Text and references accompanying Nevada Bureau of Mines and Geology Open-File Report 17-6

Preliminary Geologic Map of the North Half of the Independence Valley NW Quadrangle and the Adjacent Part of the Independence Valley NE Quadrangle, Elko County, Nevada

by

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DESCRIPTION OF MAP UNITS

Quaternary Deposits

Qa – Active alluvium (Holocene) – Coarse-grained alluvial deposits in incised ephemeral drainages; typically unconsolidated and poorly to moderately sorted sand with pebble- to cobble-sized gravel. Includes low terraces above active drainages. Minimal soil development. Correlative with young alluvial-fan deposits (Qfy).

Qfy – Young alluvial-fan deposits (Holocene) – Coarse-grained alluvial deposits in intermittently active alluvial fans; typically sandy, pebble- to cobble-sized gravel with silt and boulders; some localized areas primarily comprised of silt with minimal coarse- grained material. Clasts are subrounded to subangular. Surfaces have distributary flow patterns with morphology ranging from subdued bar-and-channel forms to slightly smoothed surfaces. Typically has weak to no soil development. If present, soil development is characterized by Stage I, $CaCO_3$ coatings on bottoms of clasts. The distal margins of Qfy fans are commonly buttressed against beach bars of lacustrine gravels (Qlg). Exposed thickness of the unit is typically 1–2 m. Areas of high silt composition are isolated from major drainage outlets, or deposited beyond distal edge of gravel deposition, and are comprised of reworked fine-grained sediments, likely deposited by a pre-late Pleistocene lake in the Independence Valley (Reheis, 1999).

Qe – Eolian sand (Holocene) – Light brown, well-sorted, fine- to medium-grained sand deposits buttressed adjacent to the west side of Qlg beach bars. Commonly forms barchan dunes with asymmetries suggesting prevailing winds out of the east-northeast.

Qgwd – Groundwater discharge deposits (Holocene) – Deposits of eolian and alluvial, sand and silt with organic clay, in heavily vegetated areas surrounding actively discharging springs. Includes spring mounds, ponds and actively flowing spring-fed streams.

Qpa – Playa and alluvial deposits (Holocene) – Fine-grained deposit in the nearly flat axis of Independence Valley; typically light gray to grayish brown silt, clay and minor fine sand. Deposited during inundation of the playa with shallow standing water. Sediments include evaporite deposits and efflorescent salt crusts. Surface has sufficient gradient that playa deposits are locally reworked in shallow gullies. Interfingers with, and locally overlain by Qgwd deposits.

Qla – Lacustrine and alluvial deposits (late Pleistocene and Holocene) – Variable deposits of lacustrine silt, clay and sand; and alluvial silt, sand and minor gravel. Lacustrine silt was deposited in shallow waters of late Pleistocene Lake Clover, which had highstands at approximately 19.5 ka and 17.0 ka (Munroe and Laabs, 2013). Alluvial deposits are present in channels and are comprised of reworked lacustrine deposits and distal fan sediments.

Qlg – Lacustrine gravels (late Pleistocene) – Gray to brown deposits of moderately to well sorted pebble- to cobble-sized gravel and sand in shorelines, beach bars and spits. Clasts are rounded to subrounded. Soils consist of 20–30 cm thick Bw horizon, underlain by 30–50 cm stage I–II $CaCO_3$ horizons (Bk). Snail shells are common. Unit was deposited during highstands and regressive phases of late Pleistocene Lake Clover. Lake Clover reached a maximum elevation of 1729 m at 19.5 ka and 17.0 ka (Munroe and Laabs, 2013). Qlg shoreline deposits are

inset into Qfi fan deposits on the west side of Independence Valley. Exposed thickness of unit is 3+ m.

Qfi – Intermediate-age alluvial-fan deposits (late Pleistocene) – Coarse-grained alluvial deposits in mostly inactive alluvial fans; typically sandy pebble- to cobble-sized gravel, and local boulders. Clasts are sub-rounded to sub-angular carbonate and quartzite derived from adjacent mountains. Surface morphology is generally planar with rounded margins. Incised drainages have a tributary pattern with channel incision ranging from 1–3 m. Soils consist of stage II–III $CaCO_3$ horizons (Bk) up to 1 m thick. Exposed thickness of the unit rarely exceeds 4 m. Qfi is faulted by the Independence Valley fault zone along the west side of the Pequop Mountains, with scarp heights of approximately 1–3 m.

