shaly, chippy, and slabby, small longicones maximum diameter 1". (K-3) at 435.	10	440
Siltstone, yellowish brown, weathers dark yellowish orange, with interbeds of shale comprising half of rock.	14	430
Siltstone, yellowish brown, weathers dark yellowish orange, calcareous, thin bedded, with interbeds of shale comprising about 25% of rock.	15	416
Shale, olive gray to olive black, fissile, barren, with 25% interbeds of calcarenite, thin bedded, ledgy, fossiliferous, *Orthis*, *Macronotella* sp., orthocones.	51	401
Siltstone, yellowish brown, weathers dark yellowish orange, calcareous, few *Orthis* sp. impressions.	4	350
Shale, olive gray, weathering brownish gray, with 50% interbeds of calcarenitic *Orthis* bearing beds.	16	346
Shale, olive gray, fissile, forms slopes of fine shaly fragments, (K-2) at 330'.	64	330
Siltstone, weathers dark yellowish orange, ledge.	3	266
Shale, olive gray, weathering brown, fissile, slope forming with 50% interbeds of thin bedded pinkish gray, coarse calcarenite shell rock, *Orthis* sp. very abundant.	73	263
Shale, olive gray, fissile, as above but with only 10% interbedded calcarenite.	20	190
Shale, olive gray, fissile, with 25% interbeds of calcarenite.	20	170
Shale, light olive gray, fissile, with 50% interbedded calcarenite, thin	150	150



Fos .l Mountain from the southwest. Ledges in the foreground are ıpper beds of Juab limestone at base of Ibex measured sec ion K. Dark Dolomite member is seen near top of Fossil Mou ;ain between Swan Peak? and Eureka quartzites.



View westward toward Smooth Canyon showing Fossil Mountain on left and quartzite-capped bluff on north side of Smooth Canyon on the right. This bluff has been downfaulted slightly with respect to Fossil Mountain.

Fig. 9

bedded, coarse, weathering medium brown, very fossiliferous, slope forming with some low ledges of resistant calcarenite. (K-1) at 5', and (K-1A) at 137'.

Juab Limestone: About 80 feet of typical Juab gray calcisiltites are exposed in the foothills on the southeast base of Fossil Mountain. A cairn was erected at the top of the Juab at the contact with the lowest Kanosh olive shaly beds.

IBEX SECTION K FAUNULES: (a), abundant; (c), common; (r), rare.

K-1 Pliomerops n. sp. a (a), Bathyurellus cf. B. feitleri (Holliday) (a), n. gen. P, n. sp. a, b (c), Carolinites cf. C. killaryensis (Stubblefield) (c).

K-1A Bathyurellus cf. B. feitleri (Holliday) (c), n. gen. P, n. sp. a (c), Eleutherocentrus cf. E. petersoni Clark (c), Leperditia sp. (c).

K-2 Endoceras sp. (r), Cybelopsis n. sp. (large pygidium) (r), Orthis sp. (c).

K-3 Receptaculites sp. indet. (r), Orthis sp. (c).

K-4 Cybelopsis sp. (r), Orthis sp. (a), cystid fragments (c)

K-5 Illaenus sp. (r), Orthis sp. (c).

K-6 Modiolopsis ? sp. (c).

K-7 Barrandia ? sp. (c), Trocholites ? sp. (Small coilded ribbed cephalopod) (c), Endoceras sp. (c), Leperditia sp. (a).

IBEX SECTION L: Located on the south side of the quartzite capped bluff on the north side of Smooth Canyon and in the SE 1/4, Sec. 24, T. 22 S., R. 15 W., measured section L is about 1/2 mile northwest of measured section K. The north bluff is downthrown with respect to Fossil Mountain along the Smooth Canyon fault. Thus the Eureka quartzite and overlying Upper Ordovician dolomite are entirely exposed on the north bluff. The measurement and description of the Lehman formation and the beds above are from notes by G. W. Webb (1949, Master thesis, Columbia University).

Upper Ordovician dolomite, dark gray, with black chert nodules.

	I	II
Eureka Quartzite: White, fine grained, orthoquartzite, weathers to reddish stained massive cliffs which slope off towards the top to lighter pinkish colored sandy quartzite beneath overlying dark dolomite.		537'
Dolomite Member: Light olive gray weathering sandy dolomite, forms prominent darker band between the two quartzite formations.		85
Swan Peak ? Quartzite: Light gray to white, fine grained, orthoquartzite, thick bedded, but not as massive as the Eureka quartzite above; cross laminated in some beds, weathers to reddish brown cliffs, with some interbedded reentrant forming shaly, limy, and sandy beds.		249'
Lehman Formation:		
Calcisiltite, laminated.	8'	196'
Quartzite, weathers reddish brown, cross laminated.	20	188
Calcilutite, bluish gray weathering, sandy at top with shaly partings below, Leperditia sp., Barrandia ? sp.	50	168
Quartzite, orange weathering, grainy, laminated and cross laminated.	5	118
Calcisiltite, silt parted, cobbly weathering.	10	113
Quartzite, gray, shale parted.	5	103
Calcarenite.	20	98
Calcilutite, evenly bedded.	17	78
Shale, calcareous.	3	61
Shale.	20	58
Calcisiltite, blue gray, weathering yellowish on silty partings.	30	38
Quartzite, laminated and cross laminated.	8	8
Kanosh Shale:		
Limestones, interbedded calcisiltites, calcarenite, and calcilutite, gray, thin bedded, silty, with shaly partings, (287) Orthis sp. abundant, Clathospira-like gastropod steinkerns, Leperditia bivia White.	61	271
Calcisiltite and calcarenite, interbedded, thin bedded, gray, weathers brownish gray, (286) Leperditia bivia White, Orthis sp., large pliomerid pygidium Pliomerops sp.		

	I	II
Calcisiltite, medium gray, weathering light brownish gray, silty, with interbeds of yellowish gray weathering earthy shales, and thin bedded calcarenite containing (285) Orthis sp., Anomalorthis sp., orthocones, and gastropod steinkerns.	34	190
Calcisiltite, blue gray, weathers brownish gray silt parted, shaly, thin bedded, (284) small Orthis sp.	12	156
Siltstone dark yellowish orange weathering, alternating with earthy shales and some 1" fossiliferous calcarenite beds, (283) Orthis sp.	23	144
Shale, olive gray, fissile, barren, with 2" to 4" interbeds of fossiliferous thin bedded calcarenite, (282) Orthis sp. Anomalorthis utahensis Ulrich and Cooper, Macronotella sp., Leperditia bivia White, Bucania sp., numerous annulated orthocone impressions 1/2" to 1 1/2" diameter.	48	121
Siltstone, weathers dark yellowish orange, in beds 1" to 6" thick, alternating with brown earthy shales, (281) Orthis michaelis Clark.	8	73
Covered, shale float.	15	65
Shale, olive gray, fissile, with interbeds of thin bedded shaly calcilutite, dark gray, fossiliferous, (280) Orthis michaelis Clark abundant, Anomalorthis utahensis Ulrich and Cooper, Bathyurellus cf. B. feitleri (Holliday), bryozoans.	50'	50'

Lower beds not exposed here.

CRYSTAL PEAK SECTION, UTAH: Crystal Peak is a white quartz rhyolitic vitrophyre intruded into the Ordovician strata of the Crystal Peak Hills. Crystal Peak is located at the corner of Sections 23, 24, 25, and 26, T. 23 S., R. 16 W., and the Garrison-Black Rock graded road passes by its northern base. Of the Ordovician exposures surrounding Crystal Peak the most continuous and most easily accessible are those just north of the Garrison - Black Rock road and about a mile north of Crystal Peak. Here the Ordovician quartzites form a bluff slightly higher than Crystal Peak itself. The base of the Crystal Peak measured section described below is located just off the road from Garrison where it makes its curve southward toward Crystal Peak. Beds dip 10°, northwestward.

