UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PRELIMINARY GEOLOGIC MAP OF PATTERSON PASS AND CRATER ISLAND NW QUADRANGLES, BOX ELDER COUNTY, UTAH, AND ELKO COUNTY, NEVADA

By

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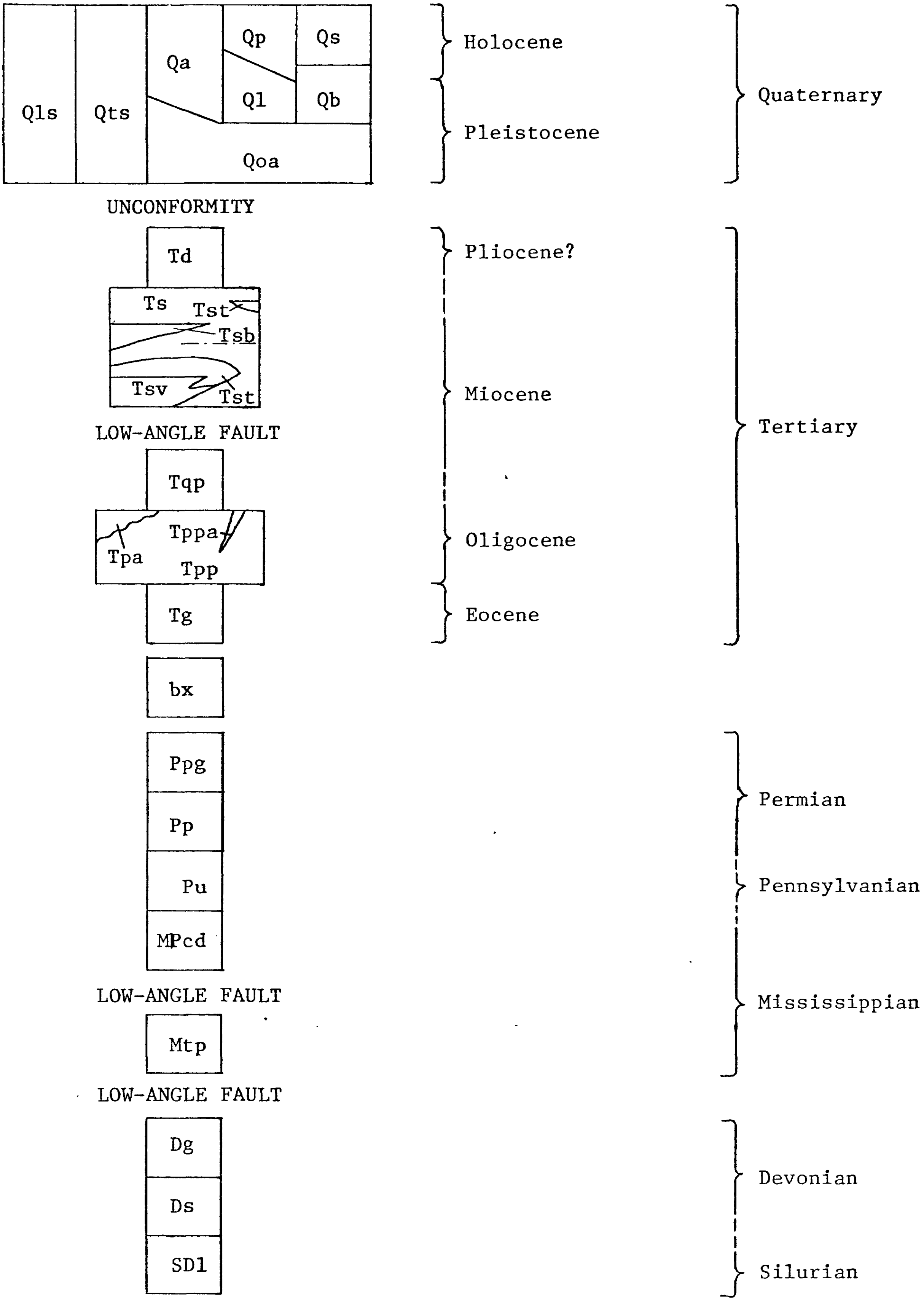
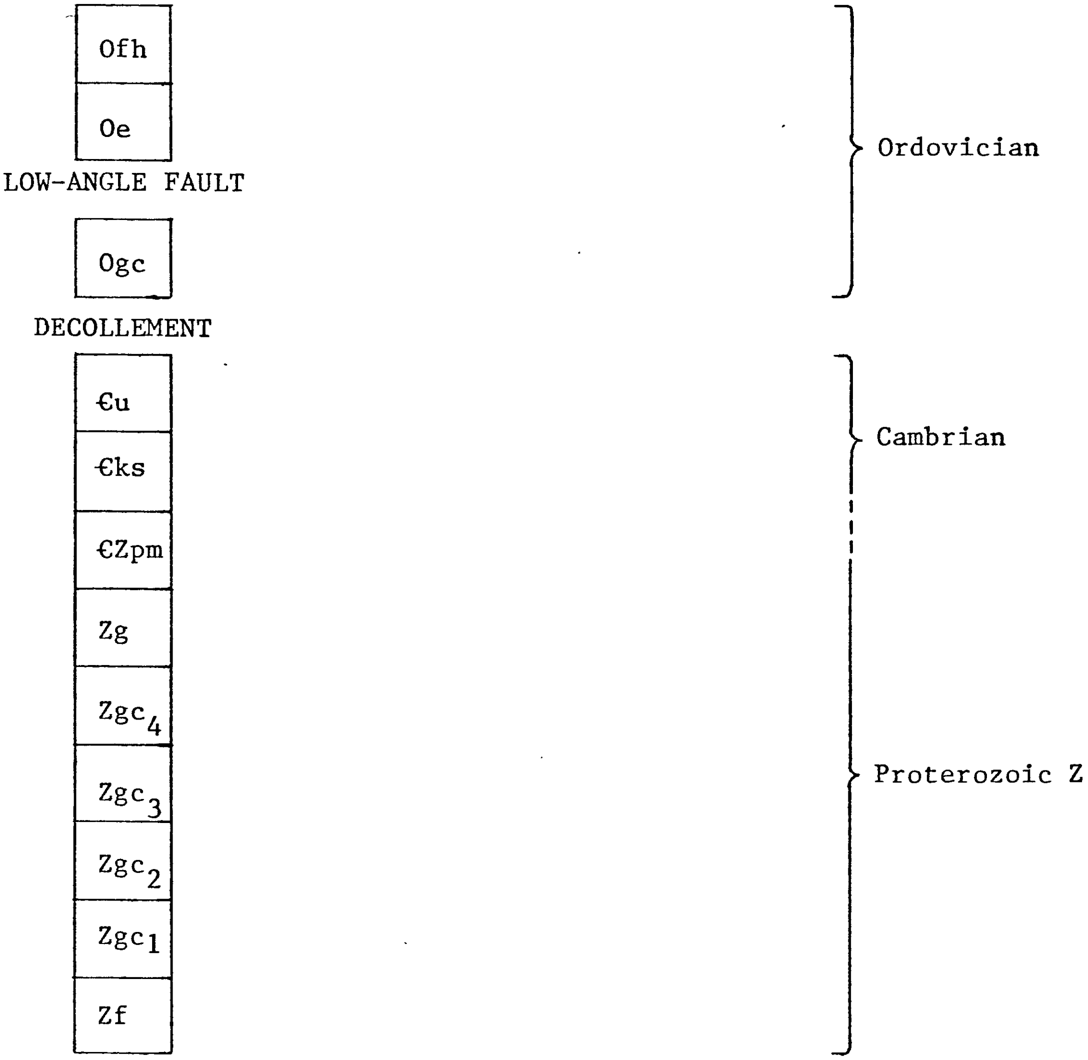
Open-File Report
82-834

CORRELATION OF MAP UNITS




Ofh
Oe
LOW-ANGLE FAULT
Ogc
DECOLLEMENT
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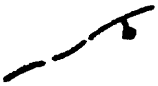
Zg
Zgc4
Zgc3
Zgc2
Zgc1
Zf
Ordovician
Cambrian
Proterozoic Z

CONTACTS--Dotted where covered



HIGH-ANGLE FAULTS--Dashed where location inferred; dotted where covered

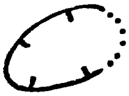
Normal fault; bar and ball on downthrown side

Strike-slip fault; arrows show sense of separation

LOW-ANGLE FAULTS--Dashed where location inferred, dotted where covered. Barbs on upper plate.