Qlgo – Older lacustrine gravels (late to middle Pleistocene?) – Gray to brown deposits of moderately to well sorted pebble- to cobble-sized gravel and sand in an isolated beach bar remnant topographically above the late-Pleistocene shoreline gravels (Qlg). Clasts are rounded to subrounded. Soils consist of 1–1.5 m thick stage II–III $CaCO_3$ horizons (Bk). Unit was deposited by a pre-late Pleistocene lake in Independence Valley (Reheis, 1999). Exposed thickness of the unit does not exceed 3 m.

Qfo – Older alluvial-fan deposits (middle Pleistocene?) – Coarse-grained alluvial deposits in inactive alluvial fans; typically sandy pebble- to cobble-sized gravel with boulders. Clasts are subrounded to subangular carbonate and quartzite derived from the Pequop Mountains. Surface morphology ranges from planar to fully rounded erosional remnants. Locally mantled by an eolian cap. Surfaces without a significant eolian accumulation have abundant litter of pedogenic carbonate. Surfaces are highly dissected with incised channels up to 20 m deep. Upper soil horizons erosionally stripped, Stage III–IV $CaCO_3$ horizons up to 2.5 m thick form a continuous carbonate rich layer with local development of laminar carbonate structure. Qfo is only exposed in the footwall of the Independence Valley fault zone. Late Quaternary displacement along the Independence Valley fault zone has uplifted Qfo surfaces a minimum of 30 m. An extensive Qfo surface near the outlet of Meyers canyon is topographically inset up to 12 m below a remnant of the QTf surface. Exposed thickness of the unit is 5 m to ~20 m.

QTb – Boulder deposit in oldest alluvial-fan deposits (middle Pleistocene? to Pliocene?) – Deposit consists of a lag of rounded to subangular boulders of Eureka Quartzite along a ~100 m wide belt that extends westward from Meyers canyon for ~1.2 km. Boulders are commonly as much as 4 to 5 m in greatest dimension and generally larger than 1 m in diameter. Any fine matrix has been eroded. Probably deposited as a coarse debris flow that was sourced from similarly coarse talus beneath cliffs of Eureka Quartzite in the northeastern part of the Meyers canyon drainage in the Pequop Summit quadrangle (Henry and Thorman, 2015) and flowed down the channel that drained Meyers canyon before capture by the current northwest-trending drainage. Approximately coeval with oldest alluvial-fan deposits (QTf).

QTf – Oldest alluvial-fan deposits (middle Pleistocene? to Miocene?) – Coarse-grained alluvial deposits; typically sandy pebble- to cobble-sized gravel with boulders. Clasts are subrounded to subangular carbonate and quartzite derived from the Pequop Mountains. A morphologically rounded, eroded remnant of the QTf surface is preserved south of the outlet of Meyers canyon. Soils horizons are largely stripped; however, abundant litter of pedogenic carbonate suggest remnants of Stage IV–IV+ $CaCO_3$ horizons (Bk) of unknown thickness. QTf stratigraphically overlies Tg with a gradational and conformable contact. The eroded remnant of the QTf surface has been uplifted a minimum of 45 m by displacement along the Independence Valley fault zone. Exposed thickness of the unit ranges from 15 m to ~25 m.

Tertiary Sedimentary Rocks

Tg – Tertiary fanglomerate (Pliocene? to Miocene) – Coarse gravel mostly expressed as a lag of boulders to pebbles of limestone, marble, and quartzite. Scattered outcrops show poorly bedded, poorly to moderately sorted, strongly to moderately calcite-cemented, fluvial gravel. Larger clasts are subangular to rounded, whereas smaller clasts are angular to subangular. Common imbrication of platy limestone and marble clasts indicates westward paleocurrents. Relative abundance of carbonate versus quartzite clasts varies north to south and probably reflects variable amount of quartzite exposure in drainages at the time, which seem to largely coincide with modern drainages. Discontinuous gravel lenses are interbedded near the top of the brown sandstone part of tuffaceous sediments (Ts), and gravel becomes predominant in the upper 10 m of the deposit. Maximum exposed unit thickness is 90 m.

