DEPARTMENT OF THE INTERIOR

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Geologic map of the Pahroc Spring SE Quadrangle, Lincoln County, Nevada

by

W C Swadley and Peter D. Rowley

U.S. Geological Survey, Denver, CO

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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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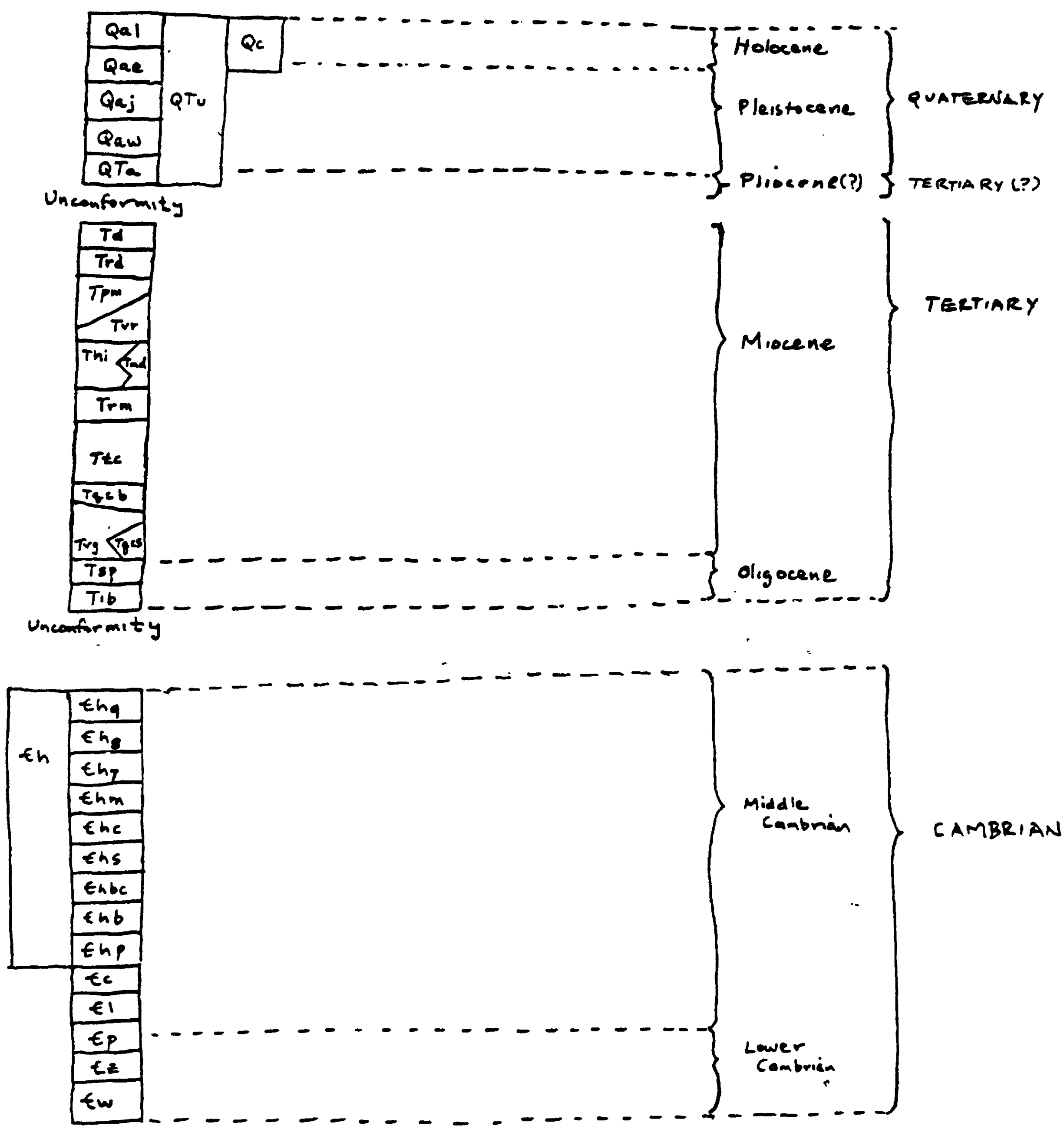
CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

[Classifications of volcanic and plutonic rocks are those of IUGS (Le Bas and others, 1986, and Streckeisen, 1976, respectively). Where necessary, isotopic ages given here have been recalculated using the IUGS decay constants (Steiger and Jager, 1977). Ages of surfical deposits were not determined by absolute dating techniques; ages are estimates based on field observations of degree of soil development and local surface dissection. The stage of carbonate development reported for soils is a visual estimate that used standards defined by Gile and others (1966). Colors of surficial units are from the Rock-Color Chart (Rock-Color Chart Committee, 1951). Where a veneer of a younger unit masks but does not completely conceal am underlying unit, fractional symbols are used (e.g.,Qae/Qaw)]

Qal **Alluvium (late Holocene)**--Pale-yellowish-brown to grayish-orange sand, gavelly sand, and small amounts of gravel; unconsolidated, moderately well sorted to poorly sorted, massive to poorly bedded. Sand is fine to very coarse near mountain front, generally fine to medium at distal edges of fans. Gavelly sand contains angular to subrounded pebbles and small cobbles of ash-flow tuff, lava flows, limestone, dolomite, and quartzite; large cobbles and sparse boulders as much as 1 m in diameter are locally present, chiefly near bedrock exposures. Unit forms the low-gradient distal edges of the large fans that cover most of the quadrangle and forms channel deposits in active washes. Maximum exposed thickness in washes is about 2 m; a borrow pit near the Delamar landing field exposes about 8 m of the unit. Most exposures exhibit no soil development; local areas have a thin sandy vesicular A horizon

Qae **Alluvium (early Holocene and latest Pleistocene)**--Light-yellowish-brown to light-brownish-gray sand, gravelly sand, and small amounts of gravel; unconsolidated to weakly consolidated, poorly to moderately well sorted, and poorly bedded. Sand is fine to very coarse near the mountain front, and commonly fine to medium on more distal parts of the fans. Gravelly sand contains angular to subrounded pebbles, cobbles, and boulders of ash-flow tuff, lava flows, dolomite, limestone, and quartzite that are commonly less than 0.3 m in diameter. Gravel is generally angular to subangular, has a sand matrix, and occurs chiefly near bedrock exposures. Unit forms large low-gradient fans over much of the quadrangle, small steep fans adjacent to the mountain front, and small terrace remnants and inset fans along the larger washes. Deposits of unit stand 1-2 m above active washes. Surface of deposit is smooth on lower fans and terraces; bar and swale topography is locally preserved near the heads of some steeper fans. Soil development on unit consists of a thin sandy vesicular A horizon, a B horizon, and a C horizon as thick as 0.5 m that has stage I carbonate in the upper part; no color change in the B horizon with respect to the parent material was observed. The C horizon is only weakly developed where the unit consists entirely of sand. Thickness of unit 0 to more than 4 m

