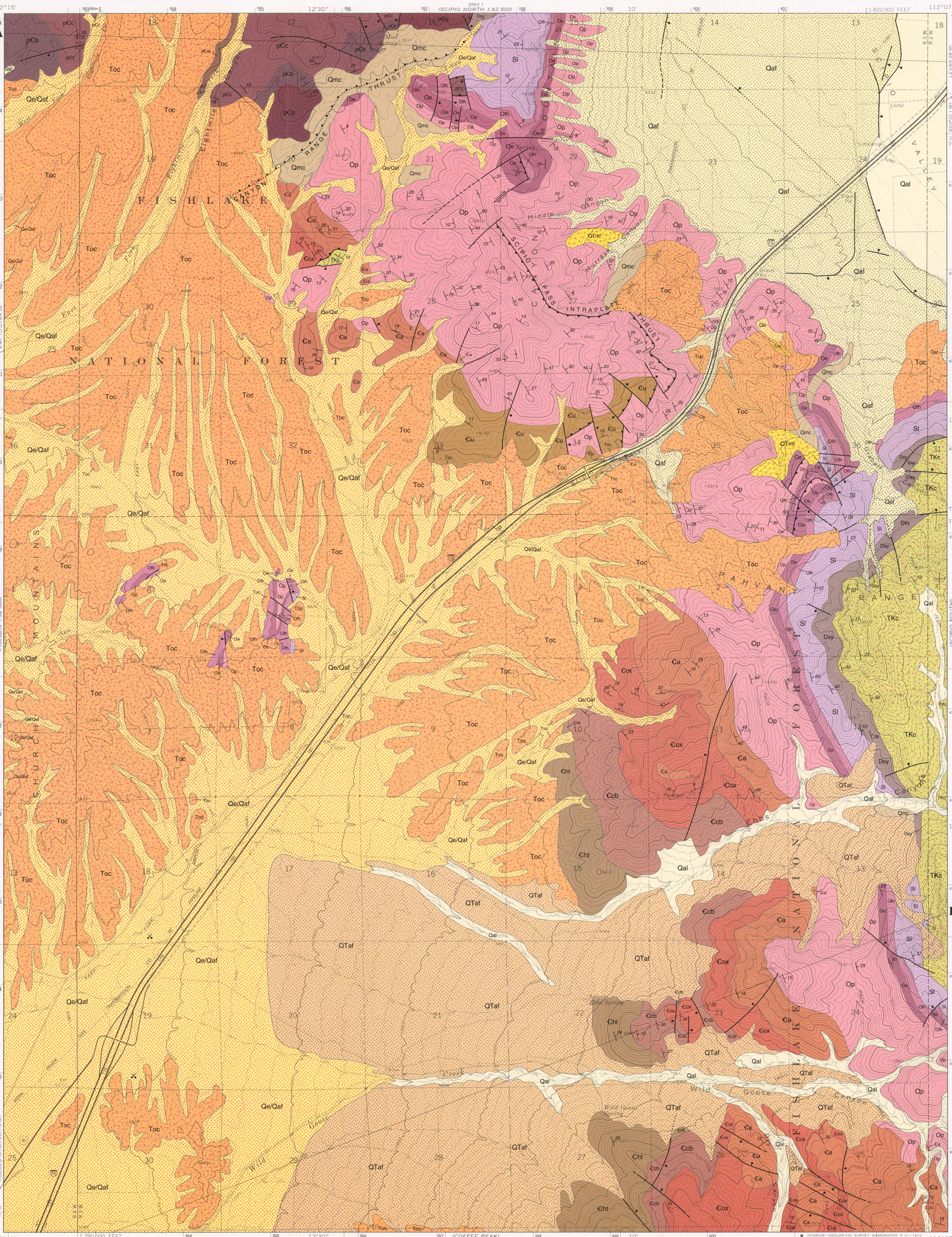
UTAH GEOLOGICAL SURVEY
a division of
UTAH DEPARTMENT OF NATURAL RESOURCES



Base from U.S. Geological Survey, Scipio Pass 7.5′ Quadrangle, 1969
Base modified 1994

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

Field work by R. Michaels 1983, 1985
Field work by L. Hintze 1990
Cartography by J. Parker

GEOLOGIC MAP OF THE SCIPIO PASS QUADRANGLE, MILLARD COUNTY, UTAH

by

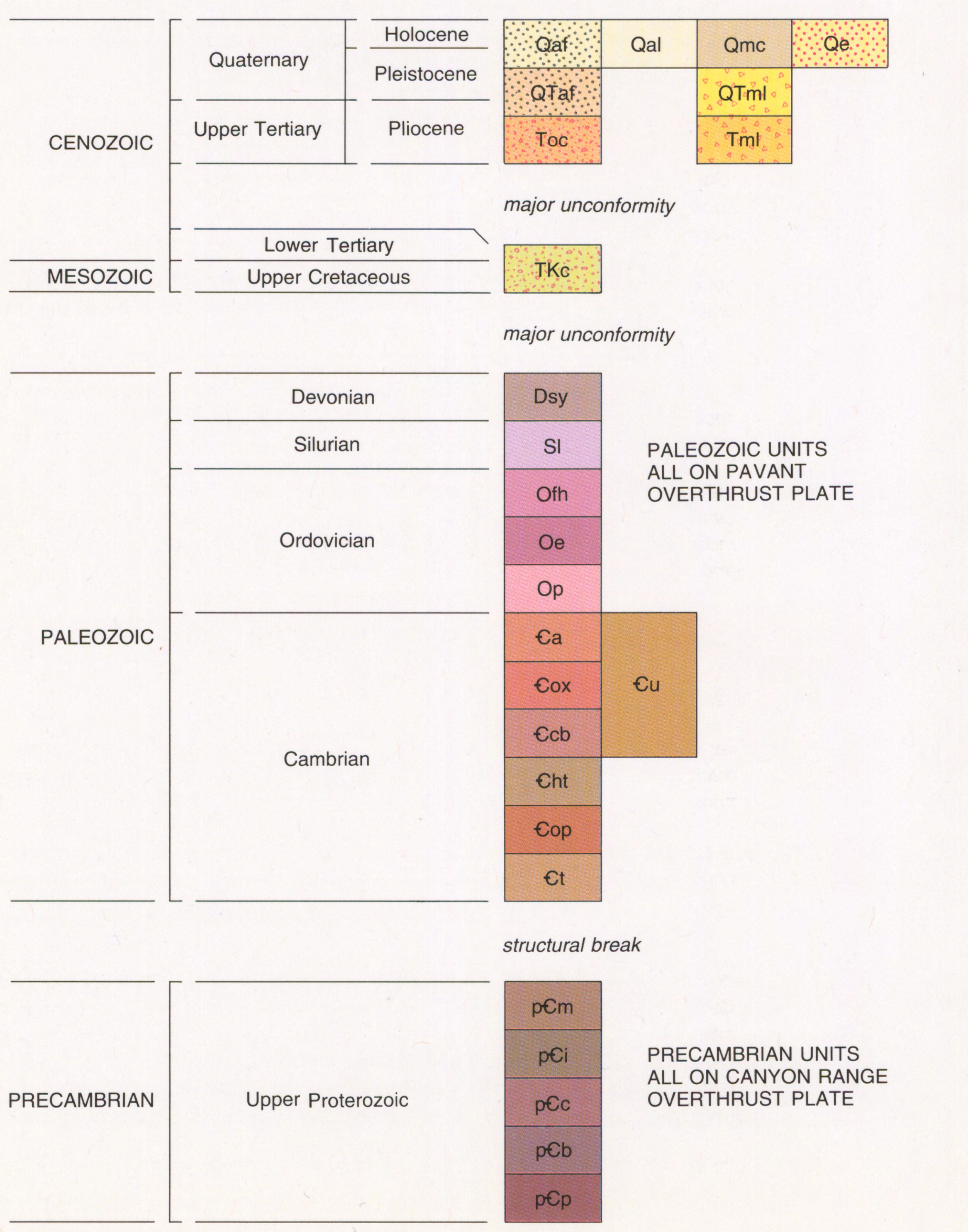
Roger B. Michaels and Lehi F. Hintze

1994

1994 MAGNETIC DECLINATION AT CENTER OF MAP
13°42′ E
243.6 MILS

UTAH
LOCATION MAP

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qal Alluvium of low-order streams-- *Fine-grained to locally coarse-grained, poorly sorted alluvium. Estimated thickness is up to 100 feet (30 m).*

Qe Eolian deposits-- *Pinkish-gray dust, silt, and fine sand, carried by prevailing north-easterly winds to the Church Mountains and southwest flank of the Canyon Mountains. Locally intermixed with contemporaneous alluvial-fan and stream deposits. As much as 15 feet (5 m) thick. Qe/Qaf means that a thin deposit of Qe overlies and may be intermixed with Qaf alluvial-fan and stream deposits.*

Qmc Colluvium-- *Deposits of mass wasting, shown on map only where they significantly conceal bedrock. Made of debris derived from bedrock units upslope from colluvial deposits. Locally may be as much as 100 feet (30 m) thick.*

Qaf Young alluvial-fan and stream deposits-- *Composed mainly of gravel, grit, sand, and silt. As mapped, it includes alluvium in steeper stream valley bottoms above the heads of fans. Also locally includes a major component of eolian silt and fine sand. Maximum thickness not known, but may be several hundred feet on the slope of major fans.*

QTaf Old alluvial-fan deposits-- *Poorly sorted, angular to subrounded boulders, cobbles, gravel, sand, and silt. Uncemented but surficial clasts commonly show well-developed caliche on the bottom side. Thickness estimated to be as much as a few hundred feet (100+ m).*

QTml Landslide and colluvial deposit-- *Broken blocks and masses of Eureka Quartzite and soil that is rich in angular quartzite fragments. Thickness probably a few tens of feet (10+ m).*

Tml Old landslide deposit-- *Composed principally of blocks of Eureka Quartzite, the largest are 12 feet (4 m) in diameter. Deposit may be more than 30 feet (10 m) thick locally.*

Toc Oak City Formation-- *Poorly sorted, unbedded, mostly uncemented materials composed of large to small boulders, cobbles, pebbles, and sand derived from local uphill sources. Clasts range from subangular to well-rounded; most are subrounded. Thickness ranges from zero to at least several hundred feet (100+ m).*

TKc Canyon Range conglomerate-- *Coarse bouldery conglomerate with a red or gray sandstone matrix. Basal part has mostly clasts of Cambrian and Precambrian quartzite; upper part includes limestone boulders and sandstone beds. Thickness 792+ feet (242+ m).*

Dsy Sevy Dolomite-- *Light-gray, fine-grained, laminated, locally cherty dolomite. Top not exposed. Partial thickness in this quadrangle is 423 feet (129 m).*

Sl Laketown Dolomite-- *Medium- to dark-gray, medium-grained, thick-bedded, cherty dolomite. Generally forms cliffs, but is locally fractured and less resistant in this quadrangle than elsewhere in western Utah. Measured thickness here is 832 feet (253.5 m).*

Ofh Fish Haven Dolomite-- *Medium-dark-brownish-gray, fine-grained dolomite that weathers light olive gray. Generally chertless, locally includes dark-gray limestone beds. Measured thickness in this quadrangle is 261 feet (79.5 m).*

Oe Eureka Quartzite-- *White, thin- to medium-bedded quartzite that generally forms cliffs. Locally brecciated and tectonically attenuated. Lowest Eureka beds are silty and weather pink, orange, or brown. Measured thickness is 180 feet (54 m).*

Op Pogonip Group, undivided-- *Lower 300 feet (90 m) is medium-gray, slightly cherty, fine-grained, thick-bedded limestone that forms cliffs and ledges. Middle 1,046 feet (317 m) is medium-gray, thin- to medium-bedded, slope-forming shaly and silty limestone characterized by intraformational conglomerate beds. Upper 320 feet (98 m) is interbedded olive-gray shale and thin-bedded, fossiliferous limestone. Brachiopod coquinas make up some beds. Thin beds of sandstone appear near the top. Total thickness of Pogonip Group is 1,666 feet (505 m).*

Ꞓu Undivided Cambrian carbonate rocks-- *Dolomitic rocks found beneath Pogonip Limestone north of Scipio Pass. The rocks are locally brecciated and are probably mostly Ajax Dolomite, but may include slivers of Opex Formation and Cole Canyon and Bluebird Dolomites, undivided. Several hundred feet of strata are involved.*

Ꞓa Ajax Dolomite-- *Light-brownish-gray to dark-gray dolomite that weathers light olive gray and is generally thick bedded and cliffs. Chert is locally present, as are stromatolitic algal structures. Measured thickness is 966 feet (295 m).*

Ꞓox Opex Formation-- *Gray, thin- to thick-bedded, shaly and bioclastic limestone, with thin interbeds of dolomite, shale, and sandstone. Bioclastic limestone beds in lower part contain the trilobite Tricrepicephalus. Measured thickness is 671 feet (205 m).*

Ꞓcb Cole Canyon and Bluebird Dolomites, undivided-- *Medium-gray to light-brownish-gray, fine-grained, thick-bedded dolomite, with interbeds of dark-gray dolomite that contain small white dolomite rods. Dolomite is locally mottled, probably from bioturbation during deposition. Measured thickness is 536 feet (164 m).*

Ꞓht Herkimer, Dagmar, and Teutonic Formations, undivided-- *Upper and lower parts are dark- to medium-gray limestone, mottled with blebs and stringers of light-olive-gray, silty dolomite. Lower part also includes oolitic and oncolitic algal structures, and Glossopleura-zone trilobites. Middle part includes distinctive light-gray to white, laminated dolomite beds that locally include algal stromatolite structures. Measured thickness is 944 feet (303 m), but base of formation is not exposed here.*

Ꞓop Ophir Formation-- *Interbedded shale and thin-bedded limestone. Not exposed in this quadrangle. Thickness shown on cross section is 500 feet (150 m).*

Ꞓt Tintic Quartzite-- *Fine- to coarse-grained, indurated white quartzite. Not exposed in this quadrangle. Thickness shown on cross section is 3,000 feet (1,000 m).*

pꞒm Mutual Formation-- *Pale-red or grayish-red, medium-grained, medium-bedded quartzite that locally shows small-scale cross bedding. Only partly exposed in this quadrangle. Thickness measured north of this quadrangle, in the Canyon Mountains, is 2,250 feet (690 m).*

pꞒi Inkom Formation-- *Silty argillitic shale. Not exposed in this quadrangle. Thickness measured in the adjacent quadrangle to the north is 270 feet (84 m).*

pꞒc Caddy Canyon Quartzite-- *Only partly exposed in this quadrangle. A few miles north of here, in the Canyon Mountains, the lower 750 feet (227 m) is silty and thin bedded; upper 1,170 feet (355 m) is light-grayish-white quartzite that weathers brown or orange, and forms cliffs and ledges.*

pꞒb Blackrock Canyon Limestone-- *Only partly exposed in this quadrangle. Thin-bedded reddish-, brownish-, or olive-gray limestone that commonly contains algal oolites, pisolites, and stromatolites. In the Canyon Mountains, north of this quadrangle, its thickness was measured to be 560 feet (169 m).*

pꞒp Pocatello Formation-- *Phyllitic, yellowish-brown quartzite, olive-gray siltstone, and light-olive-gray shale. Only a small part is exposed in this quadrangle. To the north in the Canyon Mountains a more complete section was measured to be 800 feet (250 m) thick, but the base of the formation is not exposed anywhere in the Canyon Mountains.*

MAP SYMBOLS

Contact

Normal fault-- *Dashed where approximately located, dotted where concealed; bar and ball on downthrown side.*

