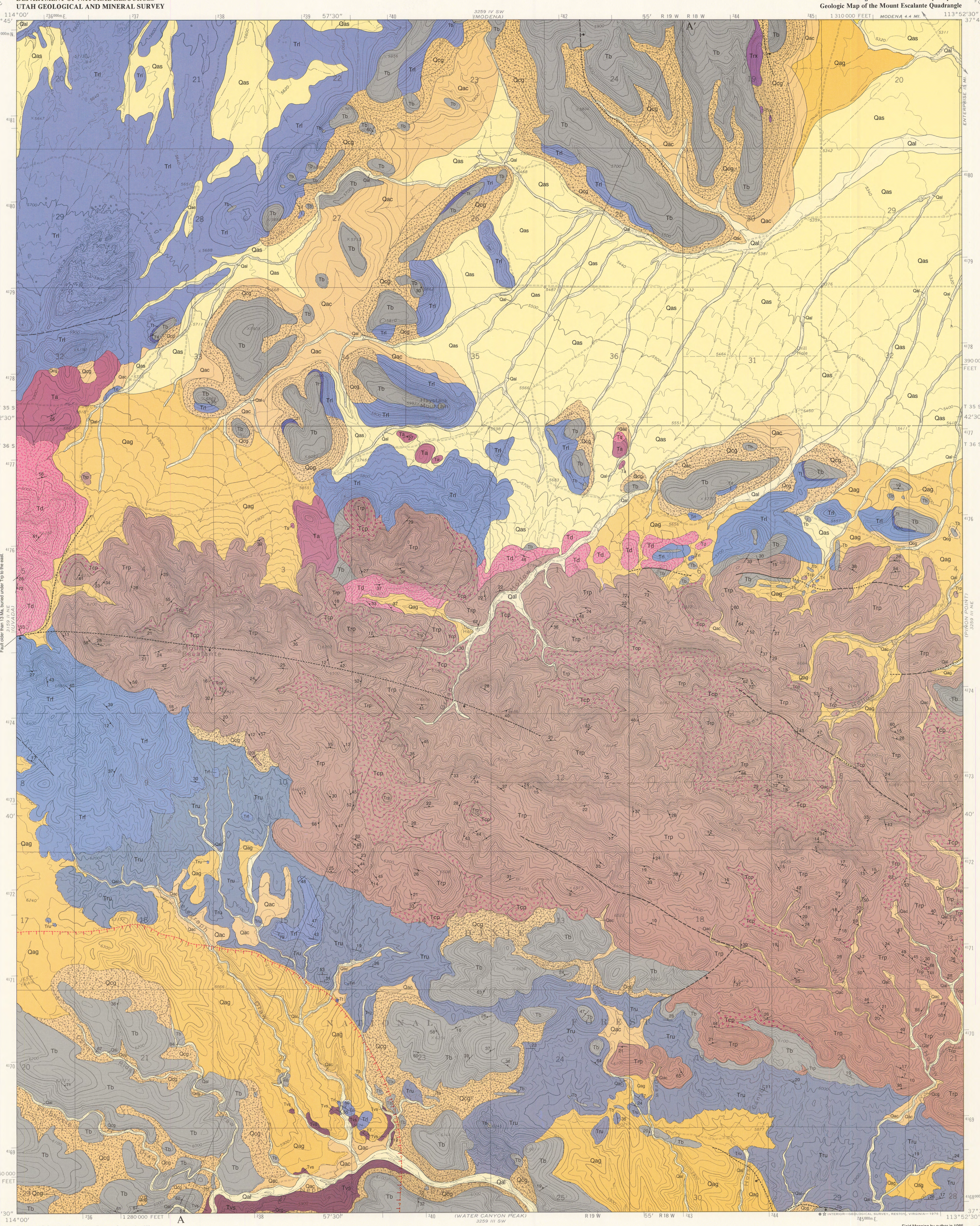
STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
UTAH GEOLOGICAL AND MINERAL SURVEY

Plate 1
Utah Geological and Mineral Survey Map 131
Geologic Map of the Mount Escalante Quadrangle



Base from U.S. Geological Survey Mount Escalante Quadrangle, 1972.

Field Mapping by author in 1985.
Patricia H. Speranza, Cartographer

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

UTM GRID AND 1991 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

QUADRANGLE LOCATION

GEOLOGIC MAP OF THE MOUNT ESCALANTE QUADRANGLE, IRON COUNTY, UTAH

by
Mary A. Siders
Utah Geological and Mineral Survey

1991

MAP SYMBOLS

CONTACT

Dashed where location inferred

NORMAL FAULT

Bar and ball on downthrown side; dashed where location inferred; dotted where covered.