Qaj **Alluvium of Jumbo Wash (late Pleistocene)**--Unit named for deposits along and near Jumbo Wash about 16 km south in the Gregerson Basin quadrangle (Scott and others, 1990). Yellowish-brown to grayish-orange sand, gravelly sand, and gravel; weakly consolidated, moderately well sorted to poorly sorted, poorly to moderately well bedded. Sand is medium to coarse near the mountain front and chiefly medium a few kilometers to the west. Gravel and the clasts in the gravelly sand are angular to subrounded ash-flow tuff, lava flows, limestone, dolomite, and quartzite pebbles, cobbles, and sparse boulders that are generally less than 0.5 m in diameter. Unit forms large fan remnants that extend as much as 7 km from the mountain front and smaller fans that are inset into fan deposits of middle Pleistocene age. Unit commonly stands 2-4 m above active washes. Surface is smooth to slightly dissected. A loosely to tightly packed stone pavement is sparsely developed; a dull-brown rock varnish is locally present on a few clasts of the pavement. Soil consists of a 3- to 5-cm-thick fine sand and silt vesicular A horizon, a 30- to 35-cm-thick, dark-yellowish-orange B horizon, and a 0.5- to 0.7-m-thick C horizon that typically has stage II carbonate development in the upper part. The carbonate zone of the C horizon is commonly thinner and less well developed where unit is composed mostly of sand. Thickness of unit 0 to more than 5 m

Qaw **Alluvium of Willow Spring (middle Pleistocene)**--Unit named for deposits near Willow Spring in the Delamar 3 SE quadrangle (Swadley and others, 1990), about 46 km south of the quadrangle. Brownish-gray to light-yellowish-brown, locally pale-red interbedded gravelly sand, sand, and gravel; weakly to moderately well consolidated, moderately well sorted to poorly sorted, poorly bedded. Gravel consists of angular to subrounded clasts of ash-flow tuff, lava, limestone, dolomite, and quartzite that are commonly less than 1 m in diameter. Unit forms large gravelly sand and sand fan remnants along the larger westward-flowing washes and small steep gravel and gravelly sand fans adjacent to the bedrock mountain front. The more distal remnants of the large fans are locally veneered by thin deposits of unit Qae. These partly covered remnants commonly stand less than 1 m above adjacent deposits of unit Qae and have sparse to common clasts of pedogenic carbonate at the surface. Depositional surface of unit is mainly intact but is moderately dissected by V-shaped washes; surface of unit typically stands 2-5 m above active washes (Qal). A tightly packed stone pavement is locally developed, in which surface clasts have a weakly to moderately well developed rock varnish. Near the northwest corner of the quadrangle, the unit forms the distal edge of an east-facing fan and consists of grayish-orange gravelly sand that is weakly consolidated. Sand is fine to coarse, poorly sorted, generally poorly bedded, but locally small-scale crossbedding occurs. Gravel consists of subangular to rounded clasts of ash-flow tuff and limestone, chiefly pebble and small cobble sized with sparse boulders as much as 1 m across. Soil includes a 4- to 6-cm-thick, silty sand vesicular A horizon, a dark-yellowish-orange to light-brown B horizon that is rarely preserved, and a 1- to 1.5-m-thick carbonate horizon that commonly has stage III carbonate development in the upper part. In a borrow pit in the east-facing fan that is exposed near the northwest corner of the quadrangle, this soil is underlain by an older soil that consists of a 0.3-m-thick light-brown B horizon and a 1-m-thick carbonate horizon that is mostly stage III but locally has as much as 10 cm of stage IV carbonate at the top. Unit thickness is 0 to more than 8 m

QTa **Alluvium (early Pleistocene and Pliocene?)**--Brownish-gray to pale-brown interbedded gravel, gravelly sand, and sand; moderately well consolidated, poorly to moderately well sorted, and poorly to moderately well bedded; weakly to well cemented by disseminated carbonate and local carbonate stringers. Gravel consists of angular to subrounded clasts of ash-flow tuff, lava flows, limestone, dolomite, and quartzite that is commonly less than 2 m in diameter. Sand is fine to coarse, poorly sorted, and poorly bedded. Unit forms small dissected fan remnants adjacent to bedrock ridges. Depositional surfaces are dissected and the dissected surfaces have rounded interfluvial divides. Unit is poorly exposed except in a few small cutbanks along active washes; a typical exposure consists of moderately steep rounded slopes that are littered with coarse rubble and common to abundant chips of pedogenic carbonate. Surfaces commonly stand 4 to 8 m above active washes; locally some small fan remnants have been eroded almost to the level of adjacent fans of unit Qaw. A tightly packed stone pavement is locally developed on gently sloping surfaces; pavement conforms to eroded surface. A dark-brown to black rock varnish occurs on some surface clasts. Soil developed on unit typically has a 4- to 6-cm-thick clayey, silty sand vesicular A horizon overlying a 1- to 2-m-thick carbonate horizon that has stage III carbonate development in the upper part. Soil has developed on the eroded surface of the unit and is probably similar in age to the soil developed on the alluvium of Willow Spring (Qaw). Thickness ranges from 0 to more than 25 m

QTu **Alluvium, undivided (Holocene to Pliocene?)**--Units Qal, Qae, Qaj, Qaw, and QTa. Shown in cross section only

Qc **Colluvium (Holocene and late Pleistocene)**--Pebble gravel and minor amounts of interbedded pebbly sand that form thin mantles that overlie and obscure bedrock. As mapped, mostly includes small areas of fan and slopewash deposits. Exposed thickness 1-2 m

Td **Delamar Lake Tuff (Miocene)**--Moderately resistant, light-gray, pink, light-greenish-tan, chocolate-brown, crystal-poor, poorly to well welded ash-flow tuff. Typically contains abundant, partly collapsed pumice as long as 10 cm and as thick as 3 cm. At least 2 cooling units, each about 10 m thick are repeated twice along northwest-striking faults. Tuff erodes commonly to large rounded boulders and plates. Contains 10-20 percent small phenocrysts (averaging 35 percent quartz, 60 percent sanidine (locally adularescent, as this word is used by Mittwede, 1987), 2 percent plagioclase, 2 percent clinopyroxene, 1 percent olivine, and trace amounts of Fe-Ti oxides). Defined as the Delamar Lake Tuff by Scott and others (in press) and correlated with member O of the Kane Wash Tuff of Novak (1984). A caldera source for the unit is inferred to be north of the Kane Springs Wash caldera, which is 20 km south of the mapped area (Scott and others, in press). Delamar Lake Tuff contains four cooling units; a single cooling unit exposed in sec. 5, T. 5 S., R. 64 E., contains a distinctive red basal glass, identifying it as the uppermost of the four (R.B. Scott, written commun., 1991). The tuffs in the mapped area bank in and pinch out against the rhyolite of Delamar Valley (Trd). Two K-Ar ages on sanidine are 15.8 ± 0.4 and 15.5 ± 0.4 Ma (Novak, 1984). Maximum exposed thickness 25 m (neither the top nor base exposed)

Trd **Rhyolite of Delamar Valley (Miocene)**--Resistant, white and light- to medium-gray, generally vesicular and amygdaloidal, locally spherulitic, flow-foliated, crystal-poor, rhyolite lava flows in the Delamar Valley graben. Probably are a sequence of coalesced volcanic domes. Rocks commonly have a patina of dark-brown desert varnish. Perlite and glass, probably representing flow margins, occur locally. Consists of 15 percent phenocrysts (averaging 40 percent quartz, 40 percent sanidine, 15 percent plagioclase, 3 percent biotite, and trace amounts of Fe-Ti oxides) in a groundmass of devitrified glass. Thickness poorly known because neither the base nor top of the unit is exposed, but the exposed relief of the domes is 70 m

