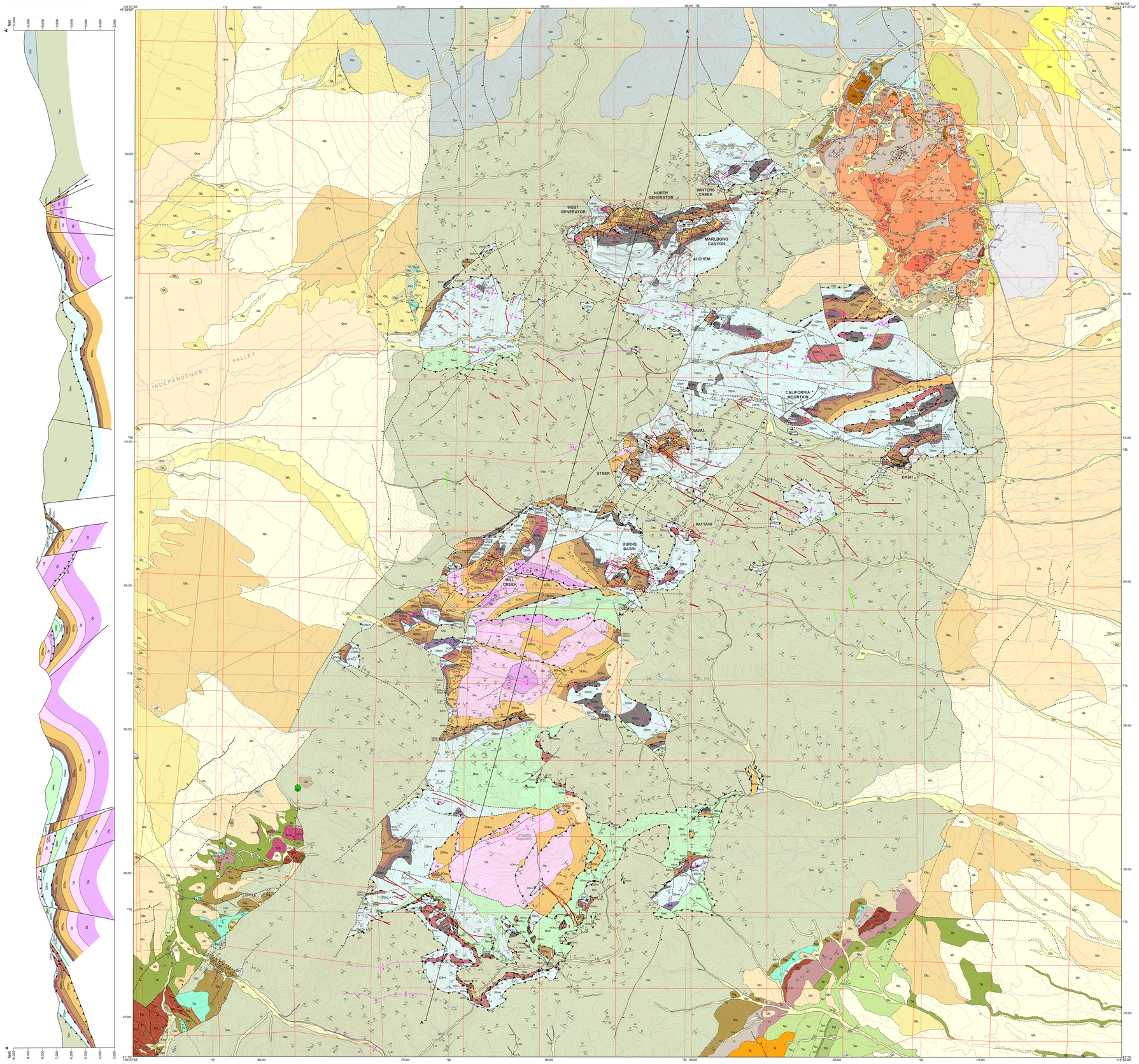
Prepared as part of the STATEMAP component of the National Cooperative Geologic Mapping Program in cooperation with the U.S. Geologic Survey and with support from Yukon-Nevada Gold Corp.



