UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PRELIMINARY GEOLOGIC MAP OF THE MILFORD QUADRANGLE, BEAVER COUNTY, UTAH

By

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This map is preliminary and
has not been edited or reviewed
for conformity with Geological
Survey standards and nomenclature.

DESCRIPTION OF MAP UNITS

Qa ALLIVIUM (HOLOCENE AND PLEISTOCENE)--Unconsolidated talus, stream and floodplain deposits in the mountains and Lake Bonneville deposits and semiconsolidated pediment gravel, fanglomerate, and other basin-fill deposits in the valleys. Total thickness locally may exceed 1,000 m

Tdh RHYOLITE OF DEAD HORSE RESERVOIR OF ROWLEY (1977) (MIOCENE)--Small plutons composed of white to pink, streaked and banded alkalic rhyolite porphyry. Phenocrysts range from sparse to abundant and consist of quartz, sanidine, oligoclase(?), minor biotite, and opaque minerals. Locally some parts are vesicular. Has a K-Ar age of 11.6 m.y. in adjacent Thermo quadrangle (Rowley and others, 1978, p. 181).

Tb BASALT OF BRIMSTONE RESERVOIR AREA (MIOCENE)--Black to medium-gray, fine-grained, locally vesicular or amygdular lava flows. Contains small phenocrysts of augite, hornblende, and labradorite in a felted matrix of plagioclase feldspar, glass, and magnetite. According to Myron G. Best (written commun., 1979) the basaltic flows in the area west of Brimstone Reservoir in the southwestern part of the Frisco quadrangle have a whole-rock K-Ar age of 13.3 m.y.; the chemical composition of the dated sample is SiO_2 52.6 weight percent, TiO_2 1.9, Al_2O_3 16.4, Total Fe as Fe_2O_3 9.7, MgO 4.6, CaO 6.9, Na_2O 3.9, K_2O 2.79, and P_2O_5 0.8. Partial analyses of two additional samples gives SiO_2 55.0 and 54.9 weight percent and K_2O 2.9 and 2.8 Named from exposures in south-central part of adjacent Frisco quadrangle. Locally about 100 m thick in Milford quadrangle

Tr RHYOLITE OF WILLOW CREEK AREA (MIOCENE)--Scattered remnants of white to light-brownish- or pinkish-gray, fine-grained, flow-banded porphyry with scattered phenocrysts of clear and smoky quartz, sanidine, biotite, and oligoclase(?) that are tentatively correlated with much thicker and more extensive rhyolitic tuffs and flows in the adjacent Shauntie Hills and in the southern Wah Wah Mountains. According to Lemmon and others (1973, p. 23) the rhyolitic rocks in the Wah Wah Mountains have yielded K-Ar ages of 20.8±0.4 m.y. (plagioclase) and 22.4±0.4 m.y. (biotite). Myron G. Best (written commun., 1979) reports a 21.5 m.y. age on biotite from the same general group of rocks in the Willow Creek area of the Wah Wah Mountains

Tf FELSITE DIKES (MIOCENE)--Narrow dikes and small plutons of brownish-gray to white, fine-grained igneous rock with rare phenocrysts of quartz and biotite. Under the microscope the greater part of the rock is seen to be a fine-grained intergrowth of sanidine and quartz

Tap APLITE (MIOCENE)--Small dikes and plugs of light-gray, saccharoidal granitic rock composed predominantly of quartz and orthoclase, with rare biotite. Exposure in the north-central part of sec. 33, T. 27 S., R. 11 W. contains much epidote, inclusions of porphyritic lava, and miarolitic cavities containing adularia and purple fluorite crystals

Tg GRANITE (MIOCENE)--Mostly pinkish-gray to white, fine- to medium-grained intrusive bodies containing 40-60 percent orthoclase, 15-40 percent quartz, 15-25 percent oligoclase, and 5 10 percent biotite or hornblende, or both. In general the granite plutons near Shauntie site contain considerably more quartz but about the same amount of plagioclase feldspar as those in the northern part of the Star Range