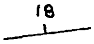
Bedding-plane fault known or presumed to be pre-Tertiary in age

Fault cutting Tertiary rocks

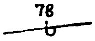


GRAVITY SLIDE BLOCK--Tertiary or Quaternary age; dashed where location inferred, dotted where covered

ORIENTATION OF BEDDING



Inclined

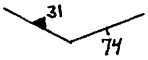


Overturned

Vertical

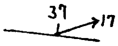
ORIENTATION OF FOLIATION

Inclined



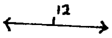
ORIENTATION OF BEDDING AND FOLIATION--Measured at same outcrop; junction of two symbols is outcrop location

ORIENTATION OF LINEATION



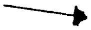
In bedding

In foliation

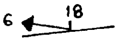


Horizontal

ORIENTATION OF SMALL FOLDS



Individual folds



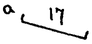
Folds in bedding

Folds in foliation

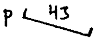
TRACE OF AXIAL SURFACE OF LARGE FOLD--Dashed where location approximate

Plunging syncline, showing plunge

ORIENTATION OF DIKES



Aplite



Pegmatite

Aplite and pegmatite combined

Micropegmatite

⊕ DRILL HOLE--Probable locations of holes reported by Doelling (1981)

MAP UNIT IDENTIFIED BY FLOAT ONLY

DESCRIPTION OF MAP UNITS

Qa	ALLUVIUM (Quaternary)--Unconsolidated stream and fan deposits of conglomerate, gravel, sand, and silt; slopewash included locally.
Qs	WINDBLOWN SAND (Quaternary)--Unconsolidated tan and light-brown fine sand and silt forming complexes of small dunes less than 1.5 m in height. Most dunes stabilized by vegetation. Windblown sand deposits commonly rim playas in Crater Island NW quadrangle.
Qp	PLAYA DEPOSITS (Quaternary)--Unconsolidated, white to gray carbonate mud, oolitic sand, and gypsum and halite evaporite deposits (Lines, 1979). Deposits on small playas behind Lake Bonneville beach bars included.
Qts	TALUS AND SLOPEWASH (Quaternary)--Unconsolidated, blocky deposits on talus slopes and conglomerate, gravel, and sand slope-wash deposits.
Qls	LANDSLIDE DEPOSITS (Quaternary)--Displaced deposits of disaggregated rock and alluvium, forming hummocky terranes.
Ql	BONNEVILLE LAKE DEPOSITS (Quaternary)--Unconsolidated gravel, sand, silt, and soft white calcereous clay, generally forming thin veneers on alluvial surfaces. Tufa mounds locally occur at wave benches.
Qb	GRAVEL BEACHES AND BARS (Quaternary)--Unconsolidated cobbles, gravel, and sand deposited in beach and bar complexes at several stands of Lake Bonneville. Clasts well-rounded and well size-sorted, commonly with little matrix material.
Qoa	OLDER ALLUVIUM (Quaternary)--Unconsolidated to partly consolidated, poorly sorted boulder, cobble, pebble, gravel, sand, and silt alluvial deposits forming raised terraces. Cut by Holocene stream channels and wave benches of the high stand of Lake Bonneville.
Td	DIABASE (Miocene or Pliocene)--Undivided reddish brown, resistant diabase dikes and large unresistant bodies that form soft, loose brown soils. Generally fine-grained, hornblende-plagioclase diabase and pyroxene-plagioclase mafic rock.
	SEDIMENTARY AND VOLCANIC ROCKS (Miocene and Pliocene(?)) Varied strata consisting of lacustrine and alluvial sedimentary rocks and silicic tuffs and lava flows. Minimum thickness exposed on eastern side of Pilot Range about 1220 m. Divided into:
Ts	Sedimentary Rocks--Lithified, but generally non-resistant, green and brown fanglomerate; siliceous lake deposits such as conglomerate, sandstone, and siltstone; limestone. Thin interbeds of white, altered, water-laid vitric tuff included. Lake deposits generally thin-bedded and fine-grained; coarser rocks occur in lower part of section. Limestone is silty, dark-brown, thin-bedded. Marker unit of pebble conglomerate containing clasts of lineated metaquartzite indicated by dot-dashed line. Greater than 350 m thick on the west side and greater than 1000 m thick on the east side of the range.
Tsb	Biotite Rhyolite Tuff--Poorly exposed, deeply weathered, biotite-alkali feldspar-plagioclase-quartz unwelded ash-flow(?) tuff. Weathers white. Minor welded tuff and air-fall tuff containing pumice clasts also present. Thickness approximately 10-50 m.
Tst	Vitric Tuff--White to light-gray, thin to thick bedded, vitric tuff containing no phenocrysts. Grading, cross-stratification, and interbedding of silt and sand suggest subaqueous deposition. Thickness 2-600 m, but generally less than 200 m; where thinner than approximately 20 m tuff is included in sedimentary rocks unit (Ts).
Tsv	Volcanic Rocks--White, altered tuff, rhyolite flows, and volcanic breccia. Tuff has phenocrysts of plagioclase, quartz, and hornblende in chalky, siliceous to clayey matrix. Rare flow-banding and rounded quartz grains occur in flows. Breccia is gray hornblende dacite(?). About 365 m thick.

Tqp	QUARTZ PORPHYRY (Oligocene or Miocene)--North-striking, steeply dipping dikes of quartz porphyry containing subhedral quartz, plagioclase, and alkali feldspar in an aphanitic, pale gray groundmass.
	MONZOGRANITE OF PATTERSON PASS (Oligocene)--Porphyritic monzogranite; pluton has altered margins, and is intruded by late-magmatic aplite.
Tpp	Monzogranite--Coarse-grained, white to gray, porphyritic monzogranite to granodiorite. Euhedral phenocrysts of alkali feldspar, as large as 5 cm maximum diameter, set in coarse-grained matrix of subhedral plagioclase and alkali feldspar (5 mm), subhedral quartz (8 mm), and biotite. Rare hornblende, zircon, sphene, apatite, and xenotime(?). Biotite, generally 6-9% modally, is partially altered to chlorite.
Tpa	Altered Rock--Fine-grained, yellow, tan, green, and brown siliceous rock containing quartz, feldspar, and calc-silicate minerals. Occurs as irregularly shaped bodies at intrusive contacts with carbonate rock and in pods within carbonate strata.
Tppa	Aplite Dikes--Fine-grained, pale-gray and cream-colored dikes of quartz-plagioclase-alkali feldspar aplite, commonly striking north and dipping steeply. Pegmatite borders or centers common.
Tg	GRANODIORITE DIKES (Eocene)--Light-gray, medium-grained, biotite-hornblende granodiorite with aphanitic to fine grained matrix. Dikes vary widely in composition, generally containing alkali feldspar, plagioclase, quartz, biotite, and hornblende.
bx	SILICIFIED BRECCIA--Dense, resistant, dark brown, brecciated jasperoid, silicified sandstone, altered carbonate rock, and siliceous vein and vug fillings.
Ppg	GRANDEUR FORMATION(?) OF THE PARK CITY GROUP (Lower Permian)--Siliceous, light- and medium-gray, thin- to medium-bedded dolomite and sandstone. Quartz sandstone is fine-grained, cemented by calcite, and commonly silicified, producing a brown weathered color. Dolomite is sandy, well-bedded, and rarely fossiliferous. Approximate thickness estimated from cross sections 490 m; top of unit not exposed.
Pp	PEQUOP FORMATION (Lower Permian)--Laminated to thin-bedded, platy, dark-gray, silty limestone; less common laminae and thin beds of siltstone are browner than limestone. Some beds bioclastic, typically containing crinoid fragments, spirifer brachiopods, and fusilinids. Thickness estimated from cross sections is 730 m, but the unit is strongly folded and fractured, and lower part is omitted by faulting.
Pu	UNNAMED SANDY LIMESTONE (Permian)--Gray and brown, slope forming, calcareous, platy sandstone and arkose, and silty limestone. Maximum thickness about 125 m.
M₱cd	CHAINMAN-DIAMOND PEAK FORMATIONS (UNDIVIDED) (Mississippian and Pennsylvanian(?))--Dark gray, dark brown, or black sandstone and conglomerate with quartz, chert, and feldspar clasts; and dark gray shale. Moderately well bedded in medium to thick beds; conglomerate beds are 0.5 to 2 m thick and form cliffs. About 185 m thick.
Mtp	TRIPON PASS LIMESTONE (Lower Mississippian)--Dark-gray to black, regularly bedded, silty limestone with subordinate interbeds of calcareous siltstone. Weathers light-gray with a pinkish hue. Maximum thickness 425 m.
Dg	GUILMETTE FORMATION (Middle and Upper Devonian)--Light-gray weathering, dark-gray, blue-gray, and black, cliff-forming limestone. Well-bedded or laminated throughout and fossiliferous. Sedimentary breccia and soft-sediment slump features common. Lower part contains common stringers and beds of dolomite. Quartz sand zones occur near top. About 390 m thick north of Cook Canyon.

