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# Preliminary Geologic Map of the West Gate Quadrangle, Churchill County, Nevada

*by*

Christopher D. Henry[1], John W. Bell[1], David A. John[2], and Joseph P. Colgan[2]
[1]Nevada Bureau of Mines and Geology,[2] U.S. Geological Survey, Menlo Park, California

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## DESCRIPTION OF MAP UNITS

### Quaternary Deposits

Quaternary units differentiated and mapped after Bell and Katzer (1987, 1990) and Bell et al. (2004). Historical fault ruptures taken in part from Calvin et al. (2012).

**Qay Recently active and modern axial wash and fan alluvium.** Soils are absent or are entisols.

**Qm Mill tailings** Fine-grained mill tailings up to about 3 m thick cover an area of ~100 x 140 m to a depth of ~3 m. The tailings were from the adjacent West Gate mill, which was built in 1939 and processed ore from districts within an ~80 km (50 mile) radius (Vanderburg, 1940; Bryan, 1972; Willden and Speed, 1974).

**Qt Tufa** Tufa consisting of thick fracture fills and subaerial coatings of coarse, commonly bladed calcite to 3 cm long occurs along and adjacent to the 1954 fault scarp along the west side of the Clan Alpine Mountains. Several small adits are developed in the largest tufa deposits, which were broken during the 1954 earthquake.

**Qfy Late Holocene alluvial fan and wash alluvium.** Alluvial fan deposits consist of pebble to cobble sandy gravel and gravelly sand; wash deposits along the axis of Dixie Valley Wash consist predominantly of sandy silt and silty fine sand with lenses of stratified and cross bedded pebble gravel. Soils are entisols to weak camborthids with 10–15 cm thick slightly reddened Bw and stage I Bk horizons.

**Qfm/Qfm2 Late Pleistocene to mid-Holocene alluvial fan deposits.** Slightly to moderately dissected fan remnants consisting of pebble to boulder sandy gravel and gravelly sand. Along the axis of Dixie Valley Wash in Stingaree Valley, Qfm2 deposits are wash-eroded Qfm remnants topographically inset below Qfm and locally veneered by Qfy. Soils are well developed camborthids to weak haplargids with 15–30 cm thick strongly reddened Bw to juvenile Btj horizons and stage II Bk horizons.

**Qfi Late Pleistocene alluvial fan deposits.** Moderately dissected fan remnants consisting pebble to boulder sandy gravel and gravelly sand. Deposits are most common in southern Stingaree Valley where they comprise a large portion of the piedmont. Soils are well developed haplargids with 30 cm thick strongly reddened argillic Bt and stage II–III Bk horizons.

**Qfo Early to mid-Pleistocene alluvial fan deposits.** Deeply dissected fan remnants consisting pebble to boulder sandy gravel and gravelly sand. Deposits are most common on the piedmont flanking the eastern side of the Clan Alpine Range. Soils are well developed haplargids to durargids where preserved.

**QTbf Late Pliocene to early Pleistocene basin fill deposits.** Deeply dissected, stratified silt, clay, sand, and pebble to cobble gravel underlying oldest alluvial fan deposits based on stratigraphic relations in southern Dixie Valley just to the west of the quadrangle.

### Cenozoic

**Tg Gravel** Coarse poorly cemented gravel composed of rounded clasts of tuff of Fairview Peak (Tfp), rhyolitic lava domes that crop out in the Bell Mountain quadrangle to the south, and other silicic volcanic rocks up to 50 cm in diameter. Caps ridges in the southern part of the quadrangle. Appears to make flat-lying deposits that overlie tilted lavas and tuffs of West Gate (Twt, Twa, Twr, Twd) and are topographically much higher than any Quaternary deposits. Possibly Pliocene.

**Tms Tuffaceous sediments** Very poorly indurated tuffaceous sediments and tephra. Well-bedded to massive, white to light tan, sandstone, siltstone, and minor pebble conglomerate composed mostly of pumice up to 2 cm in

diameter, volcanic rock fragments up to 5 mm in diameter, and mineral fragments particularly biotite. Interbedded silver or white tephra up to 30 cm thick and composed almost entirely of glass shards with sparse feldspar and quartz are common. Accretionary lapilli 2.5 cm in diameter are present in the northernmost mapped area. Much of the mapped "outcrop" consists of clayey, puffy soil weathered from tuffaceous material. Discontinuously exposed but possibly more extensive along the east flank of the Clan Alpine Mountains.

