U.S. DEPARTMENT OF THE INTERIOR
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PRELIMINARY GEOLOGIC MAP OF THE COYOTE SPRING QUADRANGLE, LINCOLN COUNTY, NEVADA

By

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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DESCRIPTION OF MAP UNITS

Descriptive colors for map units are from the Rock-Color Chart Committee (1951)

Qa **Younger alluvium** (Quaternary)--Silt, sand, gravel, and minor clay weakly cemented with secondary carbonate; mostly fluvial but locally contains considerable eolian silt and sand, and adjacent to ranges, with considerable colluvium. Where lithified and stable, mostly pale yellowish brown and yellowish gray. In most places immaturely vegetated with short (20-25 cm) white sage and other dwarf brush. Thickness 10 m and greater

Qc **Colluvium** (Quaternary)--Locally mapped talus and landslipped blocks

Qfa **Fan alluvium and fanglomerate** (Quaternary)--Conspicuously slope-graded gravel, fanglomerate, and interbeds of sand and silt, weakly to locally strongly cemented with secondary carbonate. As mapped, unit merges with alluvial map units Qa and Qoa with both sharp and gradational contacts. Thickness 20 m and greater

Qoa **Older alluvium** (Quaternary)--Conglomerate, sandstone, and siltstone moderately cemented with secondary carbonate. Conglomerate clasts vary from pebble to boulder size. Vertical exposures show layers with abundant white secondary carbonate or caliche that reflects pauses during aggradation cycles; layers also contain thin (< 1 m) beds of loose to weakly consolidated sandstone of probable eolian origin. In northwestern part of quadrangle includes much fan alluvium. Thickness 10 m and greater

Qow **Older Terrace deposits of Coyote Wash** (Quaternary)--Even-surfaced terrace deposits flanking Coyote Wash. Terrace surfaces stand 8-12 m above active washes. Unit consists mostly of pebble- and cobble conglomerates that are moderately to strongly cemented in lowermost exposures and weakly cemented in uppermost exposures where the beds are a mixture of reworked eolian silt and sand, and granule-size conglomeratic, fluvial sandstone. Deposits from base to top are varicolored in shades of light brown and moderate brown, and in contrast to the younger alluvium (map unit Qa), the even surface is maturely vegetated with purple sage as tall as 75 cm, ephedra as tall as 75 cm, minor cholla, rabbit bush, and greasewood (antelope bush). The uppermost beds weather to vertical slopes like typical loess. Thickness about 12 m and greater

QTu **Alluvial deposits undivided (Quaternary and Tertiary)**--May include any Quaternary unit listed above; shown in subsurface only, where beds as old as Tertiary probably occur. Thickness 300 m or greater

Tts **Tuffaceous sedimentary rocks (Pliocene and Miocene)**--Shown in cross section only; unit description from the adjacent Bristol Well quadrangle (Page and Ekren, 1995). Poorly exposed valley-fill deposits that are probably time equivalent to older beds of the Panaca Formation, exposed in the vicinity of Panaca, Nevada, 30 km southeast of the quadrangle (Phoenix, 1948). Exposed strata in the adjacent Bristol Well quadrangle dip as steeply as 35^{o} adjacent to ranges, and are mostly white, flaggy-weathering and thin-bedded. They appear to be mostly lacustrine and include varicolored fine-grained sandstones, reworked white to light-brown ash, thin gray papery shales, and locally light brown, medium to coarse-grained volcanic sandstones and pebble conglomerates; the strata locally includes some impure diatomite. At least 30 m of the unit is exposed in the Bristol Well quadrangle, but total thickness could be as great as several hundred meters

