U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Geologic map of the Little Clayhole Valley quadrangle, northern Mohave County, Arizona

by
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INTRODUCTION

The Little Clayhole Valley 7.5′ quadrangle is in northern Mohave County, northwestern Arizona, about 27 km south of the Arizona/Utah State line and Colorado City, the nearest settlement (fig. 1). Elevations range from about 1,463 m (4,800 ft) at the northwest corner of the quadrangle to 1,673 m (5,490 ft) near the southwest corner. Access to the quadrangle is by improved dirt road, locally referred to as the Clayhole Wash road, from Colorado City, Arizona. Several unimproved dirt roads lead from the Clayhole Wash road to various locations within the quadrangle area. Travel on these roads can be done with 2 wheel drive vehicles except on unimproved trails because of muddy, or sandy conditions.

The entire area is managed by the U.S. Bureau of Land Management, including about two sections that belong to the state of Arizona. The area supports sparse growths of sagebrush, cactus, and various grasses. Tamarisk trees (Salt Ceder) are restricted to stock tank and diversion dam areas in Clayhole and Little Clayhole Wash area.

PREVIOUS WORK

The quadrangle area is included on two Arizona state geologic maps, one by Wilson and others (1969) and the other by Reynolds (1988). A geologic quadrangle map borders this quadrangle on the east (Marshall, 1956c), on the northeast (Marshall, 1956b), on the north (Marshall, 1956a; Billingsley, 1994a), and on the northwest (Billingsley, 1994b).

MAPPING METHODS

A preliminary geologic map of this quadrangle was compiled from 1:24,000-scale aerial photographs. In particular, many of the Quaternary alluvial units having similar lithologies and merging boundaries were mapped using photogeologic methods. Detailed field investigations were then conducted to check photo interpretations and to obtain descriptions for all map units.

GEOLOGIC SETTING

The map area lies within the Uinkaret Plateau, a subplateau of the southwestern part of the Colorado Plateaus physiographic province. This part of the Uinkaret Plateau is characterized by relatively flat lying and gently folded Permian and Triassic sedimentary rocks. A few minor northwest-trending normal faults offset Triassic strata in the north-central part of the quadrangle, otherwise, the area is relatively free of faults unless they are covered by alluvial deposits.

Cenozoic deposits of fluvial pediment, alluvial fan, and valley-fill alluvium cover much of the map area. The distribution of these Quaternary deposits are an important factor for future environmental, land, and range management planning of 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. Many fluvial deposits of Clayhole and Little Clayhole Wash have been extensively eroded within the last century as evidenced by deep arroyos. As a result, soil conservation efforts by the Bureau of Land Management were undertaken in the early 1960′s to preserve soil and increase grass cover (Ferron Leavitt, Personal commun., Bureau of Land Management, St. George, Utah, 1994). The numerous water-spreader dams, diversion dikes, and control drainages are illustrated in this geologic map.

