Stratified Rock Units

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

Qbla **Quaternary Lake Bonneville lacustrine and alluvial deposits** Undifferentiated sand, gravel, and marl and older rocks 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.

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

Qol **Quaternary older alluvium** Flat-lying or gently dipping 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 present-day drainage systems developed in flanking mountain ranges.

Tc **Tertiary conglomerate** Rare, poorly exposed outcrops of conglomerate, lacustrine limestone, and marl that occur in a few of the washes cut through the older alluvium pediment surface on the east side of the Snake Range. Correlative rocks are well exposed to the south near the mouth of Smith Creek, where they are demonstrably Miocene or younger, as they contain lower plate clasts with Miocene cooling ages. The total thickness and age span of this unit is poorly known, but it apparently accumulated as part of the syntectonic basin fill to the youngest system of normal faults that bound the eastern side of the Snake Range. They are generally tilted (15-30°) westward and overlain by older alluvium along a prominent angular unconformity. Buff- to red-weathering, poorly sorted conglomerate is dominant and contains clasts of unmetamorphosed Cambrian to Pennsylvanian upper plate units, as well as Tertiary volcanic clasts. No lower plate clasts were positively identified in this quadrangle. The thickness of bedding ranges from 5 to 50 cm and the conglomerate ranges from moderately well rounded and clast supported to angular and matrix supported.

Td **Tertiary dacite** Isolated exposures of crystal-rich hornblende-biotite dacite. In the northeastern corner of the quadrangle, it appears to be a subvolcanic intrusion consisting of 30 to 40% phenocrysts of plagioclase, hornblende, biotite, and pyroxene, minor quartz and Fe-Ti oxides in a microcrystalline groundmass. Virtually identical rocks make up a very large subvolcanic intrusion in the Government Peak Quadrangle to the northwest that has been dated at about 35 Ma (Gans and others, 1989). This body is likely an outlier of the same volcanic center. Scattered exposures of dacite in the southern part of the quadrangle are more altered and appear to be more variable texturally. It is unclear whether these rocks are flows or shallow intrusions as they lack internal structure, and the contacts with the Paleozoic rocks are obscure. These rocks are probably also about 35 Ma and part of the widespread hornblende dacites in northern White Pine County.

IPe **Pennsylvanian Ely Limestone** The Ely Limestone is a tan-gray to light-brownish-gray, ledgy slope-forming, fossiliferous cherty limestone. Regionally, complete sections of the formation range from 400 to 800 m thick (Hose and Blake, 1976). Sections in this quadrangle are as much as 300 m thick but are incomplete due to faulting and erosion. The unit varies from coarse-grained bioclastic to micritic, massive or thickly bedded (~1 m) to thinly bedded (1.0-4.0 cm), with bedding defined by silty partings. Rust-weathering nodular chert is ubiquitous throughout the formation. Some intervals, tens of meters thick, contain up to 50% well bedded and stringy chert. 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 up section.

Mj **Mississippian Joana Limestone** The Joana Limestone is a medium-brown-gray, massive to poorly bedded, prominent, cliff-forming, bioclastic limestone. The lower portion is massive; the upper portion is somewhat darker gray and is well bedded (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, red, and cream-colored chert nodules and bands are common in the lower third of the formation and crudely define bedding. This unit is in fault contact with the Guilmette Formation.

Dg **Devonian Guilmette Formation** Regional thickness reported for the Guilmette is about 750 m (Hose and Blake, 1976). Medium brownish-gray, thin-bedded to massive, very fine-grained limestone and laminated brown to dark-brown dolomite. Fossils include corals, gastropods, brachiopods, crinoids, and stromatoporoids. The section is incomplete in this quadrangle (no more than a few hundred meters), and it is highly faulted and brecciated.

SO **Silurian Laketown Ordovician Fish Haven Dolomites, undifferentiated (SO dolomite)** The SO dolomite is a light-gray to dark-chocolate-brown, slope- to cliff-forming dolomite. The unit occurs in the northern portion of the quadrangle, in fault contact with younger and older formations. Regionally it averages about 600 meters thick and is commonly divided into Ordovician Fish Haven Dolomite and Silurian Laketown Dolomite. The SO dolomite varies from a poorly bedded dark-brown dolomite with rust colored to black nodular chert beds 1to 3 cm thick and spaced about 4 to 6 cm apart to a uniformly chocolate-brown to light-rust-gray, poorly bedded, fossiliferous dolomite with lesser, variable amounts of chert nodules, to a 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 a light-gray, cliff-forming, poorly bedded, sugary dolomite.

Oe **Ordovician Eureka Quartzite** The Eureka Quartzite is a white, cliff- to ledge-forming, poorly bedded orthoquartzite consisting of nearly 100% fine-grained (0.3-0.5 mm), extremely well-sorted and well-rounded, silica-cemented quartz grains. The section is incomplete in this quadrangle. Complete sections in surrounding areas are typically 40 to 150 m thick (Hose and Blake, 1976). Fresh surfaces are white and vitreous; weathered surfaces are rust-brown and pitted. The Eureka Quartzite commonly occurs as thin, brecciated, fault-bounded slivers and is often smeared out along fault planes.