Tls, (Oe), (Op), (Op*), (O€np) – Tertiary landslide deposit (Miocene?) – Megabreccia landslide deposit exposed in the scarp and uplifted footwall of the Independence Valley fault zone. Individual large blocks, a minimum of about 8 m in diameter, commonly several tens of meters in diameter, and reaching 230 m long are mapped separately and identified by their primary rock type. Individual blocks are identified by continuity of bedding orientation over the entire block but are commonly brecciated at their margins. Rock types comprising individual blocks are Eureka Quartzite (Oe), Pogonip Group (Op), Notch Peak Formation (O€np, distinguished by common dolomite and abundant, thin chert layers), and jasperoid (Op*, light red with preserved bedding, which suggests the rock is silicified Pogonip

Limestone) and undivided limestone, commonly showing small-scale internal folds. The individual blocks are the same units and have textural characteristics similar to rocks exposed along the western edge of the present Pequop Mountains, which allows them to be derived from there. Exposed thickness ranges from 20 m to 90 m.

Ts – Tertiary tuffaceous sediments (Miocene?) – Heterogeneous sequence of tuffaceous sandstone, siltstone, lesser conglomerate, and minor lacustrine limestone and pyroclastic-fall deposits. Two parts are recognizable in outcrop but insufficiently exposed to be mapped separately. Lower part is light-colored, variably calcite-cemented, shard-rich sandstone, siltstone, pebble conglomerate, and minor tuff. Sandstone is thick- to thin-bedded, and siltstone is platy bedded. Sandstone locally contains pumice up to 1 cm diameter. Upper part is light brown, massive to rarely thick- to medium-bedded, weakly calcite-cemented sandstone that contains sparse, matrix-supported clasts of quartzite, limestone, and marble to 15 cm. Irregularly bedded, white to cream-colored lacustrine limestone is locally exposed in both parts. The lower part commonly is expressed only as a nearly white soil, locally with mud cracks. The upper part is mostly covered by gravel eroding from overlying fanglomerate (Tg). Unit is up to approximately 350 m thick in the footwall of the Independence Valley fault zone. Unit Ts is interpreted to fill the late-Cenozoic depocenter in Independence Valley and may exceed 2 km thick in the deepest portions of the basin based on regional gravity modeling.

Miocene and Cretaceous Intrusive Rocks

Tr – Rhyolite dikes (Eocene) – Northeast-striking, tan-weathering, sparsely porphyritic, and mostly non-resistant rhyolite dikes intrude rocks of the Killian Springs Formation (Cks) and Toano Limestone (Ct) in the eastern part of the map area. Fewer than 1% phenocrysts of quartz and altered feldspar up to about 1 mm in diameter occur in a fine-grained matrix of quartz and feldspar with alteration products of sericite (muscovite?) or clay. In thin section, the matrix contains radial to irregular spheres that may be spherulites. Bedell et al. (2010) reported U-Pb zircon ages of 39.1±0.7 Ma (from the rhyolite along the eastern range-front fault in this map area) and 41.0±0.8 Ma (from approximately 850 m south of the map area).

Kg – Granitic sills and pods (Cretaceous) – White leucogranite makes thin (0.5 to 2 m thick) sills and pods parallel to bedding in the Killian Springs Formation (Cks) and Toano Limestone (Ct). The fine- to coarse- grained leucogranite contains quartz, plagioclase, muscovite, and minor garnet. Bedell et al. (2010) also reported microcline. Based on a discordant age population of zircons, Bedell et al. (2010) concluded that the leucogranite is no older than Late Cretaceous. Preliminary data from $^{40}Ar/^{39}Ar$ step-heating of muscovite from one sample indicate the leucogranite is probably about 85 Ma (Henry and Thorman, 2015).

