DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Geologic Map of the Newcastle Quadrangle, Iron County, Utah

by

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This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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DESCRIPTION OF MAP UNITS

[Where necessary, isotopic ages given here have been recalculated using the IUGS decay constants (Steiger and Jäger, 1977)]

af **Artificial fill**--Dam of Newcastle Reservoir

Qal **Alluvium (Holocene)**--Sand, silt, and gravel deposited in modern intermittent and perennial stream channels and flood plains in the southeast part of mapped area. Maximum thickness about 3 m

Qpy **Young piedmont-slope alluvium (Holocene and upper Pleistocene)**--Poorly to moderately sorted deposits of sand, gravel, and silt forming coalesced alluvial fans and pediments. Deposits grade from sandy gravel, containing cobbles and boulders near the mountain front, to gravelly sand, silt, and clay in distal parts. Includes modern alluvium of small streams and, in places, colluvium, alluvial sheet wash, and talus. Deposition of the unit partly spans the period of faulting along some segments of the Antelope Range fault zone. Deposits are about 2 m thick in a gravel pit southwest of Newcastle (NE 1/4 sec. 30, T. 36 S., R. 15 W.)

Qfy **Young alluvial-fan deposits (Holocene and upper Pleistocene)**--Sand and subordinate pebble gravel, silt, and clay in the alluvial fan of Pinto Creek in Escalante Valley. Surface is generally inactive, and deposits are exposed in stream cuts in modern arroyos. Includes in northern parts of the mapped area significant amounts of distal alluvial-fan deposits (Qdf) and patches of middle alluvial-fan deposits (Qfm) too small to map, as well as fine-grained alluvial sand and subordinate alluvium of small streams. Contacts gradational and approximately located, especially in northern part of mapped area. Maximum measured thickness about 3 m; maximum probable thickness 10 m

Qdf **Distal alluvial-fan deposits (Holocene and upper Pleistocene)**--Silt and clay deposited in distal parts of the alluvial fans of Pinto Creek (Qfy) and of Shoal Creek to the west of the mapped area. Erosion, chiefly by sheet wash, of older alluvial deposits in Escalante Valley also contributes material to the unit; this material is redeposited in swales and shallow, low-gradient channels. Most deposits are modern. Includes fine-grained eolian sand. Contacts gradational and approximately located. Maximum thickness unknown but probably several meters

Qac **Alluvium and colluvium, undivided (Holocene and upper Pleistocene)**--Sand, silt, and gravel deposited in intermittent stream channels and flood plains and as colluvium in the southeast part of the mapped area. Includes alluvial-fan deposits, sheetwash alluvium, and talus. Estimated maximum thickness about 5 m

Qct **Colluvium and talus, undivided (Holocene and upper Pleistocene)**--Mostly cobble, pebble, and boulder gravel on steep slopes below rock outcrops. Maximum thickness about 5 m

Qed **Eolian sand (Holocene and upper Pleistocene)**--Dune sand consisting mostly of calcium carbonate, and subordinate clastic material and gypsum derived from adjacent alluvial and lacustrine deposits. Dunes are downwind (north-northeast) from deflation basins (Qae) from which the material was derived. Dunes lack well-developed dune form and are largely stabilized by vegetation. Includes deposits in small playas between dunes. Contacts gradational and approximately located. Maximum dune height about 5 m

Qae **Alluvium and eolian deposits, undivided (Holocene and upper Pleistocene)**--Sandy deposits in deflation basins and lag material from underlying reworked alluvium. Includes reworked alluvium, minor lacustrine material, and eolian sand. Mapped only in northern part of mapped area, where contacts are gradational and approximately located. Maximum thickness about 3 m

Qty **Young stream-terrace alluvium (lower Holocene and upper Pleistocene)**--Sand, silt, and minor pebble gravel deposited in intermittent and perennial stream channels and flood plains. Terrace surfaces about 2-3 m above modern channels. Mapped only in the Pinto Creek drainage. Exposed thickness 2-3 m but maximum thickness probably 10 m

Qtm **Middle stream-terrace alluvium (Pleistocene)**--Gravel and subordinate sand and silt of middle age, deposited in stream channels and flood plains. Terrace surfaces 15-25 m above nearby modern channels. Includes fill terraces and strath terraces cut on older alluvial-fan deposits and bedrock. Maximum thickness about 20 m