PRELIMINARY GEOLOGIC MAP OF THE JERRITT CANYON MINING DISTRICT, ELKO COUNTY, NEVADA

John L. Muntean and Christopher D. Henry
2007

Quaternary Surficial Deposits

Qm **Surface mine facilities** Includes structures, tailings pond, roads, ore stockpiles, and dumps. Insufficient information to interpret underlying geology.

Qc **Colluvium**

Qls **Landslide deposits**

Qp **Playa deposits (Quaternary)** A small (~150 m diameter) closed depression along the downthrown side of a northeast-striking fault north of Taylor Canyon in the Water Pipe Canyon Quadrangle is filled with soft clay. The depression is filled with water in the spring and early summer.

Qfy **Active tributary drainages**

Qmy **Active medial drainages** Can include numerous closely spaced channels.

Qsy **Young spring deposits**

Qfy$_a$ **Qfy$_b$** **Young alluvial fans** **Qfy$_a$** is active alluvial fans. **Qfy$_b$** refers to a distinct young alluvial fan that shed off the east side of Independence Mountain. Both units are poorly incised and tend to have distributary drainage patterns.

Qfi$_a$ **Qfi$_b$** **Intermediate-age alluvial fans** Tend to have surfaces 1-3 m above younger fans. They are more incised than the younger fans and have wide flat divides between channels that have tributary patterns. **Qfi$_a$** occurs along a higher elevation surface than **Qfi$_b$**.

Qfo **Older alluvial fans** Deeply incised old fans with ridge and valley morphology mostly on the east side of the Independence Mountains with relief greater than 3-10 m.

Rocks of Unknown Age

Dikes of unknown age

Tertiary Rocks

Tmg **Gravel (Miocene?)** Poorly indurated, massive to poorly bedded, conglomerate, conglomeratic mudstone, and mudstone overlie older rocks with variable angular unconformity. Consists mostly of well-rounded, generally clast-supported clasts of Paleozoic limestone, quartzite, chert and lesser Tertiary volcanic rocks to about 25 cm in diameter in a muddy matrix. Well exposed only in artificial cuts. Occurs mostly as a lag of rounded boulders in a muddy soil.

Tmb **Basalt lava (Miocene?)** Brown-weathering, black on fresh surface, massive to amygdaloidal basalt lava. Amygdules are commonly filled with white zeolite. Occurs mostly as a lag of angular to rounded boulders with little to no interstitial soil. The lack of massive exposures suggests the deposits are either flow breccias or are reworked. Appears to overlie poorly exposed Eocene deposits with angular unconformity. Occurs only north of Taylor Canyon in the Water Pipe Canyon Quadrangle.

Tmt **Tuffaceous sediments (Miocene)** Very poorly indurated, white weathering, fine-grained tuffaceous sediments with minor pebble to cobble conglomerate lenses. Rarely crops out and commonly covered by colluvium from topographically higher units. Exposure consists mostly of light-colored, clay-rich soil with scattered chips of variably silicified platy siltstone. Recognized only near Taylor Canyon in the southwestern part of the Waterpipe Canyon Quadrangle. The presence of white to silvery tephra composed of variably altered glass shards is diagnostic of Miocene deposits.

Tid **Andesite dike (Eocene?)** A glassy, black, flow-banded andesite or dacite dike crops out along the contact between basal Tertiary conglomerate (Tcg$_1$) and limestone (Ls) south of Taylor Canyon in the Water Pipe Canyon Quadrangle. The dike is about 300 m long and up to 5 m wide. The dike and flow bands strike northwest and dip moderately northeast, approximately parallel to bedding. The rock contains phenocrysts of plagioclase, biotite, and hornblende.

Qtqd **Quartz monzonite dikes (Eocene)** Holocrystalline quartz monzonite dikes up to 20 m wide with northwest strikes. Contain fine-grained (less than 2 mm), hypidiomorphic plagioclase, hornblende, biotite, potassium feldspar, quartz and accessory magnetite. Occur in Rocky Canyon and Smith Creek areas. Dike in Smith Creek contains a 1- to 3-m wide rind of disposite-potassium feldspar hornfels. $^{40}Ar/^{39}Ar$ date: 39.2±0.1 Ma, hornblende, Smith Creek, Hofstra (1994).

