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UTAH DEPARTMENT OF NATURAL RESOURCES
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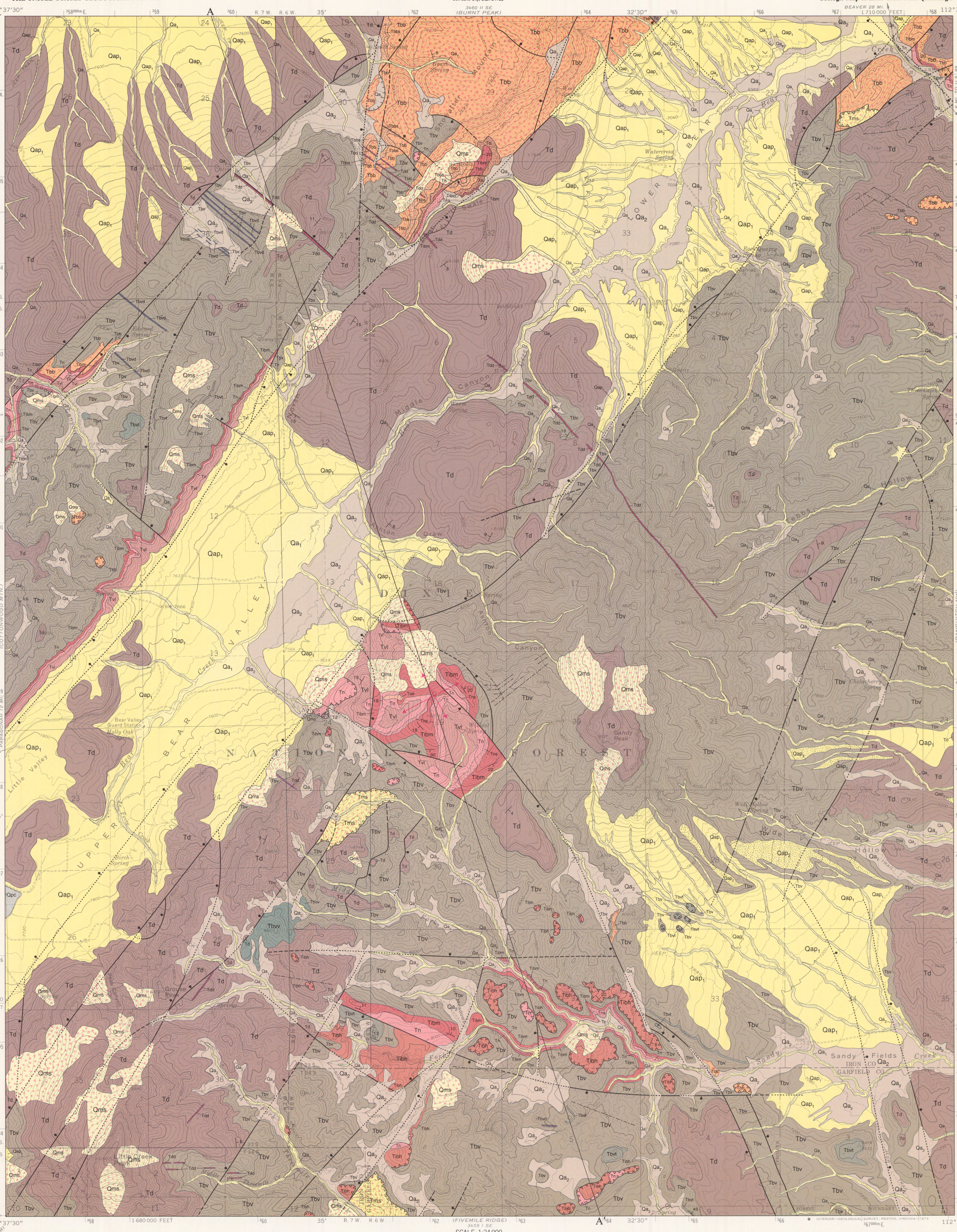
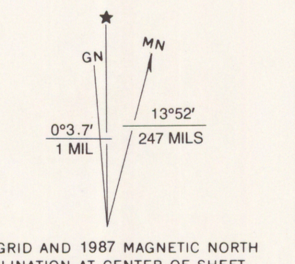
Plate 1
Utah Geological and Mineral Survey Map 104
Geologic Map of Little Creek Peak Quadrangle



Base map from U.S. Geological Survey, Little Creek Peak Quadrangle, 1971

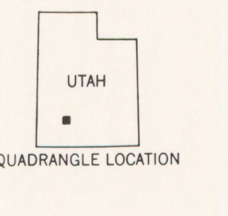
SCALE 1:24 000
1 MILE
7000 FEET
1 KILOMETER
CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Mapped by authors in 1963, 1964, 1967, and 1968
Field checked in 1984
J.W. Parker, Cartographer



