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Preliminary Geologic Map of the Griffith Canyon Quadrangle, Washoe County, Nevada

by

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The information in this report should be considered preliminary. It has not been thoroughly edited or peer reviewed.

INTRODUCTION

The preliminary geologic map of the Griffith Canyon quadrangle, first released in 1999 in PDF format, was originally drafted in Adobe Illustrator. This map was converted and modified in ArcMap Version 9.3 in 2009. Most of the Quaternary unit descriptions were only slightly modified from that original map. Some changes were made in the descriptions of various pediment deposits, and landslide deposits in Hungry Valley that were originally included in the Quaternary were later determined (see Garside and others, 2003) to be part of the Tertiary sedimentary rocks. Tertiary units older than the Nine Hill Tuff were completely remapped in the quadrangle, based on a more complete understanding of the stratigraphic sequence (e.g., Henry and others, 2004). Bedrock unit descriptions were written, modified and corrected, and a short section was added on Structural Geology. Because a variety of map compilation methods were used, the accuracy of location of some contacts is only 1–2 mm (24–48 m on the ground at 1:24,000 scale). Additionally, the preliminary and incomplete mapping of faults and contacts between surficial units in Spanish Springs Valley, done in more detail by Alan R. Ramelli, is displayed as a separate data layer.

Mineral contents of igneous rocks were estimated visually from thin sections and rock slabs (which were stained for potassium feldspar). Igneous rock names are based on the IUGS classification (e.g., Le Maitre, 1989). Unit thicknesses were estimated from the geologic map and topographic base map. Strikes and dips were averaged or rounded to the nearest 5° unless accuracy was better than that. Dike widths on the map are commonly exaggerated. Thin surficial units were omitted from cross sections; thicker deposits were combined into a single unit. Photolineaments in Spanish Springs Valley were mapped by examination of low sun-angle photographs. They could not be examined on the ground because of urbanization disturbance or because they were not visible from the ground. The lineaments do not necessarily represent faults. For example, trenching by a consulting company in 2001 did not find a fault at the north end of a long lineament west of Sugarloaf Peak.

Field work was completed in 1996–1997, and 2005. More detailed mapping of surficial deposits in southern Spanish Springs Valley was done by Alan R. Ramelli in 2006. Geologic mapping was partly supported by the U.S. Geological Survey STATEMAP Program (Agreement No. 1434-HQ-96-AG-01502 and G09AC00116).

DESCRIPTION OF MAP UNITS

Qa Alluvium Holocene alluvium, restricted to valley bottoms and localized portions of some fan surfaces. Unconsolidated, predominantly arkosic, sand and gravelly sand deposited as sheetwash and wash alluvium in Holocene to modern channels or as broad, low-gradient alluvial plains. Locally contains abundant medium sand reworked from older eolian deposits (e.g., at the mouth of unnamed canyon in NW1/4, NW1/4, Sec. 3, T21N, R20E). No soil development except on very localized Holocene terraces (not mapped), where a weak 10–15 cm gray-brown A horizon is present in some places. Includes undifferentiated alluvial fan and colluvial deposits in upland areas.

Qt Talus Coarse, angular rock fragments derived from adjacent outcrops and deposited on steep slopes. Limited to one area in Tal on northern Hungry Ridge.

Qls Landslide deposits Only one late Pleistocene or Holocene mass wasting feature was observed, a very small, localized, modern debris slide on the western flank of Hungry Ridge. The slide may have been induced by human activities.

Qp Playa deposits Light-brown, moderately well-sorted, sandy silt and clay. Present only in limited area of Boneyard Flat in Spanish Springs Valley. Mostly obscured by modern wash deposits associated with nearby quarrying activities for crushed stone and decomposed granite.

