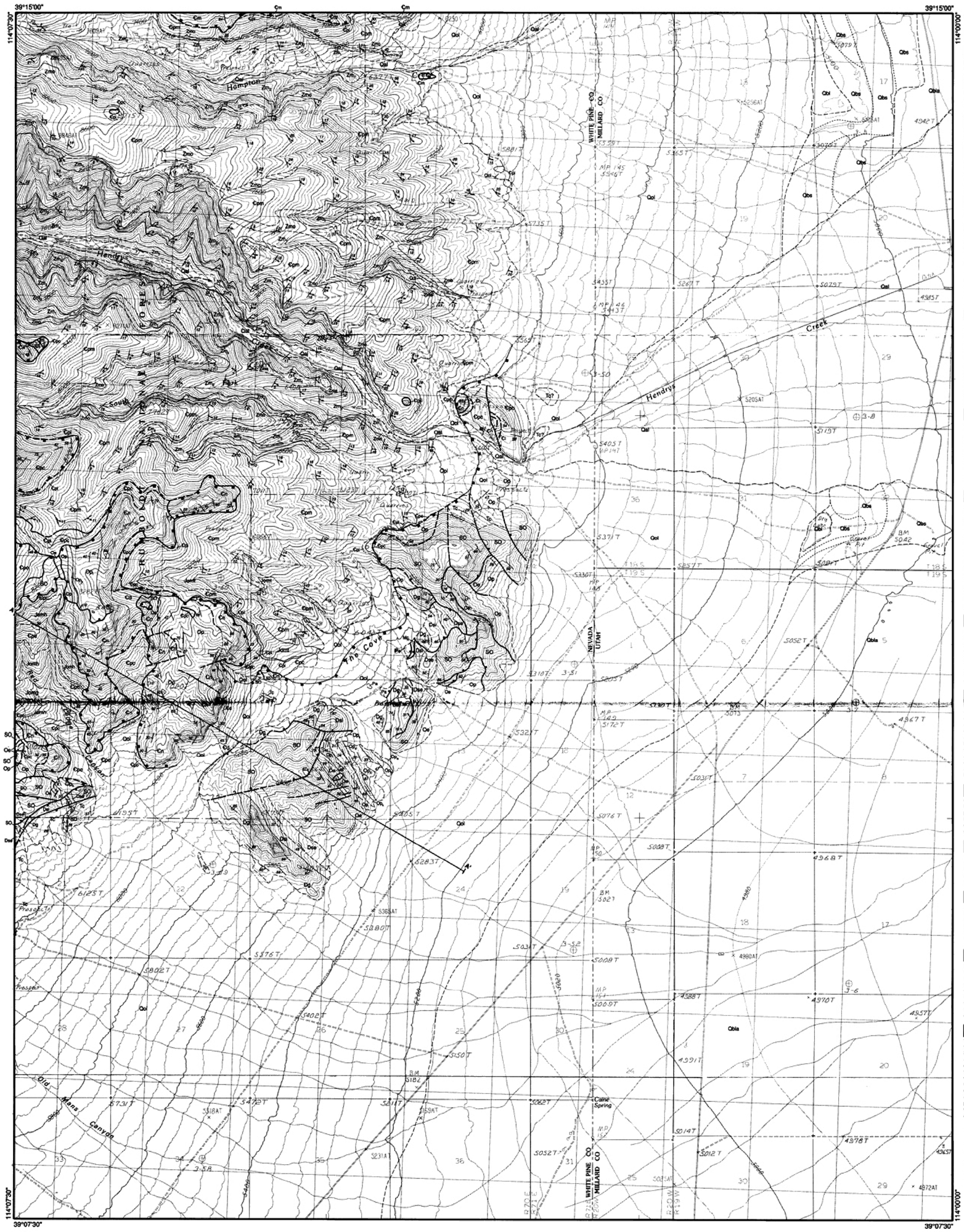


Stratified Rock Units

Qal **Quaternary alluvium** Generally unconsolidated sand and gravel deposited within modern drainage systems.