Tpm **Porphyry of Meadow Valley Wash (Miocene)**--Resistant, light- to dark-gray, pink, reddish-brown, and khaki, locally brown and tan weathering, locally flow foliated, hypabyssal porphyry characterized by large (as long as 1.5 cm), abundant phenocrysts of feldspar. Locally contains dark-gray glass near intrusive margins; some margins contain intrusive breccia. Contains miarolitic cavities. Consists of 25-35 percent phenocrysts (4-20 percent quartz, 4-30 percent sanidine, 35-60 percent plagioclase, 8 percent biotite, 5-20 percent hornblende, 1-3 percent clinopyroxene, trace amounts of orthopyroxene, 1 percent Fe-Ti oxides, and trace amounts of sphene) in a glassy groundmass. Chemically classified as high-alkali dacite, trachydacite, and rhyolite. Informally named (Rowley and Shroba, 1991) for exposures in the canyon of Meadow Valley Wash north of Caliente, which is about 20 km east of mapped area. Here and in other areas north of Caliente (Rowley and others, 1990a, b, 1991a), the porphyry occurs as dikes and plugs that follow major strike-slip and oblique-slip faults. Two preliminary concordant plateau $^{40}Ar/^{39}Ar$ dates on sanidine and hornblende from a sample collected in Meadow Valley Wash (Rowley and Shroba, 1991) are 19.3 ± 0.1 and 19.5 ± 0.1 Ma, respectively (Rowley and others, 1990b, 1991a; Snee and others, 1990). In the mapped area, however, rocks of the map unit postdate, rather than predate, the Hiko Tuff (Thi), so the porphyry must be less than 18.6 Ma in the Pahroc Spring SE quadrangle. The implications of these dates, which provide a maximum age for the onset of a major episode of extension in the area, are discussed by Snee and others (1990) and Rowley and others (1990b, 1991a). Maximum thickness of the dikes and plugs is about 400 m

Tvr **Volcanic dome of Robinson Seep (Miocene)**--Moderately resistant, light- to medium-gray, pink, light-green, and medium-purplish-gray, flow-foliated, crystal-poor, rhyolitic lava flows. Erodes to plates. Flows form a volcanic dome related to, and deposited on, the topographic margin of the Delamar caldera, source of the Hiko Tuff (Thi). Contains 20-30 percent phenocrysts (averaging 10 percent quartz, 2 percent sanidine, 60-70 percent plagioclase, 10-15 percent biotite, 5-10 percent hornblende, 1-2 percent clinopyroxene, 2 percent Fe-Ti oxides, and trace amounts of sphene) in a devitrified groundmass. Quartz is less abundant or absent in lower flows of the sequence. Maximum thickness 120 m

Hiko Tuff (Miocene)

Thi **Intracaldera facies**--Resistant, tan, pink, light- to medium-gray, purplish-gray, brownish-red, crystal-poor, moderately to densely welded, rhyolitic ash-flow tuff of the Delamar caldera. Contains conspicuous, light-gray and light-yellow, collapsed, cognate pumice as long as 15 cm and as thick as 4 cm that make up as much as 10 percent of the volume of the tuff. Also contains mostly brown, glassy, volcanic rock fragments as long as 5 cm that make up less than 0.5 percent of the tuff volume. Forms a thick intracaldera sequence that contains few cooling breaks except in the upper part of the sequence, where intertongued lenses of the megabreccia of Delamar caldera (Tmd) occurs; here tuff cooling units typically exhibit black basal vitrophyres, which indicate that cooling units were erupted onto a cool surface. The tuff commonly weathers to massive, dense, fresh outcrops cut by vertical joints, and the outcrops resemble an intrusive rock except that the outcrops contain conspicuous pumice. Tuff contains 25-45 percent phenocrysts (10-40 percent quartz, 15-25 percent sanidine, 25-65 percent plagioclase, 2-10 percent biotite, 1-8 percent hornblende, local trace amounts of clinopyroxene, 1-2 percent Fe-Ti oxides, and trace amounts of sphene). Locally quartz phenocrysts are light-purple and are as long as 4 mm. The Hiko Tuff was named by Dolgoff (1963) (see also, Noble and McKee, 1972) for a thick outflow sequence exposed in the Hiko Range, which is 14 km west of the mapped area. Noble and others (1968) and Noble and McKee (1972) suggested that the Hiko Tuff came from the Caliente caldera complex, the west edge of which is in the mapped area. Ekren and others (1977), who mapped the Hiko Tuff in Lincoln County as part of their unit 3 (Tt3) of the welded ash-flow tuffs and interbedded ash-flow tuffs unit, confirmed the ideas of Noble and coworkers when they discovered that the Hiko source caldera forms the west lobe of the Caliente caldera complex; this lobe was named the Delamar caldera by Rowley and Siders (1988). The following K/Ar dates have been determined on outflow deposits of the Hiko Tuff from samples collected from southeast Nevada: (1) 18.1 $\pm$ 0.6 Ma on a biotite-hornblende mixture and 18.2 $\pm$ 1.0 Ma on plagioclase from the same sample (Armstrong, 1970); (2) 18.4 $\pm$ 0.4 Ma on impure biotite (Armstrong, 1970); and (3) 20.1 $\pm$ 0.5 Ma on sanidine (Noble and others, 1968; Noble and McKee, 1972). These dates, however, have been superceded by more precise $^{40}Ar/^{39}Ar$ dates, including a plateau date on biotite from the North Pahroc Range, which is about 15 km northwest of the mapped area, of 18.5 $\pm$ 0.4 Ma (Taylor and others, 1989); on the basis of this and unpublished dates of samples collected in Rainbow Canyon 15 km east of the mapped area, Taylor and others (1989) favor an age of 18.6 Ma for the Hiko Tuff. Thickness at least 400 m, although neither the base nor the top is exposed

Tmd **Megabreccia of Delamar caldera (Miocene)**--Moderately resistant, reddish-brown, brown, tan, light- to medium-brownish-green breccia that consists mostly of clasts of aphanitic and porphyritic andesitic flow rocks and local sedimentary rocks in a muddy matrix. Map unit occurs as lenses that are thickest near the caldera margin, and this unit intertongues with intracaldera facies deposits of the Hiko Tuff (Thi). Porphyritic andesitic flow rocks contain about 5-20 percent phenocrysts of mostly small (less than 1 mm) plagioclase and subordinate to minor hornblende, local minor pyroxene, and minor Fe-Ti oxides. Some clasts in the megabreccia are derived from Tertiary tuffs, such as the Isom Formation, or sedimentary units, such as the Highland Peak Formation, but most clasts are of local flows. Clasts of recognized rock units were derived from the topographic margin of the caldera and were carried into the caldera by landslides from caldera walls that had been oversteepened by subsidence of the caldera. For example, a deformed rib of limestone of the Highland Peak Formation (Ch) that is about 0.5 km long and 0.1 km wide occurs just northwest of Seven Oaks Spring in the northeast part of the mapped area; it is surrounded by megabreccia of volcanic rocks and overlain by intracaldera facies deposits of the Hiko Tuff (Thi). Other exposures of breccia were probably derived by erosion of the caldera wall and deposited by streams and mudflows. Some megabreccia probably was deposited synchronously with caldera subsidence as mudflows or small segments of lava flows during eruption of local volcanoes near the caldera margin. Maximum exposed thickness of individual lenses about 100 m

Trm **Rhyolite of Monkey Wrench Wash (Miocene)**--Moderately resistant to resistant, light-gray, light-yellow, pink, reddish-brown, and brown, flow-foliated, crystal-poor, rhyolite lava flows and flow breccia. May form one or more volcanic domes. Commonly eroded to plates. A possible vent for some flows caps the steep hill in NW 1/4 sec. 13, T. 5 S., R. 64 E; the lower part consists of brown, autobrecciated glass that contains numerous 1- to 2-cm-wide veins of light-gray rhyolite, and the upper part consists of light-gray lava flows. As mapped, unit locally includes interbedded tan conglomerate and sandstone. Rhyolite consists of 2-5 percent phenocrysts (10-25 percent quartz, trace amounts to 10 percent sanidine, 60-90 percent plagioclase, and trace amounts of Fe-Ti oxides) in a devitrified groundmass. Maximum thickness about 80 m