STRIKE AND DIP OF BEDDING

51

Inclined   Vertical

STRIKE AND DIP OF IGNEOUS FOLIATION

23

Inclined   Vertical

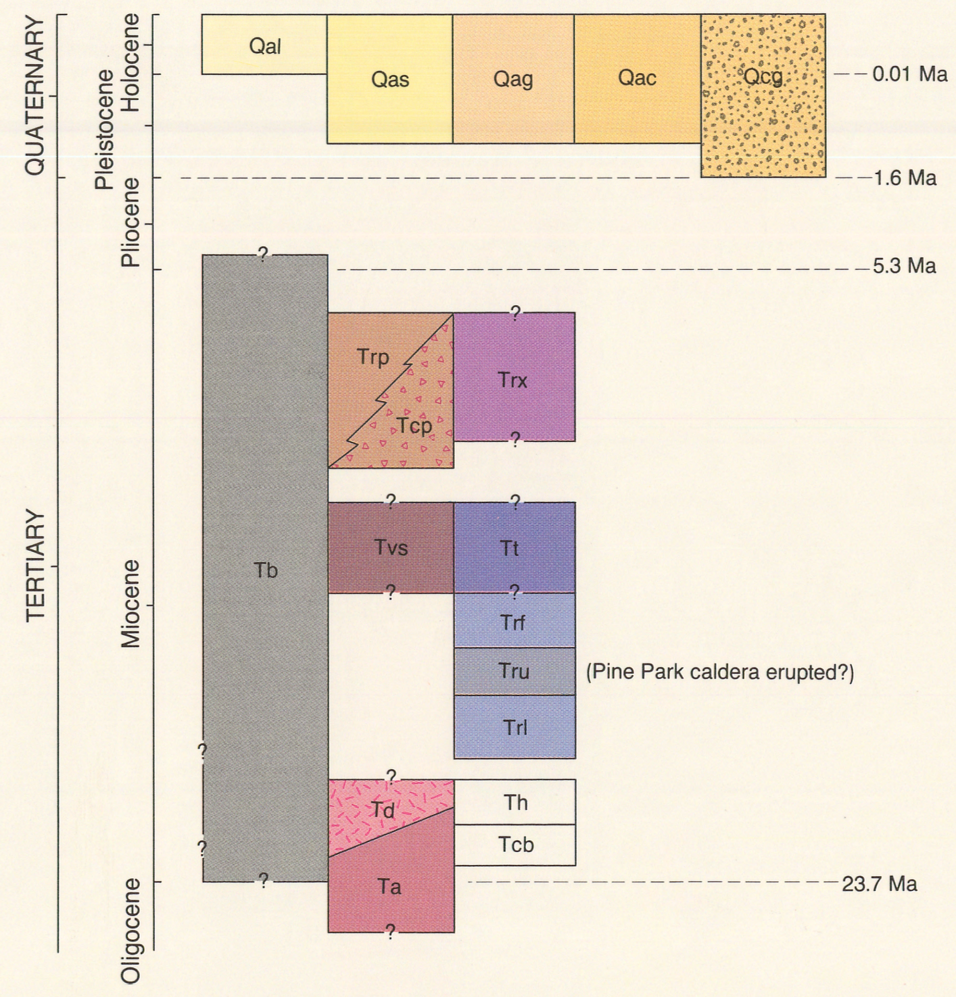
TOPOGRAPHIC WALL OF CALDERA

Covered

LINEATION

Faint linear alignment of vegetation or strong topographic alignment seen on aerial photographs, possibly related to faults or to fault-controlled surface drainage.

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qal Alluvium (Holocene) — *Unconsolidated silt and silty sand in ephemeral stream channels.*

Qas Quartzose sand and silt (Holoene and Pleistocene?) — *Unconsolidated, mainly quartz-rich sands derived from weathering of the Racer Canyon Tuff, transitional to Qag.*

Qag Sand and gravel of piedmont fans (Holocene and Pleistocene?) — *Unconsolidated sand and gravel covering slopes and plains. Also includes sand and gravel deposits with fan morphology.*

Qac Sand and gravel of sheetwash deposits (Holocene and Pleistocene?) — *Unconsolidated sand and gravel with strong colluvial component, transitional to Qcg, Qag, and Qas.*

Qcg Colluvium (Holocene and Pleistocene) — *Unconsolidated, bouldery to pebbly deposits occurring on slopes and hill tops.*

Tb Basaltic lava flows (Pliocene?, mainly Miocene) — *0-200 feet. medium to dark-gray to black, coarse-grained porphyritic to aphanitic lava flows. Many of these flows occur as isolated, erosional remnants throughout the map area.*

Trx Rhyolitic lava flows, undifferentiated (Miocene) — *Exposed thickness of 0-300 feet. Consists of porphyritic flows that form a flow-dome in the northeastern corner of the map area. The flows average 85% glassy matrix, 9% plagioclase, 4.5% sanidine, and 1.5% clinopyroxene.*

Rhyolite of Pinon Point

Trp Rhyolitic flow member (Miocene; 12.8 Ma) — *Exposed thickness of 0-1000 feet. Sparsely porphyritic, flow-layered, mottled purple-gray, gray, buff to pink rhyolitic flows, some of which have spherulitic, black to brick-red vitrophyres.*

Tcp Clastic member (Miocene) — *Exposed thickness of 0-400 feet. A crystal-poor, yellowish tuff breccia charged with reddish-purple rhyolitic lithic fragments. Underlying and interbedded with Trp.*

Tvs Volcanic and sedimentary sequence (Miocene; 16.0 Ma) — *Exposed thickness of 0-200 feet. A bedded, basin-fill sequence of non-welded tuff, airfall tuff, and tuffaceous sedimentary rocks.*

Tt Airfall tuff (Miocene; 16.7 Ma) — *0-10 feet. An assortment of airfall lapilli tuff, pumice-rich tuffaceous sediments, and fine-grained, bedded tuffaceous sandstone.*

Racer Canyon Tuff

Trf Rhyolitic lava flow member (Miocene) — *Exposed thickness of 0-300 feet. Generally perlitic, porphyritic flows that contain subequal amounts of quartz, plagioclase, and sanidine in a gray glassy matrix.*

Tru Upper tuff member (Miocene; 17.2 Ma) — *Exposed thickness 0-300 feet. Predominantly a weakly welded, cream-colored tuff charged with yellow pumice and 20 to 40% crystals. This member also includes quartz-rich sandstone and siltstone interbeds, derived from reworking of the lower tuff member.*

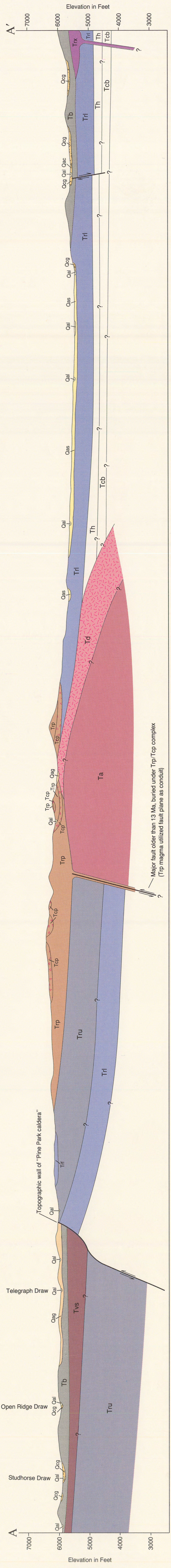
Trl Lower tuff member (Miocene: 19.2 Ma) — *Exposed thickness of 0-500 feet. A very pale-gray to pale-pink, weakly to moderately welded, crystal tuff, with sparse lithic fragments. Contains an average of 40-50% phenocrysts, listed in order of decreasing abunaance these are: plagioclase, quartz, sanidine, biotite, Fe-Ti oxides, and trace hornblende and sphene.*

Th Harmony Hills Tuff (Miocene; 21 Ma) — *ON CROSS SECTION ONLY. A moderately welded, crystal-rich, dacitic tuff containing uncut 50% crystals. Large and conspicuous plagioclase and biotite phenocrysts dominate, with lesser amounts of hornblende, quartz, pyroxene and Fe-Ti oxides. Crops out a short distance north of the mapped area.*

Tcb Bauers Tuff Member of the Condor Canyon Formation (Miocene; 22 Ma) — *ON CROSS SECTION ONLY. A densely welded rhyolitic tuff that is reddish-brown in color, with abundant and distinctive light-gray, flattened lenticules. Crops out several miles north of the map area.*