Qbla **Quaternary Lake Bonneville lacustrine and alluvial deposits** Undifferentiated sand, gravel, marl and, in general, older sediments reworked by Lake Bonneville during its existence 10,000 to 32,000 years ago.

Qbs **Quaternary Lake Bonneville sand and gravel** Shoreline beach and bar deposits related to Lake Bonneville, including sand and gravel spits formed during the high stand of the lake by wind, current, and wave activity. Dotted contacts within Qbs are mapped shorelines.

Qbl **Quaternary Lake Bonneville lagoonal deposits** Fine-grained marly sediments deposited in lagoons behind gravel and sand beaches and bars related to Lake Bonneville.

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

Tc **Tertiary conglomerate** Tilted alluvial fan conglomerate and gravel. In the adjacent Old Mans Canyon Quadrangle to the west, a uniformly dipping section of conglomerate is at least 1,500 m thick as measured in the Miller Wash region (Grier, 1984). Lensoidal masses of brecciated Paleozoic strata tens of meters up to more than a kilometer in dimension occur mostly within the Tertiary lacustrine section but are present in Tertiary conglomerate in The Cove Quadrangle. Some blocks are monolithologic, whereas others consist of several identifiable Paleozoic units. Because they are encased within the Tertiary section, they are interpreted by us and previously by Hose and Whitebread (1981) to be displaced landslide masses of bedrock or rock avalanche deposits. Fission-track analyses of apatite separated from granitic and metamorphic boulders in tilted conglomerate exposed in the Old Mans Canyon Quadrangle yielded middle Miocene ages (Miller and others, 1989, 1990).

Tl **Tertiary lacustrine limestone** Underlies and laterally interfingers with Tertiary conglomerate (Tc), mostly exposed in the adjacent quadrangle to the west. The unit is described in detail by Grier (1983, 1984). The section is between 300 and 640 m thick and consists of yellow- to tan ledgy slope-forming limestone interbedded with white, friable marl. Thin sandstone beds occur intermittently throughout the unit. Lensoidal masses of brecciated Paleozoic strata, tens of meters up to more than a kilometer in dimension, occur within the Tertiary lacustrine section. Some blocks are monolithologic, whereas others consist of several identifiable Paleozoic units. As they are encased within the Tertiary section, they are interpreted by us and previously by Hose and Whitebread (1981) to be displaced landslide masses of bedrock or rock avalanche deposits.

Pa **Permian Arcturus Formation** Regional reported thickness for the Arcturus Formation is about 1,150 m. The Arcturus Formation is predominantly a tan to white, slope-forming, fine-grained quartzose sandstone with occasional brown-gray, ledge-forming, fossiliferous, medium- to coarse-grained, thin-bedded to massive limestone. The sandstone varies from a moderately to well-sorted, poorly cemented quartzose sandstone, to a poorly sorted, calcite cemented sandstone and to a silica-cemented orthoquartzite. Limestone increases in abundance upsection and contains the diagnostic fossils mollusks and hexagonal colonial corals. Black chert nodules are common.

IPe **Pennsylvanian Ely Limestone** Regional reported thickness of the Ely Limestone is about 550 to 820 m. The Ely Limestone is a tan-gray to brown-gray, ledge- to cliff-forming, bioclastic to fossiliferous, medium- to coarse-grained limestone that can be massive, thickly bedded (>1 m) or well bedded (1.0-4.0 cm), with bedding defined by silty partings. Some of the lower sections contain up to 50% well-bedded, generally black, but also white and reddish-brown, chert stringers and nodules. Chert also occurs in large irregular-shaped patches with no apparent relationship to bedding. Fossils within the Ely Limestone include large, well-preserved brachiopods, crinoids, bryozoa, rugosan cup corals, and pelecypods. Silty limestone, silt interbeds, and sandstone lenses increase in abundance upsection. Sandstone lenses are composed of fine-grained quartzose sand and are discontinuous laterally on the order of meters to tens of meters. These lenses only form a small proportion (~15%) of the limestone and silty limestone section that is characteristic of the bulk of the Ely Limestone.

