OPEN-FILE REPORT
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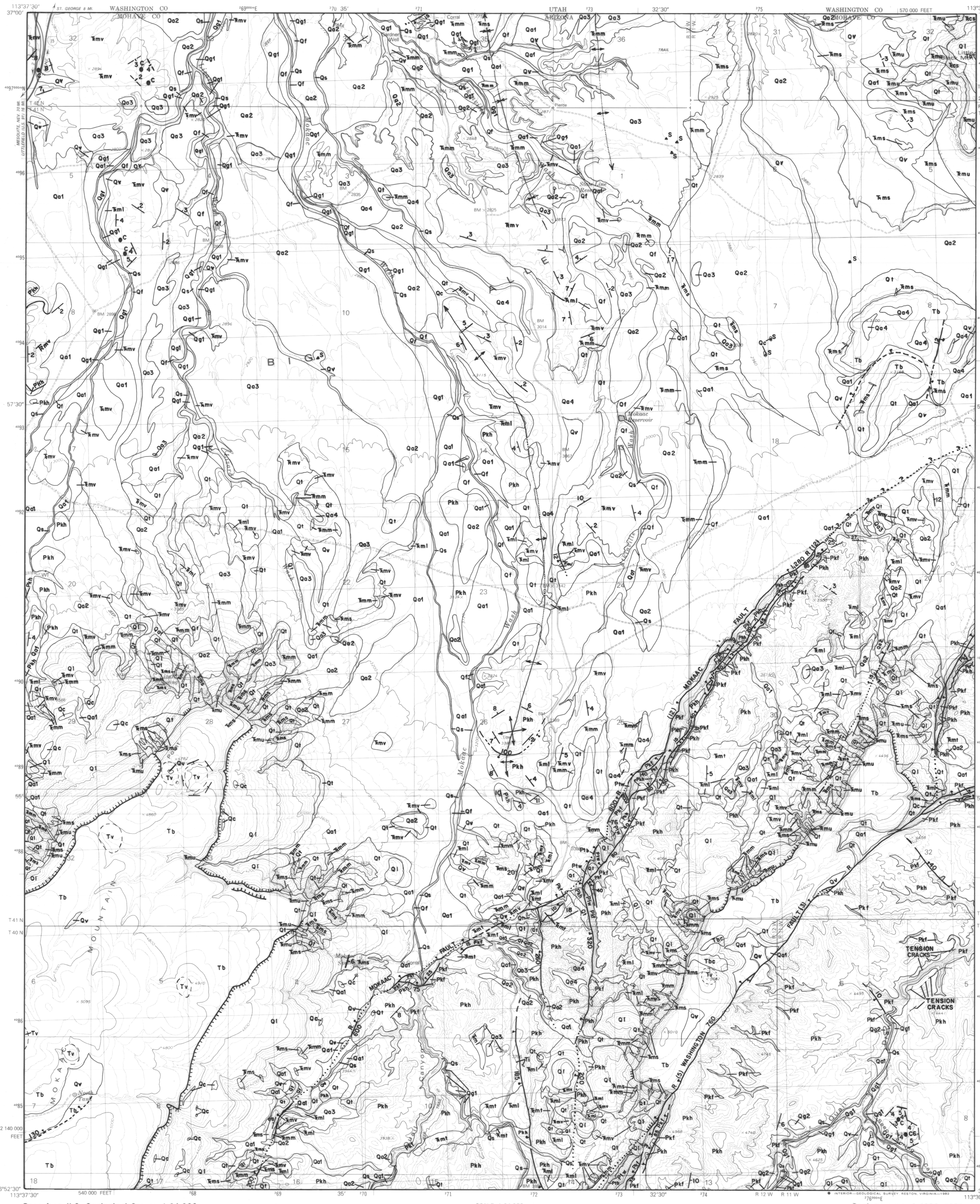


