UTAH GEOLOGICAL AND MINERAL SURVEY
UTAH DEPARTMENT OF NATURAL RESOURCES
in cooperation with
THE UNITED STATES GEOLOGICAL SURVEY

Plate 1
Utah Geological and Mineral Survey Map 129
Geologic Map of Crater Island SW Quadrangle

Base from U.S. Geological Survey,
Crater Island SW Quadrangle 1967

Field mapping by author 1979, 1988;
assisted by Andrew P. Lush, 1979.
Patricia H. Speranza, Cartographer

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 5-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

UTM GRID AND 1990 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

UTAH

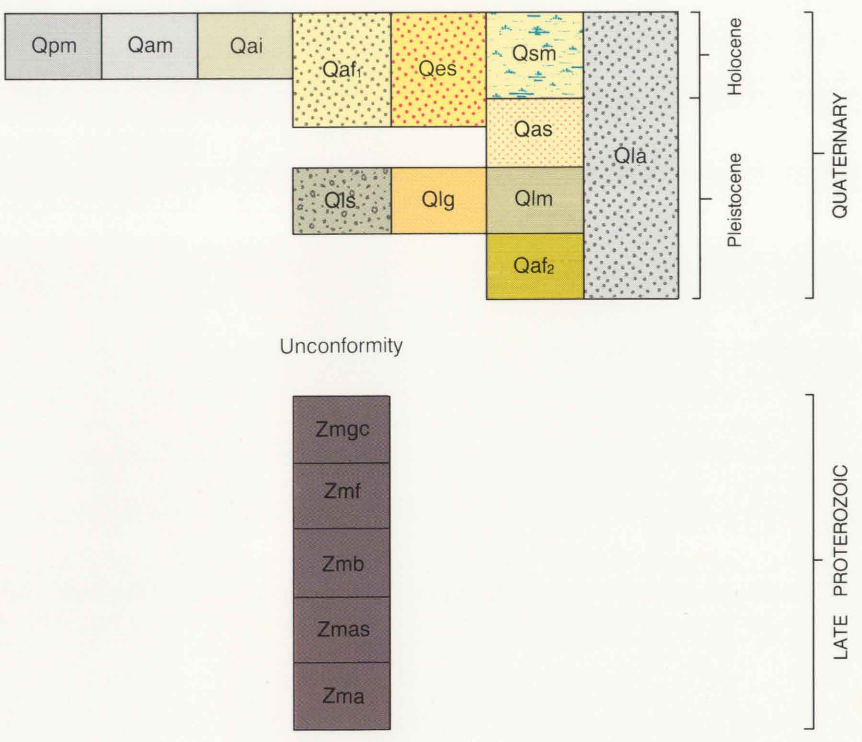
GEOLOGIC MAP OF THE CRATER ISLAND SW QUADRANGLE, BOX ELDER COUNTY, UTAH

by

David M. Miller
U.S. Geological Survey

1990

CORRELATION OF MAP UNITS



MAP SYMBOLS

CONTACT

Dashed where gradational; dotted where covered

HIGH-ANGLE FAULT

36

Dashed where location inferred; dotted where covered; bar and ball on downthrown side; dip indicated

LOW-ANGLE FAULT DISCORDANT TO BEDDING

Dashed where location inferred; dotted where covered; teeth on hanging wall

STRIKE AND DIP OF BEDDING

19

STRIKE AND DIP OF FOLIATION

11

TREND AND PLUNGE OF LINEATION

16

TRACE OF LAKE SHORELINE

—B——B— Bonneville

—P— Provo (double line indicates two parallel barrier crests)

—PV——PV— Pilot Valley (location inferred)

—G——G— Gilbert (location inferred)

DESCRIPTION OF MAP UNITS

Qpm Playa mud (Holocene)—*White to tan mud, silt, and halite of plastic consistency underlying nearly flat expanses over most of east half of Crater Island SW quadrangle.*

Qam Alluvial mud (Holocene)—*Tan to brown mud and silt in distal parts of alluvial drainage systems from Silver Island Mountains, southeast of the quadrangle. Generally gradational into playa mud (Qpm).*

Qai Alluvial silt (Holocene)—*Thin sheets of unconsolidated, poorly sorted, brown silt with subordinate fine sand and clay. Deposited by streams and sheet floods along margins of the playa. Gradational into playa mud (Qpm), and interfingers with and is overlain by eolian sand (Qes).*

Qaf_1 Alluvial fan deposits (Holocene and Pleistocene)—*Unconsolidated, poorly sorted cobble- and pebble-gravel, sand, and silt. Deposited as alluvial cones at mouths of streams, as alluvial floodplains bordering streams, and as sediments in stream channels.*

Qes Eolian sand (Holocene and Pleistocene)—*Unconsolidated fine sand and silt overlying and interfingering with lacustrine, alluvial, and playa deposits. Primarily consists of reworked regressive sandy marl deposits of Lake Bonneville. Forms thin sand sheets and small dunes less than 1 meter (3 ft) thick in most places.*

Qsm Spring mud and silt (Holocene)—*Dark-colored, organic-rich sand, silt, and mud in heavily vegetated areas surrounding freshwater springs.*

Qla Lacustrine and alluvial deposits, undivided (Holocene and Pleistocene)—*Varied, complexly interlayered deposits with lacustrine and alluvial origins. In most places, unit consists of wave-cut notches in alluvial fans and thin lacustrine gravel scattered on alluvial fan deposits.*

Qas Alluvial sand and silt (Pleistocene)—*Red sand and silt beds deposited on lacustrine marl (Qlm) and overlain by shoreline sand (too thin to be mapped) deposited during Gilbert stage of Lake Bonneville.*

Qls Lacustrine sand (Pleistocene)—*Brown, moderately sorted, unconsolidated medium and coarse sand and fine gravel. Crops out mainly between Provo and Bonneville levels. Supports conifer woodland.*