Mc **Mississippian Chainman Shale** Reported regional thickness of the Chainman Shale is about 210 to 610 m. The Chainman Shale is brown/black, slope-forming shale containing thin beds (0.5-1.5 cm thick) of tan limestone and limestone concretions around fossil shells. Outcrop is scarce, and the shale is identified by the distinctive chocolate-brown to black soil that forms as the shale weathers. An interval of reddish-weathering quartz sandstone beds that are much more resistant than the surrounding shales occurs within the Chainman Shale exposures in the adjacent Old Mans Canyon Quadrangle.

Dg **Devonian Guilmette Formation** Regional thickness reported for the Guilmette is 780 m. The Guilmette Formation consists of fine- to medium-grained limestone and dolomites. The base is generally light- to medium-gray, massive cliff-forming, micritic to very finely recrystallized, mottled, somewhat fossiliferous limestone. Fossils include gastropods, crinoids, and brachiopods. This part of the formation contains solution collapse breccias. The formation becomes better bedded upwards, where fine-grained gray limestone alternates with medium- to dark-brown, coarse-grained dolomite. Fossils are abundant and include stromatoporoids, brachiopods, crinoids, gastropods, and corals. The top of the formation is richer in limestone, and the uppermost portion is a highly burrowed, platy limestone.

Dsi **Devonian Simonson Dolomite** Regional thickness reported for this unit is 175 m. The Simonson Dolomite consists of light- to dark-brown, thin- to medium-bedded, laminated, microcrystalline to coarsely crystalline dolomite. Basal part is thicker bedded and uniformly light brown. The upper part is strikingly laminated with alternating light-brown and dark-chocolate-brown layers on a centimeter scale. Fossils include gastropods, crinoids, and brachiopods.

Dse **Devonian Sevy Dolomite** The regional thickness reported is 245 m. The Sevy consists of distinctive white-weathering, light-gray, thin- to medium-bedded, very fine-grained, nonfossiliferous, laminated dolomite. Diagnostic dark-brown-weathering stringers of well-rounded coarse- to medium-grained quartz sand occur in the Sevy. The Sevy Dolomite is noted for its lack of fossils.

SO **Silurian and Ordovician Fish Haven and Laketown Dolomites, undifferentiated (SO dolomite)** Regional reported thickness for the combined Fish Haven and Laketown Dolomites is about 460 m. The lower part is medium- to dark-brown dolomite with some stromatolitic, fossiliferous, and cherty intervals; the upper part is light-brown, coarse-grained dolomite. Fossils include colonial corals, rugose, tabulata, and stromatolites.

Oe **Ordovician Eureka Quartzite** Regional thickness reported for the Eureka Quartzite is about 135 m. The Eureka Quartzite is white, orange-brown to dark-brown-weathering cliff-forming, well-sorted, well-rounded, fine- to medium-grained, thick-bedded orthoquartzite. It is a distinctive stratigraphic marker, occurring as it does between dark dolomites above and the yellow-weathering gray, slope-forming limestone of the underlying Pogonip Group. The Eureka Quartzite also commonly occurs as thin, brecciated, fault-bound slivers. It is so resistant that large boulders of quartzite are common on slopes below outcrops of the formation.

Op **Ordovician Pogonip Group (undifferentiated)** Regional thickness for the Pogonip Group is about 460 to 500 m. The Pogonip Group 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 that are abundant in the Pogonip Group include brachiopods, ostracods, coiled nautiloids, and tabulate corals. Due to areal variations within the group, various authors have divided the Pogonip Group into different formations. In the northern Snake Range it is most convenient to follow the nomenclature of Fritz (1968), who divided the Pogonip Group into six units: A, B, C, D, Kanosh Shale, and Lehman Formation. Where exposure and sequence permitted, the Pogonip was subdivided according to the map units below, where this was not possible, it was mapped simply as Op.

Op_L **Lehman Formation** The Lehman Formation is medium blue-gray, ledge/slope-forming, thinly bedded (2-5 cm thick), fossiliferous, often mottled limestone with silty partings. This unit 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.