Base from U.S. Geological Survey 1:24,000
Lizard Point, Arizona 1979

Geology mapped 1989–1990

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

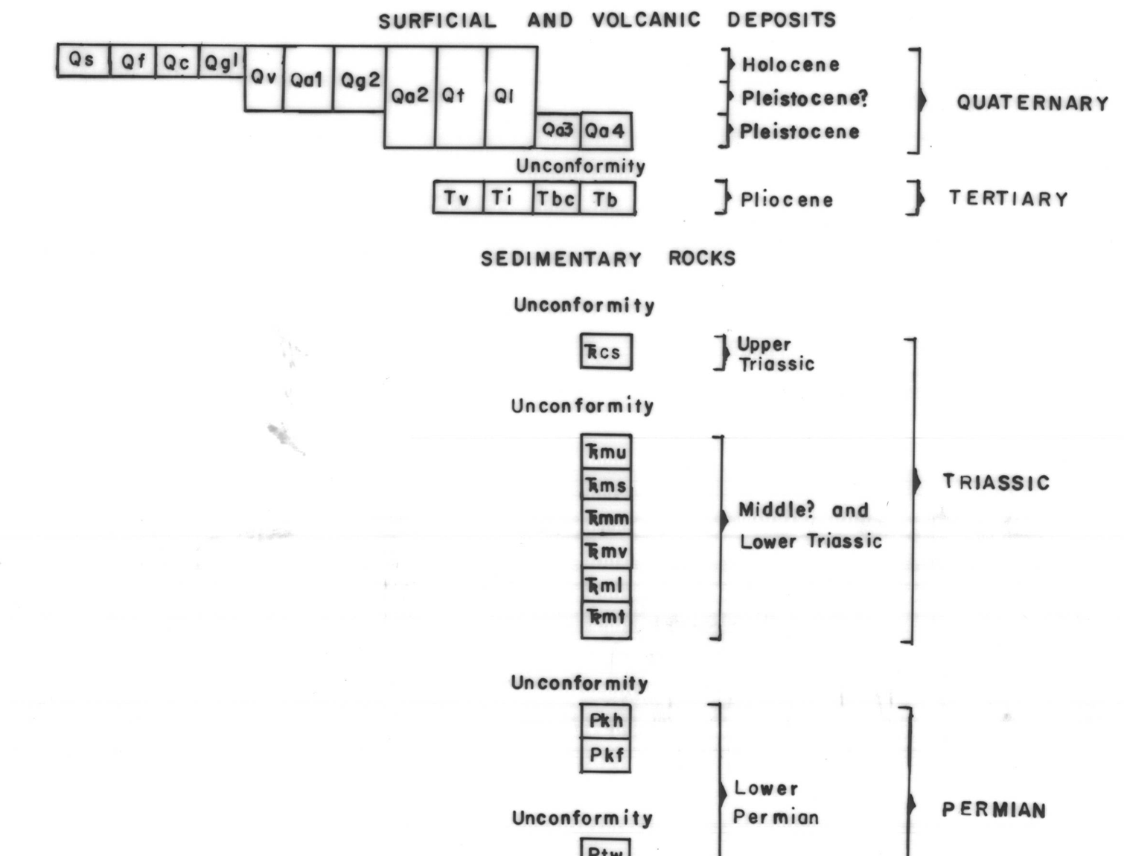
UTM GRID AND 1979 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

QUADRANGLE LOCATION

GEOLOGIC MAP OF THE LIZARD POINT QUADRANGLE, NORTHERN MOHAVE COUNTY, ARIZONA

By
George H. Billingsley

1990



INTRODUCTION

Lizard Point 7.5-minute quadrangle is in northern Mohave County, Arizona, and is bordered on the north by the Utah-Arizona State line (fig. 1). The map encompasses approximately 63 sq mi of northwestern Arizona. Elevations range from 2,680 ft at Atkinville Wash to 5,120 ft on Mokaac Mountain, southwest corner of the quadrangle. The nearest settlement is St. George, Utah, about 6 miles north of the map area. The main access to the area is by dirt road, locally referred to as the Mt. Trumbull road, that leads from St. George.

The area is mostly managed by the U.S. Bureau of Land Management; a few sections are controlled by the State of Arizona. Below 5,000 ft, the area is sparsely vegetated with sagebrush, greasewood shrubs, cactus, and desert grasses; at higher elevations are sparse pinion pine and juniper trees.