**Rocks of the Fairview Peak caldera** The Fairview Peak caldera, which lies in the Bell Mountain and Bell Canyon quadrangles to the south and southwest, formed during eruption of the tuff of Fairview Peak at ~19.5 Ma (Henry, 1996a, b; Henry and John, 2013). Following caldera collapse, a series of rhyolite to dacite lava domes erupted mostly along the ring fracture of the caldera.

**Tdp Porphyritic dacite lava dome** Moderately porphyritic dacite containing phenocrysts mostly of plagioclase up to 6 mm long, lesser biotite, and minor quartz makes a distinct topographic dome in the southeastern part of the quadrangle. Locally flow-banded and has columnar joints that generally point outward from the dome. Not dated but probably similar in age to dacite to rhyolite domes in the adjacent Bell Mountain quadrangle to the south, which range from 19.10±0.04 to 19.30±0.09 Ma and make a series of post-collapse lava domes around the Fairview Peak caldera (Henry, 1996a, b).

**Tdt Porphyritic dacite tuff** The porphyritic dacite dome (Tdp) is surrounded by a heterogeneous apron of coarse to fine air-fall tuff, poorly welded ash-flow tuff, and tuffaceous sedimentary rock. Air-fall tuff consists of beds, mostly less than 1 cm to 20 cm thick but up to ~1 m, composed of glass shards, pumice, and rock and mineral fragments, including devitrified to glassy fragments of the dome. Clasts are up to 20 cm in diameter near domes and become finer away from domes. Air-fall tuff appears to underlie the dome and probably immediately preceded lava extrusion. Minor tuffaceous sedimentary rock consists of laminar to cross-bedded sandstone and pebbly sandstone.

**Tfp Tuff of Fairview Peak** A single cooling unit of light-red-brown, densely welded rhyolitic ash-flow tuff that contains 7 to 10%, and rarely up to 15%, phenocrysts of plagioclase, subequal sanidine, and minor biotite and quartz. The tuff is mostly devitrified but has a basal vitrophyre along the largest outcrop at elevation 5449. The tuff crops out only along the southern edge of the quadrangle where it is as much as 100 m thick and is an outflow deposit from the Fairview Peak caldera in the Bell Mountain and Bell Canyon quadrangles to the south and southwest (Henry, 1996a, b). The tuff is more than 700 m thick in the caldera. Published ages: 19.50± 0.03 Ma ($^{40}Ar/^{39}Ar$, sanidine) and 19.47 ± 0.03 Ma ($^{40}Ar/^{39}Ar$, sanidine; both in the Bell Mountain quadrangle; Henry, 1996b)

**Lavas and tuffs of West Gate** Thick sequence mostly of andesitic to rhyolitic lava and lesser tuff and sedimentary rock that crops out south of US 50 and extends into the northern part of the Bell Mountain quadrangle (Henry, 1996ab). Rocks strike west to west-northwest and dip moderately to the south.

**Twt Tuff and tuffaceous sedimentary rocks** Poorly welded rhyolite ash-flow tuff and interbedded poorly indurated, white to light brown sandstone, siltstone, and conglomerate. Tuffs are up to about 20 m thick and contain fine, sparse phenocrysts of sanidine, quartz, and biotite. Common fragments of massive to flow-banded rhyolite with the same phenocryst assemblage suggest the tuffs are explosive equivalents of the rhyolite lavas (Twr). Sandstone and siltstone are composed of pumice, mineral, and rock fragments and are generally well-bedded to planar-laminated. They are sufficiently indurated to crop out locally. Conglomerates are poorly indurated and marked mostly by a lag of rounded clasts of porphyritic andesite similar to unit Twa and of unidentified rhyolitic ash-flow tuff. Published age: 22.75±0.06 Ma ($^{40}Ar/^{39}Ar$, sanidine, H93-102 from a poorly welded ash-flow tuff (Henry, 1996b).