Op_K **Kanosh Shale** The Kanosh Shale is yellowish-brown, slope-forming, thinly bedded, shaly to silty limestone with beds of dark-brown, coarsely bioclastic limestone containing 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 consist almost entirely of brachiopods, ostracods, coiled nautiloids, or other fossil types. The siltstone/shale beds are almost never seen in outcrop, rather form a distinctive brown, coarse primitive soil that can contain well-preserved brachiopods, a distinctive species of tabulate coral, and other fossils.

Op_D **Pogonip Group Unit D** Unit D is medium blue-gray, ledge- to cliff-forming, non-cherty, bioclastic, bioturbated, micritic limestone with silty interbeds. Bedding ranges from 2 to 40 cm thick. About 50% of the beds are fossiliferous, containing crinoids, gastropods, brachiopods, trilobite hash, and straight and coiled nautiloids.

Op_C **Pogonip Group Unit C** Unit C is yellow to gray, slope-forming, well-bedded, poorly exposed heterogeneous limestone containing several intervals similar to other units in the Pogonip Group. Some intervals are tan, sandy, cross-bedded limestones, some are yellow-weathering, silty, flat-pebble conglomerates similar to unit A, some are more resistant silty/cherty beds as are found in unit B, some are cliff-forming, well-bedded (2-4 cm thick) limestones as are found in unit D and some are dark brown, intensely fossiliferous silty limestones as are found in the Kanosh Shale. This unit becomes more fossiliferous upsection, as the does the Pogonip Group as a whole.

Op_B **Pogonip Group Unit B** Unit B is 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 Formation. 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.

Op_A **Pogonip Group Unit A** Unit A 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.

Cn **Cambrian Notch Peak Limestone** Regional reported thickness is about 485 to 550 m. 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-colored to brown chert nodules in beds 2 to 4 cm apart, but variations include 2- to 3-cm-thick nodular chert beds 2 to 3 cm apart, 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. Brachiopods, gastropods, trilobites, crinoids, and stromatolites are common, and echinoids are scarce.

Cd **Cambrian Dunderberg Shale** Regional reported thickness for the Dunderberg is about 20 to 100 m. The Dunderberg is distinctive olive-gray to dark-brown fissile calcareous shale and siltstone. Coarsely clastic limestone with abundant trilobite hash occurs near the base.

Cl **Cambrian Lincoln Peak Limestone** Regionally, the Lincoln Peak Limestone is about 1,220 to 1,370 m thick. The Lincoln Peak Limestone is medium- to dark-gray, thinly bedded, platy weathering, slope-forming silty limestone. Silty intervals and chert stringers weather distinctly brown. This unit contains sparse trilobite hash and oncolites.

Cpc **Middle Cambrian Pole Canyon Limestone** Reported to be about 500 to 550 m thick regionally, the Pole Canyon Limestone is alternating white, light-gray, to blue-gray to dark-gray, cliff-forming limestone with girvanella, fenestral, and oolitic horizons. The formation contains a number of thick (meters to tens of meters) silty intervals with discontinuous silty partings between thin dark-gray limestone beds. Locally thinner intervals of shale are present as well. In The Cove Quadrangle, the Pole Canyon Limestone is metamorphosed to marble and calc-silicate-bearing rocks where it is intruded by Jurassic granitic rocks within the lower plate of the NSRD (northern Snake Range décollement). Spectacular mylonites with abundant isoclinal and sheath folds are developed in these marbles. The Pole Canyon Limestone is also weakly deformed and variable metamorphosed where it occurs the upper plate. This is especially true of the lower parts of the section exposed above the NSRD in the western part of the quadrangle.

Cm **Middle Cambrian limestone, undifferentiated** Just north of The Cove Quadrangle, the above formational designations for the Middle Cambrian break down and other formational names are utilized. We have used the designation Cm for Middle Cambrian carbonates in small exposures in the very northernmost part of The Cove Quadrangle where identification and unit designation were not possible.

