Preliminary Geologic Map of the North Half of the Jerritt Canyon Mining District, Elko County, Nevada

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Quaternary Surficial Deposits

Qm Surface mine facilities Includes structures, tailings pond, roads, ore stockpiles, and dumps. Where there is no color and only stippling, there was sufficient information from drill holes and pre-disturbance mapping to interpret the underlying geology. Where there is color and stippling, there was insufficient information to interpret the underlying geology.

Qc Colluvium

Qls Landslide deposits

Qty Active tributary drainages

Qmy Active medial drainages Can include numerous closely spaced channels.

Qsy Young spring deposits

Qfy_2 Qfy_1 Young alluvial fans Qfy_2 are active alluvial fans. Qfy_1 refers to a distinct young alluvial fan that shed off the east side of Independence Mountain. Both units are poorly incised and tend to distributary drainage patterns

Qfi_2 Qfi_1 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_1** occurs along a higher elevation surface than **Qfi_2**.

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

Rocks of Unknown Age

iu Dikes of unknown age

Tertiary Rocks

Tm 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 quartzite and chert and lesser Tertiary volcanic rocks to about 25 cm diameter in a muddy matrix. Well exposed only in artificial cuts. Occurs mostly as a lag of rounded boulders in a muddy soil.

Tbcc 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 Eocene volcanic rock in the area. Contains abundant pumice up to 4 cm long that have undergone extensive vapor-phase crystallization. Erupted from the Big Cottonwood Canyon caldera ~25 km to the west. ^{40}/Ar/^{39}Ar dates from caldera area: 39.92±0.12 Ma, sanidine and 39.92±0.10 Ma, sanidine, from two samples; Henry and Boden (1998); Castor and others (2003).

Teim Mafic dikes (Eocene) 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; Hofstra (1994).

Tdt, Tdd, Tdl, Tdv 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 volcanics. 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 demonstrated by the presence of light-colored streaks marking dense 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-like 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. The distinctly tuffaceous rocks also locally contain sparse to abundant 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 volcanics, 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).

Tcg_2 Upper conglomerate (Eocene) Poorly indurated, poorly exposed, boulder to pebble conglomerate consisting of subangular to subrounded clasts of quartzite to 1.5 m, chert to 50 cm, and chert-quartzite pebble conglomerate to 20 cm. Similar to lower conglomerate (Tcg1) but overlies the plagioclase-biotite ash-flow tuff (Tt) in the northern part of the Millsite volcanic 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 Rhyolite tuff (Eocene) Low-silica rhyolite to high-silica dacite ash-flow tuff, commonly with a basal vitrophyre (**Ttv**), which is mapped separately where 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 30% phenocrysts consisting mostly of plagioclase, lesser biotite, and minor hornblende, clinopyroxene, orthopyroxene, and magnetite. Also contains a few percent pumice up to 5 cm long and sparse fragments of porphyritic andesite and lesser quartzite up to 2 cm in diameter. Bedded tuff is exposed at the base in a few artificial cuts. ^{40}/Ar/^{39}Ar date: 41.9±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 fine sandstone. 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.

Tcg_1 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, probably in a sandy-muddy matrix. Occurs almost entirely as 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).

Tls Limestone (Eocene) In the eastern Independence Mountains, mostly white to cream to light gray, thick-bedded to finely laminated micrite making discontinuously exposed layers in the upper part of the lower conglomerate. Contains common ostracods and oolites, a few gastropods (Lymnaid), and possible reed fragments. Also includes massive rock composed mostly of tubes up to 3 mm in diameter by 2 cm long of unknown origin and abundant ostracods. In the western Independence Mountains, mostly massive light-gray micrite with a few pebbles of Paleozoic chert up to 7 mm in diameter but includes well-bedded limestone with common rounded Paleozoic pebbles up to 5 cm in diameter.

Paleozoic Rocks

PPi Dikes (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; Phinisey and others, 1996). In most places, these dikes crosscut folds and thrust faults.

Rocks of the Roberts Mountains Allochthon

Om McAfee 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 305 m thick.

Osc 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 bedded barite, and an upper unit of primarily poorly bedded 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 greywacke with interbedded carbonaceous shale, chert pebble conglomerate, and bedded chert. The upper part is argillaceous sandstone interbedded with quartz siltstone and fine-grained greywacke. Attains a maximum thickness of about 330 m.

DSrm 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.