	I	II
Eureka Quartzite:		
Sandstone, gray, dolomitic, cross laminated.	18'	560
Quartzite, white, vitreous, cliff forming.	542	542

	I	II
olomite Member:		
Dolomilutite, medium dark gray, weathers olive gray, Eofletcheria sp. forms bed at 27' - 29', ledge forming.	34	89
Calcilutite, mottled bluish gray, silty.	9	55
Dolomite, olive weathering.	2	46
Calcilutite, bluish gray weathering.	3	44
Dolomite, olive weathering.	2	41
Calcilutite, mottled bluish gray, silty, slope forming.	39	39
Swan Peak ? Quartzite:		
Quartzite.	41	207
Calcilutite, medium gray, weathers bluish gray, in part dolomitic, thin to thick bedded, fossils, Leperditia sp., Barrandia ? sp.	28	166
Quartzite, ledge forming.	28	138
Sandstones, interbedded, thin bedded, and calcareous sandstone.	26	110
Quartzite, light gray to white, weathers reddish brown, cliff.	35	84
Sandstone, weak.	3	49
Quartzite, resistant.	5	46
Sandstone, weak.	8	41
Covered, but probably thin bedded calcareous sandstone, (CP-77F) at 12', Cybelopsis sp.	25	33
Sandstone.	2	8
Sandy limestone.	2	6
Sandstone, weathers orange brown, medium grained, cross laminated, forms lowest quartz sandstone ledge.	4	4
Lehman Formation:		
Calcilutite, medium gray, weathers medium bluish gray, very thin bedded, gnarly, silty, forms low ledges and slopes, with occasional interbeds of dark gray calcarenite, fossils abundant, in some beds Leperditia remains comprise most of the rock. (CP-74) at 159', (CP-69) at 131', (CP-55) at 55', (CP-54) at 49', (CP-50) at 27'.	169'	169'
Kanosh Shale:		
Calcarenite, medium gray, weathers yellowish gray, thin bedded and rubbly to medium bedded, with interbedded yellowish gray shales, Orthis sp., and Modiolopsis ? sp. common.	15	245
Calcarenite, as above but with greater proportion of shaly interbeds, shales comprising about half the strata.	5	230

Fissile Kanosh shales and interbedded fossiliferous calcarenite ledges, as exposed near the base of the Crystal Peak, Utah, measured section.

Fig. 10

	I	II
Three 4" calcarenite layers at top form ledgy outcrop. (CP-42) at 229'.		
Calcarenite, medium dark gray, weathering dark brownish gray, thin bedded, with interbeds of light gray to light yellowish gray siltstone and shales. Fossils abundant in the calcarenite. (CP-40) at 218', (CP-3) at 200'. Yellow "40" painted on rock at 218'.	45	225
Shale, weathering yellowish gray, with 50% interbeds of thin bedded shaly limestone, medium gray weathering yellowish brown, silty, fossiliferous. (CP-1) at 150', CP-2) at 160'.	55	180
Siltstone, calcareous, weathers to yellowish orange ledge.	2	125
Shale, olive, fissile.	5	123
Siltstone, calcareous, ledge forming.	2	118
Shale, fissile, slope forming.	5	116
Siltstone, calcareous, yellow "20" painted on this lowest siltstone ledge.	2	111
Shale, dark olive to very dark gray, with 20% interbeds of thin bedded calcarenite.	33	109
Shale, olive gray to brown, with 50% interbeds of thin bedded calcarenite. At 70' a few shale beds are brick red in color. (CP-13) at 71', (CP-12) at 65', (CP-11) at 60'.	32	76
Shale, olive to medium brown, fissile, with 10% interbeds of brownish weathering fossiliferous calcarenite. (CP-8) at 43', (CP-5) at 27'.	44	44

CRYSTAL PEAK SECTION FAUNULES: (a), abundant; (d), common; (r) rare.

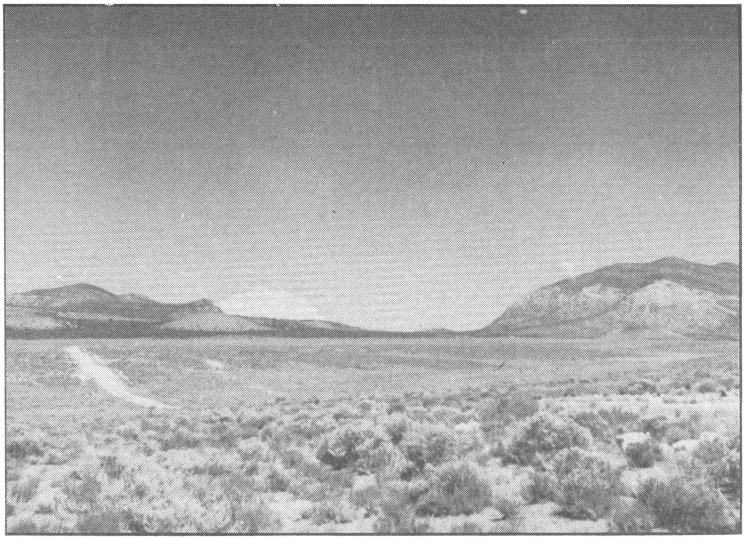
CP-5 *Bathyruellus* cf. *B. feitleri* (Holliday) (c), n. gen. *P*, n. sp. a (a), *Pliomerops* n. sp. a (c), *Orthis michaelis* Clark (c), *Macronotella* ? sp. (c), cystid, plates and balls (c).

CP-8 *Macronotella* ? sp., make up large part of rock (a), *Orthis* sp. (c), *Anomalorthis utahensis* Ulrich and Cooper (c), bryozoan colonies (c).

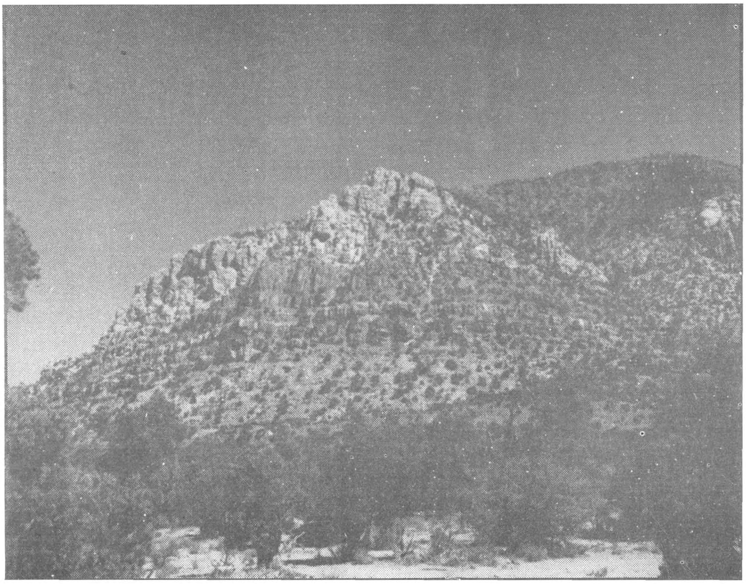
CP-11 *Bathyurellus* cf. *B. feitleri* (c), *Pliomerops* sp. indet. (r), *Anomalorthis utahensis* Ulrich and Cooper (c).

CP-12 *Pliomerops* sp. (broad-spined pygidium) (r), *Macronotella* sp. (c), *Orthis* sp., (r).

CP-13 *Anomalorthis utahensis* Ulrich and Cooper shell rock (a), *Orthis* sp., (r). cystid fragments (c).



Crystal Peak and the Crystal Peak Hills as viewed from Garrison - Black Rock road in Wahwah Valley. Section was measured on hill at right side of photo.



Closer view of Crystal Peak measured section. Hill is capped by dark Upper Ordovician dolomite; light colored Eureka quartzite overlies gray Middle Ordovician Dolomite member which overlies thinner bedded Swan Peak? quartzite. Lehman formation and Kanosh shale crop out at base of hill.

Fig. 11

CP-1 _Illaenus_ n. sp. a (a), _Nieszkowskia_ n. sp. (c), _Pseudosphaeroexochus_ sp. (r), n. gen. _P_, n. sp. c, Cybelopsis sp. (large cranidium) (r), _Barrandia_ sp. (r), Orthis sp. (c). _Anomalorthis_ sp. (c), _Lingula_ sp. (r), _Trocholites_ sp. (small ribbed coiled cephalopod) (r), _Lecanospira_-like gastropod (c), _Maclurites_ sp. ind. (c), high spired gastropod sp. indet. (r), _Leperditia_ sp. (a), spherical bryozoan colony (r).

