GEOLOGY OF THE OLD MOJAVE ROAD AND SURROUNDING AREAS, SAN BERNARDINO COUNTY, CALIFORNIA

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PART 1: TEXT

Contents

Acknowledgement and Disclaimer

This work is a compilation of geologic information and mine history data gathered from a variety of published and unpublished sources. I have not attempted to harmonize these disparate and sometimes contradictory sources, but have presented the data mostly as I found it. I have changed verb tenses and used some paraphrase for readability. When print is in Italics, these are quotations, the sources of which are noted at the end of each paragraph. OMR means "Old Mojave Road". I also have done original research for many places of interest along that OMR that supplement information contained in these published and unpublished sources. My research adds or changes some inaccurate or incomplete previous descriptions of places and histories along the OMR.

I used and adapted GIS data for the milage points from the OMR website (http://www.mojave-road.com/), but corrected several of those points and added several of my own. Those adjustments are based on comparison with USGS digital on-line maps and the geologic maps referenced in my Bibliography.

I use many of the same milage points that were described in Mojave Road Guide: An Adventure Through Time (Dennis Casebeir, 2016). The locations and milage points given in that book are similar, but not identical with mile points at http://www.mojave-road.com. I have used milage points from the website, and the milage distances described in Casebeir's book.

I ask that you support the Mojave Desert Heritage and Cultural Association by going on line and purchasing Casebeir's book at https://www.mdhca.org/store. Have it with you when using my guidebook to get additional interesting historical information about the Old Mojave Road and adjacent areas.

Avenza and Georectified .pdf Maps

All of the on-line maps in this report are in georectified .pdf format. You can get the Avenza .pdf maps appliecation at https://www.avenza.com/avenza-maps/. Download the maps to your cell phone and use it to locate yourself as you drive along the field trip route. Don't worry about keeping track of milage from the beginning. Just use the mile markers as destination way points.

APPENDICIES, AREA MAPS, ANG GEOLOGIC MOSAIC

The appendicies, area maps, and geologic mosaic for this field gudei to accompany this guide are posted at

SECTION	Academia.edu (pape sizes)	Dropbox yosoygeologo@gmail.com
PART 2: APPENDICIES (3 MB)	https://www.academia.edu/35530837/Geology_of_the_Old_Mojave_Road_and_Surrounding_Areas_San_Bernardino_County_California_and_Clark_County_Nevada_PART_2_Appendicies 8.5 x 11 in (letter)	https://www.dropbox.com/s/4fx0tw3z7irq7hh/PART%202%20APPENDICIES%20p%20200.pdf?dl=0
PART 3: AREA MAPS (43 MB)	https://www.academia.edu/35530880/Geology_of_the_Old_Mojave_Road_and_Surrounding_Areas_San_Bernardino_County_California_and_Clark_County_Nevada_PART_3_Area_Maps 11 x 14 in (tabloid)	https://www.dropbox.com/s/01r4178swq35uf8/PART%203%20AREA%20MAPS.pdf?dl=0
PART 4: GEOLOGIC INDEX AND MOSAIC (26 mb)	https://www.academia.edu/35530900/Geology_of_the_Old_Mojave_Road_and_Surrounding_Areas_San_Bernardino_County_California_and_Clark_County_Nevada_PART_4_Geologic_Mosaic 36 x 42 in (Arch E)	https://www.dropbox.com/s/auyymx3gye9w2yj/PART%204%20GEOLOGIC%20MOSAIC.pdf?dl=0

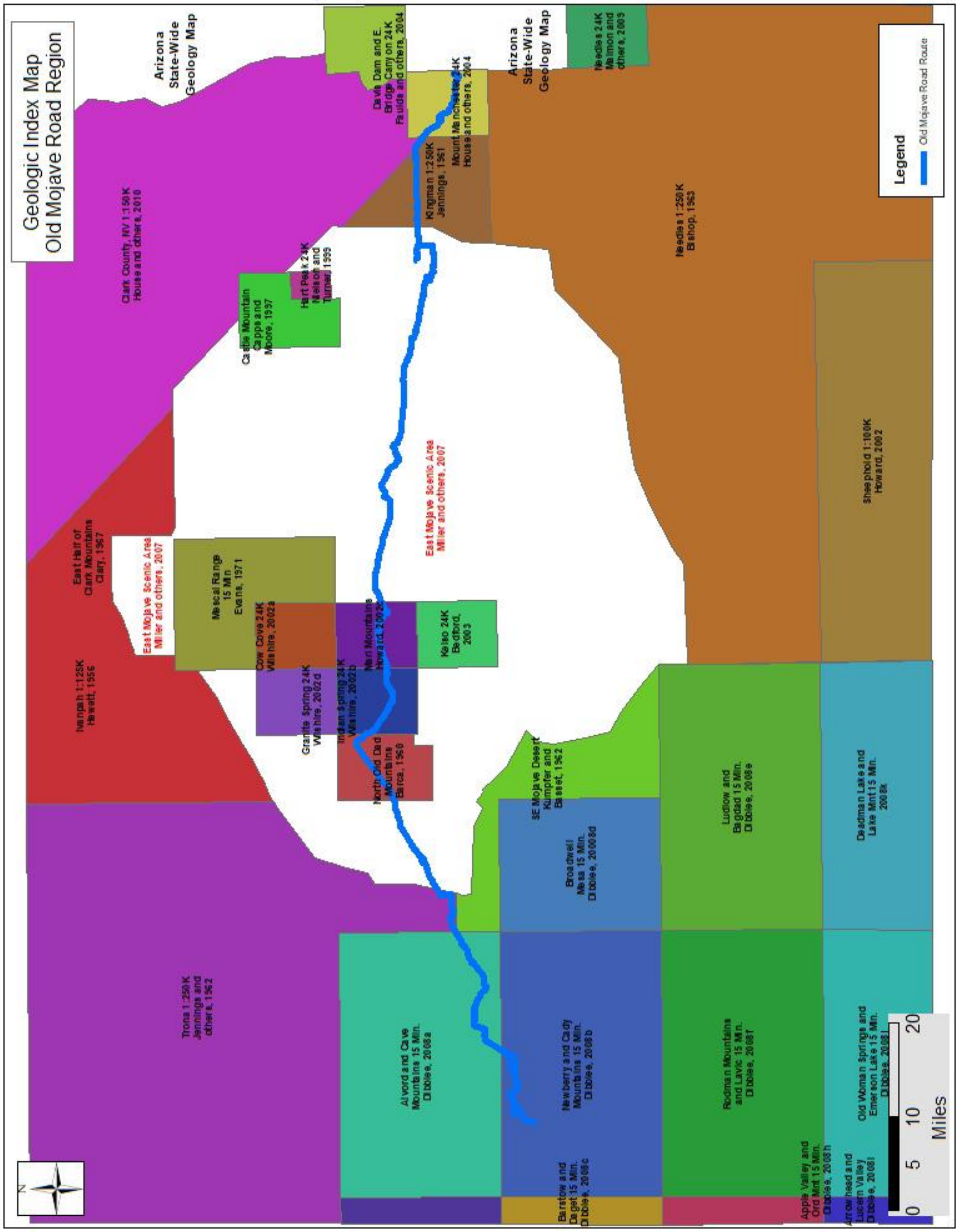


Figure 1. Geologic Index Map

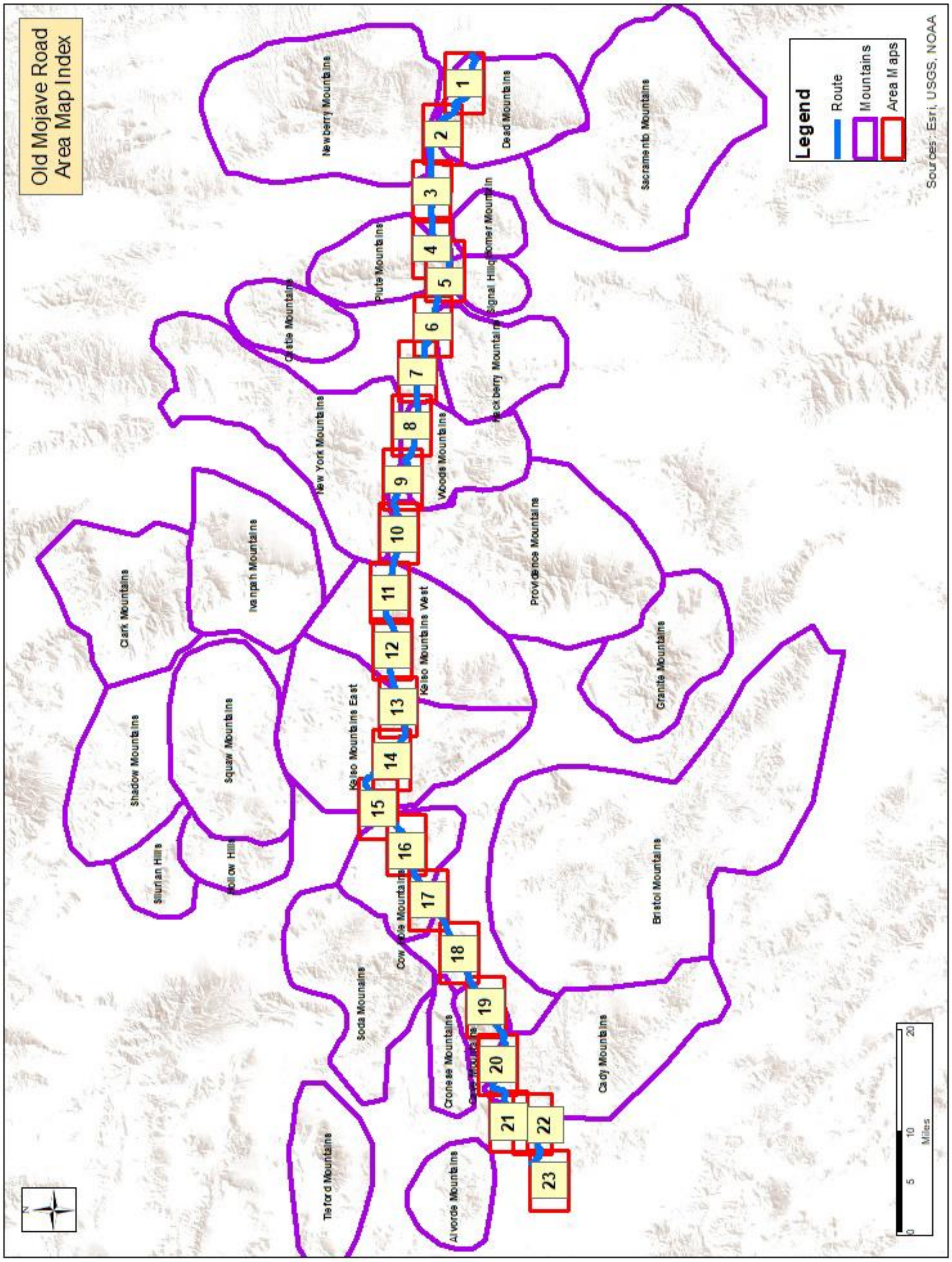


Figure 2. Index to Area Maps

GEOGRAPHIC OVERVIEW

The Old Mojave Road starts at the Colorado River in Nevada 14 miles north of Needles, California, at a point 0.6 miles east of the Casino on the Fort Mojave Indian Reservation. This starting point is in the floodplain of the Colorado River which has cut down through older units and exposed them, from youngest to oldest as we drive west to the northeastern flank of the Dead Mountains. From there we drive up on to the east-sloping pediment of the Dead Mountains, turning northwest and more or less driving parallel the California-Nevada State Line until we come to the southern slopes of the Newberry Mountains of Nevada. From there we turn west and cross the Piute Valley to the Piute Mountains. We make a detour around the Piute Mountain Wilderness area at Fort Piute, crossing the Piute Mountains at Telephone Cable Pass to the south. From there we cross Eastern Lanfair Valley to the northern end of the Vontrigger Hills. From the Vontrigger Hills we cross Western Lanfair Valley and pass to the south of Lanfair Buttes (Eagle Mountain) and Grotto Hills which are on our right (to the north). We pass out of West Lanfair Valley at the northeastern end of Table Mountain. Then we traverse southwest of Pinto Mountain and then go up and across the Mid Hills. We cross the Mid Hills at Cedar Canyon. Exiting the Mid Hills, we cross Kelso Wash to on unnamed hill at mile 66.9 and then skirt the northern flank of the Marl Mountains. Driving west and northwest we drive along the southern edge of the Club Mountain Volcanic Field to Willow Wash. Traveling northwest we greet the north end of Seventeen Mile Point in the Old Dad Mountains. From Seventeen Mile point we go southwest across Devil's Playground do the Little Cowhole and Cowhole Mountains. The Old Mojave Road goes between those two mountains to the eastern edge of Soda Lake. Crossing Soda Lake we come to the southeastern end of Soda Mountains. From there we skirt the southeast end of the Soda Mountains and the southeast flank of the Cave Mountains. Near the southwest end of the Cave Mountains we enter Afton Canyon on the Mojave River. For the Afton Canyon portion of our journey, the Cady Mountains are on the south and southwest of the Old Mojave Road. Afton Canyon ends at the Afton Canyon Campground. From there we are in sediments of the Lower Mojave River and Glacial Lake Manix to the end or our field trip near Camp Cady.

0.0 to 5.4 FLOODPLAIN FOR THE COLORADO RIVER AND BOUSE FORMATION

In this first geologic segment of the OMR, we start at the Colorado River. It has been down-cut into older floodplain and alluvial deposits. The sequence of rocks, from generally younger to older as we move west are:

Qcr1a	Post-Davis Dam channel and floodplain deposits (approximately 1937 to 1954), includes deposits that predate channelization in the southern part of the map area
Qcr2b	Inset sequence of alluvial terraces (late Holocene), includes mud, sand, and gravel B
Qcr2c	Inset sequence of alluvial terraces (late Holocene), includes mud, sand, and gravel C
Qcr2d	Inset sequence of alluvial terraces (late Holocene), includes mud, sand, and gravel D
Qcr2c	Inset sequence of alluvial terraces (late Holocene), includes mud, sand, and gravel C
Qaa	Deposits of most frequently inundated alluvial channels and fans, (late Holocene)
Qa1b	Deposits of intermittently active alluvial channels, sheetflow areas, and alluvial fans (late Holocene)

Qaa Deposits of most frequently inundated alluvial channels and fans, (late Holocene)

Qa1 with QTa on the flanks

- Qa1 Alluvium (late Holocene to modern), recently active channel and alluvial fan deposits, unconsolidated sand
- QTa Alluvium, undivided (Pleistocene and Pliocene) and gravel

Qa1b Deposits of intermittently active alluvial channels, sheetflow areas, and alluvial fans (late Holocene)

Qa1 Alluvium (late Holocene to modern), recently active channel and alluvial fan deposits, unconsolidated sand

Qaa Deposits of most frequently inundated alluvial channels and fans, (late Holocene)

Here is a stratigraphic chart of Miscellaneous and Piedmont formations

Miscellaneous Deposits

Qx	Areas of extensive anthropogenic disturbance, modern
	Pediment, pattern indicates areas where relatively thin (3-5 m) alluvial veneer overlies bedrock
Qe	Eolian dunes and sheets, latest Holocene

Piedmont Deposits (late Holocene to late Miocene)

Qa_1	Alluvium (late Holocene to modern), recently active channel and alluvial fan deposits, unconsolidated sand and gravel
Qaa	Deposits of most frequently inundated alluvial channels and fans, (late Holocene)
Qa_{1a}	Deposits of active, disperesed alluvial channels, sheetflow areas, and fans (late Holocene)
Qa_{1b}	Deposits of intermittently active alluvial channels, sheetflow areas, and alluvial fans (late Holocene)
Qa_2	Alluvium (late Holocene? to latest Pleistocene), alluvial fan remnants graded to prehistoric Colorado River (Qcb)
$Qa_{3\text{-}4}$	Alluvium, undivided (late and middle Pleistocene)
Qa_3	Alluvium (late Pleistocene), alluvial fan remnants, poorly consolidated sand and gravel
Qa_4	Alluvium (middle Pleistocene), weakly to moderately indurated alluvial fan remnants, distinctly reddened soil
QTa	Alluvium, undivided (Pleistocene and Pliocene)
Tbf	Fanglomerate, cross-stratified, contains abundant rounded pebbles and cobbles of local lithologies, interfingered locally with Tbg
Taf	Fanglomerate (late Miocene), moderately to strongly indurated alluvium, predominantly sand and gravel

Here is a stratigraphic chart of Colorado River units (From House and others, 2004):

Colorado River deposits (late Holocene to late Miocene?)

