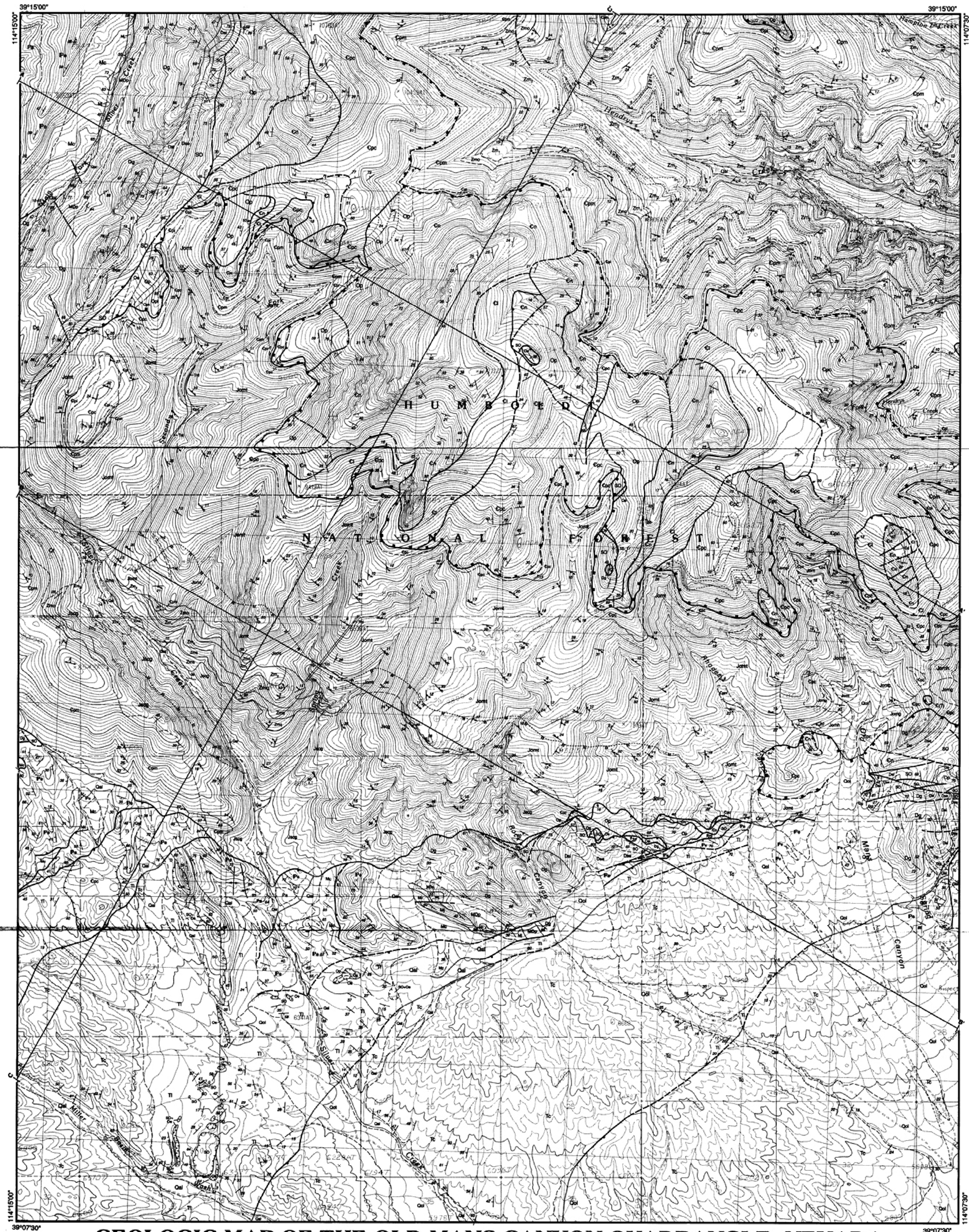

GEOLOGIC MAP OF THE OLD MANS CANYON QUADRANGLE, NEVADA

Elizabeth L. Miller, Phillip B. Gans, Susan P. Grier, Carey C. Huggins, and Jeffrey Lee

