Nevada Bureau of Mines and Geology

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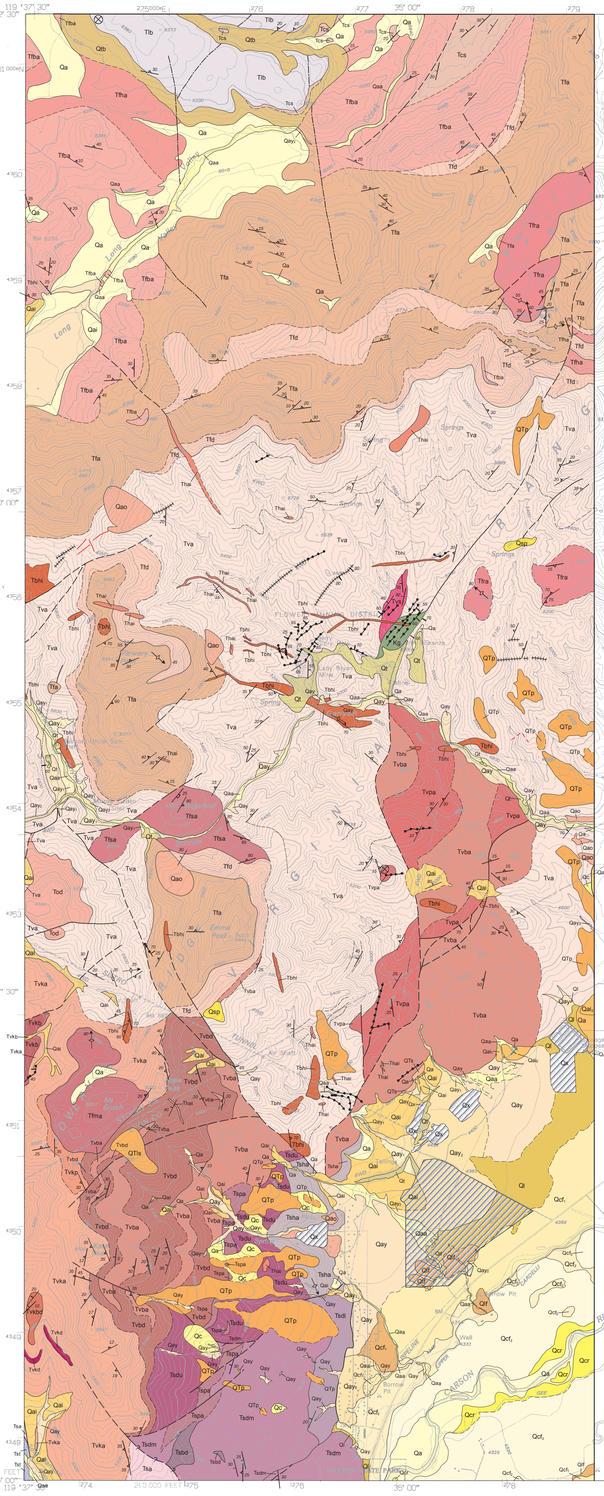
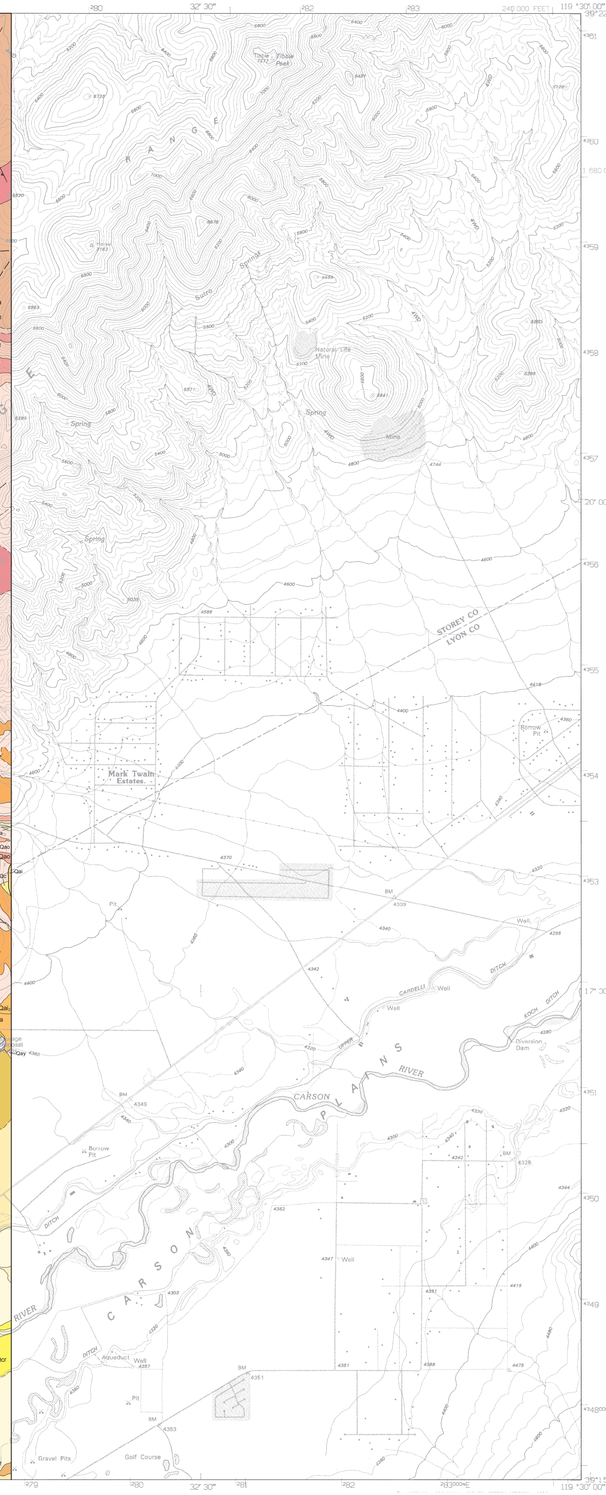
PRELIMINARY GEOLOGIC MAP OF THE WEST HALF OF THE FLOWERY PEAK QUADRANGLE, STOREY AND LYON COUNTIES, NEVADA