**Twa Porphyritic andesite lavas** Dark-gray to brown, abundantly and coarsely porphyritic, andesitic lavas with massive interiors and poorly exposed, scoriaceous and brecciated tops and bottoms. Contains 30 to 40% phenocrysts mostly of plagioclase with variable proportions of hornblende, biotite, clinopyroxene, Fe-Ti oxides, and sparse xenocrystic(?) quartz. Mafic phenocrysts are commonly altered to aggregates of iron oxides. Several flows contain probable autoliths of fine-grained diorite with similar mineralogy as the host.

**Twr Rhyolite lavas** Aphyric to sparsely porphyritic, platy, flow-banded and flow-folded, rhyolitic lavas that are mostly bleached white. Contains up to a few percent phenocrysts of small (≤1 mm) sanidine, plagioclase, and biotite.

**Twd Porphyritic dacite lavas** Abundantly porphyritic dacite containing phenocrysts mostly of plagioclase up to 1 cm long, lesser biotite, and about 1% each of quartz, sanidine, and hornblende makes thick flows in the southeastern part of the quadrangle. The flows are massive, locally columnar-jointed and planar flow-banded, and have poorly exposed basal and upper flow breccias. Published age: 22.82±0.09 Ma ($^{40}Ar/^{39}Ar$, sanidine, H93-85 from porphyritic dacite lava (Henry, 1996b).

**Rocks of the Elevenmile Canyon caldera** The Elevenmile Canyon caldera formed during eruption of the tuff of Elevenmile Canyon at ~25.1 Ma (John, 1995b, 1997; Henry and John, 2013). First recognized in the Stillwater Range, the caldera continues into the Wonder Mountain (John, 1997) and West Gate quadrangles (this study) based on the presence of extremely thick, megabreccia-bearing tuff of Elevenmile Canyon.

**Thc** **Tuff of Hercules Canyon** Multiple cooling units of reddish-brown, blue-gray, and lavender-gray, pumice- and biotite-rich dacite to low-silica rhyolite ash-flow tuff that is probably an upper, less silicic part of the tuff of Elevenmile Canyon (Tec). Most tuff is devitrified, moderately to densely welded, crystal rich, and lithic poor. Strongly flattened, biotite-rich pumice clasts commonly are as long as 10 cm. Tuff generally contains 25 to 40% medium-grained phenocrysts consisting of plagioclase, less abundant quartz and sanidine, 2 to 3% biotite, and <1% hornblende. Black to dark-gray vitrophyric zones locally present near base of cooling units contain 35 to 50% phenocrysts consisting of plagioclase, 3–7% sanidine, 5–6% biotite, <1% quartz, and local traces of clinopyroxene. Megabreccia blocks of older rhyolite (**Thcr**) are present near the north edge of the quadrangle. White, lithic-rich, crystal-poor (approx. 10% phenocrysts), poorly welded zones (**Thcp**) locally mapped between cooling units, particularly in the upper part of the unit along the eastern flank of the Clan Alpine Mountains. Lithologically and compositionally resembles less altered parts of tuff of Elevenmile Canyon, but is more pumice rich, generally contains less abundant quartz phenocrysts, and commonly contains scattered, coarse-grained (5–7 mm), tabular hornblende phenocrysts. The contact with the tuff of Elevenmile Canyon can be difficult to locate precisely where the large hornblende phenocrysts are not present. New $^{40}Ar/^{39}Ar$ age: 25.05±0.06 Ma (sanidine, MAP, H00-105; sample from ~700 m north of West Gate quadrangle in Wonder Mountain quadrangle). Published ages: biotite K-Ar age of 24.2±0.7 Ma and biotite $^{40}Ar/^{39}Ar$ age of 24.66±0.08 Ma determined from a sample collected in Hercules Canyon and biotite K-Ar age of 23.0±0.7 Ma determined on sample of crystal-poor vitrophyre, both in the Wonder Mountain quadrangle (John, 1997). Probably correlative with outflow, upper tuff of Painted Hills in the Tule Peak quadrangle, western Nevada (Faulds et al., 2003), for which a new $^{40}Ar/^{39}Ar$ age is 25.118±0.005 Ma (sanidine, AVI, H12-66).