Qpm **Middle piedmont-slope alluvium (Pleistocene)**--Mostly sandy gravel of middle age, containing boulders and cobbles, that occurs as dissected higher remnants of piedmont-slope alluvium. Contains conspicuous pedogenic calcium carbonate. Includes interbedded stream-terrace alluvium (Qtm) along Little Pinto Creek. Maximum thickness at least 30 m

Qfm **Middle alluvial-fan deposits (Pleistocene)**--Sand and silt occurring as dissected higher remnants of middle-aged alluvial fans in Escalante Valley. Deposits derived largely from ancestral Pinto Creek, ancestral Shoal Creek, and other ancestral streams that drained areas to the south. Where exposed in gravel pits, consists of 1-1.5 m-thick sandy alluvium containing moderately to strongly developed pedogenic calcium carbonate (Ulrich, 1960) and of underlying sandy pebble gravel and interbedded sand at least 2 m thick. Becomes finer grained to the north; along the northern edge of the mapped area, the material in the upper 1-2 m of the unit is chiefly fine sand, silt, and clay and probably contains a substantial eolian (loess) component. Locally the unit has been extensively reworked by wind and sheet wash; deflation has locally removed upper soil layers and exposed lower layers of pedogenic calcium carbonate. Contacts gradational and approximately located, especially in northern part of mapped area. Includes the entire thickness of Quaternary basin-fill deposits, which attain a maximum thickness of more than 300 m (Mower, 1982)

Qp **Playa deposits (Pleistocene)**--Fine-grained, tan, granular gypsum and clayey, silty, and sandy gypsiferous and calcium-carbonate-rich deposits exposed in deflation basins in Escalante Valley. Sample from the top of a bed, about 1 m thick, from NW 1/4 SE 1/4 sec 24, T. 35 S., R. 16 W. contains 68 percent gypsum and 6 percent calcium carbonate (G.C. Christenson, unpub. data). Mapped only in northern part of mapped area, where contacts are gradational and approximately located. Thickness at least 3 m

QTpo **Old piedmont-slope alluvium (Pleistocene and Pliocene?)**--Light-gray, tan, and light-yellow, poorly to moderately consolidated cobble, pebble, and boulder conglomerate and sandstone. Clasts are generally rounded and consist of all local volcanic rock units and quartzite from the Claron Formation (Tc), as well as of some rock units not exposed in the mapped area. The most distinctive clasts are boulders of magnetite as much as 1 m in diameter derived from the Iron Springs mining district (Rowley and Barker, 1978); the closest source of this magnetite is Iron Mountain about 10 km east of the mapped area. High-level piedmont surfaces capping the deposit are highly dissected, but some remnants survive. Contains significant pedogenic calcium carbonate. Unit probably correlative with older alluvial-fan deposits (QTaf) of Shubat and Siders (1988), which also contains magnetite boulders and which underlies extensive high-level dissected surfaces in the area to the east. Maximum exposed thickness about 30 m

Ts **Sedimentary basin-fill deposits (Pliocene? and upper Miocene)**--Tan and light-red, poorly to moderately consolidated, medium bedded, pebble, cobble, and boulder conglomerate and sandstone. Locally contains blocks of volcaniclastic rocks of Newcastle Reservoir (Tnv) as long as 3 m. Clasts commonly subangular and probably represent coarse, rapidly deposited, fluvial basin-fill material along and west of the fault-bounded margin of the Escalante Valley. Thickness at least 300 m but probably considerably thicker under Escalante Valley (Cook and Hardman, 1967; Pe and Cook, 1980)

Td **Dacite of Bullion Canyon (Miocene)**--Resistant, light-purple and light-gray, flow-foliated, crystal-rich dacite lava flows of a volcanic dome. Characterized by large, abundant (about 40 percent by volume) phenocrysts of plagioclase, subordinate sanidine (as long as 1 cm), biotite, and quartz, and minor Fe-Ti oxides (Shubat and Siders, 1988, appendix), and large (as much as 1 cm in diameter) vesicular cavities lined with vapor-phase minerals, in a groundmass of devitrified glass. Informally named by Shubat and Siders (1988). K-Ar age on sanidine is 8.5±0.4 Ma (Shubat and Siders, 1988). Maximum thickness about 130 m