Qlg Lacustrine gravel (Pleistocene)—*Moderately to well-sorted pebble, cobble, and sand deposits, with sand and silt matrix. Generally unconsolidated, but in places cemented by tufa. Interfingers with lacustrine sand (Qls). Locally includes poorly exposed underlying marl.*

Qlm Lacustrine marl (Pleistocene)—*White and buff, unconsolidated marl, clay, silt and sand. Overlies lacustrine sand at elevations above Provo level, where the marl unit contains much sand and silt. Locally includes thin interbedded and (or) overlying gravel.*

Qaf_2 Alluvial fan deposits (Pleistocene)—*Unconsolidated, poorly sorted gravel and sand forming narrow piedmonts flanking the Pilot Range. Overlain by deposits of Lake Bonneville.*

McCoy Creek Group of Misch and Hazzard (1962) (Late Proterozoic) — Divided into:

Zmgc Conglomerate subunit of Unit G—*Brown phyllite and less common quartzose conglomerate.*

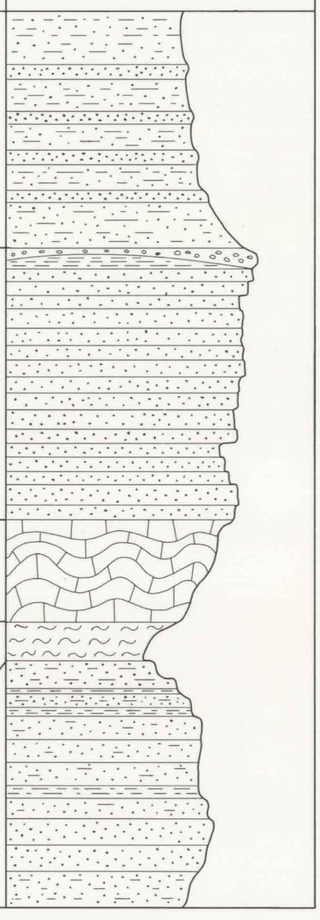
Zmf Unit F—*Thick-bedded, gray quartzite forming cliffs and steep slopes. Contains conglomerate channels near top that include phyllite rip-up wedges as clasts.*

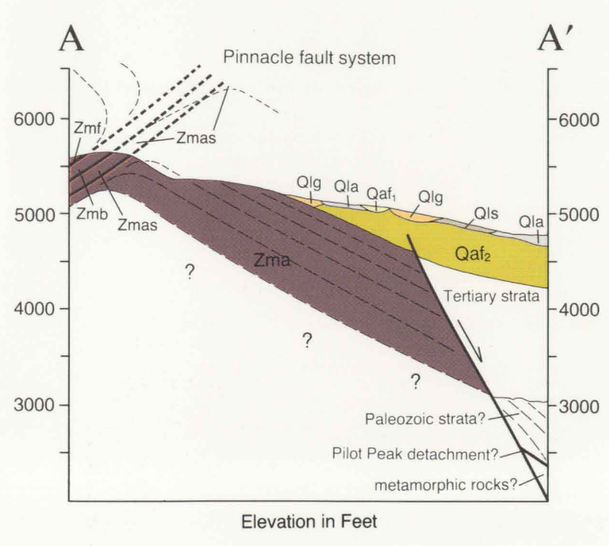
Zmb Unit B(?)—*White and gray, massive to laminated marble.*