Td Dacite lava flows (Miocene; about 22 Ma) — *Exposed thickness of 0-300 feet. A strongly porphyritic dacite containing conspicuous plagioclase and biotite, along with lesser amounts of clinopyroxene, Fe-Ti oxides, and trace amounts of hornblende, quartz, zircon, apatite, and orthopyroxene.*

Ta Andesitic lava flows (Miocene and Oligocene) — *Exposed thickness of 0-200 feet. Porphyritic, two-pyroxene andesitic and altered mafic flows that contain plagioclase, clinopyroxene, Fe-Ti oxides, orthopyroxene, lithic fragments, altered mafic grains, and trace amounts of hornblende, biotite, zircon, and apatite.*



GEOLOGIC MAP OF THE MOUNT ESCALANTE QUADRANGLE, IRON COUNTY, UTAH

by
Mary A. Siders
Utah Geological and Mineral Survey

MAP 131 **1991**

UTAH GEOLOGICAL AND MINERAL SURVEY

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UTAH DEPARTMENT OF NATURAL RESOURCES

M.A. Siders GEOLOGIC MAP OF THE MOUNT ESCALANTE QUADRANGLE, IRON COUNTY, UTAH

UGMS MAP 131

GEOLOGIC MAP OF THE MOUNT ESCALANTE QUADRANGLE, IRON COUNTY, UTAH

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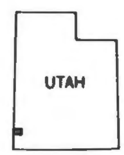

MAP 131 **1991**
UTAH GEOLOGICAL AND MINERAL SURVEY
a division of
UTAH DEPARTMENT OF NATURAL RESOURCES

UTAH GEOLOGICAL AND MINERAL SURVEY
606 Black Hawk Way
Salt Lake City, Utah 84108-1280

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GEOLOGIC MAP OF THE MOUNT ESCALANTE QUADRANGLE, IRON COUNTY, UTAH

by
Mary A. Siders[1]

ABSTRACT

Tertiary volcanic rocks dominate the geology of the Mount Escalante quadrangle. Mainly Miocene in age, these rocks include regionally widespread ash-flow tuffs as well as local lava flows of rhyolitic to basaltic composition. Products of both calc-alkaline and bimodal (basalt plus rhyolite) volcanism occur within the quadrangle. The former includes the voluminous deposits of the Racer Canyon Tuff and underlying andesitic to dacitic flows, whereas the latter is best expressed by the Pinon Point rhyolitic complex and related basaltic lava flows. The topographic wall of a mid-Miocene caldera, inferred from field and geophysical data, is located in the extreme southwestern corner of the map area. The quadrangle lies within the Basin and Range physiographic province, just north of a diffuse transition zone separating it from the Colorado Plateau province to the southeast. The northern edge of the Delamar-Iron Springs mineral belt, which is coincident in part with the Timpahute lineament, passes through the southern part of the map area. Although the quadrangle does not have a history of mining, and no prospect pits or other workings were found during the course of mapping, some potential may exist for economic mineral deposits.

Limited data suggest a low geothermal potential for the area. Data from well logs for oil and gas drilling projects are not publicly available for the quadrangle.

INTRODUCTION

The Mount Escalante quadrangle is located in southwestern Iron County, Utah, at the southwestern corner of the Escalante Desert. The western border of the quadrangle is about three miles (4.8 km) from the Nevada state line, and the northern border of the quadrangle is several miles south of Modena, Utah. The Escalante silver mine is located only ten miles (16 km) to the east, in the nearby Beryl Junction quadrangle.

Previous published work encompassing the quadrangle includes the 1:250,000 and 1:500,000 compilation maps of Utah state geology by Hintze (1963, 1980). The source of some regionally extensive Miocene ash-flow tuffs in southwestern Utah is the Caliente caldera complex west of the quadrangle, according to reconnaissance work by Dolgoff (1963), Williams (1967), Noble and McKee (1972), Ekren and others (1976), and Ekren and others (1977). Studies to the south of the quadrangle include those of Cook (1960) on Washington County and Blank (1959) on the Bull Valley Mountains. Recent work includes that of Best (1984) in the southern Wah Wah Mountains and the Indian Peak Range (Needle Range) to the north of the quadrangle, and Siders (1985a, b) in the Beryl Junction and Pinon Point quadrangles to the east.

STRATIGRAPHY

Rocks exposed in the Mount Escalante quadrangle include Miocene lava flows and ash-flow tuffs, as well as a heterogeneous assortment of sedimentary and volcanic basin-fill deposits of Miocene to Pliocene(?) age. Lava flows of andesitic and dacitic composition form the oldest units exposed in the quadrangle. These flows, along with ash-flow tuffs of the Racer Canyon Tuff, were emplaced late in an episode of calc-alkaline magmatism that prevailed in southwestern Utah in the Oligocene and early Miocene. An east-trending rhyolitic complex 12 to 13 Ma cuts across the center of the area and extends about 15 miles (24 km) from the Nevada state line through the adjacent Pinon Point quadrangle to the east. These rhyolitic lava flows and tuffs, together with basaltic lava flows, constitute a mid-Miocene bimodal assemblage overlying the older calc-alkaline volcanic rocks. South of the rhyolitic complex, upper portions of the Racer Canyon sequence and gray

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aphyric basaltic flows cover much of the area. In other areas to the south, a sequence of non-welded to weakly welded ash-flow tuffs, together with airfall tuffs and tuffaceous sedimentary rocks, fill an area that was once a structural and topographic depression. A feldspar mineral separate from an airfall tuff bed within this sequence has a K-Ar age of about 16.0 Ma. Cook's (1960) map of Washington County assigned this heterogenous assemblage of volcanic and sedimentary basin-fill deposits to the catch-all "Muddy Creek Formation." However, in the present report such deposits are grouped into non-specific "basin-fill deposits" (Tvs). Quaternary alluvial and colluvial deposits of mainly unconsolidated materials form the youngest units in the map area.

TERTIARY SYSTEM

Upper Oligocene to Lower Miocene lava flows (Ta, Td)

Porphyritic lava flows of calc-alkaline affinity crop out mainly in the central portion of the quadrangle. These flows range in composition from a coarsely porphyritic dacite (Td) to a medium-grained two-pyroxene andesite (Ta). The andesite flows in the Mount Escalante quandrangle are about 24 Ma, based on the ages of similar andesite in adjacent areas (Siders, 1985a), and they apparently underlie the porphyritic dacite flows. Modal analyses of eight samples show that the andesite consists of approximately 69 percent matrix, 18 percent plagioclase, 7 percent clinopyroxene, 3 percent Fe-Ti oxides, 1 percent orthopyroxene, 1 percent lithic fragments, 1 percent altered mafic grains, and trace amounts of hornblende, biotite, zircon, and apatite.