Tbd **Basalt dikes (Eocene)** Northeast-striking basalt dikes, less than 2 m wide, that contain 1-3 mm phenocrysts of olivine and pyroxene in felted matrix of plagioclase. $^{40}Ar/^{39}Ar$ date: 41.1±0.1 Ma, whole-rock, West Generator open pit, Hofstra (1994). Dike in Big Cottonwood Canyon, Burns Basin open pit, 39.52±0.34 Ma, whole rock, 2.8 km southwest of Burns Basin pit; 34.8±1.2 Ma, whole-rock, West Generator open pit, J. Margolis, written commun. (2005).

Tst Tsc Tsg **Sedimentary sequence of Pie Creek (Eocene)** A thick sedimentary sequence of Eocene age is well exposed in the Pie Creek area and consists of siliceous sandstone, conglomerate, and siltstone crops out extensively near Pie Creek and around Taylor Canyon. The sequence is divided into three units based on dominant type: siltstone and sandstone (**Tst**), sandstone and conglomerate (**Tsc**), and conglomerate (**Tsg**). All of the sequence was mapped as siltstone (**Tst**) around Taylor Canyon, where it is particularly poorly exposed, although all rock types are present. Siltstone is massive to finely laminated and commonly silicified, especially south of Taylor Canyon. It contains 1-5 percent angular to subrounded sand-size fragments of quartz, plagioclase, and sanidine and volcanic rock fragments, probably all dominantly reworked from underlying ash-flow tuffs. Conglomerate makes moderately continuous layers and distinct channels as much as 8 m deep. Clasts in conglomerate are mostly subrounded to subangular, ash-flow tuff and andesite up to 5 cm and locally 25 cm in diameter. Paleocoic (1990) reported a zircon U-Pb age of 39.8±0.5 Ma on a "water-lain, ash-flow tuff, 1 m diameter. Haynes (2003) reported a zircon U-Pb age of 39.8±0.5 Ma on a "water-lain, air-fall tuff, interbedded with volcaniclastic rocks in the Pie Creek area," which is probably from this sequence.

Ta **Andesite lava (Eocene)** Porphyritic andesite lava and breccia crops out south of Pie Creek in the Mahala Creek West Quadrangle and more extensively south of there. Most of the deposit consists of flow and clastic debris flow breccia containing massive to vesicular, and crystalline to vitrophyric blocks of andesite in a sandy exposed matrix of finer andesite clasts. Haynes (2003) reported a zircon U-Pb age of 39.8±0.3 Ma on possibly correlative dacite from the "Pie Creek area."

Tx **Megabreccia (Eocene)** Coarse breccia composed of blocks, mostly of tuff of Big Cottonwood Canyon and Nelson Creek, crops out extensively near Pie Creek and in a small area north of Taylor Canyon. Clasts are commonly up to 3 m and locally to 20 m across and range from angular to rounded. Areas of abundant clasts can be confused with ash-flow tuff in place, but individual blocks have highly divergent compaction foliation. Matrix is not exposed in this area but consists of coarse sand and variably rounded pebbles and cobbles in similar deposits elsewhere in northeastern Nevada.

Ttbc **Tuff of Big Cottonwood Canyon (Eocene)** Poorly to moderately welded, devitrified, rhyolitic ash-flow tuff containing ~20% phenocrysts of subequal amounts of smoky quartz, sanidine, and plagioclase with lesser biotite is the youngest major ash-flow tuff in the area. Contains abundant pumice up to 4 cm long that have been completely devitrified and commonly altered to white mica. Crops out in Big Cottonwood Canyon (pattern ~25 km to the west. $^{40}Ar/^{39}Ar$ dates from caldera area: 39.62±0.12 Ma, sanidine and 39.82±0.10 Ma, sanidine, from two samples: Henry and Boden (1998); Castor and others (2003).