Qe Eolian deposits Discontinuous thin mantles of eolian sand are widespread in Hungry Valley and Spanish Springs Valley, especially near modern washes. These deposits lack dunal morphology, however, and are too thin and discontinuous to map as sand sheets. As a consequence, the only Qe deposits mapped are low, small dunes in the vicinity of Boneyard Flat. These low dunes are mostly low, rounded, stabilized features on the northern and eastern sides of the playa. Soil development is minimal, in most places consisting of a weak gray-brown A horizon 5–12 cm thick.

Qpg Pediment deposits Most late Pleistocene/ Holocene piedmont surfaces adjacent to mountains in the western half of this quadrangle are pediments. Most younger pediment surfaces primarily consist of subexposures of older bedrock or alluvium, with widespread, but localized, patchy accumulations of pediment gravels. In particular, extensive areas of Tertiary deposits in Hungry Valley display pediment surfaces of various ages. In order to avoid obscuring stratigraphic and structural relationships of older rocks, pediment surfaces were not mapped unless accumulations of Qpg were sufficiently thick to obscure underlying materials. Where not removed or modified by subsequent erosion, pediment deposits above fine-grained Ts are characterized by thin (30–50 cm) but well-developed soils possessing a red argillic B horizon up to 30 cm thick. Visible carbonate accumulations, if present, are typically at or beneath the soil-bedrock contact, where they form thin, commonly continuous, cemented white coatings on fracture and bedding planes. Pediment surfaces cutting older alluvial sediments may display thicker, but less well-developed, soils up to 1 m or more in thickness. B horizons are weakly argillic, and carbonate, usually powdery, may discontinuously coat clasts, root channels, and bedding planes to a depth of several meters.

Qoa Older alluvial fan deposits Alluvial fan remnants with moderately to deeply incised surfaces. Developed along both sides of Spanish Springs Valley.

Qpgo Older pediment deposits and/or surfaces These deposits are associated with late and middle(?) Pleistocene and older, deeply dissected pediment surfaces cut into older bedrock and sediments. The deposits are found on Cretaceous granitic rocks in the eastern part of the quadrangle. They are also found along the southeastern margin of Hungry Ridge north of Eagle Canyon Road, where surfaces are mostly formed on QTa. Deposits typically vary from 1 to 4 m in thickness and locally have been partially or totally eroded. Localized, thin, patchy accumulations of older pediment gravels are widely present on many piedmont surfaces, but were not mapped unless sufficiently thick and extensive to obscure underlying materials. Where not modified by younger erosion, pediment deposits are characterized by prominent red soils up to 1 m or more in thickness. Associated B horizons are red and distinctly argillic. Visible carbonate accumulations are typically at or beneath the soil-bedrock contact, where they form 1–3 mm, usually continuous, white coatings on fracture and bedding planes in zones 1–2 m thick. No massive, cemented B_k or K horizons were observed, however. Surfaces cutting older alluvial sediments may display thicker, but less well-developed, soils up to 1 m or more in thickness. B horizons are weakly argillic, and carbonate, usually powdery, may discontinuously coat clasts, root channels, and bedding planes. In the eastern half of the quadrangle, extensively developed pediment surfaces on Cretaceous granitic rocks are shown with a stipple pattern. Deposits associated with these surfaces (Qpgo) are present in some areas of the stipple pattern, but were not mapped separately unless extensive.

QTls Landslide and debris flow deposits Chaotic mixtures of sand- to boulder-sized rock fragments found in several areas along the east face of Hungry Ridge. The deposits apparently formed as rock avalanches or debris flows, and consist predominantly of material derived from pre-Tnh ash-flow tuffs. The deposits are partly eroded and the source areas can not easily be determined. Based on this, their age is probably latest Pliocene or Pleistocene.