UTM GRID AND 1987 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

GEOLOGIC MAP OF THE LITTLE CREEK PEAK QUADRANGLE, GARFIELD AND IRON COUNTIES, UTAH

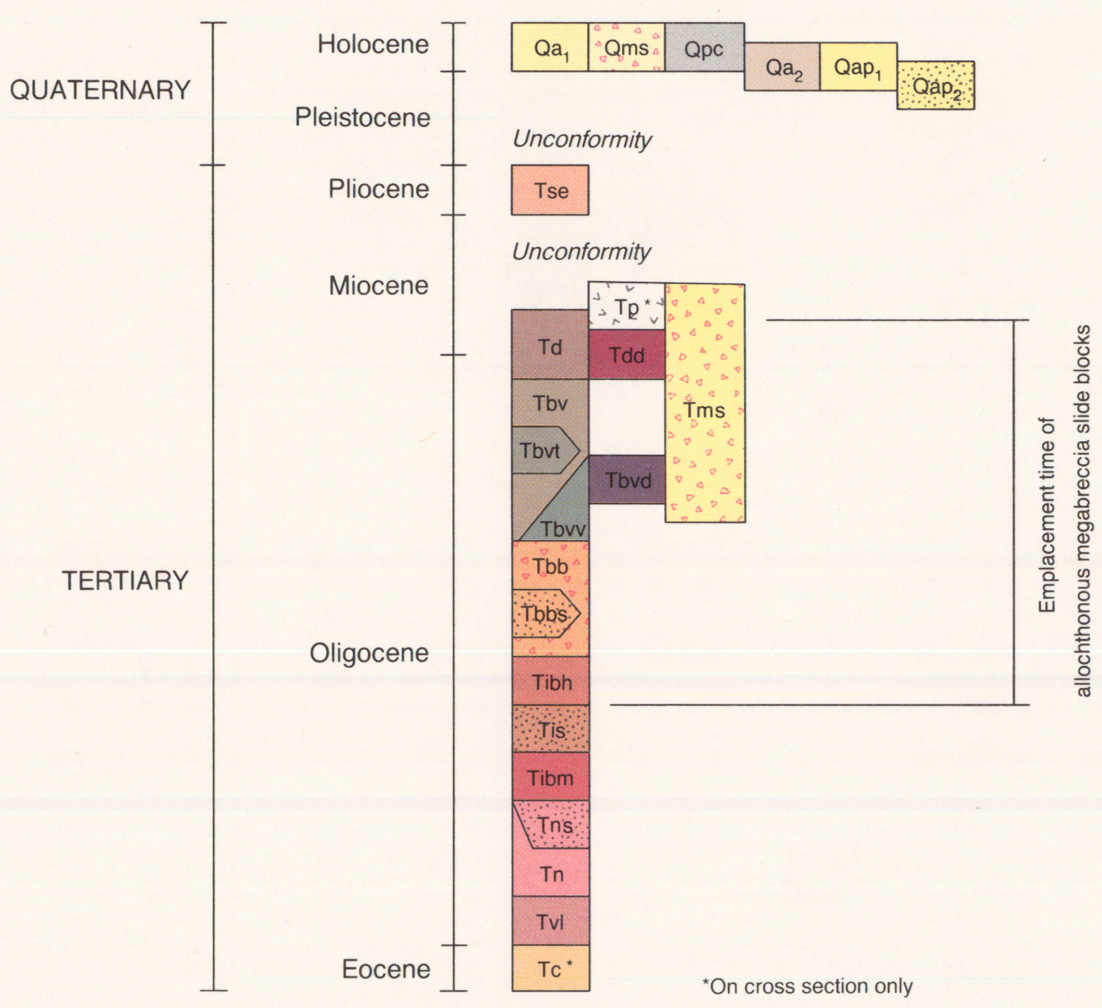


QUADRANGLE LOCATION

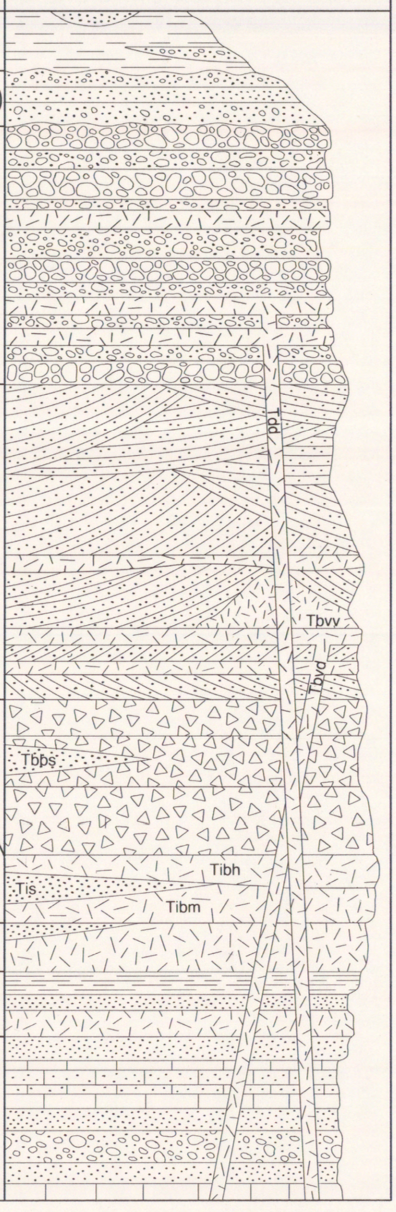
by
John J. Anderson, Thomas A. Iivari, and Peter D. Rowley
U.S. Geological Survey

1987

CORRELATION OF MAP UNITS



SYSTEM	SERIES	STRATIGRAPHIC UNIT	SYMBOL	Thickness in Feet (Meters)	LITHOLOGY
QUATERNARY	Holocene	Surficial deposits	Qa$_1$/Qms/Qpc/Qa$_2$/Qap$_1$/Qap$_2$	0-100 (0-30)	
	Pleistocene	Sevier River Fm.	Tse	0-10+ (0-3+)	
TERTIARY	Pliocene	* Mt. Dutton Formation	Td	1000+ (300+)	
		• Feeder dikes	Tdd		
	Miocene	Bear Valley Formation	Tbv	500-1000 (150-300)	
		• Welded tuff unit	Tbvt	0-30 (0-10)	
		• Feeder dikes	Tbvd		
		• Volcanic vent	Tbvv		
		Buckskin Breccia	Tbb	0-750 (0-230)	
		• Local sandstone unit	Tbbs	0-100 (0-30)	
		Isom Formation • Baldhills Tuff Mbr. • Sandstone member • Blue Meadows Tuff Mbr.	Tibh Tis Tibm	30-250 (9-75)	
		Wah Wah Springs Fm. • Local sandstone mbr.	Tn/Tns	30-100 (10-30)	
		Local volcanic and sedimentary strata	Tvl	0-250 (0-75)	
	Eocene	Claron Formation (Cross-section)	Tc		



★ Emplacement time of plutonic rock (Tp on cross-section)

DESCRIPTION OF MAP UNITS

Qa$_1$ Alluvium—*Unconsolidated silt, sand, and gravel along active streams and washes.*

Qms Landslide debris—*Disaggregated rock and surficial deposits.*

Qpc Playa lake deposits—*Lacustrine clay, silt, and sand in undrained depression.*

Qa$_2$ Older alluvium—*Dissected deposits of unconsolidated silt, sand, and gravel along streams and washes.*

Qap$_1$ Piedmont-slope deposits—*Unconsolidated, poorly sorted silt, sand, and gravel occurring on broad, sloping surfaces (piedmont slopes) formed by deposition (as alluvial fans) and by erosion (as pediments).*

Qap$_2$ Older piedmont-slope deposits—*Poorly indurated, poorly sorted silt, sand, and gravel mantling erosional remnants of pediments that formed graded to the Sevier River as much as 300 feet (90 m) above present drainage levels.*

Tse Sevier River Formation—*Light-gray, light-brown, and pinkish, poorly to moderately consolidated silt, pebbly sandstone, and conglomerate deposited in the valleys of the Sevier River and its tributaries.*

Tms Gravity slide megabreccia—*Large blocks of heterogeneous rock in a chaotic assemblage formed by gravity slides.*

Td Mount Dutton Formation—*Gray and brown, volcanic mudflow-breccia of intermediate composition and subordinate conglomerate, tuffaceous sandstone, and lava of intermediate and mafic composition.*

Tdd Feeder dikes of Mount Dutton Formation—*Medium-gray, hornblende-bearing andesite.*

Tbv Bear Valley Formation—*Pale- to dark-gray, yellowish, and greenish-gray, weak, crossbedded, zeolite-cemented, tuffaceous sandstone and subordinate felsic tuff and basaltic(?) lava and volcanic mudflow-breccia.*

Tbvt Welded tuff unit of Bear Valley Formation—*Brick-red to maroon, densely welded, vitric ash-flow tuff.*

Tbvd Feeder dikes of Bear Valley Formation—*Dark-gray to black, vesicular basalt(?).*

Tbvv Volcanic vent of Bear Valley Formation—*Dark-gray basaltic(?) lava and mudflow-breccia.*

Tbb Buckskin Breccia—*Light-colored, well-bedded, moderately resistant, lithic ash-flow tuff.*

Tbbs Local sandstone unit of Buckskin Breccia—*Light- to medium-gray and yellowish, weak, zeolite-cemented, cross-bedded, tuffaceous sandstone.*

Tibh Baldhills Tuff Member of Isom Formation—*Pale- to grayish-red and reddish-purplish-gray, ledge-forming, densely welded, vitric-crystal ash-flow tuff.*

Tis Sandstone member of Isom Formation—*Light- to medium-gray and yellowish, weak, cross-bedded, zeolite-cemented, tuffaceous sandstone.*

Tibm Blue Meadows Tuff Member of Isom Formation—*Pale- to grayish-red and reddish-gray, ledge-forming, densely welded vitric and vitric-crystal ash-flow tuff.*

Tn Needles Range Group—*Only the Wah Wah Springs Formation appears in outcrop. Reddish-brown to salmon-pink, ledge-forming, moderately welded vitric-crystal ash-flow tuff.*

Tns Sandstone member of Wah Wah Springs Formation—*Light- to medium gray, weak, zeolite-cemented tuffaceous sandstone and subordinate conglomerate.*

Tvl Local volcanic and sedimentary strata—*Local accumulations of lava, tuff, volcanic mudflow-breccia, and tuffaceous sedimentary strata.*

Tc Claron Formation—*Reddish-brown and grayish-white, well-bedded, calcareous shale and siltstone, argillaceous freshwater limestone, sandstone, and conglomerate.*

MAP SYMBOLS

Contact
Dashed on cross section where approximately located

Breakaway scarp
Teeth point downslope

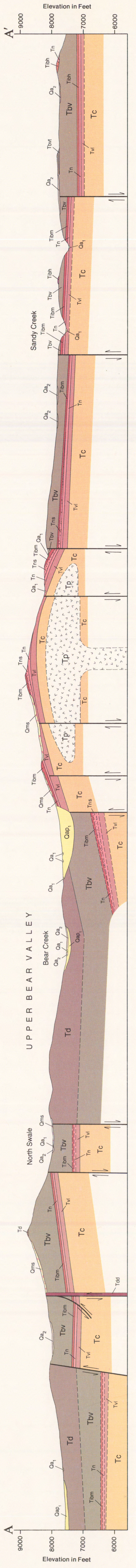
Gravity-slide block contact
Sawteeth on slide block

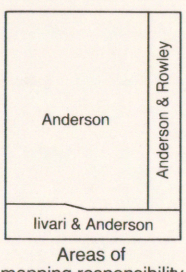
Lineament
Identifiable on aerial photographs or in the field. Probably trace of fault or joint

