

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

by

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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: the Precambrian rocks on the Canyon Range overthrust plate, the Paleozoic strata on the Pavant overthrust plate, and the post-thrusting deposits of late Cretaceous and Cenozoic age.

Precambrian rocks occur only along the north edge of the quadrangle and include partial sections of the late Proterozoic Mutual, Caddy Canyon, Blackrock Canyon, and Pocatello formations which are more than a mile (1.6 km) thick, where completely exposed in the Canyon Range, north of the quadrangle. More than 6500 feet (2000 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, and 3200 feet (1000 m) of Cambrian carbonate rocks. The quadrangle includes the best exposures of Cambrian and Ordovician strata in the Pavant 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 early Tertiary-late Cretaceous Canyon Range Conglomerate rests unconformably over the Paleozoic rocks. Surficial deposits include the Pliocene Oak City Formation which consists of several hundred feet (m) of debris-flow deposits shed off the west side of the Canyon and Pavant ranges. These are overlain by Quaternary alluvium, colluvium, and eolian and alluvial-fan deposits that range up to several hundred feet (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 Pavant 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 show this fault. COCORP deep seismic reflection data, available only for the west half of the quadrangle, suggest that the Pavant thrust may be identifiable in some east-dipping reflections.

The quadrangle has no economic geologic resources other than gravel that has been used in local road construction. No one lives permanently within the quadrangle, although thousands of people pass through the quadrangle each month 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 of pastureland in Scipio Valley. The quadrangle is on the west edge of the Intermountain Seismic Belt. Fault scarps that cut Quaternary alluvium in Scipio Valley indicate that major earthquakes have occurred in the area within the last 10,000 years. Seismic records for the past three decades show a few magnitude 3 earthquakes but none in the nearby areas 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 Range on the northwest and the Pavant Range in the southeast. The highest point along the highway here, Scipio Pass, at an elevation of 5969 feet (1819 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.

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 Range and the northwestern edge of the Pavant Range in one continuous structural block. The clear lack of any normal fault between the Canyon and Pavant 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 long (100 km), that extends from near Leamington on the north to 15 miles (24 km) south of Kanosh. Scipio Pass, the low divide between the two ranges, owes its origin to the erosional nonresistance of the thin-bedded limestone and shale of the Ordovician Pogonip Limestone which makes up the bedrock exposed in the pass area. Late Cretaceous to early Tertiary conglomerate deposits lie unconformably on Paleozoic rocks of the Pavant plate. Unconsolidated late Tertiary and Quaternary alluvial

deposits are unconformable above the bedrock strata.

Maxey (1946) was the first to describe geologic features of the Pavant Range in any detail. He correctly identified the bedrock stratigraphy and described the Pavant thrust fault. Dennis, Maxey, and Thomas (1946), in a report on ground-water resources, included a map of Pavant Valley that shows both bedrock and alluvial map units. Christiansen (1952) mapped the Canyon Range 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 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 Range, 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 1:24,000 quadrangle. Oviatt (1992) mapped Quaternary deposits and faults in the Scipio Valley portion of this quadrangle.

Student mapping theses that contain relevant structural and stratigraphic observations on nearby parts of the Canyon and Pavant ranges include Lautenschlager (1952), Crosby (1959), Hickcox (1971), Sayre (1974), Higgins (1982), Davis (1983), Holladay (1984), and George (1985).

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 bedrock mapping in 1990 and remapped the Tertiary and Quaternary deposits using 1988 1:15,000 color aerial photographs 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) Early Paleozoic strata of the Pavant overthrust plate, and 3) Late Cretaceous and Cenozoic sediments that were deposited at their present location on top of the strata of the two thrust plates which had been moved eastward into this area during late Mesozoic time from their original sites of deposition in western Utah. The sequence of map units is summarized on Figure 2.

Another 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 Range were first studied by Christiansen (1952) who showed only a single map unit, "Upper Proterozoic quartzite, shale, and limestone", on his geologic map. Woodward (1972, 1976) in a regional analysis of Proterozoic rocks, applied some formation names that were originally used for strata near Pocatello, Idaho to strata in the Canyon Range and other places in Central Utah. Higgins (1982), Millard (1983), and Holladay (1984) utilized this Pocatello-based nomenclature for map units in subdividing the Precambrian rocks in the Canyon Range. 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 Range 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 Range that previous workers had assigned to the Blackrock Canyon and Pocatello formations, 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 Range because it serves well in delineating the several lithologic packages that occur here. If, at some later date, it can be clearly demonstrated by isotopic or paleontologic means, that the Precambrian correlations between southern Idaho and central Utah are incorrect, then the nomenclature used herein will have to be revised.

Pocatello Formation (pCp)

This formation is exposed along the central north edge of this quadrangle where it consists of interbeds of siltstone, phyllitic shale, and quartzite, more than 800 feet (250 m) thick. The base of the formation is not found in the Canyon Range. The part that is present forms the sole of the Canyon Range overthrust. The northern border of our map does not match that of Millard (1983) in the area where we have shown the Pocatello Formation. When we became aware of this we checked the geology of the Precambrian rocks above the Canyon Range thrust and observed that the Pocatello Formation can be traced northward from our quadrangle border for two miles into south-central part of the Williams Peak quadrangle. The best exposures of the formation in the Scipio Pass quadrangle are in section 20, T.18 S., R. 3 W.

Blackrock Canyon Limestone (pCb)

This formation crops out along the north edge of the quadrangle. The exposure in the northwest corner of quadrangle is the best one, but a complete sequence of the formation is exposed also in section 20, T. 18 S., R. 3 W. The Blackrock Canyon Limestone is the only Precambrian map unit in the Canyon Range that contains limestone beds. Millard (1983) measured 560 feet (169 m) of this formation as exposed along Whiskey Creek about 3 miles (5km) 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) presented several photographs 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 (pCc)

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, none of the recent

mappers in the Canyon Range have found it practicable 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 1170 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) the northwest corner of this quadrangle is 1920 feet (585 m).

Inkom Formation (pCi)

This formation is concealed by alluvium on this quadrangle, but is shown on cross-section AA' on Plate 2. 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 (pCm)

A small part of the Mutual Formation is exposed along the sidebank of the East Fork of Eightmile Creek in the northwest part of the quadrangle. The formation is composed 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 2250 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 (Ct)

This formation is not exposed in this quadrangle, but 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 Pavant 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. The Tintic Quartzite is about 3000 feet (1000 m) thick in the Pavant Range (George, 1985; Hintze, 1988).

Ophir Formation (Cop)

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 Pavant 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 Pavant Range according to George (1985) who called the unit "Pioche Formation". We believe that Ophir is a more

appropriate designation for this unit here, as it 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 was established.

Herkimer, Dagmar, and Teutonic Formations, undivided (Cht)

These formation names come from the Tintic mining district (Morris and Lovering, 1961) where 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 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 show our correlation with the strata named there.

The upper and lower parts of our undivided Cht 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 3). Near the top of the undivided unit, algal heads 12 inches (0.3 m) high are found just beneath the Cole Canyon Dolomite.

The alternating thin to very thick bedding of the lower part of the Herkimer, Dagmar, and Teutonic (Cht) 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 4).

Total thickness of the undivided Cht map unit is at least 944 feet (303 m) as measured in this quadrangle (see Appendix). The contact with the Ophir Formation is not exposed in our measured section, but we believe that, at most, only a few tens of feet of section at the base of the Cht unit is concealed here.

Cole Canyon and Bluebird Dolomites, undivided (Ccb)

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 5). These are called "twiggy bodies" or "bluebird bodies", by some geologists using the formation name as a descriptive term.

In the Scipio Pass quadrangle the Cole Canyon and Bluebird dolomite, undivided (Ccb) map unit is easily identified because it contains no limestone, the principal rock type of the underlying (Cht) and overlying (Cox) map units. The undivided Ccb 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, fine-grained, 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.

Our measured section (see appendix) shows a thickness for the undivided Cole Canyon and Bluebird dolomite of 536 feet (163.5 m).

Opex Formation (Cox)

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 6), 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 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 identified by Robison as Saratogia? sp., and may represent the Idahoia trilobite zone of middle Late Cambrian age.

Our measured section (see appendix) shows a thickness of 671 feet (204.5 m) for the Opex Formation in this quadrangle.

Ajax Dolomite (Ca)

In this quadrangle the Ajax Dolomite consists of dolomite units 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 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 formations above and below it. Our measured section (see appendix) shows a total thickness for the Ajax Dolomite of 966 feet (294.5 m).

Undivided Cambrian carbonate rocks (Cu)

While mapping in sections 33 and 34 just north of Scipio Pass, Michaels made a great effort to identify and differentiate the Cole Canyon-Bluebird (Ccb), Opex (Cox), and Ajax (Ca) map units that occur beneath Ordovician strata in thrust slices too indefinable to map that are structurally above the Scipio Pass intraplate thrust. These Cambrian carbonate units are apparently attenuated within the thrust plate. Most of the rock shown as Cu on our map is probably Ajax Dolomite. The Opex Formation is possibly present locally in small slices, and the Cole Canyon-Bluebird may be present. Because of our inability to be sure that Cambrian strata other than Ajax Dolomite are not present, we have shown these rocks as undivided Cambrian carbonate rocks.

