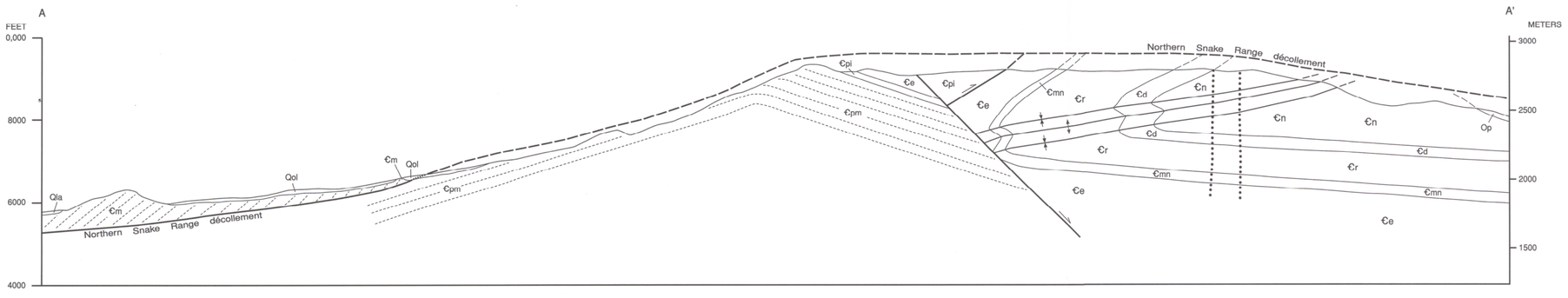
GEOLOGIC MAP OF THE THIRD BUTTE EAST QUADRANGLE, NEVADA

Jeffrey Lee, Phillip B. Gans, and Elizabeth L. Miller

1999



Stratified Rock Units

Qal **Quaternary alluvium** Generally unconsolidated sands and gravels deposited within modern drainage systems.

Ql **Quaternary landslides** Locally derived, unconsolidated, commonly matrix supported, angular and poorly sorted clasts of all sizes. Typically exhibit hummocky topography and chaotic structure.

Qt **Quaternary talus** Locally derived, generally monolithic, unconsolidated, matrix-free, angular and poorly sorted, boulder- and smaller-size rock debris.

Qla **Quaternary lacustrine and alluvial deposits, undifferentiated** Lacustrine and alluvium deposits are alluvial deposits reworked by waves and currents of a lake equivalent(?) in age to Lake Bonneville. Also includes pre-lake alluvial fans etched by wave action. A thin veneer of lacustrine deposits covers these alluvial deposits.

Qol **Quaternary older alluvium** Flat-lying consolidated to unconsolidated, alluvial fan sand and gravel deposits that form pediment surfaces, rest in sharp angular discordance above older rocks, and are incised by present day drainages. Clast types and morphology of these deposits reflect derivation from the major present-day drainage systems developed in flanking mountain ranges.

SO **Silurian Laketown and Ordovician Fish Haven Dolomites, undifferentiated (SO dolomite)** The SO dolomite is a light-gray to dark-chocolate-brown, fine- to medium-grained recrystallized, knobby slope- to massive cliff-forming, poorly bedded to well laminated, cherty, fossiliferous dolomite. It typically varies from poorly bedded dark-brown dolomite with rust- to black-colored nodular chert beds 1 to 3 cm thick and spaced about 4 to 6 cm apart to uniformly chocolate brown to light-rust-gray, poorly bedded, fossiliferous dolomite with lesser, variable amounts of chert nodules to massive, light-brown-gray dolomite. A distinctive feature of the SO dolomite is a several-meter-thick zone of algal stromatolite beds found about two-thirds of the way up through the unit. The upper part of the SO dolomite is light-gray, cliff-forming, poorly bedded, sugary dolomite. The SO dolomite commonly contains silicified zones up to 25 m thick and can be brecciated, having secondary calcite veins. The basal contact with the underlying Eureka Quartzite is gradational over several meters. The lowest 1 to 2 m of the SO dolomite consist of dolomite-cemented, well-rounded, closely packed, very well-sorted, fine- to medium-grained quartz sandstone.

Oe **Ordovician Eureka Quartzite** The Eureka Quartzite is white to orange-brown, cliff- to ledge-forming, poorly, but thick bedded (30-90 cm thick) texturally and compositionally mature orthoquartzite consisting of nearly 100% fine-grained (0.3-0.5 mm), extremely well-sorted and well-rounded, silica-cemented quartz grains. Fresh surfaces are white to vitreous, and weathered surfaces are irregular and pitted forming orange-brown, rounded outcrops. The Eureka Quartzite commonly occurs as thin, brecciated, fault-bounded slivers and is often smeared out along fault planes. Large boulders of quartzite characterize slopes below these outcrops.