1999

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 Old Mans Canyon 7.5' Quadrangle, 1986

QUADRANGLE LOCATION

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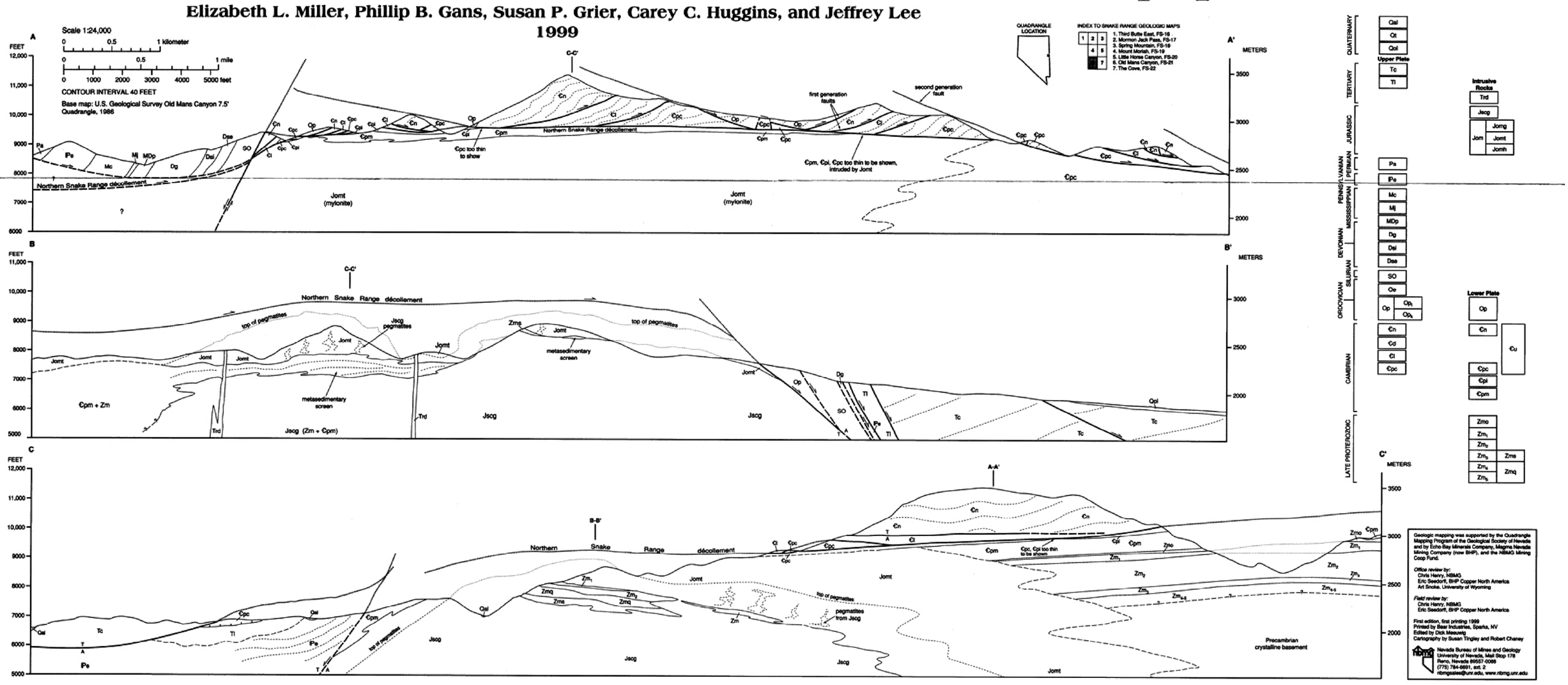

Stratified Rock Units

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

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

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 drainages. Clast types and morphology of these deposits reflect derivation from the major present-day drainage systems developed in flanking mountain ranges.

