UTAH GEOLOGICAL SURVEY
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Base map from U. S. Geological Survey
Moroni Peak, Utah 7.5' Quadrangle, 1969.

The Miscellaneous Publication Maps provide an outlet for authors who are not Utah Geological Survey staff. Not all aspects of this publication have been reviewed by the UGS.

SCALE 1:24,000

1 0.5 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET

12°53'
229 MIL

2001 MAGNETIC DECLINATION
AT CENTER OF SHEET

GEOLOGIC MAP OF THE MORONI PEAK QUADRANGLE, WAYNE COUNTY, UTAH

by

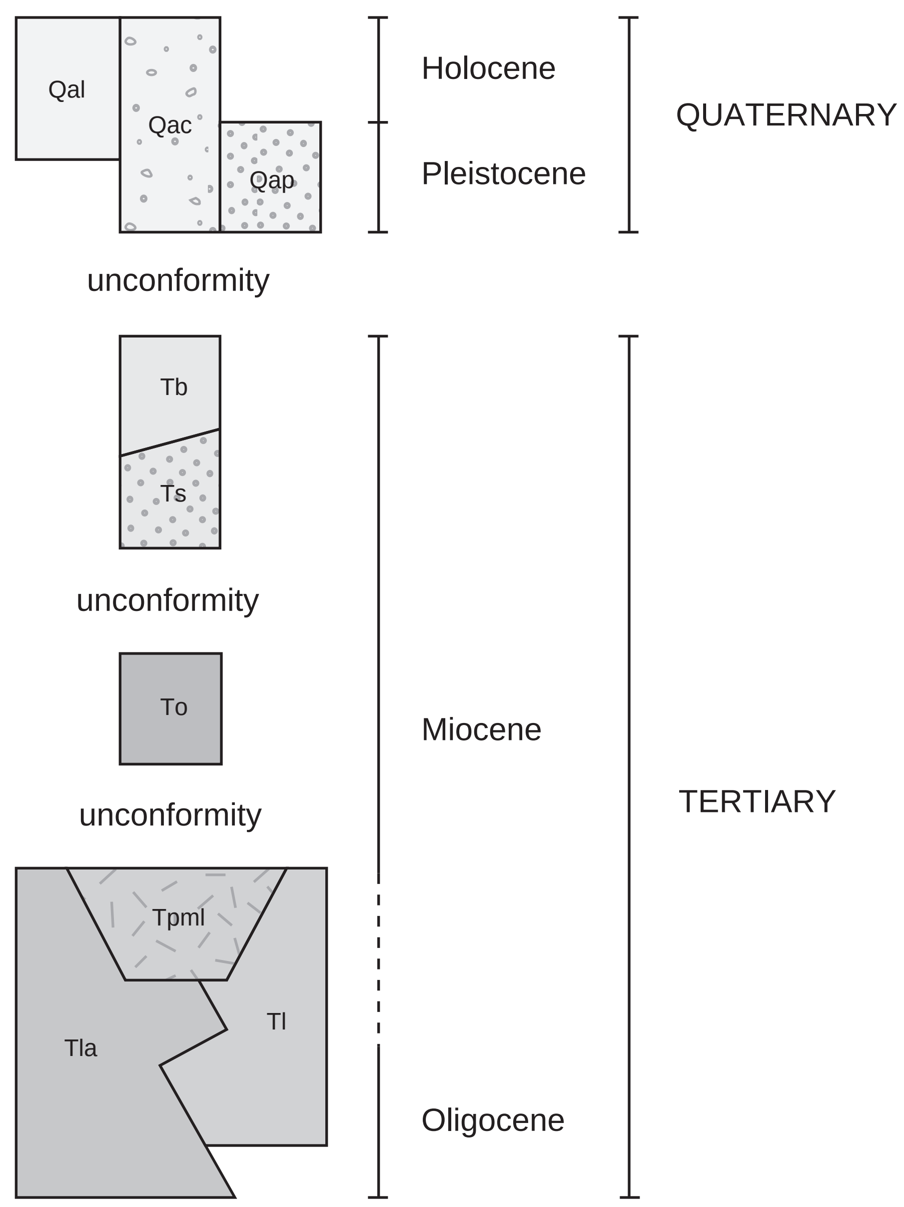
Stephen R. Mattox

2001

UTAH

QUADRANGLE LOCATION

CORRELATION OF MAP UNITS



EXPLANATION

- Contact
- Fault - long dashed where uncertain; short dashed where covered; bar and ball on downthrown side.
- Strike and dip (4)
- Horizontal beds
- Strike of vertical joints
- Sample locations (AP65)
- Vent
- Gravel pit

DESCRIPTION OF MAP UNITS

QUATERNARY

Qal Alluvium (Late Pleistocene and Holocene) -- *Gray and light brown, unconsolidated, silt, sand, and gravel along active streams and washes. Maximum exposed thickness is 20 feet (6 m).*

Qac Mixed alluvium and colluvium (Pleistocene and Holocene) -- *Gray and light-brown, unconsolidated to weakly consolidated mud, sand, cobbles and boulders in valley-fill deposits, older stream deposits, and gentle slopes below steep escarpments. Dissected by modern streams. The deposit in Long Hollow is estimated to be at least 100 feet (30 m) thick; other deposits are generally less than 20 feet (6 m) thick.*

Qap Pediment-mantle alluvium (Pleistocene) -- *Gray and light-brown, unconsolidated, fine gravel on sloping erosional surfaces. Gravel consists of eroded Osiris Tuff. Maximum exposed thickness is 40 feet (12 m).*

TERTIARY

Unconformity

Tb Basalt lava flows (Miocene) -- *Black, dark-gray, and reddish-brown, dense lava flows of olivine basalt. Contains abundant olivine phenocrysts, with less abundant phenocrysts of clinopyroxene and plagioclase in groundmass of plagioclase microlites, iron oxides, and glass. Maximum thickness, near vent, is about 270 feet (80 m).*

Ts Sevier River Formation (Miocene) -- *Gray, light-brown, and greenish-gray, moderately consolidated, medium- to thick-bedded sandstone and conglomerate. Conglomerate contains clasts from the volcanic rocks of Langdon Mountain. Maximum thickness is about 100 feet (30 m).*

Unconformity

To Osiris Tuff (Miocene) -- *Orange, reddish-brown, and light-gray, resistant, densely welded, vitric-crystal ash-flow tuff with black basal vitrophyre. Light-gray, thin-bedded ash beneath vitrophyre at one locality. Maximum exposed thickness is 130 feet (40 m).*

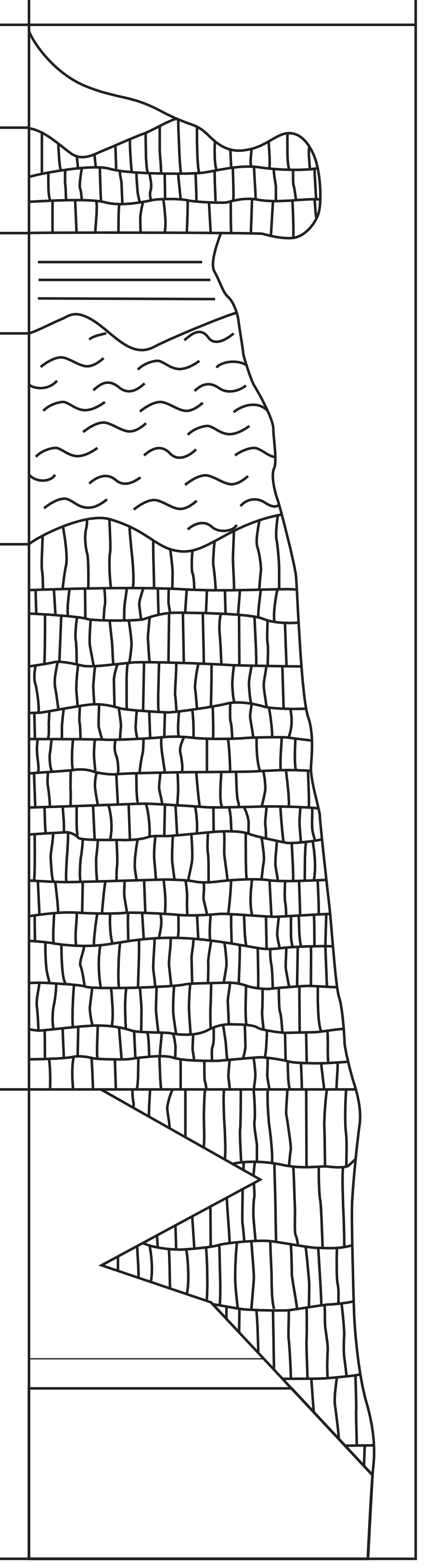
Unconformity

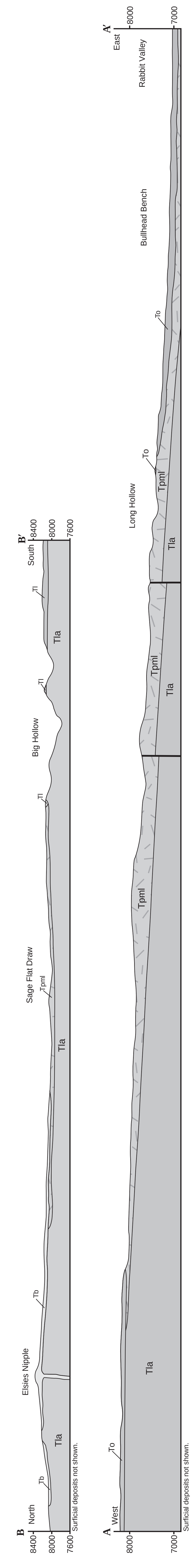
Tpml Potassium-rich mafic lava flows (Oligocene-Miocene) -- *Medium-gray to black, porphyritic lava flows containing nearly equal amounts of clinopyroxene and plagioclase and less abundant olivine, orthopyroxene, and iron oxide phenocrysts in a groundmass of plagioclase microlites, iron oxides, and glass. Maximum exposed thickness is 400 feet (120 m).*

Tl Latite lava flows (Oligocene-Miocene) -- *Black, glassy lava flows containing a few percent resorbed plagioclase, clinopyroxene, hornblende, and iron oxide phenocrysts; also medium-gray, structureless or flow-banded lava flows with conspicuous plagioclase and absence of hornblende. Maximum exposed thickness is 400 feet (120 m).*