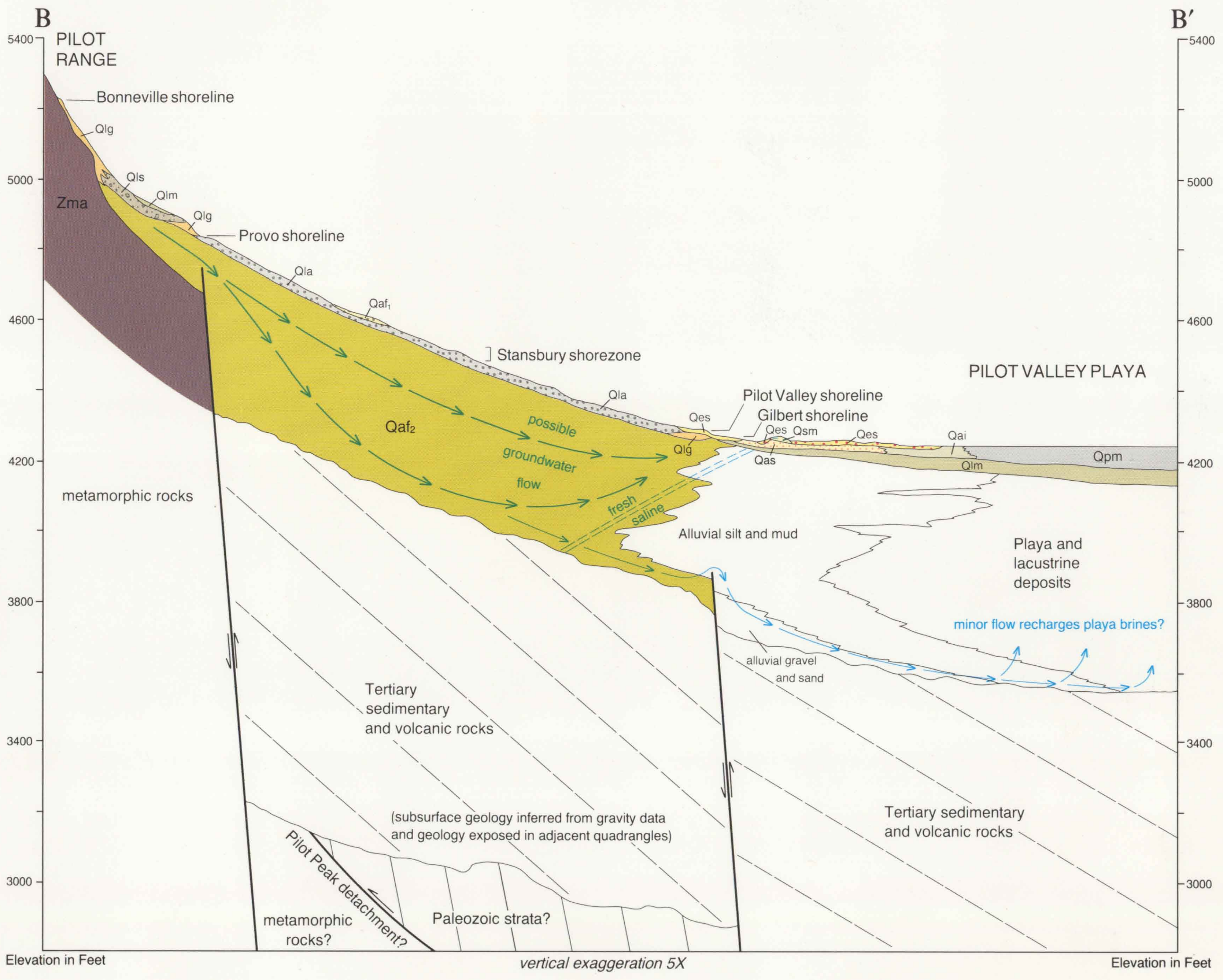
Unit A(?)—*Divided into:*

Zmas Schist subunit—*Light green amphibole schist and minor brown mica schist.*

Zma Lower subunit—*Interbedded tan flaggy quartzite, mica schist, and brown phyllite.*

FORMATION		SYMBOL	THICKNESS feet (meters)	LITHOLOGY
McCoy Creek Group Unit G conglomerate subunit		Zmgc	1250 (380)	
McCoy Creek Group Unit F		Zmf	1400 (430)	
McCoy Creek Group Unit B		Zmb	510 (155)	
McCoy Creek Group Unit A	schist subunit	Zmas	200 (60)	
	lower subunit	Zma	1275 (390)	





GEOLOGIC MAP OF THE CRATER ISLAND SW QUADRANGLE, BOX ELDER COUNTY, UTAH

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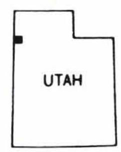

MAP 129 **1990**

UTAH GEOLOGICAL AND MINERAL SURVEY

a division of

UTAH DEPARTMENT OF NATURAL RESOURCES

UTAH GEOLOGICAL AND MINERAL SURVEY

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Salt Lake City, Utah 84108-1280

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GEOLOGIC MAP OF THE CRATER ISLAND SW QUADRANGLE, BOX ELDER COUNTY, UTAH

David M. Miller
U.S. Geological Survey

ABSTRACT

The Crater Island SW 7.5-minute quadrangle lies in northwestern Utah and includes part of the central Pilot Range, a broad piedmont, and part of the Pilot Valley playa. Late Proterozoic metasedimentary rocks are exposed in the Pilot Range in the western part of the quadrangle. Widespread Quaternary alluvial fan deposits form a steep piedmont extending eastward from the Pilot Range to the playa. During Pleistocene time, Lake Bonneville inundated much of the area covered by the quadrangle; shorelines cut into older alluvial aprons and lacustrine deposits indicate that the lake reached about 1589 meters (5210 ft) at its maximum depth. Since the withdrawal of Lake Bonneville waters, periodic flooding and desiccation of the playa have maintained a flat, vegetation-free surface underlain by saline mud.

INTRODUCTION

The Crater Island SW 7.5-minute quadrangle encompasses the eastern margin of the central Pilot Range and much of the northern Pilot Valley playa (figure 1). The playa is about 1292 to 1295 meters (4240-4250 ft) in elevation within the quadrangle and the flanking piedmont bordering the Pilot Range slopes up to about 5400 feet (1646 meters) elevation. A strip of bedrock about 1.5 kilometers (1 mi) wide underlying the northwest corner of the quadrangle is typical of the central Pilot Range.

Early studies of the Crater Island SW quadrangle vicinity by Stansbury (1853) and Gilbert (1890) dealt chiefly with the desert lowland. O'Neill (1968) mapped and described Proterozoic to Cambrian strata and several granitoid plutons in the Pilot Range just west of the quadrangle. Miller and Lush (1981) mapped this part of the Pilot Range in detail and published a preliminary map that included the western part of the Crater Island SW quadrangle.

This report on the Crater Island SW quadrangle is a continuation of geologic map studies in the northwestern Utah area (figure 2). Adjacent geologic quadrangles include Pilot Peak (Miller and Lush, 1981), Lemay Island (Miller and Glick, 1986), Crater Island (Miller and others, 1990), Crater Island NW (Miller, in press), and Patterson Pass (Miller and others, in press).

GEOLOGIC SETTING

The Pilot Valley playa is one of a series of fault-bounded, north-trending basins lying between narrow ranges, the groups of physiographic features together comprising the Basin and Range physiographic province. The extensive alluvial sediments in piedmonts flanking the Pilot Range have covered most range-bounding faults, but a few faults are younger than these sediments (Miller and Lush, 1981) and large, buried faults are indicated by gravity gradients (Cook and others, 1964).

Thick deposits of Late Proterozoic and Paleozoic sedimentary rocks, predominantly siliciclastic and carbonate, respectively, were deposited in this part of northwestern Utah. Mesozoic tectonism included plutonism, metamorphism, folding and faulting (Allmendinger and others, 1984). Cenozoic magmatism and normal faulting associated with region-wide extensional tectonics led to the development of the Basin and Range province. Lake Bonneville (Gilbert, 1890) and its precursor lakes covered much of northwestern Utah sporadically during Quaternary time, leaving distinctive lacustrine sediments and geomorphic features. Exposed in the northwest corner of the Crater Island SW quadrangle is part of the Late Proterozoic sequence; it was metamorphosed, faulted, and folded in the Mesozoic (Miller and others, 1987). Flanking alluvial piedmonts are covered by late Pleistocene lacustrine sediments that record the rise and fall of Lake Bonneville.