Fault
Mostly high-angle, dip-slip faults. Dashed where inferred or approximately located; dotted where concealed; ball and bar on downthrown side

Structural dome

15
Strike and dip of beds

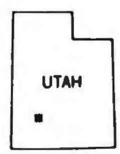




Areas of mapping responsibility

GEOLOGIC MAP OF THE LITTLE CREEK PEAK QUADRANGLE, GARFIELD AND IRON COUNTIES, UTAH

By John J. Anderson, Thomas A. Iivari, and Peter D. Rowley



UTAH GEOLOGICAL AND MINERAL SURVEY
a division of
UTAH DEPARTMENT OF NATURAL RESOURCES
MAP 104 **1987**

UTAH GEOLOGICAL AND MINERAL SURVEY

606 Black Hawk Way
Salt Lake City, Utah 84108-1280

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GEOLOGIC MAP OF THE LITTLE CREEK PEAK QUADRANGLE, GARFIELD AND IRON COUNTIES, UTAH

By John J. Anderson[1], Thomas A. Iivari[2], and Peter D. Rowley[3]

INTRODUCTION

The Little Creek Peak quadrangle is located in the north-central Markagunt Plateau, the southwesternmost of the High Plateaus of Utah (figure 1). The High Plateaus area, a subprovince of the Colorado Plateaus province, shares as many characteristics with the Basin and Range province to the west as with the Colorado Plateaus that lie to the east. Their block-faulted structures are similar to those in the Basin and Range province, whereas in high relief and elevation they resemble the Colorado Plateaus. Stratigraphically, however, although the High Plateaus share some characteristics of both adjoining provinces, they also display features that are uniquely their own. One of the latter is the Marysvale volcanic field, which dominates the geology of the central High Plateaus. The Little Creek Peak quadrangle lies on the southern flank of this field.

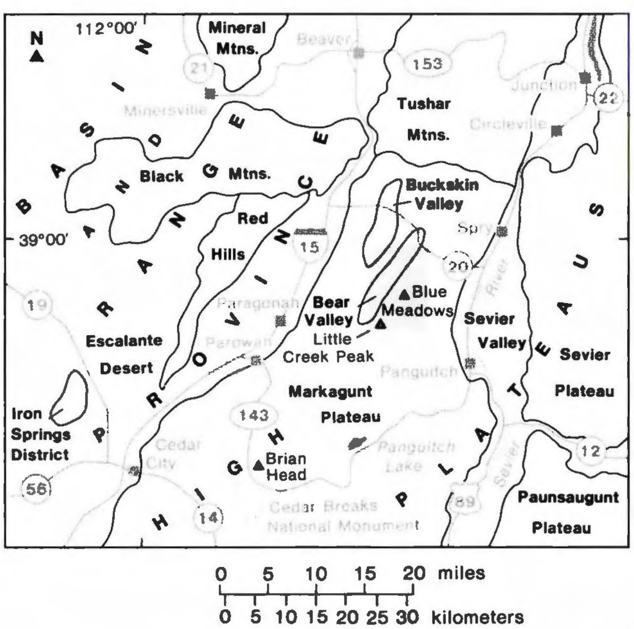

Figure 1. Southeastern High Plateaus and adjacent areas; quadrangle area is shaded.

Geologically, the Little Creek Peak quadrangle displays virtually every type of geologic feature that characterizes the southern High Plateaus. This includes a very complete stratigraphic section, paleo-fault control on the deposition of the units that make up that section, igneous intrusion and its attendant doming and dike emplacement, complex rhombic block faulting, large-scale gravity sliding, and superposition of drainage. General discussion of the geology in and near the Little Creek Peak quadrangle may be found in Anderson and others (1975), Rowley and Anderson (1975), and Rowley and others (1978, 1979).

STRATIGRAPHY

The stratigraphic section exposed in the Little Creek Peak quadrangle is 2000-3000 feet (610-915 m) thick. The Claron Formation, the basal Tertiary unit over much of southwestern Utah, is not exposed in the quadrangle but doubtlessly is present in the subsurface. The exposed units in the area are late Oligocene to Holocene. Overlying the Claron Formation is a heterogeneous local assemblage of volcanic and sedimentary strata to which no formal name has been assigned. Above this lie interbedded ash-flow tuffs and sedimentary rock belonging to the widespread Needles Range Group and Isom Formation; the volcanic strata were erupted from distant sources west of the quadrangle. Next in the section is the Buckskin Breccia, a sequence of lithic ash-flow tuffs erupted from vents located to the northeast of the quadrangle; the thickness of this unit is widely variable because it was erupted onto a block-faulted terrain. The Bear Valley Formation overlies the Buckskin Breccia. This is a blanket sand-dune deposit, with lava and ash-flow interbeds, that covered virtually the entire northern Markagunt Plateau as well as the Red Hills and Black Mountains in the Great Basin to the west. Capping the bedrock column are mudflow-breccia and lava of the Mount Dutton Formation, the thickest and most extensive rock-stratigraphic unit on the southern flank of the Marysvale volcanic field.

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[2]Currently Soil Conservation Service, Chester, Pennsylvania
[3]Geologist, U.S. Geological Survey, Denver, Colorado

Although the ash-flow tuffs of the Needles Range Group, Isom Formation, and Buckskin Breccia all possess lithologic characteristics that permit them to be identified and mapped with ease, such mapping within the quadrangle is complicated by the fact that this area was marked by local block faulting and widespread dune-sand deposition contemporaneous with their emplacement. The ash flows of the Isom Formation and Buckskin Breccia accumulated to their maximum local thickness in downfaulted areas, and thinned over or wedged out against upfaulted high areas and(or) large sand dunes. As a result, these three units are found in stratigraphic sections that differ widely in the lithology and thickness of the strata that constitute them. The tuff units may lie conformably above each other, each displaying about the same thickness; either the Isom Formation or the Buckskin Breccia may be abnormally thick; and locally dune sandstone may separate them. Further complicating the stratigraphic picture is the fact that the tuff units were buried beneath thick eolian sand of the Bear Valley Formation, deposits that cannot be distinguished from similar ones that separate the tuff units in places where these either were not emplaced or have been eroded. A final factor that complicates stratigraphic interpretation is that large blocks of all three tuff units slid from fault scarps and from the oversteepened flanks of domal structures into adjacent topographic lows where sand of the Bear Valley Formation was accumulating, thereby resulting in local duplication of parts of the stratigraphic section.

Block faulting has controlled deposition of sediment since the Miocene. Clastic sediment, eroded from upfaulted blocks, was deposited in downfaulted areas, thereby forming the Sevier River Formation. Only a small remnant of this unit remains exposed within the quadrangle, but the presence of the Sevier River Formation high in the mountains east of Bear Valley suggests that Bear Valley once was filled with these sediments, but they were largely removed after integration of through-flowing drainage. Quaternary deposits in many parts of the quadrangle reflect the episodic development of this drainage.

Terminology

Tuff may be classified by its content of crystal, vitric, and lithic material. Employed herein is the classification of Cook (1965; figure 2 of this report), which is expanded by preceding the root name of the rock, derived from Cook's particle composition triangle, with the names of the pyrogenic minerals that make up more than 15 percent of the phenocrysts. The phenocrysts are listed in quantitatively descending order — that is, the major before the minor.

Isotopic ages have been converted, where necessary, utilizing the decay constants of Steiger and Jäger (1977).

TERTIARY SYSTEM

Claron Formation

The Claron Formation comprises the oldest Tertiary rocks found throughout much of southwestern Utah. It is a succession of reddish, orange, gray, and white fluvial and lacustrine sedimentary strata that is most spectacularly exposed at Bryce Canyon National Park, some 30 miles (50 km) southeast of the Little Creek Peak quadrangle, and Cedar Breaks National Monument, about 15 miles (25 km) to the southwest. Although these strata are not present at the surface within the quadrangle, they do crop out in all adjacent quadrangles, where they record the earliest chapters of the Tertiary geologic history in this region. They therefore are shown at depth on the accompanying cross section, and deserve brief mention in this text.