Ordovician

Pogonip Limestone (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 Pavant Range, but also because of structural complications in the southern Canyon Range just north of Scipio Pass. We, therefore, have shown all of the pre-Eureka Quartzite Ordovician strata as a single map unit, and have called it Pogonip Limestone, in order to emphasize its principal rock type, rather than using the more anonymous designation "group".

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 Limestone (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 7). It is partially exposed in the road cut along the north side of the freeway right at Scipio Pass. It also forms the sole of the intra-Pogonip thrust plate shown on the geologic map 0.5 miles (0.8 km) north and west of the pass, where it makes the cliffs above the less resistant middle Pogonip units that the thrust plate sits on. Hintze (1951) reported 271 feet (82.5 m) of lower Pogonip. Michaels measured 300 feet (91.5 m) in section 24 north of Wildgoose Canyon.

The middle part of the Pogonip Limestone (identified as Fillmore Limestone, Wah Wah Limestone, and Juab Limestone by Hintze, 1951) is characterized by a distinctive rock type, intraformational conglomerate (Figure 8). 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 Limestone yellowish, or locally reddish, parting surfaces. The middle part of the Pogonip Limestone is fairly well exposed in the roadcuts on both sides of the freeway from Scipio Pass northeastward to the lowest bedrock exposures. Fragments of fossil trilobites (Figure 9) 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. Hintze (1951) reported 1046 feet (317 m) of middle Pogonip. Michaels measured a similar thickness in section 24 north of Wild Goose Canyon during his field work in this quadrangle.

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 10 and 11) with shells about 0.7 inch (1.8 cm) in diameter. In the upper part of the orthid-bearing interval, trilobite fragments (Figure 11) and receptaculitids (Figure 12) can be found. The upper part of the Pogonip Limestone 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 reported a similar thickness exposed in section 11.

Total thickness of the Pogonip Limestone in this quadrangle is about 1666 feet (505 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, easily

distinguished from the darker rocks above and below. The Eureka is relatively undeformed in section 15 along the north edge of the quadrangle, and in the line of outcrop two miles southeast of Scipio Pass. Elsewhere it is brecciated by thrust faulting, especially in the outcrops in section 5 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 clean white quartzite that is thin-to medium-bedded and forms steep slopes, ledges, and cliffs. Millard (1983) reported 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. Michaels measured 80 feet (24 m) for the lower Eureka and 100 feet (30 m) for the upper part in section 24 on the ridge north of Wild Goose Canyon.

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 opined that the upper Eureka Quartzite was deposited by an easterly transgressing sea. We believe that the thickness figures reported by Webb are somewhat excessive.

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 commonly 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 at the place in the sequence 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. As described in our appendix, Michaels measured 261 feet (79.5 m) of partially brecciated Fish Haven Dolomite in the east-central part of this quadrangle. Millard (1983) measured 78 feet (42 m) of generally brecciated Fish Haven Dolomite in the Canyon Range just north of this quadrangle.

Silurian

Laketown Dolomite (S1)

The Laketown Dolomite forms massive cliffs on the east face of the Canyon Range and on the west side of Graball Canyon in the northern Pavant 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, have formed rip-up clasts and 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, and neither have we. On the ridge north of Ebbs Canyon Michaels measured 832 feet (253.5 m) of Laketown Dolomite. Millard (1983) showed a thickness of 1045 feet (333 m) of Laketown in his section, measured on the southeast flank of the Canyon Range 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 Range Conglomerate cover the slopes formed on the Sevy. Michaels measured the partial section of Sevy Dolomite on the ridge north of Ebbs Canyon to be 423 feet (129 m) thick. Millard (1983) reported that the entire Sevy Dolomite as exposed in the Canyon Range at Hardscrabbie Canyon, some 5 miles (8 km) north of the border of our map, appears to be as much as 2720 feet (830 m) thick. Davis (1983) found the entire Sevy Dolomite to be 715 feet (216.5 m) thick in the southern Pavant Range, about 30 miles (50 km) south of the Scipio Pass area.

Post-Thrusting Deposits

Late Cretaceous - Early Tertiary

Canyon Range Conglomerate (TKc)

The coarse bouldery deposits that were deposited in the Canyon Range 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 (Santonian to Cenomanian) and is more sandstone and shale than conglomerate. Armstrong (1968) deemed Indianola to be an inappropriate name, both lithologically and age-wise for the Canyon Range deposits and termed them "Canyon Range fanglomerate". He suggested that, despite the lack of fossils or other dating evidence, the Canyon Range 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 Range near Fool Peak, about 10 miles (16 km) north of Scipio Pass. Stolle called these rocks the Canyon Range Formation 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 Canyon Range Formation includes fluvial sandstone and some lacustrine limestone. He correlated this upper part with the North Horn Formation and the Flagstaff Limestone. We believe that the Canyon Range Conglomerate in the Scipio Pass quadrangle correlates with the lower conglomeratic part of Stolle's ¹⁹⁷⁸~~(1983)~~ Canyon Range Formation. Firm age dates, based on palynology or other means, have yet to be reported for these coarse clastic deposits.

Along the east side of the Scipio Pass quadrangle almost 800 feet (245 m) of Canyon Range Conglomerate cap 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. Above this basal conglomerate the remainder of the conglomerates are

less coarse, include limestone clasts, and are interbedded with sandstone. A section measured by Michaels (see appendix) shows a total thickness of 792 feet (241.5 m) for the Canyon Range Conglomerate here.

Pliocene

Oak City Formation (Toc)

Campbell (1979) named this formation and mapped its occurrence around the west and south sides of the Canyon Range, from its type section south of Oak City, into the Scipio Pass quadrangle, a distance of some ten miles. In this quadrangle, the Oak City Formation is an unconsolidated conglomerate, 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 Pavant 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 to support his opinion. Recently Hintze, in connection with his Millard County mapping project, has traced the formation southward for more than 30 miles, along the west side of the Pavant Range, into the Dog Valley Peak quadrangle where Oviatt (1991) reported a bed of Cudahy Mine pumice, dated at 2.6 Ma, within the Oak City Formation. It thus appears that 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 to the south near Fillmore. The Oak City Formation is currently being dissected. Water erosion has formed a mature gully system that had preferentially removed smaller clasts and left the larger cobble and boulder clasts to form an armor that covers the hilltop 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 Pavant 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 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 (Tm1)

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 a small automobile. The deposit is judged to be late 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 mass movement 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 lower Pogonip and surrounded by colluvial debris derived from the overlying Oak City Formation.

Late Pliocene - Early Quaternary

Old alluvial-fan deposits (QTa)

Alluvial-fan deposits in the drainages of Ebbs Canyon and Wild Goose Canyon have been here judged to be latest Pliocene or early Pleistocene in age on the basis of the topographic position of some of their remnants high on the flank of the Pavant Range, and their partial dissection and overlayment by younger fans out of the same drainage systems. We have no datable materials out of these deposits within this quadrangle. But we note that Oviatt (1992, p. 7) used the same designation for similar alluvial-fan deposits for which he had isotopic and magnetic data to support his age assignment.

These old alluvial-fan deposits are composed of poorly sorted, angular to subrounded clasts of boulder to silt size, of bedrock formation 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 range 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 the earlier Pliocene unit.

Landslide and colluvial deposit (QTml)

A mile and a half (2 km) east of Scipio Pass the hillslope below the relay tower 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 probably a few tens of feet (meters).

Quaternary

Young alluvial-fan deposits (Qaf)

These deposits are composed mainly of gravel with pebble- to boulder-size clasts in a matrix of silt, sand, and grit. Stream-laid 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 blown in from the fine-grained Lake Bonneville deposits that cover the Sevier Desert floor to the southwest. Maximum thickness of this unit is unknown but may be several hundred feet in the lowest parts of its area. 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 of low-order streams (Qal)

The northeast corner of the map includes part of the Scipio Valley bottom that is covered

with this map unit as described by Oviatt (1992). As shown on this quadrangle, the contact between Qal and Qaf is drawn mostly along a late Quaternary fault scarp. Our map shows a slightly different Quaternary fault pattern than that shown for the same area on Oviatt's map. Oviatt (1992) shows fault contacts between Qal and Qaf again for a few miles in Scipio Valley north of the boundary of the Scipio Pass quadrangle. 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.

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 that significantly conceals the bedrock. The most troublesome 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 Pavant 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 pervasive influence of gravity. Colluvium may be locally as much as 100 feet (30 m) thick in this quadrangle.

Eolian deposits (Qe)

Deposits of pinkish-gray dust, silt, and fine sand have accumulated on the southwest side

of the Canyon Range and on the Church Mountains. This material has been derived largely by deflation of Lake Bonneville fine-grained sediments that cover the Sevier Desert southwest of the quadrangle. Prevailing winds, that blow to the northeast, are slowed down by the Canyon and Pavant ranges, and drop their eolian load, which both covers and is 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 the 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 of eolian deposits.

STRUCTURAL GEOLOGY

Compressional deformation in the Canyon and Pavant ranges took place in late Mesozoic and earliest Cenozoic time (approximately 100 to 60 million years ago) and produced a paleomountain belt, called the Sevier orogenic belt, that covered all of western Utah and eastern Nevada (Hintze, 1988). Paleostreams 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 Pavant ranges are typical ranges, and the Sevier and Black Rock deserts (Figure 1) are large basins formed at this time.

Compressional Structures

The quadrangle includes parts of two major overthrust plates which were 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 has produced an apparent inversion of 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 13 is a simplified geologic map that shows the present distribution of these

features.