Trs **Rhyolite of Silver Peak (Miocene)**--Resistant, purplish-gray, flow-foliated, rhyolitic lava flows and apparent volcanic domes. Base of unit generally consists of flow breccia. Contains about 15-20 percent phenocrysts of sanidine and quartz, and minor biotite and Fe-Ti oxides (Shubat and Siders, 1988, appendix) in a groundmass of devitrified glass containing abundant small vesicles. Rock has been hydrothermally altered in many places, yet the overlying, slightly younger dacite of Bullion Canyon (Td) is not altered (Shubat and McIntosh, 1988). Informally named by Shubat and Siders (1988). K-Ar age on sanidine is 8.4±0.4 Ma (Shubat and Siders, 1988). Base not exposed; exposed thickness about 175 m

Tnv **Volcaniclastic rocks of Newcastle Reservoir (Miocene)**--Dark-reddish-gray, dark-reddish-brown, and medium- to dark-brown, cobble, pebble, and boulder conglomerate and subordinate mudflow breccia and sandstone. Clasts subangular to subrounded and as much as 35 cm in diameter. Most clasts consist of older volcanic units in the area, especially Racer Canyon Tuff (Tr) and Harmony Hills Tuff (Th), as well as of the Claron Formation (Tc) and Iron

Springs Formation (Kis). Most beds are grain supported and probably largely represent alluvial-fan deposits and subordinate mudflow breccia and stream channel and flood-plain deposits. Shubat and Siders (1988) named the volcaniclastic rocks of Newcastle Reservoir, which they correlated with the volcaniclastic "mine series" rocks of Siders (1985b). The volcaniclastic "mine series" rocks are the host for silver ore at the Escalante silver mine, west of Escalante Valley and about 8 km west of the mapped area. The unit forms a thick sequence in a belt about 25 km east-west by 8 km north-south (Siders, 1985a, b; Siders and Shubat, 1986; Shubat and Siders, 1988), and pinches out abruptly to the north and south; it probably represents the fill in an east-trending Miocene depression, perhaps a graben. Upper limit on age indicated by a K-Ar age of 11.6 Ma on adularia from the main silver vein (Siders, 1985b), which cuts the unit at the Escalante silver mine. Thickness at least 300 m in faulted, incomplete sections; upper part not exposed

Tr **Racer Canyon Tuff (Miocene)**--Soft to resistant, light-gray and light-blue-gray, poorly to moderately welded, crystal-rich, rhyodacitic ash-flow tuff. In some places, generally at the base of cooling units, includes minor beds of parallel-bedded airfall tuff and crossbedded pyroclastic-surge tuff. Contains locally abundant cognate pumice. Contains 1-6 percent conspicuous, mostly dark-brown and dark-gray, subangular lithic clasts that are mostly less than 5 cm long and of vesicular, crystal-poor flow rock. Tuff consists of 20-35 percent phenocrysts of plagioclase and quartz, subordinate sanidine, biotite, and Fe-Ti oxides, and traces of clinopyroxene, hornblende, and sphene (Siders and Shubat, 1986). The quartz crystals locally are large (though generally less than 5 mm), deeply resorbed, and a light-purple or smoky color.

Best exposed at a large hill near the southeast corner of the mapped area, where the unit consists of at least 3 ash-flow cooling units. The lowest cooling unit is probably a premonitory eruptive deposit that is at least 10 m thick (base not exposed); it consists of a soft, light-gray, poorly welded ash-flow tuff containing about 25 percent tan cognate pumice as long as 15 cm and about 5 percent dark lithic clasts. It differs in mineralogy from typical Racer Canyon Tuff in that it contains small amounts of quartz and sanidine and relatively higher amounts of clinopyroxene, hornblende, and biotite. A lag of subangular pebbles and cobbles of mostly Harmony Hills Tuff (Th) rests on the top of this lowest cooling unit and is overlain by a tan, nonwelded, 1.5-m-thick, locally crossbedded tuff of probable pyroclastic-surge origin. This is overlain by a soft, tan, poorly welded ash-flow cooling unit about 25 m thick containing several percent conspicuous lithic clasts of Harmony Hills Tuff as long as 4 cm. This cooling unit contains the same types and ratios of phenocrysts as in typical Racer Canyon Tuff but has much lower amounts (about 10 percent total phenocrysts). Above this is the most widespread tuff, a multiple cooling unit more than 100 m thick in which quartz phenocrysts are typically large and abundant. Its base consists of white, fine-grained airfall tuff that grades upward into massive, soft to moderately resistant, gray, poorly welded ash-flow tuff, then into light-gray and light-tan, moderately resistant ash-flow tuff containing about 20 percent light-yellow cognate pumice, mostly 5 cm long, and about 2 percent dark lithic clasts as much as 1.5 cm long. Farther upward the rock is light-gray, cognate pumice is much less abundant, and quartz phenocrysts become increasingly larger (as long as 7 mm). Above the light-gray zone, near the base of a prominent ledge, black glass fiamme as long as 10 cm are conspicuous; the fiamme zone is about 30 m thick and, in the prominent ledge, the only remnants of the fiamme are flattened cavities containing vapor-phase minerals. The resistant, moderately welded ash-flow tuff of the prominent cliff is light-gray, pink, and medium-tan, weathering to tan and brown; near the top of the unit, the rock becomes somewhat less welded.