Modal analyses of twelve samples of the dacite flows average approximately 65 percent matrix, 22 percent plagioclase, 5 percent biotite, 5 percent clinopyroxene, 3 percent Fe-Ti oxides, and trace amounts of hornblende, quartz, zircon, apatite, and orthopyroxene. Mineralogically, these dacite flows are similar to the "dacite of Pinon Park Wash" in the adjacent Pinon Point quadrangle (Siders, 1985a) which overlies andesitic flows and has a K-Ar age on biotite of about 22 Ma.

Racer Canyon Tuff (Trl, Tru, Trf)

Within the Mount Escalante quadrangle, the Racer Canyon Tuff consists of three members. These include an upper and lower tuff member (Tru, Trl) and a more tentatively identified rhyolite flow member (Trf). The flow member overlies the tuff members and has a very similar mineral modal analysis, although an isotopic age determination is needed to verify or discount its inclusion within the formation.

Distinction between the stratigraphically and lithologically similar Hiko and Racer Canyon tuffs has yet to be adequately documented and described. In this quadrangle, such rocks have been named the Racer Canyon Tuff, using the name established in southwestern Utah by Blank (1959). Dolgoff (1963) defined the Hiko Tuff from exposures in Nevada, which Cook (1965) correlated with Blank's (1959) Racer Canyon Tuff and the Kane Point Tuff Member of the Page Ranch Formation of Mackin (1960). The Racer Canyon Tuff was later adopted at formational rank by Rowley and others (1979), and given precedence over the correlative Kane Point Tuff Member of Mackin (1960). The type area of the Racer Canyon Tuff is in Racer Canyon in the northeastern Bull Valley Mountains (Maple Ridge quadrangle, Washington County). The work of Noble and others (1968), Noble and McKee (1972), and Ekren and others (1977) has shown that the Racer Canyon and Hiko Tuffs are of similar age and lithology, with probable origins in the Caliente depression of southeastern Nevada.

Blank (1959) originally placed the Racer Canyon Tuff as a member in his Cove Mountain Formation, and defined it as "a succession of rhyolite ignimbrites and associated tuffaceous interbeds," including tuffaceous sandstone and conglomerate. He noted that "two varieties" of Racer Canyon Tuff were present in the Bull Valley Mountains, and he stated that it was not clear "whether the variation is due to lateral changes within individual ignimbrites, or the presence of two or more ignimbrites with differing composition." A similar variability in composition characterizes the Racer Canyon sequence in the Mount Escalante quadrangle. The variety of units within the succession, including tuffs, lava flows, and sedimentary interbeds, suggests a nearby source.

Lower tuff member (Trl) — Megascopically, the lower tuff member of the Racer Canyon Tuff and the Hiko Tuff are both weakly to moderately welded tuffs that contain large quartz bipyramids, plagioclase, sanidine, biotite, pumice and sparse lithic fragments, and sphene in a gray to white to very pale-pink matrix. The Hiko Tuff has consistently more plagioclase, biotite, and hornblende, and less quartz and lithic fragments than the lower member of the Racer Canyon Tuff.

Exposed thicknesses of much as 400 feet (122 m) of moderately welded lower tuff member have been mapped over broad areas in the northern third of the Mount Escalante quandrangle. The tuff also occurs in the adjacent Uvada and Pinon Point quadrangles, and significantly greater thicknesses of undifferentiated Racer Canyon Tuff (as much as 1200 feet, or 365 m) have been reported in the Bull Valley Mountains (Blank, 1959) and the Antelope Range (Shubat and Siders, 1988).

K-Ar ages of 18.7 and 20.8 Ma were obtained for the Racer Canyon Tuff by Noble and McKee (1972; recalculated using new constants of Steiger and Jäger, 1977). Similar ages (18.1 to 20.1 Ma) were reported for the Hiko Tuff by Noble and McKee (1972), and by Armstrong (1970; all ages recalculated using new constants of Steiger and Jäger, 1977). A new K-Ar age of 19.2±0.8 Ma is reported here from biotite in a sample of the lower tuff member of the Racer Canyon Tuff from the NW ¼ of section 33, T. 35 S., R. 19 W.

Upper tuff member (Tru) — South of the east-trending rhyolitic complex, pumice-charged, weakly welded to non-welded tuff and underlying volcanogenic quartz-rich sandstone, siltstone, and air-fall tuff, generally less than 100 feet (30 m) in exposed thickness, cover large areas. The dominant lithology of the sequence is a weakly welded, white to tan to light-gray ash-flow tuff. The most distinctive characteristic of this upper tuff member is its much lower percentage of quartz and sanidine than the average Racer Canyon Tuff and the abundance of plagioclase and biotite visible in hand sample. Well-bedded sedimentary rocks dip to the north and underlie this plagioclase-biotite tuff. Tuff beds also dip northward, projecting underneath the massive pile of rhyolitic flows and coalescing domes.

The quartz-rich sandstone and siltstone probably represent reworking of the lower ash-flow tuffs of the Racer Canyon Tuff succession in a fluvial to lacustrine environment that developed during an eruptive hiatus. The upper tuff member may represent the "last gasp" of the Racer Canyon magma system, or it may be the result of resupply of magma derived from similar sources which then erupted after a period of quiescence and erosion. Biotite from a sample of the upper tuff part of the Racer Canyon sequence, located in the southern portion of the quadrangle, has a K-Ar age of 17.2 ± 0.7 Ma (table 1).

Non-welded airfall tuff (Tt)

A diverse assemblage of lapilli airfall tuff, pumice-rich tuffaceous sediments, and fine-grained, bedded tuffaceous sandstone. Ranging from several inches to perhaps ten feet (0.1-3 m) in thickness, the tuff is easily eroded and poorly preserved. The best preserved sections are overlain by a protective cap of basaltic rocks. In the northern half of the map area, thin beds of Tt are sandwiched between the Racer Canyon Tuff and the basaltic lava flows.

The unit predates the rhyolitic complex (Tcp, Trp) by about 4 million years according to a K-Ar age of 16.7 ± 0.7 Ma obtained on feldspar from the airfall tuff. This age is statistically indistinguishable from the Tvs unit described below, and may indicate that these two units are the result of related eruptions. It is also possible that the Tt unit is related to the upper tuff member of the Racer Canyon Tuff. Continued work in the region is needed to more accurately describe the stratigraphy and lithology of the Miocene tuffs and related rocks.