Tla Volcanic rocks of Langdon Mountain (Oligocene-Miocene) -- *Red, gray, and white mudflow breccia, with minor beds of sandstone and conglomerate. Individual beds of mudflow breccia range from well sorted, clast-supported cobbles to poorly sorted, matrix-supported cobbles and boulders; clasts are andesitic in composition. Sandstones are well sorted and tuffaceous. Beds are structureless, inversely graded, and normally graded. Maximum exposed thickness is 350 feet (105 m).*

SYSTEM	SERIES	MAP UNIT	SYMBOL	THICKNESS Feet (meters)	LITHOLOGY
		Quaternary Surficial deposits	Q	0-100 (0-30)	
TERTIARY	MIOCENE	Basalt lava flows	Tb	0-270 (0-80)	
TERTIARY	MIOCENE	Sevier River Formation	Ts	0-100 (0-30)	
TERTIARY	MIOCENE	Osiris Tuff	To	0-130 (0-40)	
TERTIARY	MIOCENE / OLIGOCENE	Potassium-rich mafic lava flows	Tpml	0-400 (0-120)	
TERTIARY	OLIGOCENE	Latite lava flows	Tl	0-400 (0-120)	
TERTIARY	OLIGOCENE	Volcanic rocks of Langdon Mountain	Tla	0-350 (0-105)	
TERTIARY	OLIGOCENE	Alluvial facies			





GEOLOGIC MAP OF THE MORONI PEAK QUADRANGLE, WAYNE COUNTY, UTAH

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UTAH GEOLOGICAL SURVEY

UTAH GEOLOGICAL SURVEY

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ABSTRACT

The Moroni Peak quadrangle is 2 miles (3 km) southwest of the town of Loa in Wayne County and is near the center of the Awapa Plateau, one of the easternmost High Plateaus of central Utah. The High Plateaus represent a transition zone between the fault-dominated Basin and Range Province and the relatively undeformed, subhorizontal strata of the Colorado Plateau. The quadrangle's landscape is only slightly modified by extensional faults and its strata dip gently east, features more characteristic of the Colorado Plateau. Most of the surface of the quadrangle is a low-relief tableland that slopes gently to the northeast. Several hollows and draws dissect the surface to expose volcaniclastic, volcanic, and sedimentary rocks. Exposed bedrock units range in age from Oligocene-Miocene to Miocene. In ascending order, the units include the Oligocene-Miocene volcanic rocks of Langdon Mountain, latite lava flows, and potassium-rich mafic lava flows; and Miocene Osiris Tuff, Sevier River Formation, and basalt lava flows. The volcanic rocks of Langdon Mountain record the eastward extension of a thick wedge of volcaniclastic sediment from a source on the northern Sevier Plateau. The latite lava flows erupted from vents on the Awapa Plateau. The potassium-rich mafic lava flows erupted from vents on the Awapa Plateau, possibly just northwest of the Moroni Peak quadrangle, as tectonism shifted from compression to extension. The Osiris Tuff, a widespread ash-flow tuff in the High Plateaus, assists in the correlation of units to areas outside of the quadrangle. The Sevier River Formation preserves locally derived clastic sediments that collected in topographic lows. Basalt lava flows erupted from a vent at Elsies Nipple. Quaternary sediments are limited to a few small areas and include alluvium, mixed alluvium and colluvium, and pediment-mantle alluvium. Earthquakes, flooding, rock falls, and radon pose minimal geologic hazards because of the quadrangle's remote, undeveloped location. Sand and gravel are extracted from the quadrangle for local uses.

INTRODUCTION

The Moroni Peak quadrangle is near the center of the Awapa Plateau, which is part of the High Plateaus of central and southwestern Utah (figure 1a). The Plateaus represent a transition zone between the gently dipping and flat-lying strata of the Colorado Plateau to the east and the fault-dominated mountains and alluvial valleys in the Basin and Range Province to the west. The Awapa Plateau is one of the easternmost High Plateaus and is bordered by the Fishlake Plateau to the north and Aquarius Plateau to the south (figure 1a). According to Van Cott (1990), Awapa is a Paiute term that means "a water hole among the cedars."

The volcanic rocks of the Awapa Plateau are part of the Marysvale volcanic field (figure 1a). The Marysvale field covers much of the High Plateaus and extends westward into the Basin and Range Province. The volcanic rocks of the Marysvale field overlie lower Cenozoic, Mesozoic, and Paleozoic rocks with angular unconformity. Extensive volcanic activity began at Marysvale about 34 million years ago and continued to 19 million years ago (Rowley and others, 1994). Subsequent volcanism has been episodic, consisting of basaltic lava flows and rhyolitic ash-fall tuffs (Cunningham and Steven, 1979; Rowley and others, 1994). The volcanic rocks of the Moroni Peak quadrangle represent the east margin of the Marysvale volcanic field.

The surface of the Awapa Plateau, and that of the Moroni Peak quadrangle, is semi-barren, low in relief, and slopes gently to the northeast. The maximum elevation in the quadrangle is 8,595 feet (2,620 m) at the summit of Little Flat Top and the minimum elevation is about 6,980 feet (2,128 m) along Spring Creek in Rabbit Valley (figure 1b). Although total relief in the quadrangle is about 1,600 feet (488 m), suitable locations to examine the physical characteristics of the strata are limited to local drainages. Exposures are poor on the gently sloping areas between drainages and consist of loose, weathered boulders, cobbles, slabs, or small chips of rock. All streams in the quadrangle are ephemeral and drain east to the Fremont River. The streams dissect the plateau, creating canyons as much as 400 feet (120 m) deep and areas with good exposures. Moroni Peak, the namesake of the quadrangle, is an erosional remnant of resistant Osiris Tuff. Improved dirt roads provide access to both the plateau and the quadrangle.

Geologic maps of the Awapa Plateau have been published at small scales or covering limited areas. The Awapa Plateau is part of a map at a scale of 1:250,000 by Williams and Hackman (1971). A small area on the west front of the

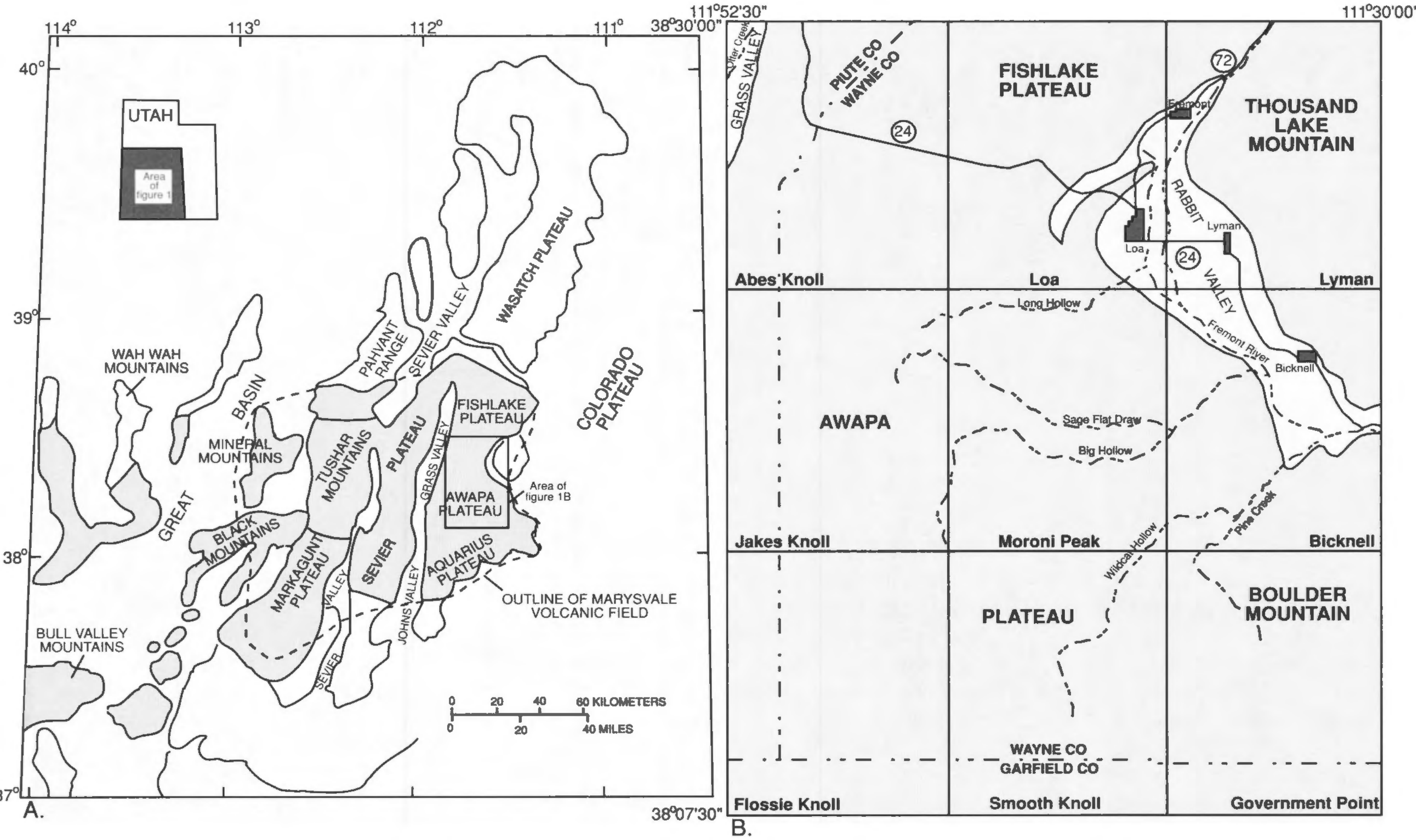

***Figure 1.** A. Index map showing locations of the plateaus and ranges of the High Plateaus, Marysvale volcanic field, and adjacent areas, simplified from Rowley and others (1994). Patterned areas are underlain largely by volcanic rocks. B. Index map showing locations of plateaus, Moroni Peak and adjacent 7.5 minute quadrangles, counties, highways, major drainages, and towns.*

plateau was mapped by Rowley and others (1986). The Moroni Peak quadrangle was chosen as the first complete quadrangle on the Awapa Plateau to be mapped at a scale of 1:24,000 because it contains the best available exposures of most of the stratigraphic units found on the plateau.