The name Racer Canyon Tuff, formalized by Rowley and others (1979), follows an informal member name suggested by Blank (1959) for exposures in the eastern Bull Valley Mountains. Blank (1959) and Cook (1960) correlated it with the Kane Point Tuff Member (Mackin, 1960) of the Page Ranch Formation (Cook, 1957). Rowley and others (1979) abandoned the Kane Point Tuff Member. The Racer Canyon Tuff is widespread east and west of the mapped area (Siders and Shubat, 1986). Biehl and Grant (1987) speculated that the caldera source of the tuff lies along the western edge of Escalante Valley, about 7 km west of the mapped area, but this idea lacks supporting evidence (compare with Siders, 1985a, b, Siders and Shubat, 1986); unpublished mapping by M.A. Siders and P.D. Rowley suggests instead that the caldera is in the eastern part of the Caliente caldera complex, about 30 km southwest of the mapped area. The Racer Canyon Tuff is similar in lithology and age to the Hiko Tuff of Dolgoff (1963), derived from a caldera near Caliente, Nevada (Noble and McKee, 1972; Ekren and others, 1977; Rowley and Siders, 1988), in the western part of the Caliente caldera complex and about 90 km to the west-southwest. Additional work, however, is needed to distinguish the two units and to determine their relative ages.

Samples of Racer Canyon Tuff have received the following isotopic ages: (1) a lead-alpha age of 19 Ma on zircon (Jaffe and others, 1959) apparently from Kane Point, about 5 km south-southeast of the mapped area; (2) 18.7$\pm$0.5 Ma on biotite from north of Gunlock, nearly 30 km south-southwest of the mapped area (Noble and McKee, 1972); (3) 20.8$\pm$0.5 Ma on biotite from Racer Canyon, nearly 25 km southwest of the mapped area (Noble and others, 1968; Noble and McKee, 1972); and (4) 19.2$\pm$0.8 Ma on biotite from the Mount Escalante area about 30 km west of the mapped area (Siders, 1989). The Racer Canyon Tuff exhibits huge thickness variations due to deposition in topographic lows created partly by faults and partly between laccoliths emplaced at 20 Ma (Mackin, 1960). Maximum thickness in the mapped area is probably about 250 m, whereas in the Silver Peak quadrangle to the east it is as much as 335 m thick (Shubat and Siders, 1988)

Tv **Local volcanic rocks (Miocene)**--Dark-reddish-brown, dark-brown, medium-gray, and purplish-red, crystal-poor, andesitic volcanic mudflow breccia, lava flows, flow breccia, and fanglomerate from unknown local sources. Consists of small phenocrysts (10-20 percent by volume) of plagioclase, subordinate pyroxene, minor olivine and Fe-Ti oxides, and local hornblende in an aphanitic groundmass of the same minerals or in a groundmass of devitrified glass. The unit occupies the same stratigraphic level as the Irontown Member of the Page Ranch Formation, but the Irontown is of generally different lithology, being largely fanglomerate of older volcanic rocks deposited in a synclinal warp between two plutons in the Iron Springs district (Mackin, 1960). Maximum thickness about 100 m

QUICHAPA GROUP (Miocene and Oligocene)--Proposed as a group by Cook (1957) for a sequence of informally named regional ash-flow tuffs, Quichapa was lowered in rank to a formation by Mackin (1960), who named the members the Harmony Hills Tuff Member, Bauers Tuff Member, Swett Tuff Member, and Leach Canyon Tuff Member. Williams (1967) and Anderson and Rowley (1975) later reinstated Quichapa to group status