Volcanic and sedimentary sequence (Tvs)

This unit consists of a heterogenous, bedded assemblage of orange to pale-gray rhyolitic airfall tuff, water-worked tuff, ash-flow tuff, and tuffaceous sedimentary rocks that appear to have filled a depression in the southwestern corner of the map area. These deposits are soft, fairly easily eroded, and generally concealed under a mantle of alluvium but where exposed they dip gently to the north. The best exposures occur where alluvium and colluvium are eroded along stream channels and on steep slopes, revealing the Tvs. A feldspar mineral separate recovered from an airfall tuff bed 2 to 3 feet thick (0.6-0.9 m) within the sequence has a K-Ar age of 16.0 ± 0.7 Ma (table 1).

Table 1. Analytical data for K-Ar age determinations for some volcanic units in the Mount Escalante quadrangle. Analyses by Krueger Enterprises, Inc., Geochron Laboratories Division.

Sample #	Map Unit	Material	$^{40*}Ar$, ppm	^{40}K, ppm	% K	$^{40*}Ar$ / Total ^{40}Ar	$^{40*}Ar/K$	Age
ME 6-27	Trp	feldspar	.004190	5.609	4.702	.2375	.000747	12.8 ± 0.6 Ma
ME 5-3	Tru	biotite	.008061	8.032	6.733	.3485	.001004	17.2 ± 0.7 Ma
ME 6-32	Tt	feldspar	.007897	8.123	6.809	.5493	.000972	16.7 ± 0.7 Ma
ME 35-2	Tvs	sanidine	.006415	6.866	5.756	.658	.000934	16.0 ± 0.7 Ma
ME 33-16	Trl	biotite	.009242	8.259	6.923	.403	.001119	19.2 ± 0.8 Ma
ME 31-24	Tb	whole rock	.003032	4.427	3.711	.620	.000685	11.7 ± 0.6 Ma

Constants used

$\lambda_\beta = 4.962 \times 10^{-10}$/year

$(\lambda_e + \lambda_e') = 0.581 \times 10^{-10}$/year

$^{40}K/K = 1.193 \times 10^{-4}$ g/g

$$AGE = \frac{1}{\lambda_\beta + (\lambda_e + \lambda_e')} \ln\left[\frac{\lambda_\beta + (\lambda_e + \lambda_e')}{(\lambda_e + \lambda_e')} \cdot \frac{^{40*}Ar}{^{40}K} + 1\right]$$

Rhyolitic lava flow member (Trf) — A series of gray, porphyritic, glassy lava flows containing subequal amounts of plagioclase (7-14 percent), quartz (8-12 percent), and sanidine (7-12 percent), as well as minor biotite (1-2 percent) crops out in the west-central part of the map area. The matrix of these flows consists of fresh to mostly devitrified glass with perlitic cracks. These flows are mineralogically similar to the Racer Canyon Tuff. This, in combination with its proximity to the Racer Canyon Tuff, suggests a possible genetic relationship, and thus the flows are tentatively assigned to the Racer Canyon succession.

H.R. Blank (USGS, written communication, 1987) noted that the regional gravity field shows decreasing Bouguer anomaly values to the southwest, suggesting that Tvs gets thicker in that direction. As discussed later in this report, the gravity data support the interpretation of a caldera topographic wall in the southwestern corner of the Mount Escalante quandrangle.

Rhyolite of Pinon Point (Tcp, Trp)

A rhyolitic complex composed of numerous lava flows, coalescing domes, and associated pyroclastic tuff-breccia extends across the central portion of the Mount Escalante quadrangle and into the nearby Pinon Point quadrangle. This complex appears to have been extruded from east-striking fissures, and it represents the felsic member of a bimodal suite, related to 13 to 10 million-year-old basaltic flows (Tb) that both underlie and overlie the rhyolite. Rhyolitic rocks with ages of 13-12 million years occur elsewhere in southwestern Utah, including the topaz rhyolite of the Steamboat Mountain Formation (Best, 1981).

The rhyolite of Pinon Point is mapped as two units: a pyroclastic tuff-breccia unit (Tcp) resulting from early explosive eruptions of gas-charged magma, and rhyolitic lavas and flow domes (Trp) that immediately overlie and are surrounded by the tuff-breccia.

Clastic member (Tcp) — The clastic member of the Pinon Point rhyolitic complex includes tuff-breccia, which contains pumice fragments and angular reddish-purple to purplish-gray rhyolite lithic fragments in a pale-yellow tuffaceous matrix, as well as spherulitic and brecciated vitrophyres that are transitional to intact vitrophyres and to the lava flows proper. The term "tuff-breccia" is used here to describe volcanic rock in which dominantly rhyolitic clasts are contained in a tuffaceous matrix of fine fragments (less than 4 mm in diameter) that comprises 25 to 75 percent of the rock by volume (Lydon, 1968). Outcrops of the tuff-breccia generally form broad flat terraces on the slopes of the rhyolitic complex, and locally form cliffs. During the explosive activity that created the tuff-breccia, blebs of rhyolitic magma were aerially ejected to form obsidian nodules. Trace element analysis of these obsidian nodules indicates that their chemical composition is identical to clasts found in stream beds south of Modena and in adjacent areas in Nevada (Fred Nelson, Brigham Young University, written communication, 1984). This type of obsidian has been found as local archeological specimens (Umshler, 1975) and may represent a newly discovered obsidian source locality in Utah.

Rhyolite lava flow member (Trp) — Sparsely porphyritic, flow-layered rhyolitic lava flows, some of which exhibit abundant spherulites and lithophysae, range in color from mottled pinkish- to purplish-gray to buff. Flow margins are often marked by greenish-black to reddish-purple vitrophyres or auto-brecciated zones. Black basal vitrophyres as much as 15 feet (4.5 m) thick underlie some of the flows. Rhyolite flows weather to massive rounded outcrops and form the highest hills in the quadrangle. Sparse phenocrysts of potassium feldspar and quartz are visible in hand sample. Thin section study reveals phenocrysts (commonly less than 5 percent) of sanidine, quartz, plagioclase, scattered Fe-Ti oxides, accessory zircon and xenocrystic olivine contained in a hyalopilitic matrix, much of which has been devitrified to spherulites. Olivine xenocrysts are typically corroded and rimmed with iddingsite or granular Fe-Ti oxides. Plagioclase phenocrysts are commonly enclosed by snaidine overgrowths that have apparently protected the plagioclase from reaction with the magma. Unprotected plagioclase typically shows the effects of resorption. The K-Ar age of sanidine from the Trp lava flows in Section 8, T. 36 S., R. 18 W. is 12.8 ± 0.6 Ma.