Mattox (1991b) provided an overview of the geology of the Awapa Plateau and described the petrology, age, geochemistry, and correlation of the volcanic rocks. For this study, one new sample was analyzed for its major-element chemistry by X-ray fluorescence at Northern Illinois University. Geochron Laboratories analyzed plagioclase separated from a basalt sample to provide a new K-Ar age determination. All isotopic ages in this report use or have been converted to the decay constants of the IUGS Subcommission on Geochronology (Dalrymple, 1979; Steiger and Jäger, 1977). Mapping was done during the summers of 1988, 1989, 1991, and 1992.

MAP UNITS

Consolidated volcanic, volcaniclastic, and sedimentary rocks exposed at the surface in the quadrangle include strata of upper Oligocene to Miocene age (plates 1 and 2). In ascending order, the bedrock units include the Oligocene-Miocene volcanic rocks of Langdon Mountain, latite lava flows, and potassium-rich mafic lava flows; and Miocene Osiris Tuff, Sevier River Formation, and basalt lava flows. Quaternary sediments include alluvium, mixed alluvium and colluvium, and pediment-mantle alluvium.

Oligocene/Miocene Rocks

Volcanic Rocks of Langdon Mountain (Tla)

The upper Oligocene-lower Miocene volcanic rocks of Langdon Mountain are the oldest exposed stratigraphic unit in the quadrangle. This informal stratigraphic unit was originally defined by Rowley (1979) and Rowley and others (1979) for exposures of andesitic rocks at Langdon Mountain on the Sevier Plateau, 15 miles (24 km) northwest of the Awapa Plateau (figure 1a). Mapping by Rowley and others (1986) showed that the alluvial facies of the volcanic rocks of Langdon Mountain extended to the west front of the Awapa Plateau. Williams and Hackman (1971) mapped this unit as andesite breccia. Most of the west half of the quadrangle consists of the volcanic rocks of Langdon Mountain. Exposures of this unit are poor on gently sloping surfaces; however, excellent exposures are found in the deeper canyons (figure 2).

The unit is predominantly mudflow breccia, with minor beds of sandstone and conglomerate. The mudflow breccia is red, gray, and white and ranges from well sorted, clast-supported cobbles to poorly sorted, matrix-supported cobbles and boulders. The sandstone is well sorted and tuffaceous,

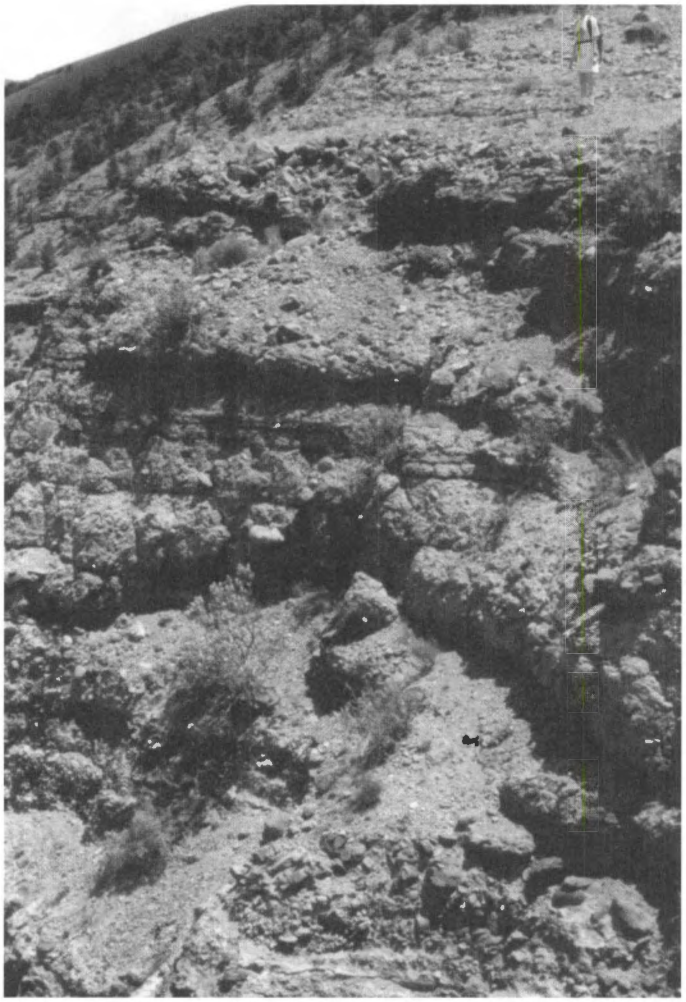

Figure 2. *Well-exposed thin beds of mudflow breccia of the volcanic rocks of Langdon Mountain in upper Big Hollow opposite Cyclone Draw (section 12, T. 29 S., R. 2 E.). Note geologist near top right for scale.*

with structureless, inversely graded, and normally graded beds. Clasts within these rocks are light- or dark-gray and plagioclase- or hornblende-phyric. Maximum long dimension observed for a clast was 1.8 feet (0.55 m). In Big Hollow (figure 1b), well-stratified beds of volcaniclastic rocks range in thickness from 1 to 6 feet (0.3 to 2 m) (figure 2). Maximum exposed thickness of the volcanic rocks of Langdon Mountain in the Moroni Peak quadrangle is 350 feet (105 m); these rocks are 2,600 feet (800 m) thick at Parker Mountain, on the west, fault-bounded side of the Awapa Plateau (Mattox, 1991b). In the western part of the quadrangle, the base of the unit is not exposed and it is overlain by the potassium-rich mafic lava flows (Tpml) and the Osiris Tuff (To). In Big Hollow, near the center of the quadrangle, the volcanic rocks of Langdon Mountain (Tla) interfinger with the latite lava flows (Tl) (figure 3, plate 1).

The volcanic rocks of Langdon Mountain have not been dated directly because of the difficulties of interpreting K-Ar dates of clastic rocks. Stratigraphic relations and ages of samples from overlying strata suggest a late Oligocene to early Miocene age. Two potassium-rich mafic lava flows on the Awapa Plateau that overlie the volcanic rocks of Langdon Mountain yielded ages of about 25 million years (Mattox, 1991b). On the western margin of the Awapa Plateau, the Osiris Tuff (To), a 23-million-year-old ash-flow tuff (Fleck and others, 1975), is interlayered with the upper part of the mudflow breccia (Rowley and others, 1986).

The stratigraphic position, lithology, mineralogy, and geochemistry of the volcanic rocks of Langdon Mountain on the Awapa Plateau (Mattox, 1991b) are similar to rocks in the western High Plateaus, specifically the Bullion Canyon Volcanics and the Mount Dutton Formation of Rowley and others (1994), but may not be correlative.

The source area of the volcanic rocks of Langdon Mountain on the Awapa Plateau is probably the northern Sevier Plateau (figure 1a). Although Rowley and others (1986) proposed a local source on the Awapa Plateau for the unit where

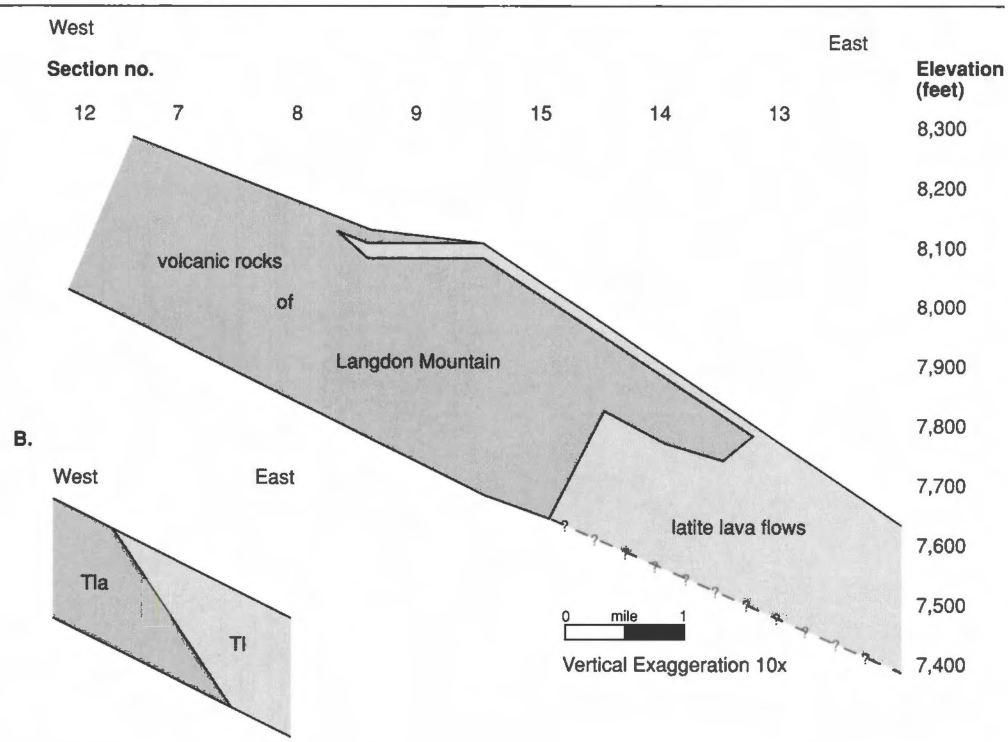

Figure 3. *A. Diagrammatic representation of interfingering of volcanic rocks of Langdon Mountain (Tla) and latite lava flows (Tl) in Big Hollow based on this mapping. B. Interpretation of stratigraphic relations based on previous mapping by Williams and Hackman (1971).*

exposed along the western front of the plateau, Mattox (1991b) argued that the gentle eastward dip of these strata and an eastward decrease in maximum clast size, abundance of breccia, and bed thickness indicated a source to the west of the Awapa Plateau (figure 1a).