Tc **Tertiary conglomerate** Tilted alluvial fan conglomerate, sandstone and lacustrine limestone and marl commonly overlapped or mantled by older alluvium. The unit is well exposed in Miller Wash drainage and on either side of the Silver Creek drainage along the southern flank of the range. A uniformly dipping section of conglomerate is at least 1,500 m thick as measured in the Miller Wash region (Grier, 1984). Fission-track analyses of apatite separated from granitic and metamorphic boulders in tilted conglomerate exposed in the Old Mans Canyon Quadrangle yield middle Miocene ages (Miller and others, 1989, 1990) demonstrating a middle Miocene or younger age for the encasing deposits.

Tl **Tertiary lacustrine limestone** Underlies and laterally interfingers with Tertiary conglomerate (Tc). The unit is described in detail by Grier (1983, 1984). The section is between 300 and 840 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 and blocks of brecciated Paleozoic strata that range from tens of meters up to more than a kilometer in dimension occur mostly 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 (1961) to be displaced landslide masses or rock avalanche deposits.

Pa **Permian Arcturus Formation** Reported regional thickness for the Arcturus Formation is about 1,150 m. The Arcturus Formation is predominantly 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 moderately to well-sorted, poorly cemented quartzose sandstone, to poorly sorted, calcite-cemented sandstone and a silica-cemented orthoquartzite. The fraction of limestone increases upsection and contains diagnostic mollusks and hexagonal colonial corals. Black chert nodules are common.

Pe **Pennsylvanian Ely Limestone** Reported regional thickness of the Ely Limestone is about 550 to 820 m. The Ely Limestone is tan-gray to brown-gray, ledgy 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 with 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 Old Mans Canyon Quadrangle.

Mj **Mississippian Joana Limestone** The regional thickness reported for the Joana Limestone is about 120 m. The Joana Limestone is a resistant unit sandwiched between slope-forming shales of the underlying Pilot Shale and overlying Chainman Shale. The Joana Limestone is a medium-brown-gray, fine-grained, massive to poorly bedded, thin but prominent cliff-forming, bioclastic limestone. Bedding in the uppermost section is thick (0.5-1.5 m) to platy (2-8 cm). Well-sorted, coarse- to medium-grained fossil debris gives the limestone a distinctive granular texture. Occasional intact fossils include large corals, crinoids, pelecypods, and brachiopods. Black, reddish-brown and light-colored chert nodules and bands are locally found and usually define bedding. The contact with the underlying Pilot Shale is abrupt.

MDp **Mississippian-Devonian Pilot Shale** Regional thicknesses reported are from 120 to 245 m. The Pilot Shale is dark gray-green to black, slope-forming, thin-bedded (2 mm to 2 cm thick) calcareous shale and siltstone. The shale contains occasional interbeds of platy, generally nonfossiliferous, fine-grained gray limestone. Locally, trace fossils and fossil hash can be found. Limestone interbeds occur at the base of the unit.

Dg **Devonian Guilmette Formation** The regional thickness reported for the Guilmette is about 760 m. The Guilmette Formation consists predominantly of interbedded limestones and dolomites. The base is generally light- to medium-gray, medium cliff-forming, micritic to very finely recrystallized, mottled, somewhat fossiliferous limestone. Fossils include gastropods, crinoids, and brachiopods. The base of this formation may contain solution collapse breccias. The formation becomes better bedded upwards where fine-grained gray limestone alternates with medium- to dark-brown coarser-grained dolomite. Fossils are abundant and include stromatoporoids, brachiopods, crinoids, gastropods, and corals. The top of the unit is more limestone rich, and the uppermost portion of this unit is highly burrowed, platy limestone that forms a gradational contact with the overlying Pilot Shale.

Dsl **Devonian Simonson Dolomite** Reported regional thickness is about 175 m. This unit consists of light- to dark-brown, thin- to medium-bedded, laminated, microcrystalline to coarsely crystalline dolomite. The basal part is thicker bedded and uniformly light brown. Fossils include gastropods, crinoids, and brachiopods.

Dse **Devonian Sevy Dolomite** Reported regional thickness is about 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. This unit is also noted for its lack of fossils.