Thrust fault-- *Dotted where concealed; teeth on upper plate.*

30 70 Strike and dip of bedding-- *Inclined, vertical, overturned.*

Gravel pit

Prospect pit

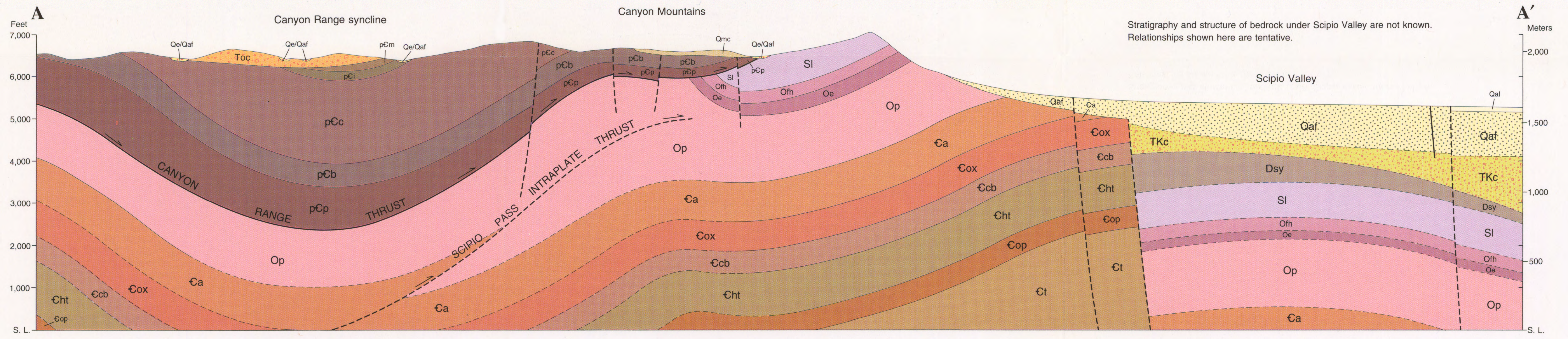
LITHOLOGIC COLUMN

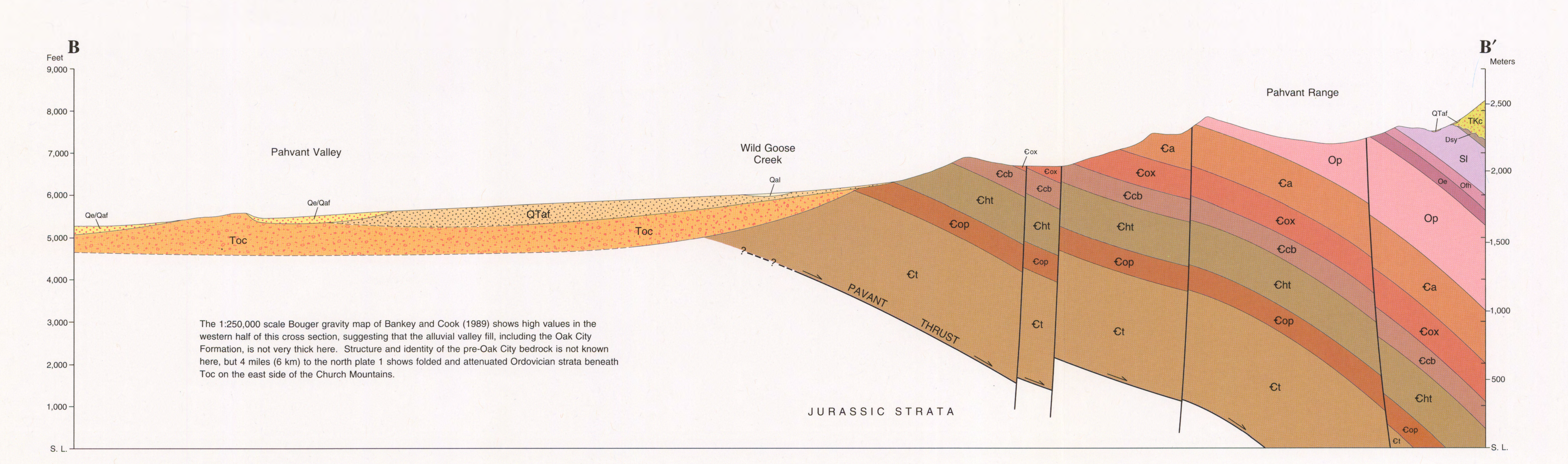
AGE	MAP UNIT	MAP SYMBOL	THICKNESS feet	THICKNESS meters	LITHOLOGY
QUATERNARY	Alluvium, colluvium, eolian silt, young (Q) and old (QT) alluvial-fan and old landslide deposits	Qal,Qmc, Qe,Qaf, QTaf, QTml	0 to several hundred		
PLIOCENE	Old landslide deposit	Tml	0-30	0-10	
	Oak City Formation	Toc	0 to several hundred		
LOWER TERTIARY-UPPER CRETACEOUS	Canyon Range conglomerate	TKc	792+	242+	
DEVONIAN	Sevy Dolomite	Dsy	423+	129+	PALEOZOIC STRATA ARE ALL PART OF THE PAVANT OVERTHRUST PLATE
SILURIAN	Laketown Dolomite	Sl	832	254	cherty
ORDOVICIAN	Fish Haven Dolomite	Ofh	261	80	locally brecciated
	Eureka Quartzite	Oe	180	54	
	Pogonip Group, undivided	Op	1,684	513	ostracodes; brachiopods; trilobite fragments; intraformational conglomerate common; cherty
CAMBRIAN	Ajax Dolomite	Ꞓa	966	295	algal stromatolites
	Opex Formation	Ꞓox	671	205	bioclastic limestone; *Tricrepicephalus* trilobites
	Cole Canyon and Bluebird Dolomites, undivided	Ꞓcb	536	164	white "twiggy bodies"
	Herkimer, Dagmar, and Teutonic Formations, undivided	Ꞓht	994+	303+	algal stromatolites; white laminated boundstone; base concealed
	Ophir Formation	Ꞓop	500	150	on cross-section only
	Tintic Quartzite	Ꞓt	3,000	1,000	on cross-section only

STRATA BELOW ARE ON CANYON RANGE OVERTHRUST PLATE

AGE	MAP UNIT	MAP SYMBOL	THICKNESS feet	THICKNESS meters	LITHOLOGY
PRE-CAMBRIAN	Mutual Formation	pꞒm	2,250*	690*	
	Inkom Formation	pꞒi	270*	84*	on cross-section only
	Caddy Canyon Quartzite	pꞒc	1,920*	585*	
	Blackrock Canyon Limestone	pꞒb	380	115	ooids and algal stromatolites
	Pocatello Formation	pꞒp	800+*	250+*	

*Only part of this formation is present in this quadrangle. Thickness figures given here are from Millard (1983).

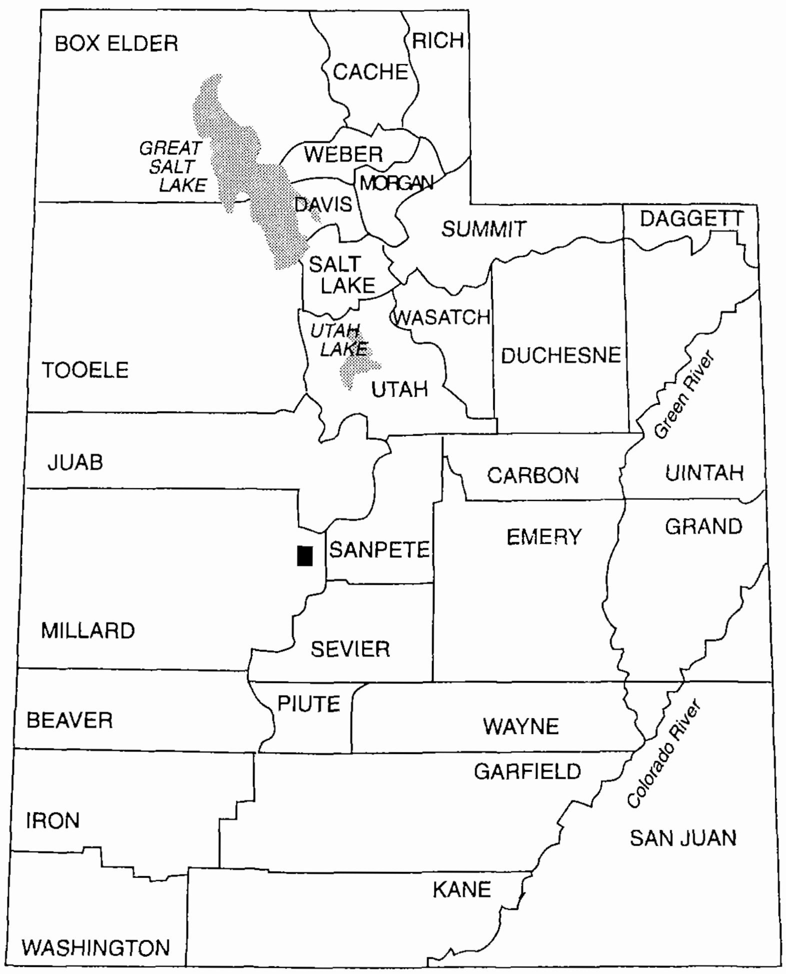




The 1:250,000 scale Bouger gravity map of Bankey and Cook (1989) shows high values in the western half of this cross section, suggesting that the alluvial valley fill, including the Oak City Formation, is not very thick here. Structure and identity of the pre-Oak City bedrock is not known here, but 4 miles (6 km) to the north plate 1 shows folded and attenuated Ordovician strata beneath Toc on the east side of the Church Mountains.

GEOLOGIC MAP OF THE SCIPIO PASS QUADRANGLE, MILLARD COUNTY, UTAH

by
Roger B. Michaels and Lehi F. Hintze

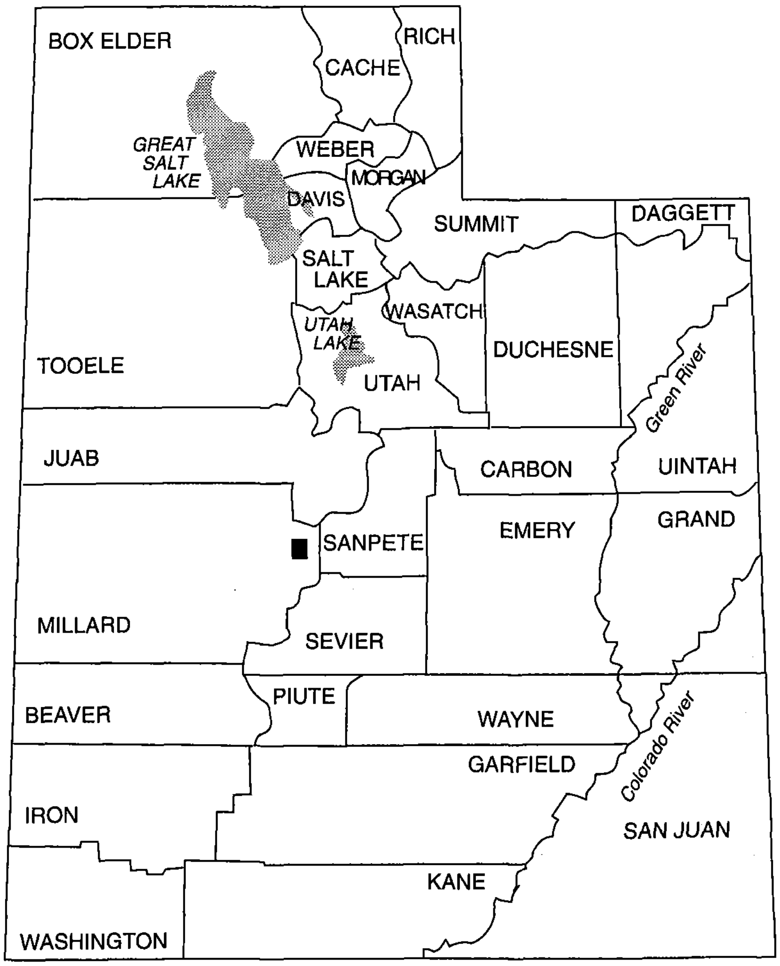


MAP 164 **1994**
UTAH GEOLOGICAL SURVEY
a division of
UTAH DEPARTMENT OF NATURAL RESOURCES

Michaels, Hintze
GEOLOGIC MAP OF THE SCIPIO PASS QUADRANGLE, MILLARD COUNTY, UTAH
Utah Geological Survey Map 164

GEOLOGIC MAP OF THE SCIPIO PASS QUADRANGLE, MILLARD COUNTY, UTAH

by
Roger B. Michaels and Lehi F. Hintze



MAP 164 **1994**
UTAH GEOLOGICAL SURVEY
a division of
UTAH DEPARTMENT OF NATURAL RESOURCES

STATE OF UTAH
Michael O. Leavitt, Governor

DEPARTMENT OF NATURAL RESOURCES
Ted Stewart, Executive Director

UTAH GEOLOGICAL SURVEY
M. Lee Allison, Director

UTAH GEOLOGICAL SURVEY
2363 South Foothill Drive
Salt Lake City, Utah 84109-1491
Phone: (801) 467-7970   Fax: (801) 467-4070

THE UTAH GEOLOGICAL SURVEY is organized into three geologic programs with Administration, Editorial, and Computer Resources providing necessary support to the programs. THE ECONOMIC GEOLOGY PROGRAM undertakes studies to identify coal, geothermal, uranium, hydrocarbon, and industrial and metallic mineral resources; to initiate detailed studies of the above resources including mining district and field studies; to develop computerized resource data bases, to answer state, federal, and industry requests for information; and to encourage the prudent development of Utah's geologic resources. THE APPLIED GEOLOGY PROGRAM responds to requests from local and state governmental entities for engineering geologic investigations; and identifies, documents, and interprets Utah's geologic hazards. THE GEOLOGIC MAPPING PROGRAM maps the bedrock and surficial geology of the state at a regional scale by county and at a more detailed scale by quadrangle. The Geologic Extension Service answers inquiries from the public and provides information about Utah's geology in a non-technical format.

The UGS manages a library which is open to the public and contains many reference works on Utah geology and many unpublished documents on aspects of Utah geology by UGS staff and others. The UGS has begun several computer data bases with information on mineral and energy resources, geologic hazards, stratigraphic sections, and bibliographic references. Most files may be viewed by using the UGS Library. The UGS also manages a sample library which contains core, cuttings, and soil samples from mineral and petroleum drill holes and engineering geology investigations. Samples may be viewed at the Sample Library or requested as a loan for outside study.

The UGS publishes the results of its investigations in the form of maps, reports, and compilations of data that are accessible to the public. For information on UGS publications, contact the Sales Office, 2363 South Foothill Drive, Salt Lake City, Utah 84109-1491, (801) 467-0401.

GEOLOGIC MAP OF THE SCIPIO PASS QUADRANGLE, MILLARD COUNTY, UTAH

by

Roger B. Michaels[1] *and Lehi F. Hintze*[2]

ABSTRACT

The Scipio Pass quadrangle lies at the west edge of the transition zone between the Basin and Range physiographic province and the Colorado Plateaus to the east. The quadrangle includes three separate packages of strata: Precambrian rocks on the Canyon Range overthrust plate, Paleozoic strata on the Pavant overthrust plate, and syn- to post-thrusting deposits of Late Cretaceous and early Tertiary age.

Precambrian rocks occur only along the north edge of the quadrangle and include partial sections of the Proterozoic Mutual, Inkom, Caddy Canyon, Blackrock Canyon, and Pocatello Formations which are more than a mile (1.6 km) thick where completely exposed in the Canyon Mountains, north of the quadrangle. More than 6,500 feet (2,000 m) of Paleozoic strata are exposed in the quadrangle including about 400 feet (120 m) of Devonian dolomite, 800 feet (250 m) of Silurian dolomite, 2,100 feet (640 m) of Ordovician limestone, quartzite, and dolomite, and 3,200 feet (1,000 m) of Cambrian carbonate rocks. The quadrangle includes the best exposures of Cambrian and Ordovician strata in the Pahvant and Canyon ranges. These are important because they are the easternmost exposures of lower Paleozoic rocks at this latitude in Utah. About 800 feet (240 m) of Upper Cretaceous to lower Tertiary Canyon Range conglomerate rests unconformably over the Paleozoic rocks. Surficial deposits include the Pliocene Oak City Formation which consists of several hundred feet (100+ m) of debris-flow deposits shed off the west side of the Canyon and Pahvant ranges. These are overlain by younger Pliocene and Quaternary alluvium, colluvium, eolian, landslide, and alluvial-fan deposits that are up to several hundred feet (100+ m) in thickness locally.

Structures in the quadrangle were produced during two different stress regimes. Easterly directed compressional forces, operating during the Sevier orogeny between 100 and 60 million years ago, produced major folds and overthrusts, as well as minor folds, intraplate thrusts, and local brittle attenuation of strata. East-west extensional forces, along with regional vertical uplift in late Cenozoic time, produced the current topography. The Pahvant and Canyon ranges, together, are a basin-and-range fault block with the major range-bounding fault along the east side. Regional gravity and magnetic surveys do not delineate this fault. COCORP deep seismic reflection data, available only for the west half of the quadrangle, suggest that the Pavant thrust, which is exposed within the Pahvant Range south of this quadrangle may be identifiable in some east-dipping reflections.

Economic geologic resources produced from the quadrangle have, to date, been limited to gravel used in local road and freeway construction. The quadrangle contains abundant limestone, dolomite, and quartzite that has potential as lime, cement, and silica sources. No one lives permanently within the quadrangle, although thousands of people pass through the quadrangle each day on the I-15 freeway. There are no perennial streams within the quadrangle. The few springs are used seasonally for stock watering. The only cultivated ground in the quadrangle is about two square miles (5 km^2) of pastureland in Scipio Valley.

The quadrangle is on the west edge of the Intermountain seismic belt. Fault scarps cutting Quaternary alluvium in Scipio Valley indicate that major earthquakes have occurred in the area within the past 10,000 years. Seismic records for the past three decades show a few earthquakes of magnitude 3 or greater have

Editor's note: *The term "Canyon Range" has been used in geologic literature since 1890 to refer to the Canyon Mountains. It is retained in this report for geologic names while Canyon Mountains is used for the physiographic feature. The spelling of Pahvant for the physiographic feature reflects a U.S. Board on Geographic Names decision. "Pavant" is retained for geologic names established through time.*

1. 597 North 300 West, Mapleton, Utah 84664
2. Utah Geological Survey

occurred close to the quadrangle, but none in nearby areas were large enough to cause appreciable damage. A cloudburst flood might cause local damage to the freeway if an unusually heavy storm hit one of the small drainage basins near Scipio Pass, but major flood damage is not likely.

INTRODUCTION

This quadrangle lies between the towns of Scipio and Holden in central Utah (figure 1). Interstate highway I-15 cuts southwesterly across the quadrangle, passing between the Canyon Mountains on the northwest and the Pahvant Range on the southeast. The highest point along the highway in the map area, Scipio Pass at an elevation of 5,969 feet (1,819 m), gives the quadrangle its name. Although the highway's course follows the principal route to California used since pre-pioneer days, no one has yet settled permanently within the quadrangle area.

Land ownership within the quadrangle is 73 percent federal, 2 percent state, and 25 percent private. Federal lands are administered by the U.S. Forest Service which controls the high parts of the Pahvant and Canyon ranges, and the U.S. Bureau of Land Management which is in charge of most of the juniper-covered foothills. Private ownership is mostly in the Scipio and Pahvant Valley lowlands. The area is used principally for cattle range; only a small part of the northeast corner of this quadrangle is irrigated pastureland.

Geologically, the quadrangle lies in the transition zone between the Basin and Range physiographic province to the west and the Colorado Plateaus to the east. Precambrian strata of the Canyon Range overthrust plate lie along its northwest edge. Cambrian, Ordovician, Silurian, and Devonian strata of the underlying Pavant overthrust plate are exposed on the southeastern corner of the Canyon Mountains and the northwestern edge of the Pahvant Range in one continuous structural block. The clear lack of any normal fault between the Canyon and Pahvant ranges, as shown on this quadrangle, demonstrates that these ranges together form a single westward-tilted basin-and-range fault block, more than 60 miles (100 km) long, that extends from near Leamington on the north to 15 miles (24 km) south of Kanosh (figure 1). Scipio Pass, the low divide between the two ranges, results from the lack of erosional resistance of the thin-bedded limestone and shale of the Ordovician Pogonip Group. Upper Cretaceous to lower Tertiary conglomerate deposits are unconformable on Paleozoic rocks of the Pavant plate. Unconsolidated upper Tertiary and Quaternary alluvial, colluvial, eolian, and landslide deposits are unconformable above the bedrock strata.