Ttc **Tuff of Cottonwood Wash (Miocene)**--Soft, light-green, light-yellow, and tan, nonwelded to poorly welded ash-flow, water-laid, and airfall rhyolite tuff intertongued with soft, light-gray, light-green, and light-red, locally crossbedded, tuffaceous conglomerate, sandstone, siltstone, and debris-flow deposits. Tuff typically contains as much as 30 percent by volume of light-red, reddish-brown, and reddish-tan, subangular to subrounded, autolithic, volcanic rock fragments of densely welded ash-flow tuff as long as 1 m. Tuff contains 1-10 percent phenocrysts (about 20 percent quartz, 20 percent sanidine, 60 percent plagioclase, 1 percent biotite, and trace amounts of Fe-Ti oxides). Red volcanic rock fragments contain 5-15 percent phenocrysts (about 25 percent quartz, 20 percent sanidine, 50 percent plagioclase, 1 percent biotite, and 1 percent Fe-Ti oxides) .Clasts in sedimentary beds include those derived from the Bauers Tuff Member (Tqcb) of the Condor Canyon Formation, the volcanic rocks of Grassy Spring (Tvg), and the Baldhills

Tuff Member (Tib) of the Isom Formation. Clasts in sedimentary beds are subangular to subrounded and commonly boulder size; one Bauers-derived clast in a mudflow bed is 5 m long. Where unit is mapped in south part of sec. 14, T. 5 S., R. 64 E.,it consists of soft, tan, light-gray, light-green, light-yellow, and light-red, mostly hydrothermally altered, mostly thick-bedded (more than 0.5 m), pebble and cobble conlomerate, conglomeratic sandstone, and debris-flow deposits. The upper map contact, with the overlying rhyolite of Monkey Wrench Wash (Trm), is poorly exposed and locally either unit, as mapped, may contain beds of the other; probably the rocks of the map unit, in fact, may partly represent precursor explosive eruptions to the deposition of the rhyolite of Monkey Wrench Wash, with which the map unit is chemically similar. The lower part of the map unit locally intertongues with the underlying volcanic rocks of Grassy Spring (Tvg), and in these places the lower map contact is placed between where thetwo lithologies are dominant in the rock section. Maximum thickness 120 m

QUICHAPA GROUP (MIOCENE AND OLIGOCENE)

[The name "Quichapa Group" was proposed by Cook (1957) for a sequence of informally named regional ash-flow tuffs in southwestern Utah. Mackin (1960) subsequently reduced the unit in rank to the Quichapa Formation and divided it into the Harmony Hills Tuff, Bauers Tuff, Swett Tuff, and Leach Canyon Tuff Members. Anderson and Rowley (1975) (see also, Williams, 1967a, b) renamed the unit the Quichapa Group, made up of the Harmony Hills Tuff, Bauers and Swett Tuff Members of the Condor Canyon Formation, and Leach Canyon Formation. Age of the group was extended by Rowley and others (1991) to include Oligocene on the basis of recalculation of isotopic dates of the Leach Canyon Formation; this formation is not exposed in the mapped area, however, so all rocks of the Quichapa Group in the quadrangle are Miocene]

Condor Canyon Formation (Miocene)--Originally named by Cook (1965) (see also, Anderson and Rowley, 1975). In the mapped area, consists, in descending order, of two previously defined (see Mackin, 1960) rhyolitic ash-flow tuff units, the Bauers Tuff Member and Swett Tuff Member. In the mapped area, the Bauers overlies the volcanic rocks of Grassy Spring (Tvg), whereas the Swett is intertongued with the volcanic rocks of Grassy Spring

Tqcb **Bauers Tuff Member**--Resistant, reddish-purple, red, brown, orange-tan, tan, and light-purplish-pink, crystal-poor, densely welded ash-flow tuff. Consists of two thin cooling units, each a lenticulite zone characterized by light- to dark-gray, thin, ash-flow tuff lenticules as long as 2 m; the zone passes abruptly downward into a basal vitrophyre. Well exposed along the west side of the ridge in W 1/2 sec. 12, T. 5 S., R. 64 E., where occur the upper 5-m-thick cooling unit of lenticulite and dark-orangish-tan vitrophyre and the lower 10-m-thick cooling unit of lenticulite. Tuff contains 10-25 percent phenocrysts (30 percent sanidine, 60 percent plagioclase, 8 percent biotite, 0 to trace amounts of clinopyroxene, and 1 percent Fe-Ti oxides). The caldera source of this member was predicted on the basis of isopach data by Williams (1967a) to be in the Caliente caldera complex. This hypothesis was recently confirmed, and the source of the Bauers was named the Clover Creek caldera (Rowley and Siders, 1988) of the Caliente caldera complex for exposures north of Caliente (Rowley and Shroba, 1991; Rowley and others, 1991b, 199_), which is 20 km east of the mapped area. Average K/Ar age on outflow facies is 22.3 Ma from two dates on biotite and sanidine by Armstrong (1970) and one date on plagioclase by Fleck and others (1975); these dates have been superceded by more precise $^{40}Ar/^{39}Ar$ dates on outflow facies that average 22.78 Ma (Best and others, 1989b, table B3). Maximum thickness about 20 m

Tqcs **Swett Tuff Member**--Resistant, light-purplish-gray, red, and reddish-purple, crystal-poor, densely welded ash-flow tuff. Two thin cooling units consist mostly of lenticulite zones and basal vitrophyres that have weathered to crumbly, red and salmon devitrified zones. The lenticulite zones contain dark-gray, thin, ash-flow tuff lenticules as long as 5 cm and as thick as 3 cm. Well exposed in NE 1/4 SE 1/4 sec. 11, T. 5 S., R. 64 E., where occur an upper 2-m-thick cooling unit of crumbly, pink vitrophyre and a lower 10-m-thick cooling unit of crumbly, red vitrophyre. Member contains sparse lithic fragments and vesicles. The Swett Tuff Member contains about 10 percent phenocrysts (about 85 percent plagioclase, 10 percent biotite, and 3 percent Fe-Ti oxides). Lithologically resembles the Bauers Tuff Member but can be distinguished from it by the absence of sanidine in its rocks. Because of its petrographic and chemical similarity to the Bauers, the Swett also may have been derived from the Clover Creek caldera. Average isotopic age is 23.7 Ma on the basis of six K-Ar ages on biotite and plagioclase by Armstrong (1970). Maximum thickness about 15 m