Qr	Colorado River extent June 1994, includes some active sand and gravel bars
Qcr	Colorado River floodplain terraces, paleochannels, and local flood deposits (latest Holocene), includes mud, sand, and gravel
Qcr_1	Colorado River deposits that postdate Hoover and Davis dams, includes mud, sand, and gravel
Qcr_{1a}	Post-Davis Dam channel and floodplain deposits (approximately 1937 to 1954), includes deposits that predate channelization in the southern part of the map area
Qcr_{1b}	Post-Davis Dam channel and floodplain deposits (approximately 1954 to at least 1994)
Qcr_2	Pre-Hoover Dam fluvial deposits of the Colorado River (late Holocene), includes an inset series of braid-plain terraces, floodplain terraces and meander-scroll platforms
Qcr_{2a}	Sandy braid-plain deposits abandoned immediately prior to 1938 as determined from aerial photographs dated April 1938
Qcr_{2b}, Qcr_{2c}, Qcr_{2d}	Inset sequence of alluvial terraces (late Holocene), includes mud, sand, and gravel
Qc	Undivided Colorado River alluvium (Pleistocene), includes mud, sand, and gravel
Qcb	Alluvium of Big Bend, fluvial gravel, sand, and mud (Holocene to latest Pleistocene), deposits of the lowest Colorado River terrace with varnished gravel veneer
QTc	Undivided Colorado River alluvium (Pleistocene and late Pliocene), broadly defined unit that includes remnants of a series of large-scale cut and fill sequences of mud, sand, and gravel
Tc	Bullhead alluvium (Pliocene to late? Miocene), fluvial gravel, sand, and mud; compositionally immature at base

Here is a legend for the Bouse Formation (From House and others, 2004):

Bouse Formation (late Miocene)

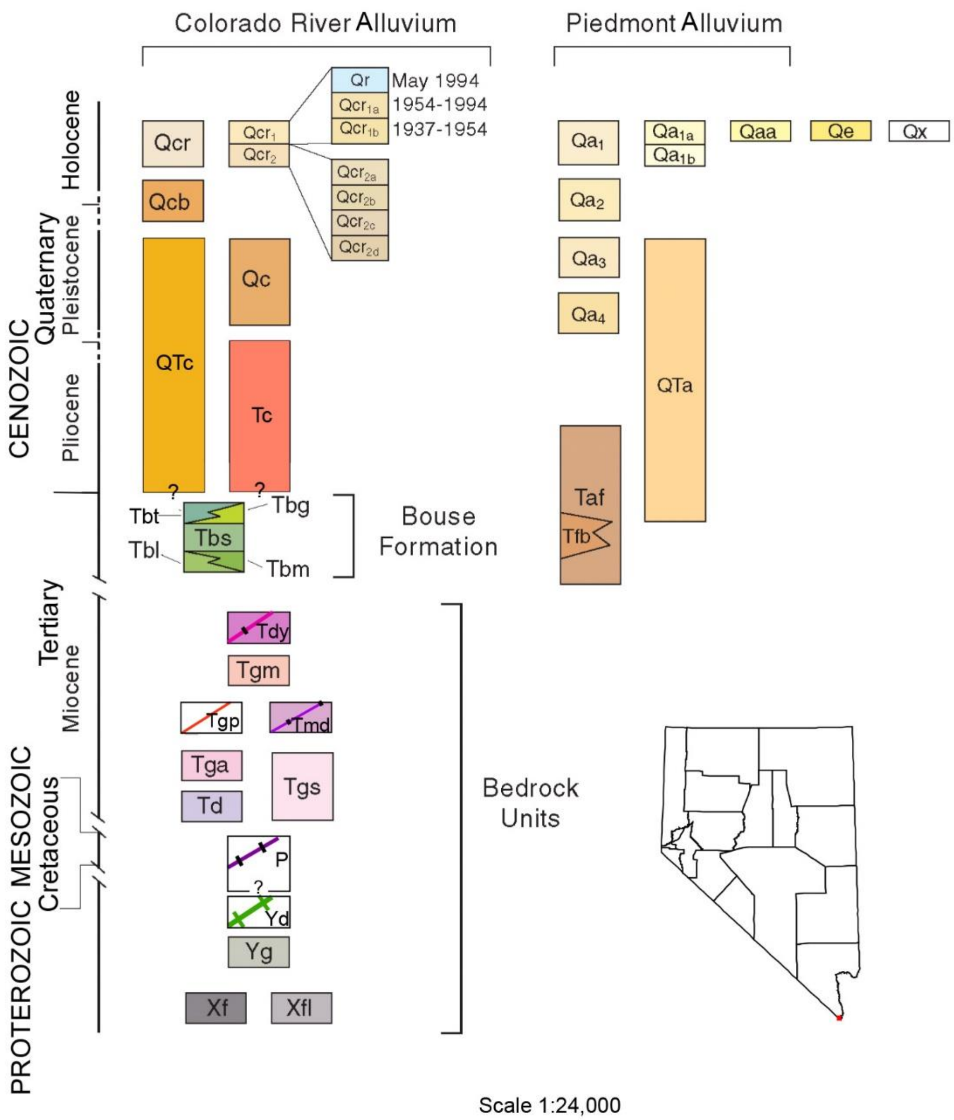
Tbg	Rounded pebble gravel and cobbles, derived from local lithologies, possible beach gravel, interbedded locally with Tbf and Tbs
Tbt	Tufa
Tbs	Flat-bedded medium to coarse-grained sand, interfingers with Tbm
Tbm	Flat-bedded mud and minor sand
Tbl	Calcareous mudstone, marl, and muddy limestone

Here is a legend of other Bedrock Units (From House and others, 2004):

Bedrock units (Middle Miocene to Early Proterozoic)

Tdy	Younger mafic dikes (middle Miocene)
Tgm	Granite of Mirage (middle Miocene), biotite granite to hornblende-biotite granodiorite
Tgp	Granite porphyry dikes (Miocene), fine-grained to very fine-grained biotite microgranite
Tmd	Microdiorite dikes (Miocene), hornblende microdiorite, leucomicrodiorite, and subophitic diabase
Tgs	Granite of Spirit Mountain (Miocene), coarse-grained biotite leucogranite and leuco-quartz monzonite
Tga	Granite of Avi (Miocene), biotite granite to hornblende-biotite granodiorite
Td	Quartz diorite (Miocene), biotite-hornblende quartz diorite, leuco-quartz diorite, and hornblende gabbro
P	Pegmatite dikes (Cretaceous or Proterozoic?), contain muscovite and garnet
Yd	Diabase (Middle Proterozoic?), medium-grained diabase, texture subophitic to trachytic, cuts Fenner gneiss
Yg	Granite of Davis Dam (Middle Proterozoic), coarse-grained porphyritic biotite granite with K-feldspar megacrysts
Xf	Fenner Gneiss? (Early Proterozoic), dark, coarse-grained to medium-grained biotite granite to granodiorite augen gneiss containing very coarse, commonly rapakivi, white feldspar augen
Xfl	Fenner Gneiss? leucocratic facies (Early Proterozoic), leucocratic augen gneiss, rapakivi texture marked by very coarse K-feldspar augen mantled by plagioclase

Here is a stratigraphic correlation chart (From House and others, 2004).



AREA MAP A-01

0.0 Starting Point: Colorado River

This guidebook starts near the Colorado River on what today is part of the Fort Mojave Indian Reservation.

There was an army post on the Arizona side of the river named Fort Mojave (https://en.wikipedia.org/wiki/Fort_Mohave, accessed Sept. 17, 2017).

At this starting point, we are in the floodplain of the Colorado River. The floodplain deposits were mapped as the Qcr1a unit by House and others (2004). There is a strip of Qx Holocene river terrace unit within Qcr1a that denotes man-made features.

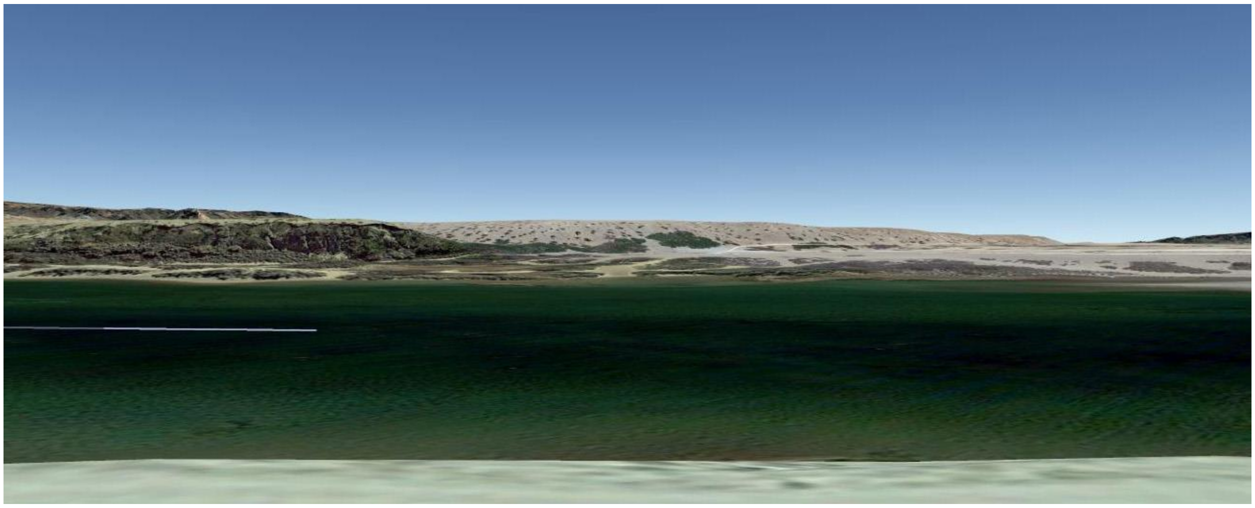


Figure 3. Colorado River. View to east from Mile 0.0 Photo from Google Earth (2011).

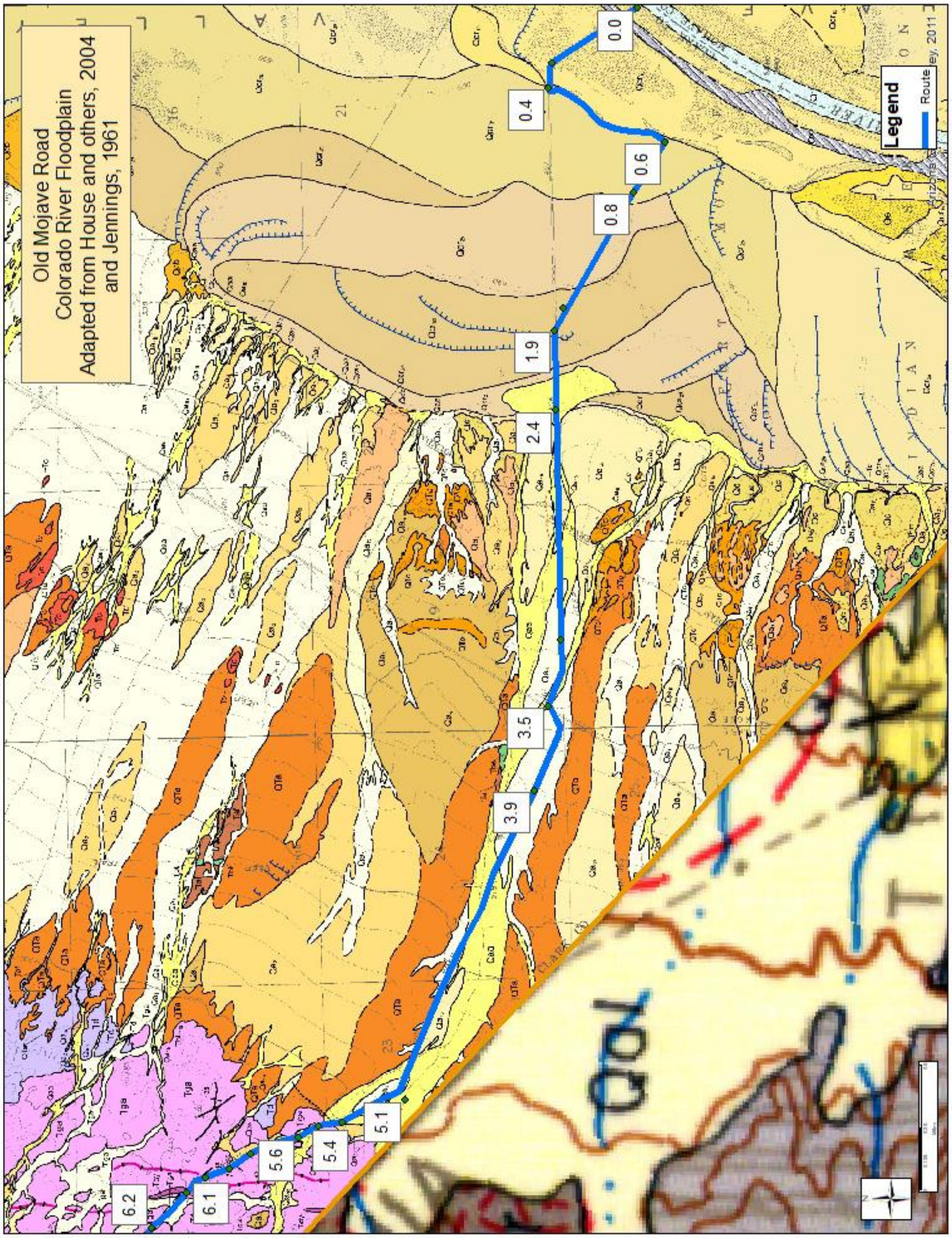


Figure 4. Mile 0.0 to 5.4 Floodplain of the Colorado River and Bouse Formation.

0.4 Geologic Contact

Here we cross from the Qcr1a unit of House and others (2004) on to their Qcr2b river terrace. From this point to Mile 0.6 we follow the geologic contact between these two units.

0.6 Geologic Contact

Here we leave the Qcr1a -Qcr2b river terrace contact and move uphill and west on to the older Qcr2b river terrace (House and others (2004).

0.8 Aha Macav Parkway

The original track of the OMR is depicted on USGS topographic maps and labeled as "Government Road". The original OMR cannot be followed here because of new construction, so we make a detour.

The OMR passes the northern extremity of Beaver Lake in this area. Here is what Wikipidia says about this lake:

Beaver Lake was a length of a slough or a former channel of the Colorado River, cut off and isolated from the river sometime before 1858, when it featured as the site of the opening engagement in the Mohave War, when the camp of Lieutenant Colonel William Hoffmanwith 50 soldiers of the 6th Cavalry on the First Mohave Expedition was surrounded and attacked by Chief Cairook with about 300 Mohave men.

In the 1875 Topographical Sketch by 1st Lt. George M. Wheeler of the Colorado River it shows the upper part of Beaver Lake had become one of two channels of the Colorado River again.[1] *The lake appears again intact with that name on a September 1911 reprint of a U. S. Geological Survey, Reconnaissance Map, Arizona, Nevada, California, Camp Mohave Sheet, Edition of March 1892, reprinted.*[2] *The lake as since dried up, after being cut off from the spring flooding of the river, following the construction of the Hoover Dam* (https://en.wikipedia.org/wiki/Beaver_Lake_(Nevada), accessed Sept. 17, 2017.

At the Aha Macav Parkway, we are in the center of Colorado River Terrace Qcr2b (House and others, 2004).

1.9 River Terrace Scarp

Slumping river terrace scarps dip to the east. At this point we are on the Qcr2d unit (House and others, 2004.

2.4 Geologic Contact: Piedmont Alluvium

Here we enter onto an alluvial fan created from erosion of the Piedmont Alluvium. As we drive westward we drive through various members of this unit. The Piedmont Alluvium deposits, as well as the older Bouse Formation are of interest to geologists interested in the history of the Colorado River. Back to the east are river terraces of the Qcr unit. Westward are the Qa (Holocene) and QTa (Holocene-Pliocene) units of the Piedmont Allluvium group (House and others, 2004).

3.5 Needles Highway

Where the OMR crosses the Needles Highway, we are on the Qa (Holocene) and QTa (Holocene-Pliocene) units of the Piedmont Allluvium group (House and others, 2004).

3.8. Bouse Formation

On the north side of the OMR is an exposure of Tbs, the central member of the Pliocene Bouse Formation (House and others, 2004).

3.9 Pole Line

From Mile 3.9 to 5.1 we are driving up a wash made of Quaternary alluvium Qaa unit of House and others (2004).

5.1 Second Pole Line

The canyon to the west is called Picture Canyon, so named for its Indian petroglyphs . The petroglyph locations are noted on the U.S. Geological Survey topographic maps. (For photos see http://deathvalleyjim.com/picture-canyon-petroglyphs-pictographs-dead-mountains/, accessed Sept. 17, 2017

At the Second Pole line, the OMR is crossing the Quaternary alluvium Qaa unit of House and others (2004).

5.4 to 9.8 NORTHEAST FLANK OF THE DEAD MOUNTAINS

The Dead Mountains are made of Pre-Cambrian rocks. Jennings (1961) shows the north part of the Dead Mountains as “Earlier Precambrian Metamorphic Rocks” (ep€) and the middle part as “Undivided Precambrian gneiss” (e€g). Bishop (1963) shows the southern Dead Mountains to be “Undivided Precambrian gneiss” (p€g) to the west with “Pleistocene non-marine” (Qc) and “Quaternary nonmarine terrace deposits” (Ql) to the east. The northeastern flank of the Dead Mountains is made of the “Earlier Precambrian Metamorphic Rocks” (ep€) unit of Jennings (1961). These rocks are in the Proterozoic (Xf and Xfl) unit of House and others (2004).