Tsp **Shingle Pass Tuff (Oligocene)**--Three simple cooling units, each about 10-m-thick, are present. A genetic relationship for the three units is indicated by welding characteristics, type and color of pumice, overall rock color, and petrography. The three units are assigned to the Shingle Pass Tuff because they all contain alkali feldspar that shows broad zoning like the cooling units at Shingle Spring in the Egan Range--the type locality of the Shingle Pass Tuff (Cook, 1965). In addition, the crystal-poor lowest cooling unit in this quadrangle is modally identical to the number-two cooling unit at the type locality (second unit above base), which there and here contains abundant biotite, minor hornblende, no pyroxene, and no quartz. All three units assigned to the Shingle Pass in this quadrangle are densely welded. The highest unit is pale pink to pale red purple and weathers pale red where densely welded. It grades downward to a vitric, partially welded brown shard tuff with black and tan shards. The densely welded part (one thin section) contains 7.7 percent phenocrysts consisting of (in percent): quartz 13.0 (1 mm), alkali feldspar 22.1 (1 mm), plagioclase 44.2 (to 2 mm, mostly 1 mm), biotite 16.9 (to 2 mm), hornblende 3.9 (2 mm). The middle unit is pale red purple in the densely welded upper part, and weathers pale reddish brown. It contains dark yellowish orange pumice lapilli that are well-flattened and about 2 cm long. This unit grades down to a brown shard base, which directly overlies the basal unit. A single thin section of the middle tuff revealed 12.4 percent phenocrysts consisting of (in percent): quartz 8.9 (1 mm), alkali feldspar 42.7 (1.5 mm), plagioclase 41.9 (to 2.5 mm), biotite 3.2 (to 2 mm), altered hornblende 0.8 (1 mm), altered pyroxene 1.6 (1 mm), opaques 0.8. The lowest cooling unit is pale red purple weathering to pale reddish brown. It contains well-flattened pumice lapilli about 2 cm long that are pale blue to pale pink. A thin section contained only 4.4 percent phenocrysts (4.8-5.8 at the type locality) consisting of (in percent): quartz 0, alkali feldspar 27.3 (1-2 mm), plagioclase 54.5 (1-2 mm), biotite 15.9 (to 2 mm), hornblende 2.3 (2 mm). The age of the Shingle Pass Tuff is reported to be 26.7 to 26.0 Ma (Best and others, 1989a). For other information concerning the Shingle Pass, see Swadley and Rowley (1994) and Ekren and others (1977). Total thickness of the Shingle-Pass section, 20-30 m

Isom Formation (Oligocene)

Tiu **Upper tuff**--Consists of at least three thin (10 m) similar, high-temperature ash-flow tuffs. The uncertainty of exact number of units is a function of complex faulting and the overall similarity of the units. Conspicuous black vitrophyres as thick as 3 m disappear along strike suggesting incomplete cooling breaks. Where devitrified, the tuffs are dark reddish brown, grayish purple, and moderate red. Well-flattened pumice tends to weather to pits. Lithics of andesitic composition are common throughout. Phenocrysts range from 10 to 15 percent and consist of (in percent) plagioclase, about 60 (2-5 mm), pigeonite 15 to 20, opaque oxides, 10 to 17. Thickness 30 to 40 m

Til **Lower tuff**--A single cooling unit of lava-like high-temperature ash-flow tuff that is flow-laminated and layered from base to top. The rock is dusky yellow green and weathers olive gray. It is discontinuous and appears to have filled topographic lows like a series of flash floods. A single thin section revealed 5 percent phenocrysts consisting of (in percent): plagioclase 64.7 (less than 2 mm), clinopyroxene-pigeonite 11.8 (less than 2 mm), opaque oxides 5.9 (less than 0.5 mm). The age of the Isom Formation is about 27 Ma (Best and others, 1989a). For other pertinent information for the Isom, see Swadley and Rowley (1994), Scott and others, in press, Mackin (1960), and Anderson and Rowley (1975). Thickness 0 to 30 m

Tah **Andesite lava**--Very similar to older lavas of map unit Ta; mostly dark gray, weathering grayish brown and black, generally with conspicuous plagioclase phenocrysts (mostly less than 5 mm) and with both clinopyroxene and orthopyroxene (less than 2 mm); includes considerable flow breccia. Thickness 100 m