Tvg **Volcanic rocks of Grassy Spring (Miocene)**--Mostly resistant, heterogeneous sequence of localy flow-foliated, amygdaloidal, andesite to dacite lava flows and subordinate amounts of other volcanic rocks and sparse sandstone. Upper part mostly reddish-brown, reddish-salmon, and light- to medium-gray lava flows and minor flow breccia and densely welded ash-flow tuff characterized by 5-25 percent, mostly small phenocrysts (75-90 percent plagioclase, 5-10 percent clinopyroxene, trace amounts of orthopyroxene, and 2-15 percent Fe-Ti oxides) in a devitrified groundmass. Some flows contain distinctive small (1-2 cm long)lenticular masses that were probably clots of magma and that are darker than the matrix. Some flows contain black basal vitrophyres. Moderate- to dark-gray, moderate-bluish-gray, and green where hydrothermally altered. As mapped, upper part locally includes thin beds of tahe Bauers and Swett Tuff Members (Tqcb, Tqcs) of the Condor Canyon Formation that are too thin to map separately. Lower part, which intertongues with basal rocks of upper part, made up mostly of soft to moderately resistant, khaki, medium- to dark-gray, and light- to medium-green, typically propiliticaily altered, andesitic volcanic volcanic-mudflow breccia, lava flows, and flow breccia. Volcanic-mudflow breccia consists of matrix-supported, angular to subrounded clasts, as large as 2 m, of flow rock in a sandy and muddy matrix that generally makes up 50-80 percent of the rock. Lava flows and clasts in the lower part are largely aphanitic, and they consist of fine-grained altered plagioclase and ferromagnesian minerals. Some flows and clasts, however, consist of as much as 15 percent small (less than 1 mm long) phenocrysts (about 70 percent plagioclase and 30 percent altered ferromagnesian minerals in an aphanitic groundmass. Other andesitic flows consist of 10-25 percent large (maximum length 0.5 cm) phenocrysts (95 percent plagioclase, 5 percent clinopyroxene, and in some rocks 5-10 percent hornblende). Unit named for exposures of the lower part of the unit at and east of Grassy Spring and exposures of the upper part 2 km southeast of Grassy Spring on the west side of a ridge in sec. 12 and the east half of sec. 11, T5 S., R. 64 E. Oblique-slip and strike-slip faults have juxtaposed sections of the rock unit that are significantly different from each other in rock type and thickness. For example, exposures about 200 m south of Grassy Spring are mostly of the upper part and include thin beds of tuff breccia, ash-flow tuff, and tuffaceous sandstone totalling only about 40 m. Yet rocks of the lower part immediately to the east of the Grassy Spring fault zone are at least 150 m thick and their basal contact is nost exposed. Rocks of the upper part 2 km southeast of Grassy Spring are at least 200 m thick. Thus maximum thickness of the map unit is at least 300 m

Tsp **Shingle Pass Tuff (Oligocene)**--Resistant, light-purplish-gray, pink, and light-gray, densely welded, crystal-poor, rhyolitic ash-flow tuff. Contains distinctive white ash-flow tuff lenticules as long as 0.5 m and as thick as 2 cm. Contains as much as 2 percent gray, angular volcanic rock fragments. Contains 5-10 percent phenocrysts (10 percent quartz, 60 percent sanidine, 20 percent plagioclase, 10 percent biotite, 1 percent altered clinopyroxene and orthopyroxene, trace amounts to 5 percent olivine, and 2 percent Fe-Ti oxides). In many places, olivine and pyroxene phenocrysts weather to conspicuous red spots. These rocks are correlated with the lower cooling unit of Best and others (1989b, table R2). Our understanding of the relative stratigraphic position of the map unit with respect to the Baldhills Tuff Member (Tib) of the Isom Formation is based partly on preliminary paleomagnetic and stratigraphic studies by S.C. Gromme (written commun., 1990). Unit named by Cook (1965) (see also Ekren and others, 1967). Caldera source probably in the Quinn Canyon Range, about 90 km northwest of mapped area (Best and others, 1989b, fig. R19). $^{40}Ar/^{39}Ar$ date of the lower cooling unit is 26.7 Ma, whereas a regional upper cooling unit is 26.0 Ma (Best and others, 1989b). Biotite and sanidine from a cooling unit in the Quinn Canyon Range have identical plateau $^{40}Ar/^{39}Ar$ dates of 26.2 Ma (Taylor and others, 1989). Maximum thickness about 15 m

Isom Formation (Oligocene)

Tib **Baldhills Tuff Member**--Resistant, reddish-brown and dark-brown, densely welded, crystal poor, trachytic ash-flow tuff, tufflava, and possible lava flows. At least two cooling units, which contain vesicles, linear vesicles, and local ash-flow tuff lenticules; upper parts of cooling units are locally flow foliated. Contains 5-15 percent phenocrysts (85 percent plagioclase, 10 percent mostly weathered clinopyroxene and orthopyroxene, and 5 percent Fe-Ti oxides). At base, includes a a rare, moderately resistant, lower to middle Tertiary, light-gray, pebble to boulder (as large as 1 m) conglomerate in which clasts are subrounded limestone derived from the Highland Peak Formation and that rests on the Highland Peak Formation.

Conglomerate is thickest (10 m) and best exposed in center of sec. 11, T. 5 S., R. 64 E. but is too thin and patchy to be mapped separately at this scale. The conglomerate in the mapped area is correlative with a scattered, thin conglomerate that occurs locally at the base of the Tertiary section east of the mapped area (e.g., conglomerate, Tc, of Rowley and others, 1991b). The Isom Formation was defined by Mackin (1960) (see also Blank and Mackin, 1967) to consist of the upper Hole-in-the-Wall Member and the underlying Baldhills Member. Averitt (1967) and Anderson and Rowley (1975) later renamed these units the Hole-in-the-Wall Tuff Member and the Baldhills Tuff Member. Source caldera of the Baldhills and perhaps the Hole-in-the-Wall is unknown but isopach data indicate that the source was near the north and west edge of Escalante Valley of Utah and Nevada, perhaps centered near the town of Modena (Best and others, 1989b), which is about 75 km east-northeast of the mapped area. If so, the source is covered by younger Tertiary volcanic rocks and by Tertiary and Quaternary basin-fill sedimentary deposits (Best and others, 1989a). Average K/Ar age of the Baldhills is 25.7 Ma based on a whole-rock date by Armstrong (1970) and a plagioclase date by Fleck and others (1975). The Baldhills also has a $^{40}Ar/^{39}Ar$ date of about 27 Ma (Best and others, 1989b, fig. R1; analytical data not published). Maximum thickness about 20 m

Ch **Highland Peak Formation, undivided (Upper and Middle Cambrian)**--Mostly resistant, mostly light- to dark-gray, well bedded, laminated (less than 0.5 cm) to thick-bedded (more than 0.5 m), marine limestone and dolomite. Locally mottled or contains black- and white-striped oolite beds, locally contains oncoids and orange-brown partings between beds. Unit was originally named the Highland Peak Limestone by Westgate and Knopf (1932); later renamed the Highland Peak Formation by Wheeler and Lemmon (1939) (see also, Merriam, 1964). Has a maximum thickness of about 1500 m in the Pioche mining district, about 40 km north-northeast of the mapped area (Merriam, 1964). Undivided unit mapped only in the northeast part of mapped area, where a bed about 15 m thick cannot be assigned to a specific member. Elsewhere in the mapped area, individual units or members, all belonging to the middle and lower parts of the formation, are mapped. Unit and member designations are from Merriam (1964), who studied the lower part of the formation in greater detail than the upper part; thus he applied member names in the lower part but only numbered "units" above that. Merriam's "units" generally correspond to the lettered "divisions" of the Highland Peak Formation as used by Wheeler and Lemmon (1939). All units are well exposed north and northeast of the mapped area (Lewis, 1987; Sleeper, 1989, Burke, 1991; Rowley and others, 1991b, 199_). The upper part of the formation, where it is exposed, is Late Cambrian in age, but the exact position of the Upper-Middle Cambrian boundary locally is not known (Tschanz and Pampeyan, 1970); probably the boundary lies within a unit stratigraphically above those mapped in this quadrangle, and thus all units shown here are designated as Middle Cambrian in age

