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Preliminary Geologic Map of the Kinsley Mountains, Elko and White Pine Counties, Nevada

by

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DESCRIPTION OF MAP UNITS

Quaternary Deposits

Qmd – Mine disturbance (Anthropocene) – Excavations and tailing piles of the Kinsley Mountain Mine.

Qay – Active alluvium (Holocene) – Alluvial deposits in the ephemeral Kinsley Draw; typically unconsolidated and poorly to moderately sorted sand and silt with pebble- to cobble-sized gravel. Surface has bar-and-channel morphology. 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 and channels; typically sandy, pebble- to cobble-sized gravel with silt and boulders; clasts are subrounded to subangular. Surfaces have distributary flow patterns and subdued bar-and-channel morphology. Typically has weak to no soil development. If present, soil development is characterized by Stage I, $CaCO_3$ coatings on bottoms of clasts. Exposed thickness of the unit is typically 1–2 m.

Qfi – Intermediate-aged alluvial-fan deposits (late Pleistocene) – Coarse-grained alluvial deposits in mostly inactive alluvial fans and channels; typically sandy pebble- to cobble-sized gravel, and boulders. Clasts are sub-rounded to sub-angular carbonate and quartzite derived from the Kinsley Mountains. Surface morphology is generally planar with rounded margins. Qfi fans commonly bury Qfo surfaces near the Kinsley Mountains range-front, but downslope become confined to inset channels in the Qfo surfaces. Drainages incised into Qfi have a tributary pattern with channel incision ranging from 1–3 m. Soils consist of stage II $CaCO_3$ horizons (Bk) up to 1 m thick. Exposed thickness of the unit rarely exceeds 4 m.

Qla – Lacustrine and alluvial-fan 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 Warring. Interfingered alluvial deposits are present in channels and are comprised of reworked lacustrine deposits and distal fine-grained fan sediments.

Qlg – Lacustrine gravels (late to middle Pleistocene?) – Moderately to well sorted, pebble- to cobble-sized gravel and sand in shorelines, beach bars and spits. Clasts are rounded to subrounded. Soils generally consist a 30–50 cm stage I–II $CaCO_3$ horizons (Bk). The majority of the gravel was deposited during a highstand and regressive phases of late Pleistocene Lake Waring. However, a stage III Bk soil horizon exposed in a gravel pit excavated into a compound beach ridge in the northern-most part of the map area suggests at least some of the gravels may have been deposited during an earlier pluvial highstand. Lake Waring reached a maximum late Pleistocene elevation of 1761 m (Reheis, 1999). The highstand was dated by Munroe and Laabs (2013) who obtained a 16.8 ka radiocarbon age from a beach deposit to the north in Goshute Valley. Qlg gravels and associated shorlines are inset into, and postdate Qfo surfaces. Exposed thickness of the unit is 5+ m.

Qai – Intermediate-aged alluvium (late Pleistocene) – Alluvial deposits in an abandoned stream terrace adjacent to Kinsley Draw; typically moderately sorted sand and silt with pebble- to cobble-sized gravel. Surface morphology is

planar with a 0.25–0.5 m thick eolian cap. Soils consist of stage II $CaCO_3$ horizons (Bk) up to 0.5 m thick. Exposed thickness of the unit is typically 1–2 m.

Qfo – Older alluvial-fan deposits, undivided (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 Kinsley Mountains. Surface morphology ranges from planar to fully rounded erosional remnants. Locally mantled by an eolian cap. Surfaces without a significant eolian accumulation have surficial litter of pedogenic carbonate. Surfaces are dissected with incised channels up to 7 m deep. Upper soil horizons erosionally stripped, Stage III–IV $CaCO_3$ horizons up to 2 m thick form a continuous carbonate rich layer with local development of laminar carbonate structure. Qfo is faulted by the Kinsley Mountains fault zone along the northern east side of the range, with scarp heights of approximately 2.5–3 m. Exposed thickness of the unit is 3 m to 7 m.

QTf – Oldest alluvial-fan deposits (middle Pleistocene? to Pliocene?) – Coarse-grained alluvial deposits; typically sandy pebble- to cobble-sized gravel with abundant boulders of Eureka Quartzite. Clasts are subrounded to subangular. Surfaces are fully rounded erosional remnants and soil horizons are entirely stripped. Maximum exposed thickness of the unit is approximately 20 m.