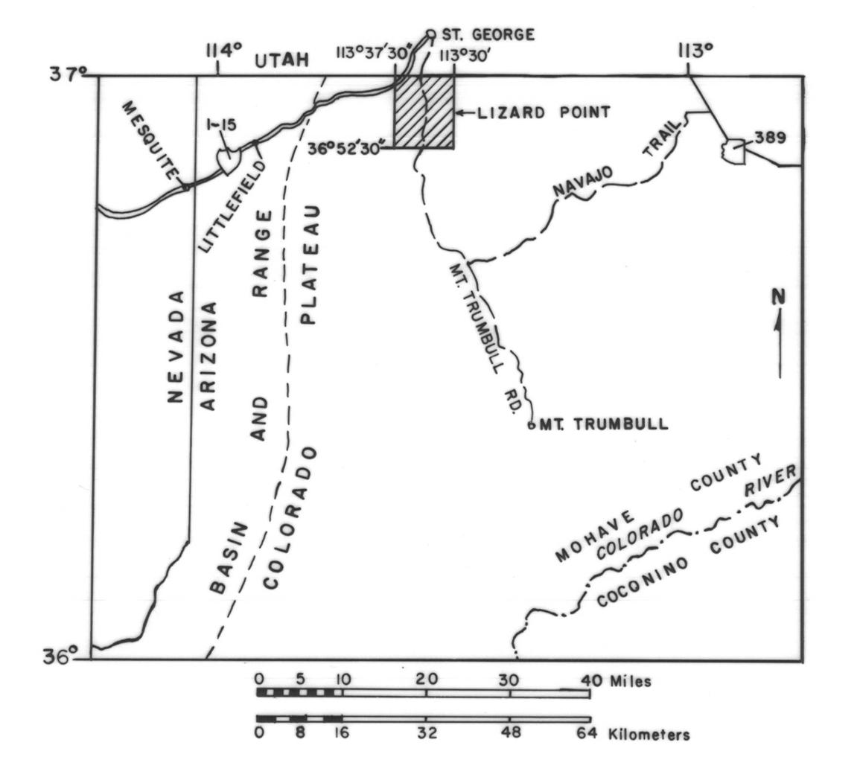


Figure 1. Location map of Lizard Point 7.5-minute quadrangle, northern Mohave County, Arizona.

PREVIOUS WORK

Petersen's 1983 preliminary geologic map of the Washington Fault zone at a scale of 1:24,000 covers part of this quadrangle. The area was included in state geologic maps at a scale of 1:500,000 (Wilson and others, 1969) and at a scale of 1:1,000,000 (Reynolds, 1988). Geologic maps in preparation of bordering areas include, on the north, the St. George 15-minute quadrangle, Utah; on the west, the Purgatory Canyon 7.5-minute quadrangle, Arizona; and on the south, the Wolf Hole Mountain East 7.5-minute quadrangle, Arizona.

GEOLOGIC SETTING

The quadrangle lies in the southwestern Colorado Plateau Geologic Province characterized by Mesozoic and Paleozoic strata that dip about 3° to the east or northeast. The area is partly dissected by tributary drainages to the Virgin River, just north of the quadrangle.

STRATIGRAPHY

About 1,600 ft of Permian and Triassic rock strata are exposed in the quadrangle. Lower Triassic rocks once covered the entire area but have been eroded away except where protected by Late Tertiary basalt flows. The formations exposed are, in ascending order, the Toroweap Formation and Kaibab Formation (both Lower Permian), and the Moenkopi Formation (Middle? and Lower Triassic). The oldest formation, the Brady Canyon Member of the Toroweap Formation, crops out along the Washington fault, south-central part of the map. Much of the bedrock at the surface of the southern part of the quadrangle is gray cherty limestone, gray and white siltstone and gypsum of the Kaibab Formation. The less resistant strata of the Moenkopi Formation crops out in much of the northern half of the map and in patches below Tertiary basalt capped areas southwest corner of the map. The youngest strata, the Chinle Formation, crops out in the northeast corner of the quadrangle. Stream-deposited and mass-moved surficial deposits cover much of the bedrock area. Details of the stratigraphy are given in the description of map units.

GEOMORPHOLOGY

Erosion of Mesozoic and Paleozoic strata that dip regionally about 3° easterly to northeasterly has resulted in the development of questa and strike valleys perpendicular to regional dip. During much of the Tertiary, the questas and associated valleys migrated down-dip to the east or northeast. Late Pliocene basalt flows occupy some of the north- to northeast consequent strike-valleys such as under Mokaac Mountain. The gradient of the flows on Mokaac Mountain is about 200 ft per mile to the north.