PRELIMINARY GEOLOGIC MAP OF THE WEST HALF OF THE FLOWERY PEAK QUADRANGLE, STOREY AND LYON COUNTIES, NEVADA

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2005

LATE CENOZOIC UNITS

ANTHROPOGENIC DEPOSITS

Qt **Mine tailings** Discarded broken rock from mining activity, mostly from recent open-pit mining in the Flowery district. Includes small areas of light-colored, fine mill tailings along the Six Mile Canyon drainage.

Qyd **Extensively disturbed areas (e.g., gravel pits and borrow pits)** Disturbed ground including excavations and product piles at gravel pits and earthworks around water and sewage ponds. Does not include excavations for residential construction.

ALLUVIAL DEPOSITS

Qaa **Recently active alluvium** Deposits of silt, sand and gravel in active single-thread stream channels and principal distributary channels on active alluvial fans. Includes some bouldery debris flow deposits in the Virginia Range and near the range front. No soil development.

Qa **Holocene and Pleistocene alluvium** Undivided deposits of silt, sand, and gravel in various settings throughout the quad including stream channels, fluvial terraces, alluvial fans, and alluvial slopes.

Qay **Holocene alluvium** Deposits of silt, sand, and gravel on active alluvial fans, in stream channels, and on broad piedmont slopes. Includes some fluvial terraces flanking stream channels and bouldery debris flow deposits in narrow valleys in the Virginia Range front. Divided into subunits Qay_1 and Qay_2 from basis of relative topographic relations.

Qai **Late Pleistocene alluvium** Deposits of silt, sand, and gravel on inactive alluvial fans at the foot of the Virginia Range and in isolated patches within the range. Moderate soil development evident as weak argillic (Bt) horizon and stage II-III calcic (Bk) horizon. Divided into subunits Qai_1 and Qai_2 from basis of relative topographic relations.

Qao **Middle to early Pleistocene alluvium** Deposits of sand and gravel on inactive alluvial fans and terraces near the Virginia Range front. Moderate to strong soil development evident as strong stage III calcic (Bk) and strong argillic (Bt) horizon.

QTp **Pliocene to Pleistocene alluvium** Pediment gravels—deposits of gravelly alluvium on planated bedrock erosion surfaces in the foothills of the Virginia Range. Strong soil development (strong Bt horizon) evident locally. Surfaces mostly stripped to a lag of coarse gravel. May include weathered bedrock locally where underlying unit composition similar

CARSON RIVER

Qcr **Active channel of the Carson River** Well-sorted deposits of gravel, sand, and silt associated with the modern meanderbelt of the Carson River. Unit includes splays and gravel bars associated with the 1997 flood.