Rhyolitic lava flows, undifferentiated (Trx) — Coarsely porphyritic, rhyolitic lava flows contain about 15 percent total phenocrysts, including plagioclase, sanidine, clinopyroxene, Fe-Ti oxides, and quartz. The matrix ranges from a crumbly, black vitrophyre to a dense, red-purple and gray streaked zone, to a light-gray pumiceous phase. All types, which have nearly identical mineralogical compositions, crop out only in the northeastern corner of the quadrangle and are of unknown affinity and age. The unit appears to overlie the Racer Canyon Tuff and is in turn overlain by basaltic flows. These constraints support a rough age of 18 to 11 Ma for the Trx unit.

Basaltic lava flows (Tb)

Basaltic magmatism occurred intermittently throughout the early to middle Miocene, and several distinct varieties of basaltic lava flows, ranging from dark-gray coarsely porphyritic flows to medium-gray aphyric flows, are found in the Mount Escalante quadrangle. The oldest flows, which apparently underlie Td based on poorly exposed field relationships, occur in sections 1, 2, and 3, T. 36 S., R. 19 W. south of Haystack Mountain in the central portion of the map area. These are dark-gray to black, vesicular, coarse-grained flows. Greater volumes of basaltic flows are related, as part of a bimodal assemblage, to the 13-12 million-year-old rhyolite of Pinon Point. Some bimodal basalt flows underlie and some overlie the rhyolite. Similar dark-gray, coarse-grained, olivine-augite, basaltic flows occur as isolated remnants overlying the Racer Canyon Tuff in the northern half of the map area. Such basaltic flows also form broad mesas along the northern edge of the map area and have a K-Ar age of 10.8 Ma (Best and others, 1980). Some of the isolated basaltic outcrops are interpreted to be erosional remnants of flows that occurred along paleochannels or filled topographic lows, as no evidence indicates they represent slump blocks. In outcrop, most basaltic flows of the bimodal association occur as gray to black, blocky-fracturing rocks that produce abundant slope debris (Qcg). Phenocrysts of plagioclase, greenish-black pyroxene, and orangish altered olivine are generally visible in hand sample. These same phases, together with Fe-Ti oxides, occur in an intergranular to subophitic matrix.

Similar dark-gray basaltic flow remnants that occur in the south-central portion of the map area, particularly in sections 3 and 4, T. 36 S., R. 19 W., are interpreted to be the remains of a flow that filled an east-west-trending paleochannel. No compelling evidence was found suggesting a dike origin for the linear distribution of basalt outcrops.

On low hills in the southwestern part of the map area, gray aphyric flows of basaltic composition crop out. These lava flows are characterized by platy fracturing, medium-gray to brownish-red weathered surfaces, fine-grained texture, and a conspicuous lack of phenocrysts (less than 4 percent average). All weather to form extensive colluvial mantles. A new K-Ar whole-rock age reported here for these flows is 11.7 ± 0.6 Ma (table 1).

QUATERNARY SYSTEM

Colluvium (Qcg)

Unconsolidated bouldery to gravelly colluvium occurs as slope deposits that commonly conceal the underlying geology. Where the identity of subjacent bedrock can be inferred with confidence, the colluvium is not shown on the geologic map. Elsewhere, such as downslope from basaltic flows where the identity of the underlying units is difficult to establish, the colluvial-mantled area is mapped as Qcg. The composition of the Qcg deposits reflects their source area.

Sand and gravel of sheetwash deposits (Qac)

Qac consists of unconsolidated deposits of sand and gravel, with a texture gradational between colluvial deposits (Qcg) and alluvium of ephemeral stream channels (Qal). The deposits occur at the base of slopes or over broad areas subjected to sheetwash, and the clasts are predominantly of near-source colluvial origin.

Sand and gravel of piedmont fans (Qag)

Alluvial deposits of unconsolidated sand and gravel as well as poorly sorted, bouldery slope wash are included in the Qag unit. Many of these deposits exhibit fan morphology, and all have compositions that reflect local sources.

Quartzose sand and silt (Qas)

This unit consists predominantly of alluvial sand and occurs downstream from or adjacent to outcrops of the Racer Canyon Tuff. The sand composition is dominated by quartz grains derived from erosion of the crystal-rich tuff. This deposit is gradational to the sand and gravel of piedmont fans (Qag) and formed by the same processes, but it is distinctive for its high quartz-sand content.

Alluvium (Qal)

Young alluvium (Qal) occurs as unconsolidated alluvial deposits in active, ephemeral stream channels. These deposits are generally fine-grained and consist of silt and silty sand, much of it derived from reworking of earlier alluvial deposits.

CALDERAS

Much of southwestern Utah, including the Mount Escalante quadrangle, lies within the extensive ash-flow tuff province of the Great Basin. In this region, a thick veneer of Tertiary ash-flow tuffs and related volcanic rocks overlie a pre-Tertiary basement. A substantial thickness of ash-flow tuffs and lava flows was verified by M.G. Best (personal communication, 1985) who examined drill cuttings from two geothermal test wells, one located three miles (4.8 km) south of Beryl, Utah, in section 18, T. 34 S., R. 16 W., and another located five miles (8 km) east of Table Butte, in section 8, T. 34 S., R. 13 W. Best described at least 5000 feet (1525 m) of tuffs and other volcanic rocks.

A number of caldera complexes have been described within the general area of southwestern Utah and southeastern Nevada (figure 1). Caliente caldera complex depression, which is centered about 20 miles (32 km) southwest of the Mount

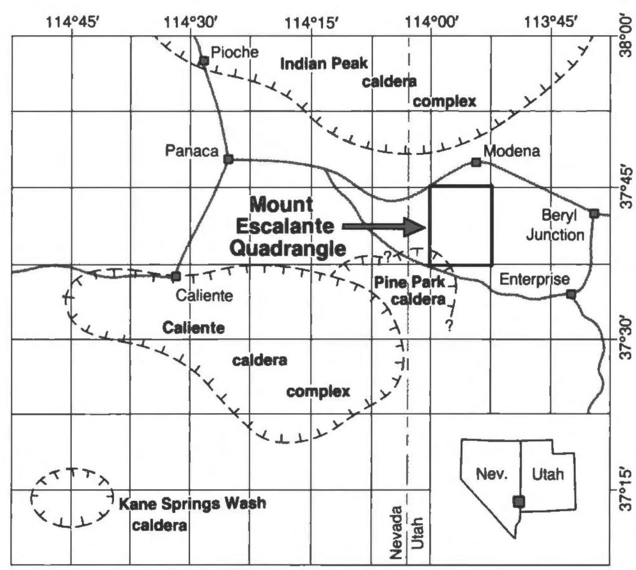


Figure 1. Calderas and caldera complexes in a part of southwestern Utah and southeastern Nevada. Location of Kane Springs Wash caldera and Caliente caldera complex from Ekren and others (1977). Location of Indian Peak caldera complex from Best (1986). Boundary of the proposed "Pine Park caldera" is defined outside the Mount Escalante quadrangle on the basis of geophysical data (H.R. Blank, U.S.G.S, written communication, 1987).