The gypsum in individual beds and in gypsiferous siltstone and mudstone in the Moenkopi Formation is easily removed in solution. As a consequence, Moenkopi strata cropping out on steep slopes beneath the basalt-capped areas are unstable. Shallow blocks of Moenkopi strata give way and in sliding down, sap the basalt caprock, which becomes part of the landslide. Breaks too small to show on the map, have developed in the basalt cap near rims above landslides, especially on the east side of Mokaac Mountain where the dip facilitates slippage along bedding planes. The landslide masses probably began their movement in the Pleistocene and have continued to slide intermittently.

STRUCTURAL GEOLOGY

Faults

Two high-angle reverse faults, the Washington fault (Petersen, 1983) and the Mokaac fault, named in this report, cut Mesozoic, Paleozoic, and Cenozoic rocks in the southeastern quarter of the quadrangle. Stratigraphic displacement of both the Washington and Mokaac faults amount to as much as 1,300 ft of throw down to the northwest. Both faults displace late Pliocene basalts about the same as the underlying Mesozoic and Paleozoic strata. Thus, most of the displacement along these faults occured in late Pliocene to Holocene time. Holocene movement along both faults has cut fault scarps in steep talus and alluvial deposits up to 12 ft and is shown as a solid line on the map with an estimated displacement in parenthesis.

Displacement along the Washington fault decreases to the northeast whereas displacement along the Mokaac fault increases to the northeast, but the overall sum is maintained. The Mokaac fault dips about 76° to the southeast, visible in a drainage just east of the Mt. Trumbull road, T41N, R12 W, center of Sec. 36 (A on fig. 2). The Washington fault is estimated to dip to the southeast about 80-86° from an exposure in a drainage along the south part of the fault (B on fig. 2).

Small normal faults and grabens present on the upthrown crests of the Washington and Mokaac faults reflect local tensional stress associated with the bending of strata. Displacement along these faults and grabens are generally less than 100 ft, and commonly less than a quarter-mile long.

Several large tension cracks parallel the drainage of Quail Draw, southeast corner of map (C on fig. 2). The cracks are in the Fossil Mountain Member of the Kaibab Formation with open fissures 2-10 ft in width and over 100 ft in depth. The cracks have a northeast strike that parallel Quail Draw.

Folds

A gentle plunging anticline and complimentary plunging syncline are located in the northcentral part of the quadrangle. A gently dipping, doubly plunging anticline divides local drainages in the central part of the quadrangle. The anticlines and syncline trend in a northly direction and are not conspicuous folds. These folds probably date from the time of Laramide regional tilting. Other folds, too small to show at map scale, are the result of solution of gypsum and are commonly associated with collapse structures.

Collapse Structures

Circular collapse structures, minor folds, and other surface irregularities in the Kaibab and lower Moenkopi Formations are mostly due to solution of gypsum and gypsifereous siltstone. Some bowl-shaped areas in the Kaibab and Moenkopi formations that have inward dipping strata may be collapse-formed breccia pipes, originating in the deeply buried Mississippian Redwall Limestone (Wenrich and Huntoon, 1989). On this map such features, commonly with inward-pointing dip symbols, are marked by a dot and the letter "C" to denote possible deep-seated breccia pipes. They cannot with certainty be distinguished by surface forms from shallow collapse structures caused by removal of gypsum. Moreover, some deep-seated breccia pipes are known to be overlain by collapse features related to solution of gypsum (Wenrich and others, 1986). The deep-seated breccia pipes are potential hosts for economic deposits of copper and uranium; the shallow structures are unlikely to be mineralized (Wenrich, 1985). Currently, drilling seems to be the best way to determine shallow collapse structures from deep-seated breccia pipes.

Several shallow sinkholes and karst caves have developed with the solution of gypsum in the Kaibab and Moenkopi Formations. They are denoted on the map with a triangle symbol and the letter "S" if the sinkhole forms an enclosed depression or pit on the land surface. The sinkholes are young features, Holocene and perhaps as old as Pleistocene, and are commonly filled with colluvial deposits.