MAP UNITS

LATE PROTEROZOIC ROCKS

The McCoy Creek Group of Misch and Hazzard (1962) was defined for a thick sequence of quartzite and phyllite underlying the Cambrian and Late Proterozoic (restricted) Prospect Mountain Quartzite of Misch and Hazzard (1962) in the Schell Creek Range, east-central Nevada. This nomenclature was extended to the Pilot Range by Woodward (1967), O'Neill (1968), and Miller (1983). Miller (1983) followed Stewart (1974) by including the uppermost unit of Misch and Hazzard's (1962) McCoy Creek Group, unit H,

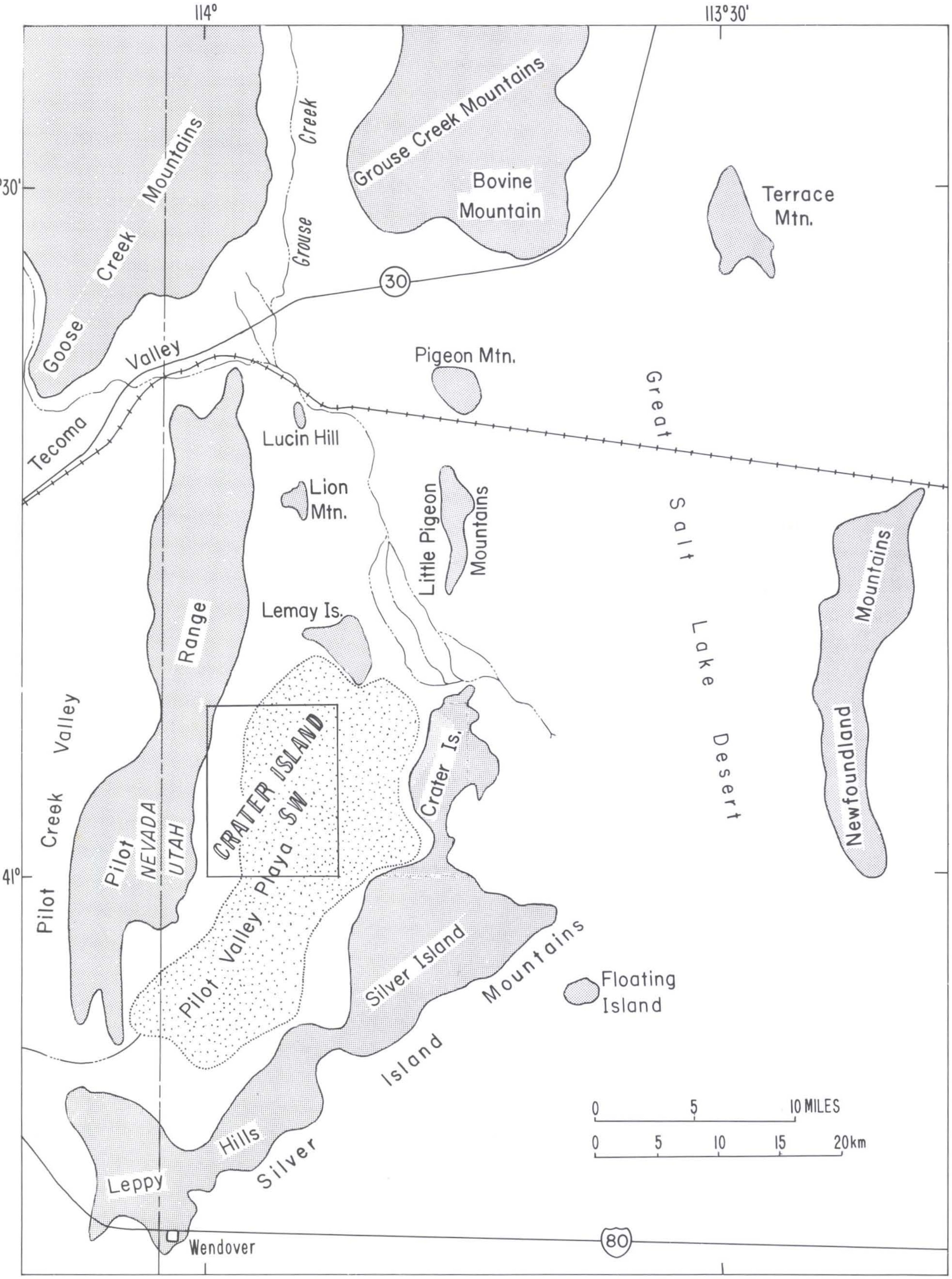

Figure 1. Location of physiographic features in the vicinity of the Crater Island SW quadrangle, northwestern Utah.