Qcf **Holocene/late Pleistocene floodplain deposits** Deposits of sand, silt, and mud underlying floodplain terrace landforms. Divided into three subunits on principal basis of topographic separation and inset relations. Qcf_3: Late Holocene; Qcf_2: Early-middle Holocene; Qcf_1: Latest Pleistocene

LACUSTRINE DEPOSITS

Ql **Undivided lacustrine deposits** Deposits of sand, silt, and mud associated with pluvial Lake Lahontan. May also include interrelated fluvial deposits of the Carson River (Qlf)

Qlf **Fluvio-lacustrine deposits** Deposits of well-sorted sand and silt. Elaborate current structures and soft-sediment deformation features common. Contains abundant granite-rich sand indicating likely Carson River source.

OTHER LATE CENOZOIC UNITS

Qsp **Spring deposits** Deposits of silt and fine sand with some pebbles occur adjacent to some of the Flowery Range springs along the southeast slope of the Flowery Range. Only the largest one has been mapped.

Qtb **Basalt talus** Talus composed exclusively of angular fragments of Lousetown Basalt (Tlb). The talus covers slopes that are underlain by Tcs, Tlba, and Tfba.

Qc **Holocene(?) and Pleistocene colluvium** Slope-mantling deposits of coarse gravel. Commonly downslope from surfaces underlain by unit QTp. May include weathered bedrock locally.

QTls **Landslide deposits** A single landslide deposit has been mapped southeast of Mount Grosh. It is mainly composed of Tfma.

QTs **Spring deposits** White to light gray, locally limonite stained, sandy to silty material in small range front exposures north of Sutro. The age of this material, which appears to be hydrothermally altered in places, is unknown. It was probably deposited during hot spring activity along a range front fault. It may

MIOCENE ROCKS

Tlb **Lousetown Basalt** Gray fine-grained basalt with seriate texture forms the top of gently northwest dipping mesas in the northwest part of the quadrangle. Crystals of labradorite-bytownite, olivine, and clinopyroxene are generally less than 1 mm long. The plagioclase and pyroxene range in size down to groundmass grains with an average size of 30 μ. The groundmass also contains opaque microlites and brown glass. The rock is locally vesicular and has distinct flow foliation in places that yields north to northwest dips that are more steeply dipping than the overall dip of the unit. An $^{40}Ar/^{39}Ar$ date of 7.54±0.08 Ma was obtained on groundmass in a sample from about 2 km north of the Flowery Peak Quadrangle (Schwartz and Faulds, 2002).

Tcs **Sedimentary rocks of the Chalk Hills** Poorly exposed white, light-gray, very-pale-orange, pale-greenish-yellow, and light-brown pebble conglomerate, sandstone, fine-grained tuff, lapilli tuff, and diatomaceous siltstone occur near the north border of the quadrangle. In many places, white chips of diatomaceous rock provide the only indication of the extent of this unit, which is better exposed in the Chalk Hills Quadrangle to the north (Schwartz and Faulds, 2002). The unit probably provided stream-polished pebbles of volcanic rock that are locally mixed with basalt talus (Qtb) directly below basal outcrops of the Lousetown Basalt. An $^{40}Ar/^{39}Ar$ date of 12.63±0.14 Ma was obtained on hornblende from tuffaceous rock in this unit from a site about 1 km north of the Flowery Peak Quadrangle (Schwartz and Faulds, 2002).

Tod **Dacite of Occidental Quarry** Biotite hornblende dacite that was quarried for building stone at the Occidental Quarry forms a nearly circular exposure more than 0.5 km in diameter near the west edge of the Flowery Peak Quadrangle. It is typified by large phenocrysts, containing commonly conjoined plagioclase phenocrysts to 1.5 cm; hornblende phenocrysts to 1 cm; and minor biotite as books to 6 mm across. The rock is distinguished by quartz that occurs in minor amounts as rounded and embayed grains to 2 mm. Very minor opaque grains are found along with traces of apatite as tiny, clear prisms. The matrix is dominated by plagioclase laths that average about 50 μ long and form pilotaxitic texture in a field of granular potash feldspar, hornblende, and opaque microlites. Tod contains more than 64% SiO_2; it is relatively silica-rich compared with other intermediate rocks in the Virginia City area. An $^{40}Ar/^{39}Ar$ date of 12.91±0.18 Ma on hornblende further distinguishes this rock from other intermediate rocks in the area.