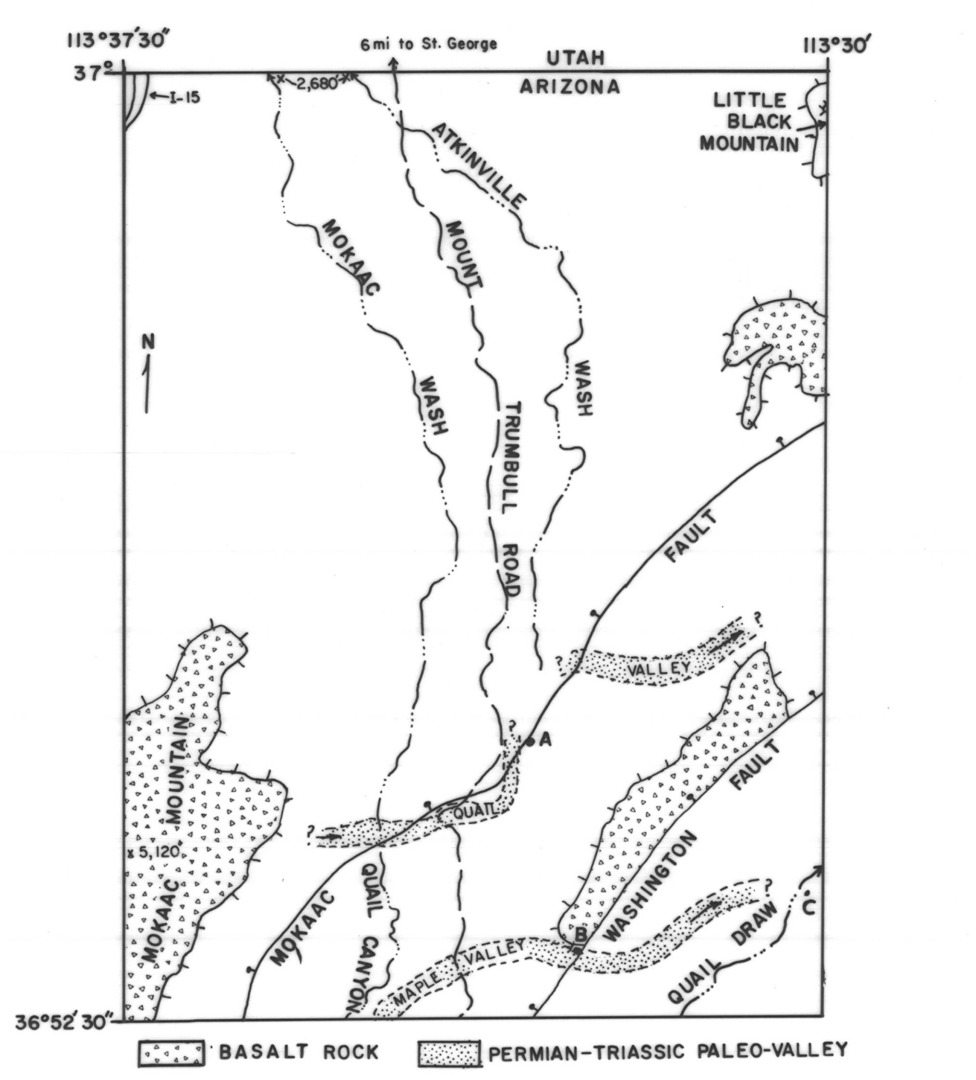


Figure 2. Map showing some physiographic, structural, and cultural features of the Lizard Point 7.5-minute quadrangle.

DESCRIPTION OF MAP UNITS

Surficial Deposits

Qs **Stream-channel alluvium (Holocene)**--Unconsolidated to poorly consolidated, interlensing silt, sand, and pebble to boulder gravel. Intertongues with floodplain, alluvial-fan, and valley-fill deposits. Subject to high-energy flows and flash floods. Little or no vegetation. Contacts approximate. Estimated thickness 10-30 ft

Qf **Floodplain deposits (Holocene)**--Interbedded, unconsolidated silt, sand, and pebble to boulder gravel; intertongues with stream-channel, valley-fill, alluvial-fan, and talus deposits. Thickly vegetated by grass, cactus, rabbit brush, and sagebrush. Thickness about 3-20 ft

Qc **Colluvial deposits (Holocene)**--Chiefly silt and fine-grained sand, and lesser amounts of angular pebble to cobble gravel; locally consolidated. Accumulates in enclosed basins created by landslide debris or sinkhole depressions. Subject to temporary ponding. Sparse or no vegetation. Estimated thickness 10-30 ft

Qg1 **Young terrace deposits (Holocene)**--Unconsolidated pebble to boulder gravel composed about equally of well-rounded limestone, sandstone, and basalt clasts and interstratified lenses of silt and sand. Commonly merges with stream-channel, floodplain, alluvial-fan, and talus deposits. Forms a bench about 3-15 ft above modern stream beds. Thickness averages about 10-20 ft