Canyon Range Overthrust

Only the southern end of the preserved remnant of the Canyon Range plate is exposed on this quadrangle (see Figures 14 and 15); its full extent is shown on Figure 13. Christiansen (1952) was the first geologist to describe this overthrust, and to note its present synclinal shape. Millard (1983), Holladay (1984), and Higgins (1982) mapped the Canyon Range 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 Range.

At the south end of the Canyon Range plate, the lowest Precambrian unit, the Pocatello Formation, rests on Ordovician Pogonip Limestone on the Pavant plate. Northward, the thrust fault cuts stratigraphically upwards 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 13. Age of the Canyon Range Conglomerate is poorly constrained, as is, therefore, the age of the thrusting.

Sharp (1984) estimated that total eastward translation of the Canyon range plate may have been as much as 26 miles (42 km).

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 13. 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 1400 feet (450 m) lower than the nearest exposure of the thrust in the Canyon Range. This could be explained by postulating a low-angle normal fault between the Canyon Range and the 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.

Pavant Overthrust

Although the thrust surface at the base of the Pavant overthrust plate is not exposed in this quadrangle, it is confidently 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 ^B~~SEM~~. The thrust relationships there are simple and regular. The Tintic Quartzite, about 3000 feet (1000 m) thick, is at the bottom of the overthrust plate. The in-place rock beneath is Jurassic Navajo Sandstone, about 1800 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 our measured section traverses (see appendix) was selected to take advantage of the least broken, least attenuated sequences we could find. We believe that 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 Pavant ranges.

Scipio Pass Intraplate Thrust

As noted earlier in this report, in the section on stratigraphy, 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 7); 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. 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 Pavant ranges.

On the north side of the freeway, 0.3 miles (0.5 km) north of the overpass on the summit, the limestone exposed in the roadcut (Figure 15) is the upper part of the massive basal Pogonip. Proceeding northeastward, the freeway roadcuts expose successively higher beds within the middle Pogonip. The roadcut farthest down the slope, just below Hill 5922, contains trilobites of the Ross-Hintze J-zone (see Hintze, 1988, p. 22), identifying this as the highest part of the middle Pogonip. The freeway apparently transects the entire middle Pogonip, best exposed on the north side road cuts.

Midway in this transect, in the northwest corner of section 35, a prominent gray cliff rises out of the slope about 360 feet (120 m) above the level of the freeway (Figure 16). This cliff is the basal Pogonip Limestone, here thrust over the middle Pogonip. We call this the Scipio Pass intraplate thrust, and show it on our map extending 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 the 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 ~~6C4~~¹³, its axis can be traced northward for about 15 miles 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 Cretaceous synorogenic 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 would appear that at the beginning of thrusting a nearly horizontal plate of Precambrian strata rode out on a nearly horizontal set of Paleozoic strata that made up the pre-fold Pavant plate.

The Scipio Pass anticline, not shown on Figure 13, 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 Pavant 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.

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 Pavant 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 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. The lower elevation of the exposures in the Church Mountains suggests that these structures may have been dropped down in Cenozoic time on a low-angle, down-to-the-west, normal fault.

Extensional Structures

Round Valley-Scipio Valley Normal Fault

Figure 13 shows a dotted (concealed) fault along the east base of the Pavant Range from Richfield to Scipio where it cuts the corner of this quadrangle and continues northward along the east base of the Canyon Range. The physiographic expression of this fault is very impressive along the west side of Round Valley, south of Scipio. There, the mountains rise steeply up from the valley floor in the classical form of a block-faulted mountain front. North of Scipio, the escarpment along the Canyon Range is less abrupt and a broad alluvial apron spreads eastward from the range front.

Movement in this fault zone has continued into 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. We believe that most of the small faults were produced by internal jostling of rocks in the Pavant overthrust plate during their long distance horizontal transport, and that 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 17. None of these anomalies impinge directly on the Scipio Pass quadrangle, but they do have some relevance to certain features in the quadrangle.

The Sevier Valley low trends northeastward and this trend is continued in the San Pitch Valley low. Figure 13 shows that the Sevier Valley low is bounded on its west side by a major

fault which diverges away from the trend of the low gravity anomaly north of Richfield and follows the east side of the Pavant Range northward to Scipio without producing a major gravity anomaly. The Sevier Valley and San Pitch Valley lows may reflect anomalously thick Jurassic salt beneath these valleys, or they may reflect deeper gravity contrasts in the upper mantle. The fault that produces the striking fault 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 17, is centered over Oak City, west of the Canyon Range. The Canyon and Pavant 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, Shuey, and Kirby, 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, that were shed off the west side of the Canyon and Pavant ranges, have been elevated several hundred feet, probably in Late Pliocene or early Quaternary time.

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 SGM shows station locations for the eastern sixth of this line. The station numbers correspond to similar numbers shown on Figure 18. The focus of the COCORP survey was to

identify features related to Cenozoic extension or Mesozoic compression. Figure 18, from Allmendinger and others (1983), shows the analysis by the COCORP team of the reflection data.

The most prominent and continuous reflection is shown as event A on Figure 18, 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 depth of 5 seconds (12-15 km). Its average westward dip is about 12°, but it shows some moderate variations from that. Figure 13 shows that station 1525, where the Sevier Desert detachment nears the surface, is at the west edge of the hills south of Oak City, where the Pliocene Oak City Formation conceals older bedrock.

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

Event D, 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 13, event D lies one second (3-4 km) beneath the west side of the Church Hills, underneath the brecciated Ordovician, Silurian, and Devonian rocks of the Pavant plate mapped by Sayre (1974).

Event E 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 survey line in central Utah by Standlee (1982).

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 18, 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 80 km deep 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. 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, the 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.

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 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 Pavant 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 Pavant 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 per year. Hydrographs for major streams in the southern part of the Pavant Range show run-off peaks in May. Their chart showing data on minor streams in Pavant Valley includes the following information on streams that flow within this quadrangle:

<u>Stream</u>	<u>Drainage Basin</u>	<u>Flood Maximum</u>
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, off the southwest edge 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 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 below the surface.

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

GEOL●GIC 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.

Earthquake Faults

The northeast corner of our map shows faults that cut unconsolidated Quaternary deposits in Scipio Valley. These faults were first recognized by Christiansen (1952) but were more

completely discussed by Bucknam and Anderson (1979) who recognized that the scarps represent at least two periods of Quaternary fault activity. Maximum surface offset on the faults is about 35 feet (11 m) with a maximum scarp slope of 25 degrees. The scarps shown on the present map were identified on 1988 U.S. Forest Service color aerial photographs, scale 1:15,000. They are part of a series of scarps that can be followed along the east side of the Canyon and Pavant ranges. Scarp height suggests that they were produced during an earthquake of a magnitude of at least 6.5. Scarp slope angle suggests that the most recent earthquake occurred within the last few thousand years.

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. In central Utah the belt is centered under Sanpete Valley, about 25 miles (40 km) east the quadrangle. The University of Utah Seismic Stations furnished us a list of all earthquakes located within a 12 mile (20 km) radius of the northeast corner of this quadrangle that were recorded between 1962 and 1991. The list showed 255 earthquakes, of which nine, listed below, had magnitudes greater than 3.0.

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 (9km) and 8 miles (13 km) southeast of Scipio respectively.

Flood Hazards

The quadrangle does not include any permanent streams. The drainage basin areas and flood maxima for the principal intermittent streams is 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 high-pressure natural gas pipeline, constructed in 1990, parallels the freeway on its west side. It is buried to a depth of about 6 feet and would not likely be affected by flooding.

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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 SE 1/4, Section 22, T19S, R3W.

Ajax Dolomite is overlain conformably by Ordovician Pogonip Limestone.

	<u>Ajax Dolomite</u>	<u>Feet</u>	<u>Meters</u>
47	Dolomite, medium dark to brownish gray, weathers olive gray with light olive gray mottling; very thick bedding, forms prominent edges especially in lower half of unit; some darker layers present with white dolomitic rods; limestone float abundant 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; large 15 cm diameter algal head structures obvious.	25	(7.5)
37	Dolomite, similar to unit 39, slope former.	39	(12)

Measured thickness of Ajax Dolomite 966 (294.5)

Opex Formation

- 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; oncolites up to 1.8 cm especially abundant in basal 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 intraformational flat pebble conglomerate common; small black ooids very abundant especially near the top; orange pink color increases towards 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 resistant layers 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

- | | | | |
|----|--|-----|--------|
| 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 | | |

			58
	15 below.	74	(22.5)
17	Dolomite, similar to unit 21, but blocky rubble makes up good portion of dip slope, occasional dark bed 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 "twiggy 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 occur, especially in the basal 2 m of the unit; dolomite rubble and float cover much of the ledgy slope.	49	(15)
<hr/>			
	Measured thickness of Cole Canyon and Bluebird Dolomites, Undivided	536	(163.5)

Herkimer, Dagmar, and Teutonic Formations, Undivided

- | | | | |
|----|--|----|--------|
| 13 | Limestone, dark gray, weathers medium gray with mottled light olive gray stromatolitic stringers and blebs of dolomite generally 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 oncoïd zone, 10 feet (3 m) wide with oncoïds 1.5 cm in diameter present near middle; oncoïds 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 very thin beds of light creamy 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 limestone and light creamy colored 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)
<hr/>			
	Measured thickness of exposed Herkimer, Dagmar, and Teuntonic Limestones, undivided. Base of section concealed.	994	(303)

APPENDIX B

UPPER ORDOVICIAN THROUGH CRETACEOUS-TERTIARY

Section measured from the Upper Ordovician Fish Haven Dolomite through part of the Tertiary-Cretaceous Canyon Range Conglomerate. The section is located on the ridge north of Ebbs Canyon beginning at NW 1/4, section 12, T19S, R3W and ending at SE 1/4, section 1, T19S, R3W.