**Tec** **Tuff of Elevenmile Canyon** Black, greenish-gray, and white, crystal-rich low-silica dacite to rhyolite ash-flow tuff. Generally contains 20 to 40% phenocrysts consisting of medium-grained plagioclase, less abundant sanidine and quartz, 1 to 5% biotite, and <1% hornblende. Generally densely welded. Commonly contains abundant dark-green, chloritized, crystal-rich, flattened pumice clasts as long as 6 cm and abundant fragments of pre-Tertiary rocks and the older andesite (Toa) unit. Clasts of tuff of Poco Canyon (Tpc) locally present in Hercules Canyon area. Megabreccia blocks consisting of tuff of Job Canyon (**Tecj**), older andesite (**Teca**), and older rhyolite (**Tecr**) as much as 300 m wide are present locally in the central part of the quadrangle. Irregular lenses of mesobreccia (**Tecm**) containing rounded blocks up to 1.5 m in diameter of tuff of Poco Canyon, tuff of Job Canyon, and a few Nine Hill Tuff are common in the upper part of the unit along the eastern flank of the Clan Alpine Mountains. The lower part of the tuff is commonly propylitized, argillized, or bleached, whereas the upper part is unaltered to weakly altered. New $^{40}Ar/^{39}Ar$ ages: 25.117±0.010 Ma (AVI, sanidine, H12-61 from upper part of unit ~1.8 km north of Middlegate); 25.07±0.06 Ma (MAP, sanidine, H00-104 from ~90 m north of West Gate quadrangle in Wonder Mountain quadrangle. Published ages: biotite K-Ar ages of 24.5±0.7, 24.8±0.7 Ma and 23.2±0.7 Ma, and biotite $^{40}Ar/^{39}Ar$ age of 24.58±0.06 Ma (John, 1997). Probably correlative with outflow, lower tuff of Painted Hills in Tule Peak quadrangle, western Nevada (Faulds et al., 2003), for which a new $^{40}Ar/^{39}Ar$ age is 25.115±0.010 Ma (sanidine, AVI, H12-68).

**Tc** **Conglomerate** Conglomerate composed of angular to subrounded clasts of calcareous phyllite (Jl), sparsely porphyritic rhyolite (Tor), and other rhyolite overlies lower Jurassic shale (Jl) and underlies tuff of Elevenmile Canyon (Tec) in a 100 x 10 m area ~150 m north of US 50. Conglomerate is locally present along the same contact south of US 50 but was not mapped.

**Tpcl** **Tuff of Poco Canyon** Reddish-brown to lavender-gray, densely welded, devitrified crystal-rich rhyolite tuff forming crest of Pirouette Mountain just west of map area (John, 1995a) and extending into the western part of the Wonder Mountain quadrangle. Tuff is pumice and lithic poor and contains 35 to 45% medium-grained phenocrysts composed of smoky quartz, K-feldspar, and minor plagioclase. Basal part of unit includes finely laminated siltstone, quartz-rich sandstone, and lithic-rich tuff breccia containing abundant clasts of porphyritic andesite and rhyolite porphyry as much as 1 m wide. Tuff tentatively is correlated with lower cooling unit of tuff of Poco Canyon exposed in southern Stillwater Range on the basis of petrographic and modal similarities (John, 1995b). New $^{40}Ar/^{39}Ar$ ages: 25.26±0.07 Ma (sanidine, MAP, 86-DJ-107 from intracaldera tuff in the Table Mountain quadrangle, Stillwater Range; Henry and John, 2013); 25.291±0.008 Ma (sanidine, AVI, H12-70 from outflow tuff in Tule Peak quadrangle, western Nevada [Faulds et al., 2003]).

**Trft** **Rheomorphically flowed tuff** White, greenish-gray, black, and brown, densely welded, rhyolite tuff. Locally vitrophyric. Commonly rheomorphically folded. Contains about 5% medium-grained phenocrysts consisting of subequal amounts of clear quartz, sanidine, and plagioclase. Forms discontinuous erosional remnants between the tuffs of Elevenmile Canyon and Job Canyon.