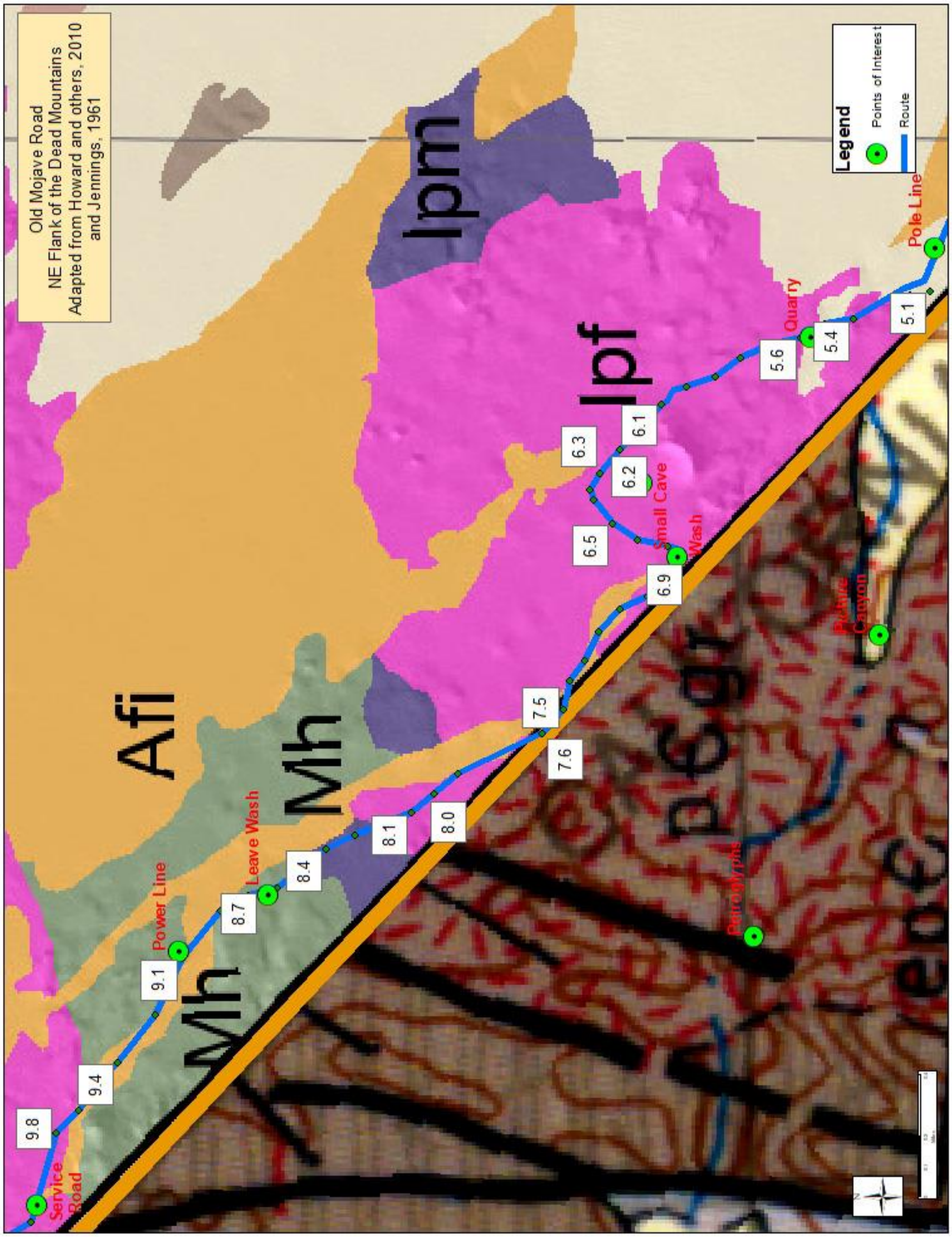


Figure 5. Mile 5.4 to 9.8 Northeast flank of the Dead Mountains

5.4 Road Junction

To the west is the Qa2 unit of the Piedmont Alluvium group (House and others, 2004). Keep to the west.

5.45 Fault Scarp

Here we cross a buried fault shown on the map of House and others (2004). Northwest of this fault there are Middle Miocene Granite of Mirage unit (Tga) on either sides of the wash (House and others, 2004).

5.6 Quarry

The quarry is surrounded on all sides of the wash by Granite of Mirage (Tga, House and others, 2004).

6.1 Mafic Dike

The OMR crosses the Tdy mafic dike unit which strikes north-south through the Granite of Mirage (Tga, House and others, 2004).

6.2 Decomposed Granite

From this point to mile 8.4 we travel mostly through Quaternary river wash deposits (Qa) and Miocene Granite of Mirage (Tga, of House and others, 2004).

6.3 Summit

We are in Granite of Mirage (Tga). To the north are the Newberry Mountains made mostly of PreCambrian units (p€ux1). To the south are the Dead Mountains exposing mostly PreCambrian rocks (p€) (Nevada Geological Survey).

6.5 Pole Line

We are in Granite of Mirage (Tga, House and others, 2004).

6.9 Unnamed Wash

We are in Granite of Mirage (Tga, House and others, 2004).

7.5 Small Cave

A rock cave can be seen on the left (west) side of the OMR. We are in decomposed Granite of Mirage (Tga, House and others, 2004) and in the PreCambrian granite unit p€gr of Jennings (1961).

7.6 First Trailhead

This is the first of two trailheads leading to petroglyphs noted on the USGS topographic map in Section 6 of T11N, R.21E, SBM.

AREA MAP A-02

8.0 Yucca Plants

Here are a collection of Mohave Yucca (yucca schidigera), also known as "Spanish Dagger" (https://www.desertusa.com/cactus/mohave-yucca.html accessed Sept. 17, 2017).
We are in a wash of Quaternary alluvium. To the west is Older alluvium (Qa) and to the east is Miocene Granite of Mirage (Tga, House and others, 2004)

8.1 Diorite

The slope to the northeast, above the alluvium is pre-Cretaceous Diorite (Td, House and others, 2004). Continuing up the wash to the north-northwest, the west side of the OMR is Pleistocene Older Alluvium (Qab1) and the east side is Holocene Alluvium (House and others, 2004).

8.2 Granite of Mirage

From 8.2 to 8.4 miles, both sides of the wash expose Miocene Granite of Mirage (Tga, House and others, 2004).

8.4 PreCambrian and Quaternary Formations

At this point on the OMR, some of the oldest rocks in the state are to the west (Proterozoic, Xfl), the streambed is Holocene alluvium, and the rocks to the east are the Pleistocene Older Alluvium Qa2 unit of House and others (2004). The peak to the east, at 1942 feet exposes Proterozoic PreCambrian units (Xfl).

8.7 Road Intersections: Leave Wash

The rocks cropping out the west are Proterozoic PreCambrian rocks of the Xf unit of House and others (2004).

9.1 Power Line and Service Road

The rocks to the uphill to the south are Proterozoic unit Xf (House and others, 2004). The Xf unit will be on both sides of the OMR, above the Quaternary Alluvium wash materials from here to mile 9.8.

9.4 Small Prospect Adit

A prospect adit is to the right (west). Rocks on both sides of the OMR at this point in the wash are Proterozoic Pre-Cambrian units (Xf) (House and others, 2004).

9.7 Cholla

This area has cholla cactus, Cylindropuntia echinocarpa (formerly Opuntia echinocarpa). For an example photograph of this plant, see http://mojavedesert.net/cactus/silver-cholla.html (accessed Sept. 17, 2017).

Figure 6. Cylindropuntia echinocarpa . From https://en.wikipedia.org/wiki/Cylindropuntia_echinocarpa#/media/File:Cylindropuntia_echinocarpa_1.jpg accessed Nov. 12, 2017.

The wash is Quaternary Alluvium (Qal) and the rock in hills to the northeast and southwest are Proterozoic Pre-Cambrian units (Xf, House and others, 2004).

9.8 Geologic Contact

The Nevada geologic map (USGS) has a contact here between Upper PreCambrian and Lower PreCambrian rocks. House and others (2010) mapped the rocks north of mile 9.8 as Felsic Plutonic Rocks (lpf) and those to the south as High-grade Metamorphic rocks (Mh). We will be in the Lower PreCambrain unit (Felsic Plutonic Rocks, lpf) until Mile 12.5.

9.8 to 12.5: SOUTHERN FLANK OF THE NEWBERRY MOUNTAINS, NEVADA

The southern flank of the Newberry Mountains of Nevada was mapped by House and others (2010). Their mapping shows that the Newberry Mountains are dominated by Felsic Plutonic Rocks (lpf). The USGS 750K digital map of Nevada shows these as Tertiary Felsic Intrusives (Tfi). The Kingman 250K Map by Jennings (1961) mapped these plutonic rocks in California as Early Pre-Cambrian Undivided granitic rocks (ep€). The hills hosting the Gibraltar claims (T13N, R.20E, Section 32, SBM) at the California-Nevada state line were mapped as Undivided pre-Cambrian by Jennings, 1961 (ep€) and as High-grade Metamorphic rocks (Mh) by House and others, 2010.

These are the rocks we traverse on the OMR between mile 9.8 and 11.4.

The southwest flank of the Newbery Mountains, from east to west are composed of

Afo	Middle Pleistocene Old alluvial fan deposits
Afx	Pliocene to Late Miocene
Afy	Holocene Young alluvial fan deposits
Afi	Late Pleistocene Intermediate alluvial fan deposits
Afxk	Pliocene to Late Miocene Extremely Old Alluvial fan, k denotes massive calcrete

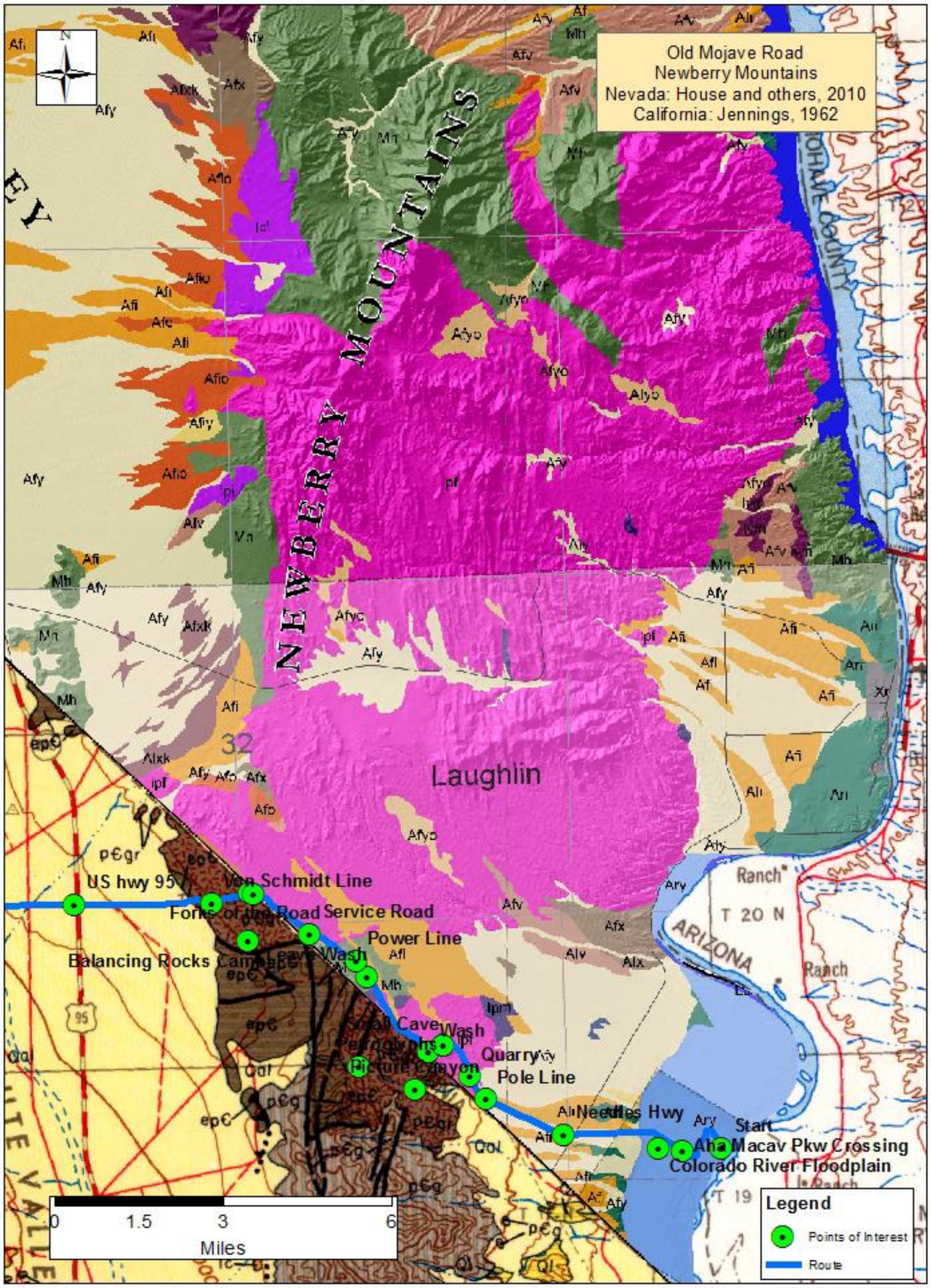


Figure 7. Geologic map of the Southern Newberry Mountains. Adapted from House and others (2010, Nevada) and Jennings, (1961, California).

10.1 Cross Old Underground Telephone Cable Service Road

On June 20, 1963 during the "Cold War" Era, the United states and the Soviet Union agreed to build a "hot line" communication system between the two nations. This was a result of the Cuban Missile Crisis of October 1962 (http://www.history.com/this-day-in-history/united-states-and-soviet-union-will-establish-a-hot-line). This system was almost entirely on land. It had isolated self-sustaining nuclear-hardened power plants every 100 miles along the cable route to sustain communications during a nuclear war.

The Old Mojave Road crosses this cable line at this point. At Mile 10.1 we are on the Lower PreCambrian rock units (Nevada Geological Survey and USGS).

11.2 Weaving Traces of OMR

The rocks are PreCambrian Granite (p€gr, Jennings, 1961), or Felsic Plutonic Rocks (Tertiary; House and others, 2010).

11.4 Road Intersection at the Nevada-California State Line

The present California-Nevada Border crosses the OMR at this point.
The original survey for the California-Nevada State line was performed by Surveyor General William Eddy in 1855. That survey was questioned and another survey was done by Surveyor General J. F. Houghton in 1863. That survey was superseded by the Von Schmidt Survey of 1872-73. Many U.S. Geological maps show the location of this older state line. Litigation over this line lead to the U.S. Geological Survey to perform another survey in 1893-94. The litigation from all these surveys culminated in a Supreme Court Decision in 1980. That decision recognized the validity of the Von Schmidt Line from Oregon to the north shore of Lake Tahoe, and the U.S.G.S. line from there to the Colorado River (Wilusz, 2002a, 2002b). The rocks here are PreCambrian Granite (p€gr, Jennings, 1961) or Felsic Plutonic Rocks (Tertiary; House and others, 2010).

11.6 High Pass on OMR between Newberry Mountains and Dead Mountains

The rocks at the summit are PreCambrian Granite (p€gr, of Jennings. 1961) or Felsic Plutonic Rocks (Tertiary; House and others, 2010). To the north are the Newberry Mountains made mostly of PreCambrian units (p€ux1). To the south are the Dead Mountains exposing mostly PreCambrian rocks (p€) (Nevada Geological Survey).

11.9 View of Piute Range and Piute Valley

The rocks at this viewpoint are PreCambrian Granite (p€gr, Jennings, 1961) or Felsic Plutonic Rocks (Tertiary; House and others, 2010).

12.0 Desert Training Center and California-Arizona Maneuver Area

This area of the OMR is within the former WWII Desert Training Center. The following is from Wickipedia:

*The **Desert Training Center** (**DTC**), also known as **California-Arizona Maneuver Area** (**CAMA**), was a World War II training facility established in the Mojave Desert and Sonoran Desert, largely in Southern California and Western Arizona in 1942. Its mission was to train United States Army and Army Air Corps units and personnel to live and fight in the desert, to test and develop suitable equipment, and to develop tactical doctrines, techniques and training methods* https://en.wikipedia.org/wiki/Desert_Training_Center, accessed September 24, 2017.

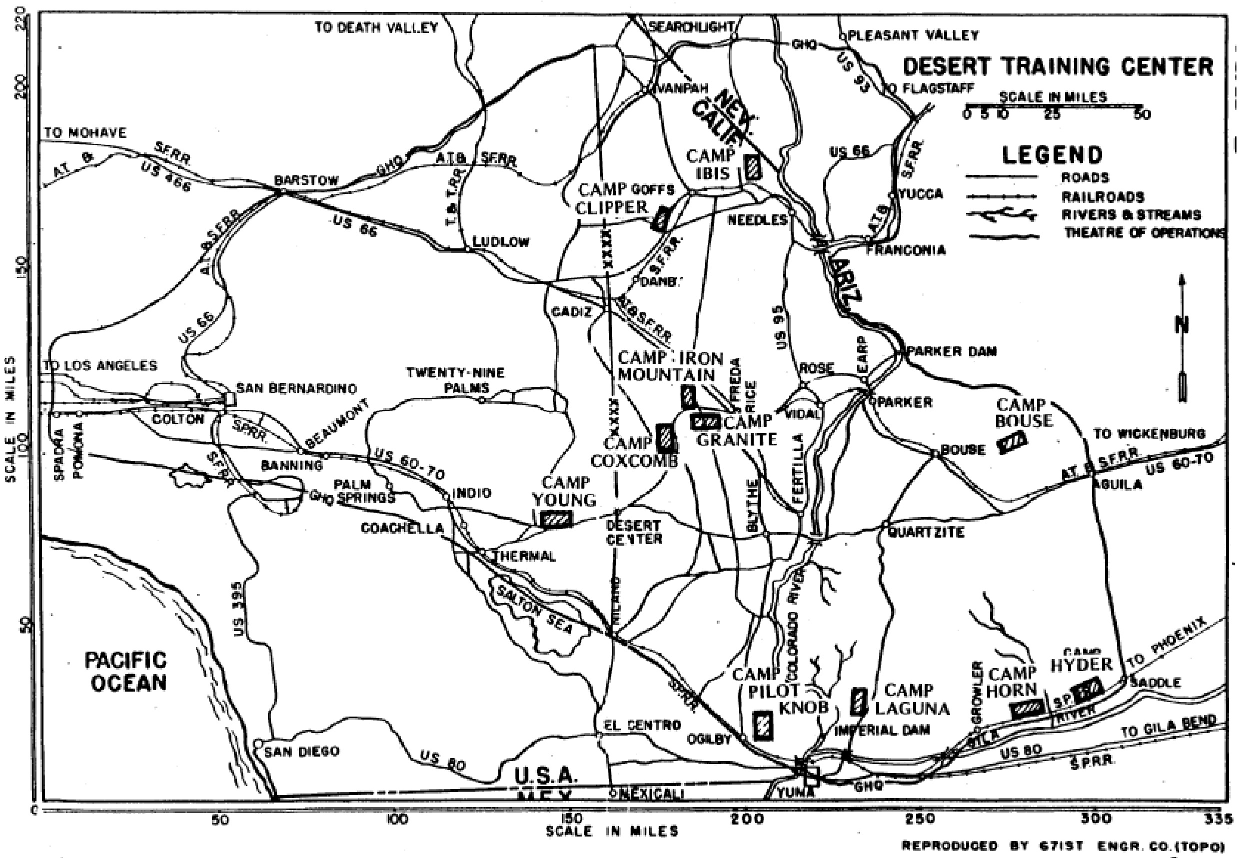


Figure 8. By US Army via United States Bureau of Land Management - http://www.blm.gov/pgdata/etc/medialib//blm/ca/pdf/pdfs/needles_pdfs.Par.9550550e.File.pdf/map2.pdf, Public Domain, https://commons.wikimedia.org/w/index.php?curid=9736241

The rocks here are PreCambrian Granite (p€gr, Jennings, 1961) or Felsic Plutonic Rocks (Tertiary; House and others, 2010).