Tdi **Dacite intrusion (Eocene)** Two thick dikes or small plugs of porphyritic, flow-banded dacite cut Paleozoic rocks and the tuff of Nelson Creek north of Taylor Canyon in the Water Pipe Canyon Quadrangle. The southern dike is elongate west-northwest and ~100 m long by 20 m wide. The northern plug is about 200 m in diameter and has a thick breccia surrounding a massive core. Flow bands in both bodies strike west-northwest and are nearly vertical. Both bodies contain about 15% phenocrysts, mostly of plagioclase with ~2% biotite, and are highly silicified.

Tdt Tdl Tdv Tdw **Dacite tuff and lava(?) (Eocene)** Abundantly porphyritic dacite containing 30 to 50% phenocrysts of plagioclase, hornblende, biotite, orthopyroxene, clinopyroxene, and magnetite makes up most of the volcanic rock of the Millsite volcanoes. The dacite ranges from poorly welded, abundantly pumiceous ash-flow tuff (**Tdt**), through densely welded tuff (**Tdd**), to lava-like rock (**Tdl**) for which a primary pyroclastic origin is at best obscure. The pyroclastic origin of the densely welded tuff is indicated by the presence of abundant compaction foliation, lithic fragments, pumice and scattered rock fragments of porphyritic andesite. Densely welded shards and pumice are apparent in thin section. The densely welded tuffs commonly also have a thin, poorly welded base. Lava rocks lack the light-colored streaks and rock fragments and do not have poorly welded bases, but thin sections show faint suggestions of very densely welded shards. Vent areas (**Tdv**) are marked by very densely welded, coarsely to finely glassy magma lumps or very densely welded dacite, indistinguishable from host dacite, that also show faint suggestions of very densely welded shards. Vent areas (**Tdv**) are marked by concentrations of large (up to 55 cm diameter) lumps that comprise as much as 80% of the rock in a dense, pumiceous matrix. In the best example of a vent for a poorly welded tuff in the southwest part of the Millsite Volcano, the size of lumps in the tuff increases progressively toward the mapped vent. $^{40}Ar/^{39}Ar$ dates: 40.4±0.1 Ma, hornblende and 40.6±0.2 Ma, biotite, from same sample, Hofstra (1994).

Ttc **Tuff of Nelson Creek (Eocene)** Poorly to densely welded, devitrified, rhyolitic ash-flow tuff containing phenocrysts of quartz, sanidine, biotite, and lesser clinopyroxene, with fewer biotite, quartz, hornblende, and sanidine. The single cooling unit grades from a poorly welded base into a thick densely welded top. The tuff contains some small pumice up to 3 cm long and a few porphyritic andesite clasts to about 1 cm. Composite thickness is at least 120 m, most of which is the upper densely welded part. $^{40}Ar/^{39}Ar$ date from a sample in the Tuscarora Quadrangle just west of Taylor Canyon: 40.15±0.11 Ma, sanidine, Hofstra (1994).

Tcu **Upper conglomerate (Eocene)** Poorly indurated, poorly exposed, boulder to pebble conglomerate consisting of subangular to subrounded clasts of quartzite up to 1.5 m, chert up to 50 cm, and chert-quartzite pebble conglomerate to 20 cm. Similar to lower conglomerate (**Tcg$_2$**) but overlies the plagioclase-biotite ash-flow tuff (**Tt**) in the tuff of the Millsite Volcano area. A clay matrix for pebble conglomerate was seen only in a cut along the haul road. Generally occurs as a lag of boulders to pebbles in a clayey soil.

Tt$_b$ **Tt$_m$** **Rhyolite tuff (Eocene)** Unsorted, crystal-rich to high-silica dacite ash-flow tuff containing about 20% phenocrysts of quartz, sanidine, biotite, and lesser hornblende, possible. Mostly densely welded, although a lower poorly welded glassy zone is extensively exposed along the ridge southeast of Winters Creek. An upper poorly welded zone is rarely exposed. Contains 25 to 50% phenocrysts consisting mostly of plagioclase, lesser biotite, and minor hornblende, clinopyroxene, orthopyroxene, and magnetite. Also contains a few percent of quartz latite lithic fragments. Composite thickness of the tuff is unknown but lower quartz latite is at least 30 m in places. Best-dated tuff is exposed at the base in a lava artificial cut. $^{40}Ar/^{39}Ar$ date: 41.5±0.1 Ma, biotite, Hofstra (1994).