Qv **Valley-fill deposits (Holocene and Pleistocene?)**--Partly consolidated silt and sand, and lenses of pebble to small boulder gravel; a Combination of playa, and sheetwash alluvium; commonly adjacent to alluvial fans and talus. Subject to sheetwash and ponding; cut by arroyos in larger valleys. Thickly vegetated by sagebrush and grass. Thickness probably as much as 30 ft

Qa1 **Low alluvial-fan deposits (Holocene and Pleistocene?)**--Unconsolidated silt and sand; contains gravel composed of subangular to rounded pebbles to boulders of basalt and chert; partly cemented by gypsum and calcite. Merges with stream-channel, floodplain, talus, and older alluvial-fan deposits near their downslope ends. Difficult to distinguish from terrace deposits northern part of map. Subject to erosion by flash floods and sheetwash. Sparsely vegetated by creosote shrubs, cactus, and sagebrush. Thickness probably as much as 25 ft

Qg2 **Low terrace-gravel deposits (Holocene and Pleistocene?)**--Similar to young terrace deposits (Qg1); partly consolidated. On benches and abandoned stream channels about 10-30 ft above modern stream beds. Merges with and locally overlain by talus, alluvial-fan, and alluvium shed from older surficial deposits. Thickness about 5-20 ft

Qa2 **Low-intermediate alluvial-fan deposits (Holocene and Pleistocene?)**--Similar to low alluvial-fan deposits (Qa1) but contains more basalt clasts; partly cemented by calcite and a gypsifereous caliche, which resembles a sandy plaster, and generally lies at higher elevation than Qa1. Basalt clasts more common than in younger (Qa1) alluvial-fan deposits. Lightly vegetated by creosote brush, cactus, sagebrush, and desert grass. Thickness about 10-60 ft

Qt **Talus deposits (Holocene and Pleistocene)**--Unsorted debris consisting of small to very large angular blocks, sand and silt; in part cemented by calcite and gypsum. Merges with landslide and alluvial-fan material. Sparse to moderate vegetation cover of pinion pine and juniper trees at high elevations, sagebrush and cactus at lower elevations. Only relatively extensive deposits are shown. Thickness probably as much as 25 ft

Ql **Landslide deposits (Holocene and Pleistocene)**--Unconsolidated masses of unsorted rock debris, including blocks of strata that have rotated backward and slid downslope. Occurs principally around highlands and below basalt flow areas in southern half of the quadrangle where basalt and underlying non-resistant rock has broken from rim and slid down as a loose incoherent jumbled mass of broken rock and deformed strata. Moderately vegetated by sagebrush, cactus, pinion pine and juniper trees. Unstable when wet. Thickness probably as much as 100 ft

Qa3 **High-intermediate alluvial-fan deposits (Pleistocene)**--Similar to younger alluvial-fan deposits (Qa1 and Qa2), but basalt clasts are more common and the clasts are coated with desert varnish. Limestone and sandstone clasts are subrounded to well rounded. Partly cemented with calcite and gypsum. Forms a conspicuous bench or tableland about 20-60 ft above younger alluvial-fan deposits. Isolated remnants form a protective caprock over non-resistant beds of the Kaibab and Moenkopi Formations. Merges with talus or landslide deposits, and younger alluvial-fan and terrace deposits north part of map. Sparsely vegetated by creosote shrub, cactus, sagebrush, and desert grass. Thickness about 10-60 ft

Qa4 **High alluvial-fan deposits (Pleistocene)**--Unconsolidated, unsorted, silt, sand, and pebble to boulder gravel composed dominantly of angular to subrounded cobbles and boulders of basalt. Basalt clast form a debris apron protecting outlying remnants of these highest and oldest alluvial fans. About 10-30 ft higher then high-intermediate alluvial-fan deposits (Qa3) but can merge with younger alluvial fans near their downslope ends. Thickness about 5-20 ft

Tv **Volcanic center or vent area (Pliocene)**--A probable vent area with scattered deposits of light-red basaltic cinder and scoria. A probable source area for one or more basalt flows of Mokaac Mountain in the southwestern part of the quadrangle