INTRUSIVE ROCKS OF UNKNOWN AGE

Tbhi **Biotite-hornblende intrusive rocks** Dikes and larger intrusions of biotite-hornblende andesite or dacite occur widely in the quadrangle. They are typically gray to light gray rocks with abundant andesine phenocrysts to 1 cm, sparse to moderately abundant hornblende to 1 cm, and minor biotite to 3 mm. Quartz is generally present as rounded and slightly wormy phenocrysts to 3 mm. Pyroxene is absent. In thin section, the hornblende ranges from brown to olive green and the biotite is typically brown. The mafic minerals are generally not replaced by iron oxide. These dikes, which mostly cut rocks of the 15.2- to 15.8-Ma Virginia City magmatic suite, may be part of the 14.2- to 14.9-Ma Flowery Peak magmatic suite, but some or all may be related to the younger (12.9 Ma) dacite of Occidental Quarry.

ROCKS OF THE FLOWERY PEAK MAGMATIC

Rocks of the Flowery Peak magmatic suite range in age from about 14.2 to 14.9 Ma, and typically contain relatively abundant hornblende. In addition, sparse to moderately abundant biotite is common, and plagioclase phenocrysts are mostly stubby grains more than 3 mm long. Rocks of this suite are mostly IUGS andesites on the basis of alkali/silica plots of samples from the Virginia City Quadrangle. A few have trachyandesitic compositions.

Tfa **Andesites of Flowery Peak undivided** We map most of the rocks in the Flowery Peak magmatic suite in this unit, which is dominantly composed of hornblende-orthopyroxene andesite and hornblende-biotite andesite flows. Some related debris-flow deposits are also included.

Phenocryst content of the andesite of Flowery Peak varies from 20 to 50%. Andesine phenocrysts, which are as much as 1 cm long, are commonly stubby, poorly formed, conjoined grains. Hornblende is the most abundant mafic phenocryst, mostly as brown crystals less than 4 mm long, but locally as much as 1.2 cm long. The hornblende is typically brown and commonly has opaque iron oxide rims or has been completely replaced by iron oxide. Brown biotite phenocrysts, where present, generally have magnetite rims, are corroded, and are less than 3 mm across. Hypersthene, as small prisms that are rarely more than 1 mm long, is commonly the dominant or only pyroxene. Some rocks contain minor clinopyroxene and olivine. Quartz is rarely present. Opaque oxide forms equant or irregular grains to 1 mm. The matrix consists of variable proportions of plagioclase, mafic mineral, and opaque microlites in devitrified glass or glass. The plagioclase phenocrysts and matrix microlites are generally distinctly different in size.

Rock that we have mapped as andesite of Flowery Peak was previously included in the Kate Peak Formation by Thompson (1956) and Hudson (2003). Hornblende $^{40}Ar/^{39}Ar$ ages on specimens from the Virginia City Quadrangle are 14.75±0.22 and 14.39±0.20 Ma (Hudson and others, in prep.).

Tfsa **Biotite-hornblende andesite of Sugarloaf** Light brownish-gray to light gray biotite-hornblende andesite with traces of quartz comprises a rock mass that forms an imposing landmark in Sixmile Canyon. On the basis of the mapped surface shape, it is considered to be an intrusive dome. It contains abundant blocky andesine-labradorite phenocrysts as much as 7 mm long, mottled reddish-brown and olive-green hornblende to 1.5 cm long, and biotite books to 3 mm. In thin section, the hornblende is mottled reddish-brown and olive-green with thin iron oxide rims, and the biotite is locally altered to chlorite. Quartz occurs as rare irregular grains to 2 mm across. Pyroxene is absent or present in trace amounts. An $^{40}Ar/^{39}Ar$ age on hornblende is 14.53±0.11 Ma.

Tfra **Biotite-hornblende-pyroxene andesite of Rocky Peak** Gray, coarsely porphyritic pyroxene-biotite-hornblende andesite with traces of quartz forms three domes in the north part of the map area. The largest, on Rocky Peak, seems to have a nearly horizontal lower contact on the south, but steeply dipping contacts to the northeast. Two smaller bodies of similar rock occur to the south. The rock contains moderately abundant stubby andesine phenocrysts to 1.2 cm. Mafic phenocrysts include hornblende to 8 mm, sparse biotite to 3 mm, and trace to minor clinopyroxene to 1.5 mm. Orthopyroxene is rare or absent. In thin section, the hornblende ranges from oxidized orange-red to relatively unoxidized olive-green colors and is locally replaced by iron oxide. The biotite is deep reddish brown to brown. Quartz phenocrysts range from small anhedra to rounded, wormy, equant grains to 2 mm. The matrix contains weakly flow-aligned to felty plagioclase microlites, along with hornblende, clinopyroxene, and opaque microlites.