Pre-volcanic Sedimentary Rock

Ts **Shale, calcareous shale (Eocene)** White-weathering, brown on fresh surfaces, very finely laminated, fissile, "paper" shale. Thin interbedded channel deposits of siltstone. Contains leaves and leaf impressions of metasequoia. Rarely crops out, occurs mostly as clay-rich soil with a lag of abundant to sparse, platy chips.

Tls **Limestone (Eocene)** Limestone outcrops are locally interbedded with the Paleocene and Eocene sedimentary rocks and are well exposed in open-pit workings. The thickest deposits, up to about 100 m, are in the Pie Creek and Taylor Canyon areas, which are probably formerly continuous parts of a paleovalley that trended east across what is now the Independence Mountains. Mostly white to cream to light gray, thick-bedded to less commonly, finely laminated micrite is most common. More finely laminated deposits commonly contain abundant ostracods and have yielded abundant charophyte oogonia fragments. Upper parts of the lower conglomerate are locally calcite-cemented in the Pie Creek area. Massive rock composed mostly of tubes up to 3 mm in diameter and 2 cm long of unknown origin and abundant ostracods is an unusual facies in the Millsite volcanic area.

Tct **Early tuff (Eocene)** Poorly to non-welded, porphyritic ash-flow tuff is locally interbedded with conglomerate (Tcg$_1$) near Taylor Canyon. The light-colored tuff contains about 10% phenocrysts, mostly of altered feldspar, with 2% biotite and sparse quartz. The tuff contains a few percent clay-altered pumice fragments to 5 mm and a similar amount of argillite clasts to 3 mm. The tuff may be more widely distributed, but the nonresistant unit rarely crops out and is mostly exposed in roadcuts in Taylor Canyon. Haynes (2003) reported a zircon U-Pb age of 40.6±0.4 Ma from the tuff in a roadcut.

Tcg **Lower conglomerate (Eocene)** Poorly indurated, poorly exposed, boulder to pebble conglomerate (composed of well-rounded to subrounded clasts of white to dark gray quartzite to 1.5 m, chert to 50 cm, and chert-quartzite pebble conglomerate to 30 cm) and lesser sandstone and siltstone. Sandstone and siltstone are a lag of pebbles to boulders in a clayey soil. Similar to upper conglomerate (**Tcg$_2$**) but rests directly on Paleozoic rocks and underlies plagioclase-biotite ash-flow tuff (**Tt**).

Paleozoic Rocks

Dike (Pennsylvanian) Porphyritic to phaneritic dikes of basaltic composition that are less than 7 m wide. K-Ar and $^{40}Ar/^{39}Ar$ dates from three of these dikes indicate emplacement at about 320 Ma (Hofstra, 1994; Phinney and others, 1996). In most places, these dikes crosscut folds and thrust faults.

Rocks of the Roberts Mountains Allochthon

Ocm **McMoe Quartzite (Ordovician)** Fine-grained, white to light gray, cliff-forming massive quartzite. Minor shale and chert. Appears to conformably overlie the Snow Canyon Formation. The unit is about 300 m thick.

Occ **Snow Canyon Formation (Ordovician)** Consists of a basal sequence of limestone, chert and greenstone (metabasalt), a middle unit of chert, argillite, siltstone, shale, and local conglomerate, and an upper unit of primarily chert, with turbiditic quartzite. Type section in Snow Canyon near the north boundary of the map measures about 366 m thick but may achieve a maximum thickness of 600 to 700 m.

Rocks beneath the Roberts Mountains Thrust

Mwc **Waterpipe Canyon Formation (Mississippian)** Consists of a basal graywacke with interbedded carbonaceous shale, chert pebble conglomerate, and bedded chert. The upper part is argillaceous sandstone interbedded with quartz siltstone and fine-grained graywacke. Attains a maximum thickness of about 330 m.

Dsf **Eastern Facies Limestone (Devonian)** Medium to dark gray thin-bedded silty limestone that is commonly fossiliferous and locally turbiditic. Thickness is approximately 10-50 m. Early Middle to early Late Devonian conodonts.