Ch_9 **Unit 9 (Middle Cambrian)**--Moderately resistant, light to medium-gray, black, white, and pink, locally stromatolitic and cherty, thick-bedded, mottled, locally oncoid-bearing limestone that is interbedded with thin-bedded (0.5 to 4 cm) and laminated dolomite and dolomitic limestone. Characterized by 1-to-4-m thick ledges of alternating dark-gray and less abundant light-gray beds locally separated by covered intervals that contain weathered-out pieces of red chert in the soil cover. Dark-gray beds locally contain pink partings. Upper half contains abundant stromatolites, many of which are cherty and weather yellow, orange, and pink; upper half also contains red stylolites and pink chert. A medium-gray, 2-m-thick marker bed at the middle of unit contains brown and orange, cherty stromatolites as much as 0.5 m in diameter; this marker bed appears to represent a syndepositional breccia. A distinctive bed near base of unit contains abundant orange chert that weathers to litter in the slope below. Merriam (1964) described the unit in the Pioche area, where it is 260 m thick. Maximum thickness in incomplete stratigraphic sections in mapped area about 200 m

Ch_8 **Unit 8 (Middle Cambrian)**--Black and dark-gray, massive cliff of mottled limestone that contains several 1- to 2-m-thick light-gray and pink beds of aphanitic limestone. Mostly poorly bedded, but locally is thin bedded and laminated in upper part and thick bedded in lower part. Contains brown silty partings and prominent and characteristic mottling. Contains abundant sparry calcite blebs known as birds-eye structure (called "bluebird" by Merriam, 1964, p. 37) structure, especially in lower part. Contains local orange chert. Merriam (1964) described the unit in the Pioche area, where it is 150 m thick. Maximum thickness in mapped area 60 m

Ch_7 **Unit 7 (Middle Cambrian)**--Moderately resistant, light-gray, white, light-yellow, tan, and medium- to dark-gray, laminated, fine-grained dolomite and limestone that form low ledges and slopes. Light-colored, laminated dolomite and limestone dominate the unit and commonly weather to form distinctive chalky-white beds. Medium- to dark-gray beds are generally limestone that is commonly mottled and non-laminated and contains silty partings. Locally contains a tan siltstone at base. Merriam (1964) described the unit in the Pioche area, where it is about 95 m thick. Maximum thickness in mapped area 50 m

Chm **Meadow Valley Member (Middle Cambrian)**--Resistant, black and dark-gray, and locally light-gray, mostly thick-bedded, mottled, dense limestone that forms numerous hackly sharp cliffs and ledges. Contains abundant, brown, khaki, orange, and pink mottles and wavy silty partings. Also contains abundant birdseye structure. Basal part of the member consists of a moderately resistant, light-gray, laminated limestone that is about 5 m thick. Member described by Merriam (1964) from exposures in the Pioche area, where it is 130 m thick. Maximum thickness in mapped area 90 m

Chc **Condor Member (Middle Cambrian)**--Soft to moderately resistant, orange, pinkish-orange, tan, and yellowish-brown, thin-bedded and laminated siltstone, fine-grained sandstone, silty dolomite, and fine-grained limestone; because of its color and lithology, the member forms the most distinctive unit within the Highland

Peak Formation. Locally ripple marked and contains dark-gray chert. Unit weathers to slopes or low ledges that are littered with orange plates. Named for exposures in Condor Canyon, north of Panaca and about 40 km northeast of the mapped area, by Wheeler (1948), who included it within his Swasey Limestone. The Condor Member was later assigned to the Highland Peak Formation by Merriam (1964), who described it in the Pioche area, where the member is about 30 m thick. Maximum thickness in mapped area 15 m

Chs **Step Ridge Member (Middle Cambrian)**--Resistant, light- to dark-gray and bluish-gray, well bedded, mostly thick-bedded, locally mottled, dense, lithographic and black- and white-striped oolitic limestone. Stratigraphic sections characteristically erode to slightly rounded "stair step" ledges and cliffs 1-5 m high. Upper part of member consists of an uppermost resistant, dark-gray to bluish-gray, thin-bedded, mottled limestone that overlies light- to dark-gray, locally crossbedded, mottled limestone that has pink partings. Below these uppermost beds, most of the upper part consists of well-bedded, mottled, fine-grained limestone and black- and white-striped oolitic limestone that commonly exhibits birds-eye structure and resistant, wavy silty partings. Lower part of the member consists mostly of light-gray, aphanitic limestone that contains birds-eye structure and more rounded ledges. Member described by Merriam (1964) from exposures in the Pioche area, where it is 225 m thick. Maximum exposed thickness in mapped area 150 m

Chbc **Burnt Canyon Member (Middle Cambrian)**--Moderately resistant, mostly medium- to dark-gray and black, well-bedded, mostly thin-bedded, dense, fine-grained and commonly aphanitic limestone and local dolomite. Stratigraphic sections characteristically eroded to 1- to 3-m-high, sharp, blocky ledges. Contains local red and tan partings, red splotches, and, in the lower part of the member, red and black oncoids. Includes local black- and white-striped oolite beds, resistant wavy silty partings, and birds-eye structure. In contrast to some dull black structureless beds in lower part of the member, beds in the upper part are medium gray or alternating medium and dark gray and lithologically gradational with the Step Ridge Member (Chs). Member described by Merriam (1964) in exposures in the Pioche area, where it is about 60 m thick. He used the name "Burnt Canyon Member" for these rocks; previously, Wheeler (1948) had called them the Burnt Canyon Limestone. Maximum thickness in mapped area 40 m

Chb **Burrows Member (Middle Cambrian)**--Resistant, well-bedded, mostly medium- to thick-bedded, crystalline ("saccharoidal"), blocky weathering, light-gray, white, and light-yellow dolomite and dense, light- to medium-gray and black, lithographic, oolitic, mottled, and birds-eye limestone. Forms rounded cliffs of alternating white and light- to dark-gray beds in upper part, above a slope formed on the same rock types that is underlain by a distinctive high, dark-gray and black, rounded cliff. Upper part locally contains a sequence, as much as 50 m thick, of alternating light- and dark-gray limestone that results in a striking black- and white-striped pattern. Limestone commonly contains resistant, wavy, silty partings. Black- and white-striped and locally crossbedded, oolitic limestone, resembling beds in the underlying Peasley Member (Chp), are more common in the upper part of the unit. The lower 10 to 25 m of the lower cliff-forming part contains distinctive beds made up of abundant oncoids that are generally less than 1.5 cm in diameter but can be several centimeters in diameter. Member described by Merriam (1964) from exposures in the Pioche area, where it ranges from 100 to 150 m thick. He used the name "Burrows Member" for these rocks; previously, Wheeler (1940) had called them the Burrows Dolomite. Maximum thickness in mapped area 100 m

Chp **Peasley Member (Middle Cambrian)**--Mostly resistant, bluish-gray and medium- to dark-gray, medium-bedded (0.2 to 0.5 m) to thick-bedded, fine- to medium-grained, locally mottled, dense, detrital, oolitic, and algal limestone. Forms several slightly rounded cliffs and ledges that are overlain by beds that are less resistant to erosion. Contains orangish-brown, light-red, tan, and greenish-tan partings and splotches, dark-gray oncoids, red chert, and scattered shell fragments. Upper soft part includes a lumpy, nodular limestone bed and dark-gray black- and white-striped oolite beds. Member described by Merriam (1964) from exposures in the Pioche area, where it is 50 m thick. He used the name "Peasley Member" for these rocks; previously, Wheeler (1940) had called them the Peasley Limestone. Maximum thickness in mapped area 15 m

Cc **Chisholm Shale (Middle Cambrian)**--Soft, khaki, pinkish-brown, and brown, locally fossiliferous, non-micaceous marine shale and lesser amounts of thin beds of medium-gray, greenish-gray, and tan limestone and siltstone. Limestone beds are well bedded and wavy bedded and contain orange splotches and partings and local small dark-gray oncoids. Named by Walcott (1916, p. 409) (see also, Westgate and Knopf, 1932) for exposures in the Pioche area. Maximum thickness about 35 m