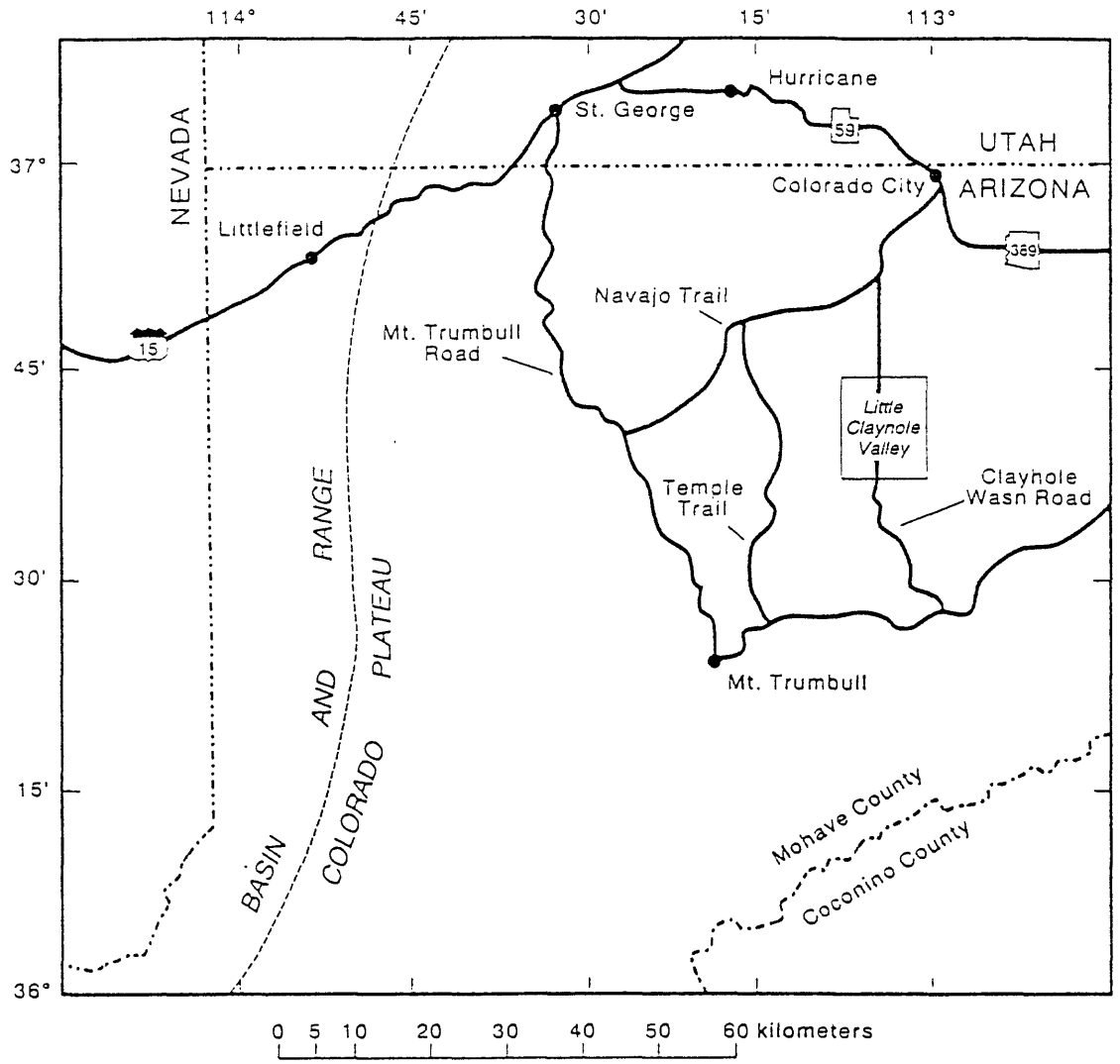

Figure 1. Index map of northern Mohave County, northwestern Arizona, showing the Little Clayhole Valley 7.5' quadrangle.

STRATIGRAPHY

The oldest rocks are sedimentary limestone, gypsum, and siltstone of the Harrisburg Member of the Kaibab Formation (Lower Permian) which crop out in the southwest quarter of the quadrangle. The youngest sedimentary rock is the Shnabkaib Member of the Moenkopi Formation (Middle(?) Triassic) which crop out in the northeast quarter of the quadrangle. The red and white gypsiferous siltstone, sandstone, and limestone beds of the lower Moenkopi Formation crop out in the central part of the quadrangle.

Two basalt flows of Pleistocene age crop out in the southern part of the quadrangle. One of the flows originates from cinder volcanoes called Seven Knolls just southwest of this quadrangle (Moriah Knolls 7.5′ quadrangle), and forms the Seven Knolls Bench. Informally called the Seven Knolls basalt, this unit is probably Pleistocene age because of similar outcrops of basalt just west and northwest of this quadrangle (Billingsley, 1994b; Harold Mehnert, U.S. Geological Survey Isotope Laboratories, Denver Co., written commun., 1993).

In the south-central part of the quadrangle, a basalt flow traveled north down Little Clayhole Wash. This flow originated from several vent areas marked by unnamed cinder cones about 16 km south of this quadrangle near the upper end of Toroweap Valley (Hat Knoll 7.5′ quadrangle). This flow is pockmarked by several caves and sinkholes south of this quadrangle, one of which is labeled "cave" on the Hat Knoll Quadrangle. Thus, for location and descriptive purposes, this basalt flow is informally named Cave basalt. The caves and sinkholes that have developed in the Cave basalt are the result of gypsum solution in the underlying Harrisburg Member of the Kaibab Formation. The Cave basalt is younger than the Seven Knolls basalt because the basalt flow occupies a drainage 18 m below the eroded edge of the Seven Knolls basalt about 6 km south of this quadrangle (Hat Knoll quadrangle).

The basalts have shed rock fragments as talus into the alluvial fan deposits, indicating that most of the alluvium is younger than the basalts. The basalts are about 0.85 Ka just northwest of this quadrangle (Billingsley, 1994b). The basalt fragments in talus and alluvium are confined to the southwest half of the quadrangle. The pediment deposits and slopes in the north-central part of the quadrangle, have a similar Pleistocene and Holocene age because they contain basaltic fragments from local dike intrusions of 0.580±0.52 Ka in the Formaster Well quadrangle north of this quadrangle (Billingsley, 1994a)

The pediment and other alluvial deposits cover more than three-quarters of the quadrangle surface area. The pediment surface is partly covered by a thin lag gravel made up of multicolored, well-rounded chert and quartz pebbles derived from the Shinarump Member of the Chinle Formation forming a desert pavement. This desert pavement distinguishes the pediment deposits from younger alluvial deposits in the quadrangle. Details of the stratigraphic sequence of alluvial deposits are given in the description of map units.