Maxey (1946) was the first to describe geologic features of the Pahvant Range in any detail. He correctly identified the bedrock stratigraphy and described the Pavant thrust fault. Dennis and others (1946), in a report on ground-water resources, included a map of Pahvant Valley that shows both bedrock and alluvial map units. Christiansen (1952) mapped the Canyon Mountains and identified the Canyon Range thrust fault. His map extended into the northern edge of the Scipio Pass quadrangle. Tucker (1954) prepared a reconnaissance geologic map of the Scipio 1:62,500 quadrangle, the northwestern quarter of

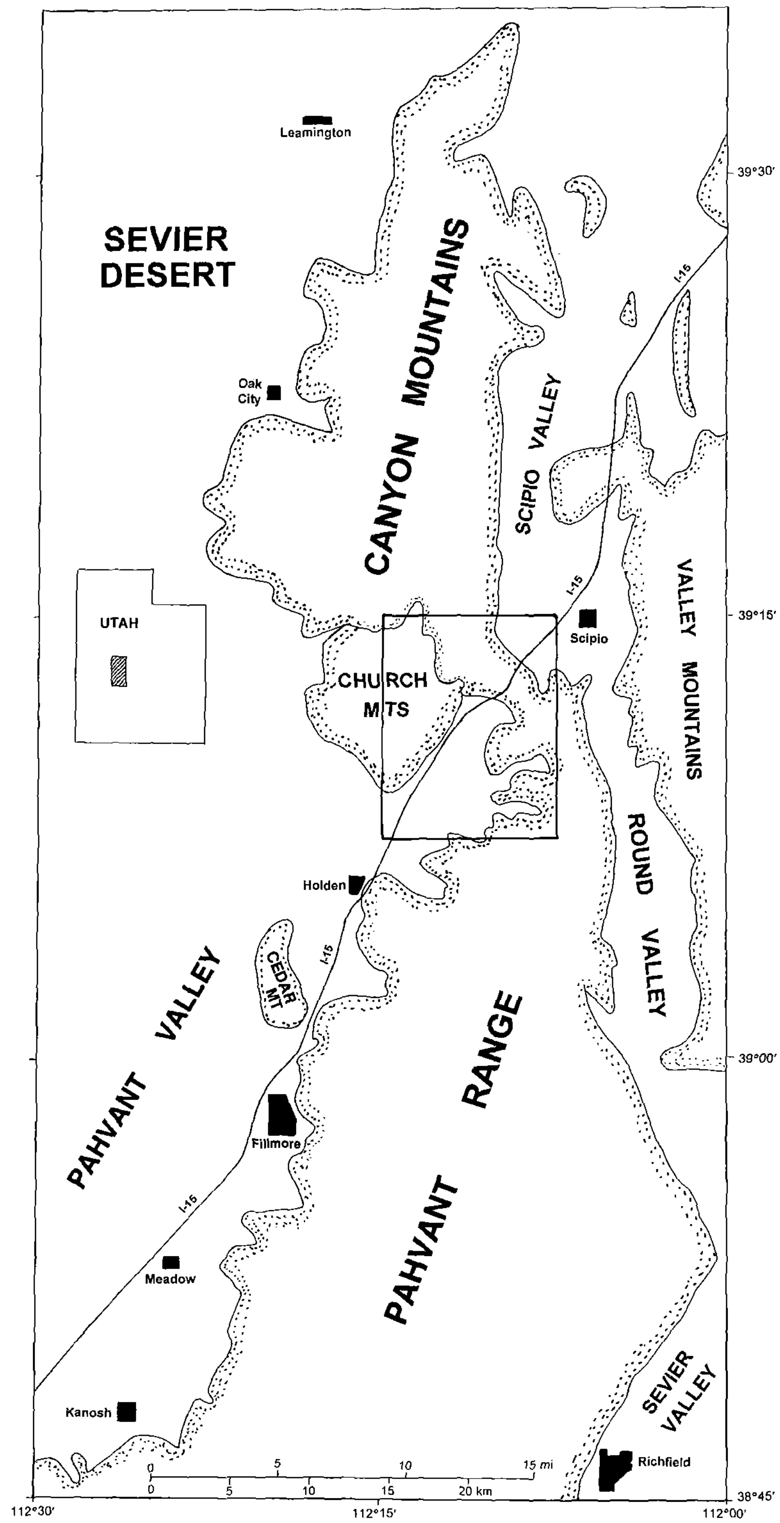


Figure 1. Index map showing location of Scipio Pass quadrangle (open rectangle) with respect to mountains, valleys, and towns mentioned in this report. Inset map of Utah shows the position of this index map within the state.

which makes up the Scipio Pass 1:24,000 quadrangle. Hintze (1951) and Webb (1956, 1958) presented detailed measured sections of Ordovician strata within the Scipio Pass quadrangle. Campbell (1979) studied Tertiary deposits and geomorphic features of the Canyon Mountains, including some within this quadrangle, Bucknam and Anderson (1979), in a regional reconnaissance study of Quaternary fault scarps, delineated some of those within the Scipio Pass quadrangle. Millard (1983) mapped the adjacent Williams Peak quadrangle. Oviatt (1992) mapped Quaternary deposits and faults in the Scipio Valley portion of the Scipio Pass quadrangle.

Student mapping theses that contain relevant structural and stratigraphic observations on nearby parts of the Canyon and Pahvant ranges include Lautenschlager (1952), Crosby (1959), Hickcox (1971), Sayre (1974), Higgins (1982), Davis (1983), Holladay (1984), and George (1985). The relationship of Cretaceous folding and thrusting to synorogenic sedimentation in the central Utah region is discussed by Fouch and others (1983), Lawton (1985), Villien and Kligfield (1986), Schwans (1988), and Lawton and Trexler (1991).

Field work by Michaels was accomplished between 1983 and 1985. In the present report he is responsible for most of the bedrock mapping and stratigraphic descriptions. Hintze, as part of the Utah Geological Survey project to prepare a comprehensive report on Millard County, reviewed Michaels' mapping in 1990 and remapped the Tertiary and Quaternary deposits. He used 1:15,000 color aerial photographs, flown in 1988, provided by the U.S. Forest Service office in Fillmore, Utah. Michaels wrote the preliminary draft of the sections on structure and stratigraphy. Hintze modified them and added the other sections of this report.

STRATIGRAPHY

Map units in this quadrangle belong to three structural packages: (1) Precambrian strata of the Canyon Range overthrust plate, (2) lower Paleozoic strata of the Pavant overthrust plate, and (3) Upper Cretaceous and Cenozoic sediments that were deposited at their present location on top of the strata of the two late Mesozoic thrust plates. The sequence of map units is summarized on plate 2.

A fourth package, Mesozoic strata beneath the Pavant thrust plate, is shown in cross section, but does not crop out in the quadrangle.

Strata of the Canyon Range Overthrust Plate

Precambrian

Precambrian strata in the Canyon Mountains were first studied by Christiansen (1952) who showed them as a single map unit, "Upper Proterozoic quartzite, shale, and limestone." Woodward (1972, 1976) in a regional analysis of Proterozoic rocks, applied some formation names that were originally used for strata near Pocatello, Idaho to Precambrian strata in the Canyon Mountains and other places in central Utah. Higgins (1982), Millard (1983), and Holladay (1984) utilized this Pocatello-based nomenclature in subdividing Precambrian rocks in the Canyon Mountains. We have extended Millard's (1983) map units into the north edge of this quadrangle. All of the Precambrian units on our map are more completely exposed in the Canyon Mountains north of our map area and are more fully described by Millard (1983) and Holladay (1984).

Christie-Blick (1982) questioned some of Woodward's (1972) correlations and suggested that the units in the Canyon Mountains that previous workers had assigned to the Blackrock Canyon Limestone and Pocatello Formation may be equivalent to the lower part of the Caddy Canyon Quartzite as known in the Pocatello area. We have elected to retain the nomenclature used by previous mappers in the Canyon Mountains because it serves well in delineating the several lithologic packages that occur here.

Pocatello Formation (p€p): This formation is exposed along the north-central edge of the quadrangle where it consists of thin- to thick-bedded interbeds of siltstone, phyllitic shale, and quartzite, more that 800 feet (250 m) thick. The base of the formation is not found in the Canyon Mountains. The part that is present forms the sole of the Canyon Range overthrust. The Pocatello Formation can be traced northward from the Scipio Pass quadrangle for two miles into the south-central part of the Williams Peak quadrangle but was not recognized there by Millard (1983). The best exposures of the formation in the Scipio Pass quadrangle are in section 20, T. 18 S., R. 3 W.

Blackrock Canyon Limestone (p€b): This formation crops out along the north edge of the quadrangle. The outcrops in the northwest corner of quadrangle are the best exposed, but a complete sequence of the formation is present also in section 20, T. 18 S., R. 3 W. The Blackrock Canyon Limestone is the only Precambrian map unit in the Canyon Mountains that contains limestone beds. Millard (1983) measured 560 feet (169 m) of this formation along Whiskey Creek about 3 miles (5 km) north of the northwest corner of our map. Here, the lowest 225 feet (68 m) is a coarsely crystalline, thin-bedded, reddish- to brownish-gray, silty and sandy, slope-forming limestone that locally contains large algal stromatolites. This is overlain by 120 feet (36 m) of massive ledge-forming, oolitic, medium-gray limestone. Above this is 155 feet (47 m) of olive-gray to grayish-orange, thin-bedded, slope-forming quartzite. The top unit is 60 feet (18 m) of olive-gray, oolitic to pisolitic, massive, ledge-forming limestone. Millard (1983) showed photographs of thin-sections of the oolitic and algal structures contained in the Blackrock Canyon Limestone. In section 20, the formation consists of 80 feet (25 m) of silty limestone overlain by about 300 feet of silty non-resistant quartzite.

Caddy Canyon Quartzite (p€c): The base of this formation is drawn at the top of the uppermost limestone bed of the Blackrock Canyon Limestone. According to Millard (1983), the lower 750 feet (230 m) of this formation includes interbeds of siltstone and thin-bedded, silty quartzite which form recessive slopes. Woodward (1972) correlated these beds with the Papoose Formation of the Pocatello, Idaho area. But, because of the gradational nature of the transition from these slope-forming beds to the cliff-forming quartzite that forms the upper part of the formation, mappers in the Canyon Mountains have found it impracticable to recognize the lower silty quartzites as a separate map unit, and they are herein included as the basal part of the Caddy Canyon Quartzite. The upper 1,170 feet (355 m) of this formation is well-sorted, medium-grained, light-grayish-white to pale-yellowish-brown quartzite that commonly weathers moderate brown or grayish orange. It includes some beds of quartz-granule and pebble conglomerate. The quartzite is thick bedded to massive and forms ledges and cliffs. The upper contact of the formation is at the base of recessive argillitic shales of the Inkom Formation, a unit that is not exposed in this quadrangle. Total thickness of the Caddy Canyon Quartzite, as measured by Millard (1983) in Whiskey Creek, 3 miles (5 km) from the northwest corner of this quadrangle, is 1,920 feet (585 m).

Inkom Formation (p€i): This formation is concealed by alluvium on this quadrangle, but is shown on cross section AA′ on plate 2 because it is inferred that it extends southward into the Scipio Pass quadrangle from the Williams Peak quadrangle, where it was mapped by Millard (1983). The Inkom Formation is a silty shale that forms recessive benches and valleys between the ledges and cliffs formed by quartzites of the Caddy Canyon and Mutual formations. Millard (1983) reported it to be 270 feet (84 m) thick in the adjacent Williams Peak quadrangle.

Mutual Formation (p€m): A small part of the Mutual Formation is exposed along the bank of the East Fork of Eightmile Creek in the northwest part of the quadrangle. The formation consists of pale-red or grayish-red, medium-grained, well-sorted quartzite. Cross-bedding is common, as are thin, pebbly quartzite-conglomerate interbeds. Millard (1983) measured a thickness of 2,250 feet (690 m) for the Mutual Formation in Dry Creek Canyon, about 5 miles (8 km) north of the north edge of the Scipio Pass quadrangle.

Strata of the Pavant Overthrust Plate

Cambrian

Tintic Quartzite (€t): This formation is not exposed in this quadrangle. It is shown on our cross sections as the basal formation in the Pavant overthrust plate because it is exposed, as such, along the west side of the Pahvant Range from 0.2 mile (0.3 km) south of this quadrangle southwards for 25 miles (40 km) (Hintze, 1980). The Tintic Quartzite is a fine- to coarse-grained, well-indurated, white quartzite that generally weathers brownish orange. It is about 3,000 feet (1,000 m) thick in the Pahvant Range (George, 1985; Hintze, 1988).

Ophir Formation (€op): This formation is not exposed in this quadrangle, but it is shown on cross sections above the Tintic Quartzite in the Pavant overthrust plate. Like the Tintic Quartzite, it is exposed south of this quadrangle for 25 miles (40 km) along the Pahvant Range. The formation is made up of interbeds of shale and limestone. Near the base its shaly beds are micaceous and bear *Glossopleura* trilobite fragments in interbedded thin-bedded limestone beds. Near the top, thin-bedded shaly limestone beds contain *Ehmaniella* trilobite fossils. The Ophir Formation is about 500 feet (150 m) thick in the Pahvant Range according to George (1985) who called the unit "Pioche Formation." Ophir is a more appropriate designation for this unit here, as the name is derived from the Tintic mining district (Morris and Lovering, 1961) from the same sequence of strata that the rest of the Cambrian names used in this report come from. Pioche is a term more appropriately applied to pre-*Glossopleura* phyllitic shale and quartzite beds in western Utah and eastern Nevada where the name has been widely applied (Hintze and Robison, 1975).

Herkimer, Dagmar, and Teutonic Formations, undivided (€ht): These formation names come from the Tintic mining district (Morris and Lovering, 1961). There the Dagmar is a conspicuous white dolomite bed 60 to 100 feet (20 to 30 m) thick that separates the Herkimer and Teutonic, which are gray, similar appearing limestones. In the Scipio Pass quadrangle the Dagmar interval locally consists of two to four white dolomite beds, 10 to 20 feet (3 to 6 m) thick, separated by thicker gray limestone beds. Because the Dagmar Dolomite does not constitute a consistently mappable unit in the quadrangle, we have grouped the three formations together as an undivided entity, retaining the Tintic district nomenclature to indicate correlation with the strata named there.

The upper and lower parts of our undivided €ht unit are dark- to medium-gray limestone, mottled with blebs and stringers of light-olive-gray silty dolomite. Mottling in the gray limestones probably was formed by bioturbation of lime muds by burrowing organisms living in the shallow waters of the Cambrian sea. The lower part of the undivided unit also includes oolitic and oncolitic algal structures. *Glossopleura*-zone trilobites occur in the lowest beds in association with the oncolites.

The white, Dagmar-type dolomite beds in the middle of this undivided unit are laminated algal mats (figure 2). Near the top of the undivided unit, algal heads 12 inches (0.3 m) high are found just beneath the Cole Canyon Dolomite.

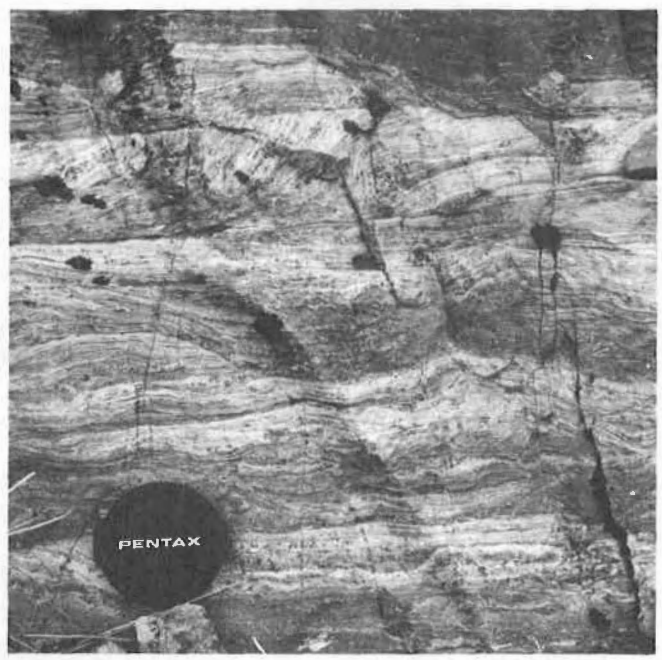


***Figure 2.** Laminated dolomite from the middle part of the Herkimer, Dagmar, and Teutonic map unit. The laminae were produced by algae that lived in shallow marine waters. The wave patterns were produced shortly after deposition when the carbonate mud was soft and easily reworked. Lens cover for scale is 2 inches (5 cm) in diameter.*

The alternating thin to very thick bedding of the lower part of the Herkimer, Dagmar, and Teutonic (€ht) map unit forms ledgy terraced slopes which are commonly mostly covered with talus or colluvium. The upper part (Herkimer equivalent) is very thick bedded and forms a steep slope with massive ledges. Locally, the upper Herkimer equivalent contains algal stromatolites (figure 3).

Total thickness of the undivided €ht map unit is at least 994 feet (303 m) (see appendix A). The contact with the Ophir Formation is not exposed in the measured section, but at most, only a few tens of feet of beds at the base of the €ht unit are concealed here.

Cole Canyon and Bluebird Dolomites, undivided (€cb): These formation names come from the Tintic mining district (Morris and Lovering, 1961) where the Bluebird Dolomite is characterized by small, white, dolomite rods interspersed in a dark-gray dolomite matrix (figure 4). These are called "twig-shaped bodies" by Morris and Lovering (1961). In the Scipio Pass quadrangle the undivided Cole Canyon and Bluebird Dolomites (€cb) map unit is easily identified because it contains no limestone, the principal rock type of the underlying (€ht) and overlying (€ox) map units. The undivided €cb map unit is made up of three interbedded rock types. The Bluebird-type dolomite is most common near the base of the map unit but occurs also interbedded with other dolomites throughout. The second common rock type is medium-light-gray to very light-brownish-gray, thick-bedded, fine-grained dolomite that weathers to massive ledges and low cliffs. The third rock type is medium-gray to light-brownish-gray, medium-grained, thick-bedded dolomite that weathers to ledges with a mottled gray appearance. The undivided Cole Canyon and Bluebird Dolomites map unit is 536 feet (163.5 m) thick (appendix A).

Opex Formation (€ox): This formation is made up of very thin- to very thick-bedded shaly and bioclastic limestone, with thin interbeds of dolomite, shale, and sandstone. The limestone is generally medium gray, with pink or yellow silty partings. Some limestone is oolitic and oncolitic (figure 5), and the formation includes a few beds of intraformational conglomerate. Some of the bioclastic limestone beds in the lower third of the Opex Formation yielded trilobite fragments identified by Professor R.A. Robison at the University of Kansas (written communication, 1985) as *Blountia* sp., *Tricrepicephalus* sp., and *Kingstonia* sp., indicative of an early Late Cambrian age. Other trilobite fragments, from just beneath the Ajax Dolomite, were identifed by Robison as *Saratogia?* sp., and may represent the *Idahoia* trilobite zone of middle Late Cambrian age. The Opex Formation is 671 feet (204.5 m) thick in this quadrangle (appendix A).