	<u>Tertiary - Cretaceous Canyon Range Conglomerate</u>	<u>Feet</u>	<u>Meters</u>
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 dip slope 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, crossbedded 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, crossbedded 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 crossbedded 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. 64
103 (31.5)

Measured thickness of Canyon Range Conglomerate 792 (241.5)

Sevy Dolomite

(partial section below unconformity)

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 (84)

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)

Laketown Dolomite

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 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)
		<hr/>	
	Measured thickness of Laketown Dolomite	832	(253.5)

Fish Haven Dolomite

6	Dolomite, medium dark gray, weathers light gray to light olive gray; somewhat mottled appearance, 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 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 blebs and stringers of limestone, 50%; dolomite is light to olive gray with darker 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)
		<hr/>	
	Measured thickness of Fish Haven Dolomite	261	(79.5)

DESCRIPTION OF MAP UNITS

- Qal** Alluvium of low-order streams. Fine-grained, poorly sorted alluvium on the floor of Scipio Valley. Estimated thickness 100 feet (30 m).
- Qe** Eolian deposits. Pinkish-gray dust, silt, and fine sand, carried by prevailing northeasterly winds to the Church Mountains and southwest flank of the Canyon Range. Locally intermixed with contemporaneous alluvial fan deposits. As much as 15 feet (5 m) thick.
- 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 deposit. May locally be as much as 100 feet (30 m) thick.
- Qaf** Young alluvial-fan 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 (meters).

- Tml Old landslide deposit. Composed principally of blocks of Eureka Quartzite, the largest being the size of a small automobile. Deposit may be more than 30 feet (10 m) thick locally.
- Toc Oak City Formation. Poorly sorted, unbedded, mostly uncemented conglomerate 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 (few hundred meters).
- 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 about 790 feet (240 m).
- Dsy Sevy Dolomite. Light gray, fine-grained, laminated, locally cherty dolomite. Top not exposed. Partial thickness in this quadrangle 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. 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 form cliffs. Locally brecciated and attenuated. Lowest Eureka beds are silty and weather

pink, orange, or brown. Measured thickness here is 180 feet (54 m).

- Op Pogonip Limestone. Lower 300 feet (90 m) is medium-gray, slightly cherty, fine-grained, thick-bedded limestone that forms cliffs and ledges. Middle 1046 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 Limestone is 1666 feet (505 m).
- Cu 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, but thickness is irrelevant because of structural complications.
- Ca Ajax Dolomite. Light-brownish-gray to dark-gray dolomite that weathers light-olive-gray, and is generally thick-bedded and forms steep slopes, ledges and cliffs. Chert locally present, as are stromatolitic algal structures. Measured thickness is 966 feet (295 m).
- Cox Opex Formation. 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).
- Ccb 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).

- Cht** 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.
- Cop** Ophir Formation. Interbedded shale and thin-bedded limestone. Not exposed in this quadrangle. Thickness shown on cross-section is 500 feet (150 m).
- Ct** Tintic Quartzite. Fine- to coarse-grained, indurated white quartzite. Not exposed in this quadrangle. Thickness shown on cross-section is 3000 feet (1000 m).
- pCm** 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 Range, is 2250 feet (690 m).
- pCi** Inkom Formation. Silty argillitic shale. Not exposed in this quadrangle. Thickness measured north of here is 270 feet (84 m).
- pCc** Caddy Canyon Quartzite. Only partly exposed in this quadrangle. A few miles north of here, in the Canyon Range, the lower 750 feet is silty and thin-bedded; upper

1170 feet is light-grayish-white quartzite that weathers brown or orange, and forms cliffs and ledges.

pCb 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 Canyon Range, north of this quadrangle, its thickness was measured to be 560 feet (169 m).

pCp Pocatello Formation. Phyllitic quartzite, siltstone and shale. Only a small part is exposed in this quadrangle. To the north in the Canyon Range 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 Range.

MAP SYMBOLS

Contact

Normal fault--dashed where location inferred, dotted where concealed; bar and ball on down thrown side.

Thrust Fault--dotted where concealed; teeth on upper plate.

Strike and dip of bedding--inclined, vertical, overturned

Gravel pit

□ Prospect pit

FIGURE CAPTIONS

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.

Figure 2. Rock column for strata in the Scipio Pass quadrangle.

Figure 3. Laminated dolomite from the middle part of the Herkimer, Dagmar, and Teutonic formations, undivided, 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.

Figure 4. Algal stromatolite heads from the uppermost part of the Herkimer, Dagmar, and Teutonic formations, undivided, map unit. Lens cover for scale is 2 inches (5 cm) in diameter.

Figure 5. Small light blebs or rods are called "twiggy bodies", and are common in the Cole Canyon and Bluebird dolomite map unit. Penny for scale in upper center.

Figure 6. Algal oncolites in the Opex Formation. Similar oncolites are common in the bottom of the Herkimer, Dagmar and Teutonic formations map unit.

Figure 7. Aerial view looking eastward at the ridge between Ebbs Canyon and Wild Goose

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Figure 8. Intraformational conglomerate typical of the middle part of the Pogonip Limestone. The pebbles are silty limestone that was ripped up from a muddy tidal flat while still incompletely hardened and redeposited near its original site of deposition.

Figure 9. Trilobite fragments such as these can be found in some beds in the middle part of the Pogonip Limestone.

Figure 10. Tubular structures about half the width of the penny are "twiggy" 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 Limestone.

Figure 11. 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 Limestone.

Figure 12. 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 Limestone.

Figure 13. Simplified geologic map covering the same area as Figure 1. Q, Quaternary deposits (uncolored); 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 sedimentary rocks (horizontal lines); C - pC, Cambrian and Precambrian marine strata (uncolored). 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 14. Panorama from the top of the Church Mountains looking northward from the Canyon Range on the left skyline, to the Pavant 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 Pavant 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.

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Nebo in distance.

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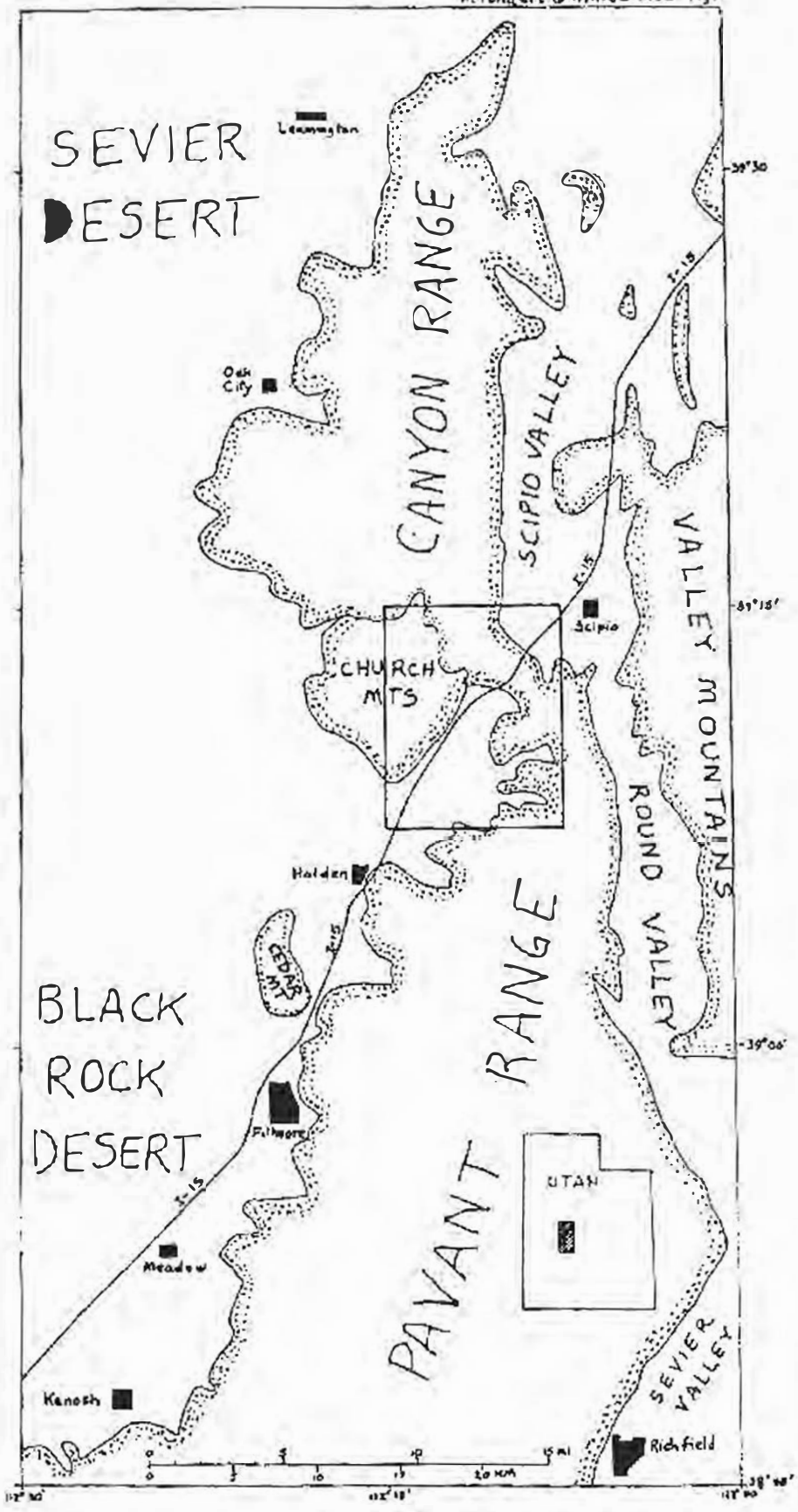