Ta ALTERED LAVA AND TUFF (MIOCENE)--Areas of volcanic rocks in the northern and western parts of the quadrangle that have been strongly argillized or silicified. The argillized area in the west-central part of the quadrangle consists of kaolinized, alunitized, and silcified lava and tuff of the quartz latite of Squaw Peak; the altered rocks in the Beaver Lake Mountains consist mostly of jasperoidized lava and tuff of the Horn Silver Andesite of Stringham (1967). Some of the jasperoidized volcanic rocks are converted to interlocking grains of quartz with minor amounts of sericite and andalusite (Butler, 1913, p. 79) and locally resemble fine-grained quartzite. These rocks commonly are cut by veinlets of quartz and contain vugs partly filled with quartz crystals

Td DARK DIKES (MIOCENE)--Narrow dikes of andesite and lamprophyre that chiefly cut quartz monzonite and other plutonic rocks

Tm MONZONITE (MIOCENE)--Light-pinkish to tannish-gray, fine- to medium-grained, moderately porphyritic, intrusive bodies containing about 45 percent andesine, 40 percent pink orthoclase, 5 percent quartz, and 10 percent biotite, augite, and hornblende, with accessory sphene, apatite, and magnetite. Quartz phenocrysts range from 3 to 8 percent in various specimens

Tqm QUARTZ MONZONITE (MIOCENE)--Gray to pinkish-gray, medium-grained intrusive bodies with hypidiomorphic-granular texture. The minerals of the rock consist of about 35 percent each of orthoclase and andesine, 10-15 percent quartz, 4 percent each of biotite and augite, 2 percent each of hornblende and hypersthene, and a total of about 3 percent of accessory minerals including apatite, zircon, sphene, rutile, and magnetite. Parts of some quartz monzonite plutons are argillized and pyritized, and near contact zones with carbonate rocks, also are mineralized with copper sulfide minerals.

Lemmon, Silberman, and Kistler (1973, p. 23) report that biotite from the quartz monzonite pluton near the Montreal mine in the Rocky Range has a K-Ar age of 20.8±0.6 m.y. and hornblende from the same specimen a K-Ar age of 27.0±0.8 m.y.

Tpqm PORPHYRITIC QUARTZ MONZONITE (MIOCENE)--Medium-gray to pinkish-gray, coarse-grained, moderately porphyritic plutons containing about 35-40 percent andesine, 30-35 percent orthoclase, 15 percent quartz, 8 percent biotite, 5 percent hornblende, and 2 percent or less of magnetite, zircon, sphene, and apatite. In general, the porphyritic quartz monzonite plutons appear to be cut by the finer, more even grained quartz monzonite intrusive bodies.

Lemmon and others (1973, p. 23) report that biotite from the porphyritic quartz monzonite intrusive body near the Copper King shaft in the northern part of the Star Range has a K-Ar age of 20.9±0.6 m.y.

QUARTZ LATITE OF SQUAW PEAK (MIOCENE)

Tsp Flow member--Light-purplish-brown, medium-grained, porphyritic quartz latite with phenocrysts of sanidine, quartz, zoned andesine, brown hornblende, green augite, and minor biotite in a fine-grained groundmass of quartz, orthoclase, and plagioclase. In hand specimen the groundmass is brown, reddish brown, or light-grayish brown. Thickness exceeds 200 m in adjacent Frisco quadrangle, where the top has been removed by erosion.

According to Lemmon and others (1973, p. 23) biotite from the quartz latite of Squaw Peak exposed in the south-central part of sec. 19, T. 27 S., R. 12 W. has a K-Ar age of 22.4 m.y.