Ajax Dolomite (€a): The Ajax Dolomite consists of dolomite beds that range from light to dark gray. The basal 130 feet (40 m) is medium-gray to light-brownish-gray dolomite that weathers light olive gray, and contains algal stromatolites 6 to 8 inches (15 to 20 cm) high. The upper Ajax Dolomite is mostly thick-bedded and forms steep slopes, ledges, and cliffs. Chert is not common in most exposures, but is locally abundant. The Ajax, which in this quadrangle is entirely dolomite, is easily distinguished from the less-resistant, predominantly limestone units above and below it. The Ajax Dolomite is 966 feet (295 m) thick (appendix A).

Undivided Cambrian carbonate rocks (€u): In sections 33 and 34, T. 18 S., R. 3 W. just north of Scipio Pass, it was not possible to identify and differentiate the Cole Canyon-Bluebird (€cb), Opex (€ox), and Ajax (€a) map units. These rocks occur beneath Ordovician strata in thrust slices too indefinable to map and structurally above the Scipio Pass intraplate thrust. These Cambrian carbonate units are apparently attenuated within the thrust plate. Most of the rock shown as €u on our map is Ajax Dolomite. The Opex Formation is possibly present locally in

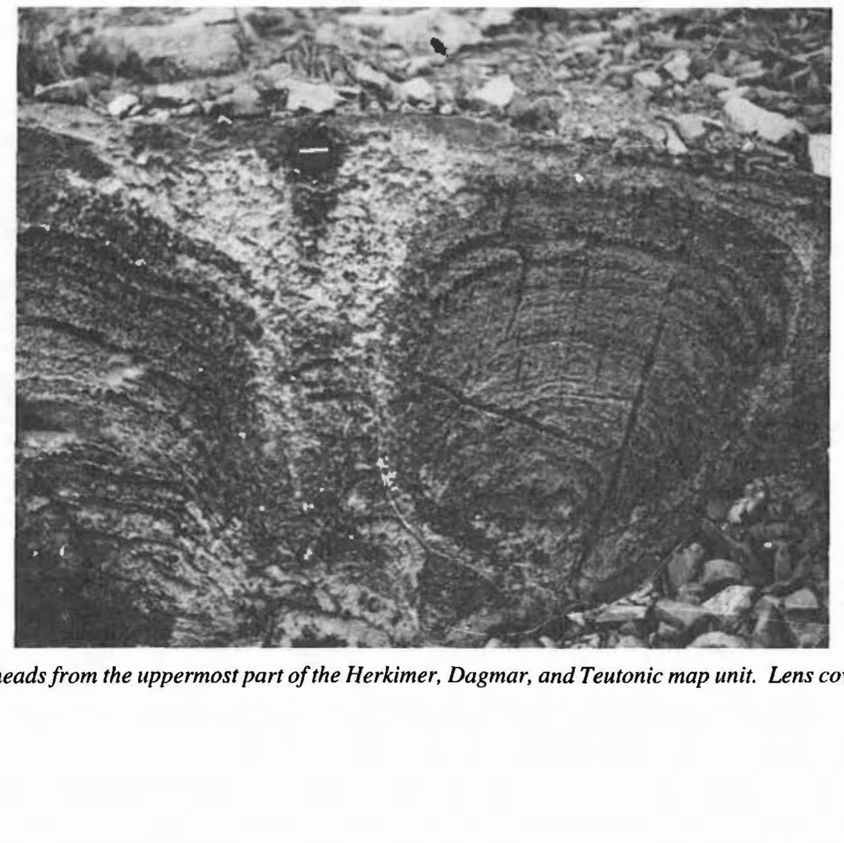


Figure 3. *Algal stromatolite heads from the uppermost part of the Herkimer, Dagmar, and Teutonic map unit. Lens cover for scale is 2 inches (5 cm) in diameter.*

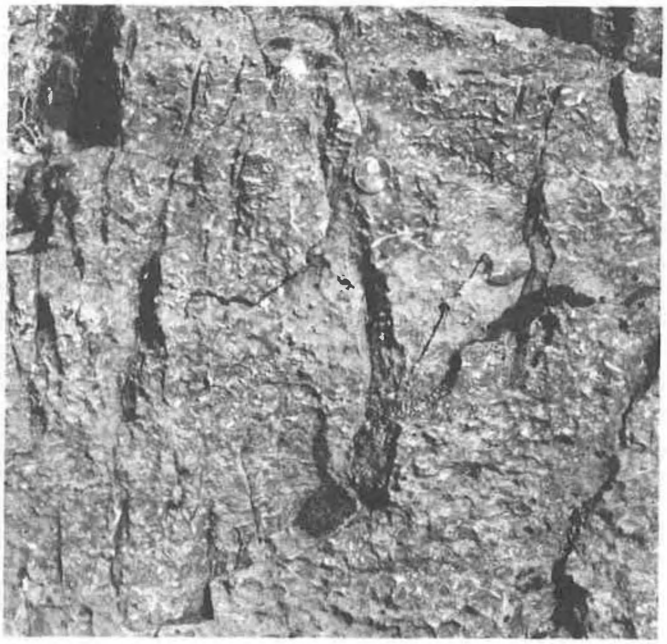


Figure 4. Small, light blebs or rods are called twig-shaped bodies, and are common in the Cole Canyon and Bluebird Dolomite, undivided map unit. Penny for scale in upper center.

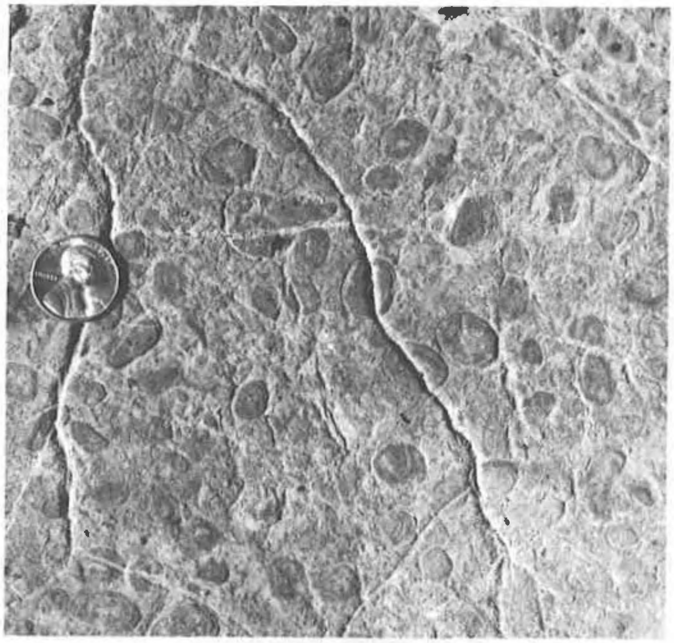


Figure 5. Algal oncolites in the Opex Formation. Similar oncolites are common in the bottom of the Herkimer, Dagmar and Teutonic map unit.

small slices, and the Cole Canyon-Bluebird may be present. Because of the presence of Cambrian strata other than Ajax Dolomite, we have shown these rocks as undivided Cambrian carbonate rocks. Structural complications preclude measuring their thickness.

Ordovician

Pogonip Group, undivided (Op): Hintze (1951) measured the Ordovician strata in this quadrangle and described six formations within the Pogonip Group. Although these individual formations are recognizable locally within the quadrangle, we have not found it possible to trace them as mappable units, primarily because of colluvial cover in the Pahvant Range, but also because of structural complications in the southern Canyon Mountains just north of Scipio Pass. We, therefore, have shown all of the pre-Eureka Quartzite Ordovician strata as a single map unit.

The basal Pogonip is a medium-gray, slightly cherty, fine-grained limestone that forms ledges and low cliffs. It is the most resistant part of the Pogonip Group (identified as House Limestone by Hintze, 1951) and is well exposed on Hill 7335 two miles (3 km) south of Scipio Pass, and on Hill 7847 south of Ebbs Canyon (figure 6). It is partially exposed in the road cut along the north side of the freeway at Scipio Pass. It also forms the sole of the Scipio Pass intraplate thrust shown on the geologic map north and west of the pass, where it forms the cliffs above the less-resistant middle Pogonip. Hintze (1951) reported 271 feet (82.5 m) of lower Pogonip. Michaels measured 300 feet (91.5 m) in section 24 north of Wild Goose Canyon.

The middle part of the Pogonip Group (identified as Fillmore Limestone, Wah Wah Limestone, and Juab Limestone by Hin-

Figure 6. Aerial view looking eastward at the ridge between Ebbs Canyon and Wild Goose Canyon. Prominent light cliff, just below middle of photo, is the basal Pogonip Group. Ledges just above middle of photo are, from bottom to top, Eureka Quartzite, Fish Haven Dolomite, Laketown Dolomite, Sevy Dolomite, and Canyon Range conglomerate. Upper third of picture shows Wasatch Plateaus east of this quadrangle.

tze, 1951) is characterized by a distinctive rock type, intraformational conglomerate (figure 7). The middle Pogonip is generally medium gray, thin to medium bedded, and forms slopes and low ledges. Interbedded with the intraformational conglomerate are beds of silty limestone, shaly limestone, shale, and bioclastic limestone. The shale is typically olive gray when fresh, and the silty and shaly components weather to give the Pogonip Group yellowish, or locally reddish, parting surfaces. The middle part of the Pogonip Group is fairly well exposed in the roadcuts on both sides of the freeway from Scipio Pass northeastward to the mouth of the canyon where the freeway enters Scipio Valley. Fragments of fossil trilobites (figure 8) and brachiopods, typical of the middle part of the Pogonip, can be found in the roadcuts north of the freeway in the center of section 26, T. 18 S., R. 3 W. Hintze (1951) reported 1,046 feet (317 m) of middle Pogonip. A similar thickness in section 24, T. 19 S., R. 3 W. north of Wild Goose Canyon was measured for this study.

The upper part of the Pogonip (identified as Kanosh Shale by Hintze, 1951) is fairly well exposed beneath Eureka Quartzite ledges in the northeast part of section 12, 2 miles (3 km) south of Scipio Pass. It is better exposed in section 15 along the north edge of the map. The upper Pogonip shales are olive gray, and include thin interbeds of quartzite and limestone coquinas of orthid brachiopods (figures 9 and 10) with shells about 0.7 inch (1.8 cm) in diameter. In the upper part of the orthid-bearing interval, trilobite fragments (figure 10) and receptaculitids (figure 11) can be found. The upper part of the Pogonip Group is very fossiliferous which makes it easy to recognize wherever it is exposed. Millard (1983) measured 320 feet (98 m) of upper Pogonip strata just north of the Scipio Pass quadrangle. Hintze (1951) reported a similar thickness exposed in section 11, T. 19 S., R. 3 W. Total thickness of the Pogonip Group, undivided, in this quadrangle is 1,684 feet (513 m).

Eureka Quartzite (Oe): Because of its light color and resistant outcrops, the Eureka Quartzite is the most easily recognized formation in the area. It forms a prominent light band on aerial photographs that is easily distinguished from the darker rocks above and below. The Eureka is relatively undeformed in section 15, T. 18 S., R. 3 W., along the north edge of the quadrangle, and in the line of outcrops 2 miles southeast of Scipio Pass. Elsewhere it is brecciated by thrust faulting, especially in the outcrops in section 5, T. 19 S., R. 3 W., on the east side of the Church Mountains where the Eureka is greatly attenuated by thrusting.

The lower Eureka is light-gray silty quartzite that weathers to light shades of pink, orange, or brown. It shows some minor cross-bedding and crops out as ledges or cliffs. The upper Eureka is made up of white quartzite that is thin to medium bedded and forms steep slopes, ledges, and cliffs. Millard (1983) reported thicknesses of 63 feet (19 m) for the lower Eureka, and 161 feet (49 m) for the upper part in a section measured just north of the Scipio Peak quadrangle. In section 24, T. 19 S., R. 3 W., on the ridge north of Wild Goose Canyon, thicknesses of 80 feet (24 m) for the lower Eureka and 100 feet (30 m) for the upper part were measured.

Webb (1956) assigned the lower quartzite beds to the Swan Peak (?) Quartzite which he thought was deposited during a westward regression of the Ordovician shoreline. He also con-

Figure 7. Intraformational conglomerate typical of the middle part of the Pogonip Group. The pebbles are silty limestone that was ripped up from a muddy tidal flat while still unconsolidated and redeposited near its original site of deposition.

Figure 8. Trilobite fragments such as these can be found in some beds in the middle part of the Pogonip Group.

Figure 9. Tubular structures, about half the width of the penny, are twig-shaped bryozoans, a colonial marine animal. These are some of the earliest bryozoans in the fossil record. The sea shells are brachiopods of the orthid type, common in the uppermost part of the Pogonip Group.

Figure 10. Above and left of the penny is a trilobite head, partly covered. To its right is an orthid brachiopod, the hallmark fossil of the upper part of the Pogonip Group.

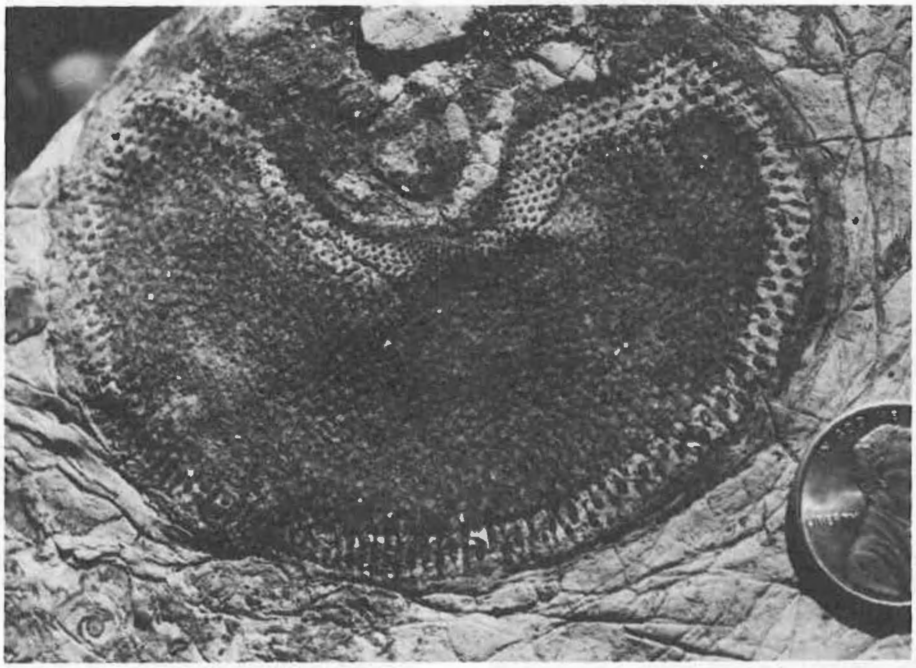


Figure 11. Fossil receptaculitid, an extinct sponge-like animal that is sometimes called "the sunflower fossil" by amateur collectors. Found just below the Eureka Quartzite in the uppermost beds of the Pogonip Group.

sidered that the upper Eureka Quartzite was deposited by an easterly transgressing sea.

Fish Haven Dolomite (Ofh): The generally dark dolomitic strata that overlie the white Eureka Quartzite regionally include rocks of Ordovician age at the base and Silurian age above. Fossils that are definitive of either age are lacking except for some Silurian corals and brachiopods near the top of the dolomite (Millard, 1983), so the assignment of the lower dolomitic beds to the Ordovician and the upper ones to the Silurian is made somewhat arbitrarily by stratigraphers and mappers by picking a locally traceable horizon as a contact. We have followed Millard (1983) in placing the map contact where the dolomite becomes cherty. Thus defined, the Ordovician rocks here are generally chertless, and the Silurian rocks generally contain chert. As measured on the ridge north of Ebbs Canyon, the lower part of the Fish Haven Dolomite is medium-dark-gray to brownish-gray, fine-grained dolomite which weathers light gray to light olive gray. The middle part of the Fish Haven includes several thick dark-brownish-gray limestone beds that form ledges, giving a stair-step appearance. The uppermost dolomite bed is a medium-dark-gray, thick-bedded, ledge-forming dolomite. Appendix A describes 261 feet (79 m) of partially brecciated Fish Haven Dolomite measured in the east-central part of this quadrangle. Millard (1983) measured 78 feet (42 m) of generally brecciated Fish Haven Dolomite in the Canyon Mountains just north of this quadrangle.

Silurian

Laketown Dolomite (Sl): The Laketown Dolomite forms massive cliffs on the east face of the Canyon Mountains and on the west side of Graball Canyon in the northern Pahvant Range. Elsewhere the formation is more fractured and brecciated and erodes to less precipitous slopes. The dolomite is medium light gray to medium dark gray, medium grained, and thick bedded to massive. Locally it includes beds with stromatolitic laminations which, in some places, contain rip-up clasts that form intraformational conglomerates. Millard (1983) reported finding an orthid brachiopod and a rugose coral near the top of the Laketown, but stated that he found no other fossils in the formation. No fossils were found during the present study. On the ridge north of Ebbs Canyon 832 feet (254 m) of Laketown Dolomite was measured. Millard (1983) showed a thickness of 1,045 feet (333 m) of Laketown in his section, measured on the southeast flank of the Canyon Mountains about a mile north of the edge of the Scipio Pass quadrangle.

Devonian

Sevy Dolomite (Dsy): The Sevy Dolomite is a uniformly light-gray, fine-grained, locally cherty and laminated dolomite that contrasts conspicuously with the underlying darker Laketown Dolomite. Exposures of Sevy Dolomite in this quadrangle are poor, in large part because bouldery debris from the overlying Canyon Mountains conglomerate covers the slopes formed on the Sevy. The partial section of Sevy Dolomite on the ridge north of Ebbs Canyon is 423 feet (129 m) thick. Millard (1983) reported that the entire Sevy Dolomite as exposed at Hardscrabble Canyon, some 5 miles (8 km) north of the border of our map, appears to be as much as 2,720 feet (830 m) thick. Davis (1983) found the entire Sevy Dolomite to be 715 feet (216.5 m) thick in the southern Pahvant Range, about 30 miles (50 km) south of the Scipio Pass area.