$SOhc_1$ $SOhc_2$ $SOhc_3$ $SOhc_4$ Hanson Creek Formation (Silurian and Ordovician) Divided into five members. Attains a maximum thickness about 230 m. The uppermost member, **$SOhc_1$**, is a 3- to 40-m-thick sequence of rhythmically interbedded black chert and carbonaceous limestone. Bedding thickness averages 5 cm. It is well-exposed because of common pervasive silicification. **$SOhc_2$** is up to 30 m thick and is a gray limestone comprised of thick-bedded, fine-grained limestone, thin-bedded to nodular limestone, oolitic limestone, and wavy laminated limestone. The unit is commonly fossiliferous and dolomitized. **$SOhc_3$** is up to 90 m thick and consists of interbedded carbonaceous micritic limestone, 2.5 to 5 cm thick, and carbonaceous argillaceous dolomitic limestone, generally less than 2.5 cm thick. Minor chert is locally present. Commonly does not crop out. **$SOhc_3$** hosts most of the gold ore in the Jerritt Canyon district. **$SOhc_4$** 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. Though not mapped on the surface, a basal fifth member has been recognized in drilling. It is 5 to 30 m thick and consists of chert, limestone, and laminated calcareous siltstones.

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

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).

Geologic Symbols – contacts, faults, folds, strike and dips

Lithologic contact Showing dip. Solid where continuously exposed, such as in pit walls. Dashed where inferred between outcrops. Dotted where concealed.

Slippage contact Showing dip, teeth 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

Overturned anticline axial trace

Syncline axial trace

Overturned syncline axial trace

Correlation Diagram
NONE for this round!

Bedding strike and dip
Inclined Horizontal

Flow foliation strike and dip

Compaction foliation strike and dip

Explanatory Notes
Paleozoic geology was compiled by J. Muntean with the assistance of Queenstake Resources Ltd., the current owner and operator of the gold mines at Jerritt Canyon. Queenstake made available all previous data collected by themselves and previous operators of the mine, including Freeport Exploration Company, Independence Mining Corporation Inc., and Anglo Gold. These data were utilized in the compilation. Starting points were previous compilations completed by William Daly in the late 198 and James

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Wise in 1997. These compilations were then checked by going back to original maps completed by Freeport and 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 all the data loaded in ArcGIS. Muntean mapped some areas 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 not that detailed and only a few holes have been drilled in the Tertiary rocks. Therefore, C. 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 Christenson and Purcell (1985) for the Basin and Range province of the southwestern United States.

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Index of Geologic mapping.
As discussed, small index map subdivided into numbered plates that ties to Geologic Mapping Sources. See Carlin trend map for an example.

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.

<u>Area 1</u>

1. KV *(need to get name for initials)*, 1984, Snow Canyon Geology, 1:6000 scale, Freeport Exploration, unpublished map.
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2. Muntean, J. L., 2006, geologic mapping, this study.
3. Daly, W. E., unpublished map of the Jerritt Canyon district, 1:24,000 scale. Untitled and undated. (late 1980s?)
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<u>Area 2</u>

1. Doyle, J. B., 2005, unpublished geologic mapping for M.S. thesis, University of Nevada, Reno.
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2. Bratland, C. T., 1982, Winters Creek Geology, 1:6000 scale, Freeport Exploration, unpublished map.
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3. Muntean, J. L., 2006, geologic mapping, this study.
4. Daly, W. E., unpublished map of the Jerritt Canyon district, 1:24,000 scale. Untitled and undated. (late 1980s?)
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5. KV, PH *(need to get name for initials)*, 1984, Independence Mountain Geology, 1:12,000 scale, Freeport Exploration, unpublished map.
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<u>Area 3</u>

1. Henry, C.D., 2005-2006, geologic mapping, this study.
2. Doyle, J.B., 2005, unpublished geologic mapping for M.S. thesis, University of Nevada, Reno.
3. Bratland, C.T., 1982, Winters Creek Geology, 1:6000 scale, Freeport Exploration, unpublished map.
4. Muntean, J.L., 2006, geologic mapping, this study.
5. Daly, W.E., unpublished map of the Jerritt Canyon district, 1:24,000 scale. Untitled and undated. (late 1980s?)
6. Douglas, I.H., Winters Creek Highwall Geology, 1:600 scale, Independence Mining, undated (1990s?), unpublished map.
7. KV, PH *(need to get names for initials)*, 1984, Independence Mountain Geology, 1:12,000, Freeport Exploration, unpublished map.