STRUCTURAL GEOLOGY

Minor normal faults with offsets less than 4.5 m are scattered in the quadrangle. It is likely that other faults are present, but are presently covered by alluvial deposits and are not visible in the alluvium. Geologic mapping west of this quadrangle (Billingsley, in press a, b), indicates that faulting probably began in the late Pliocene, but was most active in the Pleistocene and Holocene.

Several gently folded plunging anticlines and synclines have a general north to northwest axial trend in the northwest part of the quadrangle, and a northeast trend in the northeast part of the quadrangle. The overall regional exposure of strata suggests an east to northeast regional dip of about 2° or more in the southwest quarter of the quadrangle, and less than a 1° dip in the northeast half. These folds, like others found elsewhere on the Colorado Plateau, are probably related to early Laramide compressional stresses (Huntoon, 1989). Locally, warped and bent strata, too small to show at map scale, are the result of solution of gypsum in the Harrisburg Member of the Kaibab Formation (southwest quarter of the quadrangle).

Circular bowl-shaped areas (west-central edge and southeast corner of the quadrangle), have inward-dipping strata and may be collapse-formed breccia pipes that originates in the deeply buried Mississippian Redwall Limestone (Wenrich and Sutphin, 1989). The deep-seated breccia pipes potentially contain economic deposits of copper and uranium minerals (Wenrich, 1985), but none were observed at this location.

DESCRIPTION OF MAP UNITS

Surficial and igneous deposits

Qaf **Artificial fill and quarry pits (Holocene)**--Alluvial and bedrock material removed from pits and trenches to build stock tanks and drainage diversion dams for flood control and soil conservation

Qs **Stream-channel alluvium (Holocene)**--Unconsolidated and poorly sorted, interlensing silt, sand, and pebbles. Intertongues, overlaps, or inset to alluvial fan (Qa_1), terrace-gravel (Qg_1 and Qg_2), and 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

Qf **Flood-plain deposit (Holocene)**--Chiefly gray silt and fine-grained sand and clay; locally cemented by clay, gypsum, and calcite. Subject to frequent temporary ponding. Sparse or no vegetation, locally supports thick growths of Tamarisk trees and some grass. Floodplains are relative young since the diversion spreader dams were built in the early 1960's. Estimated thickness 2 to 3 m

Qg_1 **Young terrace-gravel deposit (Holocene)**--Unconsolidated, light-brown to pale-red siltstone, sandstone, and lenses of gravel. Includes pebbles of well rounded black, red, yellow, gray, and white quartzite and basaltic fragments. Includes reworked materials from alluvial fan (Qa_1), pediment (Qp), and higher terrace-gravel (Qg_2) deposits. Forms terrace bench about 0.5 to 1.5 m above local stream beds. Sustains moderate growth of Tamarisk trees and some grasses. Averages about 2 m thick

Qa_1 **Young alluvial fan deposit (Holocene)**--Unconsolidated silt and sand. Includes lenses of coarse gravel composed of multicolored, rounded pebbles of chert and quartzite and few cobbles of light red sandstone in northeast half of quadrangle; locally contains basaltic fragments in southwest half. Partly cemented by calcite and clay. Intertongues with stream-channel alluvium (Qs), upper part of valley-fill (Qv), and terrace-gravel (Qg_2) deposits. Alluvial fan subject to erosion by sheet wash and flash floods. Supports sparse vegetation growths of cactus, and grass. About 4 m thick

Qv **Valley-fill deposit (Holocene and Pleistocene)**--Partly consolidated silt, sand, and lenses of pebble to cobble gravel. Contains red, yellow, and black, well-rounded pebbles, sand and silt, reworked from pediment (Qp) and alluvial fan (Qa_2) deposits in northeast half of quadrangle; partly cemented by calcite and gypsum. Intertongues with floodplain (Qf), low terrace-gravel (Qg_1), and alluvial fan (Qa_1), and overlaps older alluvial fan (Qa_2) deposits. Valleys subject to sheetwash flooding and temporary ponding; cut by arroyos as much as 3 m deep in larger valleys. Supports sparse to moderate growths of sagebrush, grass, cactus, and Tamarisk trees. Ranges from about 2 to 4 m thick