Syn- and Post-thrusting Deposits

Upper Cretaceous and Lower Tertiary

Canyon Range conglomerate (TKc): The coarse bouldery conglomerates deposited in the Canyon Mountains area along the east margin of the overthrust belt have been assigned various names by successive geologists. Christiansen (1952) called them "Indianola Group(?)," taking the name from the Sanpete Valley area, 30 miles (50 km) to the east. The type Indianola is early Late Cretaceous (Campanian to Cenomanian) according to Fouch and others (1983), and is more sandstone and shale than conglomerate. Armstrong (1968) deemed Indianola to be an inappropriate name, both lithologically and temporally for the Canyon Mountains deposits and called them "Canyon Range fanglomerate." He suggested that, despite the lack of fossils or other dating evidence, the fanglomerate might be a lateral equivalent of the Paleocene and Eocene Flagstaff Limestone of central Utah. Stolle (1978) made a detailed study of these coarse clastic deposits on the east side of the Canyon Mountains near Fool Peak, about 10 miles (16 km) north of Scipio Pass. Stolle (1978) called these rocks the Canyon Range formation (informal name) and concluded that its lower conglomeratic part was likely equivalent to the Late Cretaceous Price River Formation and the Cretaceous-Paleocene North Horn Formation to the east. The upper part of Stolle's (1978) Canyon Range formation includes fluvial sandstone and some lacustrine limestone. He correlated this upper part with the North Horn Formation and the Flagstaff Limestone. The Canyon Range conglomerate in the Scipio Pass quadrangle probably correlates with the lower conglomeratic part of Stolle's (1978) Canyon Range formation. Firm age dates, based on palynology or other means, have yet to be reported for these coarse clastic deposits. A measured section (appendix B) shows a total thickness of 792 feet (241.5 m) for the Canyon Range conglomerate along the east side of the Scipio Pass quadrangle, where the unit caps the mountaintop. The lower 300 feet (90 m) is a conglomerate composed mostly of quartzite cobbles and boulders (some as much as 5 feet [1.5 m] in diameter) in a red sandy matrix. Overlying conglomerates are less coarse, include limestone clasts, and are interbedded with sandstone.

Pliocene

Oak City Formation (Toc): Campbell (1979) named this formation and mapped its occurrence around the west and south sides of the Canyon Mountains, from its type section south of Oak City into the Scipio Pass quadrangle, a distance of some ten miles (16 km). In this quadrangle, the Oak City Formation is mostly a sandy, bouldery, gravel, the internal sedimentary structure of which is exposed only locally within roadcuts and gravel pits. There it is seen to be poorly sorted and poorly bedded and made up of clasts ranging from silt to boulder size, but sand-, pebble-, and cobble-size clasts are most common. Clast shape ranges from subangular to well rounded, with most being subrounded. Clasts are of quartzite, dolomite, limestone, and conglomerate. They were derived locally from bedrock units exposed in adjacent highlands of the Canyon and Pahvant ranges. They probably represent flood and mudflow deposits that formed alluvial aprons on the west and southwest sides of the westward-tilted Canyon-Pavant fault block.

Age of the Oak City Formation was thought by Campbell (1979) to be Miocene, but he had no direct evidence. Recently Hintze (unpublished data), in connection with his Millard County mapping project, has traced the formation southward for more than 30 miles, along the west side of the Pahvant Range, into the Dog Valley Peak quadrangle. There Oviatt (1991) reported a bed of Cudahy Mine pumice, dated at 2.6 million years, within the Oak City Formation. Thus the Oak City Formation is somewhat younger than Campbell (1979) surmised.

Known extent of the Oak City Formation is limited to the western side of the Canyon-Pavant fault block. It forms foothills along the base of the mountain front and isolated low hills such as the Church Mountains (the east side of which are on the west side of this quadrangle) and Cedar Mountain 12 miles (18 km) to the south near Fillmore. The Oak City Formation is currently being dissected. Water erosion has formed a mature gully system that has preferentially removed smaller clasts and left the larger cobble and boulder clasts to form an armor that covers the hilltops and ridges where the formation is exposed. The stream and gully courses are generally filled with a mixture of alluvial debris and eolian silt made up of small particles blown northeastward off the Sevier Desert floor and piling up on the lee side of ridges in the Church Mountains and the lower parts of the Canyon and Pahvant ranges.

Thickness of the Oak City Formation within the quadrangle ranges from zero, at its depositional and/or erosional edge against bedrock units, to at least several hundred feet (100+m) along the west side of the quadrangle as estimated from map elevations between high and low exposures. Because no bedding is apparent within the poorly exposed formation, no attitudes are shown on the map; the lack of bedding information precludes more precise thickness estimates.

Old landslide deposit (Tml): The ridge between Murrays Canyon and Middle Canyon is covered with a landslide deposit consisting principally of blocks of Eureka Quartzite, some of which are as large as 12 feet (4 m) in diameter. The deposit is judged to be upper Tertiary because it is isolated from the nearest probable bedrock source, the Eureka outcrops on hill 6739, by the headward erosion of Middle Canyon. The deposit may be more than 30 feet (10 m) thick locally. Another landslide deposit of semi-coherent Eureka Quartzite was mapped on the northeast slope of hill 6129 in section 26, T. 18 S., R. 3 W. Here the jumbled Eureka blocks appear to be contained within the Oak City Formation. Alternatively, this latter occurrence might represent a tectonic slice of Eureka Quartzite that is out of place on the lower Pogonip and surrounded by colluvial debris derived from the overlying Oak City Formation.

Upper Pliocene and Pleistocene

Old alluvial-fan deposits (QTaf): Alluvial-fan deposits in the drainages of Ebbs Canyon and Wild Goose Canyon are late Pliocene or early Pleistocene in age on the basis of the topographic position of some of their remnants high on the flank of the Pahvant Range, and their partial dissection and burial by younger fans out of the same drainage systems. No datable materials have been collected from these deposits within this quadrangle, but Oviatt (1992) used the same designation for similar alluvial-fan deposits dated with isotopic and magnetic data.

These old alluvial-fan deposits are composed of poorly sorted, angular to subrounded, boulder- to silt-size clasts of bedrock exposed upstream. They appear to be unbedded and uncemented, but clasts exposed at the ground surface commonly show well-developed caliche buildups on their bottom sides. Thickness of these old alluvial-fan deposits may be up to a few hundred feet as estimated from their topographic distribution. They are definitely younger than the somewhat similar deposits of the Oak City Formation because they overlie or lap around the edge of that earlier Pliocene unit.

Landslide and colluvial deposits (QTml): The hillslope below the relay tower 1.5 miles (2 km) east of Scipio Pass is covered with broken blocks and masses of Eureka Quartzite and soil that is full of angular grit- and pebble-size quartzite fragments. This is probably a mass-movement deposit derived from the Eureka outcrops above. Alternatively, it could have been tectonically emplaced as slices of Eureka Quartzite below the more conspicuous slice that the relay tower sits on. Thickness is unknown, but is probably a few tens of feet (10+ m).

Quaternary

Young alluvial-fan and stream deposits (Qaf): These deposits are composed mainly of gravel with pebble- to boulder-size clasts in a matrix of silt, sand, and grit. Small-scale cross bedding can be observed in some road cuts, gravel pits, and stream channel banks. In the western half of the quadrangle this map unit includes a major component of wind-blown silt and fine sand from the fine-grained Lake Bonneville deposits that cover the Sevier Desert floor to the northwest. Maximum thickness of this unit is unknown but may be several hundred feet in the distal fan portions. Nothing has been found within the map area to provide a direct determination of its age, but Oviatt (1992) has assessed the age of this unit in the Scipio Valley area to the north as late Pleistocene to Holocene, on the basis of its stratigraphic relationships to the older fan gravel (QTaf), the alluvium of low-order streams (Qal), and Lake Bonneville deposits.

Alluvium (Qal): The northeast corner of the map includes part of the Scipio Valley floor that is covered by this map unit. Oviatt (1992) gives a detailed description of this unit. The contact between Qal and Qaf is drawn mostly along a late Quaternary fault scarp. Oviatt (1992) described this unit as "fine-grained, poorly sorted alluvium in ephemeral streams and on the floor of Scipio Valley." Oviatt (1992) assigned a late Pleistocene to Holocene age to this unit, and estimated that it might be as much as 100 feet (30 m) thick in Scipio Valley.

Deposits of unsorted silt, sand, gravel, and boulders are in, and adjacent to, ephemeral stream channels in the southeastern quadrant of the quadrangle. These deposits are thickest and most extensive in Ebbs and Wild Goose Canyons which have steep gradients. Holocene flash flooding has undoubtedly produced a large proportion of these deposits. The clast lithologies reflect that of bedrock nearby or upstream. The thicknesses of these deposits range from 0 to probably 25 or 30 feet (7.5-9 m) in places.

Colluvium (Qmc): Deposits from mass-wasting, widespread as a thin veneer on most hillslopes, have accumulated in a few areas that are large enough to show as a map unit. The most extensive colluvial cover is in the area around Mud Spring, along the north edge of the map, where colluvium conceals the trace of the Canyon Range thrust fault. Other smaller colluvial masses are found near the base of cliffs and steep slopes at the north end of the Pahvant Range. Colluvium is made of materials derived from bedrock units exposed upslope. The colluvial materials have become loosened from bedrock outcrops and crept downslope under the influence of gravity. Colluvium may be locally as much as 100 feet (30 m) thick.

Eolian deposits over alluvial-fan and stream deposits (Qe/-Qaf): Deposits of pinkish-gray dust, silt, and fine sand have accumulated on the southwest side of the Canyon Mountains and on the Church Mountains. This material has been derived largely by deflation of Lake Bonneville fine-grained sediments that cover the Sevier Desert northwest of the quadrangle. Prevailing winds that blow to the northeast are slowed down by the Canyon and Pahvant ranges, and drop their eolian load. The deposits both cover and are intermixed with alluvial materials in the same area. In some wind-sheltered areas the eolian deposits are as much as 15 feet (5 m) thick as revealed in the trench dug for a natural gas transmission pipeline in the summer of 1991. Ridge tops on the Oak City Formation are generally free of eolian sand, but ridge flanks, particularly on the northeast side, may have substantial accumulations. On our geologic map the unit Qe is used in combination with Qaf and shown as Qe/Qaf. This means that a thin cover of Qe overlies and may be intermixed with the Qaf alluvial-fan deposits.

STRUCTURAL GEOLOGY

Compressional deformation in the Canyon and Pahvant ranges took place in late Mesozoic and earliest Cenozoic time (approximately 100 to 60 million years ago) and produced a mountain belt, called the Sevier orogenic belt, that covered all of western Utah and eastern Nevada (Hintze, 1988). Streams flowing eastward off this highland deposited bouldery alluvial materials, such as the Canyon Range conglomerate, along the eastern edge of the Sevier orogenic belt.

Much later, in late Cenozoic time (from about 15 million years ago until the present), Utah was subjected to vertical uplift and horizontal extensional deformation that produced the basin-and-range topography of the Great Basin. The Canyon and Pahvant ranges are typical ranges, and the Sevier Desert and Pahvant Valley (figure 1) are large basins formed at this time.

Compressional Structures

The quadrangle includes parts of two major overthrust plates which moved eastward during late Mesozoic time. The Canyon Range overthrust plate was the first to move and it temporarily came to rest some distance west of its present location. The slightly younger Pavant thrust cut beneath the Canyon Range plate and transported it "piggyback" farther eastward, folding it into an open syncline in the process. The imbricate stacking of these two major thrust plates produced an apparent anomaly in the regional stratigraphy. Precambrian and Cambrian strata of the Canyon Range plate overlie Paleozoic strata of the Pavant plate, which, in turn, overlie Mesozoic strata that have not been much displaced from where they were originally deposited. Figure 12 is a simplified geologic map that shows the present distribution of these features. Villien and Kligfield (1986) suggested that late movement on the Canyon Range thrust may have been backthrusting.

Canyon Range Overthrust

Only the southern end of the preserved remnant of the Canyon Range plate is exposed in this quadrangle (see figures 13 and 14); its full extent is shown on figure 12. Christiansen (1952) was the first geologist to describe this overthrust, and to note its present synclinal shape. Higgins (1982), Millard (1983), and Holladay (1984), mapped the Canyon Mountains in greater detail than Christiansen, and identified formational subdivisions within the Precambrian and Paleozoic sequences that clearly showed that the Canyon Range plate originated farther to the west than the Pavant plate, upon which it rests. Cambrian strata of the Canyon Range plate, as mapped by Higgins (1982) are similar to strata in the Cricket, Drum, and House Ranges to the west, whereas Cambrian strata of the Pavant plate are like those in the East Tintic Mountains north of the Canyon Mountains.

At the south end of the Canyon Range plate, the oldest Precambrian unit, the Pocatello Formation, rests on Ordovician Pogonip Limestone in the Pavant plate. Northward, the thrust fault cuts stratigraphically upward in both the lower and upper plates. In the Canyon Range plate, the strata just above the thrust are, successively northward, the Blackrock Canyon Limestone, and the Caddy Canyon Quartzite. In the Pavant plate, the thrust cuts upsection to upper Devonian strata on the east side of the range, 8 miles (14 km) northwest of Scipio. At that point, Precambrian strata of the Canyon Range plate have overridden the synorogenic Canyon Range conglomerate, as shown on figure 12. Age of the Canyon Range conglomerate is poorly constrained, as is, therefore, the age of the thrusting. The trace of the Canyon Range thrust is concealed by colluvial cover on this quadrangle, but it presumably loops under cover to connect with its exposure on the west side of the range as shown on figure 12. A probable outlier of the Canyon Range thrust is present on the west side of the Church Mountains, where Sayre (1974) mapped Precambrian quartzites overthrust on brecciated Upper Ordovician, Silurian, and Devonian carbonate rocks. Elevation of the thrust exposed in the Church Mountains is about 1,400 feet (450 m) lower than the nearest exposure of the thrust in the

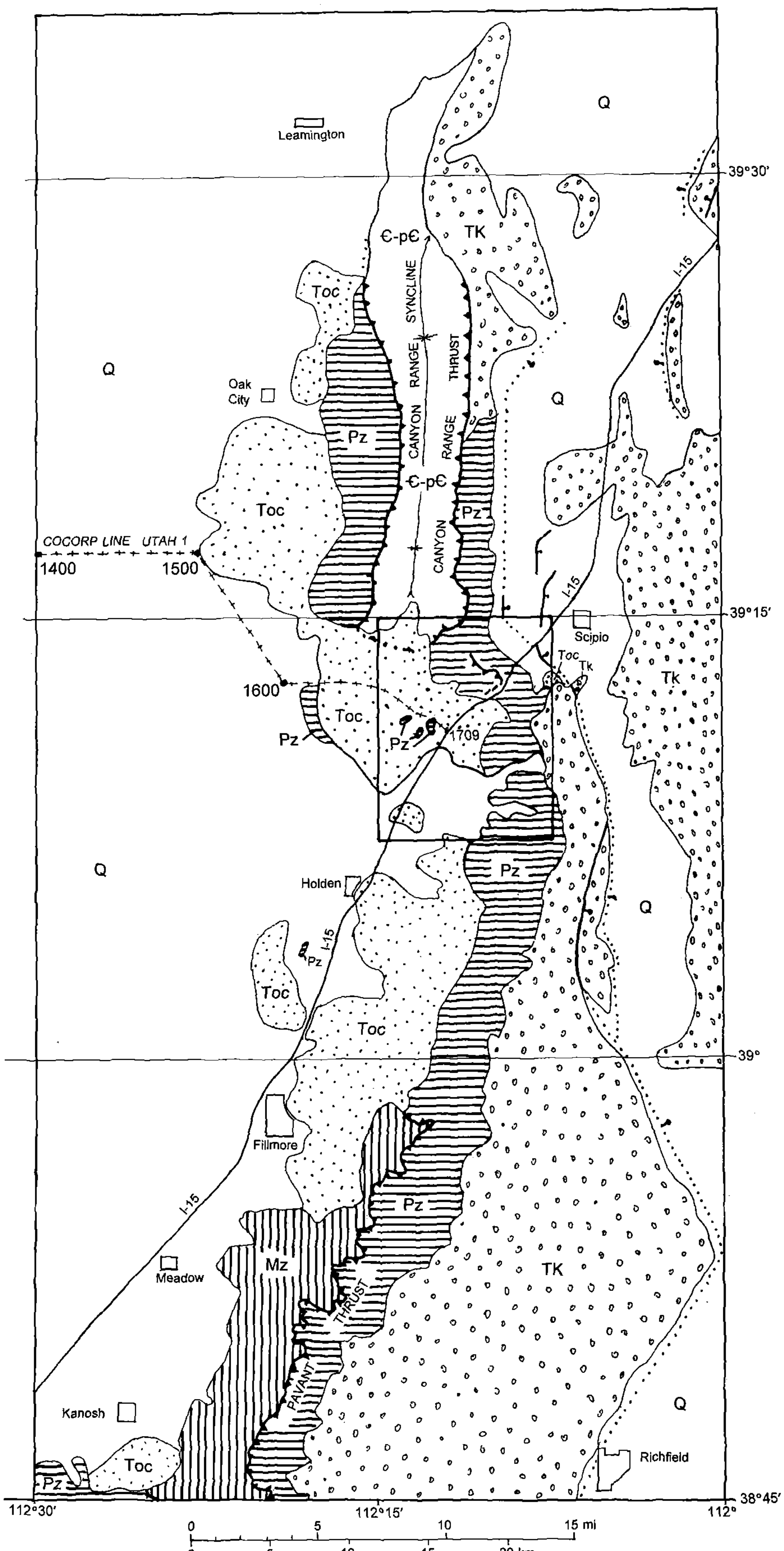


Figure 12. Simplified geologic map covering the same area as figure 1. Q – Quaternary deposits (unpatterned); Toc – Oak City Formation (small dots); TK – Tertiary-Cretaceous continental sedimentary rocks (open circles); Mz – Mesozoic marine and continental sedimentary rocks (vertical lines); Pz – Paleozoic marine sed- imentary rocks (horizontal lines); Є-pЄ – Cambrian and Precambrian marine strata (unpatterned). Location of COCORP deep seismic reflection survey line indicated with station numbers west of freeway I-15. Box outlines position of Scipio Pass quadrangle.

Figure 13. Panorama from the top of the Church Mountains looking northward to the Canyon Mountains on the left skyline, to the Pahvant Range at the right edge of the photo. Relay tower at Scipio Pass is one-fifth of the width of the photo from the right edge. Note that, except for the high part of the Canyon and Pahvant ranges, rocky exposures are not prominent. Most of the brush- and juniper-covered hillslopes have unconsolidated alluvium of the Pliocene Oak City Formation at the surface.