SO **Silurian Laketown and Ordovician Fish Haven Dolomites, undifferentiated (SO dolomite)** Regional reported thickness for the combined Fish Haven and Laketown Dolomites is about 460 m. The lower part of this sequence 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** Reported regional thickness for the Eureka Quartzite is about 135 m. 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 sheared out along fault planes. It is such a resistant unit that large, hard boulders of quartzite are common on slopes below outcrops of the unit.

Op **Ordovician Pogonip Group (undifferentiated)** Regional thickness for the Pogonip Group is about 490 to 600 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. Units A, B, C, and D were not distinguished in this quadrangle and the Pogonip Group was mapped simply as Op except where Kanosh Shale and Lehman Formation could be indentified.

Opl **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.

Opk **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 almost entirely consist 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.

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 within stratified units indicate bedding.

Normal fault Dashed where approximately located, dotted where concealed, queried where uncertain; ball on downthrown side; arrow shows trend and plunge of striations.

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

Limit of abundant pegmatite and aplite

Slide block Tics on slide block side

Surface trace of axial surface

Synform Antiform

Strike and dip of bedding

Inclined Vertical Overturned

Strike and dip of metamorphic foliation

Inclined

Showing trend and plunge of intersection/elongation lineation.

Cambrian Notch Peek 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- to brown-colored 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.

Cu **Undifferentiated Cambrian carbonates**

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. The Lincoln Peak is poorly exposed in the map area, forming forested slopes at the higher elevations.

Cpc **Middle Cambrian Pole Canyon Limestone** Reported to be about 500 to 550 m thick regionally, the Pole Canyon Limestone is an 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. Some thinner intervals of shale are present as well. Where mappable, these are shown by a series of dotted lines within the formation boundaries. In the Old Mans Canyon 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 where they occur beneath the NSRD in the eastern part of the Old Mans Canyon Quadrangle. The Pole Canyon Limestone is also weakly deformed and variable metamorphosed where it occurs in an upper plate position. This is especially true of the lower part of the section exposed above the NSRD in the southeastern part of the quadrangle.

Cpi **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. Its thickness is variable but generally less than 20 m. Contacts are 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 upper Hendry's Creek the formation has been ductilely attenuated and is only about 200 m thick, about one-eighth of its original thickness. In the Silver Creek region, the Prospect Mountain Quartzite has been similarly thinned and is intruded by Jurassic granite, which is also deformed. In general, the flaggy, resistant quartzite beds of the Prospect Mountain Quartzite form impressive buff to reddish-brown cliffs. 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. Where visible, cross-beds are highly strained and often exhibit isoclinal and sheath folds. In hand specimen, the quartzite is white to gray to light brown, fine to medium grained, and consists of 90 to 95% quartz, 5% feldspar, and lesser muscovite, chlorite and opaque oxides. Coarse mica-rich partings occur between the flaggy quartzite layers. In this section, the Prospect Mountain Quartzite is a quartzose mylonite. Its quartz fabrics have been studied in some detail (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 (but some thin horizons are present), lack of pelitic intervals, the greater abundance of cross-beds, 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, 1990). 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 dominantly green to gray blue, although locally, maroon colors are common (Miller and others, 1993).

Zm_1 **Unit 1, quartzite** Lower plate exposures of McCoy Creek Group unit 1 in the Old Mans Canyon Quadrangle show considerable variation in composition and thickness. In the Silver Creek drainage, McCoy Creek Group unit 1 is a distinctive, thin, quartz pebble and cobble conglomerate similar in character to but more deformed than the closest correlative exposures in the southern Snake Range. To the north, in the Hendry's Creek drainage, McCoy Creek Group unit 1 is a 30- to 60-m-thick, resistant cliff former of grayish-white to buff, slightly feldspathic quartzite that weathers buff to orange. Thin conglomeratic horizons are present only at the top of the unit. In the southern Snake Range, McCoy Creek Group unit 1 varies in a similar fashion from a thin conglomeratic quartzite, no more than 30 m thick, in the north to a well-bedded quartzite 50 m or more in thickness in the southern part of the range (Miller and others, 1993).

