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Geologic map of the Lost Spring Mountain West quadrangle, northern Mohave County, Arizona

by
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INTRODUCTION

The Lost Spring Mountain West 7.5′ quadrangle (96 sq km) is located in northern Mohave County, Arizona about 13 km west of Colorado City, Arizona. The quadrangle borders the Utah/Arizona state line (fig. 1). Altitudes range from about 1,295 m at Short Creek (northwest corner of quadrangle) to 1,737 m on Lost Spring Mountain (east-central part of quadrangle). Access to the quadrangle is by improved dirt roads, locally referred to as the Honeymoon Trail from Hurricane, Utah, and the Navajo Trail from Colorado City, Arizona (fig. 1). Several unimproved dirt roads lead from the Honeymoon and Navajo Trails to various locations within the quadrangle area.

The area is managed entirely by the U.S. Bureau of Land Management including about four and a half sections that belong to the state of Arizona and about two sections of private land just west of Lost Spring Mountain. At the lower elevations, the area supports sparse growths of sagebrush, cactus, and various desert shrubs. At higher elevations, thin to moderate growths of sagebrush thrive in alluvial valleys and pinyon pine and juniper trees are common on Lost Spring Mountain.

PREVIOUS WORK

The first photogeologic map of this quadrangle was made by C.H. Marshall (1956) for the U.S. Atomic Energy Commission; it was compiled onto Arizona state geologic maps (Wilson and others, 1969; Reynolds, 1988). A geologic map is available for the Rock Canyon, AZ 7.5′ quadrangle (Billingsley, 1992c), which borders this area on the west.

MAPPING METHODS

A preliminary geologic map was made from aerial photographs, scale 1:24,000. In particular, many of the Quaternary alluvial units having similar lithologies were mapped using photogeologic methods based on regional geomorphic characteristics. Detailed field investigations were then conducted to insure accuracy and consistency of all map units for descriptive purposes.

GEOLOGIC SETTING

The map area lies within the Uinkaret Plateau, a subplateau of the southwestern part of the Colorado Plateaus physiographic province. The Uinkaret Plateau in this quadrangle is characterized by relatively flat lying bedrock strata having an average regional dip of about 2° east. About 400 m of Triassic strata are exposed in the quadrangle. They are folded and faulted in a north-trending belt in the center part of the quadrangle. Permian strata are exposed in the southwest quarter of the quadrangle.

Cenozoic deposits are widely distributed in the map area consisting of surficial alluvial, sand dune, and landslide deposits. The distribution of Quaternary alluvial deposits are an important factor in future environmental, land, and range management planning projects in this area by federal, state, and private organizations. The surficial units are useful in the study of local geomorphology and have intertonguing and gradational contacts.