Latite Lava Flows (Tl)

Upper Oligocene-lower Miocene latite lava flows of the latite unit of Williams and Hackman (1971) underlie most of the southeast part of the quadrangle. Although this unit is trachyte based on geochemistry (figure 7), the nomenclature established by Williams and Hackman (1971) is used. On gentle slopes, the latite flows have weathered to poor exposures of small chips or thin slabs. However, as much as 400 feet (120 m) of flows are well exposed along steep canyon walls, such as at Big Hollow (figure 4). In Wildcat Hollow, three flows, with a combined thickness of 300 feet (90 m), are exposed as discontinuous outcrops of platy lava. Based on petrography, two types of latite lava flows are exposed in the quadrangle: black, glassy flows that contain a few percent phenocrysts of resorbed plagioclase, clinopyroxene, hornblende, and iron oxides; and medium-gray, structureless or flow-banded latite lava flows that have more conspicuous phenocrysts of plagioclase and lack hornblende.

Latite lava flows form the base of the exposed stratigraphic section in the southeast part of the quadrangle. In Big Hollow, the lava flows interfinger with the volcanic rocks of Langdon Mountain (plate 1, figure 3). The lava flows crop out beneath the volcanic rocks of Langdon Mountain (Tla) in NE1/4 section 15, T. 29 S., R. 2 E. and climb rapidly to the east, relative to the volcanic rocks of Langdon Mountain (Tla), reaching near the rim of the hollow in NW1/4 section 14, T. 29 S., R. 2 E. A thin flow of latite caps the wedge of volcanic rocks of Langdon Mountain (Tla) and extends 2.5 miles (4 km) to the west to NE1/4 section 8, T. 29 S., R. 2 E. This flow, in turn, is overlain by a higher eastward-thinning wedge of volcanic rocks of Langdon Mountain that extends eastward to NW1/4 section 16, T. 29 S., R. 2 E. and NW1/4 section 9, T. 29 S., R.2 E. The maximum exposed thickness of the latite lava flows is 400 feet (120 m) in Big Hollow (figure 4). The latite lava flows (Tl) are conformably overlain by thin wedges of volcanic rocks of Langdon Mountain (Tla) and by the potassium-rich mafic lava flows (Tpml). The unit is unconformably overlain by the Osiris Tuff (To) and basalt lava flows (Tb).

The late Oligocene to early Miocene age for the latite lava flows is constrained by a single K-Ar date and by stratigraphic position. A date of 23.1 ± 1.0 million years ago was reported by Mattox (1991b) for a sample (AP 119) collected in Wildcat Hollow just outside of the southeast corner of the quadrangle. The 23-million-year-old Osiris Tuff (Fleck and others, 1975) overlies the latite lava flows.

Correlation of the latite lava flows beyond the Awapa Plateau is difficult. Three stratigraphic units mapped elsewhere in the High Plateaus – the Antimony Tuff Member of the Mount Dutton Formation (Anderson and Rowley, 1975), the tuff of Albinus Canyon (Steven and others, 1979; Cunningham and others, 1983; Willis, 1986), and the lava flows of Deer Spring Draw (Nelson, 1989) – share a similar stratigraphic position and mineralogy with the latite lava flows but differ considerably in geochemistry and age. Both the Antimony Tuff Member and the tuff of Albinus Canyon, which are below the Osiris Tuff, are crystal poor and feldspar bearing, characteristics shared with the latite lava flows. Because of the reconnaissance nature of the mapping of Williams and Hackman (1971), all three tuff units may have been lumped within the latite unit. However, unpublished geochemical data of Stephen Mattox and Grant Willis (Utah Geological Survey) are distinctive for each of the units, and K-Ar ages reported by Rowley and others (1994) show the Antimony Tuff and the tuff of Albinus Canyon to be 25 million years old, significantly older than the 23-million-year-old date on the latite. The lava flows of Deer Spring Draw, exposed

Figure 4. Latite lava flows that are well exposed in the walls of Big Hollow in S1/2 section 12 and N1/2 section 13, T. 29 S., R. 2 E. Thousand Lake Mountain in background. View is to the east.

north of Thousand Lake Mountain, have been described by Nelson (1989). Characteristics shared with the latite lava flows on the Awapa Plateau include stratigraphic position and low abundance of phenocrysts. However, the lava flows of Deer Spring Draw are older (26.3 million years old) and significantly different in chemical composition (figure 7; Nelson, 1989). Field relations between the latite and other stratigraphic units of the Awapa Plateau clearly demonstrate that the latite lava flows are relatively thin and laterally discontinuous (Mattox, 1991b), suggesting that they erupted in small volumes from local vents and never extended beyond the margins of the plateau.

Potassium-Rich Mafic Lava Flows (Tpml)

The basaltic andesite unit of Williams and Hackman (1971) is herein referred to as potassium-rich mafic lava flows. Williams and Hackman (1971) based the name of the unit on mineralogy. Chemically, the rocks are latite or banakite using the classification schemes of Le Bas and others (1986) and Peccerillo and Taylor (1976), respectively. The new designation is based on stratigraphic nomenclature of similar rocks to the west, on mineralogy, and on the chemical composition of the lava flows. On the Markagunt Plateau and adjacent valleys (figure 1a), mafic lava flows with greater than 3 weight-percent potassium are informally designated potassium-rich mafic lava flows by Anderson and others (1980, 1981) and Cunningham and others (1983). This chemical criterion distinguishes these flows from upper Cenozoic (less than 16 million years old) mafic flows that are lithologically similar but contain less than 3 weight percent potassium (Best and others, 1980; Mattox, 1994 and 1997; Rowley and others, 1994).

The potassium-rich mafic lava flows are exposed over large areas in the northern and northeastern part of the quadrangle. The flows are also exposed in smaller outcrops of limited extent in the south-central part of the quadrangle and in Wildcat Hollow. The best exposures are in Long Hollow (figure 5). Most of the flows weather to discontinuous ledges or boulder-strewn hillsides. They are medium-gray to black and porphyritic, with nearly equal amounts of clinopyroxene and sieve-textured, embayed plagioclase phenocrysts. The flows contain less abundant phenocrysts of olivine, some altered to iddingsite, orthopyroxene, and iron oxides. The phenocrysts are in a groundmass of plagioclase microlites and less abundant iron oxides and glass. Vesicles are common and elongate in the direction of flow. In the Moroni Peak quadrangle, the potassium-rich mafic lava flows conformably overlie the volcanic rocks of Langdon Mountain (Tla) and latite lava flows (Tl) and unconformably underlie the Osiris Tuff (To), the Sevier River Formation (Ts), and the basalt lava flows (Tb). The stratigraphic position of the potassium-rich mafic lava flows, beneath the Osiris Tuff, differs from the relations to the west, where the potassium-rich mafic volcanic rocks lie stratigraphically above the Osiris Tuff (Rowley and others, 1994). Maximum thickness of the flows is approximately 400 feet (120 m) in a hill southeast of Elsies Nipple (section 34, T. 28 S., R. 2 E.) where flows filled a broad topographic depression in the volcanic rocks of Langdon Mountain. Vents for the flows were not found in the quadrangle. However, the flows can be followed gradually uphill to the northwest for four miles (2.5 km) to Black Point, a possible vent in the adjacent Abes Knoll quadrangle.

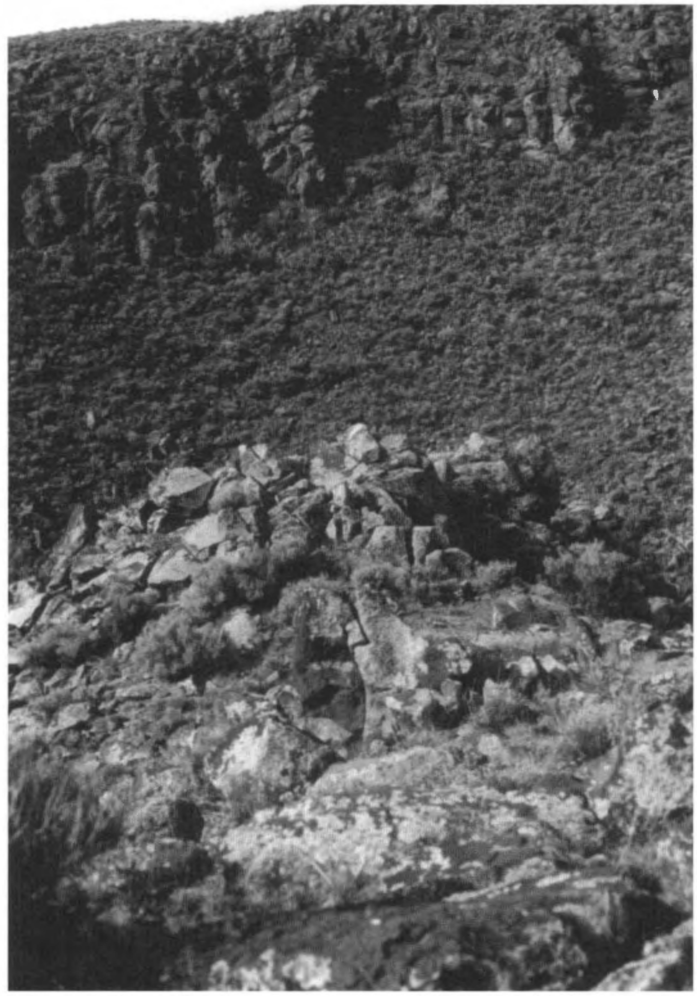

Figure 5. *Potassium-rich mafic lava flows that are well exposed along much of Long Hollow.*

Based on K-Ar dates and stratigraphic relations, the potassium-rich mafic lava flows in the Moroni Peak quadrangle are Oligocene to Miocene. Best and others (1980) determined a K-Ar whole-rock date of 24.5 ± 0.4 million years for a sample from a lava flow south of Fish Lake that was originally mapped by Williams and Hackman (1971) as latite and basaltic andesite undifferentiated. Geochemical data presented in Mattox (1991b) showed that this lava flow is potassium-rich and is not a latite. Three K-Ar plagioclase dates were reported for the potassium-rich mafic lava flows in Mattox (1991b). Two of these, from the eastern (AP 126) and southern (AP 47) margins of the plateau, yielded dates of 25.8 ± 1.4 and 25.2 ± 1.6 million years, respectively. The third sample (AP 99) from the top of a section of the unit and just beneath the Osiris Tuff, provided a date of 23.3 ± 1.5 million years. On the Awapa Plateau, all potassium-rich mafic lava flows underlie the Osiris Tuff, a regional stratigraphic marker that has been dated at about 23 million years old (Fleck and others, 1975).