Tpc **Petroglyph Cliff Ignimbrite**--Compound cooling unit with at least two partial (possibly complete) cooling breaks. Basal vitrophyre rests directly on upper tuff of the Lund Formation with little or no sediments between. The tuff is dusky red on fresh surface and weathers moderate brown. Pumice, as long as 0.4 m, commonly is glassy and black near base, and brown near top. Where devitrified the tuff displays a peculiar "woven" fabric expressed by pale-purple and interwoven moderate red tuff. Pumice in this zone is light pinkish gray and tends to weather to pits. Plagioclase is dark colored, rectangular in hand specimen, and conspicuously zoned. Clinopyroxene is dark brown to brownish black. Two thin sections revealed 23 percent phenocrysts consisting of (in percent): plagioclase 88-91 (to 5 mm), clinopyroxene (pigeonite) 5.1-7.6, iron-oxide opaques 3.8-4.0 (less than 0.5 mm), biotite trace. The lithology of this unit is so similar to the overlying units of the Isom Formation that a genetic affinity and common source is indicated for the two tuff sequences. The Petroglyph Cliff Ignimbrite was first defined by Cook (1965) but it has not been dated. According to Scott and others (1994) its age is stratigraphically restricted between about 27.3 Ma, the age of the Monotony Tuff, and about 27.9 Ma, the age of the Lund Formation. For additional mineralogical, chemical, and petrographic information for the Petroglyph Cliff, see Scott and others (1994, 1995) and Swadley and others (1994). Thickness from 50 to 100 m

Needles Range Group and Intercalated Lava and Tuffs (Oligocene)--The Needles Range Formation was originally defined by Mackin (1960). It was later elevated to group status by Best and Grant (1987). In this quadrangle, three genetically related crystal-rich ash-flow tuff formations, all of intermediate composition, are present and, in addition, a genetically unrelated rhyolite tuff, the tuff of Deadman Spring, is intercalated at the top between the uppermost tuff of the Needles Range Group, the Lund Formation, and the Wah Wah Springs Formation. The lowest formation is the Cottonwood Wash Tuff (Best and others, 1989b). According to Best and Grant (1987), the age of the Lund Formation is about 27.9 Ma, the Wah Wah Springs Formation is about 29.5 Ma, and the Cottonwood Wash Tuff is about 30.6 Ma. For pertinent description of these units in adjoining quadrangles see Scott and others (1994, 1995) and Swadley and others (1994). According to Best and others (1989b), the three formations in this quadrangle are all dacite in composition

Tnl **Lund Formation undivided**

Tnl_2 **Lund Formation, upper tuff**--Light brownish gray to light olive gray in upper part, grading downward to yellowish gray, moderately to weakly welded with conspicuous white pumice lapilli; forms recessive cliff. Two thin sections, one from the base and one from top, show that the phenocryst assemblage is more rhyolitic at the top than at the base. Both thin sections contained about 30 percent phenocrysts consisting of (in percent): quartz 5.3 base, 13.3 top (to 1.8 mm); sanidine 0 base, 5.6 top (to 1 mm); plagioclase 56.1 base, 61.5 top (to 3 mm); biotite 15 base, 8.6 top (to 2 mm); hornblende 20.8 base, 9.6 top (to 2 mm); magnetite 2 (to 0.5 mm); sphene 7 grains base, 5 grains top. Thickness 10 to possibly 30 m

Tnl_1 **Lund Formation, lower tuff**--Very light gray to pinkish gray weakly welded tuff with fairly conspicuous small white pumice lapilli; weathers to a slick, poorly exposed rim in northernmost exposures and to a smooth, loess-like cliff where separated from the "upper Lund" by a sandwich of andesite lava just southwest of the southwest corner of the quadrangle. A single thin section contained 26 percent phenocrysts consisting of (in percent): quartz 13.1 (to 3 mm), sanidine 2.4 (0.7 mm), plagioclase 63.7 (1.5 mm), biotite 12.2 (to 2 mm), hornblende 3.8 (2 mm), magnetite 3 (to 0.5 mm). This slide contained 20 grains of sphene. Thickness 10 to possibly 30 m