**Tjc** **Tuff of Job Canyon** Multiple cooling units of white, dark-gray, greenish-gray, and dark-brown, densely welded, rhyolite ash-flow tuff. Contains about 20 to 30% phenocrysts consisting of fine-grained plagioclase and less abundant K-feldspar. Hornblende locally present. Devitrified and generally propylitically or argillically altered. Locally lithic-rich containing abundant subrounded clasts of andesite and flow-banded rhyolite (Toa and Tor, respectively) that form as much as 30–40% of unit. Biotite $^{40}Ar/^{39}Ar$ age of 27.64±0.08 Ma from intracaldera tuff collected in the southern Stillwater Range (table 1). New U-Pb Shrimp age 29.4±0.2 Ma (zircon, 10-DJ-2

from intracaldera tuff in the Cox Canyon quadrangle, Stillwater Range).

**Tjcx Megabreccia of tuff of Job Canyon** Breccia composed almost entirely of blocks of tuff of Job Canyon up to 30 m long and possibly larger, with a few areas containing blocks of older rhyolite (Tor) and older andesite (Toa). Unlike blocks of tuff of Job Canyon (Tecj) engulfed in tuff of Elevenmile Canyon, the breccia is entirely within the tuff of Job Canyon and underlies tuff of Elevenmile Canyon. The breccia is probably still related to collapse of the Elevenmile Canyon caldera.

**Tts Tuffaceous sedimentary rocks** White, waterlain tuff and fine-grained tuffaceous sandstone, siltstone, mudstone, and minor conglomerate. Conglomerate contains abundant rounded clasts of the older rhyolite (Tor). Unit overlies, or is interbedded with, the upper part of the older rhyolite unit.

**Tor Older rhyolite** Red, light-purple, green, black, and gray, generally sparsely porphyritic rhyolite and dacite(?) lava flows, flow breccia, and possibly shallow intrusive rocks. Mostly contains ≤5% altered feldspar phenocrysts to 2 mm, minor strongly resorbed quartz, and trace amounts of altered mafic minerals in a microfelsite groundmass. Locally more abundantly porphyritic with 10% altered feldspars and 3% quartz. Commonly strongly flow banded and locally columnar jointed. Bedded pyroclastic rocks containing clasts of rhyolite and minor sedimentary deposits containing rhyolite and older andesite (Toa) are locally present and may be more common but are nonresistant and rarely exposed. Crops out along most of the west side of the Clan Alpine Mountains and is particularly thick north of the large area of Jurassic rocks where it overlies coarse conglomerate/sedimentary breccia (Toax) and filled against Jurassic rocks in the paleocanyon wall.

**Torp Abundantly porphyritic older rhyolite** Distinctive more coarsely and abundantly porphyritic phase of older rhyolite that contains 15% altered K feldspar and plagioclase to 6 mm and 5% quartz to 3 mm in a cream-colored felsic matrix. Makes probable lava dome at top of unit east of mine canyon.

**Toa Older andesite lava and conglomerate** Dark-green, dark-gray, and dark-lavender-gray, aphyric to medium-grained to rarely coarsely plagioclase-phyric, porphyritic andesite, dacite, and basaltic andesite lava flows. Phenocrysts consist of tabular plagioclase, mostly ≤1 to 3 mm long but up to 1 x 10 mm in basaltic andesite, hornblende, and pyroxene, although mafic phenocrysts are mostly altered. Generally altered to propylitic mineral assemblages containing abundant epidote, chlorite, and sericite. Locally flow banded and finely to coarsely vesicular. Crops out mainly south of the large area of Jurassic rocks along the west side of the Clan Alpine Mountains where it overlies coarse sedimentary breccia/conglomerate (Toax) and both filled a deep canyon cut into Jurassic rocks. Smaller outcrop areas are along the eastern and southern flank of Chalk Mountain. Corvalan (1962), Willden and Speed (1974). And Bryan (1978) interpreted the older andesite and the coarse conglomerate/sedimentary breccia (Toax) as Triassic-Jurassic metavolcanic rocks that were thrust over the Triassic and Jurassic sedimentary rocks (Jm, Jl, and TRd).