Cpl **Lower Cambrian Pioche Shale** The Pioche Shale forms an important lithologic transition between dominantly clastic Lower Cambrian and older strata and the overlying clastic-absent Middle Cambrian limestone section. In the map area, the Pioche occurs only in the lower plate, where it is highly deformed and metamorphosed to biotite- and muscovite-bearing psammite, schist- and calc-silicate-bearing rocks, obscuring original bedding and sedimentary structures. It is gradational with the overlying Pole Canyon marbles and underlying Prospect Mountain Quartzite in many places. Regionally, the Pioche Shale consists of dark siltstone, sandy siltstone, and calcareous quartzite that is greenish gray to khaki colored, is mostly thin bedded, and is about 90 m thick in the southern Snake Range.

Cpm **Lower Cambrian Prospect Mountain Quartzite** A complete section of the Prospect Mountain Quartzite is present in Hendry's Creek, where it lies in gradational contact below the Pioche Shale and above the Osceola Argillite, the uppermost unit of the Late Proterozoic McCoy Creek Group. The regional reported thickness of the Prospect Mountain Quartzite is about 1,525 m, but in the lower part of Hendry's Creek the formation is attenuated by ductile deformational processes and is about 100 m thick or less, less than one-tenth of its original thickness. In general, the flaggy resistant quartzite beds of the Prospect Mountain Quartzite form impressive buff to reddish-brown cliffs. Sets of vertical joints are conspicuous. Because of the attenuation of individual beds, cross-beds, which are ubiquitous in undeformed equivalents, are difficult to see and are generally reduced to wispy black laminations parallel to the tectonic foliation in the rocks. Coarse mica-rich partings occur between the flaggy quartzite layers. In thin section, the Prospect Mountain Quartzite is a quartz mylonite; its quartz fabrics in Hendry's Creek have been studied in some detail (Marks, 1994; and Lee and others, 1987). The Prospect Mountain Quartzite is distinguished from similar quartzite units in the underlying McCoy Creek Group by its general lack of pebble conglomerates (thin horizons are, however, occasionally present), by lack of pelitic intervals, and by its thinner and more regular flaggy bedding.

Late Proterozoic McCoy Creek Group

Zmo **Osceola Argillite** The Osceola Argillite is well exposed in the Hendry's Creek drainage, where its attenuated thickness is about 12 to 20 m. Upper and lower contacts with the Prospect Mountain Quartzite and McCoy Creek Group unit 2 are concordant and gradational. The Osceola Argillite is typically muscovite-rich, silvery-gray to gray-blue schist, which, depending on metamorphic grade, contains chlorite, biotite, cordierite, kyanite, garnet, and/or staurolite. Accessory minerals include ilmenite, hematite, tourmaline, apatite, epidote, zircon, and monazite (Huggins, 1989). It is distinguished from other schist units lower in the succession by its general absence of coarser clastic horizons and by its highly aluminous composition. In the Hendry's Creek drainage, the Osceola Argillite typically contains a greenschist-facies assemblage that includes muscovite, chlorite, and biotite. The Osceola Argillite in less metamorphosed and deformed sections in the southern Snake Range is about 200 m thick and consists of well-bedded to laminated slates and siltstone that are distinctively green to gray blue, although locally, maroon colors are common (Miller and others, 1993).

Zm_1 **Unit 1, quartzite** McCoy Creek Group unit 1 occurs in the lower plate in The Cove Quadrangle, where it is a 30- to 60-m-thick, resistant cliff-former of grayish-white to buff, slightly feldspathic quartzite. Thin conglomeratic horizons are present at the top of the unit. Sets of vertical joints are conspicuous in the lower Hendry's Creek exposures.