Figure 14. Panorama westward from the upper relay tower near Scipio Pass. Pahvant Butte on left side in distance. Large, lower relay tower and Scipio Pass in left foreground. Cliff in middle of picture just above the freeway is lowermost Pogonip overthrust on middle Pogonip. Right center shows Canyon Mountains on skyline. Top of range is Precambrian quartzite that has been thrust over lighter Devonian dolomite. Scipio interchange at right edge of photo, with Mt. Nebo in distance.

Canyon Mountains. This could be explained by postulating a low-angle normal fault between the Canyon and Church Mountains.

Movement of the Canyon Range plate over the underlying strata produced brecciation, and minor folds and thrusts, particularly where the underlying rock was the shaly, thin-bedded, relatively incompetent Pogonip Limestone. Rocks on the overriding Canyon Range plate seem less deformed near the thrust contact than do those beneath the thrust. Sharp (1984) estimated that total eastward translation of the Canyon Range plate may have been as much as 26 miles (42 km).

Pavant Overthrust

Although the thrust surface at the base of the Pavant plate is not exposed in this quadrangle, it is shown on cross section B-B′ on plate 2 because it is well exposed for 16 miles (25 km) along the mountain front east of Fillmore and Kanosh as shown on figure 12. The thrust relationships there are simple and regular. The Tintic Quartzite, about 3,000 feet (1,000 m) thick, is at the bottom of the overthrust plate. The in-place rock beneath, the Jurassic Navajo Sandstone, is about 1,800 feet (550 m) thick. The rocks beneath the overthrust show more minor folds and faults than the overlying Tintic Quartzite does.

All of the Paleozoic strata exposed in this quadrangle are part of the Pavant overthrust plate. On the basis of palinspastically restored sections, Sharp (1984) estimated that eastward displacement on the Pavant overthrust may have been as much as 30 miles (50 km). Given this considerable distance of transport, perhaps the remarkable fact is that these Paleozoic strata have held together as coherently as they have. The rocks are certainly not pristine, but neither are they metamorphosed. Many have been brecciated and brittlely attenuated. All have been fractured. Cambrian carbonate units that characteristically form bold cliffs elsewhere, here form slopes and rounded hillsides. Location of measured section traverses (appendix A and B) were selected to take advantage of the least broken, least attenuated sequences we could find. They represent as good an example of the Cambrian carbonate stratigraphy of the Pavant plate as can be found in the range. The same can be claimed for the Ordovician units. However the Silurian and Devonian strata are better preserved elsewhere in the Canyon and Pahvant ranges.

Scipio Pass Intraplate Thrust

As a whole, the Pogonip Limestone is the least resistant Paleozoic formation in the map area, and consequently it is responsible for the existence of the Scipio Pass divide between the Canyon and Pahvant ranges and for localization of the Scipio Pass intraplate thrust. Three distinctive parts can be readily recognized within the Pogonip Limestone, although, because of cover and structural complications, they were not mapped separately. The lower Pogonip is a resistant, massive, cliff-forming, cherty limestone (figure 6); the middle Pogonip is thin- to medium-bedded silty and shaly limestone with common interbeds of intraformational conglomerate; the upper Pogonip contains olive shale interbedded with fossiliferous, bioclastic limestone and a little thin-bedded sandstone.

On the north side of the freeway, 0.3 miles (0.5 km) north of the overpass on Scipio Pass, the limestone exposed in the roadcut (figure 14) is the upper part of the massive basal Pogonip. Proceeding northeastward, the freeway roadcuts expose successively higher beds within the middle Pogonip. The roadcut lowest on the slope, just below Hill 5922, contains trilobites of the Ross-Hintze J-zone (Hintze, 1988), identifying this as the highest part of the middle Pogonip. The freeway apparently transects the entire middle Pogonip, best exposed in the road cuts on the north side.

Midway in this transect, in the northwest corner of section 35, T. 18 S., R. 3 W., a prominent gray cliff rises out of the slope about 360 feet (120 m) above the level of the freeway (figure 15). This cliff is the basal Pogonip Limestone, here thrust over the middle Pogonip. This thrust fault is the Scipio Pass intraplate thrust, which extends 1.7 miles (2.7 km) northwestward. The thrust surface cuts upsection northwestward in both the upper and lower plates. At its northern end, the base of the upper plate is in the lower part of the middle Pogonip. The top of the underlying plate is variously in upper Pogonip, or in the upper part of the middle Pogonip.

Attitudes show that the Pogonip beds strike mostly northwestward, parallel to the trace of the thrust. Dips are highly variable but overturned beds seem uncommon. The Scipio Pass intraplate thrust is not believed to represent displacement of any great distance. It is likely a minor side-effect produced by major movement on the Canyon Range overthrust.

Major Folds

The Canyon Range syncline is the most prominent fold in the area. As indicated on figure 12, its axis can be traced northward for about 15 miles (24 km) through the high part of the range, from this quadrangle on the south to a point northeast of Oak City where the axis veers northeastward to disappear beneath the synorogenic Canyon Range conglomerate. The fold is open and asymmetric; the east flank dips 30-50 degrees westward; dips on the west flank range from vertical to 70 degrees eastward. The syncline plunges gently northward. Angular discordance of beds above and below the Canyon Range thrust is not great. It appears that at the beginning of thrusting a nearly horizontal plate of Precambrian strata rode over a nearly horizontal set of Paleozoic strata.

The Scipio Pass anticline, not shown on figure 12, can only be identified in the immediate vicinity of Scipio Pass. It is a fold of a width similar to the Canyon Range syncline but its western limb (the limb it has in common with the Canyon Range syncline) is exposed only north of Scipio Pass. Its eastern limb (which forms the west side of the Pahvant Range in this quadrangle) is exposed only south of Scipio Pass. The axis of the anticline is complicated by minor folds and thrusts. These structures can be seen on the ridge at the heads of Middle Canyon and Murrays Canyon, two miles (3 km) north of Scipio Pass.

These folds certainly formed after the Canyon Range overthrust. They probably formed at about the same time as the Pavant thrust. They are not indicated on the map because fold axes are poorly defined in the quadrangle due to complex internal structure, later faulting, and extensive Tertiary and Quaternary cover.

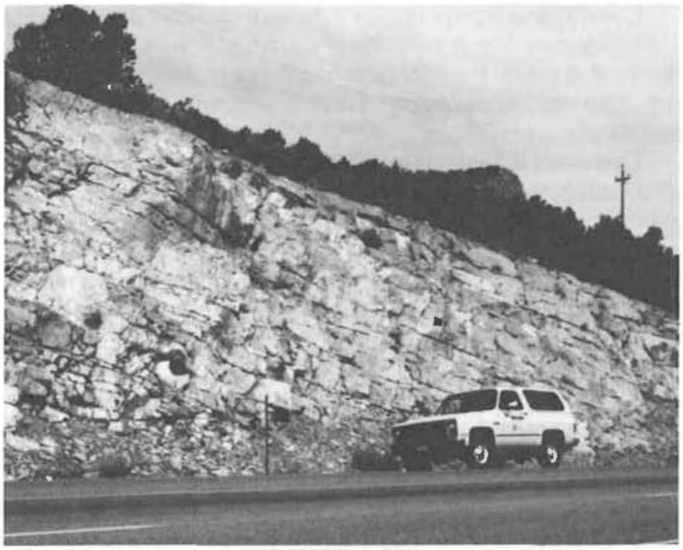


Figure 15. *Resistant limestone of the basal Pogonip Group exposed in freeway roadcut near Scipio Pass. Knob on skyline to left of power pole is the same massive basal limestone which has been thrust over middle Pogonip beds.*

Minor Folds and Thrusts

In addition to the minor folds in the Pogonip Limestone near the Scipio Pass intraplate thrust, discussed above, there are two other areas where small-scale deformation is localized. The first, on the north end of the Pahvant Range a mile (1.6 km) east of Scipio Pass, shows imbricate thrusting of the Eureka Quartzite and Fish Haven Dolomite. The second, in sections 5 and 6, T. 19 S., R. 3 W., on the east side of the Church Mountains, involves the same formations which are here severely brecciated and attenuated, and tightly folded. Both limbs of the small overturned anticline here dip about 40 degrees west. In both places the deformation is believed to have been caused by the overriding of incompetent Pogonip beds by the Canyon Range overthrust.

Extensional Structures

Round Valley-Scipio Valley Normal Fault

Figure 12 shows a concealed (dotted) fault along the east side of the Pahvant Range from Richfield to Scipio which cuts the corner of this quadrangle and continues northward along the east side of the Canyon Mountains. The physiographic expression of this fault is very impressive along the west side of Round Valley, south of Scipio. There, the mountains rise steeply from the valley floor in the classical form of a block-faulted mountain front. North of Scipio, the escarpment along the Canyon Mountains is less abrupt and a broad alluvial apron spreads eastward from the range front.

Movement in this fault zone has continued into late Quaternary time, as evidenced by fault scarps that cut alluvial sediments in the northeast part of this quadrangle. These fault scarps are discussed later in this report under earthquake hazards.

Minor Faults of Diverse Trends

Several faults, mostly less than a mile (1.6 km) long, are shown on the geologic map cutting bedrock formations in various directions. Displacement is generally small. All have been represented as normal faults, but some of them may, in fact, be small strike-slip faults, or have a component of strike-slip displacement. Most of the rocks cut by these faults are carbonates in which slickensides are not preserved. The Eureka Quartzite shows many slickensides, but it is badly brecciated and the slickensides are of diverse orientation. Most of the small faults were likely produced by internal jostling of rocks in the Pavant overthrust plate during their long-distance horizontal transport, and both the apparent normal offset, and the strike-slip offset was produced by this movement. Alternatively, they may be associated with oblique-slip, or strike-slip motion associated with basin and range block faulting. Eddington and others (1987), and Arabasz and Julander (1986) show young strike-slip faulting within this part of Utah.

Geophysical Observations

Regional Gravity and Magnetic Surveys

Bouguer gravity maps by Isherwood (1969), Bankey and Cook (1989), and Cook and others (1989) show major high and low anomalies in central Utah that are outlined on figure 16. None of these anomalies impinge directly on the Scipio Pass quadrangle, but they are relevant to certain features in the quadrangle.

The Sevier Valley low trends northeastward and this trend is continued in the San Pitch Valley low. Figure 16 shows that the Sevier Valley low is bounded on its west side by a major fault which diverges from the trend of the low-gravity anomaly north of Richfield and follows the east side of the Pahvant Range northward to Scipio without producing a major gravity anomaly. The Sevier Valley and San Pitch Valley lows may reflect anomalously thick Jurassic evaporites beneath these valleys, or they may reflect deeper gravity contrasts in the upper mantle. The fault that produces the striking escarpment on the west side of Round Valley cuts obliquely across contours on the gravity maps. However, the density of control points in the Round Valley area is minimal; additional gravity observations might show a different picture in this area.

The Oak City high, which dominates the central part of figure 16, is centered over Oak City, west of the Canyon Mountains. The Canyon and Pahvant ranges are not outlined by gravity anomalies. The Oak City high must represent a major gravity contrast deep beneath the surficial rocks. The regional aeromagnetic map (Zietz and others, 1976) shows no basement features that correspond to this major gravity high. Whatever its cause, the Oak City high does bear a geographic relationship to the location of the upraised alluvial deposits of the Oak City Formation. These Pliocene materials, which were shed off the west side of the Canyon and Pahvant ranges, have been elevated several hundred feet (200-300 m), probably in Late Pliocene or early Quaternary time.

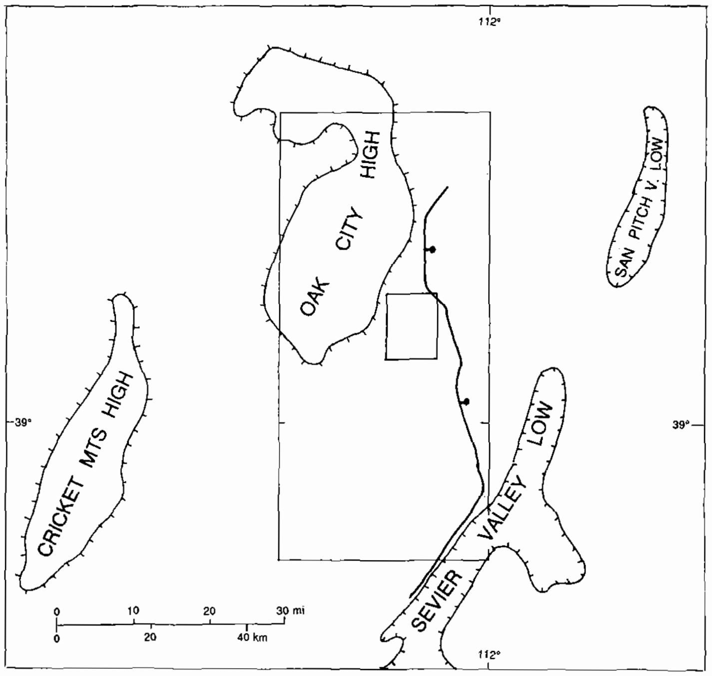


Figure 16. Bouguer gravity anomalies in west-central Utah. Large rectangle outlines area of figure 1. Small rectangle is Scipio Pass quadrangle. Heavy line is Sevier Valley-Round Valley-Scipio Valley normal fault. Highs (-175 milliGals) and lows (-235 milliGals) are generalized from Cook and others (1989).

COCORP Deep Seismic Reflection Data

In 1982 the Consortium for Continental Reflection Profiling (COCORP) ran a seismic line across west-central Utah from the Nevada border to freeway I-15 in the Scipio Pass quadrangle. Figure 12 shows station locations for the eastern sixth of this line. The location of station numbers is also shown on figure 17. The focus of the COCORP survey was to identify features related to Cenozoic extension or Mesozoic compression. Figure 17, from Allmendinger and others (1983), shows the analysis of the reflection data by the COCORP team.

The most prominent and continuous reflection is shown as event A on figure 17, and referred to as the Sevier Desert detachment. It can be traced from near the surface at station 1525 westward for about 43 miles (72 km) where it fades out at a travel time of 5 seconds (7-9 miles, or 12-15 km). Its average westward dip is about 12°, but it shows some moderate variations from that. Figure 12 shows that station 1525, where the Sevier Desert detachment nears the surface, is at the west edge of the hills south of Oak City, northwest of this quadrangle, where the Pliocene Oak City Formation conceals older bedrock.

Event B shows offset of Pliocene basalt by normal faults at stations 1230 and 1285. The faults do not extend deep enough to offset the Sevier Desert detachment.

Event C, at the east end of survey line, was interpreted by Allmendinger and others (1983, 1986) to represent the east-dipping and east-verging Pavant thrust. On figure 12, event C lies one second (2-2.5 mi or 3-4 km) beneath the west side of the Church Mountains, underneath the brecciated Ordovician, Silurian, and Devonian rocks of the Pavant plate mapped by Sayre (1974).

Event D was interpreted by Allmendinger and others (1983, 1986) as possibly representing structurally lower Mesozoic thrusts that are inferred in the subsurface beyond the east end of the COCORP line in central Utah by Standlee (1982) and Villien and Kligfield (1986).

Following the initial interpretation of the COCORP data by Allmendinger and others (1983), other authors have integrated the deep seismic data with shallow seismic, gravity, and well log information. Smith and Bruhn (1984) presented a cross section, similar to that on figure 17, developed from proprietary shallow seismic data made available to them by industry sources, and interpreted the Sevier Desert detachment as a low-angle normal fault. Smith and others (1989) considered deep crustal structure in the eastern Basin and Range and presented velocity layer information extending 50 miles (80 km) into the upper asthenosphere. Planke and Smith (1991) presented the most complete study of geophysical data of the Sevier Desert basin using deep and shallow seismic data, and gravity and well log information. Most recently Anders and Christie-Blick (1994) interpreted event A on figure 17 as an unconformity between Tertiary and Paleozoic rocks. It is beyond the scope of our report on the Scipio Pass quadrangle to summarize the many observations and interpretations presented in these comprehensive regional reports, to which the interested reader is referred.

ECONOMIC GEOLOGY

Mineral prospecting within the quadrangle has been very limited. The topographic map shows a prospect on the south edge of section 11, T. 19 S., R. 3 W. It consists of a chunky mass of white travertine within the Opex Formation that has been exposed by a small bulldozer excavation, apparently done several decades ago. There is no indication that any travertine was shipped from the prospect. Other shallow prospect pits are found in sections 16, 21, 28, and 34, T. 18 S., R. 3 W. In section 16, limonite staining appears at the thrust contact between Precambrian quartzite and Silurian dolomite. Limonite stain appears to be the mineral that attracted the prospectors. No sign of copper or other base metals appears in any of the old diggings, which have no claim notices or markers to indicate their age.

The only mineral resource that has been developed and used within the quadrangle is gravel used for highway foundation and road surfacing. Several gravel pits are shown on the topographic map. This gravel is mostly from alluvial-fan deposits, and in some pits the gravel is clean and fairly well sorted. Elevations in the quadrangle are all above the highest level of Lake Bonneville, so the quadrangle does not have the clean, well-sorted gravel deposits that can be found widely in lower areas nearby. Limestone, dolomite, and quartzite are abundantly available within the quadrangle and could be developed for industrial uses should the economics of transportation and other factors allow these deposits to compete with similar deposits widely distributed throughout western Utah.