Tstf Flow rocks within tuff member of Quartz Latite of Squaw Peak--Includes two types of volcanic rocks: one is a reddish- to purplish-brown, aphanitic lava 0-70 m thick, and the other is a reddish-brown, medium-grained, porphyritic lava similar to the main flow member of the Quartz Latite of Squaw Peak containing small to medium-sized phenocrysts of sanidine, quartz, andesine, augite, and biotite; it is 0-85 m thick

Tst Tuff member--Heterogeneous, white, tan, gray, or pink, weakly indurated pyroclastic unit ranging in texture from fine-grained tuff to coarse-grained tuff breccia with some layers of perlitic vitrophyre near base. This unit is at the expected volcano-stratigraphic position of the Bauers Tuff member of the Condor Canyon Formation and the Leach Canyon Formation, both of the Quichapa Group, but its great thickness, locally exceeding 300 m in Frisco quadrangle, and its compositional similarity and intimate association with the flow member of the quartz latite of Squaw Peak, indicate that is probably of local origin. It is possible, however, that some undifferentiable units of the Quichapa Group may be present within the tuff member of the quartz latite of Squaw Peak. Lithologically the rock is composed of largely devitrified glass shards enclosing crystal fragments of quartz, sanidine, andesine, and biotite along with many small lithic and vitric fragments

Tfb BASALT OF FRISCO SUMMIT AREA (MIOCENE)--Dark-gray, dense, aphanitic rock that weathers brownish red. Under the microscope the rock is seen to contain small phenocrysts of labradorite, pigeonitic augite, and minor magnetite in an irresolvable groundmass. This rock unit apparently is present only in the northeastern part of the Frisco quadrangle and the adjacent northwestern part of the Milford quadrangle, where it overlies the Isom Formation and underlies the tuff member of the quartz latite of Squaw Peak. It is probably less than 200 m thick

Ti ISOM FORMATION (OLIGOCENE)--A single ignimbrite cooling unit consisting of a basal black or dark-reddish-brown vitrophyre 1-2 m. thick overlain by a medium- to dark-red, densely welded, vuggy ash-flow tuff 10-15 m thick. The stony textured upper layer commonly contains small white discoidal inclusions representing collapsed pumice fragments; in cross section these inclusions form distinctive white streaks about 3 cm long and 3 mm thick. Phenocrysts make up only about 10 percent of both layers and consist of sparse sanidine, andesine, quartz, and biotite. According to Armstrong (1970, p. 203), the Isom Formation has a K-Ar age of 25.7 m.y. In contrast Lemmon and others (1973) report a K-Ar age for the Isom in the adjacent Frisco quadrangle of 21.9 m.y., but this younger apparent age may be the result of the loss of radiogenic argon during periods of post-Isom volcanic activity in the Frisco area

Tgd GRANODIORITE (OLIGOCENE)--Pinkish or lavender-gray, locally trending toward medium-brownish-gray, medium-grained granitic rock that is mostly granodiorite, but which ranges from quartz monzonite to quartz diorite. It is composed of about 46 percent andesine, 22 percent orthoclase, 17 percent quartz, 8 percent hornblende, 4 percent biotite, and 3 percent accessory minerals, including magnetite, zircon, apatite, and sphene.

According to Lemmon and others (1973, p. 24) hornblende from the granodiorite pluton exposed in the vicinity of the OK mine in the southeastern part of the Beaver Lake Mountains has a K-Ar age of 28.4 m.y. similar to that of the granodiorite of the Cactus stock in the Frisco quadrangle

Tnr NEEDLES RANGE FORMATION (OLIGOCENE)--Moderately resistant pink, light-reddish-purple, or light-gray, moderately welded, crystal-rich, dacitic ash-flow tuff. Exposures in Milford quadrangle probably include parts of the Cottonwood Wash, Wah Wah Springs, and Lund members, which are not differentiated on the present map. All members contain small- to medium-sized phenocrysts of biotite and andesine, which are abundant, and various amounts of hornblende, quartz, sanidine, and minor magnetite and sphene. White pumice lapilli are common in some units. The thickness of the Needles Range Formation in the Milford quadrangle is about 300 m, but variations are common due to uneven surface on which the formation was deposited. An isotopic age of 29.7 m.y. for the Needles Range Formation has been well established (Armstrong, 1970; Lemmon and others, 1973)

Ths HORN SILVER ANDESITE OF STRINGHAM (1967) (OLIGOCENE)--Heterogeneous, medium-gray to reddish-, purplish- or greenish-gray, medium-grained porphyritic eruptive rocks ranging in composition from andesite to dacite and quartz latite. The greater part of the formation consists of medium- to thick-bedded flow units, but discontinuous layers of intraformational tuff, breccia, and cognate agglomerate are common. Under the microscope the flow rocks are seen to consist of andesine, quartz, conspicuous hornblende, biotite, augite, and abundant magnetite in a glassy to fine-grained matrix. In general, the formation is predominantly a dacite.