Lithology, mineralogy, texture, and chemical composition indicate that the potassium-rich mafic lava flows of the Awapa Plateau (Mattox, 1991b) are similar in character to the potassium-rich mafic volcanic rocks to the west (Rowley and others, 1994) and the lava flows of Riley Springs to the north (Nelson, 1989).

The potassium-rich mafic volcanic rocks to the west were interpreted by Rowley and others (1994) to be the first eruptive products associated with an increase in extensional deformation in west-central Utah. Mattox (1991a) and Mattox and Walker (1989), however, used geochemistry to suggest that the volcanics are related to the demise of subduction beneath western North America.

Miocene Rocks

Osiris Tuff (To)

A welded, vitric-crystal ash-flow tuff on the Sevier, Fishlake, and Awapa plateaus was mapped and informally designated the tuff of Osiris by Williams and Hackman (1971). Anderson and Rowley (1975) recognized the tuff throughout the Marysvale volcanic field and formally defined it as the Osiris Tuff. Excellent exposures of the Osiris Tuff can be found in upper Long Hollow in the extreme northwest corner of the quadrangle. In the south, two mesas, Big Flat Top and Little Flat Top, provide exposures of moderate quality surrounded by large, weathered boulders of tuff. At Big Rocks, in the northeast corner of the quadrangle, the tuff is poorly exposed in small knobs and shallow drainages.

The Osiris Tuff consists of orange, reddish-brown, or light-gray, resistant, densely welded, crystal-poor ash-flow tuff. Black vitrophyre is exposed at the base of the tuff in upper Long Hollow. South of Big Rocks, the basal vitrophyre is underlain by 2 feet (0.5 m) of light-gray, thin-bedded ash, possibly a base surge deposit (figure 6). In the main body of the tuff, plagioclase is the most common phenocryst. Sanidine and biotite are present in minor amounts. Phenocrysts of clinopyroxene and iron oxides are rare. The tuff weathers to pebble-sized chips, ledges, boulders, and cliffs. Poor exposures of the tuff resemble weathered latite lava flows but are distinguished by the presence of biotite. Maximum exposed thickness of the tuff in the quadrangle is about 130 feet (40 m) at Big Flat Top. The basal vitrophyre is a few feet thick. The Osiris Tuff unconformably overlies the volcanic rocks of Langdon Mountain (Tla), the latite lava flows (Tl), and the potassium-rich mafic lava flows (Tpml).

The Osiris Tuff is 23 million years old (Rowley and others, 1994), based on three concordant K-Ar dates reported in Fleck and others (1975). The Osiris Tuff erupted during subsidence associated with development of the Monroe Peak caldera in the northern part of the Sevier Plateau (Steven and others, 1984).

Sevier River Formation (Ts)

Williams and Hackman (1971) informally assigned well-bedded conglomerate, sandstone, and siltstone to their volcanic sediments unit. They recognized that this unit was at least partly equivalent to the Sevier River Formation of Callaghan (1938). The Sevier River Formation consists of alluvium that was derived from uplifted areas and deposited in adjacent valleys. Based on stratigraphic position, lithology, and age, similar sedimentary strata of the Moroni Peak quadrangle will be referred to as the Sevier River Formation.

The Sevier River Formation is well exposed in the first drainage north of Blackburn Hollow (section 36, T. 28 S., R. 2 E.). The best exposures are in and immediately adjacent to the stream bed. Upslope, away from the stream bed, the strata have weathered to pebble- and cobble-covered slopes. A continuous section of Sevier River Formation is exposed in road cuts in Big Hollow about 0.5 mile (0.8 km) east of the east margin of the quadrangle.

Figure 6. Thin beds of ash, possibly of base surge origin, exposed beneath the basal vitrophyre of the Osiris Tuff in SE1/4 section 25, T. 28 S., R. 2 E.

In the Moroni Peak quadrangle, the Sevier River Formation consists of gray, light-brown, or greenish-gray, moderately consolidated, medium- to thick-bedded sandstone and conglomerate. Subrounded clasts within the conglomerate were derived from the volcanic rocks of Langdon Mountain, latite lava flows, and potassium-rich mafic lava flows. The formation was probably of fluvial origin and represents an early episode of sedimentation that filled some paleo-valleys. Subsequent erosion removed most of the sediment, leaving remnants on valley floors (section 36, T. 28 S., R. 2 E.), and, just east of the quadrangle, plastered against valley walls (section 7, T. 29 S., R. 3 E.) and protected beneath resistant caprock (section 6, T. 29 S., R. 3 E.). In the Moroni Peak quadrangle, the Sevier River Formation unconformably overlies the potassium-rich mafic lava flows (Tpml) and Osiris Tuff (To). The contact with the overlying basalt lava flows (Tb) is sharp. Maximum thickness in the quadrangle is about 100 feet (30 m). In road cuts about 0.5 mile (0.8 km) east of the quadrangle, the formation is 200 feet (60 m) thick.

The age of the Sevier River Formation in the Moroni Peak quadrangle is probably Miocene but is difficult to better constrain. It overlies Osiris Tuff (To) and, in section 25, T. 29 S., R. 2 E., underlies basalt lava flows (Tb) that have not been dated. The basalt lava flows in section 25, however, may be an erosional remnant of flows that originated from Elsies Nipple. The flows from Elsies Nipple have been dated at 6.9 ± 0.3 million years (late Miocene) (see below) where they overlie the Sevier River Formation immediately east of the Moroni Peak quadrangle.

Basalt Lava Flows (Tb)

Late Cenozoic basaltic volcanic centers are concentrated along the periphery of the Marysvale field (Dutton, 1880; Williams and Hackman, 1971; Cunningham and others, 1983; Steven and others, 1990). Basaltic vents are rare in the interior of the volcanic field (Rowley and others, 1994). On the Awapa Plateau, basaltic volcanic centers are common because the plateau is on the extreme east margin of the Marysvale volcanic field (figure 1a; Williams and Hackman, 1971).

A single basalt volcanic center, Elsies Nipple, located near the center of the quadrangle, contains pahoehoe lava that spread radially as much as 4,000 feet (1,220 m) in all directions from the vent. Two flows extend still farther east. The northern of these flows (N1/2 section 34, T. 28 S., R. 2 E.) followed a valley for about 4,000 feet (1,220 m) beyond the margin of the main flow. The south flow (section 3, T. 29 S., R. 2 E.) moved to the southeast, passed through a topographic constriction, ponded in Terza Flat, and continued east, terminating about 500 feet (150 m) outside the quadrangle. After this flow was emplaced, the topography has reversed and the lava flow, which originally filled a topographic low, now stands above adjacent rocks. This reversal is most pronounced in Sage Flat Draw where the stream has preferentially cut into the older latite lava flows. In most places, the margin of the flow is a steep cliff 10 to 20 feet (3-6 m) high that provides good exposures. The surface of the flow weathers to slabby float. A second area of basalt lava flow is between Big Rocks and Blackburn Hollow. There is no recognizable vent associated with this lava and it may be the erosional remnant of the northern flow from Elsies Nipple. The margin of this flow is not a steep cliff and exposures are poor, consisting of small boulders and slabby float.

The basalt lava flows are dense and black, dark gray, and reddish brown in color. They contain olivine phenocrysts, commonly altered to iddingsite, and less abundant phenocrysts of plagioclase and clinopyroxene in a groundmass of plagioclase microlites, iron oxides, and glass. Basalt lava flows unconformably overlie all of the older stratigraphic units. Near the vent, lava has accumulated to a thickness of about 270 feet (80 m). The maximum thickness of the distal margin of the flow is 25 feet (8 m).

The basalt flows in the quadrangle are probably Miocene. A new K-Ar date of 6.9 ± 0.3 million years was determined on a feldspar concentrate from a sample collected north of Sage Flat Draw at the terminus of the lava flow (table 1) just east of the quadrangle boundary. A similar date, 5.9 ± 0.6 million years was reported in Mattox (1991b, AP 127) for a basalt flow on the extreme eastern margin of the Awapa Plateau. Best and others (1980) reported three dates, ranging from 5.0 to 6.6 million years old, for basalt flows near the southwestern margin of the plateau. Just north of the Awapa Plateau, a basalt flow was dated at 16.4 ± 1.0 million years, the oldest so far reported in the High Plateaus (Mattox, 1991b, AP 26). Northeast of the Awapa Plateau, basalt lava flows dated by Delaney and others (1986) and Nelson (1989) range in age from 3.8 to 5.4 million years old.

Quaternary Deposits

Three Quaternary units were mapped in the Moroni Peak quadrangle. All are derived by fluvial and sheetwash erosion of local bedrock units and unconformably overlie older units. Talus and colluvial deposits, common near the base of steep hillsides, were not mapped due to limitations of map scale and the generally poorly defined morphology of such deposits.

Pediment-Mantle Alluvium (Qap)

Bullhead Bench in the northeastern corner of the quadrangle consists of gray or light-brown, unconsolidated, fine gravel that mantles pediment surfaces. The gravel was derived from erosion of the underlying Osiris Tuff. Streams have dissected the gravels down to the pediment surface, exposing a maximum thickness of 40 feet (12 m). The deposit is interpreted to be Pleistocene.

Mixed Alluvial and Colluvial Deposits (Qac)

Mixed alluvial and colluvial deposits form gentle slopes below steep escarpments, fill valleys, and include older stream deposits. The deposits consist of gray or light-brown, unconsolidated to weakly consolidated mud, sand, cobbles, and boulders. Modern streams have dissected the deposits in Long Hollow. An extensive deposit in Long Hollow exceeds 100 feet (30 m) in thickness. Relatively thin, less than 20 feet (6 m) thick, mixed alluvial and colluvial deposits were

Table 1. Data for new potassium-argon date, Moroni Peak quadrangle, Utah.[1]

Rock Unit	Location	Sample	Material[2]	%K_2O	$^{40}Ar/^{40}K$	Apparent Age
Basalt lava	Awapa Plateau[3]	AP 173[4]	feldspar	1.27	0.000399	6.9 ± 0.3 Ma

[1] Age determination by Geochron Laboratories, Cambridge, MA.
[2] Constants: $\lambda_\beta = 4.962 \times 10^{-10}$/year, $(\lambda e + \lambda e') = 0.581 \times 10^{-10}$/year, and $^{40}K/K = 1.93 \times 10^{-4}$ g/g.
[3] NE1/4 section 7, T.29S., R.3E.; 38°18′31″N, 111°37′25″W. In Bicknell quadrangle (figure 1b) near boundary with Moroni Peak quadrangle.
[4] Same lava flow as AP 107, see table 2.

mapped along several upland draws south of Long Hollow and in tributaries just west of Wildcat Hollow. The deposits are interpreted to be Pleistocene and Holocene.