Paleozoic Sedimentary Rocks

Paleozoic unit thicknesses are from this study, Thorman (1970), and Camilleri (2010). Due to internal folding within less competent units, probable bedding-plane and attenuation faulting, and brecciation of competent units, thicknesses are best estimates where the rocks are undeformed or least deformed.

Units Pp, Ofh, Oe, and Zmc are not exposed in the map area and are only shown in cross section A–A'. See Camilleri (2010) for a description of these units.

Op – Pogonip Group (Lower Ordovician) – Medium gray, fine-grained, platy to medium-bedded limestone with argillaceous bedding planes and irregular tube-shaped features, possibly burrow casts. The rocks exposed in the southeast map area are the lowermost Pogonip, overlying the Notch Peak Formation, and are probably the House Formation (Henry and Thorman, 2015). The mapped megabreccia blocks may be any part of the Pogonip Group. No measured thickness was estimated in the map area, although Camilleri (2010) shows a thickness of 550 m to 700+ m.

O€np – Notch Peak Formation (Early Ordovician to Late Cambrian) – Predominantly light to medium gray dolomitic marble with local thick interbeds of blue and white limestone. Dolomitic marble is massive to banded light gray or tan to medium gray or tan. Somewhat nodular, medium gray chert layers are sparse to locally abundant, especially near the top of the formation. No measured thickness in the map area, Camilleri (2010) shows thickness ranging from 350 m to 600 m.

€d – Dunderberg Shale (Cambrian) – Recessive weathering, poorly exposed unit consisting of green and black shale metamorphosed to phyllite and schist, commonly with fine porphyoblasts. Muscovite is parallel to foliation. Numerous thin (≤10 cm) micaceous limestone interbeds. Approximately 60 m thick in the map area.

€o – Oasis Formation (Cambrian) – White to light gray medium- to thick-bedded limestone and dolomite marble that are commonly cliff forming. The occurrence of thin-bedded silty limestone or shale marks the contacts with overlying and underlying Dunderburg and Shafter, respectively. Approximately 200 m thick in the map area.

€s – Shafter Formation (Cambrian) – Thinly bedded gray to blue limestone marble with silty orange to gray interbeds. Unit is recessive, with areas weathered to a dark brown color. Approximately 130 m thick in the map area.

Ꞓdl – Decoy Limestone (Cambrian) – Distinctive cliff-forming blue-gray recrystallized limestone with silty limestone interbeds. Approximately 50 m thick in the map area.

Ꞓmp – Morgan Pass Formation (Cambrian) – Recessive weathering shale and platy limestone. The contact with the underlying Clifside is sharp at the base of the lowest shale or silty limestone above the distinct cliff-forming gray Clifside Limestone. Approximately 175 m thick in the map area.

Ꞓcl – Clifside Limestone (Cambrian) – Wavy-foliated, light gray-blue calcareous marble with gray or orange-brown silty layers and locally, abundant crinoids and other strongly recrystallized fossils. A minor brown silty limestone section near the middle of the Clifside is recessive and poorly exposed. Approximately 120 m thick in the map area.

Ꞓt – Toano Limestone (Cambrian) – Foliated, dark grayish green micaceous marble with much less phyllite and tremolite schist. Protoliths were likely thin-bedded limestone and silty limestone. Some beds are chaotically folded, probably due to slumping and soft-sediment deformation because the enveloping layers are not deformed. The contact with the overlying Clifside Limestone is placed at the distinct color and lithologic change, Toana being darker green and more micaceous. Approximately 170 m thick in the map area.

Ꞓks – Killian Springs Formation (Cambrian) – Black- to dark greenish gray micaceous marble, phyllite, and biotite-muscovite schist with tremolite-bearing layers. Protoliths were likely siltstone, calcareous siltstone and thin-bedded limestone. Contact with underlying Cambrian Prospect Mountain Quartzite is sharp. Approximately 170 m thick in the map area.

ꞒZpm – Prospect Mountain Quartzite (Early Cambrian to late Neoproterozoic) – Light to blue gray massive quartzite with minor, cm-thin, garnet-bearing micaceous layers. Fine to medium grained with quartz-pebble conglomerate layers. This unit is only in the cross section of this map but is exposed just south of the southeast map boundary.

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