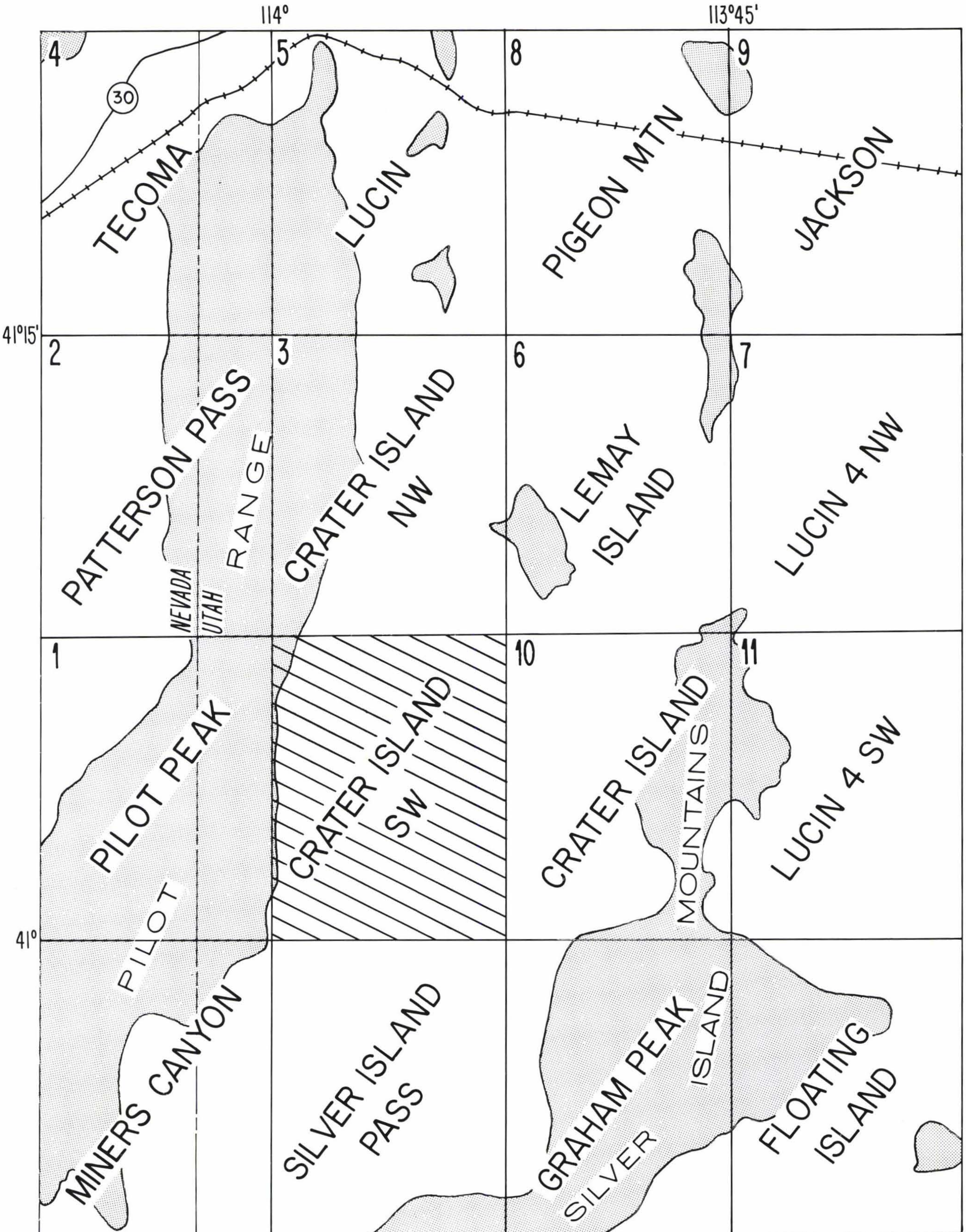

Figure 2. *Quadrangle index for Crater Island SW quadrangle and vicinity, showing geologic maps published at 1:24,000. 1. Miller and Lush, 1981; 2. Miller, Lush, and Schneyer, in press; 3. Miller, in press; 4. Miller and Schneyer, 1985; 5. Miller, 1985, 6. Miller and Glick, 1986; 7. Glick and Miller, 1986; 8. Glick and Miller, 1987; 9. Miller and Glick, 1987; 10. Miller, Jordan, and Allmendinger, 1990; 11. Miller, 1990.*

in the lower part of the Prospect Mountain Quartzite because the two units are indistinguishable in most locations. This modified sequence of the McCoy Creek Group extends from unit G at the top to unit A at the bottom.

At the Pilot Range, five lithologic units closely matching those at the Schell Creek Range lie stratigraphically below the Prospect Mountain Quartzite and were accordingly assigned to units G, F, E, D, and C of the McCoy Creek Group by Woodward (1967), O'Neill (1968), Miller and Lush (1981), and Miller (1983). Two lower units, structurally separated from the foregoing sequence, are lithologically similar to units A and B of the McCoy Creek Group at the Schell Creek Range, and were provisionally extended to the Pilot Range by Miller (1983), following O'Neill (1968).

Structurally thinned parts of units A(?), B(?), F, and G of the McCoy Creek Group crop out in the northwestern Crater Island SW quadrangle. These rocks were metamorphosed to greenschist facies in most places, but some of the structurally lower rocks contain remnants of amphibolite facies mineral assemblages.

McCoy Creek Group, unit A(?): Heterogenous rocks assigned to unit A(?) are about 450 meters (1475 ft) thick but are structurally truncated. Impure quartzite, phyllitic siltstone, mica schist, and amphibole schist are the main rock types. Clastic rocks of the lower part of the unit (Zma) are structurally overlain by amphibole schist assigned to the upper schist subunit (Zmas) of unit A(?) by Miller and Lush (1981); in the Pilot Peak quadrangle, the schist subunit is in stratigraphic continuity with the lower part of the unit.

The lower part of unit A(?) consists of flaggy, tan-weathering quartzite with subordinate lenticular bodies of light-brown phyllite, biotite-muscovite schist, steel-gray graphitic schist, and muscovite schist. A few quartzite beds are dark in color; some show cross-lamination and rarely are pebbly. Relict sillimanite (?), garnet, and cordierite indicate amphibolite facies conditions for metamorphism.

The schist subunit of unit A(?) is light-green, crenulated actinolite schist. Locally included in its upper part are lenses of brown biotite-muscovite schist and cordierite-muscovite-actinolite-graphite schist. The schist contains as much as 95 percent amphibole (the remainder is plagioclase), suggesting that it represents metamorphosed impure dolomite.