Op **Ordovician Pogonip Group, undifferentiated** The Pogonip Group in the upper plate is yellow-weathering, ledge/slope- to slope-forming, well-bedded, fossiliferous, medium-blue-gray to light-blue-gray, silty limestone. A number of fossil types are abundant in the Pogonip Group, including brachiopods, ostracods, coiled nautiloids, and tabulate corals. The Pogonip Group consists of five subdivisions, which have not been distinguished in this quadrangle.

The basal subunit is yellow-weathering, slope-forming, well-bedded (5-15 cm thick), flat-pebble limestone conglomerate interbedded with easily eroded silty intervals. Well-rounded, gray, tan and brown, oblate rip-up clasts (2-3 cm in diameter) are set within the yellow silty interbeds. This unit is generally poorly fossiliferous.

The basal subunit grades upwards into a yellow-weathering, ledge/slope- to cliff-forming, well-bedded, silty/cherty light-gray limestone. The distinctive rust-colored silicified silty zones vary from silty laminations to massive, irregular, poorly bedded blobs 1 m or more across to nodular, silty chert similar to those of the Notch Peak Limestone. Beds range from 2 to 100 cm thick to massive intervals. Rare flat-pebble conglomerates are present, as well as some bioclastic beds containing brachiopods, trilobite hash, and nautiloids, and some beds containing ichnofossils of unorganized, horizontal burrowing or castings.

Overlying the above subunit is yellow to gray, slope-forming, well-bedded, poorly exposed heterogeneous limestone containing several intervals similar to other units in the Pogonip Group. Intervals vary from tan, sandy, yellow-weathering cross-bedded limestones, to silty, flat-pebble conglomerates, to more resistant silty/cherty beds, to cliff-forming, well-bedded (2-4 cm thick) limestone and dark-brown, intensely fossiliferous silty limestones. This unit becomes more fossiliferous upsection, as does the Pogonip Group as a whole.

Above this heterogeneous unit is medium-blue-gray, ledge- to cliff-forming, non-cherty, bioclastic, bioturbated, micritic limestone with silty interbeds. The thickness of bedding ranges from 2 to 40 cm. About 50% of the beds are fossiliferous, containing crinoids, gastropods, brachiopods, trilobite hash, and straight and coiled nautiloids.

Near the top is a subunit of yellowish brown, slope forming, thinly bedded, shaly to silty limestone containing beds of dark-brown, coarsely bioclastic limestone composed of phosphatic brachiopods and echinoderm spines, as well as the characteristic fauna of the Pogonip Group cited above. Near the top of the section are blue or brown-gray, micritic limestones that contain beds that almost entirely consist of brachiopods, ostracods, coiled nautiloids, or other fossil types. The siltstone/shale beds are almost never seen in outcrop and instead form a distinctive brown, coarse primitive soil that can contain well-preserved brachiopods, a distinctive species of tabulate coral, and other fossils.

The topmost subunit is medium blue-gray, ledge/slope-forming, thinly bedded (2-5 cm thick), fossiliferous, often mottled limestone with silty partings. This subunit contains some fossiliferous (trilobite debris) flat-pebble conglomerates, some beds of horizontal trace fossil burrows and numerous death assemblages containing generally one type of organism: brachiopods, trilobites, bryozoa, ostracods, or coiled nautiloids. This unit seems to have the highest faunal diversity of the Pogonip Group.

In the lower plate, the lower Pogonip Group consists of light-yellow to tan, coarse-grained, slightly micaceous, well-foliated marble.

Cn **Upper Cambrian Notch Peak Limestone** In the upper plate, the Notch Peak Limestone is medium-gray, fine- to medium-grained, cliff- to ledge-forming, bedded (typically 1-6 cm, and as much as 30 cm thick) cherty limestone. Typically the limestone contains 1- to 2-cm-thick, rust- to brown colored chert nodules in beds 2 to 4 cm apart, but variations include sporadic chert nodules in massive limestone and massive to thinly bedded limestone without chert. Bedding, defined by silty interlayers, can be irregular to well developed. Locally, the lowest 5 m of the Notch Peak Limestone consists of buff, fine- to medium-grained limestone, designated the Barton Canyon Member of Young (1960). Medium- to dark-brown, ledge-forming, medium-grained, chert-poor dolomitic intervals are common in the middle part of the unit. The upper part of the Notch Peak Limestone contains several variations in lithology. These include intervals of silty, chert-poor, well-bedded (1-3 cm thick) limestone, dark-gray limestone beds with mauve mottling 2 to 4 cm thick, and tan, buff, and gray blocky limestone beds containing well-preserved trilobite genal spines and pygidia. Within more massive intervals are lenses and beds of dark-gray, bioclastic limestone. The uppermost section is light-gray, massive to poorly bedded, chert-poor, cliff-forming, fossiliferous limestone. Fossils include commonly observed brachiopods, gastropods, trilobites, crinoids, and stromatolites, as well as scarce echinoids.