CP-2 _Orthis_ sp. (c), _Leperditia_ sp. (c).

CP-3 _Anomalorthis_ sp. (c), _Modiolopsis_ ? sp. (a), _Raphistoma_ ? sp. (c), high spired gastropods sp. indet. (c).

CP-40 _Illaenus_ N. sp a (c), _Pseudosphaeroexochus_ sp. (r), n. gen. P, n. sp. c, (r), _Barrandia_ ? sp. (r), _Orthis_ ? sp. (c), _Lecanospira_-like gastropod (c), high spired gastropod (r), _fenestrellate_ bryozoan (r), _Leperditia_ sp. (a).

CP-42 N. gen. P. n. sp. c (r), _Orthis_ sp. (c), _Leperditia_ sp. (very large individuals) (a).

CP-50 _Cybelopsis_ sp. (large) (a), _Barrandia_ ? sp. (c), _Anomalorthis_ ? sp. (c).

CP-54 _Barrandia_ ? sp. (c), _Leperditia_ (c), raphistomid steinkerns (a).

CP-55 _Cybelopsis_ sp. (large) (c), _Barrandia_ ? sp. (c).

CP-69 _Barrandia_ ? sp. (with telson) (a), _Leperditia_ sp. (a).

CP-74 _Barrandia_ ? sp. (with telson) (c).

CP-77 _Cybelopsis_ sp. (large) (c), _Leperditia_ sp. (c).

DESERT RANGE EXPERIMENT STATION SECTION, UTAH: Several exposures o Ordovician quartzite extend in a broken line from Sec. 36, 25 S., R. 18 W., in the Halfway Hills, to Tunnel Spring Mou tain, in Sec. 4-5, T. 24 S., R. 17 W., but the best exposur are in the vicinity of Tunnel Spring Mountain. The section given below is a composite of two measured sections, the be below the Lehman formation being measured on the northwest slopes of the hill across the canyon one-half mile south of Tunnel Spring Mountain, and the beds above being measured o the southwest and west face of Tunnel Spring Mountain.

Upper Ordovician Dolomite:

Dolomite, dark gray, with black chert, thickness not measured. This formation is in normal fault contact with the Eureka quartzite at all places observed in the Tunnel Spring Mountain area, but the displacement is not believed to be great

	I	II
Eureka Quartzite:		
Quartzite, white, fine to medium grained, the lower beds banded and stained reddish, beds in the middle part vitreous and lacking evidence of bedding and much brecciated by minor faulting and jointing. The upper hundred feet are more sandy and less resistant and are laminated in the top 15'.	415'	41
Sandstone, medium brown weathering yellowish and pinkish gray, thin bedded, forms weak ledge.	4	
Dolomite Member:		
Dolomite, olive gray, thin bedded, grading upward into silty sandstone in upper 5'.	14	14
Quartzite, light brown, ledge forming.	14	12
Siltstone, dolomitic, thin bedded, weathers olive gray, slope forming, some pinkish shaly beds near top.	13	11
Quartzite, pinkish orange gray, ledge.	7	9
Dolomite, fine grained, medium gray, weathering light olive gray, ledge.	2	9
Calcisiltite. medium dark gray, weathers medium bluish to dark gray, with olive gray silty partings, 3" Eofletcheria bed 4' from top.	19	9
<u>Eofletcheria</u> bed, dolomitic matrix, forms resistant ledge capping the bluff forming calcisiltite below.	3	7
Calcisiltite, medium dark gray, weathers medium bluish gray mottled with yellowish gray, thick bedded, forms massive bluff, unfossiliferous.	68	6
Swan Peak ? Quartzite:		
Quartzite, grayish red and grainy at top grading downward through vitreous quartzite to 7' of brown weathering sandstone at base.	21	1
Calcisiltite, medium gray, weathering bluish gray, thin bedded, grades upward into sandy calcisiltite in upper 2', reentrant.	12	1

	I	II
Quartzite, light orange brown, weathering, cross laminated, ledge.	9'	141'
Calcilutite, medium dark gray, weathering bluish gray, silty thin bedded, gnarly, slope forming, upper 3' sandy, gastropod impressions and Leperditia sp., this lithology like typical Lehman formation.	56	132
Sandstone, light brown weathering, calcareous thick bedded, ledge.	13	76
Calcisiltite, medium dark gray, thin bedded, slopes, Leperditia sp., Barrandia ? sp. (DR-1)	26	63
Interbedded, medium gray sandy limestone and sandstone thin bedded, some beds cross laminated.	12	37
Shale, grayish red, with some very thin beds of silty calcisiltite, forms reentrant.	11	25
Sandstone, thin bedded, weathering medium brown, laminated with calcareous beds in the lower 4', ledge forming.	14	14
Lehman Formation:		
Calcilutite, medium dark gray, weathering medium bluish gray, with yellowish gray silty partings, thin bedded, forms low ledges on hillside, occasional interbeds of calcarenite, abundant fossils in a number of beds, Leperditia bivia White, large Pliomerops sp., large Cybelopsis sp., Barrandia sp., Illaenus sp., Clathospira-like gastropod impressions, bryozoans, orthid brachiopods. (DRES-127 to 134).	95'	180'
Calcilutite, weathers medium bluish gray, slity, forms the bottom ledge in a series of more ledgy outcrops than the beds below.	10	85
Calcilutite, medium gray, weathering medium bluish gray, silty, thin bedded, rubbly slopes, Barrandia ? sp., Leperditia bivia White. (DRES-124 to 126).	75	75
Kanosh Shale:		
Calcisiltite, gray, shaly, thin bedded, slopes and rubbly float, Orthis sp., Pliomerops sp., Leperditia sp., orthocones, (DRES-120 to 123).	60	355
Covered, calcisiltite and calcarenite float, cystid fragments, Leperditia sp. (DRES-117 to 119).	60	295
Shale, yellowish gray, with interbedded thin bedded calcargillutite, Pliomerops sp., Anomalorthis sp. (DRES-116).	30	235

Covered, shaly limestone float, *Orthis michaelis* Clark. (DRES-114 and 115).	70	205
Shale, olive gray, fissile, barren, with interbedded thin bedded fossiliferous coarse calcarenite weathering medium brown, outcrops mostly float covered with occasional limestone bed cropping out, *Anomalorthis utahensis* Ulrich and Cooper, *Orthis michaelis* Clark, *Pliomerops* n. sp. a, *Eleutherocentrus* sp., *Macronotella* sp., *Receptaculites mammillaris* Walcott, Cystids and bryozoans, Lecanospira-like gastropod steinkerns, (DRES-107 to 112).	115	135
Shale, weathering medium brown, with interbeds of brown weathering calcarenite. The lithology change is abrupt from the Juab calcisiltites below. (DRES-106) *Bathyurellus* cf. *B. feitleri* (Holliday), *Pliomerops* sp., bryozoans.	20	20
Juab Limestone:	I	II
Calcisiltite, medium gray, silty partings, thin to medium bedded, low ledges and slopes, *Orthis* sp., *Pliomerops* sp. (DRES- 102 to 105F).	31'	45'
Calcisiltite, medium light gray, with chickenwire silty partings, forms one to two foot ledges in gully bottom at base of traverse, occasional intraformational conglomerate layers, Orthis sp. (DRES-100 to 101).	14	14

Fillmore Limestone: About 300 feet of predominantly thin bedded intraformational conglomerate was measured in the foothills about 1 1/2 miles wouthwest of Tunnel Spring Mountain and although no fossils were found the lithology suggests assignment of these beds to the Fillmore limestone. The distance between the top of these beds and the base of the beds described above was not measured and the intervening interval is covered.