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Age	Map Unit	Map Symbol	Thickness feet meters		
QUATERNARY	Alluvium, colluvium, eolian silt, young (Q ₁) and old (Q ₂) alluvial fans, and old landslide deposits	Q ₁ , Q ₂ , Q ₃ , Q ₄ , Q ₅	0 to several hundred		
PLIOCENE	Old landslide deposit	Tml	0-30	0-10	
	Oak City Formation	Toc	0 to several hundred		
EARLY TERTIARY-LATE 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	cherty
	Eureka Quartzite	Oe	180	54	locally brecciated
	Pogonip Limestone	Op	1666	505	ostracods brachiopods trilobite fragments interformational conglomerate common
CAMBRIAN	Ajes Dolomite	Ea	966	295	cherty algal stromatolites
	Opex Formation	Eox	671	205	bioclastic limestone Tricrioccephalus Ectolobites
	Cole Canyon and Bluebird dolomites, undivided	Ecb	536	164	white "twiggy bodies"
	Merker, Dagmar, and Teutonic formations, undivided	Eht	994+	303+	algal stromatolites white laminated sandstone
	Ophir Formation	Eop	500	150	base concealed on cross-section only
	Tintic Quartzite	Et	3000	1000	on cross-section only
	STRATA BELOW ARE ON CANYON RANGE OVERTHRUST PLATE				
PRECAMBRIAN	Mutual Formation	pEm	2250*	690*	on cross-section only
	Inkom Formation	pEi	270*	84*	on cross-section only
	Caddy Canyon Quartzite	pEc	1920*	585*	
	Blackrock Canyon Limestone	pEb	560*	169*	Ooids and algal stromatolites
	Pocatello Formation	pEp	800*	250*	

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

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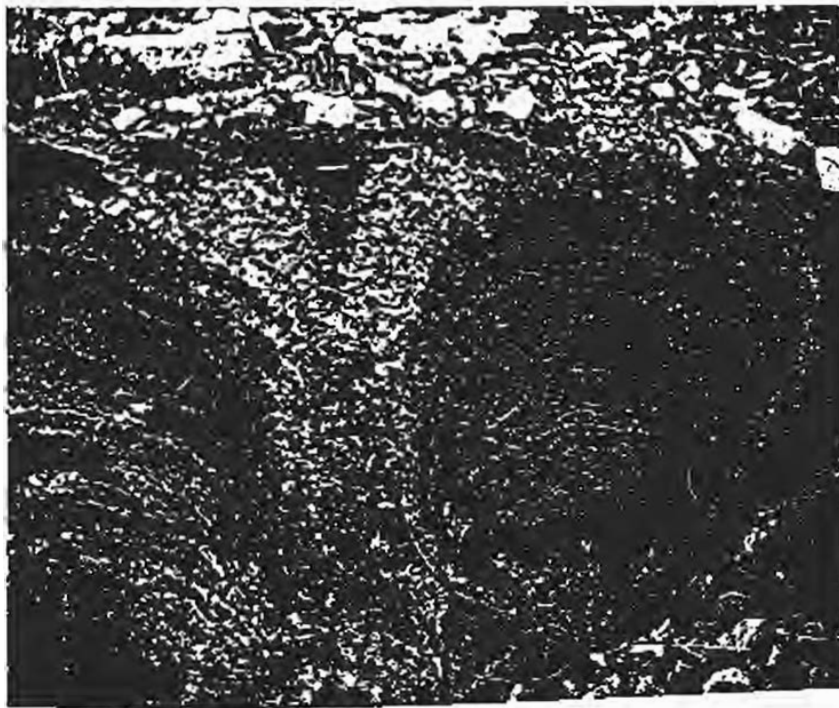


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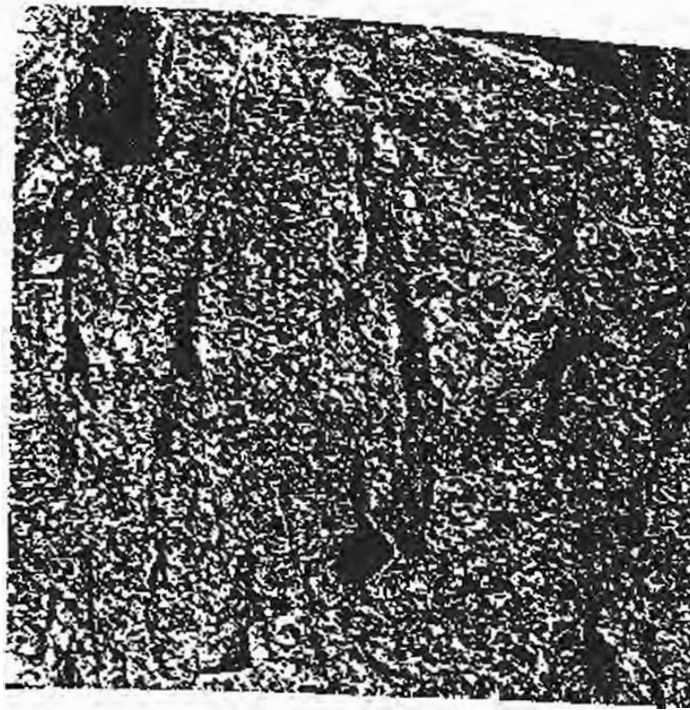


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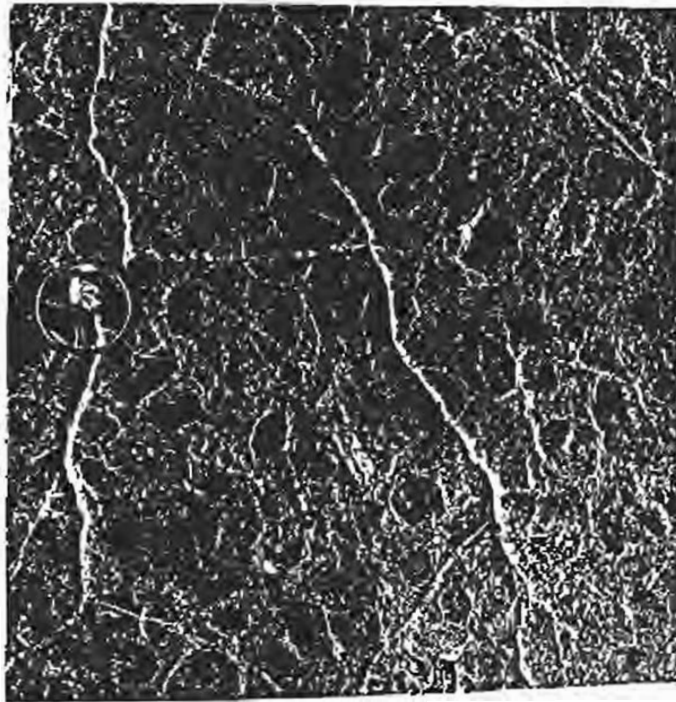


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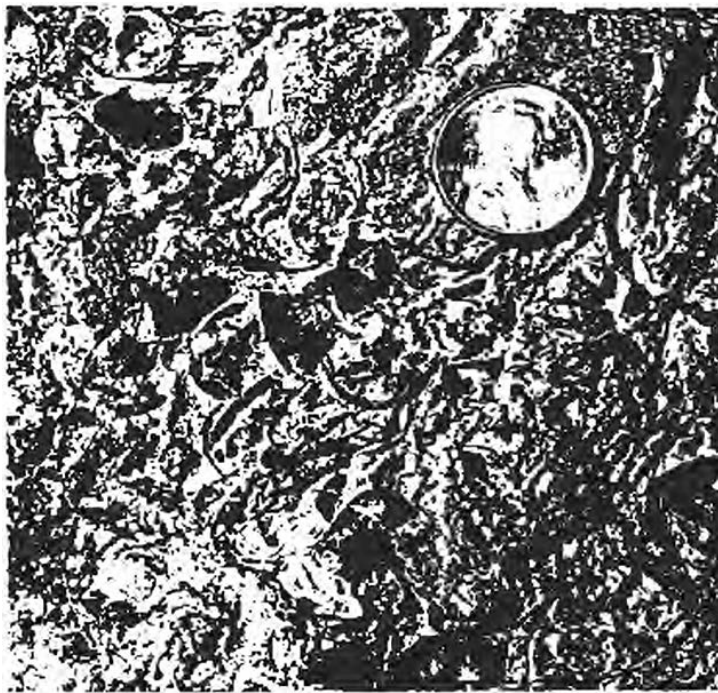