Th **Harmony Hills Tuff (Miocene)**--Resistant light-gray, tan, brownish-gray, and pink, moderately welded, crystal-rich, dacitic ash-flow tuff. Appears to form one compound cooling unit in the mapped area and locally contains a dark-gray, mostly devitrified basal vitrophyre. Contains light-gray and pink, cognate pumice as much as 10 cm long and 3 cm thick. Consists of 35-50 percent phenocrysts of plagioclase, subordinate hornblende and biotite, and minor quartz, clinopyroxene, and Fe-Ti oxides in a groundmass of devitrified shards. Isopach maps of the unit suggest a source in the Caliente caldera complex of Nevada-Utah (Williams, 1967). Elevated to formation status by Cook (1965). The average isotopic age is 21.2 Ma, based on four K-Ar ages on biotite and plagioclase by Armstrong (1970). Thickness about 125 m

Tcc **Condor Canyon Formation (Miocene)**--Defined by Cook (1965) to include two ash-flow tuff members, Bauers Tuff Member above and Swett Tuff Member below, both of which had previously been defined by Mackin (1960). The Swett Tuff Member, which lithologically resembles the Bauers Member but has a different mineralogy, appears to be thin and locally missing in the mapped area. The two members were not separately mapped, but petrographic study confirms the presence of the Swett Tuff Member in the extreme southeast corner of sec. 20 and the SW 1/4 sec. 29, T. 36 S., R. 15 W.

The Bauers Tuff Member is a resistant, crystal-poor, densely welded, rhyodacitic ash-flow tuff. A compound cooling unit, it consists mostly of an upper vapor-phase zone of light-gray and light-blue-gray homogeneous ash-flow tuff containing bronzy biotite and white pumice, grading downward into a brownish-red, reddish-purple, brown, and reddish-tan lenticulite zone containing abundant thin, gray ash-flow tuff lenticules as much as 2 m long. The lenticulite zones passes abruptly downward into a lustrous black basal vitrophyre, as much as 2 m thick, which is locally devitrified to crumbly orange rock. Consists of 10-20 percent phenocrysts of plagioclase, lesser sanidine, minor biotite and Fe-Ti oxides, and traces of clinopyroxene in a groundmass of mostly devitrified shards. Caldera source was predicted by Williams (1967) to be in the Caliente caldera complex; this hypothesis was recently confirmed (Rowley and

Siders, 1988). Average isotopic age is 22.3 Ma based on two K-Ar ages on biotite and sanidine by Armstrong (1970) and one K-Ar age on plagioclase by Fleck and others (1975). Maximum thickness about 140 m

The Swett Tuff Member is a resistant, crystal-poor, densely welded, dacitic ash-flow tuff. A simple cooling unit consisting of light-red to brownish-red tuff, it locally contains a crumbly, orange and dark-gray, mostly devitrified basal glass zone, consists of 10-15 percent phenocrysts of plagioclase and minor biotite and Fe-Ti oxides. Caldera source was predicted by Williams (1967) to be in the Caliente caldera complex. The isotopic age is about 23.7 Ma, based on six K-Ar ages on biotite and plagioclase by Armstrong (1970). Thickness as much as 10 m

Tl **Leach Canyon Formation (Oligocene)**--Soft to moderately resistant, pink, tan, light-purple, reddish-brown, and light-gray, poorly to moderately welded, crystal-poor, rhyodacitic ash-flow tuff. Contains abundant light-gray and tan cognate pumice as long as 5 cm and distinctive, mostly red or reddish-brown, subangular lithic clasts as much as 6 cm in diameter but generally less than 1 cm in diameter. Comprises several compound cooling units: the upper and less welded units belong to the Table Butte Tuff Member and the lower and more welded units belong to the Narrows Tuff Member (Williams, 1967; Anderson and Rowley, 1975). These members were not separated in the mapping, however. Consists of 10-20 percent phenocrysts of plagioclase, quartz, and sanidine, and minor biotite, Fe-Ti oxides, and hornblende in a groundmass of mostly devitrified shards. Isopach maps of the unit suggest a source in the Caliente caldera complex (Williams, 1967). Elevated to formation status, as Leach Canyon Tuff, by Cook (1965); called Leach Canyon Formation by Williams (1967) and Anderson and Rowley (1975). Average isotopic age is 24.7 Ma based on three K-Ar ages on biotite, sanidine, and plagioclase by Armstrong (1970), but there is significant variation in these ages (22.9-26.7 Ma). Incomplete section is about 160 m thick; to the east, it is about 150 m thick (Shubat and Siders, 1988)