12.1 Von Schmidt State Line

The rocks here are PreCambrian Granite (p€gr, Jennings, 1961) or Felsic Plutonic Rocks (Tertiary; House and others, 2010).

12.5 to 28.2: PIUTE VALLEY

The Piute Valley section of the OMR is dominantly alluvial materials of Holocene and Pleistocene age. In this segment we pass through several old homesteads, and see evidence of WWII desert training maneuvers.

12.5 Geologic Contact

Here the OMR crosses a geologic contact between Precambrian Gneiss to the east (Jennings, 1961) or Felsic Plutonic Rocks (Tertiary; House and others, 2010) and Quaternary Alluvium to the west (Jennings, 1961).

12.7 View of Table Top Mountain through a pass in the Piute Range

To the west we see the flat-topped Table Mountain between the Mud Hills and Woods Mountains. Table Top Mountain is a relic of reverse topography. The flat summit is a lava flow (Qpv) that once filled a depression in Mesozoic granitic rocks (gr) (Jennings, 1961). Differential erosion took away the granite and left the basalt high on the Table Top. Hewett (1956) mapped the flow as Tertiary sediments and flows (Tsf). Miller and others (2007) mapped it as Miocene Wild Horse Mesa Rhyolite Tuff (Tw). Miller and others (2012) mapped the flow as a Hill Slope Deposit with fv Substrate materials. (Qha/fv).

The geologic materials of the OMR at this point are Quaternary Alluvium (Qal, Jennings, 1961).

From the southwest flank of the Newberry Mountains and northwest flank of the Dead Mountains, we now travel due west across the Piute Valley to eastern side of the Piute Mountains. These rocks are mostly Quaternary Alluvium (Qal of Jennings, 1961) and Quaternary Alluvial Fanglomerate (Qaf of Miller and others, 2007).

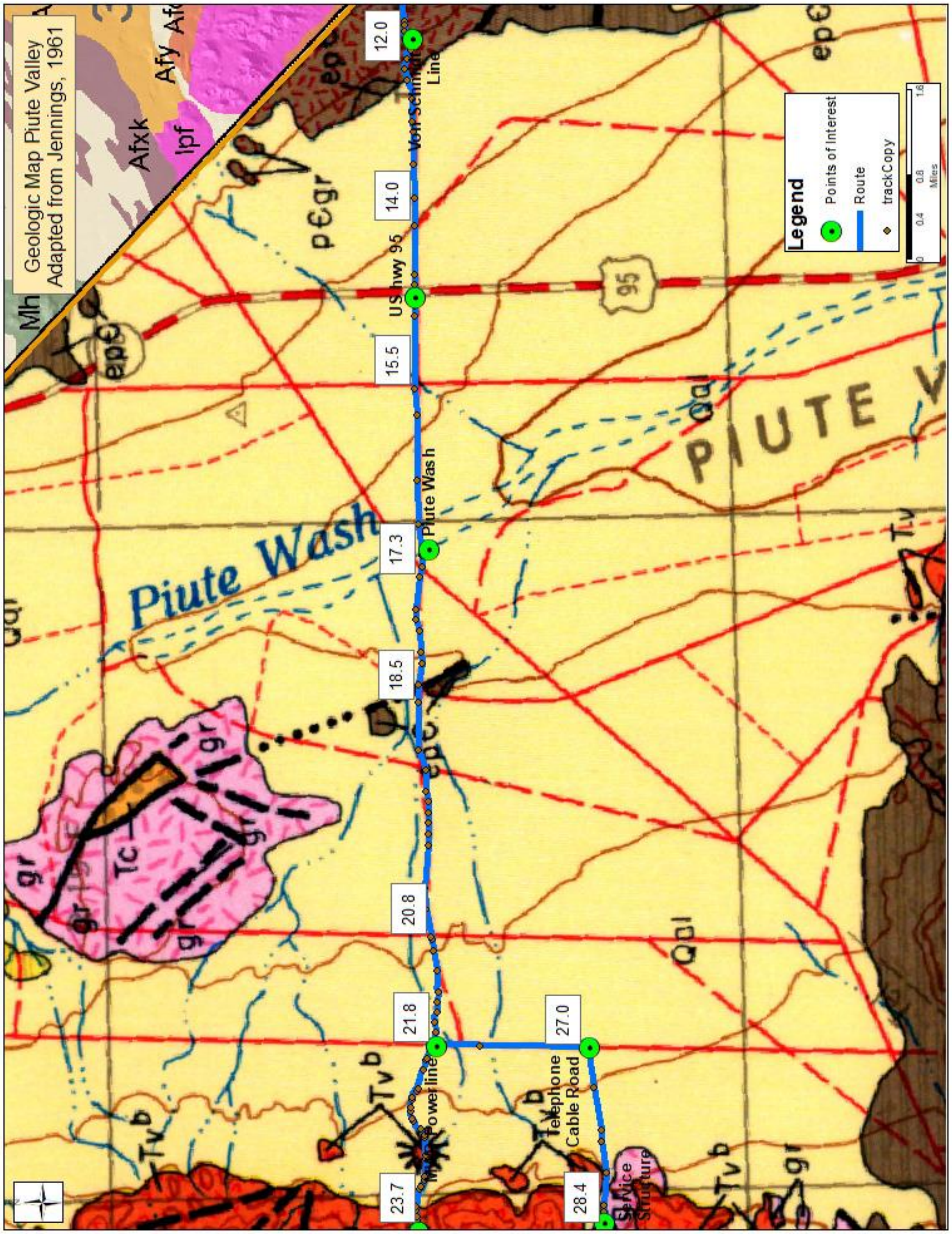


Figure 9. Geologic Map of Piute Valley. adapted from Jennings, 1961.

AREA MAP A-03

14.0 Private Drive and Piute Valley

To the north of the OMR, land in Section 16 of T.12N, R.20E, SBM and the area west of the Von-Schmidt Line in Section 9 of T.12N, R.20E, SBM are private lands.

Section 16 is a former School Section that was given to the State of California on January 6, 1925 under the authority of the California Enabling Act of March 3, 1853 (10 Stat. 244). It was later sold to a private party. The land is still in private ownership.
For patent documents see
https://glorecords.blm.gov/details/patent/default.aspx?accession=CACAAA%20000001%20%201Q&docClass=SER&sid=vk5qjblm.g2u

Section 9 was given to the Southern Pacific Railroad Company on July 27, 1866 under authority of the Grant-RR-Atlantic and Pacific (14. Stat. 292). The patent number is 1050896. It was signed by President Herbert Hoover. This land is still in private ownership.
For patent documents see
https://glorecords.blm.gov/details/patent/default.aspx?accession=1050896&docClass=SER&sid=vk5qjblm.g2u
A copy of this patent is reproduced in Appendix 14.0

The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961).

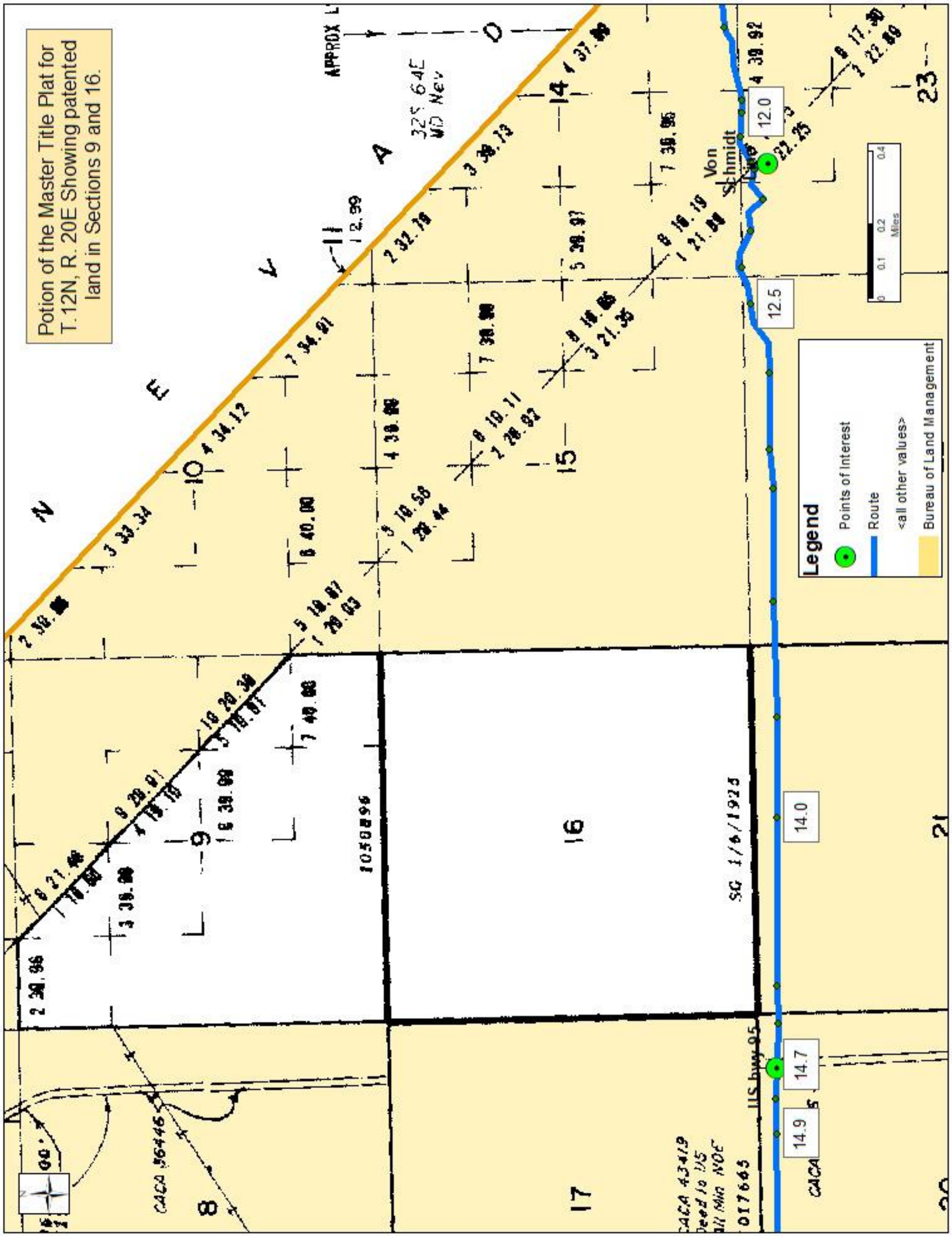


Figure 10. Private Lands shown in white in Sections 9 and 16 of T.12N. R.20E, SBM. Data from BLM web site.

14.7 Highway 95 and OMR

The geologic materials here are Quaternary Alluvium (Qal, Jenning, 1961).

14.9 Piute Valley and Desert Tortoises

This is an area of critical habitat for Desert Tortoise (BLM digital database). For more information about them see http://www.deserttortoise.org/. There are three varieties Gopherus agassizii, Gopherus evgoodei, and Gopherus morafkai.

The geologic materials here are Quaternary Alluvium (Qal, Jenning, 1961). Tortoises are generally found in sandy soils. They avoid hard rocks because they are difficult to dig through to make their burrows.

Figure 11. Gopherus (Desert Tortoise). Photo by Ken Nussar. From http://www.deserttortoise.org/ accessed Nov. 12, 2017.

15.5 Cattle Guard

The geologic materials here are Quaternary Alluvium (Qal, Jenning, 1961).

16.8 Lowest Point in Piute Valley for OMR: Piute Wash

The geologic materials here are Quaternary Alluvium (Qal, Jenning, 1961).

17.3 Relics of WWII training maneuvers

Soil disturbances in this area may be a legacy of WWII training maneuvers of General Patton (See map at mile 12.1, also Casebier, 2016, p. 59). The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961).

Figure 12. Desert Training during WWII. Photo from http://skytrail.info/new/picture_library/with%20patton%20on%20desert%20maneuvers%20tanks%20trucks.gif accessed Dec. 21, 2017

Figure 13. Desert training, 1942. Photo from https://www.kcet.org/sites/kl/files/atoms/article_atoms/www.kcet.org/arts/artbound/images/01_dtc-n5-manevering-over-rought-desert-terrain-aug-1942-signal-corps-photo-us-army-photo.jpg accessed Dec. 21, 2017.

18.5 Second Relics of WWII training maneuvers

Soil disturbances in this area may be a legacy of WWII training maneuvers of General Patton (See map at mile 12.1, also Casebier, 2016, p. 59). The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961). Hills to the north and south are Early Pre-Cambrian rocks. The east edge of these rocks are bounded by a fault (Jennings, 1961).

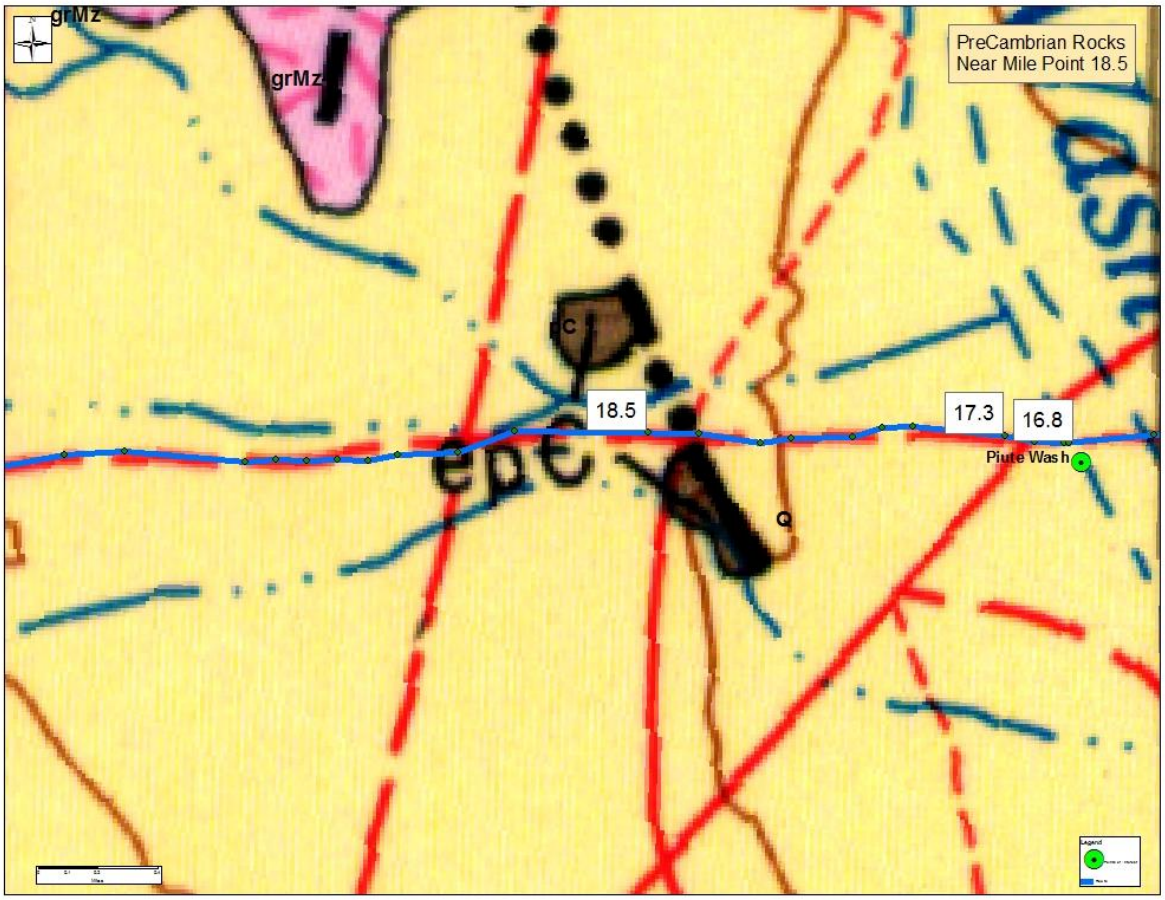


Figure 14. Pre-Cambrian rocks near mile post 18.5. Adapted from Jennings, 1961

AREA MAP A-04

20.8 Road Intersection: Former Telephone Service Road

The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007).

21.1 Cretaceous Granite Hills

The hills to the north are composed of Younger Cretaceous Granitoid Rocks (Kg1) of Miller and others (2007).