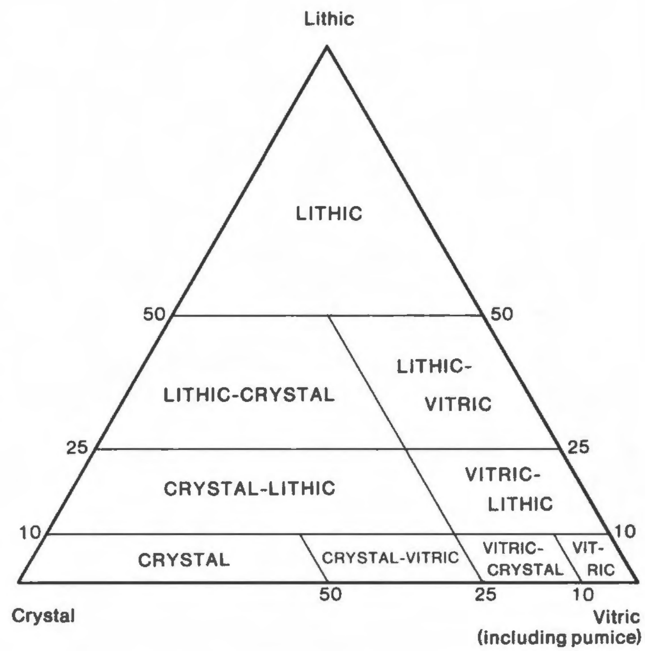

Figure 2. Particle composition triangle for ash-flow tuffs (Cook, 1965).

First described in the southern High Plateaus by Howell (1875) and Dutton (1880), these strata were first defined as the Claron Formation by Leith and Harder (1908) in the Iron Springs mining district west of Cedar City, Utah. The nomenclature of these deposits, especially the confusion resulting from references to them as "Wasatch Formation," has been reviewed by Anderson and Rowley (1975). Descriptions of the Claron Formation in nearby quadrangles may be found in Moore (1982), Hilton (1984), Anderson and others (1986), and Anderson and Grant (1986).

Local volcanic and sedimentary strata

The Claron Formation in the northern Markagunt Plateau is overlain by a heterogeneous volcanic and sedimentary strata assemblage, which differs from place to place. These deposits are assigned to an informal rock-stratigraphic unit designated as "local volcanic and sedimentary strata." The base of the unit is defined as the base of the first rock stratum of volcanic origin (lava, ash-flow tuff, autoclastic flow-breccia, or volcanic mudflow breccia, but not airfall tuff or tuffaceous sandstone) that overlies the Claron Formation. The top is defined as the base of the stratigraphically lowest regional rock unit of volcanic origin (in most cases, an ash-flow tuff of the Needles Range Group). The age of this unit is Oligocene, based on its position between formations of well-established Oligocene age, as well as on a K-Ar age determination of about 32 Ma made on an ash-flow tuff from it (Fleck and others, 1975).

In the Little Creek Peak quadrangle, these strata are represented by two sections that, while not exceptionally thick, are very diverse in the rock types that they contain. In the mountains just east of Upper Bear Valley, a section of the unit about 250 feet (75 m) thick is exposed in a small dome. Marked at its base by a very light gray, dense, felsic ash-flow tuff, this section consists for the most part of tuffaceous sandstone and mudstone and an interbedded 10-20 foot-thick (3-7 m) augite-sanidine-plagioclase crystal-vitric welded tuff. Along the base of the mountains west of Upper Bear Valley about 100 feet (30 m) of strata belonging to the unit are exposed. Chiefly of eruptive volcanic origin, they include pale-red, biotite-sanidine-plagioclase vitric-crystal tuff, and grayish-orange-pink, quartz-sanidine-plagioclase vitric welded tuff. Present also are thin (<5 feet; <2 m) beds of calcitic, silty to sandy tuffaceous mudstone.

The sources of the volcanic rocks found in these two sections are unknown. Their known presence only within the Little Creek Peak and nearby quadrangles suggests, however, that the sources were local ones that remain buried by younger rock units.

Needles Range Group

The Needles Range Group (formerly Formation) may well comprise what is areally the most extensive and volumetrically the largest related succession of ash-flow tuffs in North America. First described by Dutton (1880), it was defined by Mackin (1960) in the Needle Range (Mountain Home Range) that lies near the border of southwestern Utah and Nevada.

Best and Grant (in press) have provided an excellent summary of what is known about the Needles Range Group as well as contributing many significant new data concerning it; it is they who have raised its stratigraphic rank from formation to group. They estimate that the ash flows of the Group had a minimum volume of 2500 miles^3 (6600 km^3) and spread over an area of at least 8500 miles^2 (22,000 km^2). The source for this vast outpouring of tuff was along the southern Utah-Nevada border, where it formed the large Indian Peak caldera.

From the base upward, the formations that make up the Needles Range Group are the Escalante Desert Formation, Cottonwood Wash Tuff, Wah Wah Springs Formation, Ryan Spring Formation, and Lund Formation; only the Wah Wah Springs Formation crops out in the quadrangle.

Wah Wah Springs Formation

Areally, the most extensive unit of the Needles Range Group is the Wah Wah Springs Formation. In the Little Creek Peak quadrangle, an ash-flow tuff sheet belonging to it typically forms a prominent ledge about 50 feet (15 m) thick. Typically, the base of the unit is densely welded but has not formed a vitrophyre; the overlying portion is moderately welded.

The characteristic rock of the Wah Wah Springs Formation is plagioclase-hornblende-biotite crystal-vitric welded tuff; it also contains minor quartz, augite, and Fe-Ti oxides, and trace amounts of apatite and zircon. It is a resistant, reddish-brown to salmon-pink, crystal-rich rock that in hand specimen easily could be confused with a hypabyssal intrusive rock.

Local sandstone member

In places in the quadrangle the Wah Wah Springs Formation is separated from the overlying Isom Formation by a few tens to 150 feet (10-45 m) of tuffaceous sandstone with conglomeratic interbeds; these strata are included in the Wah Wah Springs Formation as a local, informal member. The sandstone strata typically are light- to dark-gray, vary from 1 to 6 inches (0.4-2.4 cm) in thickness, and commonly are cross-bedded. The sandstone consists of fine- to medium-grained, moderately to well-sorted, sub-angular to well-rounded volcanic rock fragments, pyrogenic mineral grains (plagioclase, amphibole, pyroxene, biotite), and quartz. The conglomerate is pebbly and cobbly; it is made up largely of volcanic rock fragments, and occurs in lenticular beds 4 to 8 inches (10-20 cm) thick.

The age of the ash-flow tuff of the Wah Wah Springs Formation is Oligocene. This has been established by isotopic age determinations ranging from 27 to 31 Ma, and averaging 29.5 Ma (Armstrong, 1970; Noble and McKee, 1972; Lemmon and others, 1973; Fleck and others, 1975; and several unpublished ages cited by Best and Grant, in press). The age of the local sandstone member also is Oligocene, based on its stratigraphic position between the dated Wah Wah Springs and Isom Formations.

Isom Formation

The Isom Formation, defined by Mackin (1960), consists largely of rock that is radically different in appearance from that of the Needles Range Group. Both, however, originated as ash flows, and together they form a stratigraphic couplet that in an area of more than 5000 miles^2 (12,500 km^2), which includes this quadrangle, serves as an ideal stratigraphic and structural datum.

The characteristic rock of the Isom Formation is a resistant, pale- to grayish-red and pale- to grayish-reddish-purple, densely welded, vitric-crystal ash-flow tuff of dacitic composition. Typically, it consists of 5-20 percent phenocrysts, 1-3 mm in size, of plagioclase and subordinate augite and Fe-Ti oxides in a groundmass having the texture and appearance of unglazed porcelain. Locally, it exhibits secondary flowage features, including autobrecciation and flow layering; it also contains numerous horizontal, pancake-shaped, light- to medium-gray ash-flow tuff lenticules that are either collapsed pumice or the products of devitrification by gas trapped during the vapor phase of cooling and compaction.

Three members have been defined within the Isom Formation. The oldest is the Blue Meadows Tuff Member (Anderson and Rowley, 1975), which is found only in the area of the Markagunt Plateau. Overlying the Blue Meadows Tuff Member is the Baldhills Tuff Member (Mackin, 1960), which can be found over an area of at least 7500 miles^2 (18,750 km^2) in the Great Basin and the southern High Plateaus. Both members are found in the quadrangle. Overlying the Baldhills Tuff Member, but found only within the Great Basin, is the Hole-in-the-Wall Tuff Member (Mackin, 1960). All three members have a similar appearance, but the phenocryst content of the Baldhills Tuff Member (10-20 percent) generally is about twice that of the other two. Outcrops of the Blue Meadows and Baldhills Tuff Members also have much in common, consisting of a dark-brownish-gray to black basal vitrophyre overlain by brick-like devitrified rock.