Tfma **Biotite-hornblende-pyroxene andesite of Mount Grosh** Coarsely porphyritic gray to pale red pyroxene-biotite-hornblende andesite with minor quartz comprises a dome in the southwest part of the quadrangle. It contains abundant andesine-labradorite phenocrysts commonly as masses of conjoined grains to 1.2 cm across. Hornblende is present as wholly altered (iron oxide+pyroxene+plagioclase) phenocrysts as much as 1 cm long. Biotite as slightly rounded reddish-brown books to 8 mm across, and clinopyroxene as unaltered grains to 1.5 mm. The rock contains trace to minor quartz as rounded, vermiform, equant phenocrysts to 3 mm. The rock commonly contains very fine-grained biotite-hornblende diorite xenoliths.

Tfba **Biotite hornblende andesite** Light-brownish-gray-weathering, light-gray rock containing about 30% phenocrysts occurs in the north part of the quadrangle. Phenocrysts consist of stubby andesine as much as 5 mm long, elongate hornblende to 2 mm long, distinctive large biotite books as much as 5 mm in diameter and 2 mm thick, minor bottle-green augite, and locally, traces of rounded pinkish quartz grains and rounded olivine. The matrix is light gray. It is assigned to the Flowery Peak magmatic suite on the basis of $^{40}Ar/^{39}Ar$ ages of 14.20±0.43 Ma on plagioclase and 14.58±0.12 Ma on hornblende from specimens in the Virginia City Quadrangle.

Tfha **Hornblende andesite** Medium- to light-gray andesite containing phenocrysts of elongate hornblende to 1 cm long and equant, separate and conjoined plagioclase to 4x5 mm occurs in the north part of the quadrangle. Pyroxene can be observed by hand lens in some samples. Biotite and quartz are absent or rare in most of the unit. Phenocrysts also include brown hornblende (variably rimmed with opaque material), and in some samples minor pyroxene and traces of biotite. The matrix is pilotaxitic and consists of plagioclase microlites, opaques, and devitrified glass. Some plagioclase phenocrysts have growth zones near the rims with fine cellular sieve texture. A clast of hornblende andesite from a related unit in the Virginia City Quadrangle gave an $^{40}Ar/^{39}Ar$ age on hornblende of 14.51±0.12 Ma (Hudson and others, in prep.).

Tfd **Debris flows with biotite-hornblende andesite clasts** Debris-flow breccias that contain biotite-hornblende andesite occur in and at the base of Tfa. In places, such debris flows form sequences as much as 150 m thick. Particularly thick sequences occur beneath Tfa on the south side of Rocky Peak, on the northeast side of Flowery Peak, and on the east side of Emma Peak. The breccia contains subrounded light-gray biotite-hornblende andesite and gray hornblende andesite clasts to 2 m. It is mostly matrix supported and locally contains relatively fine-grained sandy to pebbly beds. It lies, without notable angular discordance, on Tva.

Thai **Hornblende andesite intrusive rocks** Dikes and larger intrusions of hornblende andesite with little or no biotite occur widely in the quadrangle, and are particularly abundant in and near the Flowery mining district. The rock is typically gray or dark gray with sparse to abundant stubby plagioclase phenocrysts to 1 cm long. In some dikes, border zones can be seen to contain less plagioclase phenocrysts than core rock. In some examples, hornblende phenocrysts are abundant and large, as much as 1.5 cm long. Biotite is typically lacking, but may be present as rare corroded grains. Quartz is also generally absent. Where present, pyroxene occurs as small grains of clinopyroxene and hypersthene. A hornblende andesite dike in the Virginia City quadrangle has been dated at 14.53±0.42 Ma by $^{40}Ar/^{39}Ar$ on hornblende (Hudson and others, in prep.), which suggests that such dikes may be part of the Flowery Peak magmatic suite.

ROCKS OF THE VIRGINIA CITY MAGMATIC SUITE

Rocks of the Virginia City magmatic suite range in age from 15.2 to 15.8 Ma on the basis of $^{40}Ar/^{39}Ar$ ages on specimens from the Virginia City Quadrangle (Hudson and others, in prep.). They have variable phenocryst assemblages, ranging from pyroxene andesite, through hornblende andesite, to biotite-hornblende andesite and include flows and debris flow deposits. Rocks of this suite are mostly andesites in the IUGS classification on the basis of alkali/silica plots, but a few have basaltic andesite and trachyandesite compositions.