21.8 Road Junction at the MWD high line.

The Metropolitan Water District (MWD) has a major complex here (see Casebier, 2016, p. 58-60). Information about MWD can be found at http://www.mwdh2o.com/. Here is an excerpt from that website:

> *Seventy-five years ago this year, water from the Colorado River Aqueduct was first delivered to a rapidly growing and thirsty Southern California, keeping a promise made to voters in the depth of the Great Depression. The milestone culminated a years-long construction effort by the Metropolitan Water District of Southern California. The district was formed in 1928 for the purpose of building the great aqueduct across hundreds of miles of sun-baked desert to bring Colorado River water to the young and vibrant metropolis. Decades later, the effort still stands as an historic engineering and construction achievement.*

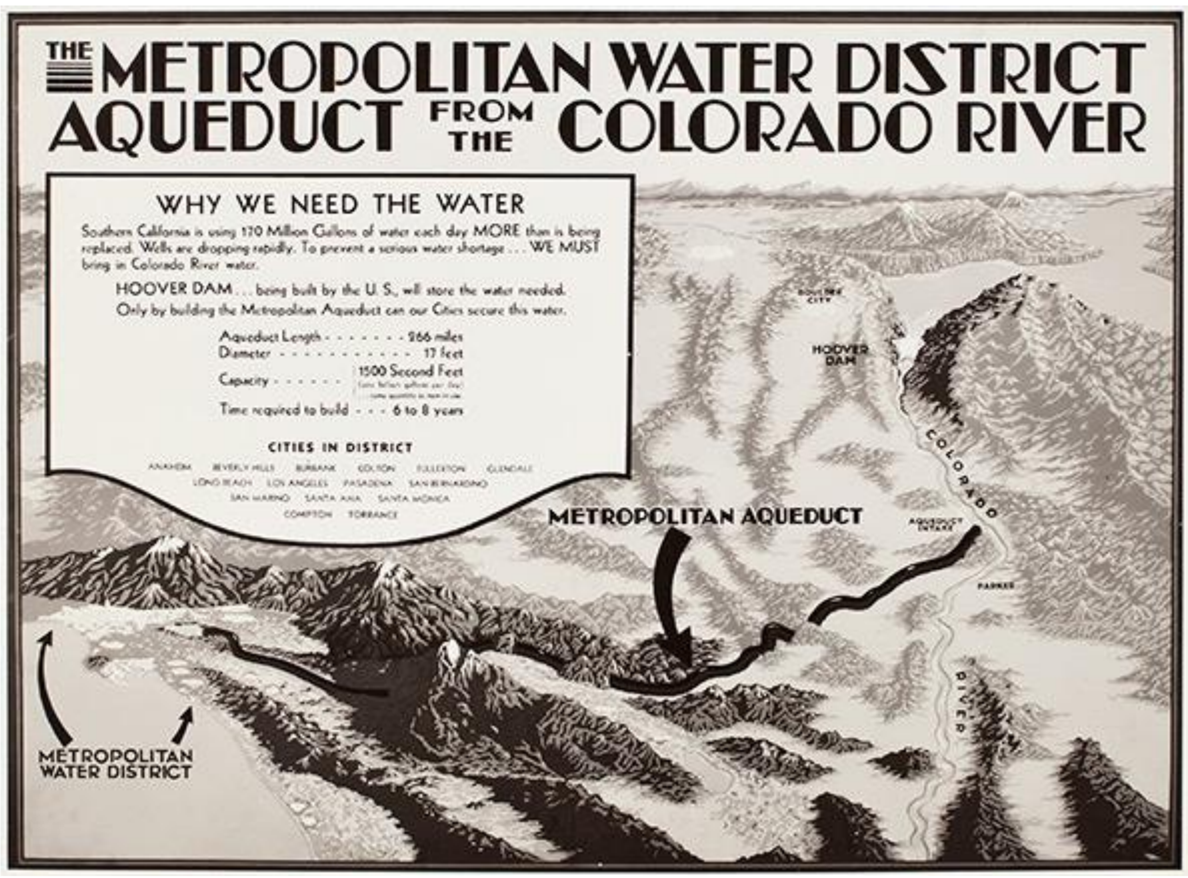


Figure 15. Map of MWD aqueduct, from http://www.mwdh2o.com/WhoWeAre/History/75years/Pages/default.aspx, accessed Sept. 24, 2017

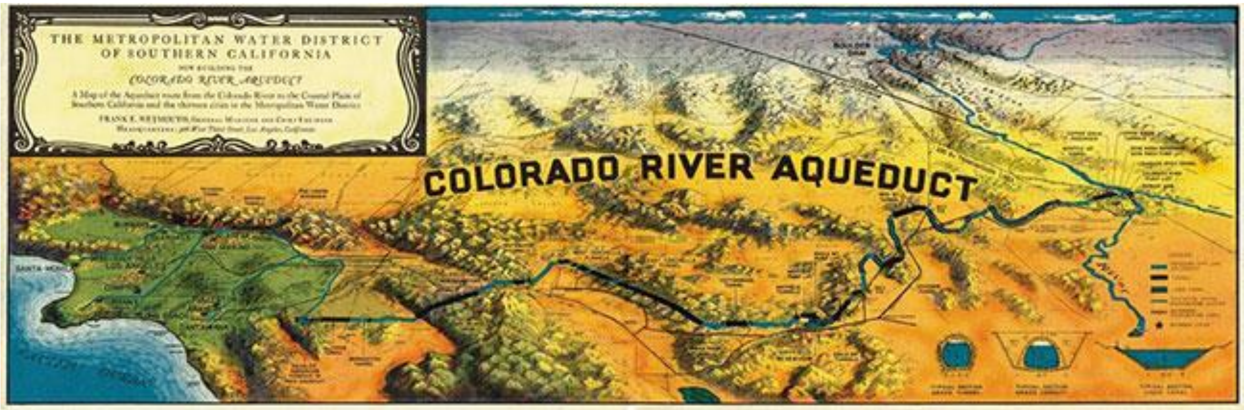


Figure 16. Map of the MWD aqueduct. From http://www.mwdh2o.com/WhoWeAre/History/75years/Pages/default.aspx, accessed Sept. 24, 2017.

The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007).

AREA MAP A-05

22.8 White-Toped Steel Poles and Miocene Dacite

The hill to the southeast is underlain by Miocene Dacite (Td) of Miller and others (*2007).*

22.9 Road Intersection at MWD Power Line

The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007).

23.2 Thomas Van Slyke Homestead

From Mile 22.8 to 23.7, the OMR passes through lands now managed by the California Department of Fish and Wildlife. The CDFW acquired land that had been patented to Thomas Van Slyke in SE1/4SE1/4 of Section 18 of T.12N, R.19E, SBM and S1/2NE1/4 of Section 13 of T.12N, R.18E, SBM. These 139 acres were patented on September 27, 1937 under the authority of the 1862 Homestead Entry Law (12 Stat. 392).

Information about this patent can be obtained from the BLM records website (https://glorecords.blm.gov/details/patent/default.aspx?accession=1092500&docClass=SER&sid=pwbxu4et.avc). A copy of that patent is provided in Appendix Mile 23.2. Desert USA (see Fort Piute, below) reports that Van Slyke sold his homestead George and Virginia Irwin in 1944. They tried to raise turkeys, but eventually moved away. The land was later acquired by the California Department of Fish and Wildlife.

The geologic materials here at the Van Slyke Homestead are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007).

Figure 17. California State-managed lands between Mile 22.8 and 23.7.

23.7 Fort Piute

This is the end of the road for vehicular travel. Historical information about Fort Piute is found in Casebier (2016, p.62-65) and also in the article by Scott Schwartz at https://www.desertusa.com/desert-trails/fort-piute.html (accessed Sept. 24, 2017).

Here is an excerpt from Schwartz's article: (Schwartz, 2017).

The year was 1859. During that year, a Colonel William Hoffman and the 60 soldiers under his command stopped for water at Piute Spring. Apparently deciding to make a stand against some hostile Indians, Hoffman had about half his men shoot at the Indians, killing roughly 20 of them. The rest ran off (Schwartz, 2017).

Several months went by before Major James H. Carleton and his 1st Dragoons came through this area and established an actual post, which he named Fort Beale. The name was in honor of a Navy officer who had previously led an experimental camel caravan through the area (Schwartz, 2017).

Although called a "fort", the Piute Springs outpost was really just one of several desert "redoubts" -- ie, temporary fortifications that were established in order to protect travelers along the Mojave Road against the hostile Indians who frequently stole livestock from and murdered them (Schwartz, 2017).

Not surprisingly, the troops stationed at Fort Beale were transferred east at the start of the Civil War. Clearly, and probably correctly, the Army's priorities lay elsewhere. While the war raged on in the east, Fort Beale and the other installations were manned by soldiers of the California Volunteers. These were state militia men who had not been "Federalized", and who stayed in California to protect the roads. Despite the presence of the California Volunteers, thefts of settler's livestock continued (Schwartz, 2017).

When the Civil War ended, however, the desert redoubts were abandoned. Complaints from local settlers, and the fact that the Mojave Road was a U.S. Mail route, prompted the U.S. Army to re-occupy the posts in 1866. At this point, Fort Beale was renamed Fort Piute (Schwartz, 2017).

Life here was tough for the soldiers. Aside from the dangers of combat, the men lived in tents full-time, because the fort itself was intended to provide cover and a place to retreat to during combat. In addition, the soldiers ate all of their meals outside. Given the remote location and harsh environment, desertions were not unheard of. Perhaps it is no surprise that Fort Piute was abandoned again -- this time for good -- in 1868 (Schwartz, 2017).

The remains of the stone blockhouse that was once Fort Piute are still standing today. Plus, the fort is positioned right near the Mojave Road, which is open to four wheel drive vehicles in this area (Schwartz, 2017).

The rocks at Fort Piute are Miocene Dacite (Td). To the north-northeast, on the spur of land that juts out in that direction, is a mass of Miocene Granite (Tga) on the mid-slope of the hill and Pliocene-Pleistocene Gravel (QTg) on the lower slope (Miller and others, 2007).

Figure 18. Ruins of Fort Piute. From https://www.desertusa.com/desert-trails/photos/Mojave-022.jpg accessed Jan. 19, 2017.

Return to Municipal Water District (MWD) power line road.

25.6 Road Intersection at MWD Power Line

The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007).

26.1 Piute Creek

The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007).

27.0 Intersection with Underground Telephone Cable Road

The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007).

28.2 to 30.9: PIUTE MOUNTAINS

The OMR crosses through the center of the Piute Mountains. The Northern Piute Mountains are mostly Tertiary dacite (Td) with a few outcrops of Early Proterozoic Gneiss and granitoids (undivided, Xg) and Cretaceous Younger Granitoid Rocks (Kg1) on the eastern edge. The southern Piute Mountains are mostly Cretaceous Porphyritic Granodiorite (Kpg) with bodies of Early Proterozoic Younger Granitoids (Xg1) to the east and Miocene Basalt Flows (Tb, 10 m.y.) to the west (Miller and others, 2007).

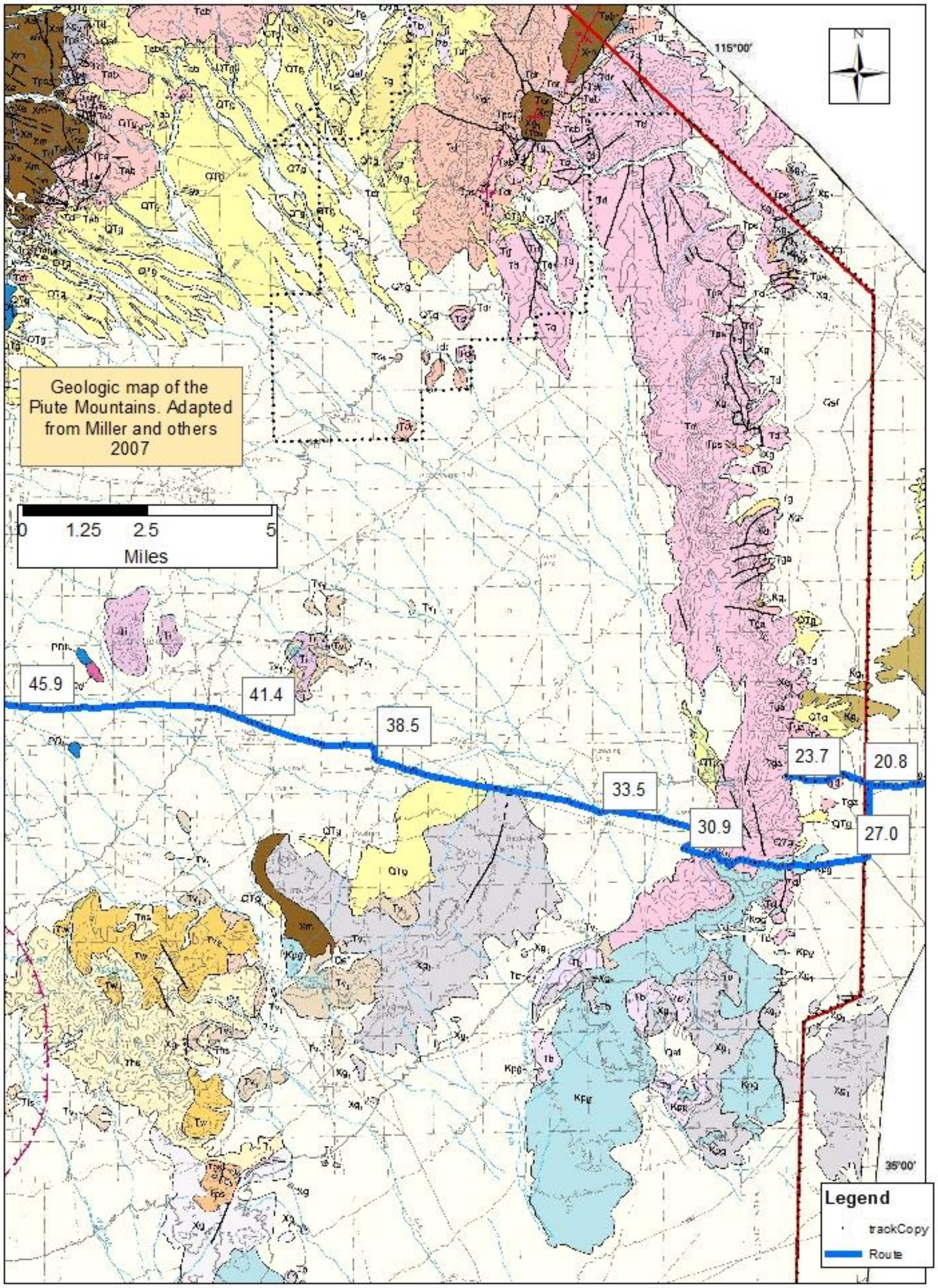


Figure 19. Geologic map of the Piute Mountains. Adapted from Miller and others, 2007.

28.2 Outcrops of Cretaceous Porphyritic Granodiorite

On both sides of the OMR are outcrops of Cretaceous Porphyritic Granodiorite (Kpg) of Miller and others (2007). From here to the geologic contact at mile 29.2, the OMR will be on this geological unit.

28.4 Road Intersection

We are in a wash of Qal. On both sides of the OMR are outcrops of Cretaceous Porphyritic Granodiorite (Kpg) of Miller and others (2007).

29.2 Geologic Contact

Heading west, here we pass from Cretaceous Porphyritic Granodiorite (Kpg) to Miocene Dacite (Td, Miller and others, 2007).

29.3 Cross Main Wash

This wash is underlain by rocks of the Miocene Dacite (Td) unit (Miller and others, 2007).

29.8 Geologic Contact

Heading west, here we pass from Miocene Dacite (Td) to Cretaceous Porphyritic Granodiorite (Kpg, Miller and others, 2007).

30.5 Summit

At the summit, the OMR crosses a geologic contact between Miocene Dacite (Td) to the west and Cretaceous Porphyritic Granodiorite (Kpg) to the east (Miller and others, 2007).

30.55 Cross Cold War Era Telephone Cable

See discussion of this feature at mile 10.1

30.65 Geologic Contact

Going west we cross from Miocene Dacite (Td) to Quaternary Alluvium Materials (Qaf) (Miller and others, 2007).

30.9 Former Site of Cattle Guard and Fence Line

For a discussion of this fence and cattle guard, see Casebier (2016, p. 74).
The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007).

30.9 to 35.1: EASTERN LANFAIR VALLEY

The Lanfair Valley was mapped by Miller and others (2007) as Holocene and Pleistocene Alluvial Fan Deposits and Alluvium (Qaf). In 2012 Miller produced a Quaternary surface geology map for the Ivanpah 30º x 60º quadrangle. That map shows two major depositional groupings, one west and one east of the “Large Unnamed Wash” at mile 32.2.