Area 4

1. *10 authors*, Wright Window Geologic Map, 1:6000 scale, Freeport Exploration, undated (198?), unpublished map.
2. Henry, C.D., 2006, geologic mapping, this study.
3. Yesilyurt, S., 1992, Cow Canyon Area, 1:6000 scale, Independence Mining, unpublished map.
4. Muntean, J.L., 2006, aerial photograph interpretation, this study.
5. Daly, W. E., unpublished map of the Jerritt Canyon district, 1:24,000 scale. Untitled and undated. (late 1980s?)

Area 5

1. Birak, D. J. and 20 others, 1985, M.A.P., Gracie, Bidart Geologic Map, 1:6000 scale, Freeport Exploration, unpublished map.
2. Zoerner, F., 2004, Bidart Project, 1:2400 scale, Queenstake Resources, unpublished mapping.
3. Parkinson, C.L., 1984-1987, Upper North Generator Hill Highwall Map, 1:1200 scale, Freeport Gold, unpublished map.
4. Hodkiewicz, P. and Weidemann W.L., 1990-1992, West Generator Hill Highwall Geology, 1:1200 scale, Independence Mining, unpublished map.
5. TRM *(need to get initials)*, 1987, Marlboro Canyon Geologic Work Map, 1:1200, Freeport Gold, unpublished map.
6. Loranger, R.J., 1983, North Lower Generator Hill Final Pit Geology Map, 1:480 scale, Freeport Gold, unpublished map.
7. MM *(need to get initials)*, 1982, North Lower Generator Hill Geology Map, 1:480 scale, Freeport Gold, unpublished map.
8. Muntean, J.L., 2006, geologic mapping, this study.
9. Daly, W.E., unpublished map of the Jerritt Canyon district, 1:24,000 scale. Untitled and undated. (late 1980s?)
10. Douglas, I. H, Alchem Highwall Geology, 1:600 scale, Independence Mining, undated (199?), unpublished map.
11. Douglas, I.H., 1992, Alchem West Pit Highwall, 1:600 scale, Independence Mining, unpublished map.
12. Yesilyurt, S., 1992, Greenstone Draw and North California Mountain Area, 1:6000 scale, Independence Mining, unpublished map.

13. Bratland, C.T., 1982, Winters Creek geology, 1:6000 scale, Freeport Exploration, unpublished map.

Area 6

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2. Yesilyurt, S., 1992, Greenstone Draw and North California Mountain Area, 1:6000 scale, Independence Mining, unpublished map.
3. Wise, J., unpublished map of the California Mountain area, 1:6000 scale, Independence Mining, untitled and undated (1997?).
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2. Muntean, J.L., 2006, aerial photograph interpretation, this study.
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Area 8

1. Birak, D.J. and nine others, 1985, Lost Mine/Saval Canyon/Steer Canyon Geologic Map, 1:6000 scale, Freeport Exploration, unpublished map.
2. Unpublished digital level plans of the Steer-Saval mine areas, Independence Mining.
3. Wise, J., unpublished map of the California Mountain area, 1:6000 scale, Independence Mining, untitled and undated (1997?).
4. Yesilyurt, S., 1992, Cow Canyon Area, 1:6000 scale, Independence Mining, unpublished map.
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2. Yesilyurt, S., 1991, Mahala-Jim Creek Area, 1:6000 scale, Independence Mining, unpublished map.

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3. Everhart, P., unpublished, untitled, and undated (2004?) final map of Dash pit, 1:600 scale, Queenstake Resources.
4. Anonymous, unpub geologic map of the Dash pit, 1999, 1:1200 scale, Anglo Gold.
5. Daly, W.E., unpublished map of the Jerritt Canyon district, 1:24,000 scale. Untitled and undated. (late 1980s?)
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9. Yesilyurt, S., 1997, unpublished and untitled geologic roadcut map, 1:2400 scale, Independence Mining.
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2. Yesilyurt, S., 1992, Cow Canyon Area, 1:6000 scale, Independence Mining, unpublished map.
3. Daly, W.E., unpublished map of the Jerritt Canyon district, 1:24,000 scale. Untitled and undated. (late 198?)
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2. Dahl, A. and four others, 1985-1986, Burns Basin geology, 1:6000 scale, Freeport Exploration, unpublished map.
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Area 12A

1. MM (need to get initials), 1985, untitled geologic map of Plate 12A, Freeport Exploration, unpublished map.
2. Henry, C.D., 2006, aerial photograph interpretation, this study.

Area 13

1. Henry, C.D., 2005-2006, geologic mapping, this study.
2. Henry, C.D., 2006, aerial photograph interpretation, this study.

Area 14

1. Muntean, J.L., 2006, aerial photograph interpretation, this study.
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Acknowledgments

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