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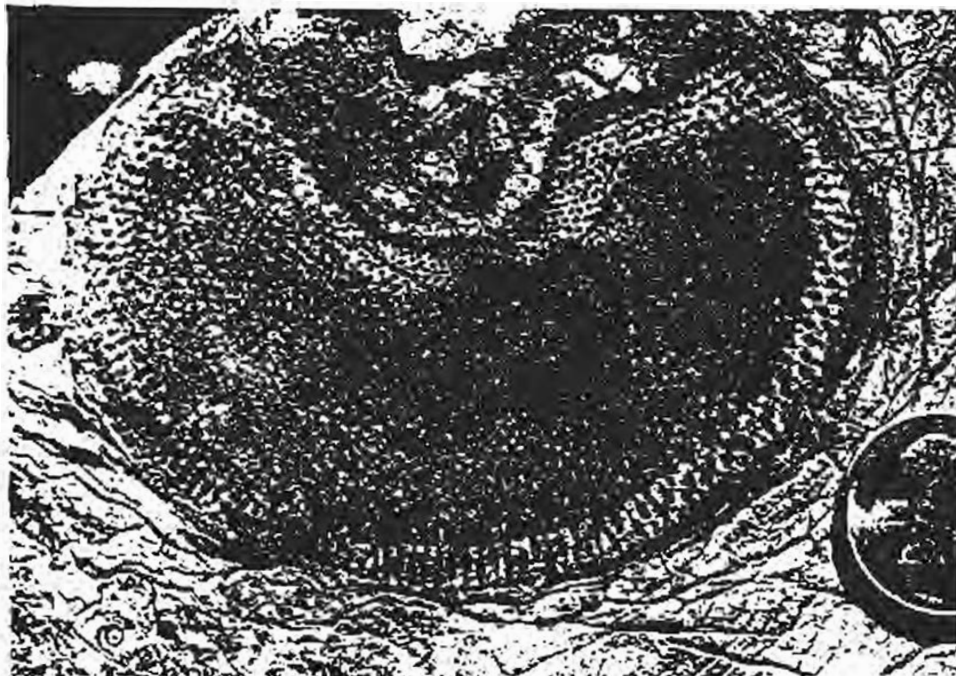


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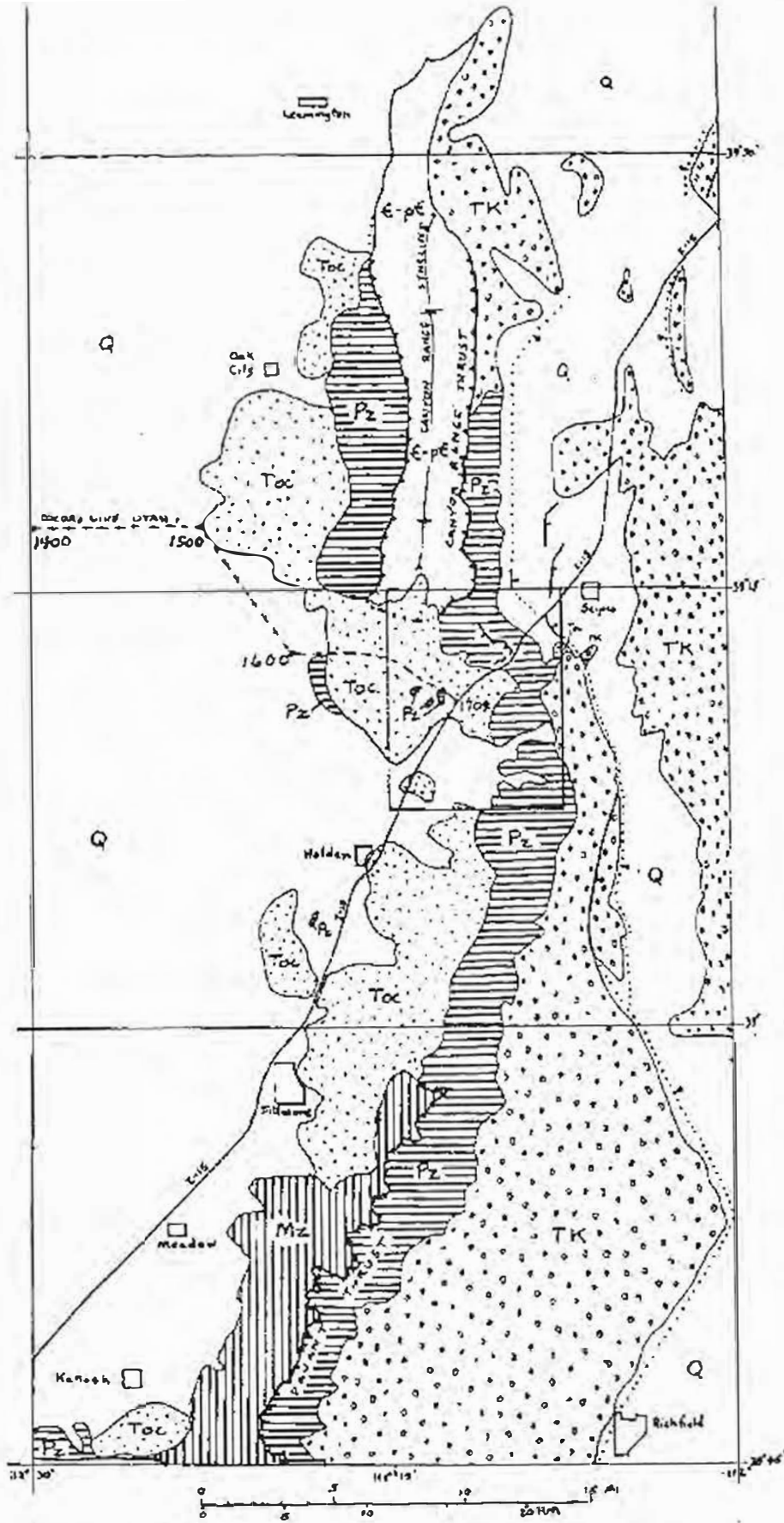


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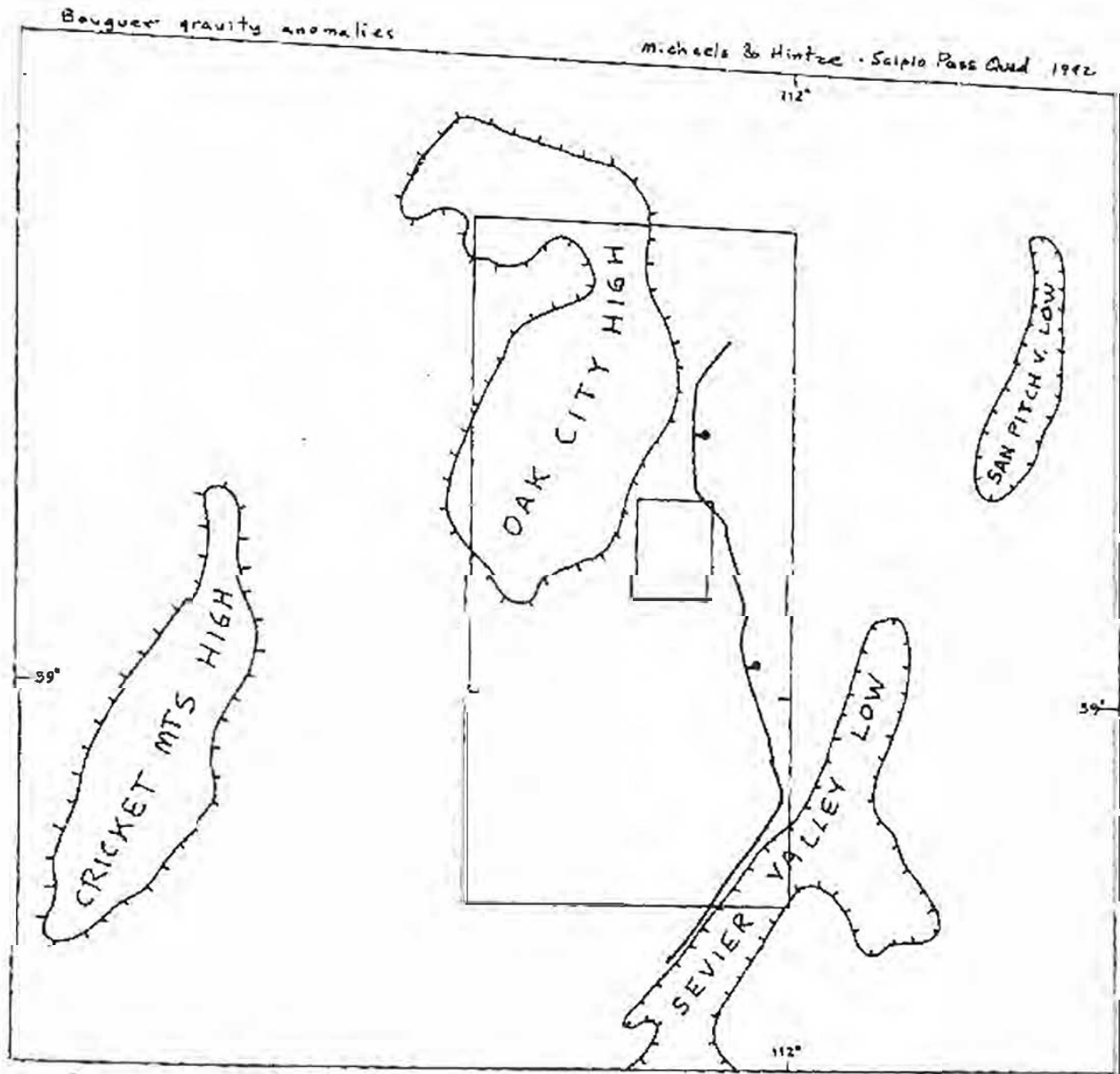