From the western edge of the Piute Mountains to the Large Unnamed Wash at mile 32.2, the mapped units, from east to west along the OMR are (Miller, 2012):

Qmc	Holocene and Pleistocene Mass-Movement colluvial deposits
Qya	Holocene and Latest Pleistocene Young alluvial fan deposits
Qia	Late and Middle Pleistocene Intermediate alluvial deposits
Qya+Qaa	Holocene and Latest Pleistocene Young alluvial fan deposits and Latest Holocene active alluvial fan deposits

From the Large Unnamed Wash to the northeastern edge of the Vontrigger Hills, the mapped units, from east to west along the OMR are (Miller, 2012):

Qiag	Late to Middle Pleistocene Intermediate alluvial fan deposits composed of grus
Qyw+Qaw	Holocene and Latest Pleistocene Young wash deposit and Active wash deposit
Qoag	Middle toe Early Pleistocene Old alluvial fan deposit composed of grus
Qiag/Qoag	Late to Middle Pleistocene Intermediate alluvial fan deposit composed of grus / Middle to Early Pleistocene Old alluvial fan deposit composed of grus
Qiag/fpg	Late to Middle Pleistocene Intermediate alluvial fan deposit composed of grus / Felsic plutonic rocks that weather to grus
Qoag	Middle to Early Pleistocene Old alluvial fan deposit composed of grus

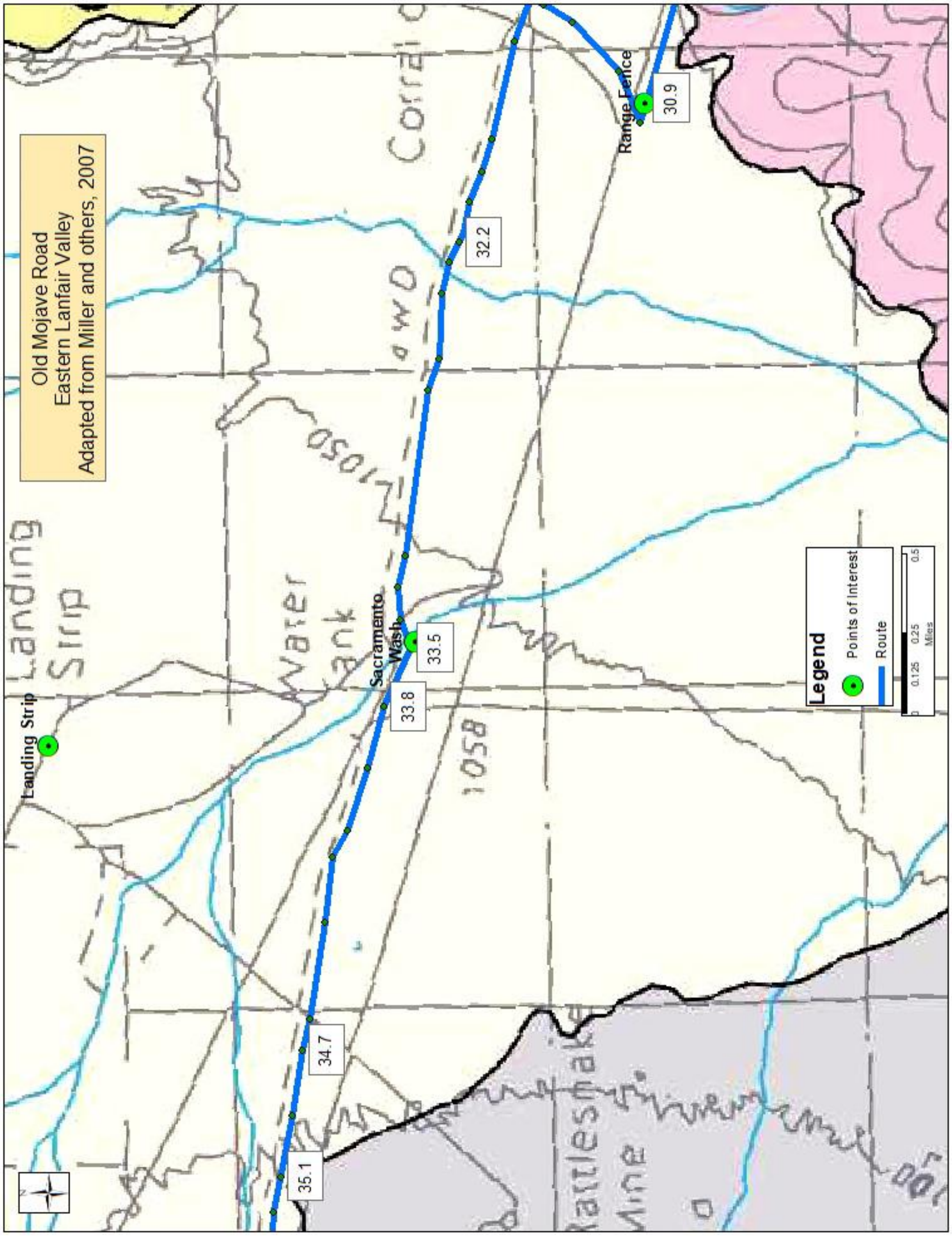
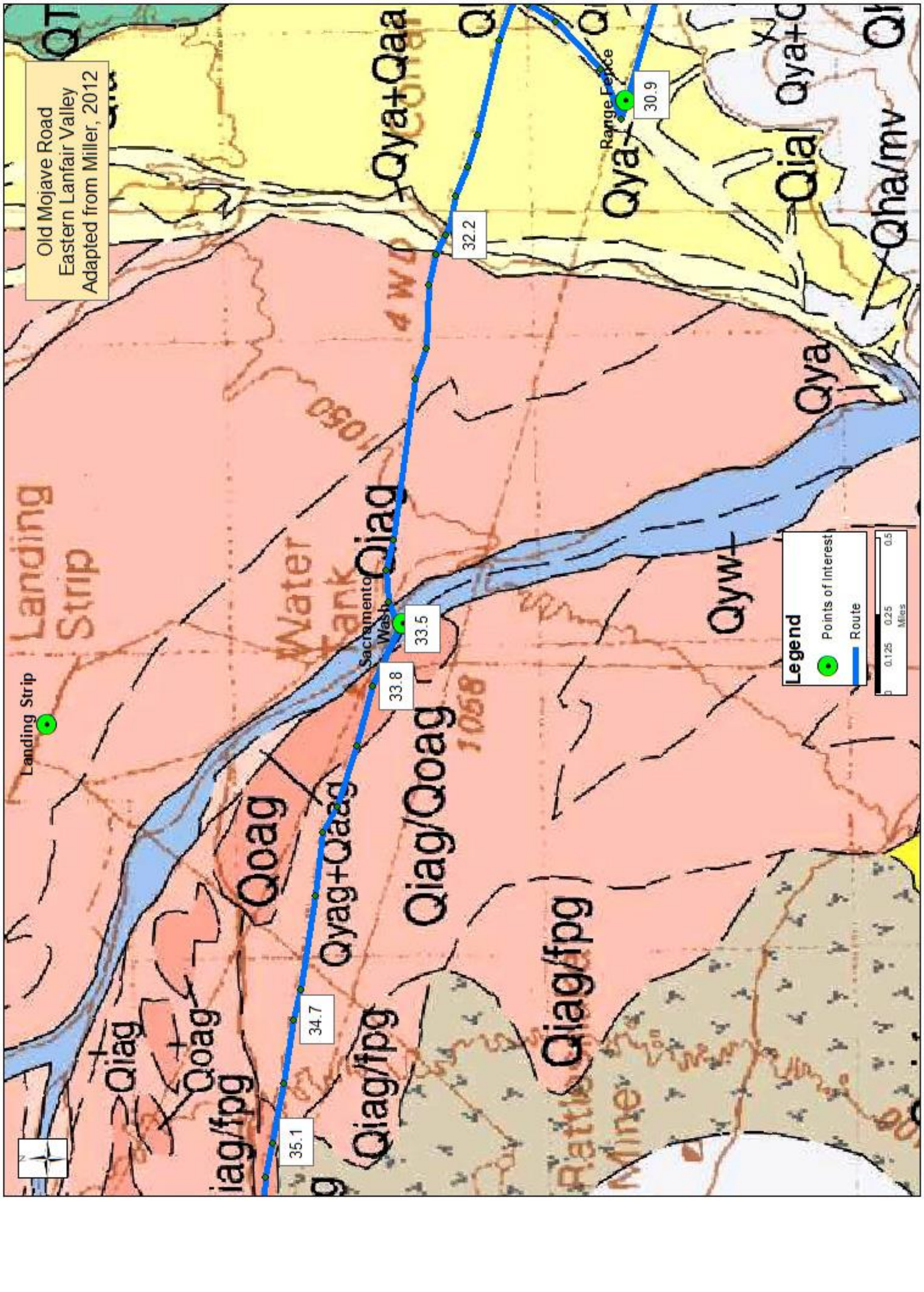


Figure 20. Mile 30.9 to 35.1: Eastern Lanfair Valley


Old Mojave Road
Eastern Lanfair Valley
Adapted from Miller, 2012
Landing Strip
Sacramento Wash
Range Fence
35.1
34.7
33.8
33.5
32.2
30.9
Qiag
Qoag
Qiag/fpg
Qyag+Qaag
Qiag/Qoag
Qyw
Qya
Qya+Qaa
Qial
Qha/mv
Qya+Q
Water Tank
Legend
Points of Interest
Route
0 0.125 0.25 0.5
Miles

31.4 Road Intersection

The road going north leads to Piute Corral. The geologic materials here, at the turn-off and up to the hiking trail, are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007).

32.2 Large Unnamed Wash Crossing

The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). This wash markes a depositional boundary

33.5 Sacramento Wash

The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007, Qaw Active Wash of Miller, 2012).

AREA MAP A-06

33.8 Road Intersection

The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007).

33.85 "Y" Road Intersection

The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007).

35.1 Eastern edge of Vontrigger Hills

35.1 to 37.0: NORTH FLANK OF VONTIGGER HILLS

The Vonntrigger Hills are mostly Early Proterozoic Younger Granitoids (Xg1) with a small amount of Miocene Younger Volcanic Rocks (Tv1) northwest of the California Mine and another mass of Tv1 northeast of the American Flag Gold mines.

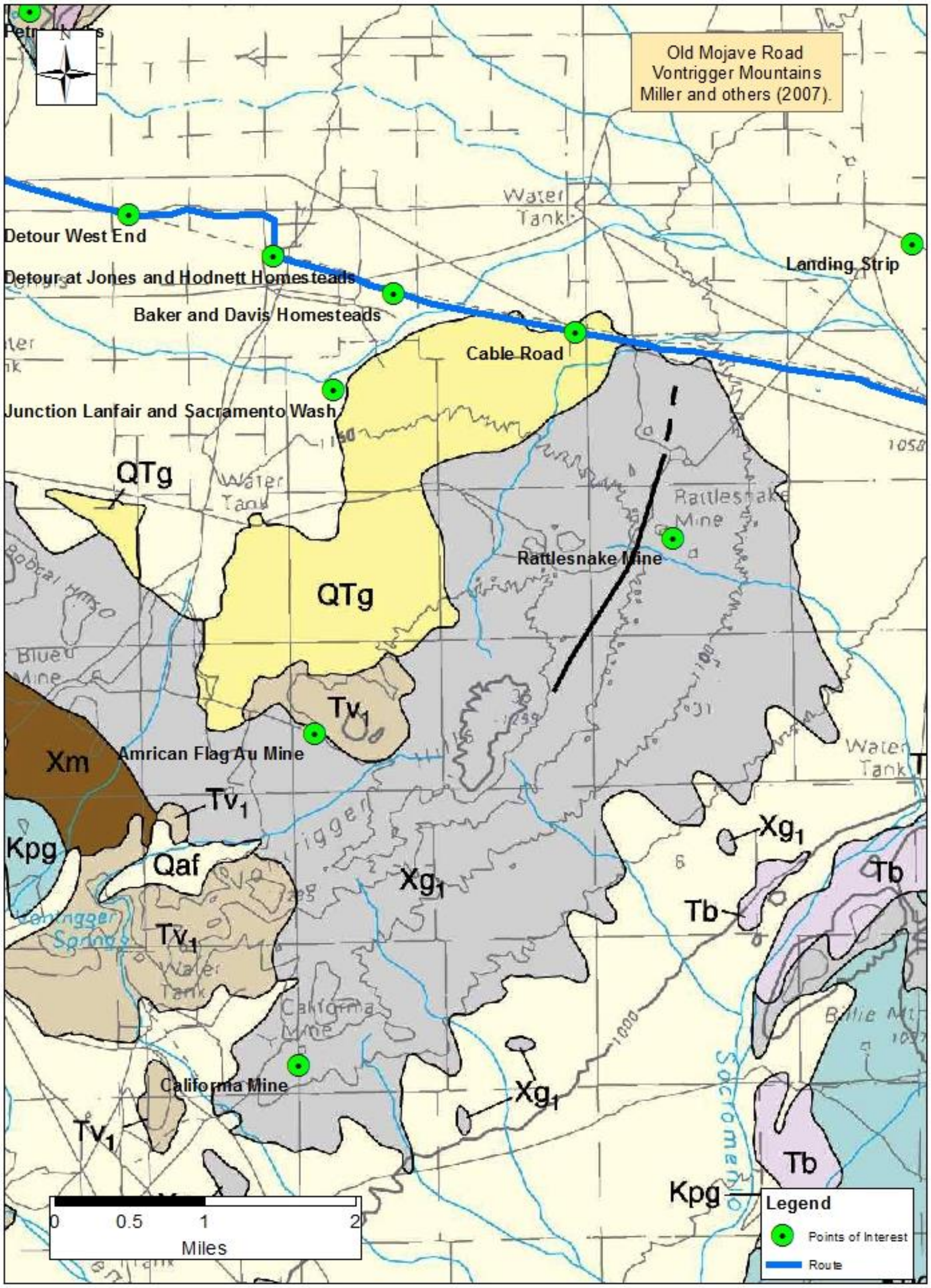


Figure 21. Geologic map of the Vontrigger Hills. Adapted from Miller and others, 2007.

34.7 Road Intersection with the Cable Road

The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007; Late to Middle Pleistocene Intermediate alluvial fan deposits composed of grus Qiag/fpg of Miller, 2012).

35.8 Road Intersection to Rattlesnake Mine

The road to the south leads to the Rattlesnake Mine. The U.S. Geological Survey MRDS database has two “Unnamed” mines in the area noted on the USGS topographic maps as “Rattlesnake Mine”. The MRDS database indicates they are gold-copper mines.

The geologic materials at this intersection are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007, Qiag/fpg of Miller, 2012). 270 feet south on this road is PreCambrian Granite 1 rock unit (Xg1) of Miller and others (2007).

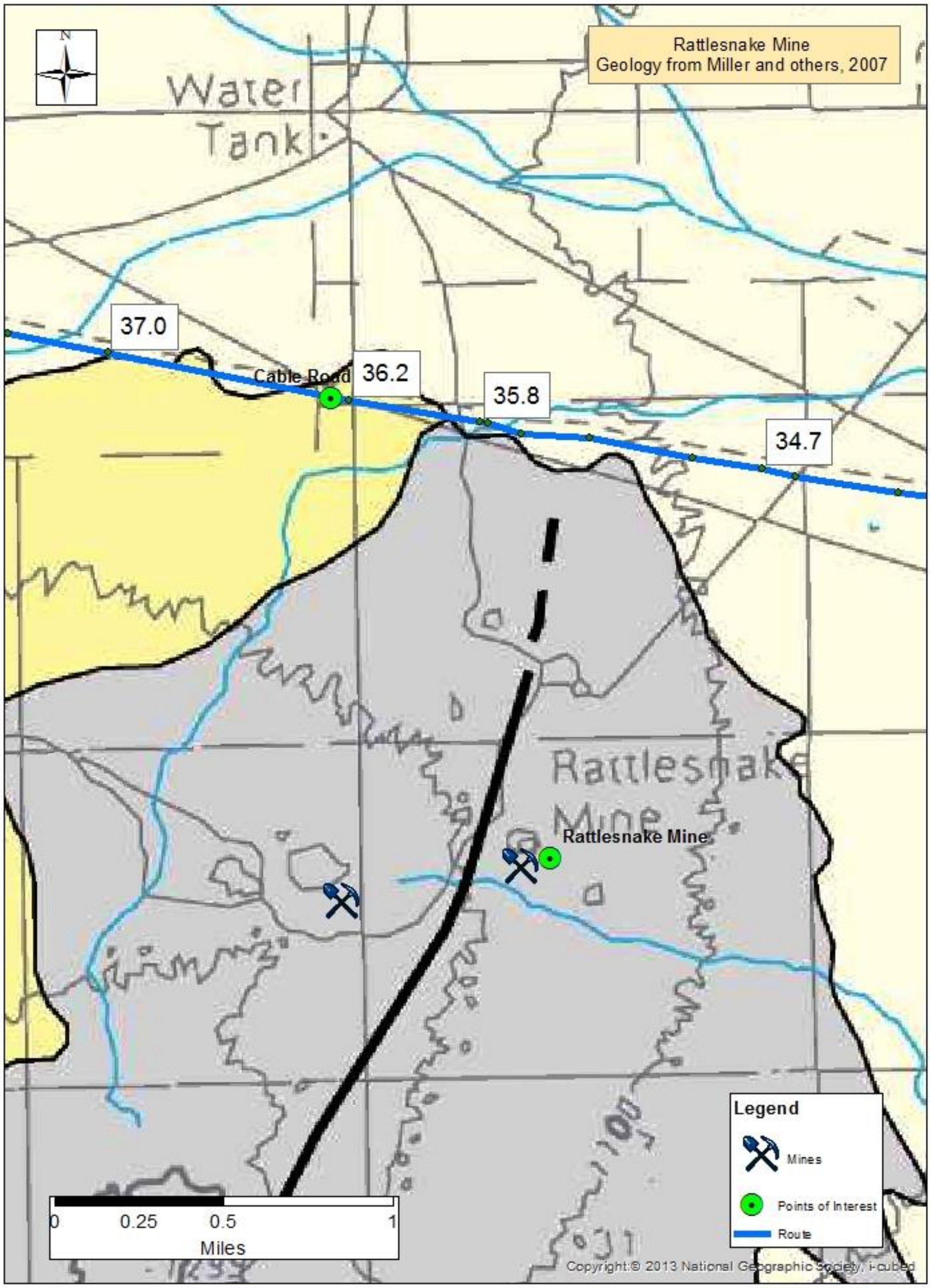


Figure 22. Rattle Snake Mine.

35.9 Geologic Contact

Heading west, the OMR crosses into Pliocene-Pleistocene Gravel (QTg) of Miller and others (2007); Late to Middle Pleistocene Intermediate alluvial fan deposits composed of grus (Qiag/fpg) of Miller (2012). We will be in the QTg unit until Mile 37.3.

36.2 Cable Road Intersection

The geologic materials here are Plio-Pleistocene Gravel (QTg, Miller and others, 2007).

37.0 to 43.7 WESTERN LANFAIR VALLEY: VONTRIGGER HILLS TO GROTTO HILLS

Between the northwestern edge of the Vontrigger Hills and Grotto Hills (mile 43.3) the quaternary rocks of Lanfair valley are Late to Middle Pleistocene Intermediate alluvial fan deposits composed of (Qiag) of Miller (2012).