In the lower plate, the Notch Peak Limestone is light- to dark-gray and white banded, ledge- to cliff-forming, cherty, well foliated marble. The base of this unit typically consists of a distinctive 1.5- to 6-m-thick, generally coarse-grained, pure white marble that corresponds to the Barton Canyon member of Young (1960) in unmetamorphosed sections. Above this member is platy to non-platy, fine-grained marble containing laterally discontinuous beige and light-gray to brown and rust-colored chert stringers and nodules that have been thinned and stretched parallel to the foliation. The uppermost part of the unit is light-gray to light-yellow, coarse-grained, non-chert-bearing, slightly micaceous-bearing marble. This unit contains a well-developed, shallow-dipping mylonitic foliation, defined by color banding, and a moderately developed stretching lineation, defined by elongate calcite grains and strung-out chert nodules.

Cd **Upper Cambrian Dunderberg Shale** In the upper plate, the Dunderberg Shale is platy, well-bedded, poorly exposed, slope-forming interbedded khaki/olive green, somewhat bioclastic shale and dark-gray, fine- to medium-grained, fossiliferous limestone with dark-red-brown interbeds and mottlings. Bedding in the limestone is typically 0.5 to 1.0 cm thick. Generally, all that is seen of this unit is limestone float, with a brown to rust-colored siltstone coating. The limestone contains phosphatic inarticulate brachiopods and trilobite debris.

In the lower plate, the Dunderberg Shale is a light- to dark-brown, slope-forming, thinly laminated to platy calc-schist/calc-silicate rock. Small (<2 mm across) white mica/phlogopite flakes are common on parting surfaces. The middle part of the unit is a calc-schist containing large (up to 0.5 cm across) brown magnesium-rich biotite porphyroblasts (Ann_{45}) (Lee, 1990) and includes the mineral assemblage clinozoisite + muscovite + quartz ± plagioclase ± calcite ± sphene. The uppermost part of the unit is fine-grained, finely laminated, yellow-tan and gray marble with brown chert stringers and nodules that grades into the overlying Notch Peak Limestone.

Cm **Middle Cambrian limestone, undifferentiated** In the upper plate, the Middle Cambrian limestone is thick, medium- to light-gray, massive to thickly bedded and cliff-forming limestone. In the northern Snake Range, this unit lacks its depositional base due to truncation by the northern Snake Range décollement. The uppermost part of the Middle Cambrian limestone typically forms prominent white cliffs beneath the Dunderberg Shale. It is cliff-forming, light-gray, thickly bedded (1-2 m thick), nearly micritic limestone. Below this upper part is dark-brown-gray, slope- to ledge-forming, thinly bedded (2-4 cm thick), sparsely fossiliferous (trilobites and phosphatic brachiopods), bioturbated (burrows) limestone with yellow silty intervals and partings overlain by slope-forming, well-bedded, light- to medium-gray dolomites. This section contains an approximately 1- to 3-m-thick distinctive interval of 0.2 to 0.7 m thick beds of yellow-tan, ledge-forming, massive, silty limestone beds. Below is medium-gray, cliff-forming, massive, evenly banded, recrystallized micrite limestone. The laterally continuous banding (about 1 m thick) is formed by the dark resistant silty/dolomitic laminations. The underlying section forms light-gray, thick-bedded (2-4 m thick), nearly vertical cliffs of recrystallized micrite limestone. This section shows internal variation that includes beds containing thin zones (<1 m thick) of laterally continuous, dark-brown resistant silty/dolomitic laminae (spaced 5-10 m apart); other beds contain evenly distributed, filamentous silty/dolomitic stringers (1 mm by 1 mm by 10-60 mm); and others contain sporadic silty/cherty nodules. The basal section consists of medium-gray to yellow-buff, cliff-forming, massive, fenestral, recrystallized, micritic limestone with irregular zones (0.5-1.5 m thick) containing resistant dark-brownish-gray silty/dolomitic laminations. This section contains two darker-gray, massive subsections with well-bedded dark-brown silty intervals. This section showed several tens of meters of dark-gray, massive limestone containing fenestra, occasional cross-bedding and oolitic intervals, sparse girvanella, and increasing amounts of silty/dolomitic laminae (about 1 cm thick and 1-3 cm apart) upsection.