SAN FRANCISCO MINING DISTRICT: The literature bearing on the Ordovician of the San Francisco district has been reviewed by the author(Hintze, 1949, p. 48). The Morehouse quartzite, originally assigned to the Ordovician and Silurian by Butler, is actually an overthrust sheet of the Cambrian Prospect Mountain quartzite. The overthrust apparently extends from the San Francisco Mountains northward to the Cricket Hills. The only rocks in the San Francisco Mountains which are now unquestionably considered to be of Ordovician age are those of a small, fault-isolated sliver of Ordovician shales and limestones on the east side of the range near Barrel Spring Canyon. These beds dip eastward with the slope so that only two or three hundred feed of beds are exposed. These beds are assigned to the Chazyan Kanosh shale as they bear its typical faunal and lithologic characteristics. The fauna collected from these beds is as follows:

Bathyurellus cf. *B. feitleri* (Holliday)
Eleutherocentrus sp.
Pliomerops sp.
Orthis michaelis Clark
Receptaculites mammillaris Walcott
Endoceras sp.
Leperditia sp.
Macronotella ? sp.

SCIPIO SECTION, UTAH: Ordovician rocks are exposed in a limited area on the western foothills of the Pavant Range in Sections 3 and 10, T. 19 S., R. 3 W., about 5 miles south of Scipio, Utah. The measured section is readily accessible by following a car trail about a mile south-eastward from the top of the road cut where U. S. Highway 91 crosses the Pavant Range-Canyon Range divide. Although this section is neither as well exposed nor as fossiliferous as the Ordovician of the Ibex area, it is significant as the easternmost Ordovician exposure at this latitude in Utah. I am indebted to Dr. F. W. Christiansen for informing me of the existence of this exposure. The beds strike N. 30° W., and the dip to the northeast varies from 80° in the lowest beds to 20° in the upper Ordovician beds. The Ordovician quartzite is overlain by medium to dark gray Paleozoic limestones and dolomites which form the west face of the Pavant Range beneath the unconformably overlying Cretaceous or Eocene conglomerate. The contact of the Ordovician quartzite with the overlying Paleozoic carbonates is not exposed, but there does not appear to be an angular discordance between them.

Swan Peak ? Quartzite:	I	II
Quartzite, light pink, medium grained, float chips and blocks only, slope forming.	157'	394'
Quartzite, light pink, medium grained, slope forming about 20% exposure as low ledges, remainder quartzite float.	91	237

	I	II
Sandstone and quartzite, moderate brown, medium grained, slope forming, mostly float but low ledge crops out at base, and float blocks up to 1' are common.	75	146
Sandstone and quartzite, moderate brown, small float chips only.	71	71

Lehman Formation:

Nothing was found in the study of this section which had either the lithologic appearance or the typical fauna of the Lehman formation which is thus absent here between the Kanosh shale and the overlying quartzite.

Kanosh Shale:

Covered, shaly float mixed with quartzite float from above.	47	367
Shales, mostly covered, forming small subsequent strike valley along belt of outcrop. At 320' (Sc-10) a low ledge of coarse, medium dark gray weathering brownish calcarenite crops out bearing *Orthis michaelis* Clark, Pliomerops sp. and cystid plates.	320	320

Juab Limestone:

Calcarenite, medium light gray, fine, thick bedded, forms low ledges cropping out on hillslope, (Sc-9) at 57' silicified *Orthis* cf. *O. subalata* Ulrich and Cooper.	33	72
Calcarenite, medium light gray, weathering light yellowish brown, fine grained, silty to fine sandy, gnarly and laminated, (Sc-9) at 39'. Beds form prominent ledgy outcrops on hillslope of an overall light brownish gray color.	39	39

Wahwah Limestone:

Covered, platy limestone talus.	47'	113'
Calcisiltite and fine calcarenite, medium gray, silty to siliceous, weathering medium light gray with light yellowish brown silty gnarly partings, small amount of light brown chert in irregular bedding plane masses, this sequence is resistant forming low ledgy outcrops. (Sc-6) at 70', (Sc-7) at 66'. At 3' near the base of this ledgy outcrop, where the beds were well exposed low on the slope near the creek bottom, a large yellow "4" was painted.	66	66

	I	II
Fillmore Limestone:		
Intraformational conglomerate float.	19	861
Intraformational conglomerate, medium gray weathering same, calcilutite pebbles in calcarenite matrix, about 30% outcrop as low ledges, (Sc-5) at 842'. Lowest outcropping of this intraformational conglomerate is near base of backslope of the front ridge.	119	842
Covered, scrub oak.	385	723
Intraformational conglomerate and calcarenite, gray, weathering light medium gray, small elongate subrounded calcilutite pebbles in coarser and darker matrix, thick and thin bedded, ledges up to 2' crop out, but about 60% of sequence is covered.	57	338
Intraformational conglomerate and calcarenite, medium dark gray, about 80% covered but thicker bedded ledges up to 2' crop out. Light yellow siliceous to cherty material up to 100% noted in some blocks. (Sc-4) at 199'.	82	281
Intraformational conglomerate, medium gray weathering light medium gray, calcilutite pebbles in calcilutite matrix, mostly covered on backslope but thicker beds crop out.	77	199
Intraformational conglomerate, medium gray, weathers light medium gray, with 5% light brown chert as irregular nodules and siliceous masses, pebbles of calcilutite in fine calcarenite matrix. (Sc-3) at 120' Hystricurus several species. Yellow reference numbers painted on ledges, "3" at 122', "2" at 54'.	122	122
House Limestone:		
Covered, calcarenite float.	33	271
Calcarenite, fine to coarse, and calcilutite, medium gray weathering light gray, thin bedded, low ledges toward top of backslope of front ridge.	20	238
Covered, calcilutite float.	48	218
Calcilutite, medium gray, weathers light gray, thick bedded, forms the east slope near crest of front ridge, the beds dipping northeastward much steeper than the slope, well exposed.	56	170
Calcilutite, medium gray, weathers light gray, thick bedded, resistant, with 5% light brown chert in bedded nodules. This sequence forms the backbone of the front ridge, and yellow reference number, "1", was painted on the highest outcrop on this ridge at 114'.	21	114

	I	II
Calcarenite, fine to coarse, medium gray to dark medium gray, occasional thin layers of intraformational conglomerate of small pebbles.	35	93
Calcarenite, fine, medium light gray, with 5% light pinkish gray chert kernels, thin bedded, poorly exposed in saddle to west of front ridge. Cairn erected at base of measured section. Limestones conformable with underlying dolomites.	58'	58'

Cambrian ? dolomite:

Dolarenite, medium dark gray, weathering medium light gray, thin to thick bedded. Thickness not measured but estimated at several hundred feet.

SCIPIO SECTION FAUNULES: (a), abundant; (c), Common;(r), rare.

Sc-3 Parahystricurus sp. (r), Hystricurus oculilunatus Ross (c), Goniophrys prima Ross (r), Hyperbolochilus sp. (cranidium) (r), several unassigned pygidia Ross zone F.

Sc-4 Indet. trilobite fragments.

Sc-5 Trigonocerca typica Ross (c), Kirkella sp. (r), Hesperonomia sp. (r).

Sc-6 Endoceras sp. (r).

Sc-7 Lachnostoma latucelsum Ross (c), Cybelopsis cf. C. speciosa Poulsen (c), Pliomerops cf. P. insolita Poulsen (r), Hesperonomia cf. H. dinorthoides Ulrich and Cooper.

Sc-8 Orthis sp. (c), Eleutherocentrus ? sp. (r).

Sc-9 Orthis cf. O. subalata Ulrich and Cooper.

Sc-10 Orthis michaelis Clark (c), cystid balls and fragments.

KANOSH SECTION, UTAH:

Ordovician rocks crop out on both sides of highway U. S. 91 in Baker Canyon about 13 miles by speedometer southwest of the town of Kanosh, Utah. The exposures are in Section 26, T. 24 S., R. 7 W., and are best on the east wall of the canyon where exposed by road cuts and side washes. Higher on the hillside the beds are masked by soil. Although the beds are overturned, somewhat distorted, and incompletely exposed, this is an important section as the southeastermost exposure of Ordovician in Utah known to the writer. The overturned beds strike N 30°- 50°E., and dip 40° - 80° N W. Ordovician quartzite also crops out along the highway southward about a mile near Dog Valley, and to the north in White Sage Flat, Section 32, T. 23 S., R. 6 W. The writer is indebted to Dr. F. F. Hintze for the discovery of this exposure. The description of the quartzite is by G. W. Webb (1949, Masters Thesis, Columbia University, pg. 17) and is a composite of two overlapping exposures about 300 feet apart. Structural complications may be concealed, but it is thought that the section is essentially correct as shown.