Cl **Lyndon Limestone (Middle Cambrian)**--Mostly resistant, medium- and dark-gray, black, greenish-gray, and locally light-gray, dense, thin- to thick-bedded, fine-grained, marine limestone. Limestone is detrital and commonly includes oolites and conspicuous silty orange and tan partings and mottles, and orange and red chert. Upper part weathers to a light-gray, rounded, thick-bedded ledge, whereas lower part weathers to dark-gray, ledgy, locally mottled, locally black- and white-striped, well-bedded limestone that locally contains red oncoids and birds-eye structure. Named by Westgate and Knopf (1932) for exposures in the Pioche area, where the formation is a massive cliff-forming unit 115 m thick. In the mapped area, unit forms a cliff that has a maximum thickness of only about 40 m

Cp **Pioche Shale (Middle and Lower Cambrian)**--Soft, green (locally weathering brown and khaki), locally fossiliferous, micaceous, marine shale and lesser amounts of siltstone and sandstone, and scattered beds of resistant, tan, grayish-green, and gray, oncoid-bearing, locally fossiliferous limestone. Upper part contains brown, fine-grained sandstone. Basal part is gradational with the Zabriskie Quartzite (Cz) over about 30 m, where thin-bedded interbedded shale and red and yellow quartzite (mapped with the Zabriskie) grade into Pioche Shale. Named by Walcott (1908) for exposures in the Pioche area, where the unit is about 250 m thick; it is about 275 m thick in the Delamar area (Callaghan, 1937), about 5 km south of the mapped area. North of the mapped area, a bedding-parallel Tertiary(?) detachment fault, known as the Stampede detachment fault (Axen and others, 1988a, b; Bartley and others, 1988; Burke and Axen, 1990), mostly follows the map unit, which is attenuated and is locally absent (Rowley and others, 1991b, 199_). This fault apparently dies out southward or ramps upsection because the fault is missing in the mapped area, although apparently small-displacement bedding-parallel faults locally occur in incompetent rocks of the Pioche Shale and in the lower members of the Highland Peak Formation. Partial sections in mapped area have a maximum thickness of about 200 m

Cz **Zabriskie Quartzite (Lower Cambrian)**--Mostly resistant, thin-bedded, pure quartzite forming two main units: (1) a 20-m-thick upper unit of pink and light-gray, thin beds of quartzite that are interbedded with khaki and green shale and siltstone; and (2) a pink, red, and light-gray, resistant, locally crossbedded, fine- to medium-grained, pure quartzite that is about 70 m thick in incomplete, faulted sections. Commonly weathers tan and locally contains thin-bedded, coarse-grained sandstone and grit conglomerate in some beds. Contains Scolithus worm tubes and, in places, horizontal burrows as long as 8 cm. Unit originally named by Hazard (1937) as the Zabriskie Quartzite Member of the Wood Canyon Formation for exposures in southern California, about 200 km southwest of mapped area. Wheeler (1948) (see also, Barnes and others, 1965) later called these rocks the Zabriskie Quartzite. Stewart (1970) noted that it is characteristically a pinkish-gray ledge-forming unit, as much as 300 m thick, that commonly contains Scolithus borings but is otherwise unfossiliferous. Based on a study of a measured section south of Delamar and about 10 km south of the mapped area, Stewart (1974, 1984) made the correlation with rocks formerly assigned (Callaghan, 1937) to the upper part of the Prospect Mountain Quartzite (Hague, 1883) of Late Proterozoic to Early Cambrian age. Depositional environment of the sequence is probably shallow-water marine in the upper unit and fluvial and shallow-water marine in the lower part (Link and others, in press). Thickness in the Delamar area is 80 m (Stewart, 1984); maximum thickness in mapped area 100 m

Cw **Wood Canyon Formation (Lower Cambrian)**--Moderately resistant, medium- to dark-greenish-gray, yellowish-brown, and red, well-bedded, thin-bedded siltstone, arkosic, fine- to medium-grained but locally coarse-grained, crossbedded sandstone, and dark-brown shale. Distinguished from the Zabriskie Quartzite (Cz) because the Zabriskie is lighter colored and consists almost entirely of quartzite free of feldspar grains. Formation locally contains water-expulsion and soft-sediment-deformation structures, as well as sparse ripplemarks and mudcracks. Unit named by Nolan (1929) for exposures in southern Nevada, about 150 km southwest of mapped area. Stewart (1970) determined that the formation southwest of mapped area consists of three extensive informal members that are as thick as 1200 m in thickness; the upper and lower members are fine grained, whereas the middle member is coarse grained and is typically arkosic. Siltstone beds in the upper member contain abundant animal borings, trilobite(?) scratches and trails, drag marks, and sparse Scolithus tubes; the upper member also contains dolomite and limestone beds. Abundant early Early Cambrian fossils occur in upper part of formation, whereas lower part may be Late Proterozoic (Barnes and Christiansen, 1967; Stewart, 1970; Link and others, in press), but fossil evidence and regional stratigraphic correlations now indicate that the formation is entirely Early Cambrian (Link and others, in press). Based on a measured section in the Delamar area, Stewart (1974, 1984) correlated rocks formerly assigned (Callaghan, 1937) to the Prospect Mountain Quartzite with the Wood Canyon Formation. Depositional environment of Stewart's middle member is probably fluvial, whereas the rest of the formation is probably shallow-water marine (Link and others, in press). Thickness in the Delamar area about 400 m (Stewart, 1984). Consists of incomplete faulted sections in the mapped area, with a thickness of about 80 m

Contact

Fault--High-angle normal, oblique, and strike-slip faults showing direction and dip angle of fault plane (barbed arrow) and direction and rake angle of slickensides (diamond arrow), where known. Dashed where approximately located; dotted where concealed; queried where uncertain. Cross-hatched pattern denotes is a wide zone of breccia. For faults that have demonstrable dip-slip offset, bar and ball is on downthrown side, where relative offset is known. For faults that have demonstrable strike-slip offset, opposed arrows show relative direction of slip, where known; querried arrows indicate probable relative strike-slip direction. On cross section, opposed arrows show relative dip-slip movement, and T (toward) and A (away) show relative strike-slip direction. Relative offset on some slickensided faults determined by the methods of Angelier and others (1985) and Petit (1987)

Fault scarp in surficial deposits--Hachures indicate unit deposited after offset. Triangle and number indicate height of scarp in meters

Caldera--Approximate location of buried topographic wall of Delamar caldera

Hydrothermally altered rock--Altered rocks of argillic or higher grade; propyliticaily altered rocks not shown

Sample locality of isotopically dated rock--Showing sample number and showing age in million years (Ma). Age determined by L.W. Snee

Sample locality of chemically analyzed rocks--Showing sample number of mineralized and(or) hydrothermally altered rocks. Data given in table

Strike and dip of beds

Inclined

Horizontal

Strike and dip of flow foliation

Area of artificial fill

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TABLE 1.--Chemical analyses of grab samples of hydrothermally altered and mineralized rocks from the Pahroc Spring SE quadrangle, Nevada

[Flame atomic absorption analyses of Te, Tl, and Au by C.A. Motooka and R.H. Hill, USGS. DC-ARC AES analyses of other elements by R.T. Hopkins and B.M. Adrian, USGS. Ca, Fe, Mg, Na, and Ti given in precent; all other values reported in ppm. Lower limit of determination of each element given in parentheses. N, not detected at limit of detection; <, detected but below limit of detection; >, greater than. Ge and Th not detected.]