QTa Late Tertiary/early Pleistocene alluvial and alluvial fan deposits Moderately to strongly consolidated alluvial gravels and alluvial fan sediments. These deposits are exposed only in a low pass near the western margin of the map area in Sec. 21, T21N, R20E, and portions of surrounding sections. In areas just outside the map boundary these deposits are well-bedded, clean, and tectonically deformed. Gravel units contain small quantities of rock types exotic to Hungry Ridge. Alluvial fan sediments of this age are restricted to the southeastern side of Hungry Ridge. Deposits are poorly sorted and arkosic, with cobbles and boulders of various intrusive rock types. These deposits have been modified by pediment erosion and are poorly exposed in most areas. Soils associated with these sediments are deeply eroded in all available outcrops. Alluvial fan facies post-date the gravel facies of this map unit.

Tg Gravel Poorly exposed cobble to boulder gravel which is characterized by lag-mantled surfaces of cobbles and large boulders. Finer grained units (sandstone and pebble conglomerate), which are rarely exposed, resemble similar units in Tsp. Boulders consist of granite (Kgr), ash-flow tuff, hornblende andesite (Tha?), and basalt (Tl?). Interfingers with Tl in the area south of Curnow Canyon and lies on an irregular erosion surface developed on Kgr or Tertiary ash-flow tuff. At its southern extent, it is interpreted to mainly overlie Tsp. Probably deposited as alluvial fans, including stream and debris flow deposits. Thickness <150 m.

Sedimentary rocks and landslide deposits of Hungry Valley

Tsh White, very light gray, very pale orange, and greenish-yellow, tuffaceous, coarse to fine volcaniclastic to feldspathic or arkosic bedded sandstone, pebbly sandstone, and conglomerate interbedded with tuffaceous siltstone. Rare tufa and ostracode or pisolitic limestone. Finer grained claystone beds make up most of the unit basinward. Locally cemented with calcite or, rarely, iron oxides. Lies with angular unconformity or nonconformity on most older Tertiary and pre-Tertiary rocks. Locally overlain by a very thin veneer of pediment deposits and lag (particularly west of the axis of Hungry Valley), which is not mapped where the underlying unit can be discerned. Thickness probably <100 m on Hungry Ridge and over 300 m below alluvium in Hungry Valley. Probably ~8 Ma, based on correlation with rocks to the north of the quadrangle (Garside and others, 2003).

Landslide deposits [$Tshl_3$ to $Tshl_1$] These deposits crop out in the northwest part of the quadrangle, on the west side of Hungry Ridge. They lie on Kmr, Tertiary ash-flow tuffs, and tuffaceous siltstones of Tsh. To the north of the quadrangle, they are interbedded with the upper part of Tsh (Garside and others, 2003). The deposits are somewhat variable, but generally consist of chaotically arranged medium to large boulders of intrusive or volcanic rocks in a sand matrix that is commonly not exposed. Individual deposits are predominantly monolithologic, but all contain a mixture of rock types to some degree. The exact source areas cannot be determined, but were in northern Hungry Ridge. Characteristics of the deposits suggest that the movement may have been in the form of rock avalanches. Temporal relationships between the various exposures are uncertain, and the distinction between map units was made on the basis of predominant clast lithology; however, there are some indications of stratigraphic superposition, and there is a suggestion that the deposits have an inverted stratigraphy, with the youngest rock avalanches derived from the oldest and last exhumed rocks. Tentatively, $Tshl_3$ is interpreted to be the youngest and $Tshl_1$ the oldest.

$Tshl_3$ Deposits are dominated by blocks and smaller fragments of Kmr or Kgr in a sparse matrix of coarse arkosic material. Most blocks are ≤1 m, but rarely some are up to 9 m in diameter and 3 m thick. Some large boulders are rounded and weathered along pre-slide(?) internal fracture planes, but others display angular, irregular fracture surfaces with little apparent weathering and no matching boulder fragment opposite the fracture. Fracture plane orientations are inconsistent from boulder to boulder. Commonly ≤10 m thick. Includes two separate rock avalanche deposits; one narrow, elongate deposit along the east margin of Hungry Valley near the end of Eagle Canyon Road, and another 3-km-long deposit that caps ridges west and northwest of Little Hungry Spring (extending into the Fraser Flat quadrangle; Garside and others, 2003). The deposits form resistant mantles atop bedded rocks of Tsh, in some cases protecting the underlying rocks from erosion and forming low ridges up to 20 m high with no apparent connection to potential source areas.