	I	II
Swan Peak ? Quartzite:		
Quartzite, purplish gray weathering, sugary.	137'	137'
Covered, no exposure.	30	30
Lehman Formation:		
Calcisiltite, dark gray weathering, some chert, poorly exposed.	27	31
Quartzite, brown weathering yellowish, fine grained.	4	4
Covered, no exposure, attitude of beds changed indicating possible fault.	35	35
Kanosh Shale:		
Calcarenite, thin bedded, weathering brown, interbedded with olive brown shales, <u>Orthis michaelis</u> Clark, bryozoans, cystid fragments, large pliomerid pygidium.	45	45
Juab Limestone:		
Calcisiltite, medium gray, silty, <u>Orthis</u> sp., <u>Pliomerops</u> sp.	70	70
Wahwah Limestone:		
<u>Hesperonomiella minor</u> Walcott shell rock.	1	231
Calcisiltite, medium gray, silty, <u>Lachnostoma latucelsum</u> Ross, <u>Pliomerops</u> sp.	55	230
Alternating light olive shale and thin bedded calcarenite bearing intraformational conglomerate beds.	65	175
Shale and intraformational conglomerate, interbedded, weathers light olive gray, well exposed in road cut, small gastropods.	35	110
Intraformational conglomerate and calcarnite, shaley, thin bedded.	30	75
Calcarenite, medium dark gray, with some intraformational conglomerate beds, <u>Lachnostoma latucelsum</u> Ross, abundant at 45' (246).	45	45

	I	II
Fillmore Limestone:		
Calcarenite, light gray, silty.	40	240
Calcarenite, medium light gray, thin bedded, silty, with few beds of silty calcilutite, cystid columns.	25	200
Covered, thin bedded slabby intraformational conglomerate and calcilutite float.	119	175
Intraformational conglomerate, medium light gray, small subrounded calcilutite and calcisiltite pebbles, with yellowish gray shaly parting, thin bedded with interbeds of calcilutite.	56	56

TULE VALLEY:

Due west of Notch Peak across Tule Valley in the hills on the east side of the Confusion Range, in T. 19 S., R. 15 W., the light colored Eureka quartzite crops out prominently in one of the fault blocks as an almost horizontally bedded cliff forming unit. Sheepwagon trails lead almost to the base of this exposure. Between the quartzite cliffs and the valley alluvium some of the fossiliferous beds of the Lehman formation and the Kanosh shale are partially exposed.

Upper Ordovician dolomite:

Dark gray cherty dolomite rests with no angular discordance on the quartzite. Thickness not measured.

	I	II
Eureka ? Quartzite:		
Sandstone, light gray, dolomitic.	7'	380'
Quartzite, white, vitreous, forms pinkish stained cliffs.	373	373
Dolomite member:		
Dolomilutite, thin to thick bedded, weathers light olive gray.	24	61
Dolomite, sandy.	5	37
Dolomilutite, medium dark gray, weathering light olive gray, thick bedded, ledge forming.	32	32
Swan Peak ? Quartzite:		
Quartzite, white, ledge forming.	21	194
Sandstone, shaley, very thin bedded, reentrant.	10	173
Sandstone, dolomitic.	5	163
Quartzite, light brown weathering, ledge.	7	158
Dolomilutite, medium dark gray, weathering olive gray, thin bedded in the upper 8', ledge forming.	15	151

	I	II
Quartzite, light yellowish gray, stained reddish brown, ledge.	55	136
Covered, probably thin bedded sandstone.	5	81
Alternating weak thin bedded sandstone and resistant thick bedded quartzite ledges, the more resistant beds becoming more closely spaced toward the top.	32	76
Sandstone and quartzite, alternating thin and thick bedded, some of thicker beds show cross laminations up to 4".	33	44
Sandstone, fine grained, light brown weathering, thick bedded below, thin bedded in upper 3'.	11	11

Lehman Formation:

	I	II
Calcisilitite and calcilutite, medium gray, thin bedded, weathers bluish gray, slope forming. Upper 6' very thin bedded, shaly, weathering reddish and yellowish gray.	31	137
Sandstone, light brown, weathering orangish brown, fine to silty, forms the lowest predominantly quartz ledge of this section.	16	106
Calcisiltite, medium dark gray, weathering same, thin bedded, silty, Modiolopsis sp.	24	90
Calcilutite, thin bedded, weathers medium bluish gray, with yellowish silty partings, Orthis sp., Bolbocephalus ? sp., Pliomerops sp., Leperditia bivia White, high spired gastropods, raphistomid gastropods, cystid fragments, fossils abundant. (T-4, T-3, T-2).	66	66

Kanosh Shale:

	I	II
Shale, dusky yellow, fissile, with interbedded thin bedded, gray fossiliferous limestone, Leperditia bivia White, Orthis michaelis Clark, Anomalorthis utahensis Ulrich and Cooper, gastropod impressions, orthocones, (T-1).	40	40
Covered, lower beds masked by talus but float indicates presence of shales for at least 200 more feet. Some of these Orthis and Anomalorthis bearing shales in this section weather a red color similar to some of these beds at Crystal Peak. No shale beds of this color were observed at Ibex however.		

FISH SPRINGS SECTION, UTAH:

Base of section is located about one mile southeast of the Utah Mine and directly beneath the letter "i" in the word "Springs" as shown on the 1910 edition of the Fish Springs quadrangle map, reprinted 1943, in T. 11 S., R. 14 W., at the north end of the Fish Springs Range. Base of section can best be reached by following trail from Fish Springs Pony Express monument near the Thomas ranch westward to a point where a small hill in the canyon bottom is found opposite a northeastward trending side gulch. Follow this side gulch southwestward to the top of the massive ledge forming dark gray Upper Cambrian dolomite. Beds dip westward 10° at base of section increasing to 35° dip for the Ordovician Eureka quartzite along ridge crest.

Upper Ordovician Dolomite:

Thickness not measured; attitude same as underlying quartzite, but at the base of this formation about three feet above the uppermost typical Eureka quartzite bed is a two foot gray sandy dolomite bed suggesting an unconformity between the quartzite and the overlying dolomite.

Eureka Quartzite: (after Webb, 1949)	I	II
Quartzite, dark and with pearly surface.	2	142
Sandstone, calcareous, poorly exposed.	4	140
Quartzite, white and brown layers, interbedded with sandstone.	34	136
Covered.	19	102
Quartzite, white, vitreous, with interbedded brown mottled sandstone.	27	83
Covered, calcareous and shaly sandstone float.	27	56
Quartzite, strongly cross laminated at base.	20	29
Sandstone, friable, fine grained, weathers yellowish.	9	9
Dolomite Member:		
Dolomite, medium light gray, weathers light brownish gray, resistant, forms ledges at base of Eureka quartzite cliffs.	78	78
Swan Peak Formation ? :		
Covered.	33	61
Siltstone, weathers reddish brown, forms low ledges.	28	28
Lehman Formation:		
Calcilutite, medium bluish gray, silty layers weathering yellowish gray, thick bedded.	33	50
Dolomite, medium gray, weathers light brownish gray, crystalline, ledge forming.	17	17

	I	II
Kanosh Shale:		
Shale and calcarenite interbedded, weathering brownish gray, *Orthis michaelis* Clark, *Pliomerops* sp., *Macronotella* sp. cystid fragments.	22	33
Siltstone, calcareous, weathering yellowish brown, thin bedded, fragmental fossils poorly preserved, *Orthis* sp.	11	11
Note: Faulting repeats part of the Wahwah and Juab limestones in this vicinity on the east side of the Fish Springs Range. The section description below is on the east side of the fault line.		
Juab Limestone:		
Calcisiltite, medium gray, thin bedded, slope forming backslope to hillside; *Orthis* sp., *Pliomerops* sp.	188	188
Wahwah Limestone:		
Calcisiltite, medium gray, silty, with few intraformational conglomerate beds, forms resistant series of hogback ledges; siliceous throughout and with some dark brown chert as stringers and nodules particularly near the top where two six foot ledges are over half chert; *Pliomerops* cf. *P. insolita* Poulsen at base; *Goniotelus* sp., *Hesperonimia fontinalis* (White) at 16'; *Cybelopsis* cf. *C. speciosa* Poulsen at 27'; *Lachnostoma latucelsum* Ross, *Pseudocybele nasuta* Ross, *Carolinites genacinaca* Ross abundant in float blocks.	133	133
Fillmore Limestone:		
Calcisiltite, medium gray, thin bedded, slope forming.	22	761
Calcarenite, medium gray, thin to thick bedded, with abundant unsilicified trilobite remains in upper hundred feet, *Trigonocerca typica* Ross; at top a horizon contains abundant elongate sponge-like fossils cf. Receptaculites elongatus.	166	739
Intraformational conglomerate, medium gray, thin bedded, silty to siliceous, unsilicified trilobite fragments.	128	573
Calcisiltite, medium gray, thin bedded, siliceous, with light colored chert as irregularly bedded masses.	6	445