McCoy Creek Group, unit B(?): White and gray laminated marble (Zmb) of unit B(?) lies within a fault slice above unit A(?). The marble contains small amounts of mica, quartz, and iron oxide minerals. Although typically medium to coarse grained, the marble is fine grained near the faults as the result of extreme plastic deformation.

McCoy Creek Group, unit F: This unit (Zmf) is composed of gray, well-bedded, cross-laminated quartzite that forms cliffs and steep slopes. The thick beds of quartzite typically display tabular, wedge, and trough cross laminations. Bed surfaces bounding the cross sets locally carry scattered white vein quartz pebbles. The uppermost part of the unit, about 20 meters (60 ft) thick, contains channels and beds of massive conglomerate separated by quartzite and rare mica schist beds. Rip-up wedges of phyllite and feldspar clasts are common throughout the upper part of the unit. Unit F, about 430 meters (1400 ft) thick in this part of the Pilot Range (Miller, 1983), is incomplete in the Crater Island SW quadrangle.

McCoy Creek Group, unit G: Miller (1983) divided unit G into two subunits—the conglomerate subunit and upper subunit. Of these, the lower part (interval 1) of the conglomerate subunit (Zmgc) crops out in the Crater Island SW quadrangle. These outcrops contain crenulated brown phyllite.

QUATERNARY DEPOSITS

Most Quaternary deposits in the Crater Island SW quadrangle are eolian, alluvial, and lacustrine in origin. Lacustrine deposits are widespread and varied, and they represent an excellent record of Lake Bonneville history in the northwestern part of the ancient lake. Along the steep piedmont flanking the Pilot Range, the lake formed shorelines and deposited sediments during its rise to the deepest level (represented by the Bonneville shoreline) and its decline to playa conditions. Younger alluvial, eolian, and playa deposits overlie lacustrine deposits in places.

Lacustrine and alluvial deposits, undivided: Pre-Lake Bonneville piedmont alluvium (Qaf_2) is commonly overlain by gravels that are slightly reworked along paleo-lake shorelines or by irregular sheets of lacustrine marl (Qlm). These deposits are mapped as an undivided unit (Qla) where exposures are complex or poor. Elsewhere, lacustrine and alluvial units are subdivided.

Lacustrine marl: The white marl unit (Qlm) of Gilbert (1890) is exposed in only a few locations in the quadrangle but is represented by thick accumulations in the extreme southern outcrops and in outcrops above the Provo shoreline. The latter accumulations are brown because they include much silt and sand. Here, the marl overlies lacustrine gravel (Qlg) and sand (Qls) and is in turn overlain by a thin coating of coarse gravel (not mapped). Thin, poorly to well-sorted gravel (not mapped) deposited in the shorezone during the terminal regression of the lake and (or) by post-Bonneville streams typically overlies the marl along the flanks of the Pilot Range.

Lacustrine gravel: Gravel deposited at the shorezones of Lake Bonneville (Qlg) is widely represented in the western part of the Crater Island SW quadrangle. Regionally mappable shorelines, including the informally designated Pilot Valley shoreline (Miller and others, 1990), are summarized in table 1. In addition to these shorelines, less well-developed wave-cut notches and gravel barriers mark numerous intermediate shorelines. One prominent barrier whose crest is at an elevation of 1513 meters (4965 ft) is located near the southwest corner of the quadrangle. The Bonneville and Provo (Gilbert, 1890) shorelines are represented by broad erosional platforms and gravel constructions in several places. Gravel accumulations at the Bonneville shoreline along its southern 2 kilometers (1.5 mi) extent in the quadrangle are particularly thick; they primarily contain quartzite clasts carried south 3 to 6 kilometers (2 to 4 mi). Provo shoreline deposits are voluminous at the south end of the quadrangle where major streams issuing from Pilot Peak provided abundant detritus. Here, multiple beach ridges representing several highstands of the Provo shoreline are excellently displayed.

Gravel associated with the Stansbury shoreline is irregularly expressed within a zone bounded by 1375 meters (4510 ft) and roughly 1359 meters (4460 ft). Its expression is too erratic to be mapped in the quadrangle. Especially thick marl sections commonly are exposed downslope from the gravels in the Stansbury zone. Cemented sand and gravel, about 1341 meters (4400 ft) elevation, overlies sandy marl (Qlm) 0.5 kilometers (0.4 mi) north of the southern boundary of the quadrangle and just west of the Wendover-Lucin road. Sedimentary structures in both sand and marl indicate south-directed currents. This gravel deposit, and many others below the Provo shoreline, ascend in elevation southward and evidently are the products of gravel deposition during the transgression of Lake Bonneville.

Table 1.

Typical elevations of prominent shorelines

Shoreline	Feature	Elevation feet	Elevation meters
Pilot Valley	beach crest	4285 ± 10	1306 ± 3
Provo	abrasion platform	4840 ± 5	1475 ± 2
	beach crest	4855 ± 2	1479 ± 1
Bonneville	abrasion platform	5210 ± 5	1588 ± 2
	beach crest	5220 ± 5	1591 ±2

The Pilot Valley shoreline was recognized along the margin of Lemay Island (Miller and Glick, 1986), Little Pigeon Mountain (Glick and Miller, 1986; Miller and Glick, 1986), Pigeon Mountain (Miller and Glick, 1987), and Crater Island (Miller and others, 1990) as a prominent shoreline gravel accumulation about 1306 meters (4285 ft) elevation. This shoreline also appears to be developed locally west of Pilot Valley. At several locations in the north half of the Crater Island SW quadrangle, and particularly in section 36, T. 5 N., R. 19 W., thin eolian deposits rest on a bench of gravel (not mapped) at 1306 meters (4285 ft) elevation. East of this bench is a wave-cut notch at 1301 meters (4270 ft) elevation. The gravel at the Pilot Valley shoreline represents shorezone accumulations of the early, transgressional phase of Lake Bonneville (Miller and others, 1990), and the wave-cut notch may represent a regressional lake stand or the Gilbert shoreline.