$Tshl_2$ A single, thin, ridge-capping rock avalanche deposit dominated by blocks and smaller fragments of unit Tcs; believed to lie on $Tshl_1$ south of Little Hungry Spring. A few meters thick.

$Tshl_1$ Rock avalanche deposits consisting predominantly of blocks and smaller fragments of pre-Tnh tuffs or Tnh, or in one area, Tba. South of Little Hungry Spring the unit is interpreted to underlie $Tshl_2$ and $Tshl_3$. Thickness varies from a few meters to tens of meters.

Tsp Sedimentary rocks of Pah Rah Range Very light gray, yellowish-gray, and light-brown volcaniclastic and arkosic sandstone, pebbly sandstone, conglomerate, and lesser finely laminated, tuffaceous(?) shale. Local beds of dark-reddish-brown basaltic tephra. Thin to thick bedded. Sandstones are medium to coarse grained and locally cross bedded. Pebbles consist of granitic rock, basalt, vein quartz, hornblende andesite, pyroxene andesite, rhyolitic ash-flow tuff, and rare, but ubiquitous, polished black tourmaline-bearing rock. Beds and lenses of conglomerate and sandstone that are correlated with Tsp are found between flows of Tl; some of these are too poorly exposed or too thin to be mapped, except as discontinuous intra-unit contacts. Thickness <250 m.

Tl Lousetown Formation Dark-gray- to dark-brown-weathering, dark-gray olivine basalt flows. Massive to vesicular or microvesicular, locally platy jointed to crudely columnar jointed. Phenocrysts (commonly <5%) of olivine (≤1 mm), partly to completely altered to iddingsite. In addition, some flows contain tabular plagioclase (commonly 1 mm, but rarely 2 x 6 mm) and, rarely, orthopyroxene (≤0.5 mm). Pilotaxitic to trachytic, with an intergranular groundmass of fine pyroxene grains and plagioclase laths. Individual flows ≤10 m; total thickness unknown, but probably several hundred meters. Flows dip west and sequence thickens eastward; it may be part of a postulated shield volcano centered on

Spanish Springs Peak in the Pah Rah Range to the east. **Tl**, flows; **Tli**, dikes. Age of a flow, 11.19±0.06 Ma (GC-218b; table 1).

Tba, Tbai Basaltic trachyandesite Black, olivine-plagioclase- phyric, massive to vesicular. Phenocrysts (~15%) of tabular plagioclase (~14%, 1–2 mm x 1 cm) and olivine (<1%, 0.4–2 mm). **Tba**, flow; **Tbai**, 1-m-wide dike. Tba overlies units Tcs and Tal with angular unconformity. Thickness <40 m. Age 18.84±0.13 Ma (GC-124; table 1).

Tal Andesite lahars Reddish-brown-weathering, medium-gray, massive to very rarely crudely layered lahars consisting of blocks and clasts (a few cm to nearly 1 m in diameter) of light- to dark-gray, glassy to microcrystalline porphyritic andesite in a light gray matrix of finer andesitic material. Commonly matrix supported and monolithologic, although blocks of older ash-flow tuff up to 10 m in length are found locally near the base. Andesite clasts are hiatal to locally seriate, and contain phenocrysts (15–25%, <5 mm) of plagioclase ± basaltic hornblende ± biotite. Crops out on northern Hungry Ridge, where it overlies (with angular unconformity) Tdm, Tnh, and Tcs and underlies Tba. Thickness <200(?) m. A probable flow in the unit just north of the quadrangle boundary has an age of 20.98 ±0.21 Ma (FM-52, table 1).