Ti **Intrusive dike or sill (Pliocene)**--Dark-gray olivine basalt; weathers as crumbly slope. Found at one locality near Mt. Trumbull road, T40N, R12W, NW corner of section 11, east side of road

Tbc **Basalt scoria and cinder deposits (Pliocene)**--Red-brown clasts of fragmentary, angular, olivine basalt fragments; contains dark-gray basalt and cinder fragments; unconsolidated. Associated with volcanic vent areas. Little to moderate vegetation, mostly grass. Forms slope. Thickness about 50-80 ft

Tb **Basalt flows (Pliocene)**--Dark gray, olivine basalt; finely crystalline olivine in an aphanitic groundmass. Probably about same age as basalts at Seegmiller Mountain about 12 miles southeast of this quadrangle, dated at 2.35 ± 0.31 and 2.44 ± 0.51 m.y. old (Reynolds and others, 1986). Locally covered by caliche-cemented silt, sand, and angular fragments of basalt up to about 10 ft thick at some locations. Forms unconformabable caprock over less resistant beds of the Moenkopi Formation in southern part of the quadrangle, basalt flows fill pre-late Pliocene strike valleys. Unit consists of several flows of different thickness; attains a maximum thickness of about 360 ft on Mokaac Mountain

Sedimentary Rocks

Chinle Formation (Upper Triassic)

₮cs **Shinarump Member**--Resistant orange-brown to brown, thick-bedded, coarse-grained, pebbly or gritty sandstone and conglomeratic sandstone. Includes flat-bedded and medium trough cross-bedding sets with interbedded, medium-grained sandstone and conglomerate lenses, northeast corner of quadrangle. Forms cliff. Thickness about 160 ft

Moenkopi Formation (Middle? and Lower Triassic)--Includes, in descending order, the upper red, Shnabkaib, middle red, Virgin Limestone, lower red, and Timpoweap Members as defined by Stewart and others (1972)

₮mu **upper red member**--Heterogeneous sequence of conglomerate, sandstone, siltstone, mudstone, and minor gypsum; forms ledges and slope. Unconformable upper contact filled with the Shinarump Member of the Chinle Formation. Thickness is about 250 ft under basalt flows of Mokaac Mountain and Little Black Mountain

₮ms **Shnabkaib Member**--Interbedded white laminated aphanitic dolomite and gypsum; red siltstone, mudstone, and sandstone are minor components. Exposed locally below Tertiary basalt flows and in landslide blocks. Top has been eroded away locally. Forms step slope with some ledges. Upper contact placed at top of the highest beds of light gray dolomitic limestone or siltstone. Thickness ranges from about 375 to 500 ft

₮mm **middle red member**--Interbedded red-brown, laminated siltstone and sandstone, white and gray gypsum, minor white platy dolomite, green siltstone, and gray-green gypsiferous mudstone; abundant vein gypsum in siltstone. Upper contact placed at base of lowest bed of light gray dolomitic limestone. Poorly exposed, forms slope. Thickness ranges froom about 165 to 300 ft.

₮mv **Virgin Limestone Member**--Consists of three to four, light gray, ledge-forming, fossiliferous limestone beds (0-20 ft thick), separated by white to pale-yellow, slope-forming, thin-bedded gypsum and gypsiferous siltstone; includes brown, red, and green siltstone, gray limestone, green mudstone, and brown platy calcarenite. Basal limestone bed contains abundant small star-shaped echinoderm columnals (Hintze, 1986). Upper contact placed at top of the highest bed of gray limestone. Thickness ranges from about 130 to 200 ft; average thickness is about 140 ft

₮ml **lower red member**--Interbedded red, thin-bedded, sandy siltstone, gray, white, and pale-yellow laminated gypsum, and minor sandstone. Sediments are in part reworked from the Harrisburg Member of the Kaibab Formation. Upper contact placed at the base of lowest bed of limestone. Forms slope. Thickness ranges from 0 to 250 ft; thickens in paleo-valleys (fig. 2) and pinches out locally against paleo-hills of Kaibab Formation