Isom Formation (Oligocene)--Defined by Mackin (1960). Source, presumably resulting in a caldera, is unknown and probably totally or mostly concealed by upper Tertiary and Quaternary volcanic rocks and basin-fill sedimentary rocks. Its thickness is as much as 800 m on the southern side of Hamlin Valley, about 35 km northwest of the mapped area (Best and Davis, 1981; Best, 1984); M.G. Best (oral commun., 1987) prefers a source northwest of Modena, about 30 km west of the mapped area

Tih **Hole-in-the-Wall Tuff Member**--Resistant, medium-red, densely welded, crystal-poor, trachytic ash-flow tuff containing abundant vesicles of about 1-2 mm diameter. Also contains light-gray ash-flow tuff lenticules as long as 2 m and as thick as 4 cm. One simple cooling unit. Upper parts are locally flow foliated. Consists of 5-10 percent phenocrysts of plagioclase and minor clinopyroxene and Fe-Ti oxides in a devitrified groundmass of shards. Defined by Mackin (1960). Thickness about 50 m

Tib **Baldhills Tuff Member**--Moderately resistant to resistant, medium- to dark-purplish-gray, purplish-red, medium-tan, medium-reddish-tan, medium-purple, and black, densely welded, mostly crystal-poor, trachytic ash-flow tuff, especially in the upper part, and crystal-poor, trachytic and andesitic lava flows and flow breccia, especially in the lower part. Ash-flow tuff locally contains vesicles, linear vesicles, and light-gray ash-flow tuff lenticules. Locally includes beds of volcanic mudflow breccia, conglomerate, and sandstone. Consists of 5-20 percent phenocrysts of plagioclase and minor clinopyroxene and Fe-Ti oxides in a devitrified groundmass. Defined by Mackin (1960). Average isotopic age is 25.8 Ma based on a K-Ar whole-rock age by Armstrong (1970) and a K-Ar age on plagioclase by Fleck and others (1975). Exposed as incomplete sections, at least 180 m thick; at least 300 m thick in the northern Antelope Range 5-10 km east of the mapped area (Shubat and Siders, 1988)

Tc **Claron Formation (Oligocene and Eocene)**--Moderately resistant, pink, purplish-red, light-gray, white, tan, and light-yellow, medium- to thick-bedded, fluvial and lacustrine sandstone and limestone, and subordinate conglomerate and siltstone. Clastic beds locally contain volcanic detritus. Clasts in conglomerate beds are as large as 15 cm in diameter and consist largely of black and gray limestone and subordinate quartzite and light-green sandstone. Sandstone beds locally crossbedded. Algal heads several centimeters in diameter and algal filaments occur in some limestone beds. Exposed as incomplete sections, at least 160 m thick; about 300 m thick to the east (Shubat and Siders, 1988)

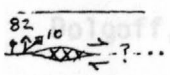
Kis **Iron Springs Formation (Upper? Cretaceous)**--Soft to moderately resistant, light-brown, light-yellow, and light-gray, thin- to thick-bedded, crossbedded, medium- to coarse-grained lenticular continental sandstone and soft interbedded shale, and subordinate, moderately resistant conglomerate, limestone, and carbonaceous shale. Most clasts in conglomerate are light-gray quartzite. Exposed as incomplete sections, at least 200 m thick; about 1100 m thick in the Silver Peak quadrangle (Shubat and Siders, 1988)

GEOTHERMAL RESOURCES

A small area near the town of Newcastle was formerly designated a Known Geothermal Resource Area by the Department of the Interior. Although there are no modern hot springs here, shallow water wells have encountered warm and hot water. Thus the church and several other buildings in the Newcastle area are heated by this water. Within the last several years a new business has begun in the area to utilize this heat source: several large greenhouses just west of Newcastle grow tomatoes and some tropical plants. The hot water, at about 70-80^{o} C, comes from a depth of about 150 m. The geothermal reservoir is discussed by Rush (1983) and Mabey and Budding (1987; see also Budding and Bugden, 1986).