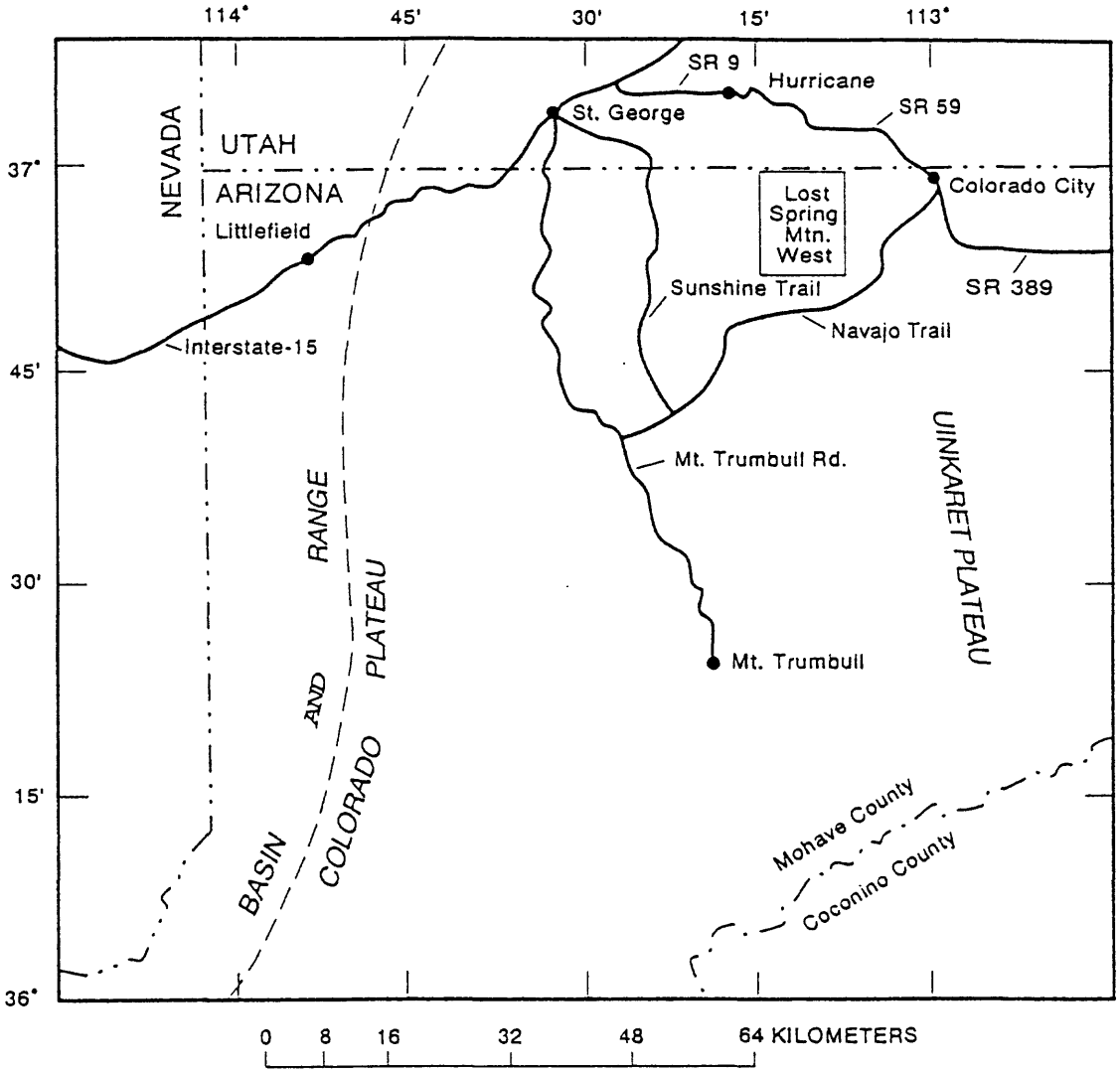

Figure 1. Index map of northern Mohave County, northwestern Arizona, showing the Lost Spring Mountain West, AZ 7.5′ quadrangle. SR = State route.

STRATIGRAPHY

The sedimentary bedrock strata of this quadrangle include, in ascending order, the Kaibab Formation (Lower Permian), and the Moenkopi and Chinle Formations (Upper, Middle? and Lower Triassic). Gray cherty limestone and gray to white siltstone and gypsum of the Kaibab Formation crop out along Clayhole Wash, west edge of the quadrangle. About three-fourths of the surface bedrock of the quadrangle area is red siltstone and sandstone and gray gypsum and dolomite of the Moenkopi Formation. Tan, brown, and black conglomeratic sandstone of the Shinarump Member of the Chinle Formation, crop out in the northeast part of the quadrangle forming a resistant caprock on Lost Spring Mountain. Thus, the Shinarump being resistant to erosion, is the reason for the existence of Lost Spring Mountain.

The predominantly Quaternary age assigned to the alluvial deposits in this map area is based mainly on field relationships of these deposits to the Pleistocene and Pliocene basalt flows west of this quadrangle (Billingsley, 1992a,b,c, and 1993). Details of the stratigraphic sequence of alluvial deposits are given in the description of map units.

STRUCTURAL GEOLOGY

The minor faults and gentle folds west and southwest of Lost Spring Mountain are the only structural features of this quadrangle. The minor faults associated with the folds have a general north-south to slightly northwest strike. Displacements along the faults are less than 15 m and down to the east. The faults are assumed to be late Pliocene and Pleistocene age, similar to those mapped west of this quadrangle (Billingsley, 1992a,b,c, and 1993). The bedrock strata have a regional east to slightly northeast dip averaging about 2 to 3°. The Hurricane Fault, a major structure in this region, lies about 8 km west of the quadrangle.

The small folds present in the quadrangle are probably related to early Laramide compressional stresses (Huntoon, 1989). Warped and bent strata along the west edge of the quadrangle are too small to show at map scale and are the result of solution of gypsum in the Harrisburg Member of the Kaibab Formation. These bent strata are commonly associated with solution of gypsum along drainages.