In the lower plate, marbles and calc-schists correlative with Middle Cambrian strata in the upper plate are the Raiff Limestone, the Monte Neva Formation, and the Eldorado Limestone of Young (1960).

Cr **Middle Cambrian Raiff Limestone** The Raiff Limestone is predominantly dark-gray and light-gray, coarse-grained, platy, slope- and ledge-forming, well-foliated marble alternating with white to light-gray, massive, coarse-grained dolomite. The dolomite is quite distinctive in that it is not foliated. The middle portion of the unit contains a thin interval of gray to light-brown, biotite porphyroblast (up to 0.5 cm across) bearing calc-schist/calc-silicate. The unit is typically capped by white to light-gray, massive to laminated pure marble.

Cmn **Middle Cambrian Monte Neva Formation** The Monte Neva Formation is a medium- to dark-brown, slope-forming, medium- to coarse-grained, platy calcareous schist. The base is typically characterized by an approximately 2.5 m thick, laterally discontinuous dark-brown, fine-grained muscovite and biotite graphitic phyllite/schist. The predominant calcareous schist contains a variable mineral assemblage of large brown magnesium-rich biotite books (up to 0.5 cm across), smaller tabular clinozoisite porphyroblasts on parting surfaces as well as quartz + calcite ± plagioclase ± tremolite ± sphene. The unit is typically capped by a thin platy, less silty section that contains light- to medium-gray limestone interlayered with light-brown calcareous schist layers that contain small (<2 mm across) muscovite/phlogopite grains.

Ce **Middle Cambrian Eldorado Limestone** The Eldorado Limestone is predominantly white- and blue-striped, slope- to ledge-forming, fine- to coarse grained, massive to finely foliated pure marble. The base of the unit is characterized by dirty-white to light-tan silty marble interlayered with thin (1-5 cm) white mica-bearing schist layers and calcareous-schists. This basal silty section grades upwards into the predominant pure blue- and white-striped marble. The upper third of the unit contains meter-scale, irregular-shaped blocks of coarse-grained, white to light-gray to blue, massive dolomite. This unit has nearly the same characteristics as the Raiff Limestone; the most distinguishing feature of the Eldorado Limestone is that it contains fewer dolomite intervals. Foliation is defined by silty layers in the basal section and by alternating blue and white (millimeter to centimeter scale) bands in the marble. Minor constituents minerals in the marble are biotite, phlogopite, sphene, and tremolite.

Cpi **Lower Cambrian Pioche Shale** The Pioche Shale is a slope-forming unit that can be subdivided into three subunits. The basal unit is garnet-bearing, medium- to coarse-grained biotite + muscovite + quartz schist that grades upwards into subunit 2, a fine-grained biotite + muscovite + chlorite phyllite. Subunit 3 may contain thin interlayers of gray to gray-blue marble, which is gradational with the overlying Eldorado Limestone, or it may contain 5- to 15-cm-thick layers of fine- to medium-grained calc-silicate rock containing amphibole + diopside + epidote + calcite + quartz + plagioclase. The amphibole is commonly coarse-grained (up to 5 cm in length), forming radiating grains on parting surfaces.

Cpm **Lower Cambrian Prospect Mountain Quartzite** The Prospect Mountain Quartzite is rust-brown to tan, cliff- to talus-forming quartzite. The quartzite contains minor amounts of muscovite (both dispersed and on micaceous partings), feldspar, opaque minerals and occasional thin (<2 cm) pebble-bearing horizons. Contact with the overlying Pioche Shale is gradational as the quartzite becomes increasingly schistose at the top, with thin (1-5 cm thick), medium- to coarse-grained, garnet-bearing, muscovite + biotite + chlorite + quartz schistose layers becoming more common. The foliation is defined by micaceous minerals and flattened quartz grains, and the stretching lineation is defined by elongate quartz grains and pebbles.