₮mt **Timpoweap Member**--Includes basal gray, red-brown, or pale-yellow conglomerate consisting of subangular to rounded pebbles and cobbles of limestone and chert derived from the Kaibab Formation; pebble supported in some beds with pebbles conforming in shape to one another; where matrix supported, matrix is limestone and coarse-grained sandstone. Above are interbedded yellow and red calcareous, thin-bedded sandstone and siltstone. Fills bottom of U-shaped paleo-valley cut deep into the Kaibab Formation in the south-central part of the quadrangle (fig. 2). Imbrication of pebbles in the conglomerate indicate an east to northeast flow of the depositing stream. Upper contact is gradational and placed at the first thick bed of red gypsiferous siltstone. Forms cliff with upper slope. The paleo-valley is here named Quail valley for exposures in Quail Canyon about one mile from the south edge of the quadrangle. Quail valley strikes east to northeast from the mouth of Quail Canyon for about 3.5 miles before it becomes buried by Moenkopi strata. The valley averages about 1,200 ft wide with sloping valley walls and an average valley depth of about 350-400 ft. Above the Timpoweap, Quail valley is partly filled by sediments of the lower red. Thickness about 140-200 ft

Kaibab Formation (Lower Permian)--Includes, in descending order, the Harrisburg and Fossil Mountain Members as defined by Sorauf and Billingsley (in press)

Pkh **Harrisburg Member**--Consists of light-gray, fossiliferous, sandy, fine- to medium-grained limestone interbedded with red and gray gypsiferous siltstone and sandstone, and light gray gypsum in beds several feet thick. Beds, about 20 ft thick, of cherty limestone and of sandy limestone form resistant cliff near the middle of the member. Brachiopod-bearing limestone below tan crossbedded arenaceous cherty-dolomite at top. Solution of interbedded gypsum has locally distorted the member. Forms slope with limestone ledges. Upper contact is unconformable and locally obscure where overlain by conglomerate of the Timpoweap Member of the Moenkopi. Thickness ranges up to about 350 ft thick; locally cut out in paleo-valley filled with the Timpoweap and lower red members of the Moenkopi Formation

Pkf **Fossil Mountain Member**--Yellowish-gray to gray, fossiliferous, sandy, cherty, fine- to medium-grained, thin-bedded, limestone. Chert weathers black in cliff outcrops. Intergrades with overlying Harrisburg Member; arbitrary contact placed where limestone cliff and siltstone slope forms topographic break. Forms cliff. Thickness about 250-300 ft; locally cut into by paleo-valley filled with the Timpoweap Member of the Moenkopi Formation

Toroweap Formation (Lower Permian)--Includes, in descending order, the Woods Ranch, Brady Canyon, and Seligman Members as defined by Sorauf and Billingsley (in press). The Seligman Member is not exposed on this quadrangle

Ptw **Woods Ranch Member**--Gray siltstone and pale-red shale with thick interbeds of massive, white to gray gypsum. Commonly covered by talus and landslide debris. Much subsidence and distortion of beds as a result of solution of gypsum. Forms slope. Upper contact is an unconformity marked by solution and channel erosion; has local relief of as much as 15 ft; contact generalized because of extensive cover by talus and landslide. Thickness about 100-350 ft.

Ptb **Brady Canyon Member**--Gray, weathers dark gray; fossiliferous, medium-bedded, medium- to coarse-grained limestone. Thin beds of dolomite are found at upper contacts. Intergrades with overlying member; upper contact placed at top of cliff. Mostly covered, lower part of unit not exposed. Forms a cliff. Average thickness about 250 ft

Contact between rock units--Dashed where approximate

(12) 120 R **Fault**--Dashed where approximately located, short-dashed where inferred; dotted where concealed; bar and ball on downthrown side. R means reverse fault; number along strike indicates estimated displacement of Pre-Cenozoic rocks in feet; number in parenthesis indicates estimated displacement of alluvium in feet

Landslide detachment--Headward scarp of landslide

Syncline--Showing trace of axial plane and direction of plunge; dashed where approximately located; dotted where concealed

Anticline--Showing trace of axial plane and direction of plunge; dashed where approximately located; dotted where concealed

Dome--Symbol located near center

Strike and dip of strata

8 **Inclined**--Strike and dip measured in the field

12 **Approximate**--Strike and dip determined photogeographically

Implied--Strike and dip determined photogeologically, no measurements

Strike and dip of joints--Vertical

C **Collapse structure**--Circular collapse with strata dipping inward towards a central point. May reflect deep-seated breccia pipe collapses originating in the Redwall Limestone

S **Sinkholes**--Enclosed sinkhole depression filled with local talus and colluvial deposits

Tension cracks--No vertical displacement

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