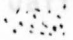
The Antelope Range fault zone, named by Shubat and Siders (1988), is a major structural feature of relatively youthful age that strikes mostly northerly, as do most of the youngest faults in the area (Siders and Shubat, 1986). The fault zone and extensional fractures related to it probably control the geothermal resource by allowing rapid migration of hot water from depth. Large gravity lows in Escalante Valley just west of the fault zone have been interpreted to indicate a thickness of the upper Cenozoic basin fill, and therefore a measure of vertical offset, of about 3 km (Cook and Hardman, 1967; Pe and Cook, 1980). The fault zone cuts other faults in the area (Shubat and Siders, 1988), and it displaces volcanic rocks as young as 8.5 Ma and surficial deposits as young as Holocene or late Pleistocene.

Contact

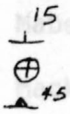


Fault--Showing dip direction and dip angle of fault plane (barbed arrow) and rake direction and rake angle of slickensides (diamond arrow), where known. Bar and ball on downthrown side, where relative offset is known. Dashed where approximately located; dotted where concealed; queried where location uncertain. Normal, oblique, and strike-slip faults, with opposed arrows showing relative direction of strike-slip movement. On cross section, opposed arrows show relative movement for predominantly dip-slip faults, whereas T (for toward) and A (for away) show relative movement for predominantly strike-slip faults

Gravity-slide block



Hydrothermally altered rock--Argillically altered rock. Propylitically altered rock not shown



Strike and dip of beds

Inclined

Horizontal

Strike and dip of flow foliation

REFERENCES CITED

Anderson, J.J., and Rowley, P.D., 1975, Cenozoic stratigraphy of the southwestern High Plateaus of Utah, in Anderson, J.J., Rowley, P.D., Fleck, R.J., and Nairn, A.E.M., Cenozoic geology of southwestern High Plateaus of Utah: Geological Society of America Special Paper 160, p. 1-52.

Armstrong, R.L., 1970, Geochronology of Tertiary igneous rocks, eastern Basin and Range province, western Utah, eastern Nevada, and vicinity, U.S.A.: Geochimica et Cosmochimica Acta, v. 34, p. 203-232.

Best, M.G., 1984, Preliminary geologic map and sections of the area between Hamlin Valley and Escalante Desert, Iron County, Utah: U.S. Geological Survey Open-File Report 84-154, scale 1:50,000.

Best, M.G., and Davis, R.L., 1981, Geologic map of the Steamboat Mountain and Bible Spring quadrangles, western Iron County, Utah: U.S. Geological Survey Open-File Report 81-1213, 18 p., scale 1:50,000.

Biehl, J.W., and Grant, S.K., 1987, The geology of the Escalante silver district, Iron County, Utah--A possible caldera setting, in Griffin, D.T., and Phillips, W.R., eds., Cenozoic geology of western Utah--Sites for precious metal and hydrocarbon accumulations: Utah Geological Association Publication 16, p. 463-469.

Blank, H.R., Jr., 1959, Geology of the Bull Valley district, Washington County, Utah: Seattle, University of Washington, Ph.D. dissertation, 177 p.

Budding, K.E., and Bugden, M.H., compilers, 1986, Annotated geothermal bibliography of Utah: Utah Geological and Mineral Survey Bulletin 121, 86 p.

Cook, E.F., 1957, Geology of the Pine Valley Mountains, Utah: Utah Geological and Mineralogical Survey Bulletin 58, 111 p.

________ 1960, Geologic atlas of Utah, Washington County: Utah Geological

and Mineralogical Survey Bulletin 70, 119 p.
________ 1965, Stratigraphy of Tertiary volcanic rocks in eastern Nevada: Nevada Bureau of Mines Report 11, 61 p.

Cook, K.L., and Hardman, Elwood, 1967, Regional gravity survey of the Hurricane fault area and Iron Springs district, Utah: Geological Society of America Bulletin, v. 78, no. 9, p. 1063-1076.

Dolgoff, Abraham, 1963, Volcanic stratigraphy of the Pahranagat area, Lincoln County, southeastern Nevada: Geological Society of America Bulletin, v. 74, p. 875-900.

Ekren, E.B., Orkild, P.P., Sargent, K.A., and Dixon, G.L., 1977, Geologic map of Tertiary rocks, Lincoln County, Nevada: U.S. Geological Survey Miscellaneous Investigations Series Map I-1041, scale 1:250,000.

Fleck, R.J., Anderson, J.J., and Rowley, P.D., 1975, Chronology of mid-Tertiary volcanism in High Plateaus region of Utah, in Anderson, J.J., Rowley, P.D., Fleck, R.J., and Nairn, A.E.M., Cenozoic geology of southwestern High Plateaus of Utah: Geological Society of America Special Paper 160, p. 53-62.