Ds	SIMONSON DOLOMITE (Lower(?) and Middle Devonian)--Interlayered dark- to medium-gray and light-gray calcareous dolomite forming steep slopes with distinctive light-dark banding. Medium to thick beds in lower part alternate in color; beds are uniformly dark or light in middle and upper parts. Characterized by fine laminations in all but a few beds, which are extensively bioturbated. Upper 20 m contains bioclastic beds, typically in an alternating limestone/dolomite sequence or in shaly limestone. Maximum thickness 365 m.
SDl	LONE MOUNTAIN DOLOMITE (Silurian and Lower Devonian)--Off-white, light- and medium-gray, poorly bedded to structureless dolomite and calcareous dolomite. Upper part light-colored throughout, unbedded, and locally contains quartz sand beds 15 m thick about 30 m below the top. Middle section is medium-gray, poorly bedded, and crinoid-bearing, with some layers of light-gray and dark-gray. Lower part is light-gray and contains sparse chert nodules. Greater than 425 m thick.
Ofh	FISH HAVEN DOLOMITE (Ordovician)--Dark- to medium-gray weathered, medium-gray to black, poorly bedded, fractured calcareous dolomite.
Oe	EUREKA QUARTZITE (Ordovician)--Fractured tectonic slices of white and light-gray medium grained orthoquartzite. Well-size-sorted and well-rounded quartz sand grains are indented by pressure solution, and in places are partly recrystallized.
Ogc	GARDEN CITY FORMATION (Ordovician)--Thinly interbedded blue-gray limestone, gray and brown silty limestone, and brown calcareous siltstone.
Ꞓu	UNNAMED LIMESTONE (Cambrian)--Gray to tan, platy, laminated and thin-bedded limestone and phyllitic limestone with dolomite and siltstone partings. Maximum thickness about 270 m.
Ꞓks	PHYLLITE OF KILLIAN SPRINGS (Cambrian)--Dark graphitic phyllite and interbedded platy limestone. About 300 m thick. Divided into lower portion, about 125 m thick, of bench-forming homogeneous dark-gray, black, and dark-blue-gray graphitic phyllite and siltstone, and upper dark gray interbedded limestone and phyllite about 175 m thick.
ꞒZpm	PROSPECT MOUNTAIN QUARTZITE (Lower Cambrian and Proterozoic Z)--Light-colored, prominently bedded and cross-laminated quartzite forming massive cliffs.
	MC COY CREEK GROUP (Proterozoic Z)--Alternating phyllitic and quartzitic units.
	Unit G--Divided into two subunits:
Zg	Upper Subunit--Dark phyllite and metasiltstone with interbedded marble and quartzite. About 525 m thick on the northern limb of major fold south of Patterson Pass; probably faulted at the base.
	Conglomerate Subunit--Divided into four intervals:
Zgc_4	Interval 4--Dark-gray to black conglomerate and coarse-grained quartzite. Quartzite generally poorly size-sorted; contains feldspar and mica. Conglomerate polymict; clasts are quartzite of various colors, jasper, and slate; clasts range considerably in size, shape, and roundness. Greater than 20 m thick.
Zgc_3	Interval 3--Dark brown, rhythmically bedded phyllite and metasiltstone forming gentle slopes. About 50 m thick. Interbedded at top and bottom with adjacent units.
Zgc_2	Interval 2--Light-gray, coarse-grained to conglomeratic quartzite forming steep cliffs. Generally medium- to thick-bedded and cross-laminated, brown weathering, and micaceous. About 145 m thick. Locally, beds contain as much as 20% feldspar. Quartzite is coarse, impure, and poorly size-sorted. Upper 105 m is polymict conglomerate similar to, but lighter in color than, the conglomerate in interval 4.

Zgc$_1$ Interval 1--Dark brown, quartzose phyllite and interbedded coarse quartzite and conglomerate. Interbedded zones of phyllite and quartzite 10 to 25 m thick; entire unit about 400 m thick. Quartzite is dark-gray, brown, and light-gray, impure and poorly size-sorted. Conglomerate is polymict and contains phyllite rip-up wedges. Forms slopes with small cliffs.

Zf Unit F--Gray, well-bedded and cross-laminated, cliff-forming quartzite about 430 m thick. Lower 40 m or so is poorly bedded gray quartzite containing feldspar fragments and rare beds of conglomerate. Remainder is superbly bedded and cross-laminated. Conglomerate at top is lenticular and as much as 20 m thick, containing rip-up clasts of phyllite, boulders and cobbles of quartzite, and rare jasperoid clasts. Interbeds of phyllite similar to phyllite of Unit G are common in upper conglomerate.

INTRODUCTION

The Pilot Range, located on the northern Nevada-Utah border about 80 km south of Idaho (Fig. 1), lies in the eastern Great Basin. The Pilot Range and nearby mountains are north trending fault blocks, typical of the northern Basin-Range province. The Pilot Range region was the site of igneous intrusion, metamorphism, folding, and low-angle faulting during the Mesozoic. Cenozoic high- and low-angle faulting and igneous activity masked the Mesozoic structures, commonly making their recognition difficult or impossible (Armstrong, 1972). Radiometric dates for low-grade metamorphism and intrusion of several plutons in the Pilot Range are now available, allowing partial resolution of the Mesozoic and Cenozoic structural history.

As part of a project to understand the Mesozoic and Tertiary tectonics of northwestern Utah, a mapping program was undertaken in the Pilot Range area. This mapping has uncovered significant structural and metamorphic relations that had not been apparent in earlier studies by Blue (1960) and O'Neill (1968). Complicated Tertiary and Mesozoic faults control the present distribution of sedimentary, metamorphic, and igneous rocks. Some of the Mesozoic deformation and metamorphism relations have been mapped and described in the Pilot Peak quadrangle (Fig. 2), where a tentative chronology of Mesozoic metamorphism, low-angle faulting and folding was determined (Miller and Lush, 1981).

This report presents map relations and data on the stratigraphy and structure of the Patterson Pass and Crater Island NW quadrangles north of the Pilot Peak quadrangle (Fig. 2). In these quadrangles folded metamorphic rocks south of Patterson Pass are continuous with those described in the Pilot Peak quadrangle and are interpreted as having the same Mesozoic structures and metamorphic fabrics. North of the pass, and separated from the metamorphic rocks by a granite pluton, occur Paleozoic strata ranging from Ordovician to Permian and Tertiary volcanic and sedimentary rocks. The rocks north of the pass are broken by numerous high- and low-angle faults, some of which are pre-Oligocene and some of which are post-Miocene.

STRATIGRAPHY

Precambrian and Paleozoic strata in the Pilot Range belong to the Cordilleran miogeocline. Cenozoic deposits include thick basin fill of Tertiary age and varied Quaternary deposits. Detailed descriptions, discussions of problematical aspects, and interrelations of these units are included in this section.

Lake Bonneville deposits -- Beaches cut by the high stand of Lake Bonneville presently are at about 1578 and 1591 m elevation on the west and east sides of the Pilot Range, respectively. Prominent beach and bar complexes in the Crater Island NW quadrangle are well developed east of Patterson Pass, and occur at about 1585, 1555, 1524, 1493, 1460, 1400, and 1340 m elevation.

Tertiary sedimentary and volcanic rocks -- Volcanic rocks, fanglomerate, and coarse sedimentary rocks containing volcanic clasts occur in the lower part of the section and finer-grained lake deposits such as silty limestone, siltstone, and sandstone occur toward the top. Sedimentary rocks typically are siliceous, and some contain recognizable reworked volcanic ash, which presumably is the source of the silica.

Poor exposures west of the Pilot Range preclude definite correlation of Tertiary rocks there with those exposed east of the range, although the two sequences are lithologically similar. Blue (1960) reported that Late Miocene or earliest Pliocene mollusks were recovered from the upper part of the sedimentary rocks.