	I	II
Intraformational conglomerate, medium gray, weathering same, thin bedded, slope forming; contains a few thin calcarenite beds. Beds dip westward 25°.	188	439
Calcilutite, medium bluish gray, thick bedded, caps a series of ledges.	59	251
Interbedded, intraformational conglomerate, calcilutite, calcisiltite, and calcarenite, thin to thick bedded, forms ledgy slope; Megalaspidiella ? sp. in float at top.	116	192
Calcilutite, medium gray, thin bedded, weathers medium light gray, silty, slope forming; Kainella sp., Leiostegium cf. L. manitouensis Walcott, Hystricurus sp., Syntrophina sp. at 6' above base.	76	76

Housean:

	I	II
Dolomite, thin bedded, slope forming, weathers light brownish gray, appears more massive in gully bottoms than on hillside.	99	99

Upper Cambrian:

Thickness not measured, conformably underlies the thin bedded dolomites above referred to the Ordovician House limestone interval of the Ibex area on the basis of similar stratigraphic position and thin bedded appearance. Similarly this thick bedded, dark gray, cliff forming dolomite is referred to the Upper Cambrian on lithologic appearance in the absence of fossils. The Ordovician Pogonip group is characteristically underlain by a thick bedded, massive, resistant formation such as this in all localities examined in western Utah.

TINTIC MINING DISTRICT, UTAH:

The older literature bearing on the Ordovician of the Tintic district is reviewed by Hintze (1949, p. 45). Later in 1949 the report of T. S. Lovering (1949) somewhat revised the age and thickness assignments of earlier workers. Recently Dr. Lovering and associates have published an abstract (GSA, Cordilleran section, 1951) indicating further revision of the Upper Ordovician, Silurian, and Devonian stratigraphy there. Ordovician stratigraphy, as summarized from these latest publications, is presented below with some comments on the Lower Ordovician strata and a Middle Ordovician erosion interval discussed in light of a fauna discovered by the author in the uppermost Opohonga beds in 1949.

	I	II
Bluebell Dolomite: Upper Ordovician and Silurian (formerly considered to be Lower to Upper Ordovician).		
"Noah dolomite", blue gray, shaly bedding near base, upper 70' massive, (Silurian).	290'	894'
"Dora dolomite", blue gray, fine grained, upper 10' wavy, thin bedded ("Curley") dolomite, (Silurian).	212	604
"Beecher dolomite", upper 60' light gray lithographic dolomite, overlies well bedded, fine grained blue gray dolomite, (Silurian).	212	392
"Eagle dolomite", light gray fine grained dolomite with dark gray cherty bed at top and a 15' bed of dark blue gray, fine grained, thin bedded, flaky dolomite at base, (Upper Ordovician).	180	180
Opohonga Limestone: Lower Ordovician.		
Limestone, thin bedded, shaly, containing many intraformational conglomerate beds. Distinguished by striped, mottled, or mosaic appearance, accentuated by alternating bands of red to yellow argillaceous material surrounding short thin lenses of gray limestone.	825	825
Ajax Limestone: Lower Ordovician.		
Limestone, magnesian, fine grained, thin to medium bedded, gray, with abundant chert in the upper part.	390	625
Emerald dolomite member, light gray, fine grained dolomite.	35	235
Lower dolomite member, dark gray, mottled dolomite and magnesian limestone; contains cross bedded and conglomeratic beds and many nodules and lenses of light gray chert; white twiggy bodies with broad black borders common near the base.	200	200
Opex Dolomite: Upper Cambrian? Possible unconformity? between this formation and the overlying beds.		

The exact equivalence of the Ordovician formations of the Tintic district to parts of either the Garden City - Swan Peak sequence of northeastern Utah or the Pogonip - Eureka sequence of western Utah and eastern Nevada has long been a matter of speculation for few fossils have been found in the Ordovician at Tintic and the lithologic sequence there differs from other nearby localities in that the middle Ordovician quartzites were absent from Tintic. A faunal collection of early Canadian age made by the writer in 1949 from near the top of the Opohonga limestone, coupled with Lovering's information reassigning the Bluebell dolomite to the Upper Ordovician and Silurian rather than to "Lower to Upper Ordovician" indicates that there is within the Ordovician here an hiatus from Lower to Upper Ordovician. This results in an interpretation more conformable to the regional Ordovician occurrence than the older concept of continuous Lower to Upper Ordovician deposition within the Bluebell formation. Assignment of only the lower 180' "Eagle dolomite" member to the Upper Ordovician gives a thickness for the Upper Ordovician interval here in accord with other Great Basin localities.

The fossils obtained from the upper part of the Opohonga formation came from within about 10 feet of beds in a series of vertically standing beds along Eureka Creek just southeast of the town of Eureka, Utah. The collecting locality is about 40 feet west, down gulch, from the first outcrops not covered by the Beck dump, and the locality was marked prominently with yellow paint. The lithology is an alternating series of thin to medium thick bedded silty calcilutites, calcarenites, and intraformational conglomerates, but most of the fossils were obtained from a coarse calcarenite bed in which the brachiopods were particularly abundant, some even being silicified. The fossils were identified as follows:

Brachiopod:- Syntrophina cf. S. carinifera Ulrich and Cooper (Slightly larger than S. carinifera)

Trilobites:- Protopliomerops superciliosa Ross
Hystricurus oculilunatus Ross
Goniophrys prima Ross
Pachycranium faciclunis Ross
Asaphellus ? sp.

Cystid stem fragments

The trilobites are distinctive of Ross (1949, 1951) faunal zone "F" which is found in northeastern Utah from 300 to 400 feet above the base of the Garden City formation. Between zone "F" and the Upper Ordovician dolomite (Fish Haven) in northeastern Utah are normally about 1100 feet of Garden City and 200 to 500 feet of Chazyan Swan Peak quartzite. The nearest lower Ordovician locality of this report to the Tintic district, and one which compares somewhat in position along the margin of the miogeosyncline is that near Scipio, Utah, about 50 miles south of Eureka. The thicknesses and lithologies there compare quite closely with those of northeastern Utah mentioned above. Further west in the miogeosyncline the thickness of beds increases so that at Ibex, near the House Range about 100 miles southwest of Eureka, zone "F" is 1000 feet above the base of the lower Ordovician and is overlain by about 2000 feet of limestones and 1000 feet of sands to the base of the upper Ordovician dolomite. Also at the Stansbury range, some 80 miles northwest of Eureka there is a thick series between zone "F" and the upper Ordovician.

The most obvious anomaly of the Ordovician section at Tintic is the absence of Ordovician sands, which are well represented in surrounding sections. In addition to the lack of sands, the vidence cited above shows that there is an even thicker series of Ordovician limestones absent between zone "F" and the upper Ordovician Bluebell. The entire Ordovician sequence is absent from the stratigraphic column in the area between the Tintic district and Ogden, Utah. This broad central and southern Wasatch area must have been positive during medial Ordovician, and if other Ordovician beds were ever present they were subsequently removed by one or more of the several erosion intervals known. Within the Tintic district the pre-Upper Ordovician erosion must have removed most of the lower Ordovician beds although there is no evidence of an angular discordance between the Opohonga and the Bluebell.