Jaffe, H.W., Gottfried, David, Waring, C.L., and Worthing, H.W., 1959, Lead-alpha age determinations of accessory minerals of igneous rocks (1953-1957): U.S. Geological Survey Bulletin 1097-B, p. 65-148.

Mabey, D.R., and Budding, K.E., 1987, High-temperature geothermal resources of Utah: Utah Geological and Mineral Survey Bulletin 123, 64 p.

Mackin, J.H., 1960, Structural significance of Tertiary volcanic rocks in southwestern Utah: American Journal of Science, v. 258, p. 81-131.

Mower, R.W., 1982, Hydrology of the Beryl-Enterprise area, Escalante Desert, Utah, with emphasis on ground water: Utah Department of Natural Resources Technical Publication 73, 75 p.

Noble, D.C., and McKee, E.H., 1972, Description and K-Ar ages of volcanic units of the Caliente volcanic field, Lincoln County, Nevada, and Washington County, Utah: Isochron/West, no. 5, p. 17-24.

Noble, D.C., McKee, E.H., Hedge, C.E., and Blank, H.R., Jr., 1968, Reconnaissance of the Caliente depression, Lincoln County, Nevada (abs.): Geological Society of America Special Paper 115, p. 435-436.

Pe, Win, and Cook, K.L., 1980, Gravity survey of the Escalante Desert and vicinity, in Iron and Washington Counties, Utah: Earth Science Laboratory/ University of Utah Research Institute Report, no. DOE/ID/12079-14, 169 p.

Rowley, P.D., and Barker, D.S., 1978, Geology of the Iron Springs mining district, Utah, in Shawe, D.R., and Rowley, P.D., eds., International Association on Genesis of Ore Deposits, Guidebook to Mineral Deposits of Southwestern Utah: Utah Geological Association Publication 7, p. 49-58.

Rowley, P.D., and Siders, M.A., 1988, Miocene calderas of the Caliente caldera complex, Nevada-Utah (abs.): Eos, Transactions, American Geophysical Union, v. 69, no. 44, p. 1508.

Rowley, P.D., Steven, T.A., Anderson, J.J., and Cunningham, C.G., 1979, Cenozoic stratigraphic and structural framework of southwestern Utah: U.S. Geological Survey Professional Paper 1149, 22 p.

Rush, F.E., 1983, Reconnaissance of the hydrothermal resources of Utah: U.S. Geological Survey Professional Paper 1044-H, p. H1-H49.

Shubat, M.A., and McIntosh, W.S., 1988, Geology and mineral potential of the Antelope Range mining district, Iron County, Utah: Utah Geological and Mineral Survey Bulletin 125, 26 p.

Shubat, M.A., and Siders, M.A., 1988, Geologic map of the Silver Peak quadrangle, Iron County, Utah: Utah Geological and Mineral Survey Map 108, 13 p., scale 1:24,000.

Siders, M.A., 1985a, Geologic map of the Pinon Point quadrangle, Iron County, Utah: Utah Geological and Mineral Survey Map 84, 12 p., scale 1:24,000.

__________ 1985b, Geologic map of the Beryl Junction quadrangle, Iron County, Utah: Utah Geological and Mineral Survey Map 85, 11 p., scale 1:24,000.

__________ 1989, Geologic map of the Mount Escalante quadrangle, Iron County, Utah: Utah Geological and Mineral Survey Map, in press.

Siders, M.A., and Shubat, M.A., 1986, Stratigraphy and structure of the northern Bull Valley Mountains and Antelope Range, Iron County, Utah, in Griffen, D.T., and Phillips, W.R., eds., Thrusting and extensional structures and mineralization in the Beaver Dam Mountains, southwestern Utah: Utah Geological Association Publication 15, p. 87-102.

Steiger, R.H., and Jäger, E., 1977, Subcommission on geochronology--Convention on the use of decay constants in geo- and cosmochronology: Earth and Planetary Science Letters, v. 36, p. 359-362.

Ulrich, R., 1960, Soil survey of the Beryl-Enterprise area, Utah: U.S. Soil Conservation Service, in cooperation with Utah Agricultural Experiment Station, series 1952, no. 9, 75 p.

Williams, P.L., 1967, Stratigraphy and petrography of the Quichapa Group, southwestern Utah and southeastern Nevada: Seattle, University of Washington, Ph.D. dissertation, 182 p.

CORRELATION OF MAP UNITS