Tdm **Tuff of Deadman Spring**--Two facies are recognized: a thin partially welded outflow sheet in the southwest and a thick sequence along the north border of the quadrangle that probably was deposited in an east-trending trough that subsided concomitantly with tuff eruptions (P.D. Rowley, oral commun., 1993). The thin outflow sheet is a simple cooling unit of moderately-welded rhyolite tuff; grayish pink in lower part with pale red pumice grading upward to a vapor-phase crystallized upper part that is pale red. A single thin section contained 23 percent phenocrysts consisting of (in percent): quartz 40 (2-4 mm), sanidine 33.9 (1-2.5 mm), plagioclase 20.7 (1 mm), biotite 3.1 (to 2 mm). Quartz bipyramids are conspicuously smoky. Thickness 15 to possibly 90 m. The "trough" facies is densely welded throughout and contains bed-like zones wherein the tuff contains only small phenocrysts (mostly 1 mm or less). These zones alternate with zones of larger phenocrysts (2-3 mm). The finer grained rock has very sparse biotite and weathers light brown; quartz in this rock is inconspicuous. The coarser grained rock, in contrast, has conspicuous smoky quartz to 3 mm; it is light brownish gray to pale red, weathering to pale reddish brown, and with 40 percent phenocrysts. Three thin sections counted by P.D. Rowley (written commun., 1994) showed a range in phenocryst volume from 36 to 46 percent consisting of (in percent): quartz 35-39, sanidine 36-40, plagioclase 22-23.5, biotite 2.4-2.6. Thickness, 300 m minimum

Tnw **Wah Wah Springs Tuff**--Light gray in basal non- to partially-welded tuff (1-3 m) that grades upward to platy-weathering very black vitrophyre with pronounced planar eutaxitic foliation. Phenocrysts (mostly about 2 mm) are markedly smaller overall than in the Cottonwood Wash basal vitrophyre and in marked contrast to the Cottonwood, this vitrophyre has pumice lumps in which plagioclase phenocrysts (commonly 4 mm) are twice as large as plagioclase in the groundmass (mostly about 2 mm). Pumice in the overlying devitrified tuff tends to be medium gray or pale blue and the overall color of the rock is gray or brownish gray in contrast to the moderate brown weathering habit of the underlying Cottonwood. Three thin sections from basal vitrophyre to near top indicate a marked upward increase in phenocrysts--26 percent at the base to 51 percent near the top. Phenocrysts consist of (in percent): quartz 2.7 at base, 12 near top (2 mm); alkali feldspar, 0 in all three thin sections; plagioclase 61 at base (0.1-2.2 mm) to 58 near top (0.3-2.2 mm); biotite 7.7 at base (0.1-2.0 mm), 8.6 in middle, 3.2 at top (0.1-2 mm); hornblende 23.8 at base, 24.1 at top (0.1-4 mm); clinopyroxene 0.4 at base, 1.1 in middle, trace at top (0.2-1 mm). Some hornblende is uralitized in all three thin sections. Thickness varies considerably probably averaging about 150 m

Tnc **Cottonwood Wash Formation**--Dusky yellow to light brown and weakly welded at base (3-5 m thick) grading upward to densely welded slab- and platy-weathering, dark gray to black vitrophyre (1-2 m thick), and thence upward into grayish red densely welded tuff that weathers light brown and rich moderate brown. Unit has conspicuous very light gray pumice that is mostly silver-dollar size, but ranging up to 10 cm. A thin section of the vitrophyre indicates 49 percent phenocrysts consisting of (in percent): quartz 11.8 (2 mm), alkali feldspar 0.8 (2 mm), plagioclase 64.1 (3 mm), biotite 10.6 (to 4 mm), hornblende 10.6 (to 3 mm), clinopyroxene 0.4 (2 mm). Biotite commonly in thick books and large diameter (4 mm) flakes in contrast to Wah Wah Springs Tuff where it occurs mostly as thin, small-diameter (2 mm) flakes. Quartz is not resorbed. Thickness varies considerably, probably averaging 150 to 170 m

Twb **Windous Butte Formation (Oligocene)**--Discontinuous outcrops of moderately welded ash-flow tuff of rhyodacite or dacite composition. Unit grades upward from a white non-welded base (0-10 m thick) into yellowish gray and thence yellowish brown moderately welded tuff about 10 m thick; no basal vitrophyre is present. Moderately resorbed quartz phenocrysts to 4 mm and abundant biotite in flakes and thin books to 3 mm in diameter are conspicuous. A single thin section from the yellowish-brown upper part contained 39 percent phenocrysts consisting of (in percent): quartz 16.5 (to 4.5 mm), alkali feldspar 12.4 (to 2 mm), plagioclase 53.1 (to 2.5 mm), biotite 11.9 (to 2 mm), hornblende 5.7 (to 2.5 mm), trace of hypersthene. Correlation of this Needles Range like tuff with the Windous Butte formation is based on paleomagnetic data obtained from outcrops in the Deadman Spring NE quadrangle (Sherman Gromme', written commun., 1994; Swadley and others, 1994), the adjacent quadrangle to the south. The tuff here and in the Deadman Spring NE quadrangle corresponds to the upper part of the Windous Butte as mapped in the Grant Range (Moores, and others, 1968), and near the source (Hot Creek Valley-Morey Peak; see, for example, Ekren and others, 1973; Dixon and others, 1972). Thickness 0-50 m