Zm_2 **Unit 2, quartzite and schist** Quartzite and schist of McCoy Creek Group unit 2 occurs in the lower plate and consists of a thick succession (about 300 m) of alternating meter-thick intervals of light-gray to buff feldspathic quartzite and grit and coarse muscovite + biotite ± garnet ± staurolite schist. It rests in sharp contact above and beneath with McCoy Creek Group unit 1 and unit 3, respectively. Within the unit, a more quartzite-rich section is a conspicuous cliff-former. Its position within the section, its variable and more feldspathic composition, and its abundant horizons of grit make correlation with the unmetamorphosed successions in surrounding ranges straightforward. In less metamorphosed sections such as those in the southern Snake Range, this unit is a brown-weathering, slope-former with ledge to cliff exposures of more feldspathic or quartz sand-rich intervals. The unit is distinguished from the Osceola Argillite by being more variable in composition and grain size and having abundant unsorted, quartzo-feldspathic grit-bearing horizons. It is a distinctive slope- or ledge/slope-former and lies in sharp and abrupt contact above the underlying massive cliff-forming quartzite of McCoy Creek Group unit 3.

Zm_3 **Unit 3 quartzite** In Hendry's Creek, deformed and metamorphosed quartzite assigned to this unit is about 100 m thick. It is a massive white cliff former with flaggy bedding, distinguished from the younger Prospect Mountain Quartzite by its greater purity and thicker layering. In less metamorphosed sections such as those in the southern Snake Range, this unit is massive, thick-bedded, cliff forming quartzite with an abrupt and sharp upper contact with McCoy Creek Group unit 2. Cross-beds are less common than in the younger Prospect Mountain Quartzite and occasional quartz pebble stringers and horizons are present.

Zm_4, **Zm_5** **Units 4 and 5 schist and quartzite** In Hendry's Creek, beneath the massive quartzite described above, is a schist unit about 100 m thick and a deeper quartzite about 100 m thick, whose base is not exposed. These two units are lithologically similar to Zm_2 and Zm_3 described above and do not have any features that clearly distinguish them from overlying parts of the succession. Because of this, they could represent a repeated part of the succession. In the Hendry's Creek drainage, these are perhaps the deepest stratigraphic levels exposed and, in any case, were the most highly metamorphosed in both the Cretaceous and Tertiary metamorphic events. Schist of McCoy Creek Group unit 4 everywhere contains garnet and staurolite. At uncertain depth beneath the canyon bottom, we indicate Proterozoic crystalline rocks, the inferred depositional base for the McCoy Creek Group.

Intrusive Rock Units

Jurassic Old Mans pluton

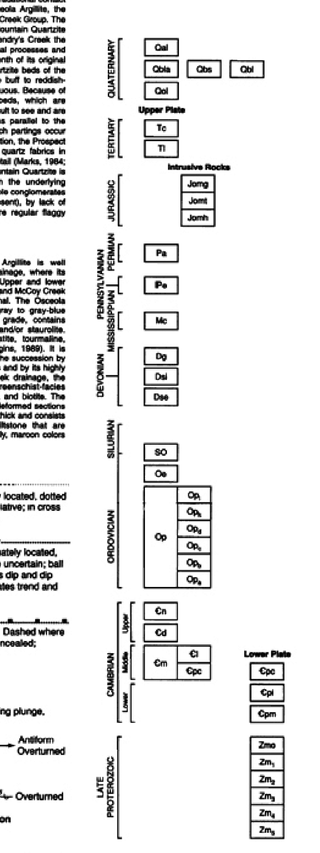
Intrusive rocks of Jurassic age occur in the southwestern most exposures of the lower plate in The Cove Quadrangle and underlie a large region of the adjacent Old Mans Canyon Quadrangle to the west. The eastern exposures of the Jurassic Old Mans pluton are exposed in The Cove Quadrangle. The Jurassic Old Mans pluton is a compositionally diverse suite of igneous rocks that ranges from diorite to granite. Most of the pluton is strongly gneissic, and mylonitic textures and fabrics are common. Strain is heterogeneous within the pluton; local zones of high strain are present, with true mylonites developed. Deformation occurred at greenschist facies conditions; chlorite and epidote are common retrograde minerals after biotite, hornblende, and plagioclase. Feldspars were deformed brittlely, and the degree of gneissic fabric development is compositionally controlled, with plagioclase- and hornblende-rich diorites having undergone the least penetrative strain. The composite Old Mans pluton is one of several similar bodies of Jurassic granitoid rocks in the Snake Range. The other ones are located in the Strawberry-Weaver Creek, Willard Creek and Snake Creek regions of the southern Snake Range (Miller and others, 1993; McGrew and Miller, 1993). Several zircon fractions from three sites in the Old Mans pluton have been dated by the U/Pb method. The zircons have an older inherited Proterozoic component, have undergone lead loss since crystallization, and yield discordant ages. Collectively, the geochronologic data and field relations suggest intrusion of the Old Man pluton at about 155±5 Ma (J. E. Wright, unpub. data).