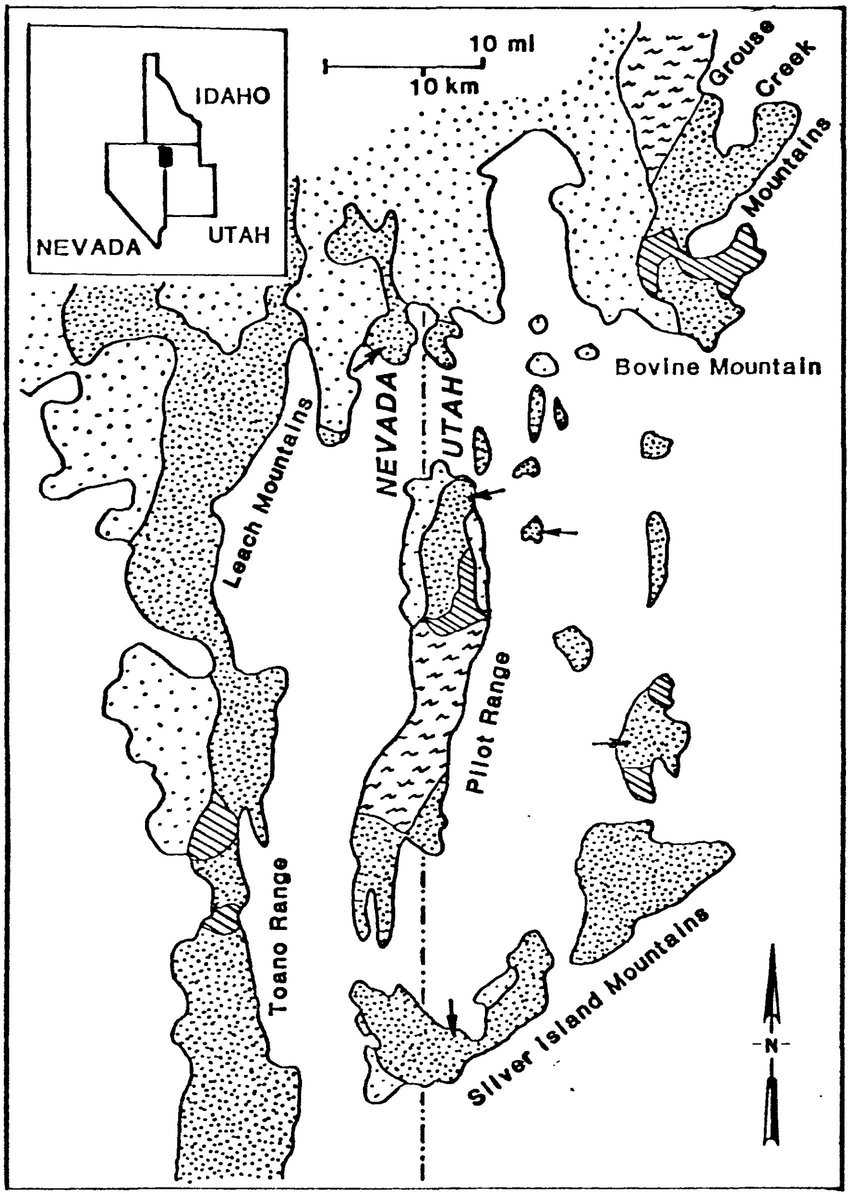


Figure 1. Location map showing Pilot Range and adjacent mountain ranges. Light stipple = Tertiary rocks; heavy stipple = Paleozoic and Precambrian strata; ruled pattern = granitic rocks; wavy lined pattern = metamorphic rocks. Arrows point to locations of silicified rock and/or low-angle faults occurring at the top of the Devonian Guilmette Formation.

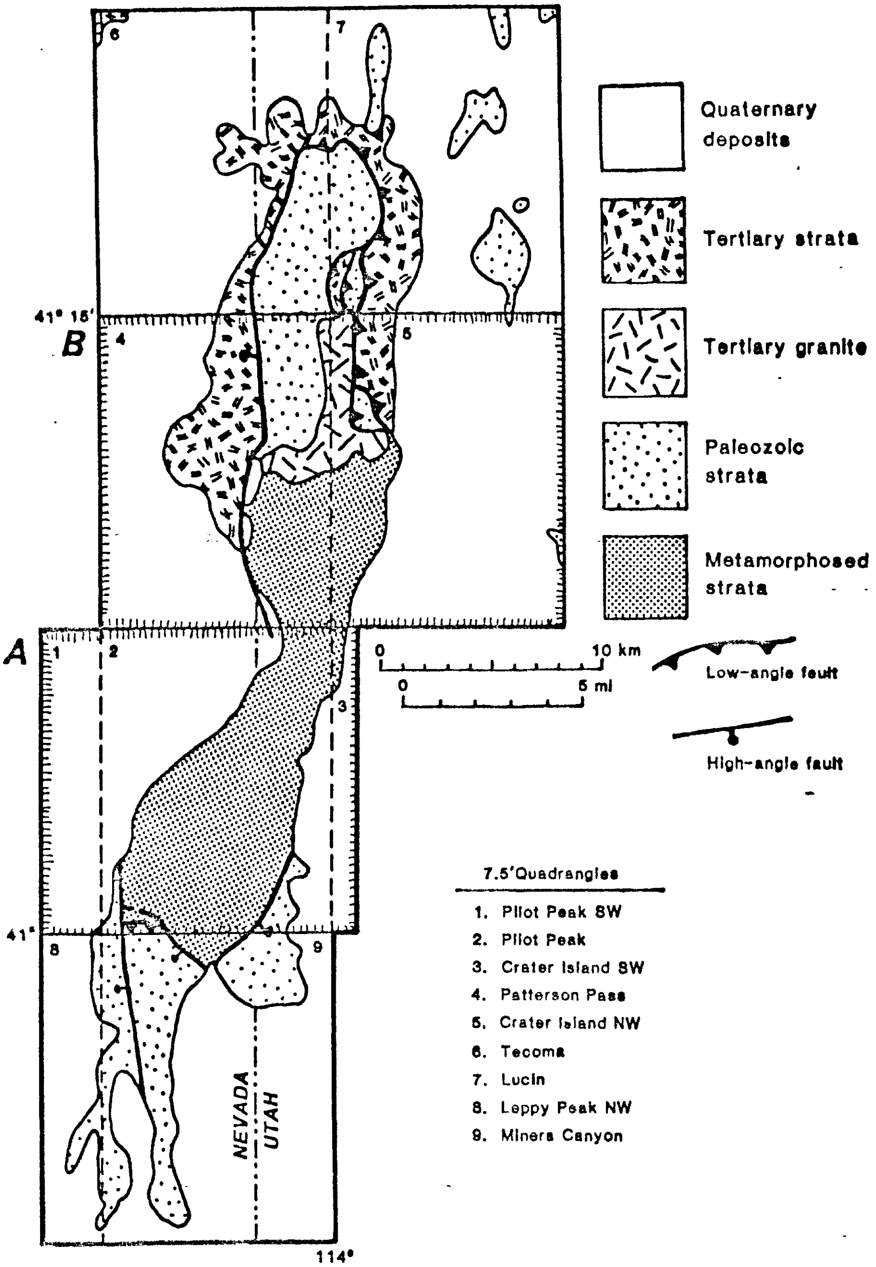


Figure 2. Generalized distribution of Paleozoic unmetamorphosed and metamorphosed strata (above and below the Pilot Peak decollement, respectively). Map A is Miller and Lush (1981); map B this report. Remainder of map generalized after D. M. Miller and J. P. Schneyer (unpubl. data, 1981).

Silicified breccia -- This rock unit, always capping cliffs of the Devonian Guilmette Formation, may be partly of hydrothermal and tectonic origin. The rock was cemented by silica following brecciation of jasperoid, indicating a long-lived silicification and brecciation event or two silicification events, prior to and following brecciation. Recognizable rock types occurring mainly as breccia fragments are calcite-cemented sandstone of the upper part of the Guilmette and carbonate rock probably also derived from the Guilmette. Rare silica solution infillings occur in voids between fragments. Disaggregated quartz sand grains morphologically identical to those making up sandstone in the upper Guilmette occur locally in the matrix.

The silicified breccia unit rests discordantly on the Guilmette Formation, and several different units ranging from Mississippian to Permian in age occur above the breccia (D. Miller and J. Schneyer, unpubl. data, 1981), suggesting that it is primarily a tectonic breccia. A sedimentary breccia origin (at a presumed unconformity) for the unit is ruled out because a) silicified fragments are brecciated and re-silicified, b) the unconformity necessary above the breccia is required to have two orders of magnitude more relief than documented unconformities in this part of the stratigraphic section in nearby ranges (Schaeffer, 1960), and c) where the presumed unconformity cuts out section, such as the removal of Tripon Pass Limestone between Regulator Canyon and Box Canyon, the breccia thickens, rather than thins, on this presumed paleo-high. A hydrothermal origin for the siliceous breccia is harder to rule out; the breccia may be partly hydrothermal as well as tectonic. The breccia was formed during Mesozoic to Paleogene faulting (see section on structures) and silicification is of unknown age.