Tha Hornblende andesite intrusive rocks Dikes and sill-like and irregular intrusive masses of light-brownish-gray-weathering, light-gray to medium-light-gray andesite. Contains phenocrysts (20–30%, rarely 50%) of plagioclase (<1 mm to several millimeters, rarely to 1 cm; having complex oscillatory zoning and spongy cores mantled by clear rims), and black hornblende (commonly as elongate euhedral crystals a few millimeters long, but very rarely 2 x 4 cm; commonly rimmed by a thin zone of dark magnetite and pyroxene?) in a pilotaxitic groundmass containing small plagioclase laths. Locally, phenocrysts of biotite and rarely pyroxene are observed. Commonly unaltered, but rarely propylitized (epidote, chlorite, albite?, ± pyrite). Exposed in the northeast part of the quadrangle, but includes a possibly related, single, narrow (1–3 m) dike with glassy margins exposed near the north end of Hungry Ridge. Age 20.82±0.25 and 20.95±0.19 Ma (FM-80 and GC-213, table1).

Tcs Tuff of Chimney Spring Pinkish-gray, locally reddish-brown-weathering, crystal rich, rhyolitic (see table 2, sample GC-133), ash-flow tuff. Slightly to moderately welded, containing phenocrysts (~25–27%) of smoky, bipyramidal to equant quartz (6%, 1–3 mm); equant to euhedral or broken, locally chatoyant, sanidine (20%, 1–2 mm), plagioclase (1–2%, ~1–2 mm), rare biotite plates (<1%, 0.5 x 0.9 mm), and accessory opaque Fe-Ti oxide minerals (0.2 mm). Contains uncommon indistinct pumice up to 3 x 20 mm. Portions weather to rounded, reddish boulders of decomposition. Appears to be a single cooling unit in the quadrangle, overlying units Td and Tnh with angular unconformity. Thickness 100–150 m. Age 25.06±0.07 Ma (GC-133, table 1).

Tnh Nine Hill Tuff Brownish-weathering, pinkish gray or grayish, strongly welded rhyolite (GC-132, table 2) ash-flow tuff. Contains phenocrysts (~15%) of subequal amounts of spongy to sieve-textured (resorbed) anorthoclase (~6%, up to 4 x 1.3 mm) and equant, fractured sanidine (~6%, ≤1 mm), with plagioclase (3%, <1 mm), small biotite (trace) and accessory Fe-Ti oxide minerals. Some samples contain rare small lithic fragments of glassy, sanidine-bearing silicic volcanic rock similar to Tnh. A poorly welded base contains ~4% phenocrysts (A.L. Deino, in Best and others, 1989, p. 105; Henry and others, 2004). Common partial to complete vapor-phase alteration, with formation of tridymite and alkali feldspar in cavities (former pumice sites); elsewhere devitrified. Local dark-grayish-black vitrophyre at base. Distinctive compressed pumice (1:3 to 1:7 aspect ratio) from less than 1 mm x 5 mm to 15 x 45 cm. Thickness ~100-130 m, variable. Age 25.23±0.07 Ma (GC-132, table 1).

Td Tuff of Dogskin Mountain Light-gray, nonwelded to slightly welded, dacitic (sample GC-134, table 2) ash-flow tuff with a distinctive phenocryst assemblage (~15–20%) of plagioclase (17%, <2.5 mm) and biotite (~2%, ~0.2 x 0.8 mm) in a glassy, shard-rich groundmass. Contains white, uncompressed pumice lapilli (~5%, most <1 cm, but up to 20 cm) and sparse light gray lithic fragments (<3–4 mm) of glassy biotite-plagioclase volcanic rock. Locally, rare slightly pinkish quartz phenocrysts are found. Thickness <100 m. Age 29.32±0.08 Ma (GC-134, table 1).

Tmc Tuff of Mine Canyon Reddish-brown-weathering, light-brown ash-flow tuff, moderately porphyritic (15–20%), with phenocrysts of equant and elongate, platy-fracturing sanidine, somewhat smaller plagioclase, and 1–2% biotite (Henry and others, 2004). Thickness, <80 m. Age 29.91 ±0.10 Ma (GC-131, table 1).