Escalante quadrangle, is one of the largest in the area. It is thought to be the source for numerous Miocene ash-flow tuffs (Williams, 1967; Noble and McKee, 1972; Ekren and others, 1977). Ekren and others speculated that the abundant, nested calderas of the Caliente complex may very likely extend eastward into adjacent parts of Utah.

One caldera is shown on the Mount Escalante quadrangle. It marks the boundary of an elliptical depression, as seen in gravity data, that includes the southwestern corner of the map area. Within this boundary, the only bedrock units exposed are tuffs younger than 17 million years and basaltic flows that postdate and partially fill the depression. Although the tuff within and derived from the caldera cannot be conclusively identified here, it may possibly be the upper tuff member of the Racer Canyon Tuff (Tru). This unit is thickest just outside the rim, and contains abundant huge autholithic pumice clasts, suggestive of near-source deposition.

On the basis of a study in progress by the U.S. Geological Survey of the geophysics of the Caliente area, H.R. Blank (personal communication, 1987) identified a number of negative gravity anomalies that extend in a linear pattern from just north of Kane Springs Wash, Nevada, and into the southwestern corner of the Mount Escalante quadrangle. The caldera margin shown on the map is probably the topographic wall, or less likely, a structural margin (i.e., ring fracture). This boundary as mapped in the field corresponds almost exactly with a steep gravity gradient noted by Blank (personal communication, 1987).

Lack of exposure in the southwestern corner of the map area precludes further study of the caldera here. Just to the southwest of the Mount Escalante quadrangle, great thicknesses of rhyolitic ash-flow tuff are exposed in canyons within the Pine Park quadrangle, suggesting that the history of this newly identified caldera may best be studied in that area. Continued work along the Utah-Nevada border may illuminate the sources for a number of Miocene tuffs, as has the work of Best (1984, 1986) for the Oligocene Needles Range Group, located a short distance to the north.

STRUCTURE AND GENERAL GEOLOGY

The Mount Escalante quadrangle lies within the Basin and Range physiographic province, which is characterized by extensional tectonics, thin crust, and high heat flow. Extending west from the Colorado Plateau, the province includes western Utah and most of Nevada, and it is bounded on the west by the Sierra Nevadas. Within the area the most recent extensional faulting has produced a series of fault-block mountain ranges that are set apart by alluvium-filled graben valleys.

A tectonic regime, involving subduction and calc-alkaline magmatism, affected southwestern Utah through the early Miocene (Rowley and others, 1979). About 21-20 million years ago this regime gave way to extensional tectonism and was approximately coincident with the change from calc-alkaline to bimodal magmatism. Calc-alkaline magmatism is recorded in the Mount Escalante quadrangle as andesite, dacite, and ash-flow tuffs. Bimodal volcanic rocks are represented by the rhyolite flows and coalescing domes of the Pinon Point rhyolitic complex, and the associated basaltic lava flows.

Late Tertiary extensional stress produced much of the present topography of southwestern Utah through basin-range style block faulting. Although no range-front faults of this type occur in the map area, the entire area of the quadrangle appears to be part of a large fault block uplifted along a north-striking basin-range fault found in the Beryl Junction quadrangle, about 10 miles (16 km) to the east.

East-trending features, such as lineaments and general trends of some volcanic units, are well expressed in the Mount Escalante quadrangle, which straddles the east-trending zone known as the Timpahute lineament. Ekren and others (1976) defined this lineament extending across Lincoln County, Nevada, and into southwestern Utah. Large, east-trending rhyolitic masses along the lineament "were undoubtedly fed from east-trending fissures," and continue into southwestern Utah (Ekren and others, 1976). The "Pinon Point rhyolitic complex" (Siders, 1985a), which cuts across the center of the map area, is considered to be one of these easterly-elongated rhyolitic masses. Most of the mapped east-trending lineaments were identified on aerial photos.

In virtually all places, any pre-19 million-year-old faults within the quadrangle are buried under younger tuffs and lava flows. An east-striking fault, apparent along the west-central edge of the map area, places older dacite to the north against the youngest member of the Racer Canyon Tuff to the south. The fault appears to continue east, though buried by the flows of the 12-13 million-year-old rhyolite complex. Similar relationships of faulted rocks older than middle Miocene and overlain by generally unfaulted rhyolitic lava flows have been noted by Best (1984) in the area north of Modena, Utah. Here, the 12-13 million-year-old Steamboat Mountain Rhyolite overlies and obscures the faults older than middle Miocene. In the Mount Escalante quadrangle, the magmas that resulted in the Pinon Point rhyolitic complex are thought to have utilized this major, east-striking fault as a conduit to the surface. Geometric relationships of the fault exposed on the western edge of the map area are most easily explained by continuing the fault under the rhyolite lava pile. Relationships of the units seen in cross section also require a down-to-the-south fault in order to produce the pattern of surface exposures (basically younger, northward-dipping rocks in the southern half of the quadrangle).

ECONOMIC GEOLOGY

No active or abandoned mines and little evidence of prospecting was found in the Mount Escalante quandrangle. Although the Escalante silver mine is located only ten miles to the east, exposures of hydrothermally altered rocks were not discovered within the map area. However, the Delamar-Iron Springs mineral belt, which is coincident in part with the Timpahute lineament, passes through the quadrangle. This lineament is characterized by localized igneous extrusive and intrusive masses, hot springs, and mineralized and hydrothermally altered rocks (Ekren and others, 1976), suggesting at least a possibility for subsurface mineralization within the quadrangle. The high-silica rhyolite of Pinon Point (Tcp, Trp) has low abundances of fluorine and lithophile elements, and it does not exhibit "porphyry-type" alteration assemblages. Rhyolitic complexes not of this type are generally barren (Burt and others, 1982) and do not themselves represent encouraging targets for exploration.