Circular collapse structures and surface sinkhole irregularities are mostly due to solution of gypsum and gypsiferous siltstone. However, some circular, bowl-shaped areas that have inward-dipping strata may be collapse-formed breccia pipes that originated in the deeply buried Mississippian Redwall Limestone (Wenrich and Huntoon, 1989; Wenrich and Sutphin, 1989). Such features on this map (northwest quarter), usually have inward dipping strata and are marked by a dot and the letter C to denote possible deep-seated breccia pipes. However, they cannot be distinguished with certainty from shallow collapse structures caused by removal of gypsum. Moreover, some deep-seated breccia pipes are known to be overlain by gypsum collapse features (Wenrich and others, 1986). The deep-seated breccia pipes potentially contain economic deposits of copper and uranium minerals (Wenrich, 1985).

Shallow sinkholes and karst caves are associated with the solution of gypsum in the Harrisburg Member of the Kaibab Formation. The sinkholes are relatively young features of Holocene and probable Pleistocene age. Sinkholes that form an enclosed basin or depression are shown on the map by a triangle symbol.

DESCRIPTION OF MAP UNITS

Surficial deposits

Qaf **Artificial fill and quarries (Holocene)**--Alluvial and bedrock material removed from pits and trenches to build stock tanks and drainage diversion dams

Qs **Stream-channel alluvium (Holocene)**--Unconsolidated and poorly sorted, interlensing silt, sand, and pebble gravel. Intertongues with or inset against alluvial fan (Qa_1 and Qa_2), terrace-gravel (Qg_1 and Qg_2), and upper part of valley-fill (Qv) deposits. Stream channels subject to high-energy flows and flash floods and support little or no vegetation. Contacts approximate. Estimated thickness 1 to 2 m

Qd **Dune sand (Holocene)**--White and light red, fine-grained, well sorted quartz sand. Sand material mostly derived from Short Creek drainage. Forms small climbing dunes or sandsheets deposited by dominant southwesterly winds. Supports grassy vegetation. Thickness about 1 to 3 m

Qg_1 **Young terrace-gravel deposits (Holocene)**--Unconsolidated, gray siltstone, light-brown or red, pebble to boulder gravel composed about equally of well-rounded limestone and sandstone and chert. Includes lenses of pale-red silt and sand. Locally contains well-rounded quartzite and petrified wood clasts derived from Shinarump Member of the Chinle Formation. Includes reworked material from alluvial fans (Qa_1 and Qa_2), terrace-gravels (Qg_2 and Qg_3), and pediment (Qpd) deposits. Forms bench about 1 to 3 m above local stream beds. Averages about 1 to 3 m thick

Qa_1 **Young alluvial fan deposits (Holocene)**--Unconsolidated pale-red silt and sand. Includes lenses of coarse gravel composed of subangular to well-rounded pebbles and cobbles of limestone, chert, and sandstone. Includes well-rounded quartzite and petrified wood clasts, northeast part of quadrangle; partly cemented by gypsum and calcite. Overlaps or intertongues with stream-channel alluvium (Qs), valley-fill (Qv), and terrace-gravels (Qg_1 and Qg_2), and older alluvial fan (Qa_2), and pediment (Qpd) deposits near their downslope ends. Alluvial fans subject to erosion by sheet wash and flash floods. Supports sparse growths of sagebrush, cactus, and grass. As much as 6 m thick

Qv **Valley-fill deposits (Holocene and Pleistocene)**--Partly consolidated silt, sand, and interbedded lenses of quartzite pebble gravel. Quartzite pebbles derived from Shinarump Member of the Chinle Formation. Intertongues with young terrace-gravel (Qg_1) deposits. Subject to sheetwash flooding and temporary ponding. Supports moderate growth of grass and cactus. Thickness as much as 6 m

Qt **Talus deposits (Holocene and Pleistocene)**--Unsorted debris consisting of breccia composed of small and large angular blocks of local bedrock as much as 1 m in diameter. Includes silt, sand, and gravel; partly cemented by calcite and gypsum. Intertongues with alluvial fan (Qa_2) deposits. Supports sparse growths of sagebrush, cactus, grass, and some juniper trees. Only relatively extensive deposits shown. As much as 9 m thick

Ql **Landslide deposits (Holocene and Pleistocene)**--Unconsolidated masses of unsorted rock debris. Includes detached blocks of strata that have rotated backward and slid downslope as loose, incoherent masses of broken rock and deformed strata, often partly surrounded by talus. Occurs principally below edges of Shinarump Member of Chinle Formation on Lost Spring Mountain. Includes strata of the Chinle and Moenkopi Formations that have slid down over shale and gypsum beds of the Moenkopi. Supports growths of sagebrush, cactus, grass, pinyon and juniper trees. Unstable when wet. Thickness probably as much as 10 m