Twc Tuff of Cove Spring Light pinkish brown, moderately to densely welded ash-flow tuff containing phenocrysts (~15%) of plagioclase (7%, 1–3 mm), sanidine (3–4%, 1–4 mm), and biotite (0–1%, <1 mm). A gray vitrophyre is found locally at the base, with an overlying, "nubbly"-weathering lower part. Underlain locally by conglomerate and sandstone (shown by a special map symbol or as unit Tts). Thickness <125 m. Age 30.13 Ma (Henry and others, 2004).

Tts Tuffaceous sedimentary rocks and conglomerate White, non-bedded, nonwelded tuff (SW¼ Sec. 10, T21N, R20E) contains white, uncompressed pumice (10–15 cm, rarely 45 x 70), dark gray volcanic glass fragments (1–2 cm), feldspar (mostly

plagioclase) and biotite. The white tuff is thought to have been reworked from nonwelded parts of older, plagioclase-biotite-bearing ash-flow tuffs. Locally a thin (<1m) conglomerate or arkosic sandstone is found at the base of Tts; conglomerate clasts include granodiorite, vitrophyre, and rarely, distinctive, very dark gray "poker-chip" porphyry containing white plagioclase phenocrysts (1 cm diameter, 1–2 mm thick). Thickness 0–60? m.

Tsu Tuff of Sutcliffe Light-grayish-brown, moderately to densely welded ash-flow tuff, containing phenocrysts (20–30%) of plagioclase (10–20%, 1–3 mm), sanidine (5–8%, 1–4 mm), and biotite (1–4%, 1–3 mm) (Henry and others, 2004). Similar to Tax, but distinguished from it by stratigraphic position and absence of a phenocryst-poor basal part. Thickness <140 m. Age, 30.43 Ma (H04-17, table 1).

Tsus Tuff and sedimentary rocks below tuff of Sutcliffe In SW¼ Sec. 4, T21N, R20E, a poorly exposed, light greenish gray tuff lies under Tsu. It consists of plagioclase (~10%, ~1mm), less sanidine (~3%, <1 mm), biotite (1–2%, <1 mm), and white, rounded pumice (2–20 mm) in a matrix of volcanic ash. The unit has indistinct bedding or parting, does not appear welded, and has a few 1–3 cm rounded pebbles of ash-flow tuff and granitic rock. Based on these characteristics, the unit is probably sedimentary, consisting mainly of material reworked from older biotite-plagioclase-bearing tuffs. About 1 km to the northeast (in NW¼ Sec. 3, T21N, R20E), a poorly welded ash-flow tuff and overlying conglomerate are exposed in a similar stratigraphic position. The conglomerate and associated tuffaceous sedimentary rocks directly underlie Tsu. Conglomerate clasts include dark granodiorite (from mafic enclaves?), ash-flow tuff, and granite with black tourmaline. A poorly welded ash-flow tuff underlies these sedimentary rocks and lies on Trc. It contains sanidine (4%, 1–2 mm), less plagioclase (~2%, 1 mm), sparse small biotite (<1%, <1 mm), and lithic fragments (1%, 2–4 mm) of reddish intermediate volcanic rock. In upper Stormy Canyon (Sec. 16, T21N, R20E), a sedimentary unit lies on Kmr below Tsu. It consists mainly of conglomerate, but locally includes fine tuffaceous sandstone and arkose. Conglomerate contains rounded clasts (1–75 cm) of granodiorite, vitrophyre, and distinctive, very dark gray "poker-chip" porphyry containing white plagioclase phenocrysts (1 cm diameter, 1–2 mm thick). Thickness 0-100 m.