No exploration wells for oil and gas have been drilled within this quadrangle. Some seismic lines have been run in nearby areas (Smith and Bruhn, 1984; Planke and Smith, 1991) and these have been interpreted to show that the area is part of a

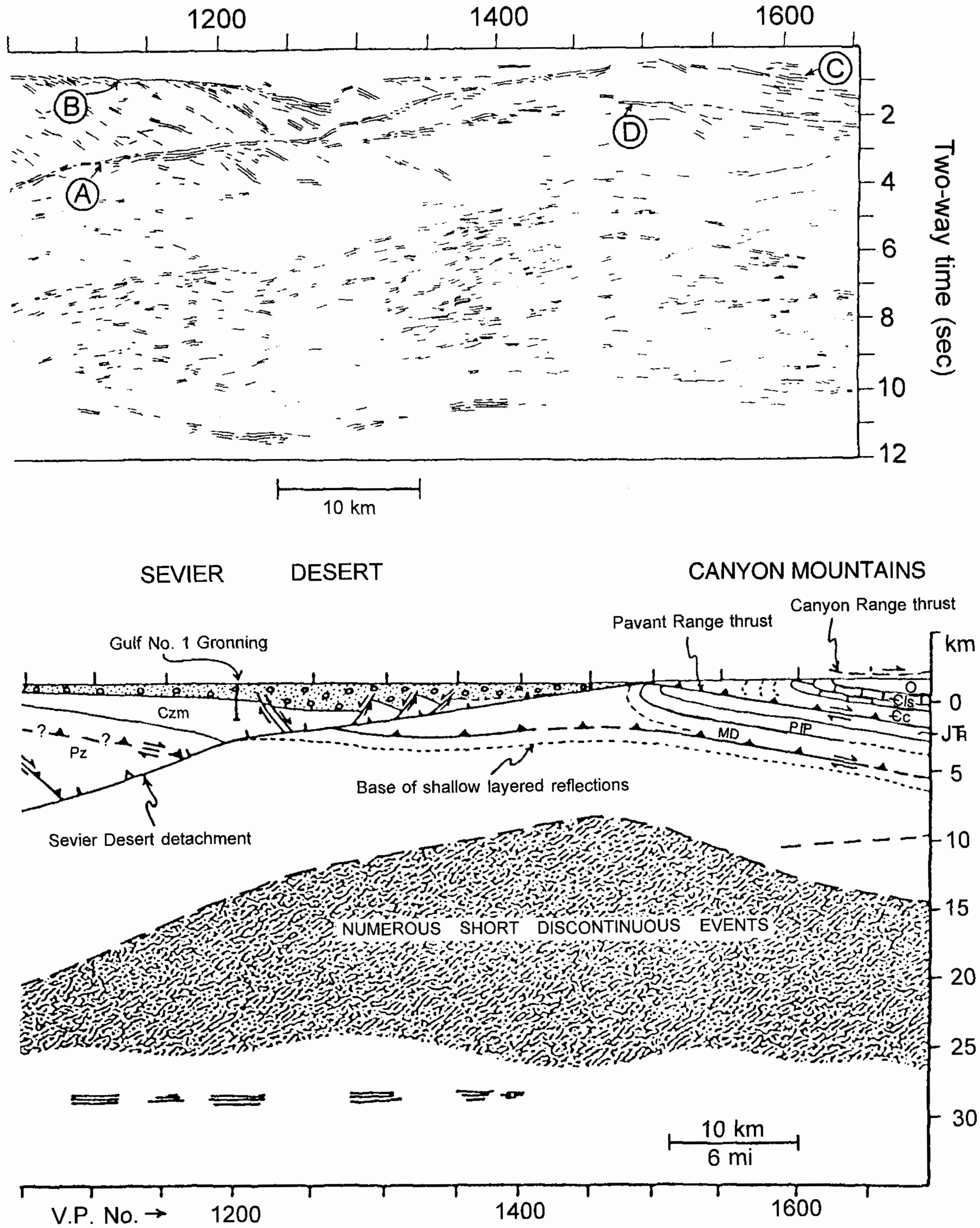


Figure 17. *Utah COCORP line 1, between station 1050 and east end of line, slightly modified from Allmendinger and others (1983). See figure 12 for location. The letters A, B, C, and D, on the sketch of reflections from the seismic record, refer to features discussed in the text. The interpretive cross section shows thrust faults (saw-teeth), a low-angle, normal fault (ticks), and other features. Symbols on interpretive cross section are: Czm = Miocene, Pz = Paleozoic, MD = Mississippian and Devonian, PIP = Permian and Pennsylvanian, €c = Cambrian clastics, €ls = Cambrian limestone, O = Ordovician, JTr = Jurassic-Triassic.*

poorly understood thrust and normal fault complex. The Paleozoic strata of the Pavant thrust plate are most likely underlain by autochthonous Mesozoic strata, probably Jurassic Navajo Sandstone as inferred from exposures along the Pahvant Range south of the quadrangle (Hintze, 1980). Potential for oil and gas recovery is unknown at present.

WATER RESOURCES

There is, at present, no published report that specifically covers the water resources within this quadrangle. Dennis and others (1946) reported on ground water in Pahvant Valley, but the northeast corner of their hydrologic map is about 5 miles (8 km) southwest of the southwest corner of the Scipio Pass quadrangle. They showed a 54-year average precipitation rate at Fillmore of 14.3 inches (36.5 cm) per year. Hydrographs for major streams in the southern part of the Pahvant Range show runoff peaks in May. Their chart showing data on minor streams in Pahvant Valley includes the following information on streams that flow within this quadrangle:

StreamDrainage	BasinFlood	Maximum
West Eightmile Creek	12 square miles	15 second feet
East Eightmile Creek	16 square miles	25 second feet
Wild Goose Creek	7 square miles	5 second feet

These three streams commonly dry up during the summer, but they are used for spring and early summer irrigation on farmlands near Holden and Greenwood, to the southwest of the Scipio Pass quadrangle.

Bjorkland and Robinson (1968) summarized the ground-water resources of the Scipio Valley area that includes the northeast corner of the Scipio Pass quadrangle. Their plate 2 shows that two water wells at Scipio Pass found water (presumably in bedrock) at 760 and 783 feet (230 and 238 m) below the surface respectively. However, wells drilled in alluvium in section 24 in the northeast corner of the map found water only 8 or 9 feet (3 m) below the surface.

GEOLOGIC HAZARDS

Because nobody resides permanently within this quadrangle the consideration of geologic hazards is mostly related to the transportation, communication, and gas pipeline facilities that go through the Scipio Pass area. Future development within the quadrangle would need to take the potential hazards discussed here into consideration.

Earthquakes

The northeast corner of our map shows fault scarps that cut unconsolidated Quaternary deposits in Scipio Valley. These scarps were first recognized by Christiansen (1952) but were more completely discussed by Bucknam and Anderson (1979) who noted that the Scipio faults probably represent only one period of Quaternary activity and that it pre-dates the Lake Bonneville highstand. The scarps shown on the present map were identified on 1988 U.S. Forest Service, 1:15,000 scale, color aerial photographs. They are part of a series of scarps that can be followed along the east side of the Canyon and Pahvant ranges. Scarp height suggests that they were produced during an earthquake of a magnitude of at least 6.5.

The Scipio Pass quadrangle lies along the west side of the Intermountain seismic belt, a belt of seismic activity that extends from southern California to Yellowstone Park (Smith and Sbar, 1974). In central Utah the belt is centered under Sanpete Valley, about 25 miles (40 km) east of the quadrangle. There have been 255 recorded earthquakes within a 12 mile (20 km) radius of the northeast corner of this quadrangle between 1962 and 1991 (University of Utah Seismograph Stations, unpublished data, 1992). Nine of them had magnitudes greater than 3.0 (table 1).

Table 1.
Earthquakes with magnitudes greater than 3.0 within 12 miles of the northeast corner of Scipio Pass quadrangle (University of Utah Seismograph Stations, unpublished data, 1992).

Date	Latitude	Longitude	Depth (km)	Magnitude
16 Jan 68	39° 18.00′	112° 3.72′	4.1	3.5
16 Jan 68	39° 17.40′	112° 2.69′	7.0	3.4
16 Jan 68	39° 18.78′	112° 2.69′	7.0	3.3
16 Jan 68	39° 16.78′	112° 1.52′	7.0	3.2
17 Jan 68	39° 15.93′	112° 2.28′	7.0	3.9
24 Mar 86	39° 13.34′	111° 59.90′	0.1	3.3
24 Mar 86	39° 14.04′	112° 0.37′	0.9	4.4
25 Mar 86	39° 13.53′	112° 0.68′	1.5	3.9
11 Jul 88	39° 11.51′	111° 59.25′	1.7	3.1

The 1968 earthquakes were centered beneath the north end of the Valley Mountains, about 4 miles (6 km) northeast of the town of Scipio. The 1986 and 1988 earthquakes were also centered under the Valley Mountains, about 6 miles (9 km) and 8 miles (13 km) southeast of Scipio respectively.

A 3-foot (1-m) high-pressure natural gas pipeline parallels the freeway across the quadrangle. Constructed in 1990, it is equipped with shut-off valves to be used if the line is broken during an earthquake.

Flood Hazards

The quadrangle does not include any permanent streams. The drainage basin areas and flood maxima for the principal intermittent streams are listed above under water resources. Ebbs Creek, with a relatively small drainage basin, is not listed above but it is conceivable that a cloudburst in the Ebbs Creek drainage could generate a flood that might cover Interstate highway I-15. Floods in other drainage basins in the quadrangle would not affect the freeway, but might damage the local graded county roads. The 3-foot (1-m) high-pressure natural gas pipeline, paralleling the freeway is buried to a depth of about 6 feet (2 m) and would not likely be affected by flooding.

Other Possible Hazards

Some parts of Scipio Valley in the northeast corner of the quadrangle may have potential problems with collapsible soils and shallow ground water. Significant development in this area should include testing to assess the extent of these hazards.

ACKNOWLEDGMENTS

We thank Jim Baer, Doug Sprinkel, Bryce Tripp, Grant Willis, and Barry Solomon for reviewing the map and manuscript.

REFERENCES CITED

Allmendinger, R.W., Farmer, Harlow, Hauser, Ernest, Sharp, James, Von Tish, Douglas, Oliver, Jack, and Kaufman, Sidney, 1986, Phanerozoic tectonics of the Basin and Range-Colorado Plateau transition from COCORP data and geologic data, a review: Washington, D.C., American Geophysical Union, Geodynamics Series, v. 14, p. 257-267.

Allmendinger, R.W., Sharp, J.W., Von Tish, Douglas, Serpa, Laura, Brown, Larry, Kaufman, Sidney, and Oliver, Jack, 1983, Cenozoic and Mesozoic structure of the eastern Basin and Range Province, Utah, from COCORP seismic-reflection data: Geology, v. 11, p. 532-536.

Anders, M.H., and Christie-Blick, Nicholas, 1994, Is the Sevier Desert reflection of west-central Utah a normal fault?: Geology, v. 22, p. 771-774.

Arabasz, W.J., and Julander, D.R., 1986, Geometry of seismically active faults and crustal deformation within the Basin and Range-Colorado Plateau transition in Utah: Geological Society of America Special Paper 208, p. 43-74.

Armstrong, R.L., 1968, Sevier orogenic belt in Nevada and Utah: Geological Society of America Bulletin, v. 79, p. 429-458.

Bankey, Viki, and Cook, K.L., 1989, Complete Bouguer gravity map and related geophysical maps of the Delta 1 degree by 2 degree quadrangle, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF 2081-A, scale 1:250,000.

Bjorkland, L.J., and Robinson, G.B. Jr., 1968, Ground-water resources of the Sevier River Basin between Yuba Dam and Leamington Canyon, Utah: U.S. Geological Survey Water-Supply Paper 1848, 79 p.

Bucknam, R.C., and Anderson, R.E., 1979, Map of fault scarps in unconsolidated sediments, Delta 1 degree by 2 degree quadrangle, Utah: U.S. Geological Survey Open-File Report 79-366, 21 p., scale 1:250,000.

Campbell, J.A., 1979, Middle to late Cenozoic stratigraphy and structural development of the Canyon Range, central Utah: Utah Geology, v. 6, no. 1, p. 1-16.

Christiansen, F.W., 1952, Structure and stratigraphy of the Canyon Range, central Utah: Geological Society of America Bulletin, v. 63, p. 717-740.

Christie-Blick, Nicholas, 1982, Upper Proterozoic and Lower Cambrian rocks of the Sheeprock Mountains, Utah - regional correlation and significance: Geological Society of America Bulletin, v. 93, p. 735-750.

Cook, K.L., Bankey, Viki, Mabey, D.R., and DePangher, Michael, 1989, Complete Bouguer gravity anomaly map of Utah: Utah Geological and Mineral Survey Map 122, scale 1:500,000.

Crosby, G.W., 1959, Geology of the south Pavant Range, Millard and Sevier Counties, Utah: Brigham Young University Geology Studies, v. 6, no. 3, 59 p.

Davis, R.L., 1983, Geology of the Dog Valley - Red Ridge area, southern Pavant Mountains, Millard County, Utah: Brigham Young University Geology Studies, v. 30, pt. 1, p. 19-36.

Dennis, P.E., Maxey, G.B., and Thomas, H.E., 1946, Ground water in Pavant Valley, Millard County, Utah: Utah State Engineer Technical Publication 3, 96 p., scale 1:62,500.

Eddington, P.K., Smith, R.B., and Renggli, Charles, 1987, Kinematics of basin and range intraplate extension: Geological Society of London Special Publication 28, p. 371-392.

Fouch, T.D., Lawton, T.F., Nichols, D.J., Cashion, W.B., and Cobban, W.A., 1983, Patterns and timing of synorogenic sedimentation in Upper Cretaceous rocks of central and northeast Utah, *in* Reynolds, M.W. and Dolly, F.D. editors, Mesozoic paleogeography of west-central United States: Rocky Mountain Section, Society of Economic Paleontologists and Mineralogists, Denver, p. 305-336.

George, S.E., 1985, Geology of the Fillmore and Kanosh quadrangles, Millard County, Utah: Brigham Young University Geology Studies, v. 32, pt. 1, p. 39-62.

Hickcox, C.W., 1971, Geology of a portion of the Pavant Range allochthon, Millard County, Utah: Houston, Rice University, Ph.D. thesis, 67 p., scale 1:62,500.

Higgins, J.M., 1982, Geology of the Champlin Peak quadrangle, Juab and Millard Counties, Utah: Brigham Young University Geology Studies, v. 29, pt. 2, p. 40-58.

Hintze, L.F., 1951, Lower Ordovician detailed stratigraphic sections for western Utah: Utah Geological and Mineralogical Survey Bulletin 39, 99 p.

Hintze, L.F., 1980, Geologic map of Utah: Utah Geological and Mineral Survey Map A-1, scale 1:500,000.

Hintze, L.F., 1988, Geologic history of Utah: Brigham Young University Geology Studies Special Publication 7, 202 p.

Hintze, L.F., and Robison, R.A., 1975, Middle Cambrian stratigraphy of the House, Wah Wah, and adjacent ranges in western Utah: Geological Society of America Bulletin, v. 86, p. 881-891.

Holladay, J.C., 1984, Geology of the northern Canyon Range, Millard and Juab Counties, Utah: Brigham Young University Geology Studies, v. 31, pt. 1, p. 1-28.

Isherwood, W.F., 1969, Regional gravity survey of parts of Millard, Juab, and Sevier Counties, Utah: Salt Lake City, University of Utah, M.S. thesis, 74 p.

Lautenschlager, H.K., 1952, Geology of the central part of the Pavant Range, Utah: Columbus, Ohio State University, Ph.D. thesis, 188 p.

Lawton, T.F., 1985, Style and timing of frontal structures, thrust belt, central Utah: American Association of Petroleum Geologists Bulletin, v. 69, p. 1145-1159.

Lawton, T.F., and Trexler, J.H., Jr., 1991, Piggyback basin in the Sevier orogenic belt, Utah: Implications for development of the thrust wedge: Geology, v. 19, p. 827-830.

Maxey, G.B., 1946, Geology of part of the Pavant Range, Millard County, Utah: American Journal of Science, v. 244, p. 324-356, scale 1:180,000.

Millard, A.W., Jr., 1983, Geology of the southwestern quarter of the Scipio North (15 minute) quadrangle, Millard and Juab Counties, Utah: Brigham Young University Geology Studies, v. 30, pt. 1, p. 59-81.

Morris, H.T., and Lovering, T.S., 1961, Stratigraphy of the East Tintic Mountains, Utah: U.S. Geological Survey Professional Paper 361, 145 p.

Oviatt, C.G., 1991, Quaternary geology of the Black Rock Desert, Millard County, Utah: Utah Geological and Mineral Survey Special Study 73, 23 p., scale 1:100,000.

Oviatt, C.G., 1992, Quaternary geology of the Scipio Valley area, Millard and Juab Counties, Utah: Utah Geological Survey Special Study 79, 16 p., scale 1:62,500.

Planke, Sverre, and Smith, R.B., 1991, Cenozoic extension and evolution of the Sevier Desert Basin, Utah, from seismic reflection, gravity, and well log data: Tectonics, v. 10, p. 345-365.

Sayre, R.L., 1974, Geology and mineralization of the Church Hills, Millard County, Utah: Utah Geological and Mineral Survey Special Study 74, 22 p.

Schwans, Peter, 1988, Depositional response of Pigeon Creek Formation, Utah, to initial fold-thrust belt deformation in a differentially subsiding foreland basin: Geological Society of America Memoir 171, p. 531-556.

Sharp, J.W., 1984, West-central Utah, palinspastically restored sections constrained by COCORP seismic reflection data: Ithaca, N.Y., Cornell University, M.S. thesis, 60 p.

Smith, R.B., and Bruhn, R.L., 1984, Intraplate extensional tectonics of the eastern Basin-Range: Inferences on structural style from seismic reflection data, regional tectonics, and thermal-mechanical models of brittle-ductile deformation: Journal of Geophysical Research, v. 89, p. 5733-5762.

Smith, R.B., Nagy, W.C., Julander, K.A., Viveiros, J.J., Barker, C.A., and Gants, D.G., 1989, Geophysical and tectonic framework of the eastern Basin and Range-Colorado Plateau-Rocky Mountain transition: Geological Society of America Memoir 172, p. 205-233.

Smith, R.B., and Sbar, M.L., 1974, Contemporary tectonics and seismicity of the western U.S., with emphasis on the Intermountain seismic belt: Geological Society of America Bulletin, v. 85, p. 1205-1218.

Standlee, L.A., 1982, Structure and stratigraphy of Jurassic rocks in central Utah – their influence on tectonic development of the Cordilleran foreland thrust belt, *in* Powers, R.B., editor, Geologic studies of the Cordilleran thrust belt: Denver, Colorado, Rocky Mountain Association of Geologists, v. 1, p. 357-382.

Stolle, J.M., 1978, Stratigraphy of the lower Tertiary and Upper Cretaceous (?) continental strata in the Canyon Range, Juab County, Utah: Brigham Young University Geology Studies, v. 25, pt. 3, p. 117-139.

Tucker, L.M., 1954, Geology of the Scipio quadrangle, Utah: Columbus, Ohio State University, Ph.D. dissertation, 360 p.

Villien, Alain, and Kligfield, R.M., 1986, Thrusting and synorogenic sedimentation in central Utah: American Association of Petroleum Geologists Memoir 41, p. 281-308.

Webb, G.W., 1956, Middle Ordovician detailed stratigraphic sections for western Utah and eastern Nevada: Utah Geological and Mineralogical Survey Bulletin 57, 77 p.