The thickness of the Horn Silver Andesite of Stringham (1967) in the Milford quadrangle is unknown, but in the adjacent Frisco quadrangle it is reported by East (1956), who separated it into two units, to be 572 m. In the southwestern part of Beaver Lake Mountains quadrangle, about 10 km north of the Carbonate mine, the Horn Silver Andesite of Stringham overlies the conglomerate of High Rock Pass, which in turn rests on Precambrian quartzite and argillite and Cambrian carbonate rocks.

According to Lemmon and others (1973, p. 24-25) minerals from dark flow rocks in the southwestern corner of the Beaver Lake Mountains quadrangle, which are continuous with the exposures of the Horn Silver Andesite of Stringham (1967) in the vicinity of the Carbonate mine, yielded K-Ar ages of 30.8 m.y. (plagioclase) and 34.1 m.y. (hornblende)

Tsh DACITE OF SHAUNTIE HILLS (OLIGOCENE)--Dark-greenish- to brownish-gray, medium-grained, porphyritic to dense flow rocks with some local lenses of tuff, breccia, and agglomerate. Under the microscope the flow rocks is seen to contain phenocrysts of andesine, quartz, chloritized augite, hornblende, and biotite in a glassy to fine-grained matrix. Magnetite is abundant. This volcanic formation is compositionally similar to the Horn Silver Andesite of Stringham (1967) and occupies the same relative volcano-stratigraphic position, and thus is believed to be equivalent to it. Its total thickness is unknown, but probably exceeds 500 m

Thr CONGLOMERATE OF HIGH ROCK PASS (OLIGOCENE)--Disorganized conglomerate mostly containing pebbles, cobbles, and boulders of limestone, quartzite, and other sedimentary rock in a gray- to red-weathering matrix of sandy siltstone and shale. Local lenses of shale and sandstone are common throughout. Some exposures in Milford quadrangle are of the uppermost part of unit, which predominantly contains clasts of volcanic rocks in an ashy matrix. This unit chiefly represents the soil and rubble zone that overlay the sedimentary rocks at the time of the first volcanic eruptions in the Frisco area, and it compositionally reflects the color and lithologic character of the underlying sedimentary rocks, but it merges upward into pyroclastic units at the base of the volcanic sequence. Named from exposures near High Rock Pass in the southwestern part of the adjacent Beaver Lake Mountains quadrangle. Thickness irregular

Jn NAVAJO SANDSTONE (JURASSIC)--Light-gray, buff, and white, medium- to fine-grained massive- to thick-bedded, friable sandstone with some pink to red layers and zones. Distinguished by large curving crossbeds of eolian origin. Locally parts of the formation are silicified forming a dense quartzite that may be confused with the Cambrian Prospect Mountain Quartzite, which is not crossbedded, or with the Permian Talisman Quartzite, which is crossbedded but which is coarser grained and tends to weather a much darker hue. Maximum thickness in the Milford quadrangle is about 300 m but the top is eroded. In adjacent areas complete sections are as much as 700 m thick

CHINLE FORMATION (TRIASSIC)

Trcp Petrified Forest Member(?)--Chiefly red to brownish-red, thin- to medium-bedded siltstone and shale with discontinuous beds of red, orange, and buff-colored sandstone, and thin layers of red-weathering, chert-pebble conglomerate. Thickness ranges from 15-130 m

Trcs Shinarump Member--Pebble conglomerate consisting of well-rounded clasts of chert and minor quartzite and limestone in a sparse, generally silicified, matrix of sandstone, siltstone, or shale. Fragments of silicified wood are common in some areas. Thickness is irregular, ranging from less than 15 m to more than 75 m