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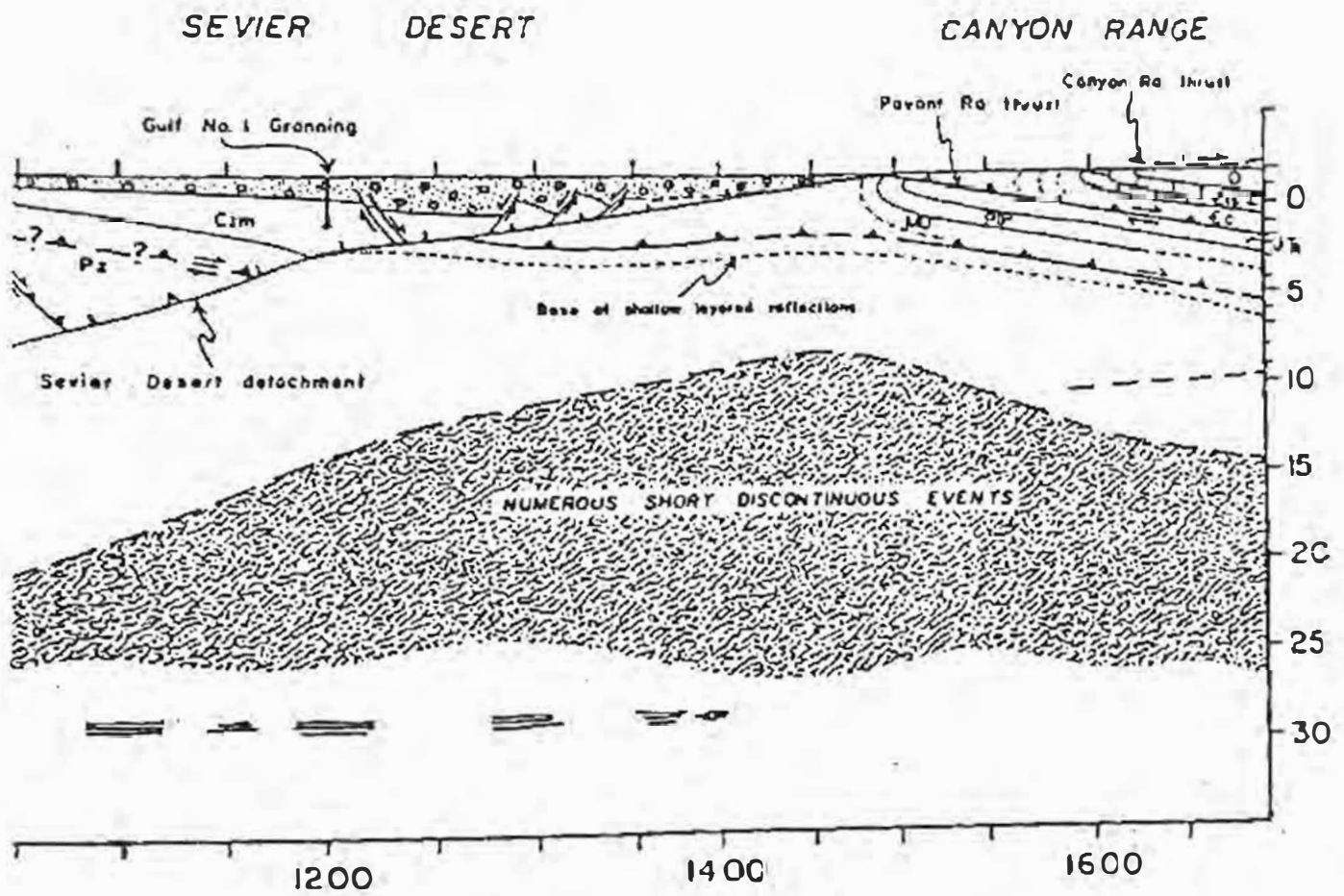
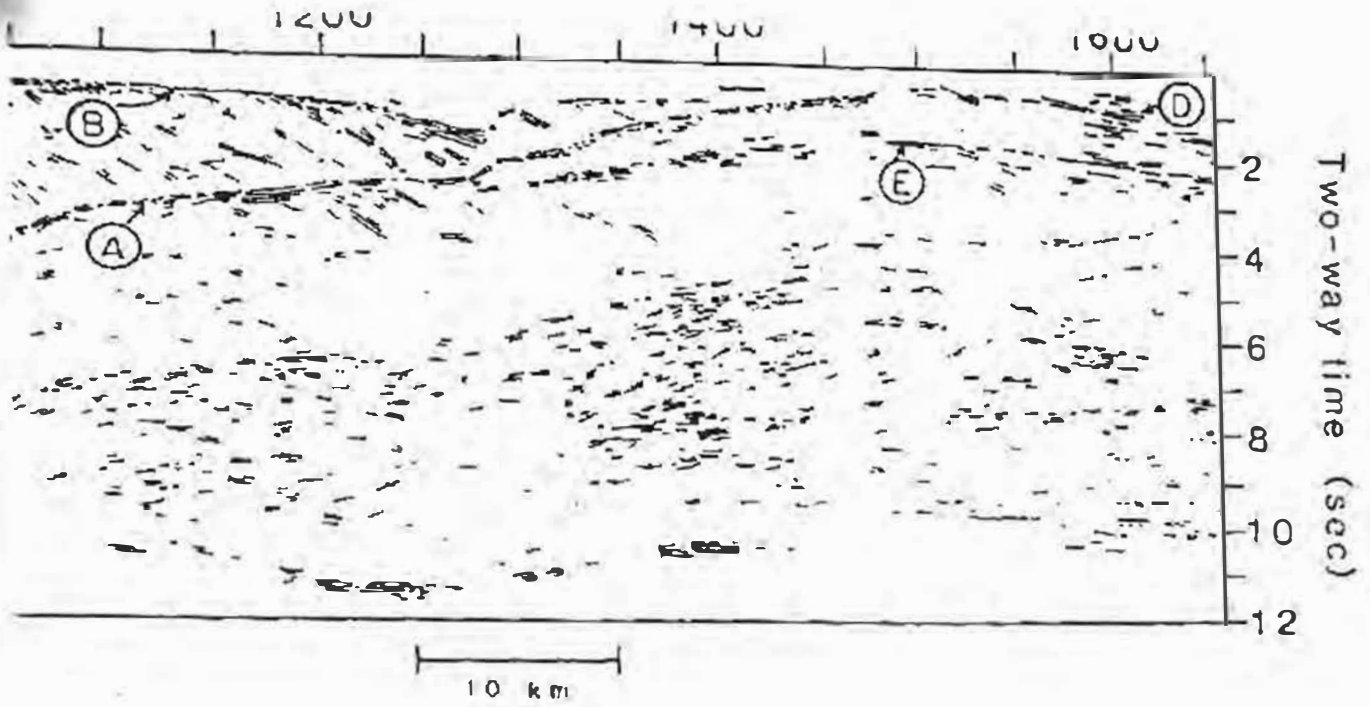
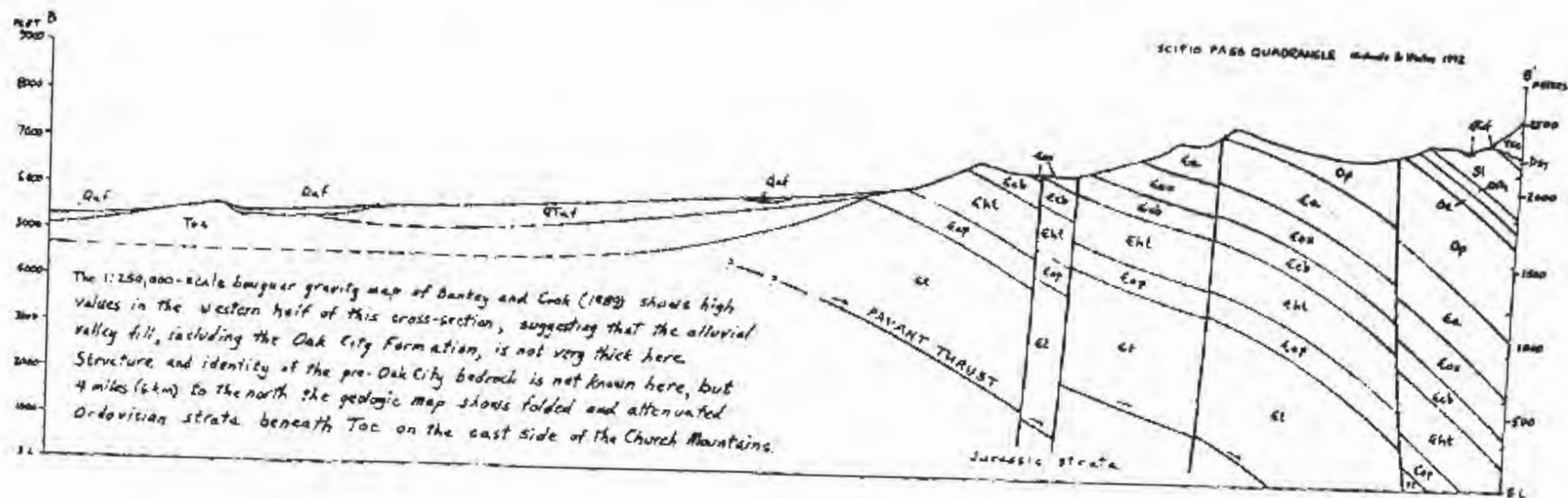
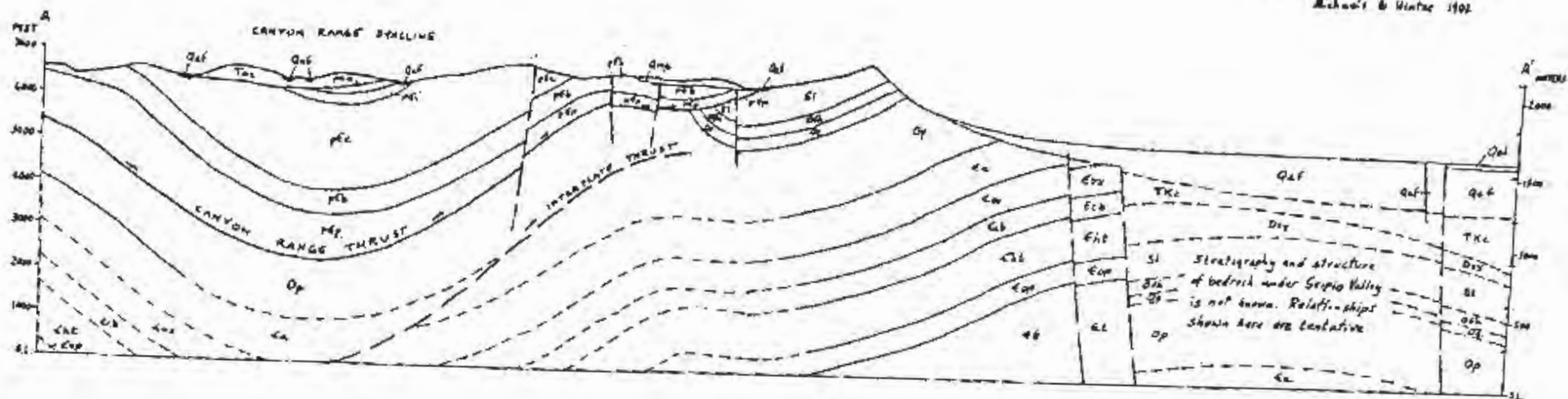