Tertiary Igneous and Sedimentary Rocks

Ts – Tertiary sediments (Pliocene?) – Tan to brownish gray, gravel to boulder conglomerate in a sandy matrix. Clasts are subrounded to subangular, with variable lithologies sourced from proximal bedrock units. Unit is primarily comprised of alluvial fan and fluvial deposits. The only outcrops of Ts in the map area are in the bottoms of two washes, approximately 2 km south of the Kinsley Mine access pit, and are composed of ~60% Paleozoic carbonate, ~30% Tertiary volcanic, and ~10% granodiorite clasts. Bedding in Ts dips 26°-27°northwest and records rotation of the hanging wall of the Kinsley mountains range-front fault system.

Volcanic Rocks

A sequence of Eocene andesitic to rhyolitic volcanic rocks occurs in the southern and eastern parts of the map. Volcanic products include poorly to highly welded tuffs, flow banded lavas, autobrecciated lava flows, possible block and ash deposits, and subvolcanic intrusions. The thickness of the volcanic sequence is a minimum of 200 m (based on drilling) and potentially greater than 600 m thick. Preliminary $^{40}Ar/^{39}Ar$ dates on biotite and U-Pb dates on zircon range from 38.96±0.76 to 35.9±0.4 Ma. The volcanic rocks are offset by northerly striking range front faults, as well as older northwesterly striking faults. Except for locally altered subvolcanic intrusions, the volcanic rocks are unaffected by hydrothermal alteration and contact metamorphism described below.

Tvf – Andesitic to dacitic lava flows (Eocene) – Predominantly dark reddish brown lava flows of andesitic to dacitic composition. Lavas are commonly aphyric, containing <5% (by volume) phenocrysts that are <1 mm in size. They are commonly flow banded and in places are vesicular and autobrecciated. Scoria and locally spherulitic zones occur locally. Where individual flows are recognizable, they are commonly floored by black vitrophyre and underlain by unwelded tuff containing phyenocrysts, lithics (predominantly andesite), and local pumice. Phenocrysts include plagioclase> biotite>hornblende>±augite±quartz±sanidine. Groundmass is pilotaxitic ir devitrified glass composed of primarily very fine grained quartz and feldspar and coarser aligned biotite that define a flow foliation. Common lithophysae and spherulites.

Tvt – Dacitic to rhyolitic tuffs (Eocene) – Mappable areas of variably welded, light gray, white and pink tuffs that commonly contain up to ~30% broken crystals that are <2 mm, ~10% lithics, which are typically <1 cm, and rare pumice in a vitroclastic matrix. Locally the tuff is a breccia, where lithics up to several centimeters comprise >50% of the volume.

Tvp – Andesitic to dacitic lava porphyry (Eocene) – Lavas and subvolcanic intrusions of porphyry lacking flow banding, containing up to 50% phenocrysts that range up to a few millimeters. Phenocrysts include plagioclase>>biotite >hornblende±augite±quartz±sanidine. Recognized only the southwest portion of the map.

Intrusive Igneous Rocks

Tgp – Granodiorite porphyry dikes (Eocene) – Variety of porphyry dikes that range from granodiorite to diorite. Thicknesses of the dikes range from 0.5 m to 12 m, with most between 0.5 and 2 m. Consist of predominantly plagioclase and biotite phenocrysts (1–5 mm) and lesser quartz, hornblende and orthoclase phenocrysts in fine-grained groundmass of alkali feldspar and quartz. Melanocratic dikes of diorite composition contain more mafic minerals and less quartz and orthoclase. The dikes are mainly confined to north-northeast corridor that is ~1 km wide and ~5 km long. Preliminary U-Pb dates on zircon range from 39.3±0.6 to 40.3±0.4 Ma, which are indistinguishable from the date of the Kinsley stock. Whole-rock geochemistry indicates the dikes are cogenetic with the stock. Dikes are only locally hydrothermally altered, showing variable replacement of feldspars by sericite and mafics by chlorite with pyrite. In places within Cambrian carbonates near the margin of the stock, dikes are altered to endoskarn assemblages of calc-silicate minerals.

Tg – Kinsley granodiorite stocks and dikes (Eocene) – Phaneritic, medium grained granodiorite stock that is ~2 km east-west by ~1.5 km north-south. Contacts with Cambrian country rocks appear steep, except along the northeastern margin of the stock. Contains euhedral plagioclase and orthoclase, (3–5 mm), anhedral quartz, euhedral biotite (1–3 mm) and euhedral hornblende (1–2 mm). Orthoclase is locally megacrystic ranging up to a few centimeters. Accessory minerals include magnetite, sphene, zircon, and apatite. The stock shows only local, weak hydrothermal alteration. North-northeast fingers and dikes extend outward from the main stock on the north and southwest side of the stock. A preliminary U-Pb date on zircon yielded an age of 39.9±0.4 Ma.