Trc Tuff of Rattlesnake Canyon Light yellowish- or reddish-gray, commonly moderately welded rhyolitic ash-flow tuff characterized by large and abundant sanidine. It contains phenocrysts (≥12%) of glassy, platy-fracturing sanidine (6%, 1–4 mm), plagioclase (6%, commonly ≤1 mm, but rarely 1 x 3 mm), trace biotite (<1 mm diameter), and quartz. Small specks of manganese oxides are commonly observed. Basal gray vitrophyre has 1–5-cm-long pumice and coarse, welded shards. Pumice is indistinct in much of the unit, and dense parts have a nubbly weathering surface. A cooling break is observed locally near the base, with gray vitrophyre overlying nonwelded to moderately welded ash-flow tuff of similar character. A local basal gravel contains clasts of granitic and metavolcanic(?) rocks in an arkosic matrix. Named for Rattlesnake Canyon about 1 km north of the Griffith Canyon quadrangle. Thickness <140 m. Age, 31.08±0.09 in Rattlesnake Canyon (RFF-141, table 1).

Tax Tuff of Axe Handle Canyon Light-gray or purplish-gray, commonly densely welded, rhyolitic ash-flow tuff. Grades upward from a sparsely porphyritic (5–10%), ≤1 mm) base containing phenocrysts of sanidine (2–4%), plagioclase (2–4%), quartz (1–2%), and biotite (≤1%) to an upper more phenocryst-rich (~20%) part having plagioclase>sanidine and 2–3% biotite. Small biotite with a few considerably larger (~3 mm) flakes is characteristic. Has a coarse shard groundmass texture where not affected by vapor-phase crystallization and commonly contains sparse, small (<1 cm) accidental lithic fragments of granitic rock, or less commonly, metavolcanic rock or metasiltstone(?). Pumice is smaller (<1 cm) near base, but up to 8 cm in upper part. Local basal gravel contains clasts (≤30 cm) of aplite, quartz, and meta-andesite. Lowest ash-flow tuff in the quadrangle; named for exposures northeast of the mouth of Axe Handle Canyon. Tax is the oldest tuff in a north-northeast-trending paleovalley that is now exposed along Hungry Ridge (see Garside and others, 2003, fig. 2). Thickness <175 m. Age, 31.16±0.08 Ma (GC-216; table 1), 31.39 Ma in Dogskin Mountain quadrangle (Henry and others, 2004).

Kap Aplite-pegmatite dikes Very light gray to pinkish-gray aplitic and locally pegmatitic dikes, consisting predominantly of pink alkali feldspar and clear quartz, locally with sparse biotite, zircon, magnetite, and tourmaline (rare). Cuts units Mzma, Kgd, and Kgr; probably related to Kgr. Commonly 1 m wide.

Kgr Granite Very light gray, pinkish-gray-weathering, medium-grained, equigranular to locally porphyritic rock consisting of plagioclase (15–40%, av. 29%), locally euhedral alkali feldspar (30–40%, av. 33%), anhedral to rounded quartz (30–43%, av. 33%), biotite (1–5%, av. 4%), Fe–Ti oxide minerals (1%), trace zircon, and rarely, sphene. Alkali feldspar occurs locally as poikilitic megacrysts (≤1.5 x 2.5 cm), and muscovite is locally present as separate crystals or intergrown with biotite. Weathers to corestones (1 to several meters in diameter) and grus. Appears to intrude Kmr and Kgd, where it is locally aplitic. Similar to Kqm of the nearby Reno and Reno NE quadrangles (Bonham and Bingler, 1975; Cordy, 1985). Age probably <85 Ma (disturbed spectrum on biotite; GC-217, table 1).

Kgl Leucocratic granodiorite Light-gray or very light gray to yellowish-gray, medium-grained, subhedral granular, light-colored granodiorite containing plagioclase (~55%, locally as <1 cm phenocrysts), quartz (~20%), interstitial alkali feldspar (10–15%), biotite + hornblende (~10%), and accessory sphene and Fe-Ti oxide minerals. Occurs as small (<0.5 km in maximum dimension) intrusive(?) masses in Kmr.