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CORRELATION OF MAP UNITS

CENOZOIC	Quaternary	Holocene	Qaf	Qal	Qmc	Qe
		Pleistocene	QTaf		QTml	
	Late Tertiary	Pliocene	Toc		Tml	
			major unconformity			
MESOZOIC	Early Tertiary		TKc			
	Late Cretaceous	major unconformity				
PALEOZOIC	Devonian		Dsy			
	Silurian		Sl			
	Ordovician		Ofh			
			ce	PALEOZOIC UNITS ALL ON PAVANT OVERTHRUST PLATE		
			Op			
			Ea			
	Cambrian		Eox			
			Ecb			
			Eht			
			Eop			
		Et				
structural break						
PRECAMBRIAN	Late Proterozoic		pEm			
			pEi			
			pEc			
			pEb			
			pEp	PRECAMBRIAN UNITS ALL ON CANYON RANGE OVERTHRUST PLATE		

SCIPIO PASS QUADRANGLE
 Michael & Vintne 1992



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

by
Roger B. Michaels and Lehi F. Hintze

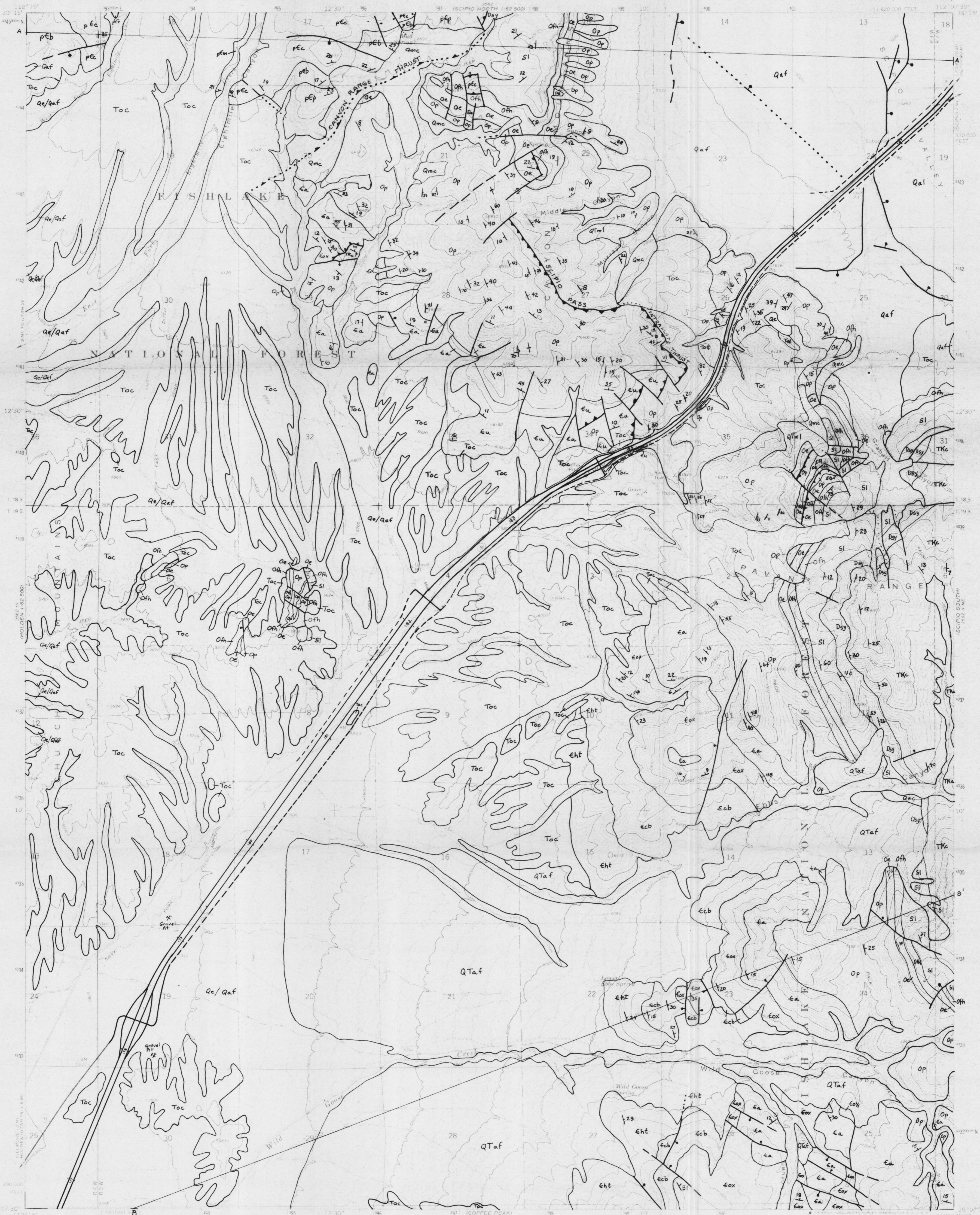
UTAH GEOLOGICAL SURVEY

OPEN-FILE REPORT 246

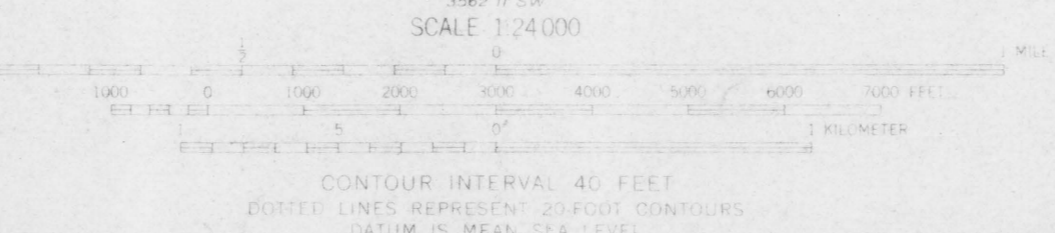
AUGUST 1992

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SCIPIO PASS QUADRANGLE
UTAH - MILLARD CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey
Control by USGS and USC&GS
Topography by photogrammetric methods from aerial
photographs taken 1968. Field checked 1969
Polyconic projection. 1927 North American datum
10,000 foot grid based on Utah coordinate system, central zone.
1000-meter Universal Transverse Mercator grid ticks,
zone 12, shown in blue
Fine red dashed lines indicate selected fence lines
Where omitted, land lines have not been plotted



ROAD CLASSIFICATION
Primary highway ———— Light-duty road, hard or improved surface
Secondary highway ———— Unimproved road
Interstate Route ———— U.S. Route ———— State Route ————
Michaels & Hintze May, 1992

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR WASHINGTON, D.C. 20242
A DESCRIPTION OF TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

SCIPIO PASS, UTAH
N3907.5-W11207.5 7.5
1969
AMS 3562 II NW - SERIES V897

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