Rm MOENKOPI FORMATION (TRIASSIC)--Consists of four members that are not differentiated on the present map: (1) Timpoweap Member; (2) lower red member; (3) Virgin Limestone Member; and (4) upper red member. The Timpoweap Member, about 200 m thick, consists of a basal chert pebble conglomerate 1-15 m thick and an overlying variable unit composed of interlayered dark-gray limestone, red, green, and gray siltstone and shale, yellowish sandstone, and thin lenses of gypsum. The cephalapod Meekoceras, a fossil characteristic of the Timpoweap Member in the type area, occurs about 70 m above the base. The lower red member is about 100 m thick and consists of brownish- to grayish-red siltstone with interbeds of ripple-marked, brownish-red shale and sandstone. The Virgin Limestone Member is about 30 m thick and is composed of light-gray, medium- to thick-bedded, cherty limestone. Most of the chert occurs as medium-sized, dark-brown nodules, and locally the limestone is streaked with thin layers of sand grains. In some areas the limestone beds are separated by thin beds of brownish- to greenish-gray siltstone. The upper red member is approximately 400 m thick and consists predominantly of grayish-green and brownish-red, fine-grained, platy, ripple-marked sandstone. Interlayered with the sandstone are some thin and massive beds of limestone and a few beds of coarse-grained sandstone. This upper member is probably equivalent to the combined middle red, Shnabkaib, and upper red members of the Moenkopi Formation in southernmost Utah and northern Arizona (Stewart and others, 1972), but these members as yet have not been differentiated in the Milford quadrangle. The total thickness of the Moenkopi Formation in the Star Range is 700-750 m. Near the larger plutons, the brown

and red shales of the Moenkopi are converted to light-green hornfels

Plu PERMIAN LIMESTONE, UNDIVIDED--In the general vicinity of quartz monzonite plutons in the west-central part of the Star Range and in the southern Rocky Range, the carbonate rocks of the Plympton, Kaibab, and Toroweap Formations have been bleached and recrystallized into marble. Locally the pyrometasomatism of some of the more argillaceous limestone also has produced skarns containing quartz, garnet, epidote, specularite, pyrite, diopside, and magnetite (Abou-Zied and Whelan, 1973). In areas where bleaching and recrystallization are most intense, the Plympton, Kaibab, and Toroweap are not differentiated on the present map

Pp PLYMPTON FORMATION (PERMIAN)--Thin-bedded, medium- to dark-gray dolomite and medium-bedded, mostly light-gray limestone, both with abundant nodules of dark-brown chert, that are interlayered with sandstone, quartzite, gypsum, and beds of chert or jasperoid. Thickness ranges from 30-100 m

Pk KAIBAB LIMESTONE (PERMIAN)--Medium- to dark-gray, medium-bedded, fossiliferous limestone, with scattered nodules and a few layers of dark-brown and black chert. Many of the limestone beds are dense to fine grained. Thickness ranges from 50 to 125 m

Pto TOROWEAP LIMESTONE (PERMIAN)--Medium- to dark-blue-gray, medium-bedded, cherty limestone and subordinate dolomite. In the lower part of the formation the limestone beds are silty, dolomitic, and commonly cherty. In the middle of the formation they are light gray and commonly phosphatic. The upper part of the formation contains much silty and sandy limestone, some limy sandstone, and at least one bed of gypsum that is typically leached away at the surface. Thickness ranges from 115-125 m

Pta TALISMAN QUARTZITE (PERMIAN)--Massive crossbedded, gray to pink orthoquartzite that locally weathers dark reddish brown. Commonly the rock is highly fractured, and develops thick accumulations of talus. Locally the formation contains lenses and beds of limestone and gypsum at base and near the middle. Thickness ranges from 70-225 m