Grandeur Formation -- The unit is highly silicified, typically having a massive to bedded cherty aspect. Fossils are rare; those observed are crinoid fragments, rare silicified brachiopods(?), and possible silicified fusilinids. The unit is highly fractured and gently folded, but appears to conformably overlie the Permian Pequop Formation because the rock types are gradational. The base is defined by a change from thin-bedded silty limestone of the Pequop to silicified, cherty sandstone and limestone of the Grandeur. About 10 m above the base the limestone gives way to dolomite typical of the remainder of the section.

Pequop Formation -- The lower 50 m of the Pequop are exposed south of Copper Mountain, and the upper part, about 730 m thick, crops out on McGinty Ridge. Thick bioclastic limestone beds south of Copper Mountain yielded Early Leonardian fusilinids (R. C. Douglass, written commun., 1982); Blue (1960) reported Early Wolfcampian fusilinids from similarly described rocks in approximately the same location. Bryozoans from near the base of the Pequop on McGinty Ridge yielded species limited to Early Pennsylvanian to Late Permian strata (O. L. Karklins, written commun., 1980). A collection from near the middle of the section contained Permian bryozoans (O. L. Karklins, written commun., 1980) and Lower Permian schwagerinid fusilinids (R. C. Douglass, written commun., 1981). Pennsylvanian to Permian productid brachiopods identified by M. Gordon, Jr. (written commun., 1980) were collected about 10 m below the top of the Pequop.

Thin-bedded silty limestone in Lemay Island is similar to the Pequop in the Pilot Range, but is generally less silty and is regularly bedded on the scale of 1 to 3 cm. It is tentatively included in the Pequop.

Unnamed sandy limestone -- This unit, lying between the Pequop Formation and Chainman-Diamond Peak Formations, is of uncertain correlation. The contact with the Chainman-Diamond Peak is a sharp change of lithology and color, but is covered; it may be either tectonic or stratigraphic. Lower beds are dark- to medium-gray, well-sorted, medium-grained, quartz sandstone with calcite matrix. Less common beds are granular to coarse-grained. Quartz is angular with undulatory extinction, similar to underlying beds of Chainman-Diamond Peak. The upper part is medium-bedded, medium- to dark-gray, sandy and silty limestone containing angular to subangular clasts of quartz and rare plagioclase and microcline. A zone in the upper part contains reworked nodules of phosphorite. Brachiopods in this zone are an undescribed species of Crurithyris, and are found in rocks ranging from late Wolfcampian to late Leonardian elsewhere in northeastern Nevada (M. Gordon, Jr., written commun., 1982). The top of the unnamed sandy limestone may be faulted; exposures are poor in the saddle between it and Pequop beds, and altered intrusive rock occurs near or at the contact. The unit is unlike the Pennsylvanian Ely Formation which conformably overlies the Chainman-Diamond Peak in the southern Pilot Range. The unnamed limestone is tentatively considered to be Wolfcampian based on its position beneath the Pequop and fossil data.

Chainman-Diamond Peak Formations (undivided) -- The unit is dominantly quartzite, with subordinate gray shale and siltstone, and heterolithic conglomerate. Sandstone clasts are dominantly three types: (1) well-rounded undeformed quartz, (2) subrounded to subangular dark chert or siliceous siltstone, and (3) subangular to angular quartz with undulatory extinction. Rare plagioclase also occurs. Lithic fragments of intermediate to mafic volcanic rocks constitute approximately 50% of the clasts in a 3 m interval low in the section. The sandstone matrix is composed of fine sand- to silt-sized quartz and clay. Conglomerate is silicified and resistant, containing clasts of chert, sandstone, calcareous sandstone, and jasperoid. Maximum clast diameter is 20 cm, but the general range is from 3 to 6 cm. Rare interbeds of medium-gray shale contain bryozoan and brachiopod fragments. Similar shale, as much as 20 m thick, occurs beneath a low-angle fault block of Permian strata east of Patterson Pass.

The Chainman-Diamond Peak is cut by a low-angle fault at its base, where it is juxtaposed with Mississippian Tripon Pass Limestone or silicified breccia. The lower contact is interpreted as a fault, rather than an unconformity, because a) beds of Tripon Pass Limestone adjacent to the contact are tightly folded and discordant to the contact, and b) the entire Chainman-Diamond Peak is truncated against the Tripon Pass south of Copper Mountain, and yet no anomalous facies indicative of 150 to 200 m of relief on an unconformity are present in the Chainman-Diamond Peak.

Tripon Pass Limestone -- The Tripon Pass limestone typically forms rounded, grassy slopes covered with light gray, fissile to platy, cleaved limestone fragments. Less common are cliffy exposures of medium to thin bedded limestone. Worm burrows, crinoids, and rare bryozoan fragments are present locally, but the unit is generally remarkably unfossiliferous. Rusty-colored sand-bearing laminae occur locally, and brown chert nodules occur locally near the top. The unit was termed the shaly limestone member of the Devonian Guilmette Formation by Blue (1960) in the absence of paleontologic data. Conodants from the Tripon Pass Limestone in a gravity slide block west of Patterson Pass are Early Mississippian (Kinderhookian) (A. G. Harris, written commun., 1980), as are conodants from the Tripon Pass north of Hogans Alley (J. Pepetski, written commun., 1982; A. G. Harris, K. Denkler, and J. Repetski, written commun., 1982). Reworked Ordovician conodants in the sample west of Patterson Pass indicate that the Mississippian conodants may also be redeposited. In the vicinity of Hogans Alley, the Tripon Pass is about 400 ft (120 m) thick and appears to rest conformably on black, cliff-forming limestone that is cherty and fossiliferous, similar to Mississippian Joana Limestone exposed in nearby ranges. The black limestone is about 10 m thick; it, in turn, rests on tectonic breccia associated with the low-angle fault that separates the Guilmette from overlying units. Conodants recovered from the black limestone are Middle Devonian to Early Mississippian (A. G. Harris, K. Denkler, and J. Repetski, 1982), compatible with assignment of the limestone to the Joana or Guilmette. Northward, the Tripon Pass tectonically rests on the silicified breccia unit and is as much as 425 m thick, perhaps because of unrecognized tectonic duplication.

The Tripon Pass Limestone in the Pilot Range is similar to the Tripon Pass exposed 40 km to the west in the Pequop Mountains, but differs from the temporally equivalent Joana Limestone exposed in the nearby Silver Island Mountains. The Joana is dark, cliff-forming, bioclastic limestone and contains only minor clastic material, and it is much thinner than the Tripon Pass (Schaeffer, 1960; I. Douglas, personal commun., 1981).

Guilmette Formation --Irregular zones of calcareous and quartzose sand at the top of the Guilmette may be sandy infilling of karst features; these fillings are locally as much as 50 m thick. Quartz sandstone with calcareous matrix, similar to the sandstone karst(?) fillings, is interbedded with the upper Guilmette northward in the Pilot Range (D. Miller and J. Schneyer, unpubl. mapping, 1981).

The contact of the Guilmette with the underlying Simonson Dolomite is difficult to define because of variable dolomitization and because lithologically distinctive zones are not laterally persistent. At Mineral Mountain the contact is defined at the top of the slope forming Simonson dolomite beds and overlying thin shaly, fossiliferous limestone, and at the base of cliff forming black limestone of the Guilmette. Southward, near Patterson Pass, the shaly limestone is not present but a fossiliferous zone of interbedded limestone and dolomite may represent the same interval. The contact there is drawn at the top of the last slope forming dolomite beds at the base of limestone cliffs.

Blue (1960) described Late Middle to Late Devonian fossils from the Guilmette (his massive limestone member). Late Middle Devonian (Givetian) conodants are present 12 m above the base of the unit (A. G. Harris, written commun., 1980).