DSm **Roberts Mountains Formation (Devonian and Silurian)** Laminated, carbonaceous calcareous to dolomitic siltstone. A 10- to 15-m-thick, laminated to thin-bedded silty limestone is present near the base. Thickness is at least 100-200 m and may be greater than 300 m in some places. **DSm** hosts a significant amount of the gold ore in the Jerritt Canyon district.

SOhc SOhc$_L$ SOhc$_U$ SOhc$_C$ **Hanson Creek Formation (Silurian and Ordovician)** Divided into five members. Attains a maximum thickness of about 230 m. The uppermost member, **SOhc$_U$**, is a 3- to 40-m-thick sequence of massive to thin-bedded limestone and dolomite with minor siltstone. Commonly weathers to form cliffs. It is well-exposed because of common pervasive silicification. **SOhc$_L$** is up to 30 m thick and is a gray limestone composed of thick-bedded, fine-grained limestone, thin-bedded to nodular limestone, oolitic limestone, and wavy laminated limestone. The unit is commonly fossiliferous and dolomitized. **SOhc$_C$** is up to 90 m thick and consists of thin-bedded limestone and dolomite. **SOhc** is up to 30 m thick and consists of thin-bedded limestone. Tongues, mostly less than 2.5 m thick, West Gem Stock in places commonly does not crop out. **SOhc$_L$** hosts a significant amount of the gold ore in the Jerritt Canyon district. **SOhc$_U$** averages about 75 m thick and is a carbonaceous, medium to coarse-grained limestone, commonly with pods and lenses of black chert. The limestone beds average about 5 cm thick. A basal fifth member has been recognized in drilling and has been mapped locally in the past, though not in a sufficiently consistent manner to be shown on the accompanying map. Dolomite, limestone, and laminated calcareous siltstones. It has been combined with **SOhc$_U$** on this map.

Ou **Eureka Quartzite (Ordovician)** Medium-grained, light gray to white, cliff-forming massive quartzite. Approximately 200 to 300 m thick.

Op **Pogonip Group (Ordovician)** Composed primarily of dark gray fossiliferous limestone and dolomitic limestone with subordinate black chert and argillite. Black chert nodules and lenses are locally abundant. The limestone weathers to a light gray and is typically coarse grained. Shale interbeds occur as stringers and discontinuous lenses that weather to yellowish brown and give outcrops a wavy appearance. A thick-bedded sequence of gray dolomite occurs near the top. The overlying contact zone with Eureka Quartzite is marked by a bed of poorly sorted sandstone with chert fragments. Thickness ranges from 237 to 457 m.

Note: All $^{40}Ar/^{39}Ar$ ages have been recalculated to an assigned age of 28.02 Ma for the Fish Canyon sanidine monitor (Renne and others, 1998).

Base map adapted from U.S. Geological Survey: Jacks Peak, California Mountain, Water Pipe Canyon, and Mahala Creek West 7.5' Quadrangles.
Projection: Nevada State Plane, East Zone, North American Datum 1983 (ft);
Universal Transverse Mercator, Zone 11, North American Datum 1983 (m);
Grid Ticks: Lambert Conformal Conic, Zone 11, North American Datum 1983 (m);
Grid Ticks: Universal Transverse Mercator, Zone 11, North American Datum 1983 (m);
Tick: Jerritt Canyon (ft)
Digital contours from 7.5' Quadrangle and Yukon-Nevada Gold Corp.

Lithologic contact Solid where continuously exposed, such as in pit walls. Dashed where inferred between outcrops. Dotted where concealed. Dash-dotted where intraformational and inferred.

Slippage contact Shown on hanging wall on upper unit. Commonly marked by breccia, small-scale fold and bedding discordance but overall offsets are minor. Solid where continuously exposed, such as in pit walls. Dashed where inferred between outcrops. Dotted where concealed.

Fault Arrow indicates dip direction. U and D refer to relative up and down. Balls indicate downthrown sides of normal faults. Solid where continuously exposed, such as in pit walls. Dashed where inferred between outcrops. Dotted where concealed.

Thrust fault Showing dip, teeth on upper plate. Solid where continuously exposed, such as in pit walls. Dashed where inferred between outcrops. Dotted where concealed.