Ta **Andesite (Oligocene)**--Medium-gray to medium-greenish-gray weathering to moderate-brown lava and flow breccia; generally with fairly conspicuous plagioclase phenocrysts to 7 mm, occasionally with obscure plagioclase the same color as the groundmass; sparse pyroxene phenocrysts to 3 mm. Phenocryst volume varies from about 10 percent to 30 percent. Where glassy the rock is dark gray or black. Thickness, 0-60 m or greater

PIPMb **Bird Spring Formation (Lower Permian, Pennsylvanian, and Upper Mississippian)**--Unit exposed only along the west central edge of the quadrangle where it consists of limestone and minor dolomite, light brownish gray, grayish red purple (fresh), and medium gray to light olive gray, and pale red to moderate brown (weathered); finely to coarsely crystalline, thin to thick bedded. Most common facies is bioclastic wackestone. Also consists of interbedded silty limestone, grayish red purple (fresh), and moderate brown to dusky brown (weathered), finely to medium crystalline, and dusky brown weathering chert. Fossils include crinoid columnals, bryozoans, brachiopods, ostracods, and solitary rugose corals. Unit forms massive cliffs and step-like ledges; thickness unknown, however, at least 1,000 m of the unit is exposed in the Deadman Spring quadrangle, about 16 km to the south (R.B. Scott, personal commun., 1994)

Msw **Scotty Wash Formation (Upper Mississippian)**--Mapped to include sandstone that forms east-dipping buttes just east of Coyote Spring and an overlying east-dipping fossiliferous limestone that is equivalent to the Indian Springs Formation of southeastern Nevada (Webster, 1969). Sandstone is mostly fine-grained including some beds with clay cement that are pale brown weathering to moderate yellowish brown. Other beds are ferruginous and weather to hard desert-varnished rinds. These resistant beds are mostly light brown, fine grained, and well sorted. Some beds are moderate brown. Ripple-marked beds occur at several intervals throughout the exposures and mud cracks were observed in sandstones in one locality. Limestone is finely to coarsely crystalline, medium brownish gray to dark brownish gray, weathering to light brownish gray, dark yellowish orange, moderate yellowish brown and grayish red, with abundant fossil hash. Fossils include rhynchoporacea, productid, spirifer and other brachiopods, small pelecypods (8 mm), crinoid columnals, solitary corals, and bryozoans; fossiliferous limestone sampled at location CS-311 yielded conodonts of Uppermost Mississippian age (Anita Harris and John Reptski, written commun., 1994). Hurtibise (1989) reports a thickness of about 220 m in the Seaman Range, 16 km west of the quadrangle. Westgate and Knopf (1932) reported about 300 m at Dutch John Mountain at the north end of Dry Lake (Muleshoe) Valley

Mc **Chainman Shale (Upper Mississippian)**--Subsurface only. Consists chiefly of black to olive gray fissile shale. In the southern Egan Range, 32 km north of quadrangle, Kellogg (1963) reported brownish gray and varicolored mudstone in the lowermost 45 to 90 m of the formation, and a thickness from 200 to 300 m for the entire unit

Mj **Joana Limestone (Lower Mississippian)**--Only the lower 60 m preserved in outcrop in this quadrangle. Consists of 20 m of cliff-forming, massive limestone at base that is quite cavernous in lower 5 to 10 m. The rock is medium gray to brownish gray, finely crystalline, obscurely bedded containing abundant crinoid columnals mostly less than 3 mm in diameter. The lower massive cliff is overlain by ledge- and bench-forming limestone that is somewhat darker than the underlying cliff but still close to the same color, and is mostly medium to coarsely crystalline; still with abundant small-diameter crinoid columnals. Some beds contain chert layers and nodules and some thicker beds are cross-laminated with coarsely-crystalline limestone alternating with finely crystalline. Some partings between conspicuous beds weather yellow and are silty or argillaceous--no sand grains were observed. At least 250 m of Joana Limestone is preserved in the adjacent Bristol Well quadrangle (Page and Ekren, 1995) where the lower cliff-forming limestone is 40 m thick