Simonson Dolomite -- The unit seems to vary in thickness, perhaps due in part to uncertainty in assigning the upper and lower boundaries. The lower boundary is generally sharp: black laminated dolomite of the Simonson overlies poorly bedded, structureless, pale to white dolomite of the Lone Mountain Dolomite. Blue (1960) considered the Simonson to be Middle Devonian on the basis of stromatoperoids and brachiopod fragments. Conodants from shaly limestone near the top of the Simonson are Middle to Late Devonian (A. G. Harris, written commun., 1980); poorly preserved brachiopods from the same locality are suggestive of Middle and Early Late Devonian forms (J. T. Dutro, Jr., written commun., 1980). Basal Guilmette beds are Late Middle Devonian, indicating that the upper Simonson is Middle Devonian, in accordance with ages of the unit in nearby ranges (Poole and others, 1977). The age of the lower part of the Simonson in the Pilot Range is not yet known.

Lone Mountain Dolomite -- The Lone Mountain Dolomite is apparently Early Devonian to Late Silurian. Beds 4 m below the top of a section west of Mineral Mountain yielded very Late Silurian to Early Devonian conodants; beds approximately 340 m below the top yielded possible Late Silurian to Early Devonian conodants; and beds 380 m below the top yielded Late Silurian to Early Devonian conodants (A. G. Harris, written commun., 1980). The base is not exposed.

Garden City Formation -- The Garden City Formation occurs in two low-angle fault slices north of Regulator Canyon. The lower fault slice, occurring above Lone Mountain Dolomite and below Eureka Quartzite, consists mainly of thinly bedded limestone with interbedded zones of silty limestone. Rare beds of quartz sand in a calcite matrix and beds containing abundant brown chert nodules also occur. The upper fault slice of Garden City is strongly cleaved and is primarily thin-bedded, silty brown limestone with very thin interbeds of medium gray limestone. Recrystallized brachiopods are abundant, and gastropods and worm burrows are common. A gastropod from the upper tectonic slice was identified as Late Early Ordovician by E. L. Yochelson (written commun., 1982) The rocks are lithologically similar to thick sections of the Garden City in the southern Pilot Range.

Unnamed limestone -- The base of the unit is drawn at the top of the uppermost dark silty limestone bed of the underlying Cambrian phyllite of Killian Springs. The lower part of the section is mainly medium-gray laminated limestone with tan dolomitic laminations and interbeds; it grades upward into very thinly bedded tan silty limestone and fissile gray calcareous and graphitic phyllite. The unit contains cubes of pyrite throughout. No diagnostic fossils have been recovered from the section, but it is lighologically similar to sequences in identical structural and stratigraphic settings in the southern Pilot Range (marble unit of Miller and Lush, 1981), and in the Toano Range and Silver Island Mountains (M. B. McCollum, written commun., 1982). The unit contains Late Cambrian(?) and Middle Cambrian faunas, respectively, in the Toano and Silver Island ranges (R. Robison, personal commun., 1981). The lithology of the unnamed limestone, characterized by platy limestone and graphitic phyllite, is in sharp contrast to shallow water facies Upper Cambrian limestone and dolomite in the southern Pilot Range (D. Miller and J. Schneyer, unpubl. mapping, 1981) and Silver Island Mountains (Schaeffer, 1960).

Phyllite of Killian Springs -- The lower part of the Killian Springs is homogneous, and only rarely is bedding discernable as fine sandstone beds in dark phyllite and siltstone. The upper, steep slope-forming, part consists of phyllite and siltstone, as in the lower part, interbedded with laminated and cross-laminated dark limestone. The limestone beds typically are 2 to 10 cm thick and interbedded phyllite is 10 to 30 cm thick. Siliceous sponge spicules are abundant (M. B. McCollum, written commun., 1982). The entire Killian Springs contains disseminated cubes of pyrite. The base of the Killian is in sharp contact with thick-bedded quartzite of the Cambrian and Proterozoic Z Prospect Mountain Quartzite of Misch and Hazzard (1962). The contact is a bedding-plane fault of probably small separation; quartzite beds are truncated at low angles in many locations, but the Prospect Mountain and Killian Springs are not greatly thinned.

The phyllite of Killian Springs was named by Miller (in press) to emphasize the contrast of lithologies in the Pilot Range sections with the broadly equivalent Pioche Formation (Hintze and Robison, 1975), which elsewhere overlies the Prospect Mountain Quartzite in much of eastern Nevada and western Utah. The Pioche consists of green siltstone, quartzite, and limestone, and is typically overlain by shallow water facies carbonate rocks; whereas the Killian is graphitic, black phyllite, and impure platy limestone, and is overlain by basinal facies carbonate rock. Cambrian strata similar to the Killian Springs occur in the neighboring Silver Island Mountains, Utah, and Toano Range, Nevada (M. B. McCollum (written commun., 1982).

Prospect Mountain Quartzite -- The unit name is herein used as defined by Misch and Hazzard (1962) and further modified by Woodward (1967) and Miller (in press). Miller (in press) described the unit in detail. White, vitreous, pure quartzite in the base is overlain by blue-gray quartzite containing feldspar fragments. The majority of the unit is thick-bedded, distinctly cross-laminated, and typically has gravel layers at the base of beds. Conglomerate beds as much as 4 m thick are locally present at the top. The unit is about 700 m thick at the north limb of the syncline south of Patterson Pass, and about 865 m thick at the south limb, where a low-angle fault occurs near the base.

McCoy Creek Group -- Alternate phyllitic and quartzitic units are assigned to the McCoy Creek Group of Misch and Hazzard (1962), following Woodward (1967), Miller and Lush (1981), and Miller (in press). Detailed descriptions of the units are given by Miller (in press).

Unit G--This upper unit of the McCoy Creek Group is divided into two subunits, the upper phyllitic subunit and the lower conglomerate subunit, following Miller and Lush (1981) and Miller (in press).

The lower part of the upper phyllitic subunit consists of phyllite and metasiltstone containing rare lenses of coarse quartzite. The phyllite grades upward to a distinctive central portion of interbedded light-colored marble, metasiltstone, and dark, fine-grained quartzite. The marble is commonly epidotized adjacent to the Patterson Pass pluton. The upper part is dark, thin- to medium-bedded and cross laminated, fine-grained quartzite.

The lower conglomerate subunit consists of four alternating intervals of phyllite and conglomerate, designated intervals 1 through 4 in ascending order. Phyllitic intervals were metamorphosed to biotite-epidote-staurolite(?)-cordierite(?) assemblages adjacent to the Patterson Pass pluton; the staurolite and cordierite are retrogressed.

IGNEOUS ROCKS

Diabase dikes -- Diabase dikes cut Miocene and Pliocene(?) strata in the Patterson Pass and Crater Island NW quadrangles, and are cut by low-angle faults displacing these strata; they are therefore Miocene or younger.

Quartz porphyry -- Quartz porphyry dikes cut the Oligocene monzogranite of Patterson Pass, and are in turn cut by diabase dikes. Quartz porphyry dikes locally pass gradationally into brown, siliceous, flow-banded breccia.

Monzogranite of Patterson Pass -- The monzogranite of Patterson Pass separates metamorphosed Proterozoic Z and Cambrian strata to the south from unmetamorphosed Ordovician to Permian strata to the north. Modal analyses of six stained slabs indicate that four are monzogranite and two are granodiorite. The unit is therefore termed "monzogranite," in contrast to names used previously: "monzonite" of Blue (1960) and Doelling (1980), and "granodiorite" of Hoggatt and Miller (1981). Schlieren and irregularly shaped zones of clotted phenocryst-rich rock are common. Inclusions of porphyritic biotite hornblende granodiorite and hornblende quartz diorite(?) typically occur in clots of numerous inclusions, each 10 to 20 cm wide. The quartz diorite is also included within the biotite hornblende granodiorite inclusions. Pegmatite, aplite, and micropegmatite, distinguished on the accompanying geologic map, occur as generally north-striking dikes.

Isotopic dating indicates that the monzogranite of Patterson Pass is Oligocene. Coats and others (1965) obtained dates of 31 ± 0.6 m.y. (biotite K-Ar) and 30 ± 10 m.y. (Pb-α), and Hoggatt and Miller (1981) obtained a date of 36.6 ± 0.5 m.y. (biotite K-Ar).

The pluton has a nearly flat roof, judging from a) its exposure northward along the east side of the Pilot Range for 11 km, b) lithologically similar rock that outcrops at the northern extreme of the map on the west side of the range, and c) drill hole data reported by Doelling (1980, p. 89) indicating that the pluton underlies Paleozoic strata along the crest of the range at a depth of about 300 m.