Tva **Virginia City andesites undivided** This is a mineralogically and texturally variable unit. It is mostly composed of flows but includes some breccias. It includes biotite-hornblende andesite, pyroxene-hornblende andesite, and two-pyroxene andesite. Phenocrysts, which make up 25–40% of the rock, are dominantly plagioclase, with subordinate pyroxene and hornblende, and rare biotite. Plagioclase phenocrysts are calcic andesine to labradorite and generally less than 3 mm long, although grains to 7 mm long occur in some rocks. Hornblende, as traces to as much as 10%, is generally less than 4 mm long, but prisms to 8 mm occur in some rocks. Hornblende is commonly partly to wholly replaced by iron oxide. Pyroxene phenocrysts are less than 2 mm long. Clinopyroxene is generally more abundant than hypersthene. Biotite, as small grains to 2 mm across, is rarely present. Tiny opaque grains, which commonly occur in clusters, make up as much as 3.5% suite of the rock. Apatite, present in some rocks in trace amounts, occurs as stubby, gray to light brown prisms to 400 mm long. The matrix in most rocks contains flow-aligned plagioclase microlites that average 50-100 long and are distinctly smaller than phenocryst plagioclase. Mafic and opaque microlites are also present. Tva is commonly altered, with plagioclase partially replaced by albite and calcite, and mafic minerals replaced by chlorite and opaque or sericite and sphene. This alteration is particularly strong in and near the Flowery mining district. In and to the east of the Flowery mining district, Tva is strongly altered to silica + sericite.

Tvka **Andesites of the Kate Peak series** Pyroxene andesite and hornblende-pyroxene andesites in the Kate Peak area in the southwestern corner of the map have been mapped separately from Tva as andesites of the Kate Peak series. They are typified by distinctly flow-aligned calcic andesine phenocrysts to 1 cm long and several percent black and pale green pyroxene phenocrysts to 2 mm long. Some flows contain no hornblende, but others contain sparse hornblende phenocrysts as much as 1 cm long. The lowest flows contain as much hornblende as pyroxene. Traces of brown apatite prisms to 300 microns long were noted in thin section, and rare olivine and biotite to 1 mm were noted in one specimen. Matrix and phenocryst plagioclase typically have seriate size distributions. Flow rock on the west side of Kate Peak in the Virginia City Quadrangle gave a hornblende $^{40}Ar/^{39}Ar$ age of 15.43±0.26 Ma (Hudson and others, in prep.).

Tvkp **Olivine-pyroxene andesite** Flows of pyroxene andesite with minor olivine occur near the top of the Kate Peak series andesites. Light gray to white bedded tuffs that contain clinopyroxene, hypersthene, and rare hornblende occur just above this unit.

Tvkbd **Biotite-bearing debris flows** A unit of debris flows containing biotite-bearing andesite caps a ridge southwest of Kate Peak. The debris includes subrounded clasts as much as 1.5 m in diameter in gray matrix. The andesite contains abundant plagioclase phenocrysts to 4 mm, sparse hornblende to 4 mm, and subordinate brown biotite phenocrysts to 2 mm in a black glassy to gray devitrified groundmass. There are also some reddish-brown oxidized hornblende andesite clasts. The unit locally contains lapilli tuff and granule sand to silt beds.

Tvkb **Biotite-hornblende andesite flows** A flow or a sequence of flows of hornblende biotite andesite occurs in the Tvka sequence. This flow rock contains minor biotite phenocrysts to 2 mm, a few percent hornblende to 3 mm, and stubby plagioclase phenocrysts to 3 mm.

Tvbd **Andesite debris flows** There are several debris flow units, most less than 10 m thick, interbedded with Tvka. Most are too thin or poorly exposed to show on the geologic map. These lahars are typically heterolithologic and contain subrounded clasts less than 30 cm and rarely up to 50 cm of several types of andesite. The matrix consists of gray silt, sand, and mud.

Tvba **Biotite-hornblende andesite flows** On the east flank of Kate Peak in the southern part of the quadrangle, the lower part of the Virginia City andesites is dominated by biotite-bearing flows and associated breccias. These rocks are gray to light reddish brown or pale red with 20-35% phenocrysts, mostly andesine phenocrysts to 1 cm long. Mafic phenocrysts include moderately abundant olive green or oxidized reddish brown hornblende prisms to 8 mm long, rare to minor biotite books to 2 mm across, and sparse small clinopyroxene phenocrysts. Trace amounts of olivine are present in some flows. Orthopyroxene is absent or very rare. Small opaque grains to 0.5 mm and traces of brown apatite to 300μ are also present.