Non-metallic resources in the Mount Escalante quadrangle include alluvial sands and gravels. However, the alkali reactivity and low mechanical strength of most weathered felsic volcanic rocks makes them less desirable than limestone, sandstone, or quartzite for use as concrete aggregate. The material is still useful as borrow or to provide road metal for local roads. The dense, blocky fracturing basaltic flows near the northern and southern margins of the quadrangle might be commercial if problems related to transport to the consumer could be overcome. Basaltic rock has uses as bituminous aggregate, concrete aggregate, road metal, riprap, roofing granules, railroad ballast, and other high-density aggregate.

Insufficient data exist at this time to adequately assess the geothermal potential in the quadrangle, however, heat flow assessment along the southern edge of the Escalante Desert (Clement, 1980) does suggest a low geothermal potential for the area. Known geothermal resource areas occur about 20 miles (32 km) to the east (Newcastle) and to the northeast (Lund) of the Mount Escalante quadrangle, but a test well drilled in the Escalante Desert near the town of Beryl, 13 miles (21 km) northeast of the quadrangle, failed to uncover any geothermal prospects. The Utah Division of Oil, Gas and Mining has no records in their files for drilling in the general vicinity of the Mount Escalante quadrangle.

GEOLOGIC HAZARDS

No evidence of landslides was observed in the Mount Escalante quandrangle, although steep slopes are found in places throughout the area. Some of the oversteepened slopes along Nephi Draw near the southern margin of the quadrangle may be susceptible to slumping or sliding. In general, the landslide potential is low for most of the area. The slope stability of the various hard rock units is, in part, related to the degree of induration. The non-welded to weakly welded tuffs and unconsolidated Quaternary deposits are less resistant and less competent than the lava flows and moderately welded tuffs and may be more susceptible to slumping or sliding on steep slopes. Rockfall may occur more commonly, as boulders and blocks of the volcanic rocks weather and loosen. Most rockfall occurrences are isolated boulders, and no evidence of major rockfalls or debris flows, aside from alluvial-fan deposits, was observed during the course of mapping.

The U.S. Soil Conservation Service (SCS) published a report on the area in 1952 and is currently reevaluating the soils for all of Iron County. According to the 1952 report, a large portion of the quadrangle consists of "rough broken and stony land associations," and "nearly all of these soils are shallow or very shallow over bedrock." The new report indicates that soils in the area have moderate to low shrink-swell potential, neutral to alkali pH (6.6 to 9.0), high corrosive activity with steel, and moderate to low reactivity with concrete. Much of the area has severely cemented hardpans below shallow soil, or severe seepage and a deep water table. Some of the soils have low mechanical strength or occur on slopes unsatisfactory for construction of buildings (G. Crandall, SCS, personal communication, 1985).

The flooding hazard is primarily restricted to arroyos throughout the quadrangle where heavy summertime cloudbursts can result in flash floods. Those areas affected are rangeland, both within and outside of the Dixie National Forest. There are no major structures or inhabited buildings within the map area, and for this reason, flooding resulting in property damage and personal injury is considered to be fairly improbable.

The Utah Seismic Safety Advisory Council places the quadrangle between seismic zones U-1 and U-2 (U-4 is the highest standard), and within seismic zone 2 of the Uniform Building Code (Ward, 1979). Ground acceleration was rated UBC-2 (0.01 g) (Ward, 1979). Since 1850, only two earthquakes with a magnitude greater than 4.0 on the Richter scale have been reported in the surrounding area, and only one epicenter (1968, magnitude 2.5) was located within the quadrangle according to the University of Utah Seismographic Station's earthquake 1979 catalog (Arabasz and others, 1979). Small-magnitude earthquakes (less than 4.0) are considered likely, and even larger earthquakes (greater than 4.0) are possible, resulting in a moderate earthquake hazard for the quadrangle. Figure 2 illustrates the locality and magnitude of earthquakes since 1850.

WATER RESOURCES

No perennial streams flow through the Mount Escalante quadrangle, although as noted above, summer cloudbursts may result in flash floods. Spring snowmelt also creates a temporary flow through the generally dry channels. The area is, for the greater part, utilized as rangeland, and a number of small dams have been built to form water catchment basins for livestock.

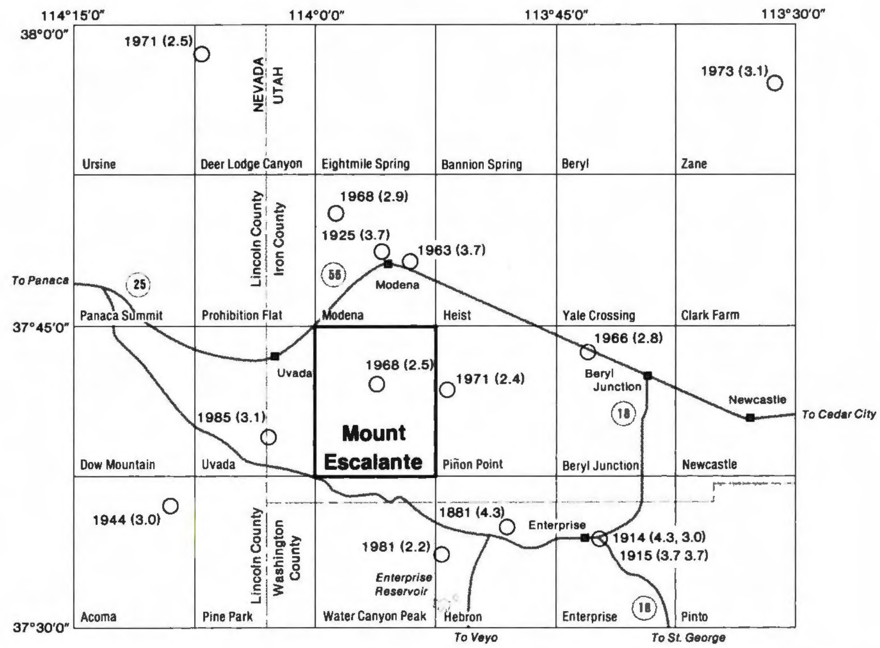
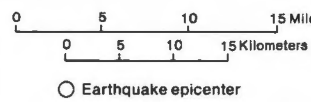


Figure 2. Epicenter location map for earthquakes greater than magnitude 2.0 (Richter Scale) for the Mount Escalante quadrangle and vicinity. Year and magnitude are included for each event (Arabasz and others, 1979).



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