Qt **Talus deposit (Holocene and Pleistocene)**--Unsorted debris consisting of breccia composed of small and large angular blocks of local basalt and bedrock as much as 2 m in diameter. Includes silt, sand, and gravel; partly cemented by calcite and gypsum. Intertongues with alluvial fan (Qa_1 and Qa_2), and valley-fill (Qv) deposits. Supports sparse growths of sagebrush, cactus, and grass. Only relatively extensive deposits shown. As much as 3 m thick

Ql **Landslide deposit (Holocene and Pleistocene)**--Unconsolidated and unsorted masses of rock debris, including detached blocks of bedrock strata that have rotated backward and slide downslope as loose, incoherent masses of broken rock and deformed strata, often surrounded by talus (Qt). Includes blocks of strata of the Moenkopi Formation and basalt near Seven Knolls Bench. Supports sparse growths of cactus and grass. Unstable when wet. Only large masses are shown. As much as 3 m thick

Qg_2 **Higher terrace-gravel deposit (Holocene and Pleistocene)**--Similar to young terrace-gravel (Qg_1) deposits. Consists mainly of light-red and gray, fine-grained sand, silt, and clay; partly cemented by calcite and gypsum. Intertongues with older alluvial fan (Qa_2) deposits. Forms flat benches about 1 to 4 m above local stream beds. Sustains sparse growth of sagebrush and grass. Averages about 3 to 5 m thick

Qg_3 **Older terrace-gravel deposit (Holocene and Pleistocene)**--Brown and gray silt, sand, gravel, and small pebbles and cobbles. Contains subrounded to rounded basalt, chert, limestone, sandstone, and minor multicolored quartzite and quartz pebbles. Basalt clasts derived from local Pleistocene flows. Forms terrace near Little Clayhole Wash, west-central edge of quadrangle. About 3 to 4 m thick

Qp **Pediment deposit (Holocene(?) and Pleistocene)**--Pale red, tan, and brown, fine-grained sandstone, siltstone and multicolored, well-rounded to rounded quartz and quartzite pebbles derived from the Shinarump Member of the Chinle Formation; partly cemented with calcite, gypsum, and clay. Pebbles form minor desert pavement as lag gravel composed of black, brown, gray, white, red, and yellow, well-rounded, averaging less than 2.5 cm in diameter; includes rare, rounded, petrified wood fragments. Includes integrated, poorly defined wind-blown sand sheet deposits. Erodes to became part of alluvial fan (Qa_1 and Qa_2), higher terrace-gravel (Qg_2), and valley-fill (Qv) deposits. Approximately 1 to 3 m thick

Qcb **Cave basalt flow (Pleistocene)**--Dark-gray, finely crystalline, to aphanitic groundmass, olivine basalt; one flow. Contains abundant olivine phenocrysts. Informally named Cave basalt from "Cave" marked on Hat Knoll 7.5′ quadrangle about 6 km south of this quadrangle. Originates from several unnamed cinder cone vent areas about 11 to 14 km south of quadrangle. Ranges from 1 to 6 m thick

Qsb **Seven Knolls basalt (pleistocene)**--Dark-gray, finely crystalline, aphanitic groundmass. Surface has thin cover of cinders. Flows originate from vent area known as Seven Knolls volcanoes about 2 km southwest of this quadrangle. Overlies Virgin Limestone and middle red members of Moenkopi Formation which are covered by talus debris. Consists of one or more flows. As much as 33 m thick

Sedimentary Rocks

Moenkopi Formation (Middle? and Lower Triassic)--Includes, in descending order, Shnabkaib Member, middle red member, Virgin Limestone Member, lower red member, and Timpoweap Member as used by Stewart and others (1972). Divided into:

Ṛms **Shnabkaib Member**--Interbedded, white, laminated, aphanitic dolomite and silty gypsum. Includes light-red, thin-bedded mudstone, siltstone, and sandstone in upper and lower part based on exposures north of this quadrangle (Billingsley, 1994a and b). Unknown thickness of upper part is eroded from this quadrangle. Gradational contact with middle red member arbitrarily placed at lowest thick white calcareous siltstone unit. Forms slope. About 30 m thick

Ṛmm **Middle red member**--Red-brown, thin-bedded, laminated siltstone and sandstone, red, white, and gray gypsum, minor white platy gypsiferous 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 m thick