MDp **Pilot Shale (Lower Mississippian and Upper Devonian)**--Slope-forming, well-bedded silty gray and pale brown limestone that weathers dusky yellow; beds are mostly 5 to 8 cm thick and weather to smooth convex and concave surfaces. Most beds are aphanic to finely crystalline and some near top are dolomitic; bedding, like that in the West Range Limestone below, is mostly stylolitic with nodular weathering zones throughout. Limestone in the uppermost 1 m or so is extremely fossiliferous containing brachiopods and abundant crinoid columnals mostly less than 3 mm in diameter. Upper contact was drawn at the base of the massive lower cliff of the Joana Limestone; lower contact with the West Range Limestone is gradational and arbitrary. As mapped, the formation is no more than 46 m thick. Tschanz and Pampeyan (1970, p. 43) point out that the only Early Mississippian fossils collected by them came from 30 to 50 feet below the base of the cliff-forming Joana Limestone-beds that here are included in the Pilot Shale. The possibility exists that all the "Pilot Shale" beds in this quadrangle are early Mississippian in age

Dw **West Range Limestone (Upper Devonian)**--From the gradational contact with the overlying Pilot Shale to the disconformable(?) contact with the underlying Guilmette Formation, the West Range Limestone consists of medium-gray to brownish-gray finely crystalline limestone in even beds mostly 2.5 to 7.5 cm thick (occasionally to 30 cm) that weather to distinct ledges 0.6 to 1.0 m thick. Bedding is almost entirely stylolitic; where extremely thin bedded, the stylolitic habit causes the thin beds to weather to nodules. Most beds contain fossils; some beds are extremely fossiliferous. In the uppermost 15 m, the nodular zones predominate and the beds become increasingly silty and weather dusky yellow like the overlying Pilot Shale. The upper contact was arbitrarily placed where the silty, dusky-yellow beds dominate. The basal contact is considered by Ekren to be a disconformity; the contact is "knife sharp" with gray and brownish gray, stylolitically-bedded, unfractured, pristine limestone of the West Range above and highly fractured quartzite and dolomite of the Guilmette Formation below. Many fractures and joints in the Guilmette simply terminate at the contact. In places, coarse sand is present in the basal limestone of the West Range, but in most other places, pure limestone rests directly on the Guilmette. No local angular discordance is apparent. Because of faulting and erratic folding, an accurate thickness was impossible to determine. Westgate and Knopf (1932) reported a thickness of 187 m about 13 km to the east at the type locality in the West Range, and Hurtibise (1989) estimated 126 to 162 m to the west in the Seaman Range. A minimum of 76 m is indicated in this quadrangle

Dg **Guilmette Formation (Middle and Upper Devonian)**--Only the upper 250 to 300 m of the formation is exposed in the quadrangle. This upper part is mostly ledgy-weathering, grayish-red or brownish-gray dolomite with minor thin beds of medium-gray and dark-gray limestone and with brown and yellowish brown quartz sandstone beds that become increasingly abundant near the top where they finally constitute (in the upper one quarter) 30 to 50 percent of the formation. *Amphipora* beds and "zebra" beds that are composed of alternating white and medium-gray or brownish-gray layers of dolomite are commonplace. The top of the formation is marked by a white bed of highly fractured orthoquartzite. The middle 100 m or so of the formation, exposed in adjacent quadrangles to the south and east, is mostly medium-gray, olive-gray, and brownish-gray dolomite interbedded with sparse beds of dark-gray limestone; stromatoporoid biostromes are common. The middle part is underlain by 150 to 200 m of cliff- and ledge-forming, alternating light gray and brownish gray dolomite (70 to 80 percent) interbedded with limestone and dolomitic limestone (20 to 30 percent). The limestone is medium gray to dark gray with some beds weathering moderate yellow brown, and commonly it is thin bedded in beds 1 to 3 cm thick that weather to "ribbon rock". Discontinuous chert layers occur sporadically and several dolomite beds contain abundant calcareous and/or siliceous stromatoporoids and *Amphipora*. The lowermost 50 to 60 m consists entirely of medium-gray and reddish-gray dolomite, mostly medium to thick bedded, medium to coarsely crystalline, containing minor chert layers near top (just below limestone "ribbon rock") and with zones of stromatoporoids and *Amphipora* in middle exposures. This lower zone looks brown from a distance; it rests on the so called "yellow bed" of Tschanz and Pampeyan (1970), which marks the base of the formation. The "yellow bed" consists of aphanic dolomite about 20 m thick in beds that average 25 cm in thickness and that contain sparse amounts of silt and fine, well-rounded grains of sand. The most conspicuous "yellow" beds are generally the beds richest in sand and/or silt. The fresh dolomite is yellowish brown that weathers dusky yellow. Swadley and others (1994) reported an estimated thickness of 600 to 650 m thick for the Guilmette in the adjacent Deadman Spring NE quadrangle, and Page and Ekren (1995) report a minimum thickness of 600 m in the adjacent Bristol Well quadrangle