Jomg **Jurassic Old Mans granite** Lesser biotite granite occurs within the composite Old Mans pluton as dikes, sills, and smaller bodies in the eastern end of the pluton. Based on crosscutting relations, it is inferred to be the youngest phase present.

Jomh **Jurassic Old Mans hornblende-bearing diorite** Hornblende-bearing tonalite and diorite are present in the eastern part of the plutonic complex. Hornblende-bearing phases of the Old Mans tonalite are gradational with biotite-bearing tonalite; more mafic hornblende diorite is often present as inclusions in tonalite, suggesting that it is the earliest phase of the pluton. Hornblende diorite is often coarse-grained and little deformed, contains variable amounts of plagioclase, hornblende, and lesser biotite with accessory epidote, sphene, allanite, apatite, and zircon.

Jomt **Jurassic Old Mans tonalite** Tonalite forms the main portion of the Old Mans pluton in the adjacent quadrangle to the west. It is a dark-brown-weathering rock that forms the dark slopes beneath the décollement along the southern flank of the range. The tonalite is coarse-grained, with a strongly gneissic to mylonitic fabric. It contains approximately 20 to 30% quartz, 40 to 50% plagioclase, 20 to 30% biotite, and little or no potassium-feldspar. Potassium-feldspar phenocrysts are present in patchy areas throughout the pluton. The tonalite can be locally intensely mylonitic. Accessory minerals include ilmenite, hematite, tourmaline, apatite, epidote, zircon, and allanite and lesser apatite and zircon.

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



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; full arrow indicates dip and dip direction of fault plane, half arrow indicates trend and plunge of fault striation.

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

Slide block Tics on slide block side

Surface trace of axial surface Showing plunge, dashed where approximately located.

Synform Overturned — Antiform Overturned

Strike and dip of bedding

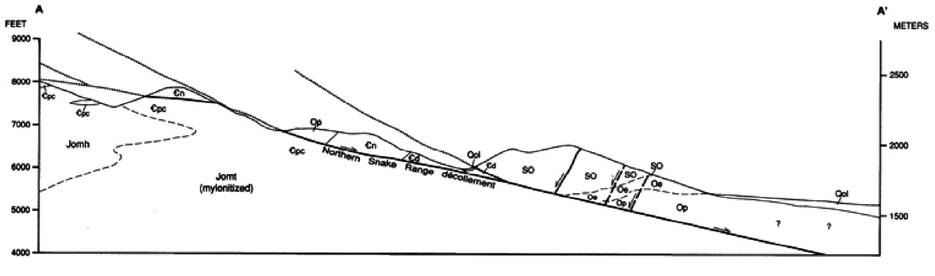
Inclined — Vertical — Overturned

Strike and dip of metamorphic foliation

Inclined

Showing trend and plunge of intersection/elongation lineation.

Inclined



GEOLOGIC MAP OF THE COVE QUADRANGLE, NEVADA AND UTAH

Elizabeth L. Miller and Phillip B. Gans

1999

INDEX TO SNAKE RANGE GEOLOGIC MAPS

1. Third Butte East, FS-16
2. Mormon Jack Pass, FS-17
3. Spring Mountain, FS-18
4. Mount Moriah, FS-19
5. Little Horse Canyon, FS-20
6. Old Mans Canyon, FS-21
7. The Cove, FS-22

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 The Cove 7.5' Quadrangle, 1986

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