**Toax Coarse conglomerate/sedimentary breccia** Coarse conglomerate/sedimentary breccia composed of various mixes of andesite (Toa), limestone, shale or phyllite, and chert (probably mostly Jurassic [Jl]), and Cretaceous(?) granodiorite up to 10 m long. Clast proportions vary from exclusively andesite clasts (where it is difficult to distinguish from andesite lava [Toa]) to almost entirely Jurassic limestone to locally abundant granodiorite. Even largest clasts are mostly rounded but can vary to subangular. Matrix mostly consists of moderately to poorly bedded, sandy to pebbly to cobbly andesite grit but is rarely exposed. Crops out in two areas north and south of large area of Jurassic rocks along west side of Clan Alpine Mountains, where it probably filled major paleocanyons cut into Jurassic rocks.

## Intrusive Rocks

### *Late dikes and sills*

**Tri Porphyritic rhyolite** Numerous finely to moderately porphyritic rhyoylitic dikes, sills, and irregular intrusions. Phenocrysts consist of subequal plagioclase, quartz, and sanidine and minor biotite, all mostly ≤2 mm in diameter. Along with porphyritic dacite dikes (Tdi), composite rhyolite-dacite dikes (Tsd) and hornblende dacite/andesite dikes (Tdh), unit makes an extensive, west-northwest-striking swarm across the northern part of the quadangle into the southern Wonder Mountain quadrangle and westward into the southern Stillwater Range (John, 1993a, 1997). Individual dikes are 3 to 10 m wide and up to 3 km long. Two biotite K-Ar ages from dikes in the Louderback Mountains are 20.2±0.6 and 19.9±0.6 Ma and a hornblende $^{40}Ar/^{39}Ar$ age from a large dike in the southern Clan Alpine Mountains is 21.5±0.2 Ma, all in the Wonder Mountain quadrangle (John, 1997).

**Tdi Porphyritic dacite** Coarsely porphyritic plagioclase-biotite-hornblende±quartz±sanidine dacite. Plagioclase phenocrysts are up to 1 cm long, and biotite up to 6 mm across. Dacite dikes commonly makes thick, up to 30 m-wide, dikes. A few porphyritic dacite dikes grade to sparsely porphyritic, even aphyric, margins. Many rocks are strongly argillized or propylitized, although fresh, locally vitric dikes are also present.

**Trd Composite rhyolite–dacite** Many dikes are composites of rhyolite and dacite, mostly as parallel bodies along the dike trend but also apparently as pods of one type in the other. Some composite dikes appear to be zoned from one rock type to the other, for example, with sparse, large plagioclase phenocrysts in more finely porphyritic rhyolite.

However, some composite dikes may be separate intrusions of the different rock types.

**Tdh Hornblende dacite/andesite** Dark-gray, variably coarsely porphyritic hornblende dacite to andesite dikes. Contain about 20% phenocrysts consisting of 1- to 8-mm-wide, tabular pink plagioclase, less abundant hornblende, and minor strongly resorbed quartz and clinopyroxene in a devitrified pilotaxitic groundmass. Scattered west- to northwest-trending dikes in the northern part of the quadrangle.

### *Intrusions of Chalk Mountain*

**Tdpc Porphyritic dacite of Chalk Mountain** Porphyritic dacite containing medium to coarse phenocrysts of plagioclase, biotite, and quartz. Makes two equant and one northwest-elongate, dike-like body surrounded by porphyritic rhyolite (Trp) or granodiorite (Tgd). However, porphyritic rhyolite appears chilled against dacite at one contact.

**Tgd Granodiorite of Chalk Mountain** Phaneritic rock containing sparse phenocrysts of pink orthoclase and white plagioclase up to 2 cm long in a medium-grained matrix of orthoclase, plagioclase, quartz, and 7–10% combined biotite and hornblende. Relative ages of granodiorite and porphyritic rhyolite (Trp) are uncertain. Granodiorite locally appears quenched against rhyolite but also contains inclusions of sparsely porphyritic, aplitic rhyolite. Dikes of fine-grained granodiorite up to 25 m wide intrude both granodiorite and porphyritic rhyolite, and granodiorite contains common enclaves of fine-grained hornblende or biotite granodiorite. Granodiorite has locally undergone strong argillic and sericitic alteration. New U-Pb Shrimp age: 24.84±0.25 Ma (zircon, JC11-26, east flank of Chalk Mountain)