Alluvium (Qal)

Alluvium covers low areas in Long Hollow, at Big Rocks, in the first drainage north of Blackburn Hollow, and along Spring Creek in Rabbit Valley. Alluvium is also found in Sage Flat Draw, Big Hollow, Balsam Hollow, and Wildcat Hollow where, due to limitations of map scale, it has been mapped as narrow discontinuous deposits. The alluvium consists of gray or light-brown silt, sand, and gravel that were deposited by intermittent streams. Maximum exposed thickness is 20 feet (6 m). The deposits are late Pleistocene and Holocene.

GEOCHEMISTRY

Volcanic rocks from the Moroni Peak quadrangle range in composition from basalt to trachyte (appendix 1, table 2, figure 7). Most map units are chemically distinct with the notable exception of the latite lava flows and the Osiris Tuff, which are remarkably similar. Classification of volcanic rocks is based on the scheme of Le Bas and others (1986). Mattox (1991b) presented additional geochemical data on volcanic rocks collected on the Awapa Plateau outside of the quadrangle.

Clasts within the volcanic rocks of Langdon Mountain (Tla) are andesite and dacite (figure 7). They are very similar in composition to lava flows in the Mount Dutton Formation, a unit on the south flank of the Marysvale volcanic field (figure 7) (Mattox, 1991b). Mattox and Walker (1992) studied the chemistry of Mount Dutton andesite and noted its similarity to modern orogenic andesite and suggested a magmatic source in Proterozoic lithosphere.

The latite lava flows (Tl) plot within the field defined for trachyte rather than latite (figure 7). Their major-element chemistry is very similar to the Osiris Tuff except iron oxide and calcium oxide concentrations are slightly higher and lower, respectively. The chemical similarity of the two units may indicate a common source, perhaps in the crust, or a parallel magmatic history. Although the latite lava flows are trachyte based on their chemical composition, they are latite based on their mineral composition, which is a more useful classification for field mapping.

Based on their chemistry, the potassium-rich mafic lava flows (Tpml) are latite. These same rocks are banakites using the classification scheme for potassium-rich rocks proposed by Peccerillo and Taylor (1976). The lava flows are chemically similar to potassium-rich mafic volcanic rocks of Rowley and others (1994) to the west (Mattox, 1991b) and the lava flows of Riley Spring, north of Thousand Lake Mountain (Nelson, 1989) (figure 7). Mattox (1992a) analyzed representative samples from all potassium-rich mafic volcanic rocks on the High Plateaus and found a range in silica compositions from 48 to 59 weight percent, with rocks from the Awapa Plateau being relatively rich in silica. Rowley and others (1994) interpreted the potassium-rich mafic volcanic rocks in the High Plateaus as marking an increase in extensional deformation in the area about 23 million years

Table 2. Chemical analyses recalculated (except for number 20) to 100%.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
SiO_2	63.18	61.23	67.49	67.32	67.57	66.83	59.24	59.07	66.89	66.80	64.67	64.77	48.97	63.56	58.61	56.51	65.02	46.72	47.78	48.41
TiO_2	0.67	0.73	0.68	0.68	0.69	0.70	1.01	1.01	0.75	0.75	0.75	0.76	1.33	0.86	1.02	0.95	0.81	1.14	1.23	1.33
Al_2O_3	15.95	17.21	16.06	16.23	15.81	16.61	16.22	16.57	16.76	16.52	17.80	17.87	16.54	14.85	16.68	17.11	15.88	15.18	15.01	14.98
Fe_2O_3	5.71	6.43	2.75	2.61	2.84	2.85	6.71	6.72	2.34	2.31	2.43	2.51	10.19	5.47	7.56	8.29	4.54	10.20	10.22	8.99
MnO	0.12	0.10	0.05	0.12	0.10	0.08	0.12	0.11	0.06	0.07	0.04	0.07	0.18	0.08	0.12	0.13	0.09	0.16	0.15	0.16
MgO	2.16	2.16	0.60	0.57	0.59	0.43	2.88	2.71	0.81	0.85	0.71	0.67	7.90	2.96	2.35	2.87	1.05	10.71	10.01	8.14
CaO	5.42	5.80	1.39	1.43	1.40	1.25	5.59	5.36	2.07	2.07	3.08	2.81	9.90	5.15	5.15	6.04	2.11	10.05	9.38	11.69
Na_2O	3.90	3.58	4.48	4.41	4.47	4.34	3.97	4.02	3.96	3.75	4.31	4.32	3.15	3.49	3.94	3.39	4.35	3.01	3.32	2.74
K_2O	2.59	2.49	6.35	6.49	6.37	6.74	3.79	3.96	6.22	6.59	6.07	6.04	1.39	3.22	4.09	3.33	5.91	2.01	2.36	2.70
P_2O_5	0.30	0.27	0.15	0.14	0.16	0.17	0.47	0.47	0.14	0.29	0.14	0.18	0.45	0.36	0.46	0.38	0.27	0.84	0.55	0.79
TOTAL	98.24	99.46	97.99	99.78	98.91	98.81	99.78	100.06	99.55	99.80	99.26	99.40	101.05	99.22	97.10	99.16	100.39	99.24	100.40	99.93

1. volcanic rocks of Langdon Mountain (Mattox, 1991b) sample AP65.
2. volcanic rocks of Langdon Mountain (Mattox, 1991b) sample AP67.
3. latite lava flows (Mattox, 1991b) sample AP60.
4. latite lava flows (Mattox, 1991b) sample AP62.
5. latite lava flows (Mattox, 1991b) sample AP63.
6. latite lava flows (NE1/4 section 15, T. 29 S., R. 2 E.) sample AP171.
7. potassium-rich mafic lava flows (Mattox, 1991b) sample AP104.
8. potassium-rich mafic lava flows (Mattox, 1991b) sample AP105.
9. Osiris Tuff (Mattox, 1991b) sample AP101.
10. Osiris Tuff (Mattox, 1991b) sample AP103.
11. Osiris Tuff (Mattox, 1991b) sample AP110.
12. Osiris Tuff (Mattox, 1991b) sample AP64.
13. basalt lava flows (Mattox, 1991b) sample AP107.
14. Mount Dutton Formation (Mattox, 1992a) sample BC5.
15. potassium-rich mafic lava flows (M.G. Best, unpublished data, 1986) sample HPL-3 (reported in Nelson, 1989).
16. lava flows of Riley Spring (Nelson, 1989) sample 2.
17. lava flow of Deer Spring Draw (Nelson, 1989) sample 12.
18. trachybasalt lava flow of geyser Peak (Nelson, 1989) sample 17.
19. trachybasalt lava flow of Forsyth Reservoir (Nelson, 1989) sample 18.
20. trachybasalt dike (Gartner, 1986) sample AVG18.

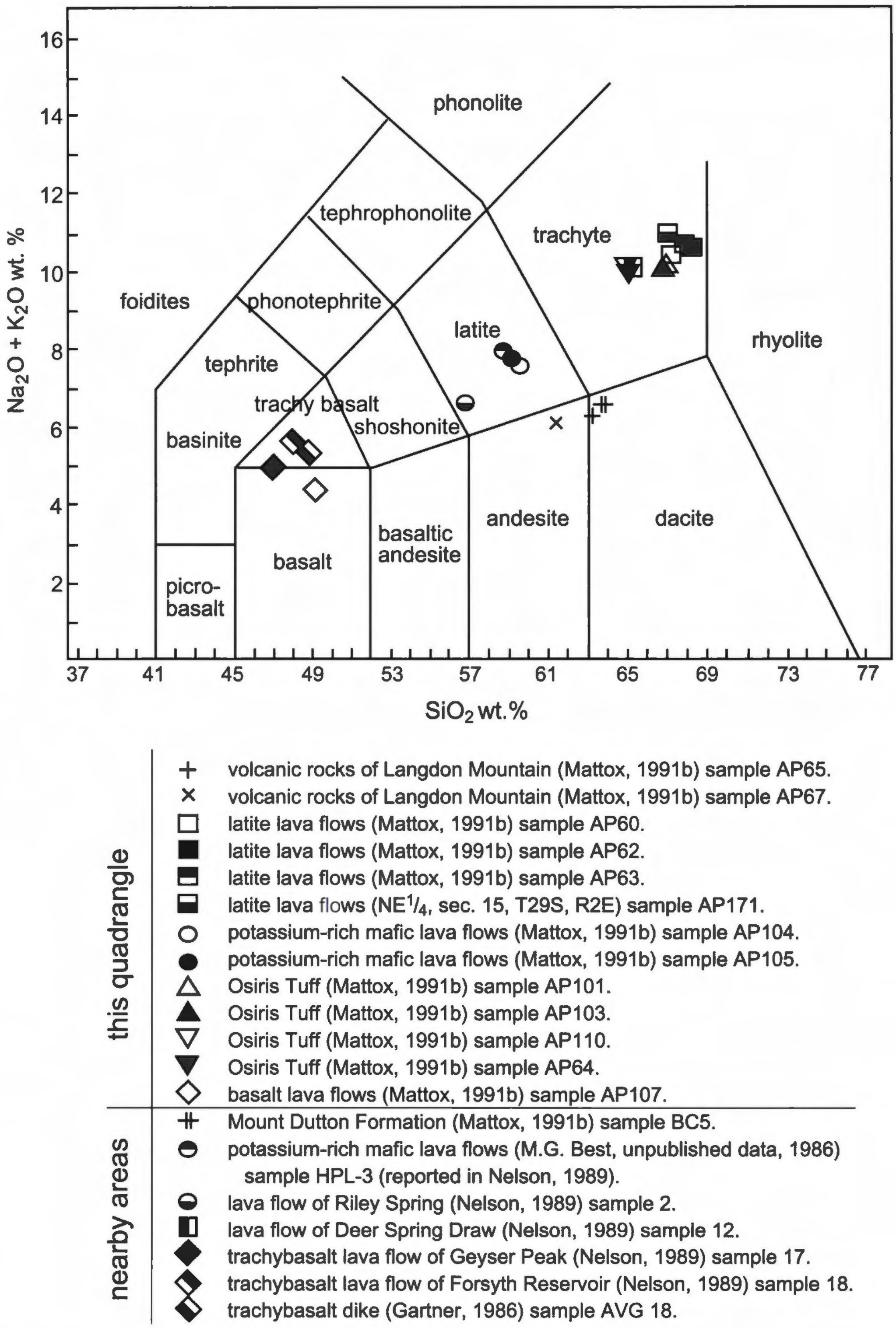

Figure 7. *IUGS classification of volcanic rocks (Le Bas and others, 1986) in the Moroni Peak quadrangle with comparisons from nearby areas.*

ago. The potassium-rich mafic lava flows of the Awapa Plateau are slightly older, 25 to 23 million years old, and probably erupted during a compressional, transitional, or less extensional tectonic regime (Mattox, 1992a). Mattox (1992a, 1993) proposed mixing of two sources in the lithospheric mantle, veins of mica-rich minette and mica-rich melanephelenite (see Tingey and others, 1991), to explain the geochemical characteristics of the potassium-rich mafic volcanic rocks. One of these sources, veins of mica-rich melanephelenite in the mantle, was dominant during earlier andesitic Mount Dutton volcanism in the southeast part of Marysvale.