The Blue Meadows Tuff Member type locality is in the quadrangle on the north side of the south fork of Sandy Creek east of Blue Meadows (SE¼ NE¼ sec. 31, T. 33 S., R. 6 W.). There, it is a continuous ledge-forming single cooling unit about 25 feet (8 m) thick resting on the Wah Wah Springs Formation. It consists of plagioclase vitric-crystal welded tuff containing 15-20 percent phenocrysts throughout its section. Over most of its outcrop area, however, the upper one-half to two-thirds of the unit contains only 5-10 percent phenocrysts.

On southern Showalter Mountain a few meters of tuffaceous sandstone, similar to that of the Bear Valley Formation (see below), separate the Isom Formation from the Buckskin Breccia. This local sandstone is mapped as an informal member of the Isom Formation (Tis).

The stratigraphy of the Isom Formation near Blue Meadows has been complicated by block faulting and dune-sand accumulation that took place before and after the emplacement of the Blue Meadows and Baldhills Tuff Members. Thus the Blue Meadows Tuff Member may be found directly overlying the Wah Wah Springs Formation, as at its type section; or the two may be separated by up to 100 feet (30 m) of tuffaceous sandstone and conglomerate, as at localities a mile or so to the east.

The control that faulting along northwest trends exerted on these stratigraphic units seems clear. The faulting apparently began locally between the times of emplacement of the Blue Meadows Tuff and the Baldhills Tuff Members. The latter thus seems to have been emplaced against, but failed to override, a southwest-facing fault scarp south of Blue Meadows.

Faulting along northwest trends appears to have continued in the vicinity of Blue Meadows following emplacement of the Baldhills Tuff, tilting fault-bounded blocks and causing large-scale gravity slides that further complicate the stratigraphic picture. These slides are discussed below.

The age of both the Blue Meadows and Baldhills Tuff Members of the Isom Formation, and by extrapolation the age of the faulting that controlled the emplacement of the latter member, is late Oligocene. This has been established by K-Ar determinations of about 26 Ma on samples from both members (Fleck and others, 1975).

Buckskin Breccia

The Buckskin Breccia, defined by Anderson and Rowley (1975), is made up of lithic ash-flow tuff, autoclastic flow-breccia(?), and mudflow-breccia(?) that contain clasts of rock identical with that of the Spry intrusion, a batholith-sized body of quartz latite porphyry that is exposed a few miles northeast of the Little Creek Peak quadrangle (Grant, 1979; Grant and Anderson, 1979). The formation's areal extent is about 250 miles^2 (650 km^2); its maximum thickness is more than 700 feet (200 m). The type section of the unit is in the extreme northeastern corner of the map area, north of Utah Highway 20 and just east of Lower Bear Valley.

The Buckskin Breccia consists of at least four separate, moderately resistant, light-colored, well-bedded units lying directly on top of each other or else separated by a few feet of tuffaceous sandstone. Although they differ in their composition of lithic fragments, all contain clasts of the Spry intrusion in a matrix that in thin-section is seen as dusty, devitrified glass enclosing fragmented grains of plagioclase, hornblende, biotite, augite, and Fe-Ti oxides. From thin-sections, three of the units can be identified as ash flows; they exhibit the effects of compaction of either compressed glass shards or biotite flakes deformed around and between other phenocrysts that themselves exhibit horizontal parallelism. The fourth unit may have originated as an ash flow but the evidence has been obscured by devitrification, or it may have been deposited as autoclastic flow breccia or possibly mudflow breccia.

The Buckskin Breccia is well exposed in the quadrangle at Showalter Mountain, where it exhibits its maximum known thickness of more than 700 feet (215 m) and clearly reveals the control that faulting exerted on its emplacement. North of the quadrangle, the section exposed on northeastern Showalter Mountain consists largely of the Claron Formation; it is overlain by the local volcanic and tuffaceous sedimentary strata, the Wah Wah Springs Formation, and the Isom Formation, all of which are relatively thin (50-100 feet; 15-30 m), as well as the uppermost unit of the Buckskin Breccia about 150 feet (45 m) thick. Southwestern Showalter Mountain, on the other hand, consists largely of a Buckskin Breccia section at least 700 feet (230 m) thick where it is in abrupt and dramatic contact with the reddish strata of the Claron Formation that make up the bulk of northeastern Showalter Mountain. Within the Little Creek Peak quadrangle, the Buckskin Breccia section thins abruptly near the southern end of Showalter Mountain, where it unconformably overlies the Isom Formation which dips about 20° to the north. Farther south, on the unnamed extension of Showalter Mountain that flanks Upper Bear Valley on the west, the Buckskin Breccia is missing from the stratigraphic section.

These key exposures both within and north of the quadrangle are interpreted as follows: the area was a rather flat and featureless lowland up through the time that the Isom Formation was emplaced. Block faulting along northwesterly trends followed, producing a graben at least 500 feet (150 m) deep at the site of southern Showalter Mountain. Locally, drag folding accompanied the faulting; it imparted the northerly dip to the Isom Formation near the southern end of Showalter Mountain. Eruption of the Buckskin Breccia then took place. These ash flows were channelled into the graben, filled it, and overflowed its margins.

Exposures in place of the Buckskin Breccia other than at Showalter Mountain within the Little Creek Peak quadrangle are few and small. In addition, allochthonous blocks of the unit also are found. These appear to have slid from the flanks of domes located north and west of the quadrangle.

Tuffaceous sandstone separates two of the ash-flow tuffs of the Buckskin Breccia at Showalter Mountain. This sandstone, which is about 50 feet (15 m) thick and in all ways similar to that of the Bear Valley Formation (discussed below), is mapped as a separate unit within the Buckskin Breccia.

About 5 miles (8 km) north of the Little Creek Peak quadrangle, an ash-flow tuff of the Isom Formation is interbedded with strata of the Buckskin Breccia. The two are thus the same age, about 26 Ma, or late Oligocene. This is also the age of the Spry intrusion, according to recent isotopic age determinations of 26.4 ± 3.2 and 26.4 ± 2.2 Ma (H. H. Mehnert, U. S. Geological Survey, personal commun., 1985). This suggests that the Buckskin originated as an eruptive phase of the same igneous activity that emplaced the Spry intrusion. An earlier isotopic age of about 32 Ma was made on the Spry intrusion by Damon (1968); this older age made previous interpretations of the relationship between the Spry intrusion and the Buckskin Breccia, with its ubiquitous content of Spry clasts, problematic (Anderson and Rowley, 1975).

Bear Valley Formation

The Bear Valley Formation, defined by Anderson (1971), is largely a wind-blown sand deposit that blanketed an area of some 1000 miles^2 (2600 km^2) in the northern Markagunt Plateau, Red Hills, and Black Mountains immediately prior to this same area being inundated by volcanics of the Mount Dutton Formation. Its type section is in the Panguitch NW quadrangle that borders the Little Creek Peak quadrangle on the east, north of Highway 20 about 1.5 miles (2.4 km) west of its junction with U.S. Highway 89; it extends from SE¼ NW¼ sec. 5, T. 33 S., R. 5 W., to NE¼ SE¼ sec. 32, T. 32 S., R. 5 W.

Most of the Bear Valley Formation is poorly indurated, pale-gray, yellow, or green (in places quite vivid), cross-bedded, tuffaceous sandstone. Two members can be distinguished. The lower is made up largely of subangular to well-rounded volcanic rock fragments and pyrogenic mineral grains (plagioclase, sanidine, pyroxene, amphibole, and biotite, and very minor quartz). The upper member contains, in addition, many subangular to angular glass shards, apparently contributed by active volcanism and hardly reworked; it also contains interbeds and lenses of welded and unwelded ash-flow tuff and rare ashfall beds, all probably from local vents. Both members are poorly to moderately cemented by clinoptilolite, a zeolite that locally has been altered to chlorite and imparts a striking green color to the rock.