Dsi **Simonson Dolomite (Middle Devonian)**--Shown in cross section only; unit description and thickness from adjacent Bristol Well quadrangle (Page and Ekren, 1995). In places, the upper part of the formation consists of finely to medium crystalline black and dark gray dolomite in beds about 1 to 2 m thick. In other places, just below the "yellow bed" of the Guilmette Formation, beds of the Simonson consist of distinctly laminated, ledgy-weathering, non-fossiliferous dolomite that is grayish red and olive brown. The upper part contains the *Stringocephalus* zone of Osmond (1954) and Langenheim and others (1969). The middle part of the formation was considered by Langenheim and others (1969) to be more or less equivalent to both the upper and lower alternating informal members of Osmond (1954) excluding the "brown cliff forming biostromal" informal member. The beds are conspicuously laminated and consist of ledgy-weathering fine, medium, and coarsely crystalline light gray and dark brownish gray dolomite. The lowest part of the formation includes the tan coarse crystalline informal member of Osmond (1954). These beds consist of medium-light-gray and light-olive-gray dolomite, coarsely crystalline, thin bedded and laminated. Thickness is estimated to be on the order of 230 m

Dse **Sevy Dolomite (Lower Devonian)**--Only one isolated outcrop of the Sevy Dolomite is exposed in the central part of the quadrangle. Unit dips gently to the west, and consists of unfossiliferous dolomite, medium dark gray (fresh), and light gray to light olive gray (weathered), aphanic, thin to thick bedded, and algal laminated. Forms ledgy slopes; thickness indeterminable because a complete section is not exposed, however, Hurtibise (1989) reported a thickness of 377 m for the Sevy in the Schell Creek Range, approximately 15 km to the northwest

Sl **Laketown Dolomite (Silurian)**--Shown in cross section only. Characteristic three part subdivision, upper dark gray, middle light gray, and lower dark gray dolomite informal members (Tschanz and Pampeyan, 1970) are exposed in the adjacent Bristol Well quadrangle (Page and Ekren, 1995). Upper dark gray member consists of finely crystalline to slightly aphanic dolomite, dark gray (fresh) and olive black (weathered). The member is thin to thick bedded and contains bedding-parallel laminations and discontinuous layers and nodules of light-brown to dusky-yellowish-brown chert. Fossils include crinoid columnals and silicified corals; upper member about 55 m thick. Middle light gray member is similar in appearance to the Lower Devonian Sevy Dolomite; however, textures range from finely to coarsely crystalline whereas the Sevy is almost entirely aphanic. Middle light gray member is less fossiliferous than upper and lower dark gray members. Lower dark gray member consists of dolomite, dark gray (fresh), medium gray, olive gray to light olive gray (weathered), finely crystalline, and thin to thick bedded with bedding-parallel laminations; also contains discontinuous layers of moderate yellowish brown chert. Lower dark gray member is highly fossiliferous and contains silicified solitary corals, *Halysites*, *Favosites*, *pentemerid* brachiopods, and crinoid columnals. Laketown forms cliffs; Kellogg (1963) reported the formation to be 315 m thick in the southern Egan Range