A sample collected from the basalt lava flows (Tb) erupted from Elsies Nipple plots in the basalt field (figure 7).

Mattox (1991b) analyzed 28 late Cenozoic lava flows on the Awapa Plateau and found most samples to be basalt or trachybasalt with only a few basaltic trachyandesites. Mafic rocks at Geyser Peak and Forsyth Reservoir (Nelson, 1989), just north of Thousand Lake Mountain, and in the San Rafael and Capitol Reef areas (Gartner, 1986), are slightly more alkalic relative to the basalt in the Moroni Peak quadrangle (figure 7). The composition of basalts changes systematically across the High Plateaus (Mattox, 1992b). Tholeiitic basalts are abundant in the west, on the Markagunt Plateau and adjacent areas (figure 1a). Alkali basalts are abundant in the east, on the Sevier and Awapa plateaus. Mattox (1994, 1997) suggested that this pattern reflects progressively lower degrees of partial melting at greater depths from west to east beneath the High Plateaus.

STRUCTURE AND TECTONICS

The Awapa Plateau is one of the easternmost plateaus in the High Plateaus of Utah. In general, these plateaus consist of gently dipping strata bounded by steep normal faults and separated by alluvium-filled valleys. Rowley and others (1979) noted that the interior of each plateau is cut by relatively few faults and that the abundance of faults and their stratigraphic displacement decreases eastward across the High Plateaus to the edge of the nearly unfaulted Colorado Plateau. The west front of the Awapa Plateau is bounded by a normal fault with about 1,600 feet (500 m) of vertical displacement. Movement along this fault, to produce the Awapa and Aquarius Plateaus, probably occurred in the last 5 million years (Rowley and others, 1981). The east margin of the Awapa Plateau is defined by the contact of gently east-dipping bedrock units and overlying valley-fill deposits.

Strata are displaced by two main faults in the Moroni Peak quadrangle. The western fault, in the north-central part of the quadrangle, strikes north and extends from Sage Flat Draw to north of Long Hollow; it creates the east margin of a shallow, alluvial-filled basin northeast of Moroni Peak. Vertical displacement on the fault adjacent to the basin is roughly 50 feet (15 m). The displacement decreases to the south to less than 10 feet (3 m) at Sage Flat Draw. The eastern fault, in the northeast part of the quadrangle, strikes northwest and terminates to the south near Sage Flat Draw. This fault is well expressed 3 miles (5 km) north of the Moroni Peak quadrangle near Loa, where it forms a 150-foot (45 m) high, northwest-facing, arcuate escarpment defined by potassium-rich mafic lava flows. Displacement along this fault also decreases to the south and is approximately 10 feet (3 m) at Sage Flat Draw. Between these two faults, a minor north-northwest-striking fault bounds the east margin of Terza Flat and is truncated by the northwest-striking fault. Displacement on this fault at Terza Flat is roughly a few tens of feet.

The timing of faulting in the Moroni Peak quadrangle is constrained by relations with the basalt lava flows (Tb). The north and north-northwest striking faults are well-expressed in the potassium-rich mafic lava flows (Tpml) but are buried by the basalt lava flows (Tb), suggesting that these faults formed between about 23 and 7 million years ago. It is possible that these faults are related to the onset of extension, which appears to have began about 21 million years ago (Rowley and others, 1981). In contrast, the northwest-striking fault offsets the basalt lava flows north of Sage Flat Draw, indicating that this fault was active after about 7 million years ago. Rowley and others (1979) suggested that the greatest displacements on faults in the High Plateaus took place about 7 million years ago. On the Sevier Plateau, immediately west of the Awapa Plateau, Rowley and others (1981) bracketed the age of major faulting between 8 and 5 million years ago. Nelson (1989) reported faults younger than 5 million years old about 12 miles (19 km) northeast of the Moroni Peak quadrangle. It is likely that all of the faulting in the Moroni Peak quadrangle is in the range of 8 to 5 million years old as proposed by Rowley and others (1981).

No faults that cut Quaternary deposits have been mapped in the quadrangle, and no fresh scarps were recognized in the older bedrock units. Joint sets are well exposed in the Osiris Tuff at Big Rocks. The near-vertical joints strike N. 10°E. at higher elevations and N. 1°E. at lower elevations. The joints are uniformly spaced at about 50 feet (15 m).

GEOLOGIC HISTORY

The geologic history of exposed rocks in the Moroni Peak quadrangle begins with coeval volcaniclastic sedimentation and volcanism in the late Oligocene in the Marysvale volcanic belt. Volcanic debris eroded from volcanic centers in the northern part of the Sevier Plateau was shed to the southeast, constructing an eastward-thinning wedge of volcaniclastic sediment (volcanic rocks of Langdon Mountain). Volcanic vents along the east margin of the Awapa Plateau erupted latite lavas that flowed to the west, filling topographic lows and burying the edges of the volcaniclastic wedge. Pulses in sedimentation and volcanism resulted in interfingering volcaniclastic sediments and lava flows. Shortly after sedimentation and volcanism ceased, new volcanic centers, possibly just northwest of the Moroni Peak quadrangle, erupted potassium-rich mafic lava flows. These eruptions began in the late Oligocene and continued into the early Miocene. Erosion followed, producing topography very similar to that of the present. In the early Miocene, the Osiris Tuff was erupted as the Monroe Peak caldera formed on what is now the Sevier Plateau and blanketed the High Plateaus in a layer of ash. Subsequent erosion removed much of the Osiris Tuff from the quadrangle and established a drainage system that flowed to the east and northeast. Some alluvium was trapped in local basins to produce the Sevier River Formation. In the late Miocene a single volcanic vent near the center of the quadrangle erupted basalt that moved radially away from the vent and ultimately filled two shallow drainages to the east. Extensional faulting, perhaps associated with uplift of the plateau, occurred shortly before and after basaltic volcanism. Erosion continued, in some areas preferentially removing relatively soft latite lava flows in preference to more resistant basalt lava flows and thus generating reverse topography.

ECONOMIC GEOLOGY

Small operations remove sand and gravel from excavations in the pediment mantle alluvium (Qap) at Bullhead

Bench. The sand and gravel is used locally for construction of roadways and for fill.

WATER RESOURCES

Annual precipitation on the Awapa Plateau is between 20 and 40 inches (50 and 100 cm). The quadrangle serves as a recharge area for aquifers utilized by farmers and ranchers in the upper Fremont River valley. Ground water in the northwest part of the quadrangle migrates north-northeast to Roads Creek valley west of Loa. Ground water in the south part of the quadrangle migrates northeast where it supplies springs on the east margin of the plateau and at Bicknell Bottoms. Artesian conditions at Roads Creek valley and Bicknell Bottoms result from water under pressure entering the valley fill from the underlying volcanic rocks (Bjorklund, 1969). No wells or springs are located in the quadrangle. Ranchers have constructed tanks to trap surface water.

GEOLOGIC HAZARDS

The principal geologic hazards in the quadrangle are related to earthquakes, flooding, and radon. Black (1993) noted that the Moroni Peak quadrangle lies in an area with a moderate to high radon-hazard potential. Although presently undeveloped, steep slopes and cliffs throughout the quadrangle are susceptible to rock fall hazards. Some slopes may be susceptible to mass movements, although none were identified and mapped during this project.

Earthquakes

There is no evidence to indicate that any historical earthquakes produced surface movement along faults within the quadrangle. Two historical earthquakes with epicenters in the quadrangle (near section 23, T. 29 S., R. 2 E. and section 18, T. 28 S., R. 2 E.) had magnitudes between 2 to 3.9 (Goter, 1990). An earthquake with a magnitude of roughly 3 occurred 15 miles (25 km) southwest of the quadrangle on November 18, 1945 (Sue Nava, University of Utah Seismograph Stations, verbal communication, 1995). The potential for damage in the quadrangle is small because of the lack of homes or major buildings.

Flooding

Intense storms or long periods of rainfall may cause flooding along stream channels. Most roads parallel or cross major streams and may be damaged by, or be impassable during, a flood. The streams are confined to narrow bedrock canyons and have not developed floodplains. With the exception of the roads, no development has taken place along the streams. Significant rainfall events may also produce debris flows that could damage roads.

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REFERENCES

Anderson, J.J., and Rowley, P.D., 1975, Cenozoic stratigraphy of southwestern High Plateaus of Utah, *in* Anderson, J.J., and Rowley, P.D., Fleck, R.J., and Nairn, A.E.M., editors, Cenozoic geology of the southwestern High Plateaus of Utah: Boulder, CO, Geological Society of America Special Paper 160, p. 1-51.

Anderson, J.J., Lanigan, J.C., Cunningham, C.G., and Naeser, C.W., 1981, Geologic map of the Beaver SE quadrangle, Beaver County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-1274, scale 1:24,000.