Low-angle fault that places younger over older rocks Showing dip, teeth on upper plate. Low-angle fault that cuts out section. Commonly marked by breccia and small-scale folds. Range from bedding parallel to bedding discordant. Solid where continuously exposed, such as in pit walls. Dashed where inferred between outcrops. Dotted where concealed.

Anticline axial trace Dashed where inferred. Arrow indicates plunge direction.

Overturned anticline axial trace Dashed where inferred. Arrow indicates plunge direction.

Syncline axial trace Dashed where inferred. Arrow indicates plunge direction.

Overturned syncline axial trace Dashed where inferred. Arrow indicates plunge direction.

Bedding strike and dip

Inclined, Horizontal, Overturned, Vertical

Flow foliation strike and dip

Inclined, Vertical

Compaction foliation strike and dip

Inclined, Vertical

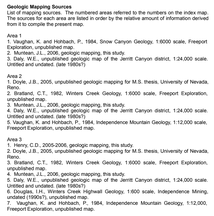
Outline of open-pit gold mine

Area of mining disturbance, sufficient information from drillholes and pre-disturbance mapping to interpret the underlying geology

Explanatory Notes

Paleozoic geology was compiled by J. Muntean with the assistance of Yukon-Nevada Gold Corp., the current owner and operator of the gold mine at Jerritt Canyon. Yukon-Nevada Gold Corp. provided the previous data collected by themselves and previous operators of the mine, including Freeport Exploration Company, Independence Mining Corporation Inc., Anglo Gold, and Queenstake Resources Ltd. These data were utilized in the compilation. Starting points were previous compilations compiled by William Daly in the late 1980s, James Wise in 1997, and John Hertel (for the south end of the district) in 2006. These compilations were based on the mapping of previous exploration companies working in Independence that were done at scales of 1:6000 and larger. In addition, the geology from 12,000 holes that were drilled by Freeport, Independence, Anglo Gold, and Queenstake were utilized. The drill holes were especially useful in areas of poor surface exposure. Areas were prioritized for field-checking. Field checks were done using a Panasonic Toughbook computer with a GPS receiver. Much of the Paleozoic geology was mapped from scratch, where previous mapping and data were insufficient. The resulting compiled Paleozoic geology is significantly different than the previous compilations, especially in the areas of the open pits, where the previous compilations did not reflect the current geology exposed in those pits. By no means was all the Paleozoic geology on the map field-checked. Therefore, the Paleozoic geology should be considered preliminary and may very likely evolve with additional field checks. Previous mapping of the Tertiary rocks was done by Hofstra (1994) in the vicinity of the Jerritt Canyon mine and by Daly (1985) in the rest of the Henry mapped the Tertiary rocks from scratch. Muntean and Henry mapped the Quaternary deposits using aerial photographs. Units were broken out using the framework for alluvial fan sequences developed by Christiansen and Purcell (1985) for the Basin and Range province of the southwestern United States.

Index of Geologic mapping.



Geologic Mapping Sources

List of mapping sources. The numbered areas referred to the numbers on the index map. The sources for each area are listed in order by the relative amount of information derived from it to compile the present map.

Area 1
1. Vaughan, K. and Hohbach, P., 1984, Snow Canyon Geology, 1:6000 scale, Freeport Exploration, unpublished map.
2. Muntean, J.L., 2006, geologic mapping, this study.
3. Daly, W.E., unpublished geologic map of the Jerritt Canyon district, 1:24,000 scale. Untitled and undated. (late 1980s?)

Area 2
1. Doyle, J.B., 2005, unpublished geologic mapping for M.S. thesis, University of Nevada, Reno.
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Area 3
1. Henry, C.D., 2005-2006, geologic mapping, this study.
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2. Unpublished digital level plans of the Steer-Saval mine areas, Independence Mining.
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Area 10
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Scale 1:24,000 — Contour Interval 40 feet

0 — 0.5 — 1 kilometer

0 — 0.5 — 1 mile

0 — 1000 — 2000 — 3000 — 4000 — 5000 feet

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Area 14
1. Daly, W.E., unpublished geologic map of the Jerritt Canyon district, 1:24,000 scale. Untitled and undated. (late 1980s?)
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Area 15
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