Between the Grotto Hills and the easten edge of Mid Hills, the quaternary rocks of Lanfair valley are also Late to Middle Pleistocene Intermediate alluvial fan deposits composed of grus (Qiag) of Miller (2012).

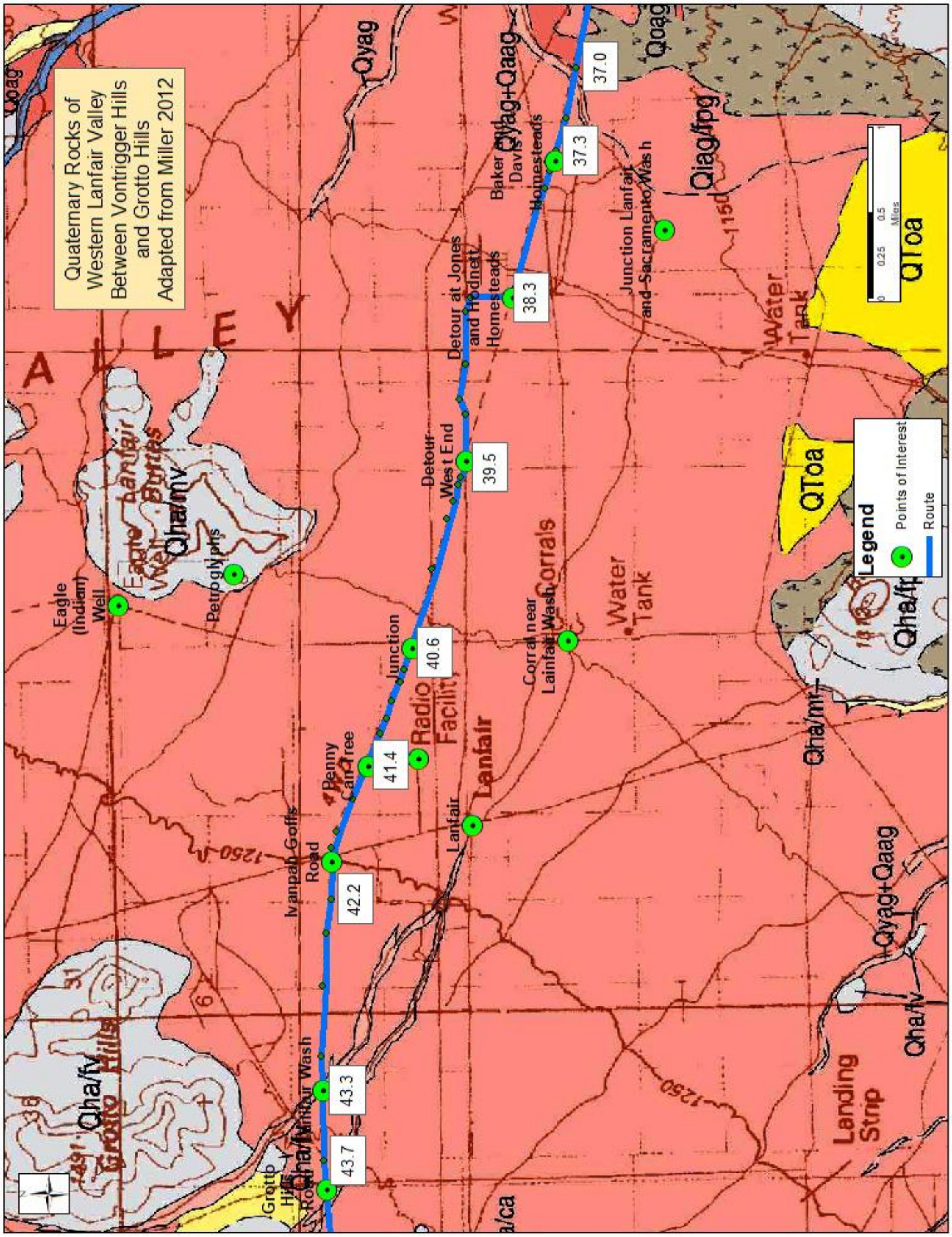


Figure 23. Quaternary rocks of Lanfair Valey between Vontrigger Hills and Grotto Hills. Adapted from Miller, 2012

37.0 Geologic Contact

Heading west, the OMR crosses from Pliocene-Pleistocene Gravel (QTg) to Quaternary Fanglomerate (Qaf) of Miller and others (2007). We will be traveling on the Qaf unit until Mile 49. Miller (2012) mapped these rocks as Qiag

37.3 Estella Baker and Thomas F. Davis Homesteads

The land patent for the Estella Baker Homestead (Patent No. 855811) was granted on May 23, 1922 for 40 acres in T.12N, R.17E, Section 14, Lot 80 and Section 15, Lot 80, SBM. This patent was issued under the authority of the May 20, 1962 Homestead Entry Original Act (12 Stat. 392). That patent was signed by President Warren Harding.
For a copy of the patent, see
https://glorecords.blm.gov/details/patent/default.aspx?accession=855811&docClass=SER&sid=s1vreriy.35l and Appendix 37.3A

The Thomas F. Davis Homestead (Patent No. 1032330) was granted on December 29, 1916 for 646.88 acres under the provisions of the Homestead Entry-Stock Raising Act (39 Stat. 862). This patent covered lands in T.12N, R.17E, Sections 11, 14, 15 and 23, SBM. That patent was signed by President Herbert Hoover.
For a copy of the patent see
https://glorecords.blm.gov/details/patent/default.aspx?accession=1032330&docClass=SER&sid=s1vreriy.35l and Appendix 37.3B
The geologic materials here are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007).

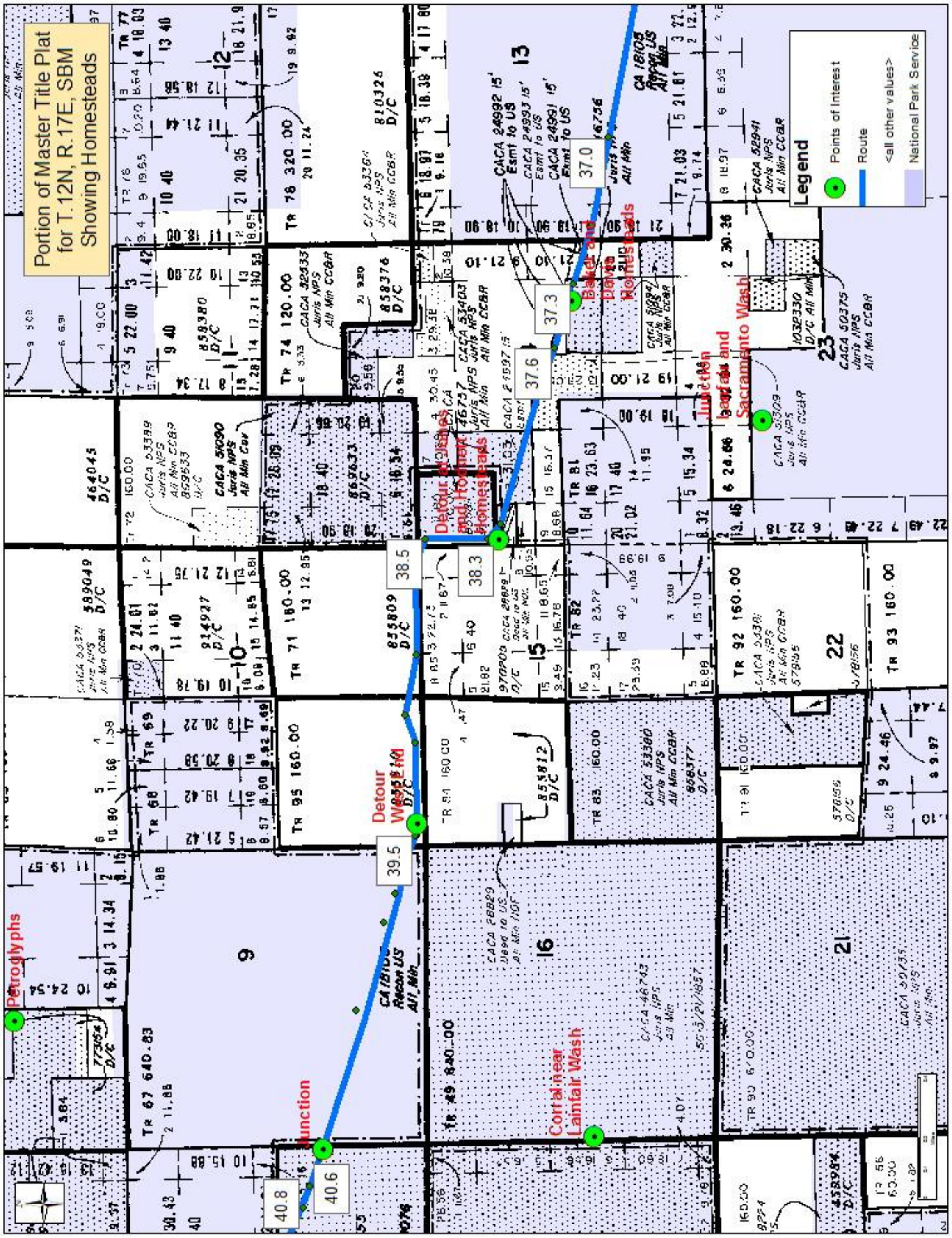


Figure 24. Portion of Master Title Plat for T.12N, R.17E, SBM.

37.6 Lanfair Valley Area Overlook

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

To the east is the Piute Mountains made mostly of Miocene Dacite (Td) to the north and Cretaceous Porphyritic Monzogranite (Kpm) to the south. To the north is Guiardo Hills (a.k.a Grotto Hills) and Castle Mountain made mostly Miocene Peach Springs Tuff (Tps). To the north-northwest is Eagle Mountain that has Miocene shallow intrusive rocks (Ti) at the summit and Miocene younger volcanic rocks (Tv1) on its flanks. The Tv1 unit has rhyolite lava flows and ash flows, basalt flows and dacite flows that overlie the Peach Springs Tuff. To slightly south of west is Table Top Mountain with its summit of Miocene Wild Horse Mesa Rhyolite Tuff (Tw) and it's bulk of Cretaceous Rock Springs Monzodiorite (Krs). To the southwest are the Hackberry mountains exposing mostly Miocene Wild Horse Mesa Rhyolite Tuff (Tw) and Miocene Hacberry Springs Volcanics (Ths). Beyond the Hackberry Mountains are the Woods Mountain which is mostly Tortoise Shell Mountain Rhyolite (Tts) of the Woods Mountain Cauldera. To the south are the Vontrigger Hills made mostly of Proterozoic Precambrian Granite (Xg1). Southwest and west of the Woods Mountains are the Providence Mountains which has Cambrian Dolomite (€d) and Siliciclastic Rocks (€Zs) rocks to the southwest, a northern core of Precambrian Granite (Xg1) and an eastern flank of Miocene Wild Horse Mesa Rhyolite Tuff (Tw) (Miller and others, 2007).

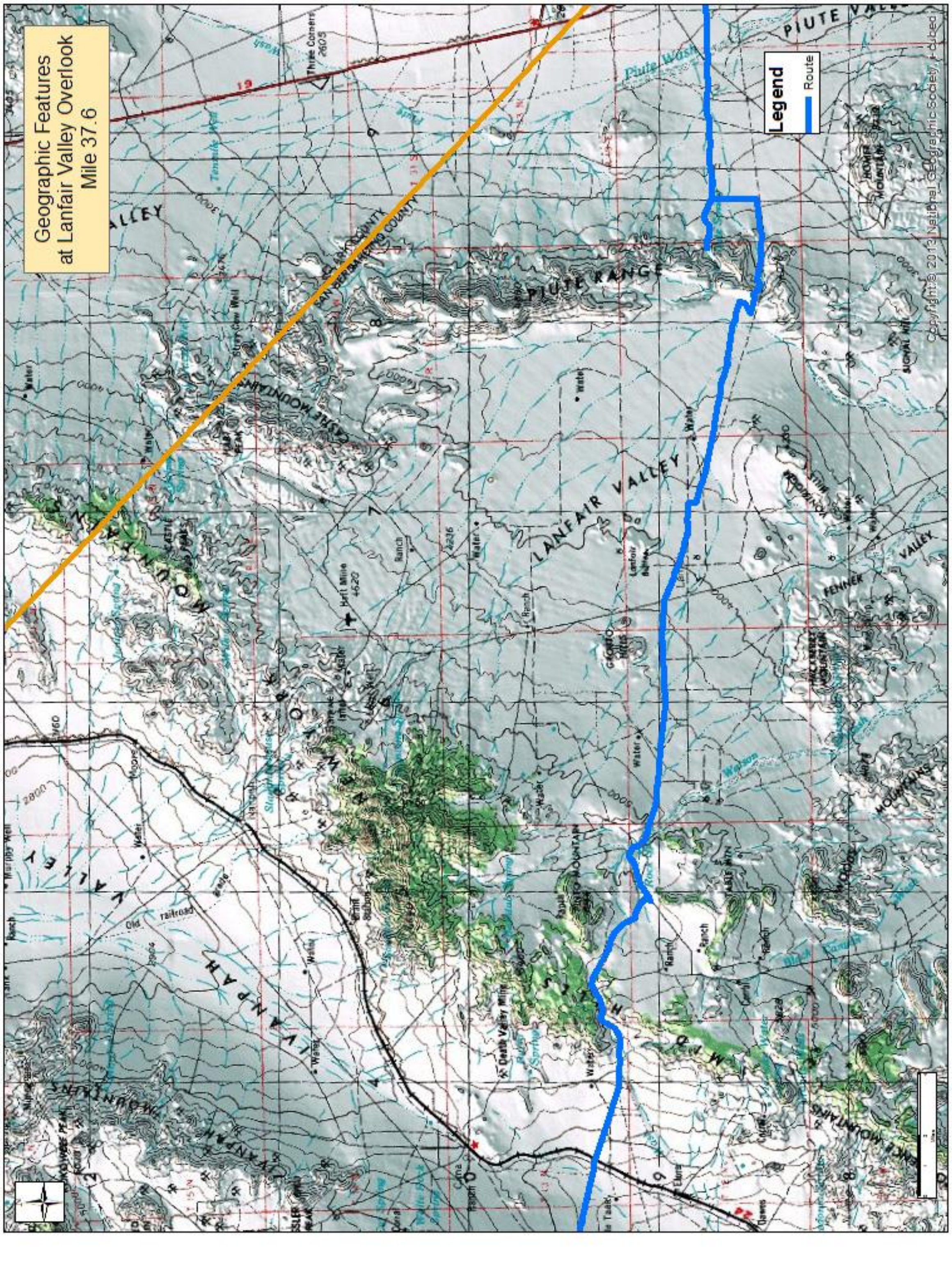


Figure 25. Geographic features viable from the Lanfair Valley Overlook.

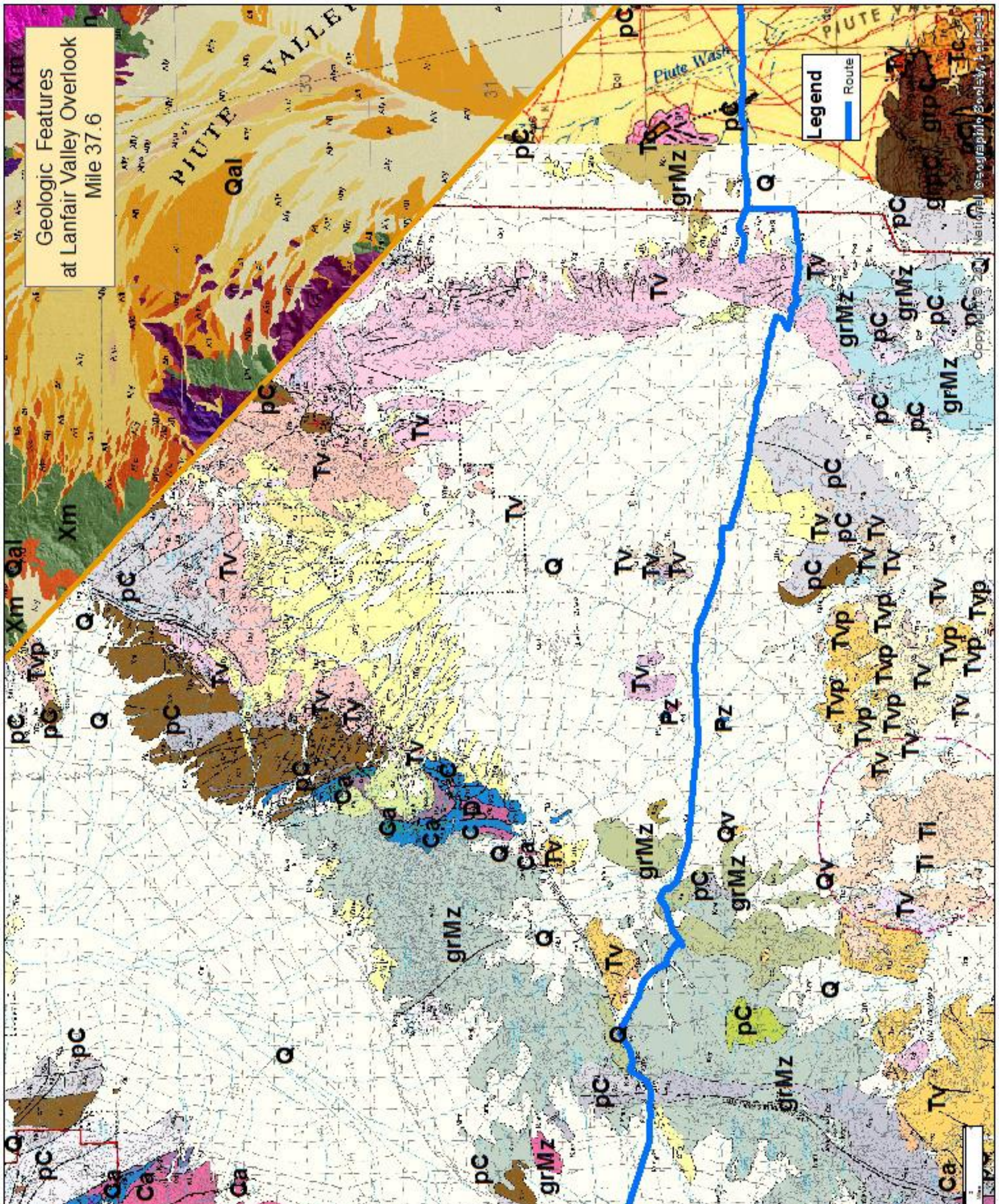


Figure 26. Geologic features visible from the Lanfair Valley Overlook. Adapted from Miller and othes, 2007 and Howard and others, 2010.