Oes **Ely Springs Dolomite (Upper Ordovician)**--Equivalent to the Fish Haven Dolomite of Richardson (1913). Only parts of the unit are exposed in fault blocks in the northwestern part of the quadrangle. Dolomite, medium dark gray (fresh), olive gray to light olive gray (weathered), finely crystalline, thin to thick bedded, and contains bedding-parallel laminations and some discontinuous beds and nodules of dark brown weathering chert. Fossils include crinoid columnals, brachiopods, and silicified corals. Forms cliffs and has a dark gray color that contrasts sharply with the underlying Eureka Quartzite. Total thickness of unit in this quadrangle is unknown; Kellogg (1963) estimated the unit to be from 150 to 160 m thick in the southern Egan Range

Oe **Eureka Quartzite (Middle Ordovician)**--Unit exposed in fault blocks in the northwestern part of the quadrangle. Quartzite, white (fresh), light brown, grayish orange, and grayish red (weathered); quartz grains are fine to medium grained and rounded to subrounded. Unit is thin to thick bedded, and shows tabular planar and trough crossbeds. Forms rounded cliff; as much as 100 m thick, top not exposed; Kellogg (1963) reported the Eureka to be from 141 to 189 m thick in the southern Egan Range

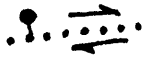
Op **Pogonip Group (Lower and Middle Ordovician)**--Only the upper 300 to 350 m of the unit is exposed in the northwest part of the quadrangle where it consists predominantly of limestone, medium dark gray (fresh), medium gray to light gray, light brown and pale red (weathered), and mostly finely crystalline. Some coarsely crystalline beds occur that contain fossil hash, oncoids and intraclasts. Abundant moderate red to grayish orange silty laminae, burrow mottles, and tracks and trails. Unit is thin to thick bedded. *Receptaculites* zone (about 10 m thick) is 40 m below top of Pogonip, and immediately below that zone is a 3-m-thick massive ledge that contains greater than 50 percent blackish red to dark reddish brown silicified and silty resistant laminae. The Pogonip is mostly thin bedded above this massive ledge and thick bedded below. Fossils include gastropods, trilobites, brachiopods, and crinoid columnals. Total thickness of unit is unknown in this quadrangle, but Kellogg (1963) estimated a total thickness of 1,080 m for the Pogonip Group in the southern Egan Range

Ꞓm **Mendha Formation (Lower Ordovician and Upper Cambrian)**--Shown in cross section only. Unit description from adjacent Bristol Well quadrangle where only part of the formation is exposed (Page and Ekren, 1995). Equivalent to the Mendha Formation of Merriam (1964). Dolomite and subordinate limestone; dolomite is medium dark gray (fresh), dark gray, olive gray, and dark yellowish orange (weathered), finely to medium crystalline, thin to thick bedded and contains medium-gray burrow mottles; also contains trilobite and brachiopod fragments. Limestone is medium gray (fresh) and medium light gray (weathered), and texturally consists of packstone to wackestone with peloids, intraclasts, and abundant trilobite fragments. Merriam (1964) and Westgate and Knopf (1932) estimated the unit to be about 600 m thick in the Highland Range, about 15 km southeast of this quadrangle

Ꞓhp **Highland Peak Formation (Middle and Upper Cambrian)**--Shown in cross section only; unit description from the adjacent Bristol Well quadrangle (Page and Ekren, 1995). Limestone, dark gray to grayish black (fresh), medium dark gray (weathered), burrow mottled to light brownish gray and light olive gray; mottles are dolomitic. Rock is finely crystalline and mostly thick bedded. Contains oncoids and poorly preserved trilobite and brachiopod shell fragments. Unit forms massive cliffs and is reported to be about 1,370 m thick 15 km to the south in the Highland Range (Merriam, 1964)

Contact

High-angle normal fault--Barbed arrow shows direction and amount of dip. Dashed where approximately located, dotted where concealed, and queried where uncertain. Bar and ball on downthrown side

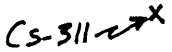


Oblique-slip Fault--Ball and bar on downthrown side; arrows show relative direction of offset. Dotted where concealed

Fault location based on gravity data--dotted where concealed

Strike and dip of beds and compaction foliation

Inclined



Sample locality for conodont analysis

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