Hydrothermally Altered and Metamorphic Rocks

Tj – Jasperoid (Eocene) – Bodies of gray to dark gray silicified rock formed by hydrothermal replacement of carbonate-bearing lithologies by quartz. Typically occur as elongated bodies, <~3 meters wide and <~15 meters long, along contacts or fault zones. In places the jasperoid is brecciated, or formed by replacement of a breccia. Commonly stained with goethite and hematite that partly formed by weathering of hydrothermal pyrite.

Tqv – Quartz vein (Eocene) – Milky white to gray quartz veins up to ~1 m wide with strike lengths up to ~50 m. Occur within the Kinsley stock and extends into the Cambrian country rocks on minor north-northeast striking faults and dike margins. Contain variable amounts of goethite and hematite that partly formed by weathering of pyrite and other sulfides.

Tgos – Gossan (Eocene) – Siliceous bodies with abundant goethite and hematite. Formed by the weathering of massive pyrite-rich sulfide bodies. Typically occur as steeply dipping vein-like bodies from 5 cm to 10 m in width in Cambrian carbonates along minor faults or dike margins. Disseminated relict chalcopyrite and pyrite locally preserved, and malachite and azurite are commonly present. Like the quartz veins, the bodies predominantly occur in the north-northeast corridor of dikes.

Tskn – Garnet-pyroxene metasomatic skarn (Eocene) – Small irregular bodies of coarse andraditic skarn and iron-bearing diopside that occur predominantly in carbonate lithologies along the margin of the Kinsley stock, tongues of the stock, or margins of dikes. Skarn has been observed in contact with the Dunderberg Shale, Hamburg formation, and the Clarks Spring member of the Secret Canyon Shale. Scheelite locally occurs as veinlets and disseminations cutting the garnet-pyroxene skarn, along with malachite and azurite.

Tm – Marble and banded marble-hornfels (Eocene) – Discontinuous aureole of calcite marble, dolomite marble, and banded calcite marble-hornfels that formed by contact metamorphism of the Dunderberg Shale, Hamburg formation, and the Secret Canyon Shale. The width of the aureole typically ranges between 100 and 250 m.

Paleozoic Sedimentary Rocks

Pa– Arcturas formation (Permian) – Complicated succession of sandstone, calcareous sandstone, calcareous siltstone, and minor dolomudstones. Very similar to the "Permian unit A" described by Silberling and Nichol's (2002) in the White Horse Pass area, located ~40 kilometers to the north. As at White Horse Pass, the succession appears to occur as sequences in which well-bedded limestones are overlain by impure sandy limestone, calcareous siltstone, fine-grained variably calcareous sandstone, and minor lime mudstone and dolomudstone. Massive limestone units are mainly bioclastic packstones and wackestones. Fusilinids are common, in places occurring in rock-forming abundances. The unit is overlain unconformably by Eocene volcanic rocks, thus its upper contact is not exposed. Minimum thickness is 425 m.

IPe – Ely Limestone (Pennsylvanian) – Light- to medium-gray, medium- to coarse-crystalline, alternate thin- and thick-bedded, fossiliferous limestone, with common brown chert stringers and nodules, and brown siliceous silty partings. Weathers to distinct light-gray bluffs. Lower contact is not exposed; minimum thickness is 550 m.

Ofh – Fish Haven Dolomite (Ordovician) – Dark gray to black, finely crystalline dolostone with black chert stringers lying parallel to bedding and local fine laminations. Individual beds, where visible, range from 2–10 cm. The lower contact with the Eureka Quartzite is conformable with interbeds of sandy black dolostone and cross-bedded, clean, white non-calcareous quartzite. Commonly occurs as klippe, in the upper plate of attenuation faults. Fish Haven Dolomite caps the ridgetop where it rests on Eureka Quartzite and crops out in several locations along the western range front. The total thickness of Fish Haven Dolomite, exposed along the ridge top, is approximately 15 m.

Oe – Eureka Quartzite (Ordovician) – White, medium-grained, well-sorted, massively-bedded to cross-bedded quartzite. It is mapped in a klippe in the upper plate of an attenuation fault at the top of the range north of the mine, along the west side of the range, where it underlies the Fish Haven Dolomite and overlies Pogonip Group limestones along a low to moderate-angle, west-dipping attenuation fault, and in a fault bound sliver in the hanging wall of the high angle normal fault on the east side of the range. Commonly occurs as a lag of white to tan, locally brecciated, quartzite boulders.

<u>Pogonip Group (Ordovician)</u>

Subdivided by Pilot Gold geologists into five informal maps units (Hannink et al., 2015: Gustin et al., 2015).

Opcf – Cliff-former member – Thick-bedded to massive light gray to bluish gray packstone with wispy bioturbated silty laminations. Aproximately 70 m thick.