Sample No.	578	579b	638	651	661	766ab	773a	784	798	807a	807b	809	811a	815	816	817	858	877	907c	1101	1103a
Te (.05)	N	N	N	N	N	1	8.1	.35	N	1.9	N	11.0	.1	8.6	N	1.2	N	N	N	40	9.8
Tl (.05)	6.5	.15	.2	.05	N	.85	.55	.05	.15	.4	.1	4.5	.2	4.8	2.2	2	1.1	1.1	.3	.2	.9
Au (.05)	N	N	N	.15	N	N	.05	.05	.1	.15	.1	.6	.1	.1	.1	.15	.15	.15	.2	.4	.05
Ca (.05)	>20	15	>20	5	5	.7	.07	.2	3	.15	3	5	2	3	.3	.7	.5	.3	.7	<	.05
Fe (.05)	.3	.7	3	1.5	7	7	2	.7	5	1.5	5	3	5	7	3	5	.7	1.5	3	2	1
Mg (.02)	.5	7	3	1.5	.05	.5	.5	1	1	1.5	1.5	.15	1	1	1	.3	.15	.15	.7	<	.3
Na (.2)	.2	<	N	N	N	.5	N	N	1.5	N	2	N	2	N	N	N	5	1.5	1.5	N	N
Ti (.002)	.002	.03	.005	.07	.002	.03	.02	.2	.7	.3	.7	1	1	.002	.3	.15	.07	.07	.3	.02	.1
Ag (.5)	N	N	N	150	<	20	20	5	N	30	.5	200	2	3	N	7	N	<	<	200	50
As (200)	N	N	N	3,000	500	1,000	<	N	N	200	N	700	N	<	N	<	N	N	N	200	<
B (10)	N	20	<	15	20	20	10	N	15	10	10	10	10	10	10	<	15	<	15	N	10
Ba (20)	>5,000	150	50	150	50	500	150	300	1,000	70	1,000	150	1,500	70	1,000	300	70	50	500	150	100
Be (1)	3	1	1.5	<	2	1.5	1.5	<	1	1	1.5	<	1	1.5	3	2	3	3	2	<	1
Bi (10)	N	N	N	N	N	N	N	N	N	N	N	30	N	N	N	N	N	<	N	1,000	15
Cd (20)	N	N	N	150	N	N	N	N	N	N	N	200	N	20	N	N	N	N	N	50	N
Co (10)	15	N	<	N	N	<	<	N	20	<	30	N	20	300	<	30	N	N	10	N	N
Cr (10)	N	20	30	15	15	N	15	15	20	15	50	30	50	20	30	20	<	15	30	N	<
Cu (5)	30	15	15	1,500	20	30	300	15	20	300	20	70	20	20	15	30	<	15	20	700	500
Ga (5)	7	7	5	<	7	20	10	5	50	10	50	50	50	10	30	15	50	30	50	<	10
La (50)	N	N	N	N	N	<	<	<	50	50	70	70	70	N	50	<	50	<	50	N	N
Mn (10)	>5,000	700	700	200	150	150	200	100	1,000	150	700	100	700	>5,000	700	700	700	1,000	1,500	50	50
Mo (5)	10	<	7	N	N	20	150	15	N	100	N	150	5	70	N	200	<	N	7	70	300
Nb (20)	N	N	N	<	N	<	<	<	<	<	<	30	20	N	20	<	30	30	20	N	N
Ni (5)	15	7	20	<	7	7	7	7	15	15	15	7	20	70	7	10	<	5	10	<	<
Pb (10)	150	20	30	5,000	100	30	30	10	30	30	50	3,000	70	300	50	50	70	70	100	3,000	70
Sb (100)	100	N	<	300	100	N	150	N	N	150	N	150	N	N	N	100	N	N	N	1,500	100
Sc (5)	N	<	<	N	N	<	<	<	15	5	15	5	15	7	7	5	5	<	7	N	<
Sn (10)	N	N	N	15	N	N	N	N	N	N	N	50	N	N	N	N	N	N	N	300	N
Sr (100)	300	150	150	300	N	N	N	N	500	N	700	150	500	500	N	500	300	N	200	<	<
V (10)	30	70	100	100	300	200	150	70	150	150	150	50	200	200	150	150	<	10	150	10	50
W (20)	100	N	<	N	70	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Y (10)	N	<	<	<	10	15	10	10	30	20	30	30	30	50	20	15	30	20	30	<	<
Zn (200)	N	N	N	500	N	N	N	N	N	N	N	1,000	N	700	N	N	N	N	200	200	<
Zr (10)	10	15	15	70	20	70	100	70	200	150	200	300	300	N	200	100	70	70	150	70	200

Lithology and location of samples: Sample 578--Mn oxides and calcite veins in the Highland Peak Formation from small mine, 37°36'28"N., 114°46'26"W.; 579b--Oxidized sulfides and quartz veins in the Highland Peak Formation from small prospect pit, 37°36'25"N., 114°46'23"W.; 638--Fe oxides from small prospect pit in fault zone in the Highland Peak Formation, 37°36'03"N., 114°45'13"W.; 651--Jasperoid and hydrothermally altered rocks in the megabreccia of Delamar caldera, 37°35'33"N., 114°45'37"W.; 661--Small piece of jasperoid along fault zone in the Lyndon Limestone, 37°36'58"N., 114°46'13"W; 766ab--Fe oxides and minor jasperoid and hydrothermally altered rocks along fault zone in the Highland Peak Formation, 37°31'31"N., 114°47'22"W.; 773a--Calcite and quartz veins and hydrothermally altered rocks from adit in fault zone in the Highland Peak Formation, 37°31'39"N., 114°47'23"W.; 784--Quartz veins and oxidized sulfides from small adit in the Highland Peak Formation, 37°31'55"N., 114°47'26"W.; 798--Hydrothermally altered andesite of the volcanic rocks of Grassy Spring, 37°32'26"N., 114°47'06"W.; 807a--Quartz veins and Fe oxides from adit in fault in the Highland Peak Formation, 37°31'26"N., 114°46'54"W.; 807b--Hydrothermally altered andesite of the volcanic rocks of Grassy Spring, 37°31'17"N., 114°46'44"W.; 809--Fe-Mn oxides and quartz veins from adit in the Lyndon Limestone, 37°31'12"N., 114°47'05"W.; 811a--Hydrothermally altered andesite of the volcanic rocks of Grassy Spring, 37°31'02"N., 114°46'29"W.; 815--Fe-Mn oxides and realgar(?) from dump near shaft in fault zone in the Highland Peak Formation, 37°30'44"N., 114°47'13"W.; 816--Hydrothermally altered porphyry of Meadow Valley Wash from prospect pit, 37°30'53"N, 114°47'17"W.; 817--Fe oxides and jasperoid from prospect pit in fault zone in the Highland Peak Formation, 37°30'54"N., 114°47'12"W.; 858--Hydrothermally altered rhyolite of Monkey Wrench Wash, 37°30'47"N., 114°45'43"W.; 877--Hydrothermally altered rhyolite of Monkey Wrench Wash, 37°30'03"N., 114°45'33"W.; 907c--Hydrothermally altered conglomerate of the volcanic rocks of Grassy Spring, 37°30'33"N., 114°47'12"W.; 1101--Sulfides in the Zabriskie Quartzite from dump of a mine, 37°31'02"N., 114°47'30"W.; 1103a--Fe-Mn oxides and quartz veins from shaft in the Highland Peak Formation, 37°31'29"N., 114°46'54"W.