Tvbd **Biotite-hornblende andesite debris flows** Sequences of clast- to matrix-supported debris flows as much as 90 m thick, dominated by biotite-hornblende andesite clasts, are interbedded with Tvba. The clasts are angular to rounded pebbles to boulders as much as 3 m in diameter. In addition to pale-red and light-gray biotite-hornblende andesite, clasts of very fine-grained microdiorite are locally common and clasts of finely porphyritic pyroxene andesite and fine-grained sedimentary rock are present in small amounts locally. The matrix is mostly light gray to pink fragmental material. Rare sandy to pebbly layers are also present.

Tvs Sedimentary rocks occur at the base of the Virginia City andesite unit and within it. They consist of well-lithified siltstone, fine- to coarse-grained sandstone, and coarser beds that range from pebble to boulder conglomerates. Most occurrences are too small to map; however, a lens of sedimentary rocks 700 m long and nearly 200 m wide lies just northwest of the Kg exposure in the Flowery mining district. This relatively large mass of Tvs contains basal conglomerate with rounded boulders of granitic rock and likely represents the local base of the Tertiary section. Above the coarse conglomerate are beds of siltstone, sandstone, and pebble breccia.

Tvpa **Pyroxene andesite flows** Flows of pyroxene andesite with little or no hornblende occur in the Virginia City andesite section, commonly at or near its base but also higher in the section above Tvba flows. These rocks are commonly altered, with plagioclase partly replaced by calcite and mafic minerals wholly replaced by chlorite + calcite + albite. Plagioclase phenocrysts are abundant, generally small but as much as 5 mm long, and range from andesine to labradorite in composition. Where unaltered the rock is nearly black and contains clinopyroxene with subordinate hypersthene.

ROCKS OF THE SILVER CITY MAGMATIC SUITE

Rocks of the Silver City magmatic suite range in age from 17.4 Ma to 18.3 Ma on the basis of $^{40}Ar/^{39}Ar$ ages on specimens from the Virginia City quadrangle (Hudson and others, in prep.). They are dominated by heterolithic debris flow breccias, but include some flow rock. Flow rocks and debris flow clasts mostly range from nearly aphyric andesite, through pyroxene andesite to hornblende andesite. A few debris flows have biotite-bearing clasts. Rocks of this suite are mostly basaltic trachyandesites and trachyandesites in the IUGS classification on the basis of alkali/silica plots.

Tsa **Silver City andesite flows undivided** Flows of finely porphyritic to aphyric basaltic andesite occur within or above Tsdm in the southwest part of the quadrangle. These flows are mostly similar to Tspa, but they include distinctive flow breccia with clasts of andesite with abundant flow-aligned coarse plagioclase plates as much as 1 cm across.

Tspa **Pyroxene andesite flows** Resistant, dark-gray pyroxene basaltic andesite flow rock that weathers reddish brown lies between Tsdu and Tsdm. It is mostly dense, finely porphyritic rock with 20-25% labradorite phenocrysts to 4 mm, fine pyroxene phenocrysts, and little or no hornblende. Some flows contain as much as 3 percent olivine phenocrysts to 1 mm that are mostly serpentinized. In places the flows have vesicular tops, and locally they include flow breccia.

Tsdu **Upper debris flow unit** Heterolithic, clast-supported breccia occurs beneath Tkva in the southwest part of the quadrangle. The clasts are angular to subrounded pebbles to boulders of Tspa and hornblende andesite. Biotite-hornblende andesite clasts are locally present near the top of the unit.

Tsdm **Middle debris flow unit** Heterolithic, clast-supported, debris-flow breccia dominated by dark gray volcanic clasts occurs in the southwest part of the quadrangle. The clasts are mostly angular, but some are subrounded, and range from pebbles to boulders. They include nearly aphyric dark gray basaltic andesite, reddish-brown to dark gray scoria, gray hornblende-bearing andesite, and white pumice. The hornblende-bearing andesite contains subequal amounts of hornblende, clinopyroxene, and hypersthene phenocrysts. The debris flow matrix is generally gray, but is locally locally light brownish gray or light brown, and consists of sand to granule fragmental material. The unit includes some medium-grained to granule sandstone and pebble gravel beds in sequences as much as 2 m thick, particularly in the upper part of the unit. Locally these gravel beds contain opalized wood. A few 2- to 3-m-thick flows of dark gray, aphyric to sparsely porphyritic basaltic andesite are locally present. The porphyritic flow rock has bytownite phenocrysts to 3 mm, sparse hypersthene to 1.5 mm, lesser amounts of small clinopyroxene and opaque grains, and traces of hornblende.