Opsh – Shaley member – A thin band of calcareous shale, less than 15 m thick.

Opbt – Bioturbated member – Heterogeneous limestone repetitive packages of primarily packstone beds that grade upward from thick to medium to thin beds. Common fossilifeorous zones. At least 200 m thick.

Opfpc – Flat pebble conglomerate member – Thin- to medium-bedded packstone and wackestone with numerous beds containing flat pebble conglomerate. Approximately 150 m thick.

Opcb – Chert-bearing basal member – Thin- to medium-bedded light tray, fine-grained fossiliferous limestone with bedded chert and chert nodules. Approximately 30 m thick.

Opu – Pogonip Group, undivided

Notch Peak Formation (Cambrian)

Ꞓnpd – Dolomite member – Medium to dark gray, massive, medium-grained dolostone with intervals of dark gray to black wispy-textured dolomite and local chert stringers. The unit varies in thickness from approximately 0 to 100 m, probably due to boudinage or thinning along low angle faults.

Ꞓnpl – Limestone member – The base of this unit is comprised of a light gray, coarsely recrystallized limestone, which grades upward to thin-bedded silty, trilobite-bearing limestone, passing into thick-bedded to massive fine- to medium-grained limestone with locally abundant chert nodules and stringers. Going upward the limestone becomes more silty with well-developed flat, planar silty partings, and consists of medium- to dark gray, thin-bedded, cherty micrite with occasional trilobite fragments. Argillaceous partings along flat, planar beds, locally banded with dark gray to black chertier beds and lighter gray argillaceous interbeds produce a striped appearance. Above the basal sequence is dark gray, medium- to massively-bedded, silty micritic limestone with distinctive, intense bioturbation. Wavy bedding with pink silty laminae defines the abundant burrows. A dark gray to almost black, thin-bedded silty limestone with locally abundant trilobite fragments overlies the bioturbated section. The uppermost part of the limestone portion of the Notch Peak Formation is composed of poorly exposed thin- to medium-bedded, fine-grained limestone with abundant chert bands, occasional oncolites and stromatolites, which is interbedded with intervals of medium- to coarsely crystalline fossiliferous limestone intervals. The inferred total thickness of the limestone portion of the Notch Peak Formation is ~330 m. The lower contact with the Dunderberg Shale is commonly faulted.

Ꞓd – Dunderberg Shale (Cambrian) – Brownish-tan to dark gray, moderately to strongly fissile shale that is variably calcareous. As described by Hannink et al. (2015), the shale is interbedded with fossiliferous medium gray limestone beds up to 3 m thick. Interlayers of siltstone also occur as well as thin beds of distinctly nodular limestone. Carbonate content increases upward in the unit. The stratigraphic thickness of the unit is unknown given its upper and lower contacts are commonly faulted and because of internal deformation of the shale within the unit. Its thickness in the map area averages around 100 m.

Ꞓh – Hamburg formation (Cambrian) – Predominantly massive medium gray dolostone in the map area. Dolomitization is not stratabound in that there are areas of undolomitzed limestone along strike of dolostone. Where locally exposed in the map area, the uppermost 10 m of the unit, which overlies the dolostone, consists of gray to brownish gray, thin-bedded (1–3 cm) fossiliferous, silty limestone with shaly partings (Hannink et al. 2015). Below the dolostone the unit grades into a sequence of massive, thick-bedded gray limestone with silty partings. Lower in the section there are alternating medium-bedded limestone and calcareous siltstone. The lower contact with the Clarks Spring Member of the Secret Canyon Shale is gradational and difficult to map on the surface. The minimum thickness of the unit is estimated to be 225 m.

Secret Canyon Shale (Cambrian)

Ꞓsccs – Clarks Spring Member – Predominantly medium to thin-bedded, medium to dark gray limestone separated by thin silt beds or argillaceous partings. The lower contact with the underlying lower shale member of the Secret Canyon Shale is marked by a gradual decrease of limestone beds. The estimated thickness is 100 m.

Ꞓscs – Shale member – Predominantly variably calcareous shale with sparse limestone nodules with common interbedded massive limestone beds. Near the Kinsley stock outside of the marble contact aureole, the unit is metamorphosed to biotite hornfels and strongly recrystallized limestone. Estimated thickness is 100 m.

Ꞓg – Geddes Limestone (Cambrian) – Thin to medium bedded, medium gray limestone with argillaceous partings. In the map area, it occurs in fault contact with Permian Arcturas formation, where it is locally metamorphosed to a calcareous hornfels or phyllite. Where drilled north of the map area, the unit is at least 300 m thick (Hannink et al., 2015).

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