Anderson, J.J., Sigmund, J.M., Cunningham, C.G., Steven, T.A., Lanigan, J.C., and Rowley, P.D., 1980, Geologic map of the Delano Peak SW quadrangle, Beaver County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-1255, scale 1:24,000.

Best, M.G., McKee, E.H., and Damon, P.E., 1980, Space-time-composition patterns of late Cenozoic mafic volcanism, southwestern Utah and adjoining areas: American Journal of Science, v. 280, p. 1,035-1,050.

Bjorklund, L.J., 1969, Reconnaissance of the ground-water resources of the upper Fremont River Valley, Wayne County, Utah: State of Utah, Department of Natural Resources Technical Publication No. 22, 54 p.

Black, B.D., 1993, The radon-hazard-potential map of Utah: Utah Geological Survey Map 149, scale 1:1,000,000.

Callaghan, Eugene, 1938, Preliminary report on the alunite deposits of the Marysvale region: U.S. Geological Survey Bulletin 886-D, p. 91-134.

Cunningham, C.G., and Steven, T.A., 1979, Mount Belknap and Red Hills calderas and associated rocks, Marysvale volcanic field, west-central Utah: U.S. Geological Survey Bulletin 1468, 34 p.

Cunningham, C.G., Steven, T.A., Rowley, P.D., Glassgold, L.B., and Anderson, J.J., 1983, Geologic map of the Tushar Mountains and adjoining areas, Marysvale volcanic field, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1430-A, scale 1:50,000.

Dalrymple, G.B., 1979, Critical tables for conversion of K-Ar ages from old to new constants: Geology, v. 7, p. 558-560.

Delaney, P.T., Pollard, D.D., Ziony, J.I., and McKee, E.H., 1986, Field relations between dikes and joints: emplacement processes and paleostress analysis: Journal of Geophysical Research, v. 91, p. 4,920-4,938.

Dutton, C.E., 1880, Report on the geology of the High Plateaus of Utah with atlas: U.S. Geographical and Geological Survey, Rocky Mountain Region (Powell), 307 p.

Fleck, R.J., Anderson, J.J., and Rowley, P.D., 1975, Chronology of mid-Tertiary volcanism in High Plateaus region of Utah, *in* Anderson, J.J., Rowley, P.D., Fleck, R.J. and Nairn, A.E.M., editors, Cenozoic geology of southwestern High Plateaus of Utah: Geological Society of America Special Paper 160, p. 53-62.

Gartner, A.E, 1986, Geometry, emplacement history, petrography, and chemistry of a basaltic intrusive complex, San Rafael and Capitol Reef areas, Utah: U.S. Geological Survey Open-File Report 86-61, 112 p.

Goter, S.K., 1990, Earthquakes in Utah, 1884-1989: U.S. Geological Survey Open-File Report 91-128, scale 1:500,000.

Le Bas, M.J., Le Maitre, R.W., Streckeisen, A., and Zanettin, B., 1986, A chemical classification of volcanic rocks based on the total alkali-silica diagram: Journal of Petrology, v. 27, p. 745-750.

Mattox, S.R., 1991a, Origin of potassium-rich mafic lava flows, Marysvale volcanic field, Utah [abs.]: EOS, Transactions, American Geophysical Union Abstracts, p. 561.

Mattox, S.R., 1991b, Petrology, age, geochemistry, and correlation of the Tertiary volcanic rocks of the Awapa Plateau, Piute, Wayne, and Garfield Counties, Utah: Utah Geological and Mineral Survey Miscellaneous Publication 91-5, 46 p.

Mattox, S.R., 1992a, Geochemistry, origin, and tectonic implications of the mid-Tertiary and late Tertiary and Quaternary volcanic rocks southern Marysvale volcanic field, Utah: DeKalb, Northern Illinois University, Ph.D. dissertation, 498 p.

Mattox, S.R., 1992b, Source and process control of the geochemical variation in late Cenozoic basalts across the Utah transition zone [abs.]: EOS, Transactions, American Geophysical Union Program and Abstracts, v. 73, p. 657.

Mattox, S.R., 1993, The influence of tectonics, regional stress, source, and magmatic processes on the geochemical evolution of the southern Marysvale volcanic field, Utah [abs.]: EOS, Transactions, American Geophysical Union Program and Abstracts, v. 74, p. 624.

Mattox, S.R., 1994, Geochemistry and tectonic significance of Late Cenozoic basalts from the Basin and Range - Colorado Plateau transition zone, Utah, *in* Blackett, R.E., and Moore, J.N., editors, Cenozoic geology and geothermal systems of southwestern Utah: Utah Geological Association Publication 23, p. 125-138.

Mattox, S.R., 1997, Geochemistry, source characteristics, and tectonic implications of upper Cenozoic basalts of the Basin and Range-Colorado Plateau transition zone, Utah, *in* Maldonado, Florian, and Nealey, L.D., editors, Geologic studies in the Basin and Range-Colorado Plateau Transition in southeastern Nevada, southwestern Utah, and northwestern Arizona, 1995: U.S. Geological Survey Bulletin 2153, p. 197-226.

Mattox, S.R., and Walker, J.A., 1989, Geochemistry and tectonism of lavas erupted during the transition from compression to extension, southern Marysvale complex, southwestern Utah [abs.]: IAVCEI Abstracts, New Mexico Bureau of Mines & Mineral Resources Bulletin 131, p. 178.

Mattox, S.R., and Walker, J.A., 1992, Mid-Tertiary volcanism in the Utah transition zone and its relationship to Farallon-Vancouver subduction [abs.]: Geological Society of America Abstracts with Programs, v. 24, p. A261.

Nelson, S.T., 1989, Geologic map of the Geyser Peak quadrangle, Wayne and Sevier Counties, Utah: Utah Geological and Mineral Survey Map 114, scale 1:24,000.

Peccerillo, A., and Taylor, S.R., 1976, Geochemistry of Eocene calc-alkaline volcanic rocks from the Kastamonu area, northern Turkey: Contributions to Mineralogy and Petrology, v. 58, p. 63-81.

Rowley, P.D., 1979, Geologic map of the Marysvale SE quadrangle, Piute County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-1115, scale 1:24,000.

Rowley, P.D., Steven, T.A., and Mehnert, H.H., 1981, Origin and structural implications of upper Miocene rhyolite in Kingston Canyon, Piute County, Utah: Geological Society of America Bulletin, v. 92, pt. 1, p. 590-602.

Rowley, P.D., Williams, P.L., and Kaplan, A.M., 1986, Geologic map of the Greenwich quadrangle, Piute County, Utah: U.S. Geological Survey Geologic Quadrangle Map GQ-1589, scale 1:24,000.

Rowley, P.D., Steven, T.A., Anderson, J.J., and Cunningham, C.G., 1979, Cenozoic stratigraphic and structural framework of southwestern Utah: U.S. Geological Survey Professional Paper 1149, 22 p.

Rowley, P.D., Mehnert, H.H., Naeser, C.W., Snee, L.W., Cunningham, C.G., Steven, T.A., Anderson, J.J., Sable, E.G., and Anderson, R.E., 1994, Isotopic ages and stratigraphy of Cenozoic rocks of the Marysvale volcanic field and adjacent areas, west-central Utah: U.S. Geological Survey Bulletin 2071, 35 p.

Steiger, R.H., and Jäger, E., 1977, Subcommission on geochronology - Convention on use of decay constants in geo- and cosmochemistry: Earth and Planetary Science Letters, v. 36, p. 359-362.

Steven, T.A., Cunningham, C.G., Naeser, C.W., and Mehnert, H.H., 1979, Revised stratigraphy and radiometric ages of volcanic rocks and mineral deposits in the Marysvale area, west-central Utah: U.S. Geological Survey Bulletin 1469, 40 p.

Steven, T.A., Morris, H.T., and Rowley, P.D., 1990, Geologic map of the Richfield 1°x2° quadrangle, west-central Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1901, scale 1:250,000.

Steven, T.A., Rowley, P.D., and Cunningham, C.G., 1984, Calderas of the Marysvale volcanic field, west-central Utah: Journal of Geophysical Research, v. 89, p. 8,751-8,764.

Tingey, D.G., Christiansen, E.H., Best, M.G., Ruiz, J., and Lux, D.R., 1991, Tertiary minette and melanephelinite dikes, Wasatch Plateau, Utah: Records of mantle heterogeneities and changing tectonics: Journal of Geophysical Research, v. 91, p. 13,529-13,544.

Van Cott, J.W., 1990, Utah Place Names: Salt Lake City, University of Utah Press, 453 p.

Williams, P.L., and Hackman, R.J., 1971, Geology of the Salina quadrangle, Utah: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-591-A, scale 1:250,000.

Willis, G.C., 1986, Geologic map of the Salina quadrangle, Sevier County, Utah: Utah Geological and Mineral Survey Map 83, scale 1:24,000.

Appendix 1

Sample Locations

Sample	Unit	Longitude	Latitude	7.5' quadrangle	Locality
AP65	Tla	111°44'45"	38°18'07"	Moroni Peak	Cyclone Draw
AP67	Tla	111°44'45"	38°18'07"	Moroni Peak	Cyclone Draw
AP104	Tpml	111°43'41"	38°22'04"	Moroni Peak	Long Hollow
AP105	Tpml	111°42'47"	38°21'59"	Moroni Peak	Long Hollow
AP60	Tl	111°38'13"	38°17'48"	Moroni Peak	Big Hollow
AP62	Tl	111°38'14"	38°17'45"	Moroni Peak	Big Hollow
AP63	Tl	111°38'15"	38°17'44"	Moroni Peak	Big Hollow
AP171	Tl	111°40'43"	38°17'30"	Moroni Peak	Big Hollow
AP64	To	111°43'05"	38°17'10"	Moroni Peak	Big Flat Top
AP101	To	111°44'28"	38°22'04"	Moroni Peak	Long Hollow
AP103	To	111°44'28"	38°22'04"	Moroni Peak	Long Hollow
AP107	Tb	111°41'41"	38°20'10"	Moroni Peak	Elsies Nipple
AP110	To	111°37'22"	38°21'49"	Bicknell	Big Rocks
BC5	Tmd	112°27'08"	38°12'30"	Circleville Mtn	Circleville Mtn