The Gilbert shoreline is marked at one location by pebbly sand (not mapped) lying on alluvial sand and silt red-bed deposits (Qas). Its elevation is roughly 1298 meters (4260 ft). The Gilbert shoreline elsewhere is probably masked by eolian sand deposits.

Lacustrine sand: Sand (Qls) deposited during the transgression of Lake Bonneville to its highstand is exposed widely in the west-central part of the quadrangle above the Provo shoreline. The sand is moderately sorted and grades upward with decreasing grain size to overlying impure marl (Qlm). The marl is in turn overlain by lacustrine gravel sheets (not mapped). The sequence is interpreted as a gradual deepening and rapidly shallowing cycle; it is notable for its high altitude, where it records the depositional characteristics during the highstand of the lake quite precisely. The lacustrine-sand deposits support a dense pinyon-juniper woodland.

Alluvial sand and silt: Red beds of fine sand and silt (Qas) rest on lacustrine marl (not distinguished on map) and are overlain by sparsely pebbled platforms probably representing remnants of Gilbert shoreline deposits. The red beds were interpreted by Currey and others (1988) as alluvial.

Spring mud and silt: Black and dark-brown alluvial materials with high organic contents (Qsm) form thick deposits around and downslope from fresh-water springs near the margin of Pilot Valley playa. These sites support dense marsh vegetation.

Eolian sand: Thin sheets of tan eolian silt and fine sand (Qes), mostly derived from reworked sandy marl, lie along the playa margin. Irregular mounds in these sand sheets are locally as much as 1.5 meters (5 ft) thick. Larger sand dunes lie near the Wendover-Lucin road about 0.5 kilometer (0.4 mi) north of the southern quadrangle boundary. Blow-out dunes here have crescents that open westward, indicating easterly transport of material. The blow-out dunes lie east of sandy marl outcrops.

Alluvial-fan deposits: Alluvial-fan deposits (Qaf_1) primarily form active stream deposits and fans downslope from the mouths of canyons in the Pilot Range. The deposits overlie lacustrine deposits in most places, indicating that they are primarily Holocene in age. Most alluvial deposits complexly interfinger with or are overlapped by eolian deposits at their distal margins.

Older alluvial fan deposits (Qaf_2) form thick piedmonts flanking the Pilot Range but are only present at the northwest corner of the quadrangle. These deposits are overlain by patches of Bonneville lacustrine deposits in many areas and have been reworked along Bonneville shorelines in others. The older fan deposits therefore are late Pleistocene or older.

Alluvial silt: Bordering the margin of Pilot Valley playa are extensive sheets of alluvial silt (Qai) that constitute a facies transitional between the coarse alluvial deposits (Qaf_1) of the piedmont and the fine playa deposits (Qpm). These deposits are composed of moderately sorted sand, silt, and clay, and are bounded by gradational contacts with playa deposits. The alluvial silt was probably deposited both as low-gradient alluvial sheets and as delta-like deposits within the margins of standing water bodies. The silt unit may also include reworked eolian (Qes) materials. The eolian deposits blanket the zone transitional between coarse alluvium and alluvial silt.

Alluvial mud: Alluvial mud deposits (Qam) underlie a small area of the southeastern corner of the quadrangle where small ephemeral streams emanating from Silver Island (figure 1) have deposited fine sediment on the playa margin. These deposits are gradational with playa mud (Qpm), which represents alluvial-derived mud as well as mud deposited during periods of standing water, and with alluvial silt (Qai). Similar deposits were not distinguishable along the west side of the playa; this is probably because they are reworked yearly by standing water and therefore are indistinguishable from playa deposits.

Playa mud: Mud and silt deposited by a combination of alluvial and lacustrine processes (Qpm) underlie broad flats of the east half of the Crater Island SW quadrangle. These mud deposits contain varying amounts of salt crystals. Although Schaeffer (1960) described a mappable salt pan in the center of Pilot Valley playa, the feature is probably only present during unusually dry years. During our studies, standing water persisted nearly year round on the west side of the playa during years of high rainfall and at least for a few weeks during low-rainfall years. Desiccation polygons are common on the playas.

STRUCTURE OF THE PILOT RANGE

Metamorphism, minor folding, and fabric development in the central Pilot Range were established as Mesozoic by Miller and others (1987). They showed that three sets of foliations and accompanying minor and major folds postdated intrusion of Jurassic dikes (165 to 155 Ma, U-Pb zircon) but accompanied metamorphism that reached its peak before 155 Ma. Mica K-Ar ages in the Pilot Range widely record cooling of metamorphic minerals by Late Cretaceous time. The fabrics and structures dated as Jurassic by Miller and others (1987) are coextensive with those in the Crater Island SW quadrangle. Cutting the metamorphic rocks in the Pilot Range is a detachment fault (Pilot Range decollement of Miller, 1983) that probably moved shortly before it was intruded by roughly 40 Ma granitoids (Miller and others, 1987). The nearly unmetamorphosed rocks in the hanging wall of this detachment are inferred to lie buried beneath the piedmonts (cross section AA') and fragments of these rocks crop out about 1 km (0.6 mi) west of the southwestern part of the Crater Island SW quadrangle (Miller and Lush, 1981).

High-Angle Faults

Two high-angle faults are mapped in the quadrangle. A north-striking fault shows small separations and drops strata down to the west. It cuts across most other structures in the area (Miller, in press). A northwest-striking fault cuts the low-angle Pinnacle fault system, displacing it down to the northeast several hundred meters. This fault is not exposed, but it is required by map relations.