Webb, G.W., 1958, Middle Ordovician stratigraphy in eastern Nevada and western Utah: American Association of Petroleum Geologists Bulletin, v. 42, p. 2335-2377.

Woodward, L.A., 1972, Upper Precambrian stratigraphy of central Utah, *in* Baer, J.L., and Callaghan, Eugene, editors, Plateau-Basin and Range Transition Zone, central Utah: Utah Geological Association Publication 2, p. 1-5.

Woodward, L.A., 1976, Stratigraphy of younger Precambrian rocks along the Cordilleran hingeline, Utah and southern Idaho, *in* Hill, J.G., editor, Symposium on geology of the Cordilleran Hingeline: Rocky Mountain Association of Geologists, p. 83-90.

Zietz, Isidore, Shuey, Ralph, and Kirby, J.R., Jr., 1976, Aeromagnetic map of Utah: U.S. Geological Survey Geophysical Investigations Map GP 907, scale 1:1,000,000.

AGE	MAP UNIT	MAP SYMBOL	THICKNESS feet	THICKNESS meters
QUATERNARY	Alluvium, colluvium, eolian silt, young (Q) and old (QT) alluvial-fan and old landslide deposits	Qal,Qmc, Qe,Qaf, QTaf, QTml	0 to several hundred	
PLIOCENE	Old landslide deposit	Tml	0-30	0-10
	Oak City Formation	Toc	0 to several hundred	
LOWER TERTIARY-UPPER CRETACEOUS	Canyon Range conglomerate	TKc	792+	242+
DEVONIAN	Sevy Dolomite	Dsy	423+	129+
SILURIAN	Laketown Dolomite	Sl	832	254
ORDOVICIAN	Fish Haven Dolomite	Ofh	261	80
	Eureka Quartzite	Oe	180	54
	Pogonip Group, undivided	Op	1,684	513
CAMBRIAN	Ajax Dolomite	€a	966	295
	Opex Formation	€ox	671	205
	Cole Canyon and Bluebird Dolomites, undivided	€cb	536	164
	Herkimer, Dagmar, and Teutonic Formations, undivided	€ht	994+	303+
	Ophir Formation	€op	500	150
	Tintic Quartzite	€t	3,000	1,000

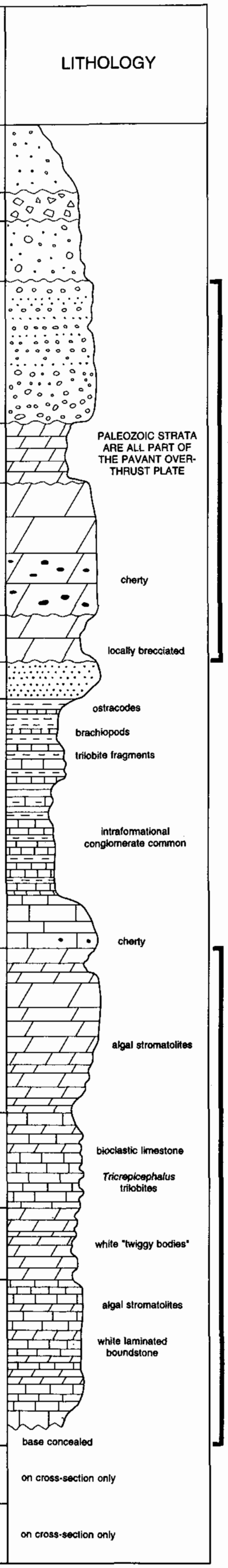


Figure 18. *Stratigraphic column for the Scipio Pass quadrangle. Measured sections in Appendix A are bracketed.*

APPENDIX A

CAMBRIAN

Measured section includes upper half of the Teutonic Limestone through the Ajax Dolomite. The section is located on the ridge north of Wild Goose Canyon starting at the SE¼ section 22, T. 19 S., R. 3 W. and ending in the NE¼ section 23, T. 19 S., R. 3 W.

Ajax Dolomite is overlain conformably by Ordovician Pogonip Limestone.

Ajax Dolomite	**Feet**	**Meters**
47 — Dolomite, medium dark gray to brownish gray, weathers olive gray with light olive gray mottling; very thick bedding, forms prominent ledges especially in lower half of unit; some darker layers present with white dolomitic rods; abundant limestone float from above.	64	19.5
46 — Dolomite, medium light gray, weathers light olive to yellowish gray, coarse grained, thin to medium bedding, forms shallow slope.	49	15
45 — Dolomite, similar to unit 47, alternating light and dark units near top, very thick bedding, forms massive cliffs.	276	84
44 — Dolomite, medium gray to light brownish gray, weathers light olive gray, very thick bedding, forms massive ledges to cliffs.	246	75
43 — Dolomite, similar to unit 47, forms massive cliffs and ledges; contact with underlying unit is sharp.	82	25
42 — Dolomite, similar to unit 44.	87	26.5
41 — Dolomite, medium to dark gray, weathers medium gray; small algal heads stand out on weathered surface as dark gray.	3	1
40 — Dolomite, medium light gray, weathers light olive gray to yellowish gray; thick bedding, forms ledges.	31	9.5
39 — Dolomite, medium gray to light brownish gray, weathers light olive gray; exposure is poor; rubbly slope-forming unit.	64	19.5
38 — Dolomite, similar to unit 39, medium to thick bedding, forms steep ledgy slope; 6-inch (15 cm) diameter algal-head structures common.	25	7.5
37 — Dolomite, similar to unit 39, slope former.	39	12
Measured thickness of Ajax Dolomite	966	294.5

Opex Formation	**Feet**	**Meters**
36 — Limestone, medium dark gray, weathers medium gray; interbedded light brownish layers of silty clay give unit its parting; very thin bedding gives slaty to flaggy appearance and forms slope; worm trails and burrows common; some tubular and nodular chert; abundant dolomite float from above; good marker bed for top of Opex, exact contact with overlying formation and underlying unit covered.	15	4.5
35 — Limestone, medium dark gray, weathers medium gray, laminated with silty layers of moderate yellowish brown; medium- to thin-bedded slope former; some flat-pebble conglomerate beds; trilobite fragments; abundant dolomite float near top of unit.	128	39
34 — Limestone, pinkish gray, weathers grayish orange pink; medium bedding.	15	4.5
33 — Dolomite, very light gray to pinkish gray, weathers yellowish gray to very pale orange; thick bedded, forms ledgy slope.	15	4.5
32 — Dolomite, medium light gray, weathers medium light brownish gray, light mottled appearance; white dolomite rods present in some layers.	39	12
31 — Limestone, oolitic, medium dark gray, weathers light olive gray; thin to medium bedded, forms slope.	108	33
30 — Dolomite, similar to units 32 and 33, interbedded.	59	18
29 — Dolomite, similar to unit 33.	30	9
28 — Dolomite, similar to unit 32.	49	15
27 — Limestone, light olive gray, weathers yellowish gray; pale yellowish orange silty layers present; oncoids up to 0.75 inch (1.8 cm) especially abundant in basal 6 feet (2 m) of unit, lower contact abrupt.	20	6
26 — Limestone, sandy, medium gray, with greenish tint, weathers to moderate brown, noncalcareous surface; interbedded calcareous sandstone, grayish red, weathers orange brown to red, very silty; thinly bedded, forms slope covered with small, flat, flaggy pieces; lower contact abrupt.	34	10.5
25 — Limestone, bioclastic to oolitic, medium dark pinkish gray, weathers medium gray with mottled pinkish gray; coarse grained; shaly units interbedded with very thick limestone units form ledgy slope; zones of		

	Feet	Meters
intraformational flat-pebble conglomerate common; small black ooids very abundant especially near the top; orange-pink color increases toward top; trilobite hash very abundant throughout unit but especially abundant in horizon directly beneath unit 26, good identifiable cephalon and pygidium were found.	70	21
24 - Limestone, medium gray, weathers light gray with grayish-orange stringers of dolomite; dolomite stringers are silty and form resistent layers 0.3 inches (1 cm) wide which give the unit a striped appearance; unit is very thick bedded and forms massive ledges.	32	10
23 - Limestone, medium gray, weathers light gray with dark-yellowish-orange to moderate-yellowish-brown stringers and spheroidal oncoids; this thin-bedded, flaggy, limestone is interbedded with a thick-bedded limestone similar to unit 24; unit forms alternating slope and ledges; basal limestone is very coarse grained, with ooids and trilobite fragments; thin-bedded limestone has small cubic pseudomorphs of limonite after pyrite which may be responsible for much of the yellow staining.	57	17.5
Measured thickness of Opex Formation.	671	204.5

Cole Canyon and Bluebird Dolomites, undivided

	Feet	Meters
22—Dolomite, medium gray to light brownish gray, weathers light yellowish to light olive gray with mottled blebs of medium olive gray; medium grained; thick bedded, forms dip slope.	30	9
21—Dolomite, medium light gray to very light brownish gray, weathers very light gray, fine grained; very thick bedded, forms dip slope.	10	3
20 — Dolomite, similar to unit 22 with dark interbeds similar to unit 15 below.	167	51
19—Dolomite, similar to unit 21.	44	13.5
18 — Dolomite, similar to unit 22 with dark interbeds similar to unit 15 below.	74	22.5
17 — Dolomite, similar to unit 21, but blocky rubble makes up good portion of dip slope, occasional dark beds, similar to unit 15 below.	25	7.5
16 — Dolomite, similar to unit 21 with occasional dark beds similar to unit 15 below; very thick bedding forms massive cliff.	98	30
15—Dolomite, dark gray, weathers olive gray; coarse grained; short white dolomite rods, "twig-shaped bodies," are characteristic of unit, with occasional oncoids of same composition; very thick bedded, forms massive cliffs and ledges.	39	12
14—Dolomite, medium light gray to very light brownish gray, weathers very light gray; fine grained; thick to very thick interbeds similar to unit 15 with oncoids, especially in the basal 6 feet (2 m) of the unit; dolomite rubble and float cover much of the ledgy slope.	49	15
Measured thickness of Cole Canyon and Bluebird Dolomites, undivided	536	163.5

Herkimer, Dagmar, and Teutonic Formations, undivided

	Feet	Meters
13 — Limestone, dark gray, weathers medium gray with mottled light-olive-gray stromatolitic stringers and blebs of dolomite generally 0.5-1 inches (1-2 cm) thick, which parallel bedding; stromatolitic stringers are more resistant, and differential weathering and color variation give unit a striped appearance; very thick bedding forms prominent ledges which are largely covered by dolomite float from above; large algal-head structures are near top of unit overlain by a zone of oncoids.	75	23
12—Dolomite, medium light gray to light gray, weathers very pale orange; finely laminated; medium to thick bedding forms ledgy slope; similar to unit 7.	10	3
11 —Limestone, similar to unit 13; beds more massive, striped appearance; no algal-head structures; massive ledge- to cliff-forming unit.	57	17.5
10—Dolomite, dark gray, weathers olive gray, coarse sugary grained; has short white dolomite rods similar to unit 15; very thick bedding, forms prominent ledge.	6	2
9 — Limestone, similar to unit 11, striped appearance; includes some beds of white wormy-textured limestone; a prominent oncoid zone, 10 feet (3 m) wide with oncoids 0.6 inches (1.5 cm) in diameter present near middle; oncoids are dolomitic and more resistant than matrix.	143	43.5
8 — Limestone, dark gray, weathers medium gray with mottled light-olive-gray stromatolitic stringers and blebs of dolomite which give unit a striped appearance, similar to unit 13 above, but interbedded with		

	Feet	Meters
very thin beds of light-yellowish-gray dolomite similar to unit 7 below; unit forms ledgy slope.	54	16.5
7 — Dolomite, light gray to medium light gray, weathers very light gray to very pale orange; fine grained and very hard, finely laminated; thin to medium bedded, forms blocky slope.	15	4.5
6 — Limestone, dolomitic, similar to unit 8 above.	49	15
5 — Dolomite, similar to unit 7.	20	6
4 — Limestone, dolomitic, similar to unit 8, but with beds of alternating laminations of dark-gray limestone and light-yellowish-gray dolomite scattered throughout; more striped and massive near top of unit; ledgy slope-forming unit.	210	64
3 — Dolomite, similar to unit 7.	10	3
2 — Limestone, coarse grained, dark gray, weathers medium gray with mottled light-olive-gray stromatolitic stringers and blebs which are dolomitic and silty and more resistant to weathering giving unit a striped appearance; a pinkish tint with white calcite blebs and rod-like structures are locally present; very thick bedding produces massive ledges on ledgy slope.	202	61.5
1 — Limestone, similar to unit 2, but ledges mostly buried with float and rubble; exposure very poor; unit covered at base by alluvium.	143	43.5
Measured thickness of exposed Herkimer, Dagmar, and Teutonic Formations, undivided. Base of section concealed.	994	303

APPENDIX B

UPPER ORDOVICIAN THROUGH CRETACEOUS AND LOWER TERTIARY

Section measured from the Upper Ordovician Fish Haven Dolomite through part of the Upper Cretaceous and lower Tertiary Canyon Range conglomerate. The section is located on the ridge north of Ebbs Canyon beginning at NW¼ section 12, T. 19 S., R. 3 W. and ending at SE¼ section 1, T. 19 S., R. 3 W.

Tertiary - Cretaceous Canyon Range conglomerate

	Feet	Meters
24 — Conglomerate with interbedded sandstone; limestone pebbles and cobbles, generally well rounded, 20%; quartzite pebbles and cobbles, subrounded to subangular, 40%; sandstone matrix, grayish orange, weathers pale yellowish brown, coarse grained, silty, lenticular, 40%; forms dipslope and strike valley.	197	60
23 — Conglomerate with interbedded sandstone, clasts similar to unit 24; quartzite, 50%; limestone 10%; sandstone, lenticular, more massive, 40%; unit forms ledgy slope.	74	22.5
22 — Sandstone, grayish orange, weathers pale yellowish brown, coarse, silty, poorly cemented, cross-bedded locally; very thick bedding forms ledges and cliffs; conglomerate lenses similar to unit 24 present locally.	108	33
21 — Conglomerate with interbedded sandstone; similar to unit 24; conglomerate consists of 70% limestone clasts, 20% whitish quartzite clasts, and 10% purple, cross-bedded quartzite clasts, with sandy matrix; limestone clasts decrease in relative percentage upwards; sandstone forms lenticular ledges in this slope-forming unit.	69	21.0
20 — Conglomerate; 70% quartzite clasts, 25% limestone clasts; sandstone float, 5%; fewer sandstone lenses than unit 24; forms ledgy slope.	49	15
19 — Conglomerate, very coarse, cobbles to boulders, well rounded to subrounded, red sandy matrix; quartzite clasts comprise at least 60% of unit, most are grayish red with blackish-red cross-bedded laminations, coarse grained, and resemble Precambrian Mutual Formation. Unit also includes pale-red quartzite boulders and cobbles, and a few gneissic clasts; no limestone clasts present; tightly cemented red sandy matrix, forms massive cliffs and ledges.	192	58.5
18 — Conglomerate, similar to unit 19, but less consolidated and massive, forms slope; some quartzite boulders up to 4 feet (1.5 m) in diameter.	103	31.5
Measured thickness of Canyon Range conglomerate	792	241.5

Devonian Sevy Dolomite (partial section below unconformity)

	Feet	Meters
17 — Dolomite, very light brownish gray, weathers very light gray with pinkish tint; fine to medium grained, some silty interlayers; thinly laminated, thin to medium bedding, forms slope.		276

	Feet	Meters
16 — Dolomite, similar to unit 17; up to 20% chert in some places, very light pinkish gray, weathers grayish orange; very thick bedding, forms massive cliffs and ledges.	147	45
Measured thickness of Sevy Dolomite	423	129

Silurian Laketown Dolomite

	Feet	Meters
15 — Dolomite, medium gray with brownish tint, weathers light olive gray, coarse, sugary; white calcite blebs and specs abundant; 5% chert; very thick bedded, forms massive ledge to cliff.	64	19.5
14 — Dolomite, medium gray with brownish tint, weathers medium olive gray; white dolomite blebs; 30% stromatolitic laminations; lighter interbeds; chert more abundant near top of unit; slight hydrocarbon odor; medium to thick bedded; forms ledgy slope.	374	114
13 — Dolomite, medium dark gray, weathers light olive gray; 4-foot (1.5 m) dolomite ledge at top of unit, medium light gray to very light brownish gray, weathers very light gray; very thick bedding, forms ledges.	74	22.5
12 — Dolomite, medium light gray to very light brownish gray, weathers very light gray; some intraformational rip-up clasts; some thin beds of stromatolitic laminations; sandy to cherty blebs; medium bedding, forms saddle.	69	21
11 — Dolomite, similar to unit 12, less intraformational rip-up clasts, more laminations; forms slope.	64	19.5
10 — Dolomite, similar to unit 13, brecciated, very thick bedding, forms massive ledges; contact with underlying unit is sharp.	20	6
9 — Dolomite, similar to unit 12, less intraformational conglomerate; some brecciation; medium bedding, forms a slope.	29	9
8 — Dolomite, medium dark gray, weathers light olive gray, brecciated; very massive bedding forms 20-foot (6-m) cliff.	20	6
7 — Dolomite, similar to unit 8; bed at base of unit consists of approximately 50% chert nodules; unit forms slope, possibly due to brecciation.	118	36
Measured thickness of Laketown Dolomite	832	253.5

Ordovician Fish Haven Dolomite

	Feet	Meters
6 — Dolomite, medium dark gray, weathers light gray to light olive gray; commonly mottled, brecciated; no chert; thick to very thick bedding, forms ledges.	44	13.5
5 — Limestone, brownish medium dark gray, weathers light gray to light olive gray with grayish-pink tint, weathers to meringue surface, medium to fine grained; calcite veins fill fractures; darker micritic interbeds present; unit very thick bedded, forms four massive ledges 6-10 feet (2-3 m) thick, separated by slopes.	84	25.5
4 — Dolomite, light brownish gray, weathers very light gray to pinkish gray, micritic; medium bedding, forms ledgy slope.	24	7.5
3 — Limestone, similar to unit 5; slightly dolomitic with dolomite laminations.	5	1.5
2 — Dolomite with 50% blebs and stringers of limestone, dolomite is light to olive gray with dark-medium-gray limestone stringers; thick bedding, forms ledges.	10	3
1 — Dolomite, medium gray, weathers light gray to light olive gray, brecciated, with calcareous fracture filling, pale reddish brown; medium bedding, forms rubbly slope.	94	28.5
Measured thickness of Fish Haven Dolomite	261	79.5