Tsbd **Biotite-Bearing Debris Flows** Light colored breccias that contain biotite-hornblende andesite clasts occur locally in Tsdm near the top of the unit.

Tsha **Hornblende andesite flow rock** Gray andesite with relatively sparse plagioclase phenocrysts to 8 mm and a few percent hornblende phenocrysts to 4 mm underlies debris flows of Tsdi and Tsdm. The rock ranges from dense to vesicular and is locally cut by well-developed columnar joints.

Tsdl **Lower debris flow unit** Light-colored, heterolithic, clast-supported debris flows occur beneath Tsdm in a small area along the east flank of the Virginia Range near the south end of the quadrangle. Most of the clasts, which are generally subrounded and range from pebbles to boulders as much as 1 m in diameter, are mostly composed of light gray to gray hornblende andesite. A few well-rounded clasts occur locally. Clasts of plagioclase-rich andesite with little or no hornblende are also present. The matrix is light gray to light brownish gray.

Tst **Santiago Canyon Tuff** Light-gray to pinkish-gray, moderately to strongly welded rhyolitic tuff crops out near the southwest corner of the quadrangle. It contains abundant phenocrysts of plagioclase, quartz, and sanidine to 4 mm, minor biotite and hornblende phenocrysts to1.5 mm, and rare sphene. Light-gray, moderately to strongly compressed pumice to 2 cm and sparse pinkish-gray felsite lithic fragments to 1.5 cm are present. The age of the Santiago Canyon is early Miocene, 23.12±0.05 Ma, on the basis of $^{40}Ar/^{39}Ar$ dating (C.D. Henry, personal commun., 2004).

PRE-TERTIARY ROCKS

Kg **Hornblende-biotite granodiorite** Granitic rock of probable Cretaceous age is exposed in the east part of the Flowery mining district. Much of it is friable light-colored rock that has been altered to a mixture of sericite and quartz with pyrite or limonite. However, less altered gray rock occurs in the south-flowing drainage just west of the Bonanza (east) pit. The least altered rock found here consists of subequal amounts of plagioclase and potash feldspar with 20–25% quartz. The rock is equigranular with average grain size of about 1 mm, but some potash feldspar grains are as much as 3 mm long.

Contact Dashed where approximately located, short dashes indicate internal contact.

Fault Dashed where approximately located, queried where uncertain, dotted where concealed.

Lineament

Quartz vein or ledge, some showing dip.

Clay vein or clay along fault

Alunite vein or ledge solid, dashed where approximately located.

Lacustrine scarp/shoreline

Strike and dip of beds
30 Inclined — Horizontal

Strike and dip of joints
30 Inclined

Strike and dip of foliation in igneous rocks
30 Inclined — Vertical

Strike and plunge of columnar joints
60

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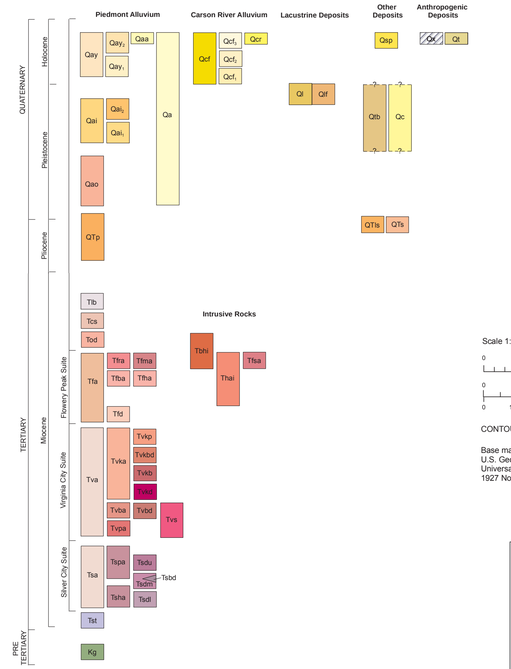

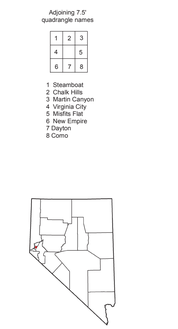

Scale 1:24,000

0 0.5 1 kilometer

0 0.5 1 mile

0 1000 2000 3000 4000 5000 feet

CONTOUR INTERVAL 40 FEET

Base map:
U.S. Geological Survey Flowery Peak 7.5' Quadrangle, 1985
Universal Transverse Mercator projection,
1927 North American Datum

Field work 2002-2005
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DRAFT
Preliminary geologic map.
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