Zm_2 **Unit 2, quartzite and schist** Quartzite and schist assigned to McCoy Creek Group unit 2 occur in the Silver Creek drainage and in the upper reaches of Hendry's Creek, where they consist of a thick succession (about 300 m) of alternating meter-thick intervals of light-gray to buff feldspathic quartzite and grit interbedded with coarse muscovite ± biotite ± garnet ± staurolite schist. Unit 2 rests in gradational but sharp contact above and beneath McCoy Creek Group units 3 and unit 1. Within the unit, a more quartzite-rich section is a conspicuous cliff-former, and its top and bottom within the unit are mapped by dotted lines. The position of McCoy Creek Group unit 2 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 in the southern Snake Range, this unit is a brown-weathering, slope former with ledge to cliff-forming 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 ledgy 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 the upper reaches of 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 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 unit 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 be 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.

Zms **Zmq** **Zms (schist) and Zmq (quartzite)** Where the above units could not be identified with confidence, such as in the screen of metasedimentary rocks between two Jurassic plutons in the Silver Creek drainage of the Old Mans Canyon Quadrangle, the designations Zms and Zmq were used.

Intrusive Rocks

Trd **Tertiary rhyolite dikes and sills** Distinctive pale-colored, reddish-weathering aphanitic rhyolite dikes and sills sharply cut Tertiary mylonitic fabrics in the Jurassic granite in Silver Creek drainage. Flow banding and glassy margins are present in the dikes along their contacts with country rocks. Rare small quartz and biotite phenocrysts occur in a fine-grained groundmass of quartz and feldspar.

Jscg **Jurassic Silver Creek granite** Weakly foliated to gneissic, medium-to fine-grained grained biotite and muscovite-bearing granite with sparse equant potassium-feldspar phenocrysts 0.5 to 1.5 cm diameter. Based on crosscutting relations, inferred to be the youngest intrusive phase of the Jurassic plutonic complex exposed in the Old Mans Canyon Quadrangle. Pegmatite and aplite dikes that are muscovite- and occasionally garnet-bearing are persistently present in a 30-m-wide zone near the top of this pluton and intrude adjacent and overlying metasedimentary and granitic rocks. Their location and association with the upper contact of the Silver Creek granite indicates they are genetically associated with this pluton and are thus assigned a Jurassic age as well.

Jurassic Old Mans Pluton

Jom The Jurassic Old Mans pluton is a compositionally diverse suite of igneous rocks that range 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, which include mylonite development. 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. Based on limited crosscutting relations, it appears that hornblende-bearing phases of the pluton are the oldest and granitic sills and bodies the youngest. The composite Old Mans pluton is one of several similar bodies of Jurassic granitoid rocks in the Snake Range. The others occur in the Strawberry-Weaver Creek, Willard Creek, and Snake-Williams Creek regions of the southern Snake Range (McGrew and Miller, 1992; Miller and others, 1993). Several zircon fractions from three sites in the Old Mans pluton and from one site in the Silver Creek granite have been dated by the U-Pb method. The zircons have an older inherited component of Proterozoic age and also indicate young lead loss. All sites yield discordant ages which, together with field relations, collectively suggest intrusion of both the Silver Creek granite and the Old Mans composite 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 and along the contact with the Silver Creek granite in the Silver Creek drainage. Here, the biotite-bearing tonalite grades to a coarse-grained gneissic biotite granite as one approaches the western margin of the Old Mans pluton. Closer to the contact, muscovite and rare garnet are locally present. Pegmatite and aplite dikes along this contact may be in part border phases related to the Old Mans pluton or, as described above, more likely part of the border phase of the younger Silver Creek granite.

Jomt **Jurassic Old Mans tonalite** Tonalite forms the main portion of the Old Mans pluton. 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, and 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 tonalite, where they are square to tabular in shape and several centimeters in size. Accessory minerals include abundant epidote, sphene, and allanite, and lesser apatite and zircon.

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 commonly present as inclusions in tonalite, suggesting that it is the earliest phase of the pluton. The hornblende diorite is often coarse grained and little deformed, contains variable amounts of plagioclase, and hornblende, and lesser biotite with accessory epidote, sphene, allanite, apatite, and zircon.

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