Tmv **Virgin Limestone Member**--Consists of three light-gray, thin-bedded to thinly laminated, ledge-forming limestone beds, 0.5 to 2 m thick, separated by white, pale-yellow, red, and gray slope-forming, thin-bedded, gypsiferous siltstone. Includes thin beds of brown, red, and green siltstone, gray limestone, and brown platy, gypsiferous calcarenite between limestone beds. Includes star-shaped crinoids and poorly preserved brachiopods in top part of lowest limestone bed; fossil algae in second highest limestone bed. Erosional unconformity at base of lowest gray limestone truncates underlying red siltstone of lower red member as much as 2 m deep. Forms small ledges in slope. As much as 20 m thick

Tml **Lower red member**--Red, thin-bedded, sandy siltstone; gray, white, and pale-yellow laminated gypsum and minor sandstone. Includes ledge-forming, light purple to gray, coarse-grained, thin-bedded, calcareous sandstone bed in lower part. Locally, gradational contact with Timpoweap Member of Moenkopi Formation. Unconformably overlies Harrisburg Member of Kaibab. Thickness ranges from 10 to 20 m

Tmt **Timpoweap Member**--Gray conglomerate consisting of subangular to rounded pebbles and cobbles of gray and dark-gray limestone, white and brown chert, and quartzite; interbedded with red siltstone and coarse-grained sandstone, all derived from Kaibab Formation. Includes matrix of coarse-grained sandstone, gravel, siltstone, and limestone. Contact with lower red member eroded or covered in this quadrangle, gradational contact elsewhere. Occupies paleovalleys eroded into underlying Harrisburg Member of Kaibab Formation. Imbrication of pebbles in paleovalley show an eastward paleoflow in depositing streams. Forms slope and ledges. Thickness as much as 10 m

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

Pkh **Harrisburg Member**--Upper part consists of slope-forming, red and gray, interbedded gypsiferous siltstone, sandstone, gypsum, and thin-bedded, gray limestone. A resistant, pale-yellow or light-gray, fossiliferous, sandy limestone bed averaging about 1 m thick forms a caprock ledge at top. Middle part is cliff-forming, basal light-gray, thin-bedded, sandy limestone overlain by gray, thing-bedded, cherty, limestone. Lower part is partly exposed in this quadrangle consisting of slope-forming, light-gray, fine- to medium-grained, gypsiferous siltstone, sandstone, thin-bedded gray limestone, and gray gypsum. Solution of interbedded gypsum in lower part has locally distorted limestone beds of middle part causing them to slump or fold into local drainages. Unit as a whole forms slope with middle limestone cliff. As much as 40 m thick

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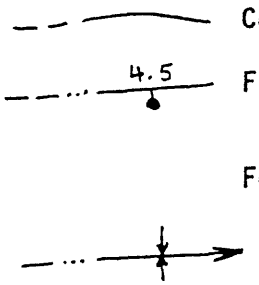


Contact--Dashed where approximately located

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

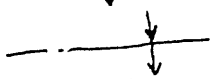
Folds--Showing trace of axial plane and direction of plunge; dashed were approximately located; dotted where concealed

Syncline

Doubly plunging syncline

Anticline

Doubly plunging anticline



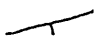
Monocline

Dome

Strike and dip of beds

Inclined

Approximate--Estimated from aerial photographs



Implied--Interpreted from aerial photographs, dip amount not determined

Strike of vertical and near-vertical joints--Interpreted from aerial photographs

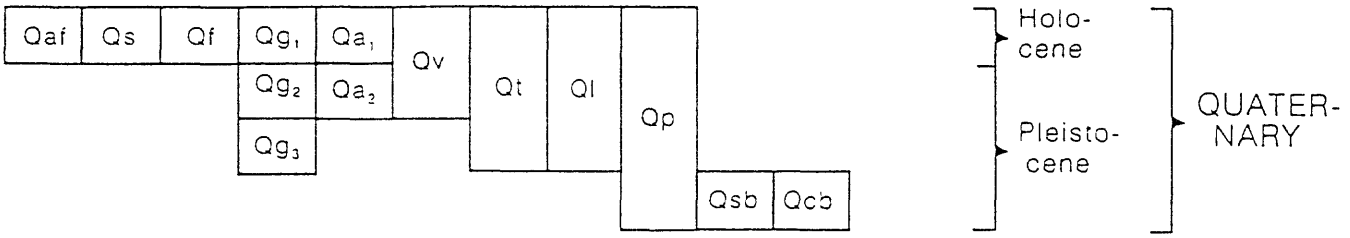
Collapse structure--Circular collapse, strata dipping inward toward central point. May reflect collapse of deep-seated breccia pipe that originated in Redwall Limestone

Sinkhole--Enclosed depression

Flow direction of basalt

CORRELATION OF MAP UNITS

SURFICIAL DEPOSITS AND IGNEOUS ROCKS



SEDIMENTARY ROCKS