Cross-beds show that sand in the Bear Valley Formation for the most part was deposited by winds that blew from the south and west. A large, northwest-trending fault scarp, evidence for which is most clearly seen in the Panguitch NW quadrangle (Anderson and Rowley, 1987), blocked the northward transport of the sand, resulting in the deposition of its greatest thickness of slightly more than 1000 feet (305 m) at the type locality. In the Little Creek Peak quadrangle, the formation has a maximum thickness in the vicinity of Sandy Peak of about 1000 feet (305 m).

The stratigraphy of the formation in the quadrangle, particularly adjacent to its contact with the overlying Mount Dutton Formation, is complicated by the products of a local volcanism that was active during deposition of both of these units. Intermediate to mafic lavas were extruded from dike-fed fissures and at least one small stratovolcano. Mudflow-breccia also was shed from the latter. Thus basaltic lava flows are interbedded with sandstone in the lower part of the Bear Valley Formation in the mountains west of Upper Bear Valley. The flows consist of very fine crystals of plagioclase, augite, and Fe-Ti oxides, and what appears to be goethite-limonite after iddingsite after olivine, in a vesicular, cryptocrystalline and glassy groundmass. Similar flows and related mudflow-breccia beds and underlying sandstone cap an incomplete section of the Bear Valley Formation in the mountains east of Upper Bear Valley. In the southern part of the quadrangle, similar lava occurs higher in the section interbedded with amphibole- and pyroxene-bearing andesitic lava flows and mudflow-breccia of the Mount Dutton Formation. Where, then, local flows are found on the surface overlying sandstone of the Bear Valley Formation, an uncertainty exists whether to assign them to the Bear Valley Formation or the Mount Dutton Formation. These problematic flows are assigned to the Bear Valley Formation if they are basaltic, and to the Mount Dutton Formation if they contain hornblende or are porphyritic. Such assignment is made because basaltic feeder dikes of local flows cut only strata of the Bear Valley Formation, whereas feeder dikes of amphibole-bearing andesite cut strata of the Mount Dutton Formation.

The stratovolcano that contributed lava and mudflow-breccia to the Bear Valley Formation has been mapped separately (Tbvv: local volcanic vent complex of Bear Valley Formation). Its location is marked by interbedded basaltic lava and mudflow-breccia dipping radially away about 30° from a center located in NE¼ sec. 25, T. 33 S., R. 7 W.

A welded vitric tuff occurs within the lower Bear Valley Formation over an area of about 20 miles^2 (50 km^2) in the southern part of the quadrangle as well as farther south. Lithologically similar to the Blue Meadows Tuff Member of the Isom Formation, it ranges in thickness from about 30 feet (9 m) to a feather edge where it pinches out against paleotopographic highs, such as sand dunes. In most places this tuff is made up of a dense, highly welded, black basal vitrophyre that is overlain by a maroon to brick-red, densely welded zone with the texture and appearance of unglazed porcelain in which are numerous ash-flow tuff lenticules. The rock is made up of about 5 percent phenocrysts, largely plagioclase, but some minor clinopyroxene and Fe-Ti oxides, and traces of quartz, hornblende, and sanidine, in a groundmass of eutaxitic glass shards. The source of this tuff may be a dike-like body of black glass that cuts strata of the Bear Valley Formation near the center of the tuff's outcrop area (see section on intrusive rock, below), as suggested by the location of the dike and the petrographic similarity of the tuff and the dike. This tuff is mapped as an informal local member of the Bear Valley Formation.

Light-gray to pinkish-gray, unwelded, felsic tuff beds are common throughout the Bear Valley Formation in the southern half of the quadrangle and areas farther south; their intimate interbedding with sandstone precludes mapping them separately. Typically, the tuff consists of from 70-80 percent glass dust and fresh to partially devitrified angular glass shards; 20-30 percent phenocrysts of plagioclase, quartz, ferromagnesian minerals, and Fe-Ti oxides; and numerous volcanic rock fragments. Outcrops of the tuff are scattered and range in thickness from 200 feet (65 m) to a feather edge. Some of the larger outcrop areas within the quadrangle are along the crest of the mountain west of Upper Bear Valley, east of Bear Creek in the hills that separate Upper and Lower Bear Valley, and in the extreme southeastern corner of the quadrangle.

Two possible source areas of the felsic tuff are in and near the quadrangle. One is to the north on central Showalter Mountain, where a large "thumb" of the tuff seemingly penetrates rock of the Buckskin Breccia at the center of a small, caldera-like depression. The other is in the extreme southeastern corner of the quadrangle (sec. 10, T. 34 S., R. 6 W.), where the northern edge of a small dome is located near the center of one of the larger and thicker accumulations of the tuff; the site is marked by numerous slide blocks and other chaotic structures perhaps indicative of explosive volcanic activity. This possible vent area is best exposed in the adjacent Five Mile Ridge quadrangle, however, within which other possible tuff vents also are found.

K-Ar ages of about 25 Ma have been determined on samples of both the welded and unwelded tuffs interbedded with sandstone of the Bear Valley Formation (Fleck and others, 1975), indicating a late Oligocene age.

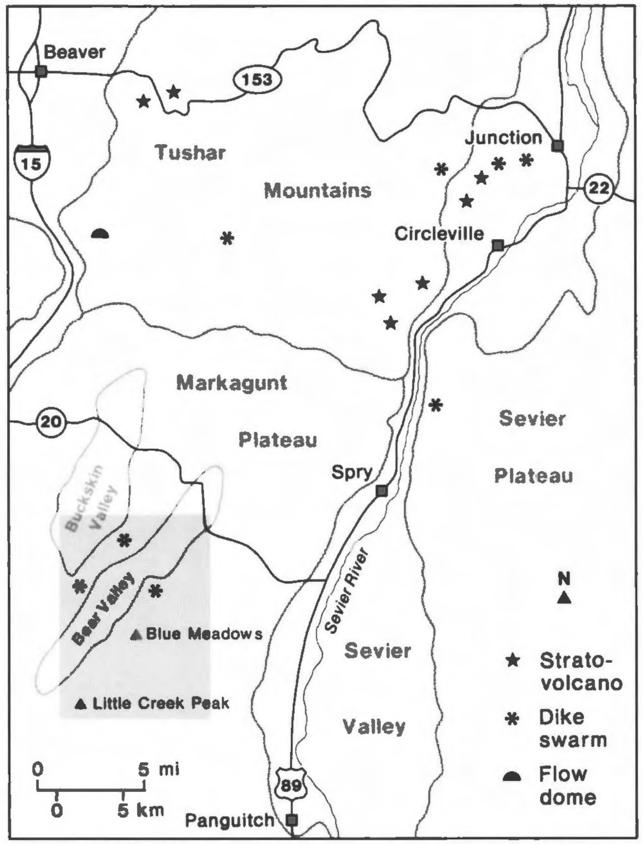

Figure 3. Volcanic vents of Mount Dutton formation; quadrangle area is shaded.

Mount Dutton Formation

The Mount Dutton Formation, defined by Anderson and Rowley (1975), contains most of the rock exposed on the southern flank of the Marysvale volcanic pile. It consists largely of volcanic rock of intermediate (dacite-andesite) composition, interbedded locally with felsic tuff, conglomerate, and tuffaceous sandstone. In accordance with the concepts of Parsons (1965, 1969) and Smedes and Prostka (1973), it is subdivided into a vent facies and an alluvial facies, both derived from generally west-trending stratovolcanos in the southernmost Tushar Mountains, as well as local vents in the Black Mountains and northern Markagunt Plateau (Lanigan, 1980; Anderson, Rowley, and Blackman, 1986; Anderson and Grant, 1986; figure 3).