As for a comparison of the Ordovician thicknesses below zone "F", the lithologies of the Opohonga are the same as one finds for this part of the Ordovician in surrounding sections and the published thickness (825') is comparable with the thickness of the same lithologies at Ibex. The upper 390' of the Ajax limestone compares lithologically with the lowest Ordovician beds of other areas that are described in this report. The Emerald and underlying dolomite compare lithologically with beds of similar position at Scipio. Whether or not these underlying lower Ajax dolomites are actually Lower Ordovician is not known, and they should not be added to the combined thickness of the upper Ajax and Opohonga for comparison with other lower Ordovician sections of this report.

STANSBURY ISLAND, UTAH: Measured on the east limb of the Stansbury Anticline at the south end of the Island. Beds dip from 50° to 68°, N 85° E.

Fish Haven Dolomite: Dark cherty dolomite; apparently conformable on Swan Peak; thickness not measured. About 40' interval covered below the dolomite ledge.

Swan Peak Formation:	I	II
Quartzite, brownish gray, weathers pale red, mostly medium grained, but some coarse grains, somewhat porous.	10'	1031'
Quartzite, white, weathers grayish orange pink, medium grained with some coarse grains, laminated by zones of less and more cemented quartzite, thin bedded, cross bedded in horizons up to 20' thick and in various directions suggesting dunes, at 769' bed with current ripple marks 1" between crests; spherical 1" to 2" pocks weather out throughout but more abundant in some zones; resistant and ledge-forming as a whole.	467	1021
Sandstone, light brownish gray, very thin bedded, cross bedded poorly cemented, forms a weaker zone beneath the overlying quartzite, pocked, shows many minor fold and joints.	212	554
Sandstone, moderate red, thin bedded, platy, forms weak zone near top of hill.	89	342
Dolomite, light gray.	2	253

	I	II
Sandstone, moderate red, thin bedded with abundant conspicuous ripple marks; interbedded red shales up to 2' beds.	23	25[illegible]
Dolomilutite, light gray.	2	228
Shales, weathering red, and sandstone weathering yellowish gray, interbedded, form weak zone.	92	226
Dolomite, gray, thin bedded, slope forming, poorly exposed, float indicates possible few thin sandstone interbeds.	62	134
Sandstone, weathers yellowish gray, medium grained thin bedded, cross bedded.	42	72
Dolomite, grayish brown weathering, thin bedded.	21	30
Quartzite.	1	9
Shale, red.	5	8
Quartzite, lowest observed quartzite, no break in sequence of deposition from underlying beds indicated.	3	3
Garden City formation:		
Dolomite, various shades of gray and grayish brown, thin bedded, forms slopes and float.	191'	1503
Dolomite, light medium gray, finely crystalline, massive, forms prominent ridge.	139	1312
Dolomite, pale yellowish brown, weathers same, silty, thin to medium bedded, conspicuously different than underlying limestones.	55	1173
Limestones, interbedded calcarentite, calcilutite, and intraformational conglomerate, gray, weathering light bluish gray with yellowish gray silty partings, thin to medium bedded, silty zones show fracure cleavage prominently.	663	1118
Dolomite, float only	70	455
Dolomite, very light gray, ledge	6	385
Dolomite, medium dark gray, thin bedded, wormy.	47	379
Dolomite, very light gray, thick bedded occasional chert nodule.	44	332
Dolomite, dark gray, with 10% black chert as bedded nodules.	12	288
Dolomite, medium dark gray weathering medium to light gray, mottled to wormy, medium bedded resistant ledges.	220	276
Dolomite, bluish gray, weathers same, with 5% light brown chert nodules, resistant, ledge forming.	56	56
Upper Cambrian ? several hundred feet of dolomites below ridge crest in core of anticline.		

STANSBURY RANGE: The only publication referring to the Ordovician in the Stansbury Range is that of Ruedemann (1947, Graptolites of North America, GSA Memoir 19, p. 109) who lists a collection of graptolites from the northwest face of Grantsville Peak. The Ordovician is faulted out on the east side of the Stansbury Range so that Cambrian rests against Mississippian. However, Ordovician rocks are widely exposed on the west side of the range from Grantsville Peak northward, but is considerably faulted.

Ross (1949, 1951) faunal zones G and J were recognized by the writer in the Garden City limestone sequence here and zone M in a series of hard olive green siliceous shales. No indication was found of an Ordovician sand overlying the shales, comparing in this respect to the section in the Lakeside Range 20 miles to the northwest where the quartzite is only one foot thick, and contrasting with the section on Stansbury Island about 10 miles to the northeast where several hundred feet of cross bedded quartzite is found.

LAKESIDE MOUNTAINS: The Lakeside Mountains are on the west side of the Great Sale Lake and 60 miles by highway from Salt Lake City. The teneral structure of the range is homoclinal so that the late Paleozoic rocks are found on the southern end of the range near Delle, Utah, while the earlier Paleozoic is exposed toward the northern end of the range. The section of Ordovician rocks described below is of fairly difficult access being located in the central part of the range on the slopes of its highest peak. This location is 11.3 speedometer miles northward from Delle along a graded desert road, thence 4 miles westward over a very rocky and narrow mining road leading up Cramer Gulch to an abandoned mining shack and dump. From this shack there is a foot trail leading southwestward up Mine Gulch about a mile to other abandoned mine workings. The measured section was begun at a small mine dump in the gulch bottom, SE-1/4, Section 23, T. 2 N., R. 9 W., and proceeded from there up the main gulch toward the peaks capped with dark, cherty, massive, Upper Ordovician dolomite. The beds dip 13°, S. 75° W.

	I	II
Fish Haven Dolomite: Thickness not measured, rests with no apparent angular discordance on the quartzite, contains <u>Streptelasma</u> sp.		
Swan Peak Formation: This formation is notable here for the thinness of the upper quartzite member, here only one foot thick. Its absence may be due to nondeposition, Middle Ordovician erosion, or both. No conclusive evidence for either was found but the persistance of the thin quartzite bed where observed suggests that erosion is the least likely of the two possibilities.		
Quartzite, light gray, fine grained, ledge.	1'	141'
Shale, pale yellowish brown, slope forming, interbedded with limestones, dark to light gray, shaley, thin bedded, and fine to coarse grained, <u>Anomalorthis</u> sp., <u>Orthis</u> cf. <u>swanensis</u> Ulrich and Cooper, echinoderm fragments, cystid plates.	25	140
Covered, float indicates yellow brown shales with thin bedded silty limestone interbeds.	15	115
Siltstone, pale yellowish brown, slope forming, shaley interbeds, <u>Orthis</u> <u>swanensis</u> Ulrich and Cooper.	30	100

	I	II
Siltstone, pale red and yellowish brown, calcareous, fucoidal markings, interbeds of yellow brown fissile shales.	20	70
Limestone, gray, silty, thin bedded, fossiliferous, Hesperonomiella? sp., Orthis sp., Anomalorthis utahensis Ulrich and Cooper, Eleutherocentrus sp., Pliomerops sp., cystid plates.	10	50
Siltstone, calcareous, gray, weathering yellow brown, Orthis sp.	5	40
Calcisiltite, banded gray and reddish, weathering yellow brown, Macronotella sp. abundant.	10	35
Intraformational conglomerate, silty limestone pebbles, flat, subrounded, somewhat random orientation but mainly horizontal, in a shaley interbeds.	10	25
Shales, yellow brown, with silty limestone interbeds.	10	15
Covered, float indicates yellow brown shales.	5	5
Garden City Formation:		
Calcilutite and calcarenite interbeded, medium gray, weathering light yellowish gray, silty, thin bedded, Syntrophopsis sp. (L-164)	29'	699'
Calcilutite, medium gray, weathering yellowish brown, silty partings.	40	670
Calcisiltite, medium gray, slope forming, indistinctly bedded, but with ledgy outcrop in upper 8'.	45	630
Limestones, light gray weathering light yellowish gray, silty, with chert in irregular bedding masses up to 4" thick but discontinuous.	35	585
Covered, float indicates shaley limestone.	70	550
Calcilutite, silty, with some bedding plane chert.	10	480
Calcilutite, gray, weathers light brown with "chickenwire" silty partings.	65	470
Limestones, calcilutites with some beds of intraformational conglomerate of calcilutite pebbles in calcarenite matrix, partly silicified brachiopods in matrix, Tritoechia sp. (L-155) at top.	25	405
Calcilutite, gray, with shaley parting.	10	380
Calcarenite, medium dark gray, weathers light grayish brown, forms ledges in gully bottom, fossiliferous, Syntrophopsis sp., Kirkella cf. vigilans (Whittington), Goniotelus sp., Isoteloides sp. (L-154)	25	370
Limestones, thin bedded shaley calcilutite with occasional interbedded calcarenites.	15	345
Covered, float indicates interbedded intraformational conglomerate and silty, shaley calcilutite.	80	330
Covered, float indicates calcilutite bearing sponge-like fossils cf. Receptaculites elongatus Walcott.	40	250