Qg_2 **Older terrace-gravel deposits (Holocene and Pleistocene)**--Similar to young terrace-gravel deposits (Qg_1), but partly consolidated. Forms benches as abandoned stream channels about 3 to 6 m above local stream beds. Locally inset to higher terrace (Qg_3) deposits. Approximately 2 to 6 m thick

Qa_2 **Older alluvial fan deposits (Holocene and Pleistocene)**--Similar to young alluvial fan (Qa_1) deposits; light brown and light gray, partly cemented by calcite and gypsum. Often overlapped by young alluvial fan (Qa_1) and intertongues with or inset against talus (Qt) deposits. Fans support moderate growth of sagebrush, cactus, and some grass. Ranges from 3 to 10 m thick

Qg_3 **Higher terrace-gravel deposits (Pleistocene)**--Similar to young and intermediate terrace-gravel (Qg_1 and Qg_2) deposits, but 1 to 2 m higher than Qg_2 and about 4 to 9 m above local drainages. Composed of well-rounded limestone, sandstone, and chert clasts in sandy gravel matrix. Locally includes abundant, well-rounded clasts of quartzite and petrified wood clasts near Clayhole Wash. Partly consolidated by calcite and gypsum cement. As much as 3 m thick

Qpd **Pediment deposits (Holocene and Pleistocene)**--Partly consolidated pale-red and tan gravel, sand, silt and minor clay, partly cemented with gypsum and clay. Contains numerous black, brown, yellow, red, and gray, very well-rounded quartzite pebbles 1 to 5 cm in diameter and rare, rounded, gray-white petrified wood fragments, all derived from Shinarump Member of Chinle Formation. Pebbles form lag gravel on pediment surface in southeast corner of quadrangle. Approximately 3 to 8 m thick

Sedimentary Rocks

Chinle Formation (Upper? Triassic)--Includes the Shinarump Member as used by Stewart and others (1972)

Trcs **Shinarump Member**--Orange-brown, black, tan, pebble to coarse-grained, cross-bedded to flat-bedded sandstone, conglomeratic sandstone and conglomerate. Weathers brown or black. Includes stream-channel gravels largely composed of well-rounded quartzite and metamorphic clasts in sandstone matrix. About 30% of clasts are black, well-rounded schist? or quartzite. Includes petrified wood fragments and petrified logs. Fills erosion channels cut as much as 5 m deep into upper red member of Moenkopi Formation. Forms resistant caprock surface of Lost Spring Mountain. Unconformable contact with Moenkopi Formation. Forms cliff. As much as 55 m thick

Moenkopi Formation (Middle? and Lower Triassic)--Includes, in descending order, upper red member, Shnabkaib Member, middle red member, Virgin Limestone Member, lower red member, and Timpoweap Member as used by Stewart and others (1972). The Middle-Lower Triassic boundary probably lies in the upper red member (Morales, 1987)

Rmu **Upper red member**--Heterogeneous sequence of red sandstone, siltstone, mudstone, and minor gray gypsum. Includes cliffs of thin-bedded sandstone in upper and lower part. Erosional unconformity at bottom of lowest red sandstone cliff is difficult to locate. Map contact with underlying Shnabkaib Member placed arbitrarily at top of highest thick white siltstone and dolomite bed of Shnabkaib which lies just below erosional unconformity of lower red sandstone cliff. Forms slope with ledges about 70 m thick

Rms **Shnabkaib Member**--Interbedded and intertonguing, white, light-gray, laminated, aphanitic dolomite and silty gypsum and red siltstone. Includes red, thin-bedded mudstone, siltstone, and sandstone in lower and upper part. Gradational contact with middle red member placed at base of lowest bed of white or light-gray dolomitic limestone or siltstone of Shnabkaib Member. Forms steep slope with ledges. As much as 115 m thick

Rmm **Middle red member**--Red-brown, thin-bedded, laminated siltstone and sandstone, white and gray gypsum, minor white platy dolomite, green siltstone, and gray-green gypsiferous mudstone. Gradational contact with Virgin Limestone Member placed at top of highest gray limestone bed of Virgin Limestone. Forms slope. About 45 to 55 m thick

Rmv **Virgin Limestone Member**--Consists of three light-gray, thin-bedded to thinly laminated, ledge-forming limestone beds, 1 to 2 m thick, separated by white, pale-yellow, red, and blue-gray slope-forming, thin-bedded, gypsiferous siltstone. Includes thin beds of brown, red, and green siltstone, gray limestone, and brown platy calcarenite. Includes star-shaped crinoids and poorly preserved brachiopod fossils in top part of lowest limestone bed and fossil algae in upper two limestone beds. Erosional unconformity at base of lowest gray Virgin Limestone bed truncates underlying siltstone of lower red member as much as 2 m deep that thickens and thins as channel fill deposit. Forms small cliffs in slope. As much as 25 to 30 m thick