Only rocks assigned to the alluvial facies of the Mount Dutton Formation are exposed within the map area. They consist for the most part of soft to resistant, mostly light- to dark-gray and brown mudflow-breccia and some fluvial conglomerate and tuffaceous sandstone. Andesitic and basaltic(?) lava flows and autoclastic flow-breccia, derived from local vents as well as the Marysvale pile, and subordinate felsic tuff make up most of the remainder of the Mount Dutton. The predominate mudflow-breccia is characterized by subrounded to angular clasts of intermediate volcanic rock that are mostly supported by a muddy to sandy matrix. The size of the clasts, the ratio of clasts to matrix, and the thickness of individual flows are widely variable. Typically, the clasts are of cobble size and make up about one-third to one-half of the rock, and individual flows are 5-10 feet (2-3 m) thick. The conglomerate is of fluvial origin, and the tuffaceous sandstone is fluvial and eolian; both consist almost exclusively of reworked volcanic detritus, doubtlessly derived in large part from the vent facies. The conglomerate and sandstone occur as local channel fillings and as lenses as much as 30 feet (9 m) thick. Most of the subordinate lava flows apparently were erupted from fissures located in the area of the northern Markagunt Plateau during deposition of the Bear Valley and Mount Dutton Formations. The flows consist largely of amphibole and(or) pyroxene andesite and basalt(?); textures range from aphanitic to conspicuously porphyritic, with phenocrysts of plagioclase, hornblende, and(or) augite set in a dark, microcrystalline and glassy groundmass. These flows rarely exceed 30 feet (9 m) in thickness.

Exposed sections of the Mount Dutton Formation within the map area for the most part are only a few hundred feet or less (<100 m) in thickness. Prior to erosion, however, the local Mount Dutton Formation section was at least 1000 feet (305 m) thick, and perhaps several times that amount. The 1000-foot thickness is preserved at Little Creek Peak; the higher thicknesses are suggested by sections in the western Markagunt Plateau and Black Mountains.

The age of the Mount Dutton Formation is late Oligocene and Miocene. This has been established by K-Ar determinations of about 26 to 20 Ma made by Fleck and others (1975) on rocks of the vent facies, with which the alluvial facies interfinger.

Gravity slide megabreccia

Gravity sliding during the late Oligocene resulted in the allochthonous emplacement of large bodies of rock in the Little Creek Peak quadrangle. Most of these bodies are made up of a single, internally brecciated mass of rock composed of one or, at most, two of the formations that crop out in the quadrangle, and thus can be mapped as allochthonous masses of these formations. In places, however, the sliding resulted in the chaotic brecciation of rock from two or more formations. Where such deposits are found, they have been mapped separately as gravity slide megabreccia of late Oligocene and Miocene(?) age.

The gravity slides apparently took place on the flanks of domes, on fault scarps, and down the dip slopes of tilted fault blocks. The faults to which the sliding was related all appear to have been the northwest-trending ones of late Oligocene age that also controlled the distribution of the Isom Formation and the Buckskin Breccia.

Intrusive rock

Plutonic rock is not exposed in the Little Creek Peak quadrangle, but the dome east of Upper Bear Valley (see cross section) indicates that it probably is present at depth there. If so, analogy with exposed plutons in adjacent quadrangles suggests that the body is a laccolith of dioritic or gabbroic composition, and that its age is Miocene (Anderson and Rowley, 1975).

Dikes crop out in the central and southern parts of the quadrangle. Although most of the dikes have the same northwest trend, differences in composition and the age of the strata that they cut suggest that these dikes belong to two separately emplaced sets. The more common set is basaltic, consisting of plagioclase, augite, and Fe-Ti oxides in a vesicular, cryptocrystalline and glassy groundmass. It is found both east and west of Bear Valley where it cut, and contributed lava flows to, the Bear Valley Formation. The other set cut and contributed lava flows to the Mount Dutton Formation. It consists of gray, porphyritic andesite characterized by phenocrysts of hornblende up to 3 inches (7.5 cm) long in a vesicular groundmass largely of devitrified glass, and very finely crystalline plagioclase, Fe-Ti oxides, and minor augite. With but one exception, dikes of this set are only found west of Bear Valley. The exceptional dike is truly that; in places up to 200 feet (65 m) thick, it cuts the mountains west of Bear Valley, the low hills that separate Upper and Lower Bear Valley, and the mountains to the east, a total distance of about 5 miles (8 km).

A unique dike in the quadrangle cuts across strata of the Bear Valley Formation in SE¼ NW¼ sec. 5, T. 34 S., R. 6 W. It consists of welded glass shards enclosing sand grains identical to those in the Bear Valley Formation. This dike probably marks the site of a fissure eruption of either the welded ash-flow tuff or the unwelded felsic tuff found within the Bear Valley Formation.

Sevier River Formation

The Sevier River Formation was deposited in the down-faulted valleys of the Sevier River and its tributaries by erosion of rocks of the upfaulted High Plateaus (Callaghan, 1938). The formation consists of poorly to moderately consolidated, light-gray, light-brown, pinkish-gray, and white, silty, pebbly sandstone and conglomerate. Airfall tuff beds within this formation near its type locality about 30 miles (50 km) to the north of the quadrangle have fission-track ages of 14 and 7 Ma (Steven and others, 1979), indicating a Miocene age. The upper part of the formation, however, probably is Pliocene and may even be as young as Pleistocene.

Although topographic and structural lows, such as Bear Valley, may be underlain by the Sevier River Formation, only one outcrop of this unit occurs in the quadrangle. This occurrence is a veneer of gravel, made up almost exclusively of quartzite, found high in the mountains east of Bear Valley (sec. 19, T. 33 S., R. 6 E.). It should be noted, however, that isolated cobbles and boulders of quartzite are ubiquitous throughout the quadrangle. That the quartzite gravel and many of the isolated quartzite clasts are not part of a Quaternary deposit is attested to by their composition. The only source of quartzite gravel in the southern High Plateaus is conglomerate of the Claron Formation, and this unit is not exposed today in the vicinity of most of these deposits up any possible slope of transportation. In quadrangles to the southwest, however, the Claron Formation has been upfaulted above the gravel deposits in question, but it would have been impossible for material eroded from these topographically higher outcrops to have found their way to their present positions across today's intervening topographic highs and lows. It therefore is concluded that the structurally closed intermontane valleys of the northern Markagunt Plateau, such as Bear Valley, at one time were filled with the Sevier River Formation to a level where drainage finally could find its way east to the Sevier River. Following the establishment of an integrated drainage system, the topographic lows were exhumed to produce the physiography of today. Any extensive deposits of the Sevier River Formation that remain on highland areas are indistinguishable from Quaternary alluvial deposits except in the unique case of those in the mountains east of Upper Bear Valley.

QUATERNARY SYSTEM

Older piedmont-slope deposits

This unit consists of 10-30 feet (3-9 m) of unconsolidated, poorly sorted silt, sand, and gravel. In the east-central part of the quadrangle, it mantles erosional remnants of pediments that graded to the Sevier River as much as 300 feet (90 m) above present erosional levels. It includes alluvium of small drainages on the pediment surface. The unit is thought to be of Pleistocene age because 1) the pediments which it caps still exist as recognizable landforms, and 2) the unit's height above present drainage levels.

Piedmont Slope Deposits

These deposits consist of unconsolidated, poorly sorted silt, sand, and gravel mainly as a thin mantle on pediments and in thicker accumulations as alluvial fans; they also include alluvium in small drainages and, locally, colluvium, slope wash, and talus. The thickness of these deposits, all of which have been dissected by present streams, varies greatly, from a few feet to tens of feet (1-10 m) on pediments to perhaps hundreds of feet (>100 m) in Bear Valley. The deposits range in age from Pleistocene to Holocene, judging from their mode of occurrence and stratigraphic position.

Older alluvium

Older alluvium consists of unconsolidated silt, sand, and gravel deposited by intermittent and perennial streams in their channels, on bordering floodplains, and in terminal alluvial fans. Locally, it also may include minor talus deposits, slope wash, and colluvium. The unit is similar to that mapped and described below as alluvium except for age. The two alluvial units are mapped separately to emphasize the great amount of recent dissection that has taken place within the quadrangle. Indeed, in places this dissection, much of which has taken place during historic time, exceeds 20 feet (6 m). This is the maximum exposed thickness of these older alluvial deposits, but they may be considerably thicker. The unit may have a considerable range in age, from Pleistocene(?) to Holocene, judging from its mode of occurrence and stratigraphic position, and some of it may be correlative with the piedmont slope deposits.

Playa-lake deposits

This unit consists of lacustrine clay, silt, and sand deposited in a small, undrained depression in Upper Bear Valley at the western border of the quadrangle. Its age is Holocene, and its thickness is probably a few tens of feet (10 m) at most.

Landslide debris

This unit is made up of mostly angular and very poorly sorted rock, in most cases of the Mount Dutton and Bear Valley Formations, that has moved downslope to form deposits of lobate form as well as broad aprons mantling steep valley walls and fault scarps. Its thickness typically is several tens of feet. Its age is Holocene.