Op **Ordovician Pogonip Group, undifferentiated** The Pogonip Group is yellow-weathering, ledgy-slope- to slope-forming, well-bedded, fossiliferous, medium-blue-gray to light-blue-gray, silty limestone. A number of fossil types occur in the Pogonip Group, including brachiopods, ostracods, coiled nautiloids, and tabulate corals. Due to areal variations within the group, various authors have divided it differently into formations. Elsewhere 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 Limestone. In this quadrangle, faulting and poor exposure precluded our subdividing the unit. Both lower and upper portions of the Pogonip are present. Maximum exposed thickness in the quadrangle is about 300 meters, but sections are incomplete. In surrounding areas the Pogonip Group is about 500 to 900 m thick.

Ꞓn **Upper Cambrian Notch Peak Limestone** The Notch Peak Limestone is medium-gray, fine- to medium-grained, cliff- to ledge-forming, well-bedded (typically 1-6 cm) 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. Locally, the lowest 5 m of the Notch Peak Limestone consist 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 with massive to poorly defined bedding and contains sparse chert. This section is generally cliff-forming and fossiliferous, including brachiopods, gastropods, trilobites, and crinoids. Meter-scale stromatolites are often well-developed in the upper portion and occur within repeated shoaling upward sequences.

In the lower plate, the Notch Peak Limestone is light- to medium-gray, ledge- to cliff-forming, cherty, well-foliated calcite marble. Original bedding is now transposed into thin, alternating white and light-blue-gray stripes, original nodular chert now occurs in millimeter-thick quartzite segregations. Micaceous partings represent original silty interbeds. Lower plate exposures of this formation are concentrated in the southwestern part of the quadrangle, and along the walls of Marble Wash.

Ꞓd **Upper Cambrian Dunderberg Shale** 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. Excellent exposures of the formation are present on the southern side of Spring Mountain, where it appears to be in fault contact with underlying Middle Cambrian limestone. 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 brown- to rust-colored siltstone coatings and containing phosphatic inarticulate brachiopods and trilobite debris.

In the lower plate, the Dunderberg Shale is now a brown-weathering calc-schist with porphyroclasts of Mg-rich biotite in a phyllic quartz + mica ± clinozoisite ± plagioclase ± calcite matrix.

Ꞓm **Middle Cambrian limestone, undifferentiated** In the upper plate, the Middle Cambrian limestone is a thick, medium- to light-gray, massive to thickly bedded cliff former. It underlies much of the eastern flank of the range along the western side of the quadrangle. Throughout the northern Snake Range, this formation lacks its depositional base due to truncation by the northern Snake Range décollement. A 1,255-m-thick partial section was pieced together in the Little Horse Canyon Quadrangle to the south, where it was divided into five informal members; from top to bottom these members were designated $Ꞓm_5$ to $Ꞓm_1$. The general lack of distinguishing lithological characteristics, along with patchy secondary dolomitization, commonly makes assignment of a particular member difficult, although all five members are probably present. In the southern part of the range, this formation was divided into Pole Canyon Limestone and Lincoln Peak Formation, following the nomenclature of Whitebread (1969) in the southern Snake Range.

Within the lower plate, marbles and calc-schists correlative with Middle Cambrian strata in the upper plate are correlative with the Eldorado Limestone, the Monte Neva Formation, and the Raiff Limestone of Young (1960). The upper two of these are well exposed on the walls of Marble Wash.

Ꞓr **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 generally not well foliated. The middle portion of the unit contains a thin interval of gray to light-brown calc-schist/calc-silicate that contains conspicuous biotite porphyroblast (up to 0.5 cm across). The unit is typically capped by white to light-gray, massive to laminated pure marble.

Ꞓmn **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.

Ꞓe **Middle Cambrian Eldorado Limestone** (in cross section only) 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 (mm- to cm-scale) bands in the marble. Minor constituents minerals in the marble are biotite, phlogopite, sphene, and tremolite.

Ꞓpi **Lower Cambrian Pioche Shale** (in cross section only) 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.

Ꞓpm **Lower Cambrian Prospect Mountain Quartzite** (in cross section only) 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.

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, short dashes indicate internal contact, and bedding in cross section.

Normal fault Dashed where approximately located, dotted where concealed, queried where uncertain; ball on downthrown side; showing dip of fault plane, trend and plunge of fault striation.

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

Strike and dip of bedding

Inclined — Vertical

Horizontal — Overturned

Strike and dip of metamorphic foliation

Inclined

Showing trend and plunge of intersection/elongation lineation.

Inclined — Horizontal

QUADRANGLE LOCATION

INDEX TO SNAKE RANGE GEOLOGIC MAPS

1	2	3
	4	5
6	7	

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

GEOLOGIC MAP OF THE SPRING MOUNTAIN QUADRANGLE, NEVADA AND UTAH

Phillip B. Gans, Elizabeth L. Miller, 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 Spring Mountain 7.5' Quadrangle, 1986

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