**Trp Porphyritic rhyolite of Chalk Mountain** Porphyritic high-$SiO_2$ rhyolite containing medium- to coarse-grained phenocrysts of quartz, K-feldspar, and plagioclase in a microcrystalline groundmass. New U-Pb Shrimp age: 25.2±0.2 Ma (zircon, JC11-32, east flank of Chalk Mountain)

**Tyr Younger rhyolite** Intensely altered, finely and sparsely feldspar-phyric rhyolite makes a thick, west-striking dike across the northern part of the quadrangle. Although spatially associated with the porphyritic rhyolite (Tsi) and dacite (Tdi) dikes, this dike is significantly older. New U-Pb Shrimp age 25.4±0.3 Ma (zircon, 12-DJ-34).

**Tai Andesite intrusion** Finely porphyritic andesite with plagioclase, pyroxene, and sparse quartz makes an irregular west-striking intrusion between lower Jurassic rocks (Jl) and coarse conglomerate–sedimentary breccia (Toax) in *mine canyon*. Probably intrusive equivalent of older andesite lava (Toa).

**Ta Aplite dikes and sills** (age uncertain) White to cream-colored, fine-grained aplite or aphyric felsite makes dikes, sills, and irregular intrusions into Jurassic rocks. Those in the southern Clan Alpine Mountains are probably aphyric equivalents of the porphyritic rhyolite dikes. The age and affinity of aplites south of US 50, which only intrude lower Jurassic rocks (Jl) and are not spatially associated with porphyritic rhyolite, are uncertain.

## Jurassic and Triassic Rocks

**Jm Middle Jurassic calcareous quartz arenite and limestone** Unit consists of calcareous quartz arenite about 61 m (200 feet) thick overlain by at least 107 m (350 feet) of thick-bedded to massive, dark gray limestone that is sandy in its lower part. Corvalan (1962) reported a Bajocian fauna that demonstrates the unit is Middle Jurassic. The contact with underlying Lower Jurassic shale and limestone (Jl) is conformable and gradational.

**Jl Lower Jurassic shale and limestone** Thin- to medium-bedded, light to dark gray limestone and sandy (quartzitic) limestone with thick interbeds of dark gray to black, calcareous shale and silstone that is variably metamorphosed to phyllite. North of US 50, Corvalan (1962) divided the unit into seven lithologic members that totaled 357 m (1170 feet) thick but could not be separated at 1:24,000. However, his member of coquinal limestone makes a mappable marker bed in the upper part of the unit. South of US 50, the unit consists of a thick, lower shale overlain by thin- to medium-bedded limestone. This unit conformably overlies the Upper Triassic dolomite (TRd) along a gradational contact. Corvalan (1962) found numerous fossils, especially ammonites, that demonstrate the unit is Lower Jurassic.

**TRd Upper Triassic dolomite** Thin-to thick-bedded, mostly light gray to almost black, strongly recrystallized dolomite and dolomitic limestone, commonly with secondary muscovite. Locally has minor argillaceous material, commonly recrystallized to muscovite or chlorite, and a layer of black, calcitic shale about 10 m thick lies within the unit south of US 50. Skarn consisting mostly of serpentine with coarse magnetite and finer epidote, garnet, and phlogopite is developed along the contact with the granodiorite of Chalk Mountain (Tgd) (Bryan, 1972). The unit is about 146 m (480 feet) thick, and the base is not exposed (Corvalan, 1962). Corvalan (1962) found late Norian fossils, especially in the black shale layer, that demonstrate that the unit is Upper Triassic.

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## AGE DATES

All new $^{40}Ar/^{39}Ar$ ages were determined at the New Mexico Geochronology Research Laboratory, New Mexico Institute of Mining and Technology, Socorro, New Mexico. AVI denotes ages determined on ArgusVI multi-collector instruments in 2013. MAP denotes ages determined on MAP215-50 instrument in 2002.