Intrusive Rock Units

Tertiary rhyolite porphyry dikes Tertiary rhyolite porphyry dikes are composed of phenocrysts of quartz + plagioclase ± muscovite ± minor biotite in a fine-grained groundmass of quartz and plagioclase. A swarm of north-trending dikes are exposed in the northeastern part of the quadrangle; smaller exposures occur to the west and south. These dikes crosscut the pegmatite-aplite body exposed in Eightmile Canyon (see below). The dikes in this quadrangle appear undeformed and crosscut the map-scale fold and associated axial planar, S_1 foliation, as well as the S_2 foliation. To the east where the Tertiary ductile strain is considerably greater, dikes of this composition contain a shallow dipping mylonitic foliation, S_2, and a west-northwest-trending stretching lineation. Dikes from the swarm yielded an age of 36.9±0.3 Ma ($^{40}Ar/^{39}Ar$ on muscovite), which is interpreted as an intrusive age (Lee and Sutter, 1991), thus placing a minimum age on formation of the fold and on mylonitic deformation along the western flank of the range (Lee, 1995).

Tertiary(?)-Cretaceous(?) mafic dikes Sills and dikes of mafic composition consist of fine- to medium-grained hornblende + biotite + plagioclase + quartz-bearing dacites and fine- to medium-grained plagioclase + hornblende ± biotite ± clinopyroxene ± quartz-bearing diorites to quartz diorites. The dikes in this quadrangle are undeformed, but elsewhere in the northern Snake Range they are variably deformed by the Tertiary mylonitic fabric. The lack of a penetrative deformational fabric is probably a function of the low magnitude of strain associated with the deformational fabrics, the competence contrast between the dikes and country rocks, and age of dike intrusion relative to age of deformation. The dikes are of unknown absolute age.

TKpa **Tertiary(?)-Cretaceous(?) pegmatite and aplite** These pegmatites and aplites are exposed as a small body in Eightmile Canyon and as small dikes and sills to the northwest and east. These aplites and pegmatites contain medium- to coarse-grained quartz + plagioclase + microcline + muscovite. The main body of these pegmatites and aplites is undeformed, but small apophyses appear to be boudinaged within the S_1 foliation. Thus, the relative age of emplacement of this body and formation of the S_1 foliation is unclear. A small muscovite-bearing rhyolite porphyry dike crosscuts the aplite and pegmatite body. Muscovite from the small aplite and pegmatite body yielded an $^{40}Ar/^{39}Ar$ plateau age of 48.3±0.3 Ma (Lee and Sutter, 1991), probably a cooling age following emplacement. These pegmatites and aplites may be part of a pegmatite and aplite swarm exposed elsewhere in the northern Snake Range that yielded an age of 82 Ma (U/Pb on monazite) (Huggins and Wright, 1989; Huggins, 1990).

See accompanying text for figures, references, and a discussion of the geologic setting, previous work, geology, and structural history of this quadrangle.

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 Third Butte East 7.5' Quadrangle, 1986

Contact Dashed where approximately located, dotted where concealed, queried where speculative; in cross section, short dashes indicate bedding.

Normal fault Dashed where approximately located, dotted where concealed, queried where uncertain; ball on downthrown side; arrow indicates dip and dip direction of fault plane.

Thrust fault Dashed where approximately located, dotted where concealed, queried where uncertain; sawteeth on upper plate.

Northern Snake Range décollement Dashed where approximately located, dotted where concealed, queried where uncertain; squares on upper plate.

Surface trace of axial surface

Synform — Overturned

Antiform — Overturned

Strike and dip of bedding

Inclined — Vertical

Showing trend and plunge of lineation.

Inclined — Horizontal

Strike and dip of metamorphic foliation

Inclined — Vertical

Showing trend and plunge of intersection/elongation lineation.

Inclined

QUATERNARY: Qal, Ql, Qt, Qla, Qol

TERTIARY: Lower Plate Intrusive Rocks; TKpa

CRETACEOUS

SILURIAN: Upper Plate: SO

ORDOVICIAN: Oe; Lower Plate: Op

CAMBRIAN — Upper: Cn, Cd; Middle: Cr, Cmn, Cm; Lower: Ce, Cpi, Cpm

QUADRANGLE LOCATION

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Office review by:
Chris Henry, NBMG
Eric Seedorff, BHP Copper North America
Art Snoke, University of Wyoming

Field review by:
Chris Henry, NBMG
Eric Seedorff, BHP Copper North America

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Printed by Bear Industries, Sparks, NV
Edited by Dick Meeuwig
Cartography by Robert Chaney and Susan Tingley

Nevada Bureau of Mines and Geology
University of Nevada, Mail Stop 178
Reno, Nevada 89557-0088
(775) 784-6691, ext. 2
nbmgsales@unr.edu, www.nbmg.unr.edu