Alluvium

The sediments here designated as alluvium are identical in lithology with those of the older alluvium; the alluvium is younger and occurs topographically lower, along the channels of present intermittent and perennial streams, including those that have dissected older alluvium. That some of this dissection occurred during historic time is shown in places where it has cut old roads and trails. The unit is Holocene; its maximum thickness is about 15 feet (5 m).

STRUCTURE

As elsewhere in the southern High Plateaus, the structure of the Little Creek Peak quadrangle is dominated by block faulting. In this quadrangle the faulting took place during two seemingly unrelated episodes of widely different age and trends. In addition, the quadrangle in places shows the structural effects of doming and gravity sliding.

The earlier episode of block faulting took place along northwest trends during the late Oligocene. Within the quadrangle, in addition to locally tilting small blocks as in the vicinity of Blue Meadows, it was responsible for controlling the distribution and thickness of the Buckskin Breccia and the Baldhills Tuff Member of the Isom Formation; east of the quadrangle it had a similar effect on the Bear Valley Formation. All three of these units accumulated to their maximum known thicknesses in the Markagunt Plateau against northwest-trending fault scarps and(or) in similarly trending downfaulted topographic lows, whereas they are thinnest or absent at the site of topographic highs that structurally were either northwest-trending horsts or tilted fault blocks.

Two sets of dikes that fed lava flows incorporated in the Bear Valley and Mount Dutton Formations also were emplaced along northwesterly trends. Both the faults and the dikes probably reflect tensional stress normal to their strikes. It therefore appears that northeast-southwest extension exerted a significant effect on the northern Markagunt Plateau during at least the late Oligocene.

The second episode of block faulting produced the physiographic features that today are the High Plateaus. It may have begun during the early Miocene (Rowley and others, 1978), but its greatest activity probably did not occur until the late Miocene or even the Pliocene (Rowley and others, 1981). The faults are along two trends, a dominant northeasterly one and a subordinate north-northwesterly one. Together these fault sets produced the zig-zag range fronts that characterize, and the strong rhombic pattern of features found within, the southern High Plateaus. The rhombic pattern is very evident in the Little Creek Peak quadrangle.

Almost all the faults of the later episode in the map area are high-angle, dip-slip ones. The best evidence of this is seen in the way fault traces are undeflected where they pass over topographic irregularities. Displacement on major faults, such as those that bound Upper and Lower Bear Valley, must be at least as great as the thickness of the Tertiary section that overlies the Claron Formation, or a minimum of about 2000 feet (600 m) and a maximum of perhaps 4000 feet (1200 m). Faults within the blocks bounded by these major faults generally have throws less than a hundred feet (<30 m).

No faults cutting Quaternary deposits have been mapped in the Little Creek Peak quadrangle. They are common in all adjacent quadrangles, however, so there is no reason to believe that this quadrangle was generally immune to Quaternary faulting. Instead, it seems probable that, coincidentally, little Quaternary faulting took place beneath the alluvium-filled valleys but instead was limited to areas underlain by bedrock.

Two structural domes are found in the Little Creek Peak quadrangle. One, east of Upper Bear Valley and centered in sec. 19, T. 33 S., R. 6 W., probably is the result of an igneous intrusion. This dome is faulted internally in a complex pattern unrelated to regional trends. The age of the doming probably is Miocene, based on structural relations and on an age determination of about 20 Ma made by Fleck and others (1975) on the Iron Peak laccolith. This intrusion is exposed a few miles west of the map area and was emplaced in the Claron Formation, the same stratigraphic unit thought to be intruded in this quadrangle. The other dome, only the northern part of which is exposed in the extreme southeastern part of the quadrangle (sec. 10, T. 33 S., R. 6 E.), may be the result of igneous intrusion, explosive volcanism, or both, that took place during deposition of the Bear Valley Formation.

Gravity sliding of blocks, ranging in size up to several tens of thousands of square feet in area and several hundred feet in thickness, took place off the flanks of domes in and near the quadrangle. It also accompanied the late Oligocene episode of block faulting along northwesterly lines. In all instances the sliding for the most part involved coherent blocks of well-indurated ash-flow tuff moving along surfaces underlain by unconsolidated tuff and tuffaceous sand of the Bear Valley Formation.

GEOMORPHOLOGY

The geomorphology of the Little Creek Peak quadrangle, dominated as it is by block faulting, is typical of the southern High Plateaus. Of particular interest, however, is the seemingly anomalous course of Bear Creek, which rises in Upper Bear Valley, flows in a narrow gorge through the hills that separate Upper and Lower Bear Valley, and then executes a sharp right-hand turn to leave Bear Valley and flow to the Sevier River east of the quadrangle. This unusual course is interpreted to have resulted from a combination of superposition and piracy as follows: Bear Valley formed as a topographically low, closed basin (graben) bounded by northeast-trending faults. The hills that today separate Upper and Lower Bear Valley were present with this low. However, perhaps they are the remnant of a northwest-trending horst formed during the late Oligocene, the boundary faults of which no longer are exposed. Bear Valley subsequently was filled to a level at least 500 feet (165 m) above the present valley floor with deposits of the Sevier River Formation eroded from adjacent highlands. This fill buried the hills that separate Upper and Lower Bear Valley. Bear Creek came into existence once this fill was thick enough to permit the exit of drainage from the area. Originally, Bear Creek flowed northeastward, tributary to westward-flowing drainage into the Great Basin; this course is suggested by the low saddle that today marks the northern end of Bear Valley. Downcutting by Bear Creek then superposed itself across the hills that separate Upper and Lower Bear Valley. Eventually, however, an eastward-flowing tributary of the Sevier River eroded headward to capture Bear Creek. Continued erosion exhumed Bear Valley and produced the physiography of today.

ECONOMIC GEOLOGY

No ore deposits are known in the Little Creek Peak quadrangle, although a few prospect holes dug in the vicinity of small domal structures indicate some exploration activity. Sand and gravel exist in abundance, however, but have not been excavated to any great extent. Sandstone of the Bear Valley Formation has been quarried for building and decorative stone in places where it displays the striking green color imparted by authigenic chlorite.

Subsurface oil and gas accumulations are possible but speculative. Buried beneath the Cenozoic section, older rock units probably include several that are known elsewhere to be petroleum reservoirs; these probably have been folded and faulted during the late Mesozoic Sevier orogeny to produce potential structural oil and gas traps. Of course Cenozoic faulting will have disrupted these traps, but it need not have destroyed them all, and it may have created others.

WATER RESOURCES

Water is the most precious resource in the quadrangle; it is not abundant, but what there is of it allows limited ranching, especially on the floor of Bear Valley. There, upper Bear Creek provides a perennial source of water sufficient for controlled grazing of cattle; lower Bear Creek, however, becomes ephemeral during the summer. Elsewhere within the quadrangle a number of other small perennial streams flow eastward from the crest of the mountains east of Bear Valley; these also furnish water for cattle, as do some local springs.

In contrast to surface water, ground water probably is very plentiful in this area. It should occur in abundance in the alluvial fill of Bear Valley, and at depth it should be present within the Bear Valley Formation, which has the attributes of an excellent aquifer. Ground water has not been exploited to any great extent, however.

GEOLOGIC HAZARDS

Earthquakes have been felt periodically during historic times throughout the southern High Plateaus, including the Little Creek Peak quadrangle. They pose no great threat to humans within the quadrangle, however, because none dwell there permanently and only a very few do so occasionally.

Floods are much more likely to occur in this area than are earthquakes, but the lack of any permanent residents makes them of little danger to human life. Locally they can and do occur frequently and regularly when summer cloudbursts create "gully washers," but the damage that they cause is limited for the most part to washing out back roads. Much the same can be said for landslides; they are a common phenomenon here but present no great danger to human life or property.

SCENIC AND RECREATIONAL AREAS

The Little Creek Peak quadrangle is not known for its recreational potential except by deer hunters. They, however, find it an excellent place to pursue their activities. The highlands in the area, especially those east of Upper Bear Valley, are quite scenic; and in places, such as the summit of the mountain that gives the quadrangle its name, offer spectacular views. Hikers therefore would be well rewarded if they followed the area's back-county trails.

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