**Table 1. New $^{40}Ar/^{39}Ar$ and U-Pb ages, West Gate quadrangle and related rocks.**

| Sample | Unit | Method | Mineral | Age (Ma) | ±2s | Quadrangle | Latitude | Longitude |
|---|---|---|---|---|---|---|---|---|
| Intrusions | | | | | | | | |
| 12-DJ-34 | Tyr younger rhyolite | U-Pb Shrimp | zircon | 25.40 | 0.32 | West Gate | 39.37044 | -118.09185 |
| JC11-26 | Tgd granodiorite of Chalk Mountain | U-Pb Shrimp | zircon | 24.84 | 0.25 | West Gate | 39.33435 | -118.12349 |
| JC11-32 | Trp porphyritic rhyolite of Chalk Mountain | U-Pb Shrimp | zircon | 25.20 | 0.20 | West Gate | 39.33378 | -118.11008 |
| Volcanic Rocks | | | | | | | | |
| H93-102 | Twt rhyolitic tuff | $^{40}Ar/^{39}Ar$ | sanidine | 22.75 | 0.06 | West Gate | 39.2603 | -118.0557 |
| H93-85 | Twd | $^{40}Ar/^{39}Ar$ | sanidine | 22.82 | 0.09 | West Gate | 39.2630 | -118.0410 |
| 12-DJ-36 | tuff of Lee Canyon (equivalent of tuff of Hercules Canyon?) | $^{40}Ar/^{39}Ar$ | sanidine | 25.120 | 0.012 | Job Peak | 39.51593 | -118.21011 |
| " | " | U-Pb Shrimp | zircon | 25.60 | 0.30 | " | 39.51593 | -118.21011 |
| H00-105 | Thc tuff of Hercules Canyon | $^{40}Ar/^{39}Ar$ | sanidine | 25.05 | 0.06 | Wonder Mountain | 39.38167 | -118.03056 |
| H12-66 | upper tuff of Painted Hills (outlflow equivalent of tuff of Hercules Canyon?) | $^{40}Ar/^{39}Ar$ | sanidine | 25.118 | 0.005 | Tule Peak | 39.89250 | -119.67190 |
| H00-104 | Tec tuff of Elevenmile Canyon | $^{40}Ar/^{39}Ar$ | sanidine | 25.07 | 0.06 | Wonder Mountain | 39.3758 | -118.0433 |
| " | " | U-Pb Shrimp | zircon | 25.27 | 0.25 | " | " | " |
| H12-61 | Tec tuff of Elevenmile Canyon | $^{40}Ar/^{39}Ar$ | sanidine | 25.117 | 0.010 | West Gate | 39.30660 | -118.03239 |
| H12-181 | Tec? tuff of Elevenmile Canyon? | $^{40}Ar/^{39}Ar$ | sanidine | 25.116 | 0.010 | New Pass | 39.57689566 | -117.5096009 |
| H12-68 | lower tuff of Painted Hills (outlfow equivalent of tuff of Elevenmile Canyon?) | $^{40}Ar/^{39}Ar$ | sanidine | 25.115 | 0.010 | Tule Peak | 39.89201 | -119.67242 |
| 86-DJ-107 | Tpc upper tuff of Poco Canyon | $^{40}Ar/^{39}Ar$ | sanidine | 25.26 | 0.07 | Table Mountain | 39.6111 | -118.2597 |
| 10-DJ-4 (86-DJ-107) | Tpc upper tuff of Poco Canyon | U-Pb Shrimp | zircon | 25.70 | 0.20 | " | 39.6116 | -118.2599 |
| H12-70 | tuff of Chimney Spring (outflow equivalent of tuff of Poco Canyon) | $^{40}Ar/^{39}Ar$ | sanidine | 25.291 | 0.008 | Tule Peak | 39.89186 | -119.67591 |
| H00-80 | New Pass Tuff (outflow equivalent of tuff of Poco Canyon) | $^{40}Ar/^{39}Ar$ | sanidine | 25.32 | 0.06 | New Pass | 39.57778 | -117.53111 |
| 12-DJ-38 | Tpcl lower tuff of Poco Canyon | U-Pb Shrimp | zircon | 25.65 | 0.17 | Job Peak | 39.51870 | -118.24154 |
| 10-DJ-2 | Tjc tuff of Job Canyon | U-Pb Shrimp | zircon | 29.4 | 0.2 | Cox Canyon | 39.6433 | -118.2708 |