Granodiorite dikes -- Lithologic similarity with the granodiorite of Bettridge Canyon in the Pilot Peak quadrangle (Fig. 2) (Miller and Lush, 1981) suggests that the dikes are the same age as that pluton. Isotopic dates for the pluton, however, are conflicting: Hoggatt and Miller (1981) concluded that the pluton was Cretaceous or older based on a hornblende K-Ar determination of 91.2 ± 1.5 m.y., which has been supported by a nearly identical date on a second split of the hornblende (W. C. Hoggatt-Hillhouse, personal commun., 1981); however, U-Pb systematics for zircons from the body indicate an age of 38.9 ± 0.9 m.y. (R. L. Zartman, written commun., 1982). The age is here considered to be Early Tertiary based on the U-Pb data, and the K-Ar results are interpreted as due to absorption of excess argon.

STRUCTURE

Several groups of low-angle faults, three sets of high-angle faults, penetrative folds and cleavage, and a major fold deform the rocks in the Patterson Pass and Crater Island NW quadrangles. Many of these structures are known or inferred to be post-Middle Jurassic and pre-Eocene in age on the basis of relations with dated igneous bodies, but some of both the low-angle and high-angle faults are Neogene or younger.

Pre-Tertiary rocks in the quadrangles can be conveniently divided into two domains based on age, metamorphism, and structural history. Unmetamorphosed Paleozoic strata north of Patterson Pass range from Ordovician to Permian and are brittley deformed by high- and low-angle faults. Low-grade metamorphic Proterozoic Z and Cambrian strata south of Patterson Pass have undergone ductile deformation on all scales. These metamorphic rocks crop out at the north end of a window that continues southward into the adjacent Pilot Peak quadrangle (Fig. 2), where the metamorphosed rocks are overlain by unmetamorphosed Paleozoic strata along a major low-angle fault (Miller and Lush, 1981), termed the "Pilot Peak decollement" by Miller (in press). The Pilot Peak decollement is inferred to lie between metamorphosed older strata south of Patterson Pass and unmetamorphosed rocks north of the pass in a structural and stratigraphic position analogous to that of the decollement at Pilot Peak. Patterson pass is underlain by the Oligocene monzogranite of Patterson Pass, a pluton that is distinctive because the roof of the body is nearly flat (Doelling, 1980). It is proposed here that the pluton intruded and spread laterally along the inferred Pilot Peak decollement.

Support for the inferrence that the Pilot Peak decollement was in the northern Pilot Range is found in the regional occurrence of the decollement. In the southern Pilot Range the Pilot Peak decollement separates shallow water facies Cambrian rocks from underlying basinal facies Cambrian rocks. Cambrian facies analogous to those in the Pilot Range are also separated by a decollement in the neighboring Toano Range (Fig. 1). Similar relations were observed in the Silver Island Mountains, where Robison and Palmer (1968) documented a thick Upper Cambrian shelf carbonate sequence north of Silver Island Pass, and south of the pass basinal facies phyllite and platy limestone occur on the Prospect Mountain Quartzite.

North of Patterson Pass, the Paleozoic strata are cut by numerous low- and high-angle faults. Low-angle faults are generally subparallel to bedding, and younger-on-older and older-on-younger faults occur. East-striking and north-striking sets of high-angle faults cut the low-angle faults. These structures are Eocene or older.

South of Patterson Pass, the metamorphosed strata are folded, ductily deformed, and cut by bedding-plane faults in a consistent sequence of deformation: 1) bedding-parallel cleavage, and 2) northeast-striking cleavage related to northeast-trending folds and low-angle faults. Later high-angle faults cut structures formed during ductile deformation. Bedding-plane faults emplace younger strata on older. These structures are Jurassic to Paleogene. High angle faults are north-trending and of minor separation, and are presumed to be Neogene.

Neogene strata and Paleogene igneous bodies are cut by young faults belonging to two groups. Low-angle faults east of the Pilot Range and north of Patterson Pass emplace Neogene and Paleozoic strata over the Oligocene monzogranite of Patterson Pass. These faults apparently dip moderately to gently northeastward. Younger(?) steeply to moderately westward-dipping sets of faults occur on the west side of the range, where they locally displace Pleistocene(?) deposits. These faults apparently form the western boundary fault zone of the uplifted Pilot Range block.

Structures are described below in order of age and structural association: (1) Pre-Neogene structures below the Pilot Peak decollement, (2) Pre-Neogene structures above the Pilot Peak decollement, (3) Neogene(?) low-angle faults, and (4) Neogene and younger high-angle faults.

Pre-Neogene structures below the Pilot Peak decollement

The oldest structural feature in phyllite below the decollement is a penetrative cleavage oriented nearly parallel with bedding containing an eastward-trending lineation. This old cleavage is deformed by a steeply northwest-dipping penetrative cleavage that is axial planar to small folds with shallowly northeastward plunging axes. The small folds are generally open to moderately tight, and are similar in geometry and orientation to the major syncline south of Patterson Pass (cross sections AA' and EE'). Small-scale northeast trending folds are especially well developed near the low-angle fault at the top of McCoy Creek Group unit G on the south limb of the major syncline. These small-scale folds, which are generally southeast vergent, are interpreted as geometrically related to faulting, indicating southeast-directed overthrusting of the Prospect Mountain. Folding apparently continued after low-angle faulting, because low-angle faults are deformed by the major syncline. On the northern limb of the major fold, poorly exposed phyllite and conglomerate intervals of McCoy Creek Group unit G are complexly folded into small-to medium-scale folds (cross section EE'). The larger folds apparently verge northwestward, whereas small-scale folds are of inconsistent vergence. Relations between these folds and the low-angle faults are not exposed, and it is not known whether the folds were developed in association with faulting, or as parasitic structures to the major fold, or both.

Low-angle faults folded by the major fold place younger rocks on older, eliminating stratigraphic section. The low-angle fault at the top of the Prospect Mountain generally eliminates less than 100 m of section in the Prospect Mountain and the phyllite of Killian Springs. The Killian Springs section is thin along the limbs and thick in the hinge of the major syncline, probably because considerable flow and faulting occurred during folding. Faulting at the Prospect Mountain-Killian Springs contact may be largely an effect of disharmonic folding. The low-angle fault at the base of the Prospect Mountain eliminates more section than the fault at the top of the quartzite, and considerable folding occurred in adjacent rocks, suggesting that the fault is a major feature. Movement along the fault probably also was partly an effect of disharmonic folding.

Folds and low-angle faults south of Patterson Pass were pre-Oligocene, because the structures were intruded by the monzogranite of Patterson Pass. In the adjacent Pilot Peak quadrangle (Miller and Lush, 1981), folds and low-angle faults, interpreted as correlative with the structures south of Patterson Pass, predate the intrusion of the 39 m.y.-old granodiorite of Bettridge Canyon. These structures formed during regional matarmorphism which predated 83 m.y. (K-Ar on muscovite; W.C. Hoggatt-Hillhouse, personal commun., 1982). Metamorphism, folding, and faulting in the Pilot Peak quadrangle postdated intrusion of muscovite granite, which has been dated as about 155 m.y. old by U-Pb methods (R. L. Zartman, written commun., 1982). Deformation in the Pilot Peak quadrangle is therefore constrained from Middle Jurassic to Late Cretaceous; deformation south of Patterson Pass is interpreted as the same age because of physical continuity with structures in the Pilot Peak quadrangle.

The Pilot Peak decollement, which places unmetamorphosed Ordovician strata tectonically on metamorphosed Cambrian strata, at least in part postdates metamorphism, and predates the 39 m.y.-old granodiorite of Bettridge Canyon, (Miller and Lush, 1981). The Pilot Peak decollement cuts north-trending folds and faults in the southern Pilot Peak quadrangle, structures which in turn cut northeast-trending folds correlated with the major fold south of Patterson Pass. The decollement therefore is at least in part substantially younger than folds south of Patterson Pass.

Pre-Neogene structures above the Pilot Peak decollement

Faults in pre-Tertiary rocks north of Patterson Pass belong to three sets: 1) low-angle faults nearly parallel to bedding, 2) north-striking high-angle faults, and 3) east-striking high-angle faults . None of these faults cut the Oligocene monzogranite of Patterson Pass, although relations are ambiguous for set 3 high-angle faults.