Kgd, Kgde Granodiorite Light-to medium-gray, medium-grained, subhedral granular to rarely porphyritic, plutonic igneous rock consisting of plagioclase (33–53%, av. 48%), quartz (10–33%, av. 21%), commonly interstitial alkali feldspar (7–28%, av. 19%), and subequal amounts of biotite and green hornblende (3–10% each, av. 6% each), with accessory sphene and Fe-Ti oxide minerals (1%). Honey-colored sphene (≤1 mm) is ubiquitous and distinctive. A few hornblende phenocrysts are up to 1 cm long. Possibly a phase of or closely related to Kmr. Age 92.5±0.4 Ma (GC-219, table 1). **Kgde**, portions of Kgd that are rich (commonly >80%) in enclaves of microgranular (≤1 mm plagioclase, hornblende, biotite, and sphene) diorite; mapped separately where exposures permit. Enclaves, commonly rounded to discoidal, vary from a few cm to 1 m in diameter.

Kmr Monzodiorite and diorite of Rocky Ridge Commonly medium-gray, porphyritic to subhedral granular plutonic igneous rock consisting of euhedral gray plagioclase (55–70%, <4 x 8 mm); interstitial, fine-grained, anhedral alkali feldspar (10–25%) and quartz (~3%); distinctive, thin, euhedral books of biotite (~7%, ≤4 mm); green hornblende (7–14%, ≤1 cm); and accessory sphene and Fe-Ti oxide minerals (3%). Sphene commonly rims the Fe-Ti oxide minerals.

Mzma Metavolcanic rocks Medium-gray, locally greenish-gray, meta-andesite and metadacite, with rare volcaniclastic sandstone and metatuff. Probably includes both lavas and hypabyssal rocks, which are now found as their metamorphic equivalents in pendants in the Cretaceous granitic rocks. Predominantly porphyritic metavolcanic rock with original phenocrysts (~10%) of milky plagioclase (mainly ≤5 mm), and smaller hornblende and biotite; locally contains pyroxene (?), alkali feldspar (?), and rare quartz. The original rocks have been metamorphosed to lower greenschist grade; mafic and groundmass minerals are converted to mixtures of finer grained chlorite, actinolite, biotite, and rarely hornblende, epidote, and piemontite. Locally, rocks could be referred to as semischist, but most are nonfoliated.

STRUCTURAL GEOLOGY

Spanish Springs Valley, in the central part of the quadrangle, is a north-northeast-striking, west-tilted half graben. It is one of several such half graben north of Reno, most of which appear to terminate at the northwest striking, right-lateral Honey Lake-Bedell Flat fault north of the quadrangle (e.g., Garside and others, 2003). Displacement on the Spanish Springs Valley fault along the west side of Spanish Springs Valley appears to decrease northward to nearly zero ~1 km north of the quadrangle. Holocene movement is indicated for the fault near the south border of the quadrangle (Bell, 1984; Adams and Sawyer, 1999).

A northwest-striking fault in the northeast part of the quadrangle, west of Axe Handle Canyon, is interpreted to have right-lateral displacement (Fontaine, 1997, Garside and others, 2003). This fault has about 2.3 km of right-lateral separation on a 20.8-Ma dike-like hornblende andesite intrusive body. The probable offset portion of the dike on the west side of the fault is exposed north of the quadrangle, in the Fraser Flat quadrangle (Garside and others, 2003). A similar amount of separation on a steep contact between two Cretaceous granitic units can be observed entirely within the Griffith Canyon quadrangle.

The map distribution of Oligocene ash-flow tuffs is partly related to their original deposition in paleovalleys (Garside and others, 2005). The main paleovalley course in the quadrangle appears to lie along the crest of Hungry Ridge. A side tributary may be marked by tuff outcrops northeast of Boneyard Flat.

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