PIPpc PAKOON(?) DOLOMITE OF WELSH (1973) AND CALLVILLE LIMESTONE (PERMIAN AND PENNSYLVANIAN)--Cyclicly bedded limestone, dolomite, and sandstone or orthoquartzite; locally mostly cherty dolomite in upper part. Limestone units are medium to light gray and streaked with silt and sand; dolomite units are darker gray, commonly cherty, and somewhat thinner bedded; arenaceous beds are gray to light brown, fine grained, and commonly crossbedded. Permian fossils have been reported from the cherty dolomite beds in the upper part of the formation and these beds have been identified as Pakoon Dolomite (Welsh, 1973), but because of alteration and pyrometasomatism, the Pakoon is not readily distinguishable from the Callville. Relatively complete sections of the two formations are 150-450 m thick

REDWALL LIMESTONE (MISSISSIPPIAN)

Mru Upper member--Mostly medium- and dark-gray, thin- to thick-bedded, cherty, fossiliferous limestone and subordinate dolomite. Gray, medium-grained sandstone beds locally are common in middle of unit. This informal member probably is equivalent to Deseret, Humbug, and Great Blue Formations of East Tintic Mountains, Utah (Morris and Lovering, 1961) and to the Arrowhead and Yellowpine Members of the Monte Christo Limestone of the Goodsprings quadrangle, Nevada (Hewett, 1931). The thickness of the upper member of the Redwall Limestone is about 240 m

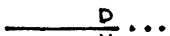
Mrl Lower member--The lower two-thirds of the member is medium- to dark-gray, thick-bedded, medium-grained dolomite and subordinate limestone, and the upper one-third is dark-gray, thin- to thick-bedded cherty limestone. Both units locally are bleached and marbleized. The lower member of the Redwall Limestone in the Milford quadrangle is probably equivalent to the Fitchville and Gardison Formations of the East Tintic Mountains, Utah (Morris and Lovering, 1961) and to the Dawn, Anchor, and Bullion Members of the Monte Christo Limestone of the Goodsprings quadrangle (Hewett, 1931). The thickness of the lower member of the Redwall Limestone is about 160 m

Dp PINYON PEAK LIMESTONE (DEVONIAN)--The lower 40-50 m is medium-gray, thin-bedded, argillaceous limestone and the upper 50-70 m is dark-gray, medium- to thin-bedded, argillaceous limestone and dolomite. According to Welsh (1973, p. 11) the lower part of the formation is equivalent to the Crystal Pass Limestone Member of the Sultan Limestone of the Spring Mountains, Nev. Total thickness of the Pinyon Peak Limestone is about 100 m

Dsi SIMONSON DOLOMITE (DEVONIAN)--In areas where it is not pyrometasomatized, it is mostly medium to dark-brownish-gray, medium-bedded, sugary textured, fetid dolomite containing a few thin beds and at least one thick bed of gray to brown quartzitic sandstone. Some geologists (cf., Baer, 1962, p. 32) who have worked in the general Milford area have assigned all or part of these rocks to the Guilmette Formation, but the brownish color, striped appearance, and abundance of dark-colored dolomite beds containing Amphipora all serve to identify it as Simonson and indicate a significant unconformity at the top of the formation. In exposures near Shauntie site and the Moscow and Mowitza mines large parts of the formation have been bleached and recrystallized to dolomite marble. Total thickness is 120-300 m

Dse SEVY DOLOMITE (DEVONIAN)--In areas where it is not pyrometasomatized, it is chiefly medium- to light-gray, medium- to thick-bedded, dense to faintly laminated dolomite. Basal part, which may be exposed about 1 km west of Hoosier Boy mine, may contain thick beds of coarse-grained quartzite. In exposures near Shauntie site essentially the entire formation is converted to white marble. Total thickness is uncertain but probably ranges from 150-175 m

CONTACT--Dashed where approximately located



HIGH-ANGLE FAULT--Dotted where concealed; D, downthrown side; U, upthrown side

THRUST FAULT--Dotted where concealed; sawteeth on side of upper plate

STRIKE AND DIP OF BEDS

NOTE: A printed list of commonly used geologic map symbols is available on request from the U.S. Geological Survey.

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