Low-Angle to Moderate-Angle Faults

Three low- to moderate-angle faults in the Pinnacle fault system dip 30° to 45° northwest, on the basis of foliations within the zone and topographic expression, and collectively truncate about 1000 meters (3280 ft) of strata. Rocks near the faults have undergone remarkable grain-size reduction and were strung out parallel to the faults as thin lenses (cross section AA'). The orientations of strata above and below the fault system are nearly orthogonal to the orientations of the faults, but bedding and foliations swing to concordance near the fault. Although the lower fault strand does not cut substantial stratigraphic section, it is marked by lenses of marble from unit B(?) within a tectonized zone. Unit F near the fault is transformed to highly deformed brown quartzose schist resembling phyllonite. In this rock and in tectonite marble of unit B(?), muscovite is stable. The Pinnacle fault system plastically deformed the metamorphic rocks, probably during waning stages of metamorphism, and juxtaposed amphibolite facies rocks of unit A(?) with greenschist facies rocks of unit F. The Pinnacle fault system cuts major folds and reorients metamorphic fabrics, suggesting that it represents a late-metamorphic denudation structure.

Minor Structures

All bedrock contains minor structures indicating plastic deformation. Schist and phyllite typically bear one or two foliations that dip at low angles, subparallel to bedding in nearby quartz-rich strata. Axes of minor folds show northeast and east-northeast trends and plunge gently northeast; these minor folds parallel a major fold train of southeast-overturned folds to the west of the quadrangle (Miller and others, 1987; Miller, in press). Crenulation lineations are weakly developed in some micaceous rocks and generally plunge moderately southeastward.

STRUCTURE OF PILOT VALLEY

Most of the Crater Island SW quadrangle is underlain by a deep Cenozoic basin inferred from geophysical data. Cenozoic high- and low-angle normal faults associated with generally east-oriented extension have been documented in the Pilot Range area, chiefly on the basis of tilted and faulted Cenozoic strata (e.g., Schneyer, 1984; Miller and Schneyer, 1985; Miller, 1985; Miller and Glick, 1986). These Cenozoic normal faults must have been of large displacement because Bouguer gravity anomalies indicate thick sequences of low-density (Cenozoic?) material in basins between the ranges (Cook and others, 1964).

Cook and others (1964) described major faults east of the Pilot Range in the Crater Island SW quadrangle on the basis of gravity gradients. This faulted basin shows about 20 mgal closure, which represents an estimated 4000 feet (1200 meters) of Cenozoic strata. It has a generally north-trending eastern margin just east of the quadrangle and a western margin characterized by two faults, one just west of the Wendover-Lucin road and one near the bedrock front of the Pilot Range (Cook and others, 1964). The positions of these faults are poorly constrained by the reconnaissance gravity data, so they are dotted on the geologic map.

ECONOMIC GEOLOGY

Although mineral deposits have been worked in the Pilot Range (Doelling, 1980), no mineralization is known in the central Pilot Range. A few quartz veins were observed in bedrock in the northwest part of the quadrangle, but minerals indicating alteration or ore enrichment are not associated with the veins.

Concentrated minerals in brines within the saturated playas of Pilot Valley may be economically retrievable. Nolan (1927) described potash composition of brines in the area, and Lines (1979) compared brines of Pilot Valley playa with those of the Bonneville Salt Flat.

Gravel that accumulated in barrier beaches of Lake Bonneville is particularly abundant at the northern and southern extents of the piedmont in the Crater Island SW quadrangle. The gravel is moderately to well size-sorted and is a source of construction materials.

HYDROLOGY

Freshwater springs are common at the toes of alluvial aprons bordering the Pilot Range. All springs issue from sediments mantled by eolian sand. The larger springs have created mappable organic-rich deposits (Qsm) because they support abundant vegetation. In fact, one large spring has been named after a pioneer party, Donner; the party was probably saved from complete disaster by finding that spring after a long, dry journey westward across the playas and salt flats.

Ground-water sources for the springs appear to correlate with run-off systems from the Pilot Range. Springs (Donner Spring and nearby springs) are more common east of the main perennial streams of the Pilot Range and less abundant farther north where the crest of the Pilot Range decreases in elevation. Each major spring to the north is directly associated with a canyon in the Pilot Range bearing a perennial stream or extra lush vegetation indicative of shallow ground water. One model for the origin of the springs is based on their direct association with streams upslope and their proximity to the saline water and fine sediment of the Pilot Valley playa. The water travels in surface streams and as ground water in buried alluvium down the topographic and hydrostatic gradient to the saline lacustrine and fine-grained basin-fill sediments, where it ramps above the denser saline water and the impervious clays of the playa (section BB'). The sharp change in texture and permeability at the toes of alluvial fans—to silt and clay of the playas—probably is the primary control for the locations of springs. Whether its flow is controlled by the salt-to-fresh water interface or by the location of impervious clays, ground water probably can be found at shallow depths in positions upslope from the springs.

GEOLOGIC HAZARDS

Flooding is the primary hazard in the Crater Island SW quadrangle. Alluvial systems downslope from many canyons in the Pilot Range are active almost yearly, with flood water and debris commonly reaching the Wendover-Lucin road. Intense rainstorms are capable of initiating devastating floods and debris flows in these geologic environments. Periodic flooding by standing water or by shallow sheet floods is also a threat near and on Pilot Valley playa.

Eolian dunes fringing the playa are active. They may migrate across improperly located roads, building sites, or other constructions.

Quaternary faults were mapped in the Pilot Range (Miller and Lush, 1981; Miller and others, in press; Miller and Schneyer, 1985). Possible Quaternary faults form topographic benches and are marked by vegetated linear traces just west of the quadrangle (Miller and Lush, 1981). Although the frequency and magnitude of earthquakes along these faults are unknown, large earthquakes in the Pilot Range could cause severe damage.

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