Low-angle faults (set 1) generally place younger rocks on older. The most areally extensive low-angle fault, herein named the Mineral Mountain fault, occurs above the Devonian Guilmette Formation, where a resistant siliceous breccia is present. The Mississippian Tripon Pass Limestone in the hanging wall is fractured and is locally entirely eliminated along the fault, and the Guilmette locally is thinned by as much as 350 m. The Mineral Mountain fault, and associated silicified breccia, continues at the top of the Guilmette to the north end of the Pilot Range (D. Miller and J. Schneyer, unpubl. data, 1981). Faults, or silicified zones, are also recognized above the Guilmette in the Jackson District several tens of kilometers northward (R. Coats, personal commun., 1980; I. Douglas, personal commun., 1981), in Lion Mountain northeast of the Pilot Range (D. Miller, unpubl. data, 1981); and in the Silver Island Mountains (Fig. 1). Approximately eastward movement on the Mineral Mountain fault is indicated by anomalous facies of strata in the hanging wall. The Tripon Pass Limestone was deposited west of its temporal equivalent, the Joana Limestone (Poole and Sandberg, 1977). However, the Tripon Pass in the Pilot Range lies southeastward of Joana outcrops in the Jackson District (I. Douglass, perosnal commun., 1981), and eastward of Joana in the Toano Range (Hope and Coats, 1976), suggesting that it was tectonically displaced from a western source. Two features of the Mineral Mountain fault are notable. First, an older-on-younger fault slice duplicating approximately 455 m of Devonian rocks at Mineral Mountain either merges with or is truncated by the Mineral Mountain fault. Similar relations are recognized in adjacent quadrangles to the north. This geometric association of younger-on-older and older-on-younger faults is unexplained at present, but the older-on-younger faults may be related to splays of adjacent tear faults. Second, there are dramatic changes in thickness of the Guilmette below the Mineral Mountain fault. Such changes occur where high-angle faults cut both the Guilmette and the silicified breccia, such as near Patterson Pass. These thickness changes presumably occur across (reactivated?) tear faults that juxtapose blocks having different amounts of truncation of the Guilmette.

Low-angle faults occurring above the Mineral Mountain fault also eliminate section. Some low-angle faults are difficult to recognize in the Carboniferous section because of the homogeneous lithology of several of the units. The Tripon Pass and Chainman-Diamond Peak are clearly structurally discordant, however. Mesoscopic folds in the Tripon Pass adjacent to the fault separating the Tripon Pass and Chainman-Diamond Peak plunge gently northeastward and verge to both the northwest and southeast. Pronounced axial plane cleavage near the fault indicates strong localized deformation in that zone. Kink folds tens of meters below the fault also trend northeastward to east-northeastward, but have vertical axial planes. Fold and cleavage orientations suggest southeastward or northwestward translation of the Chainman-Diamond Peak above the Tripon Pass. The upper and/or lower contacts of the unnamed sandy limestone may also be bedding-plane faults. The lower part of the unit contains clasts similar to those in the Chainman-Diamond Peak, suggesting that the contact between the units is depositional. The contact between the unnamed limestone and the Pequop is possibly a fault because 1) the intervening Ely Formation is not present and 2) the contact was probably a zone of weakness because altered plutonic rocks intruded it.

Tectonic silvers of Ordovician limestone north of Regulator Canyon are bounded by bedding-parallel low-angle faults that juxtapose the slivers with Silurian to Devonian strata. No truncation or folding of bedding is evident at the faults, but the disruption of the normal stratigraphic sequence and the geometry of the contacts indicate faulting. The two Ordovician limestone slivers are separated by a thin sliver of folded and fractured Eureka Quartzite, out of place with respect to strata above and below it. The Ordovician slivers are bounded by both younger-on-older and older-on-younger faults, and as a group constitute a tectonic sheet "inserted" into younger strata.

High-angle faults are distinguished on the basis of orientation: north- to north-northeast-, and east-striking. The north- striking normal faults (set 2) dip steeply eastward and have as much as 245 m of stratigraphic throw. These faults were noted in Copper Mountain by Blue (1960) during his examinations of mine workings. Surface exposures there permit, but do not require, such faults, so we have indicated a single fault in that area by dashed lines. Altered monzogranite bodies cut the north-striking faults.

East striking faults (set 3) belong to two generations, one coeval with and one cutting low-angle faults. Blue's (1960) Regulator Canyon fault, cutting strata along the south wall of the canyon, and related faults to the north and east, are approximately coeval with low-angle faulting. These faults as a group separate different lithotectonic sequences: to the north, Ordovician strata occur as fault sheets within the middle Paleozoic section, Carboniferous strata are thin or absent, and Permian strata are thick (D. Miller and J. Schneyer, unpubl. data, 1981); to the south are thick Carboniferous strata. This relation suggests that the Regulator Canyon fault system is not simply a down-to-the-south normal fault system. Termination of the Ordovician fault sheet is accomplished by one of these east striking faults that acts as a tear fault. It is probable that other members of the Regulator Canyon fault system also are tear faults related to a deeper, unexposed low-angle fault (Pilot Peak decollement?).

East striking faults south of Regulator Canyon have small separations with a large strike slip component suggested because steeply west dipping faults and moderately east dipping strata are offset by nearly equal amounts. Altered intrusive rocks related to the Oligocene monzogranite of Patterson Pass are intruded along these faults, suggesting a pre-Oligocene age for faulting. It was not possible to determine whether the monzogranite of Patterson Pass is cut by the faults.

All of the faults north of Patterson Pass discussed thus far, with the possible exception of east striking, small separation faults, are intruded by the Oligocene monzogranite of Patterson Pass and presumably postdate the deposition of the last widespread Triassic strata (Misch and Hazzard, 1962). Low- and high-angle faulting north of the pass is thus middle to late Mesozoic and/or Paleogene.

Neogene(?) low-angle faults

East of Patterson Pass, at McGinty Ridge, a low-angle fault slice enclosing Carboniferous Chainman-Diamond Peak Formations rests on the monzogranite of Patterson Pass. The monzogranite is fractured and altered by epidote and sericite adjacent to the fault, indicating moderate temperatures during fracturing and fault movement. Sandstone and shale of the Chainman-Diamond Peak is jumbled; bedding is rarely evident. Diabase is brecciated at the fault also. Faulted above the Chainman-Diamond Peak, and dipping steeply eastward into the fault, is a sequence of Permian strata that is structurally discordant with respect to underlying rocks. Eastward and northward from these Permian strata occur similarly eastward-dipping Tertiary strata. The contact between Permian and Tertiary strata is not exposed, but in adjacent quadrangles to the north this contact is a fault. The similar bedding orientations in the Tertiary and Permian strata are suggestive of a common origin for tilting of the two sequences. Northward from McGinty Ridge, the trace of the fault placing Tertiary strata on the pluton is north-trending, and the fault dips moderately eastward. Slices of Paleozoic carbonate rock occur sporadically in the fault zone, always separating granitic rocks on the west from Tertiary strata on the east. Parallel faults occur to the east. Low-angle faulting postdated deposition of early Pliocene(?) sediments in the upper plate and predated Pleistocene(?) gravels that cover the fault trace. Moderately eastward dipping, down-to-basin(?) faults occurring on the east side of the range south of Patterson Pass may belong to a low-angle fault system analogous to that north of the pass.

Neogene and younger high-angle faults

Most young high-angle faults occur along the west side of the range. These include a set in the southern part of the quadrangles which cuts Pleistocene(?) older alluvium. Along these faults are abundant springs, and graben features occur in one location. Scarps are rounded and barely recognizable. Similar faults may cause the several springs at the west side of Patterson Pass, but if present they do not cut Quaternary deposits. The straight range front north of the pass is probably controlled by similar steep faults, but none are exposed.

Spring lines and topographic lineaments at the northern edge of the quadrangles are interpreted as evidence for a buried fault, one that possibly controls the westward edge of elevated plateaus of Tertiary and Quaternary deposits north and south of Cook Canyon.

The group of east-dipping reverse faults cutting the syncline south of Patterson Pass is considered to be Neogene or younger because the faults are of small-separation, similar to Quaternary(?) faults west of the range. No diagnostic age data are available, however.

ECONOMIC DEPOSITS

Considerable mining activity took place north of Patterson Pass during the late 1800's and early 1900's, but virtually none took place south of the pass. Blue (1960) and Doelling (1980) have summarized the history of production in the Lucin district, which developed around copper, lead, silver, and iron producing mines in Regulator Canyon and on Copper Mountain. Total production exceeded several million dollars. Mineralization was dominantly by replacement of carbonate rock and in fracture fillings in middle Paleozoic carbonate strata; the most prominent group of prospects and mines occurs at the base of the Devonian Guilmette Formation.

Other features with potential economic interest are (1) small outcrops of Eureka Quartzite, a potential source for pure silica, (2) jasperoid in the siliceous breccia on the Guilmette which is similar to mineralized jasperoid occurring 15 km to the north in the Jackson mining district, (3) sorted gravel deposits along the shores of ancient Lake Bonneville, and (4) brines in Pilot Valley playa.

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