	I	II
Limestones, interbedded thin bedded intraformational conglomerates and silty calcilutites.	20	210
Siltstone, calcareous, thin bedded, with interbeds of shaley limestone and calcarenite.	30	190
Limestones, alternating yellow brown weathering silty calcisiltite and medium gray calcilutite in thick bedded layers with shaley parting, occasional intraformational conglomerate beds.	30	160
Intraformational conglomerate, with some calcilutite beds, chert noted in float.	30	130
Limestones, interbeded calcilutite, calcarenite, and intraformational conglomerate.	35	100
Covered, limestone float.	15	65
Intraformational conglomerate, calcilutite pebbles in calcisiltite matrix, thin bedded, interbedded with silty limestone.	50	50

Underlying thick series of thick bedded, massive, gray unfossiliferous limestones were not measured but probably include equivalents of the lower Garden City formation, which, because of the massive lithology and lack of fossils could not be distinguished from Upper Cambrian beds which present a similar massive appearance in this region.

PROMONTORY POINT (WEST SIDE): At one place on the west side of the Promontory which extends southward into the Great Salt Lake the Swan Peak quartzite forms some very prominent orange colored bluffs. This place is about nine miles by speedometer south of the Golden Spike Monument of the former railroad town of Promontory and may be reached by a graded road. At the foot of the quartzite the shaly member of the Swan Peak formation is poorly exposed, but beneath these shaly beds the upper half of the Garden City formation is well displayed. The lower beds here disappear beneath the alluvium but may be seen near the road on the east side of the Promontory Point about nine miles south of Bert. The author is indebted to Dr. J. Stewart Williams and Dr. R. J. Ross for bringing these sections to his attention.

Fish Haven Dolomite: Thickness not measured. This dark gray dolomite overlies the quartzite below apparently conformably, but with an exceptionally sharp contact. No more than 4" of gradational gray dolomitic sandstone was observed at the contact. This probably represents sand reworked in the erosion interval just preceding the colomite deposition.

Swan Peak Formation:	I	II
Quartzite, white, vitreous, forms yellowish orange stained cliffs.	480'	720'

	I	II
Quartzite float, large talus blocks from cliffs above, probably covers thinner bedded quartzite.	33'	240
Quartzite, apparently a bedrock outcrop in a field of talus blocks.	12	207
Covered, quartzite talus blocks, probably shales.	139	195
Shales, dark gray, with interbeds of very thin bedded silty limestone, bedrock outcrop, _Orthis michaelis_ Clark	8	56
Covered, shaly float bearing _Orthis michaelis_ Clark, _Anomalorthis_ sp., _Receptaculites mamillaris_ Walcott, orthocones, cystid fragments.	34	48
Sandstone, brown, ledge forming at crest of saddle, talus chips on side hill and ravine.	7	14
Covered.	7	7
Garden City Formation:		
Dolomite, dark gray, massive, cliff forming, lower part weathers light bluish gray, upper 15' weathers light brownish gray, unfossiliferous.	122	1472
Dolomite, dark gray weathering light bluish gray, massive, contains little silt, unfossiliferous, forms slopes beneath ledges.	86	1350
Calcilutite, medium dark gray, thick bedded, ledgy, silty, cherty, black chert in irregular bedded masses comprises up to 50% of rock in upper part and stand out as cliffs.	176	1264
Calcarenite, fine, medium dark gray weathering medium light gray, shaly, very thick bedded, gnarly, forms cliff just above the Provo lake terrace in this section.	54	1088
Covered.	114	1034
Calcisiltite, medium gray, thin bedded, slightly silty, platy weathering, _Trigonocerca typica_ Ross abundant.	6	920
Covered, Provo level lake terrace.	129	914
Calcisiltite, medium gray, thick bedded, silty to siliceous, silty material weathering in thin pinkish or yellowish gray seams which etch into relief, pseudo cross lamination effects in silty zones due to fracture cleaveage. Contains a few thin interbedded intraformational conglomerate layers, _Psalikilus typicum_ Ross at 590'.	240	785
Calcisiltite, medium gray, silty, low ledges.	30	545
Covered.	2	515
Calcisiltite, medium gray, quartz silty, fracture cleaveage effects, forms low ledges.	30	513
Calcisiltite, medium gray weathering same, silty, ledgy.	41	483
Calcarenite, coarse, medium gray, ledge.	2	442
Covered, Lake Bonneville conglomerates.	21	440
Calcisiltite, medium gray, very silty, silty beds show fracture cleaveage and weather light	42	419

	I	II
yellowish gray, about 20% interbedded intraformational conglomerate as thin beds with small subrounded pebbles.		
Calcisiltite, medium gray, thick bedded, the more silty layers show fracture cleaveage and are less resistant than the cleaner carbonate beds, ledgy, some thin intraformational congomerate beds.	72	377
Covered, rubbly calcisiltite chips.	11.5	305
Calcisiltite, medium gray, thick bedded, silty ledgy, Protopliomerops sp., Menoparia genalunata Ross, Megalaspidiella sp.	20.5	293.5
Calcisiltite, medium gray, thin bedded, ledge, Protopliomerops celsaora Ross, Menoparia genalunata Ross, Megalaspidiella n. sp.	7	273
Covered.	6	266
Calcisiltite, medium gray, with yellow brown weathering silty partings, fracture cleaveage, about 2% light brown chert as bedded nodules, few thin beds of intraformational conglomerate.	4	260
Covered.	11	256
Calcisiltite, medium gray, weathering light brownish gray, low ledges.	4	245
Covered.	9	241
Intraformational conglomerate, small calcisiltite pebbles in calcisiltite matrix, ledge.	2	232
Calcisiltite, mottled medium and medium light gray, thin bedded, silty, fracture cleaveage, forms slopes.	48	230
Calcisiltite, medium gray, thick bedded, quartz silty, siliceous, caps 10' ledge, Menoparia genalunata Ross, Psalikilus n. sp., Megalaspidiella n. sp.	6.5	182
Calcisiltite, light medium gray, silty, with thin conglomerate lenses.	2.5	175.5
Intraformational conglomerate, light medium gray, small flat calcisiltite pebbles in a coarse calcarenite matrix.	1	173
Covered.	29.8	172
Calcisiltite, medium gray, thick bedded, about 5% light brown chert in thin platy bedded masses, Protopliomerops superciliosa Ross, Goniophrys prima Ross, Hyperbolochilus marginauctum Ross, Parahystricurus fraudator Ross, Amblycranium cornutum Ross.	6.9	142.2
Calcisiltite, medium gray, silty.	10.3	135.3
Covered.	5.5	125
Calcarenite, medium gray, thin bedded, silty, gnarly.	1.5	119.5
Covered.	6	118
Calcilutite, medium gray, thin bedded, silty, very light greyish brown chert in nodules comprise 10% of upper 2'.	5	112

	I	II
Covered.	11	107
Calcisiltite and calcarenite, medium gray, thin bedded, silty, Parahystricurus sp. at 96'.	13	96
Calcisiltite, medium gray, thick bedded, forms ledge, siliceous.	12	83
Covered.	15	71
Calcilutite, medium gray, thick bedded, ledge, with layers of calcisiltite, and fine calcarenite.	14	56
Covered, probably silty calcisiltite.	22.4	42
Calcilutite, medium gray, massive ledge, round chert nodules in upper 2' comprise 5% of rock.	5.6	19.6
Calcisiltite, medium gray, silty weathers yellowish gray, fracture cleaveage pattern at 20° to bedding, forms reentrant under ledge.	3	14
Covered.	5	11
Calcilutite, medium gray, massive ledge, thin chert stringers cut bedding. This is the lowest bed exposed above alluvium.	6	6

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