Trml **Lower red member**--Red, thin-bedded, sandy siltstone; gray, white, and pale-yellow laminated gypsum and minor sandstone. Lower beds contain reworked gypsum and siltstone of Harrisburg Member of Kaibab Formation. Includes marker bed of thin-bedded, calcareous, ledge-forming, gray-red sandstone about 1 to 2 m thick. Marker bed includes raindrop impressions and rare carbonaceous plant fossils stained by malachite, northeast corner of quadrangle. Interbedded or gradational contact with limestone, sandstone, or conglomerate of Timpoweap Member. Base placed at lowermost red siltstone bed of lower red member. Locally fills paleovalleys eroded into underlying Kaibab Formation in Triassic time. Forms slope. Ranges from about 9 to 60 m thick

Trmt **Timpoweap Member**--Light gray conglomerate and limestone: In northeast quarter of quadrangle, upper part consists of interbedded light-gray, fine-grained, thick-bedded limestone and gray, coarse-grained, low-angle cross-bedded sandstone; gradational contact with underlying conglomerate of Timpoweap Member of Moenkopi or unconformabable contact with Harrisburg Member of Kaibab. Lower part consists of conglomerate composed of subangular to rounded pebbles and cobbles of gray and dark gray limestone, white and brown chert, and rounded quartzite in gray limestone matrix. Chert and gray limestone are derived from Kaibab Formation. Source of dark-gray limestone and quartzite may be Paleozoic rocks west of quadrangle. Mostly clast supported; includes matrix of gray to brown, coarse-grained sandstone, gravel, and minor siltstone. Name Rock Canyon Conglomerate was proposed and abandoned by Gregory (1948, 1952), used by Nielsen and Johnson (1979), and Nielsen (1986, 1991). Forms cliff. Fills Triassic paleovalleys eroded into Kaibab Formation. Imbrication of pebbles in lower conglomerate shows an eastward paleoflow in depositing streams. As much as 45 m thick

Kaibab Formation (Lower Permian)--Includes the Harrisburg Member as defined by Sorauf and Billingsley (1991)

Pkh **Harrisburg Member**--Only upper and middle part exposed in this quadrangle. Upper part consists mainly of slope-forming, red and gray, interbedded gypsifereous siltstone, sandstone, gypsum, and thin-bedded gray limestone; mostly removed by erosion. Includes a pale-yellow or light-gray, thin-bedded, fossiliferous, sandy limestone caprock averaging about 1 m thick. Middle part consists of two prominent limestone beds, an upper, gray, thin-bedded, cherty limestone and a lower, light-gray, thin-bedded, sandy limestone. Cherty limestone bed weathers dark brown or black and often forms the bedrock surface of map area where upper part has eroded away. Lower part not exposed. Solution of gypsum has locally distorted limestone beds of middle part causing them to slump or bend into local drainages. As much as 60 m thick

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Contact--Dashed where approximately located

12 Fault--Dashed where inferred or approximately located; dotted where concealed; bar and ball on downthrown side. Number is estimated displacement in meters.

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

Syncline

Anticline

Monocline

Strike and dip of beds

Inclined

15 Approximate--Estimated photogeologically

13 Implied--Determined photogeologically, amount of dip undetermined

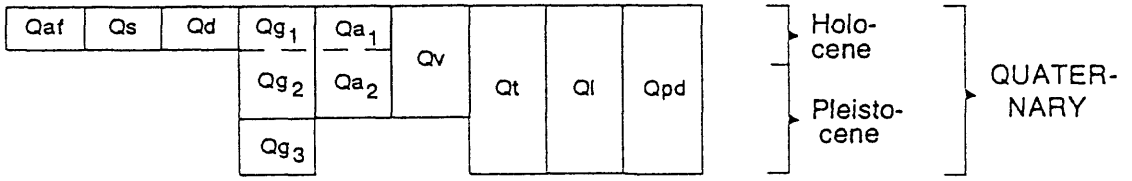
Strike of vertical and near-vertical joints--Determined photogeologically

C Collapse structure--Circular collapses, strata dipping inward toward central point. May reflect collapse of deep-seated breccia pipe in Redwall Limestone

Sinkholes--Steep-walled or enclosed depression or cave

CORRELATION OF MAP UNITS

SURFICIAL DEPOSITS



SEDIMENTARY ROCKS