38.3 Anna Jones and Ulyses Hodnett Homesteads at Eastern Side of Detour

The Anna Jones Homestead (Patent No. 970205) was granted on November 11, 1925 for 163.1 acres under provisions of the May 20, 1862: Homestead Entry Original Act (12 Stat. 392). This patent covered lands in T.12N, R.17E, Section 15, SBM. That patent was signed by President Calvin Coolidge

For a copy of the patent, see https://glorecords.blm.gov/details/patent/default.aspx?accession=970205&docClass=SER&sid=1hfs3bmn.hqk#patentDetailsTabIndex=0 and Appendix 38.3.

The Ulyses Hodnett Homestead (Patent No. 855811) was granted on May 23, 1922 for 160.0 acers under provisions of the May 20, 1862: Homestead Entry Original Act (12 Stat. 392). This patent covered lands in T.12N, R.17E, Sections 15 and 16, SBM. That patent was signed by President Warren Harding.

For a copy of this patent see https://glorecords.blm.gov/details/patent/default.aspx?accession=855812&docClass=SER&sid=1hfs3bmn.hqk#patentDetailsTabIndex=0 and Appendix 38.3

A portion of the Master Title Plat for T.12N, R.17E, SBM showing these patents are above at mile 37.3.

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

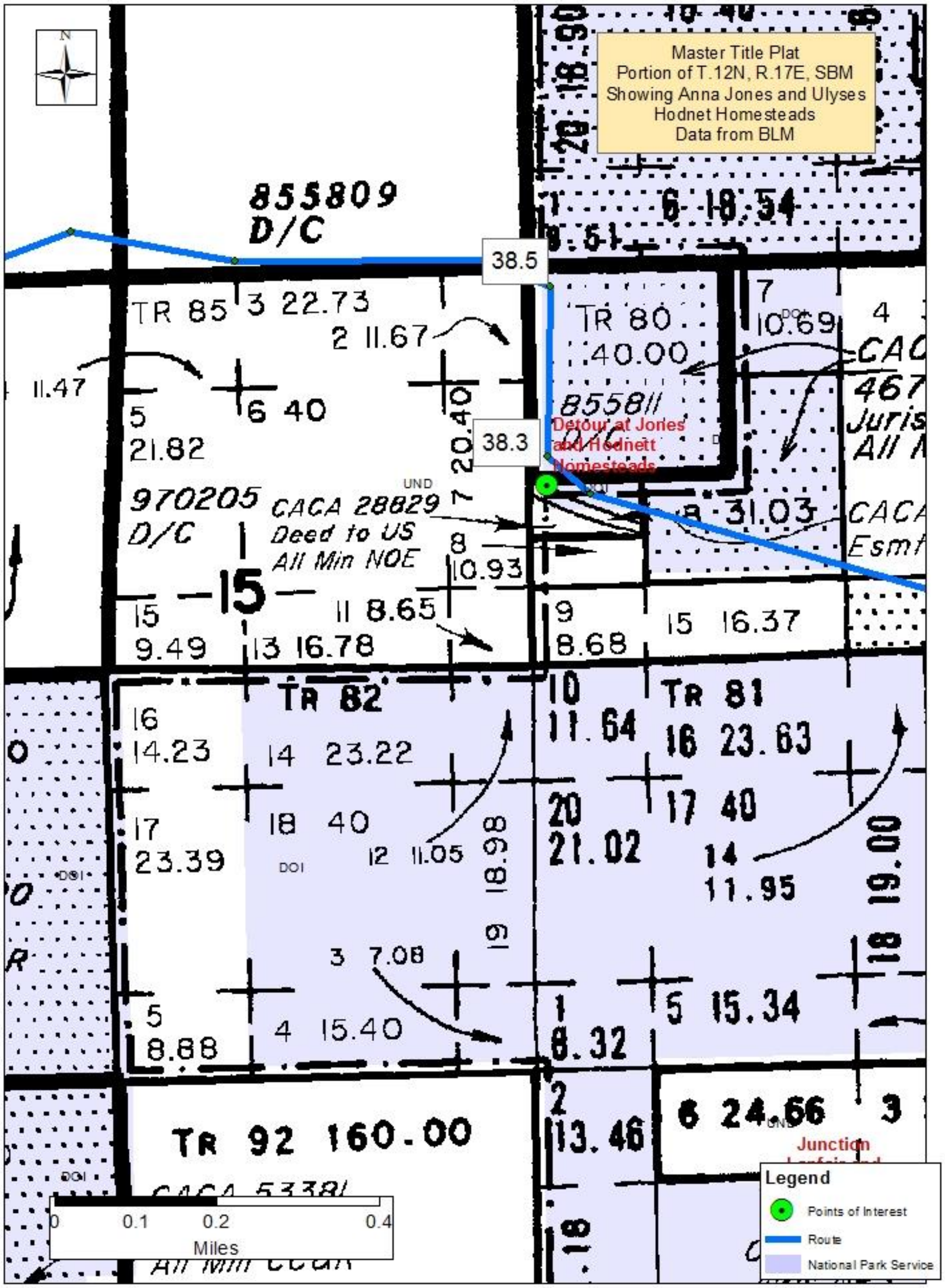


Figure 27. Portion of Master Title Plat for T.12N, R.17E, SBM.

38.5 Road Intersection

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

AREA MAP A-07

39.5 Cholla cacti at Western Side of Detour

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

40.1 Cable Road Intersection

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

40.6 Road Intersection Indian Hill Road

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

To the north-northeast is Eagle Mountain (also called Lanfare Buttes) that has Miocene shallow intrusive rocks (Ti) at the summit and Miocene younger volcanic rocks (Tv1) on its flanks. The Tv1 unit has rhyolite lava flows and ash flows, basalt flows and dacite flows that overlie the Peach Springs Tuff. There are petroglyphs in the northeast quarter of Section 42.

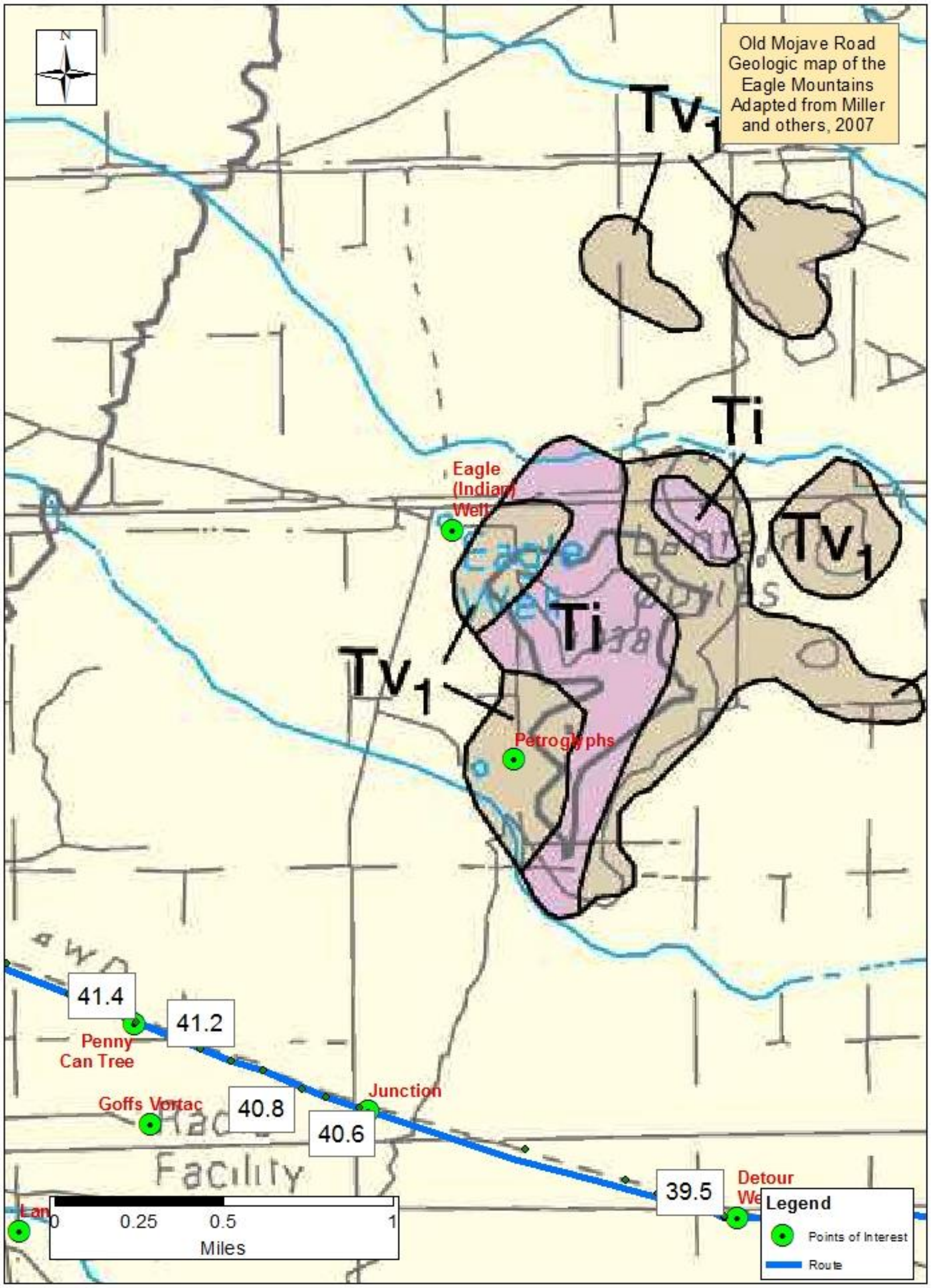


Figure 28. Geologic Map of the Eagle Mountains (Lanfair Buttes). Adapted from Miller and others, 2007.

40.8 Lanfair, Hodnett and Williams Homesteads

The Ernest L. Lanfair Homestead (Patent No. 800076) was granted on May 18, 1921 for 320 acres under provisions of the May 20, 1862: Homestead Entry Original Act (12 Stat. 392). This patent covered lands in T.12N, R.17E, Sections 7, 8, 17 and 18, SBM. That patent was signed by President Warren G. Harding.
For a copy of the patent, see https://glorecords.blm.gov/details/patent/default.aspx?accession=800076&docClass=SER&sid=css34tph.yzc#patentDetailsTabIndex=0 and Appendix Mile 40.8

The Matthew Hodnett Homestead (Patent No. 855816) was granted on May 23, 1922 for 160.0 acres under provisions of the May 20, 1862: Homestead Entry Original Act (12 Stat. 392). This patent covered lands in T.12N, R.17E, Sections 7 and 8, SBM. That patent was signed by President Warren Harding.
For a copy of the patent, see https://glorecords.blm.gov/details/patent/default.aspx?accession=855816&docClass=SER&sid=css34tph.yzc#patentDetailsTabIndex=0 and Appendix Mile 40.8

The William C. Williams Homestead (Patent No 855822) was granted on May 23, 1922 for 160.0 acres under provisions of the May 20, 1862: Homestead Entry Original Act (12 Stat. 392). This patent covered lands in T.12N, R.17E, Section 7, SBM. That patent was signed by President Warren Harding. This land is still in private ownership
For a copy of the patent see https://glorecords.blm.gov/details/patent/default.aspx?accession=855822&docClass=SER&sid=css34tph.yzc#patentDetailsTabIndex=1 and Appendix 40.8

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

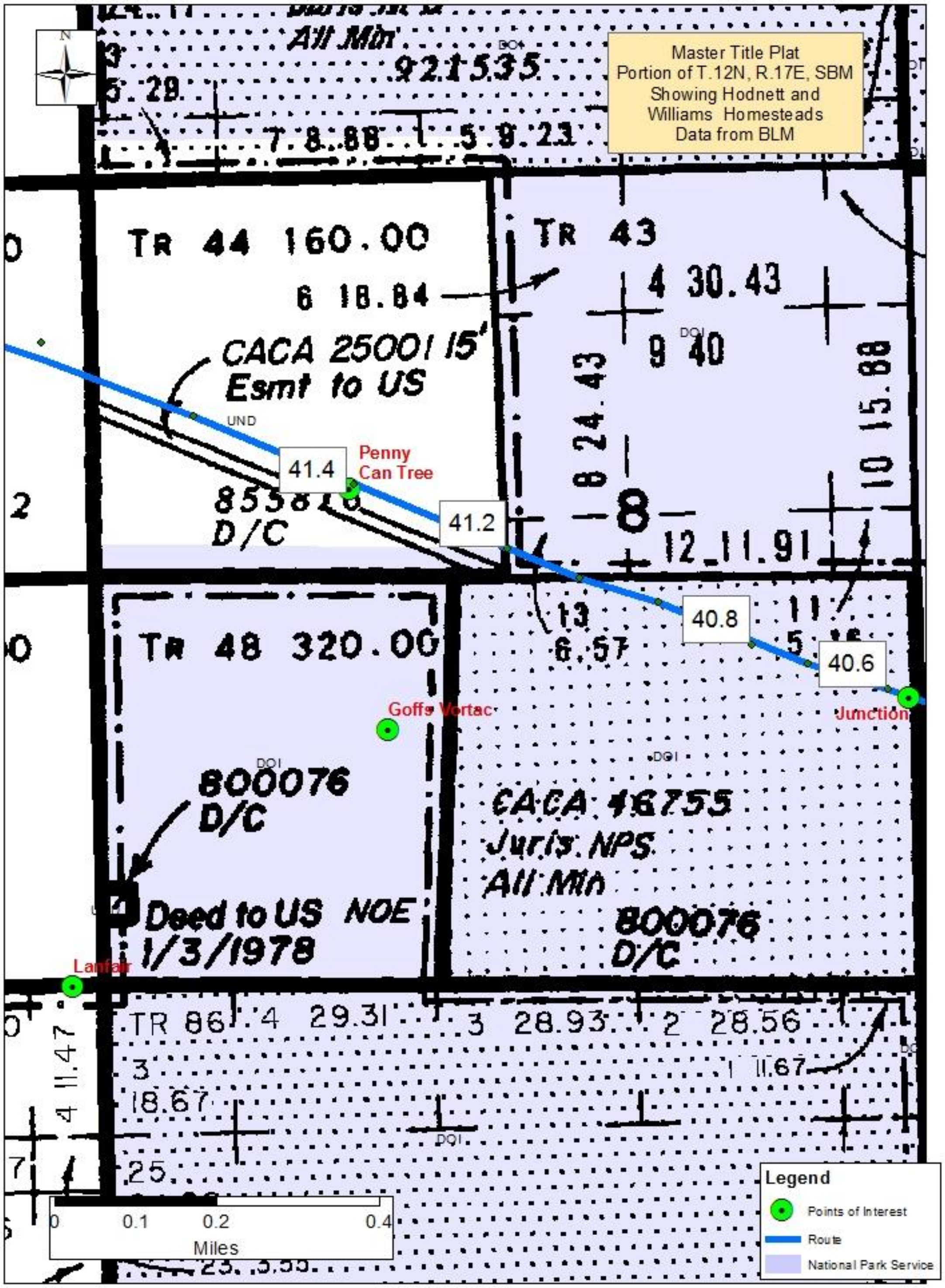


Figure 29. Portion of Master Title Plat for T.12N, R.17E, SBM.

41.2 Radio Facility Viewpoint

The USGS topographic map for this area (as well as the map of Miller and others, 2007) describes the buildings to the south as a “Radio Facility.” The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). For information about the facility, see Casebeir (2016, p. 77).

41.4 Penny Can

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

42.0 Intersection with Ivanpah-Lanfair Road

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

Reynolds and Weasma (2005, p. 9) gave the following description of this site:

Intersection of Ivanpah and Lanfair roads. The site of the Lanfair school house is to the northeast. Lanfair was a community center in the 1890s–1930s. The Nevada Southern Railroad brought supplies from Needles to mines in the mountains surrounding Lanfair Valley and connected with Manvel (Barnwell) in 1893 (Myrick, 1963). The California Eastern Railroad was continued to Ivanpah in 1902 to receive ore from the Copper World Mine and the Vanderbilt Mine. When the Tonopah & Tidewater Railroad siphoned off trade in 1907, the Santa Fe built the Barnwell & Searchlight Railway to service mines and communities. Labor difficulties and severe washouts halted rail service to Barnwell by 1923 (Myrick, 1963). Homesteaders, often working in the mines and for the railroad, grew dry crops on their 40-acre parcels and sent their children to school at Lanfair. In the hot summer months, railroad workers in Needles sent their families to the cooler reaches of Fourth of July Canyon (Reynolds and Weasma, 2005, p. 9).

42.05 Roadbed of the old Nevada Southern Railway

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). For information about the Nevada Southern Railway, see Casebeir (2016, p. 79).

42.2 Viewpoint for Grotto Hills

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

The Grotto Hills, to the northwest, has three parts. The central and eastern hills are Miocene Shallow Intrusive Rocks (Ti). The western hill is Permian-Devonian Limestone (PDl, northwest half) and Cambrian Dolomite (€d, southeast half).

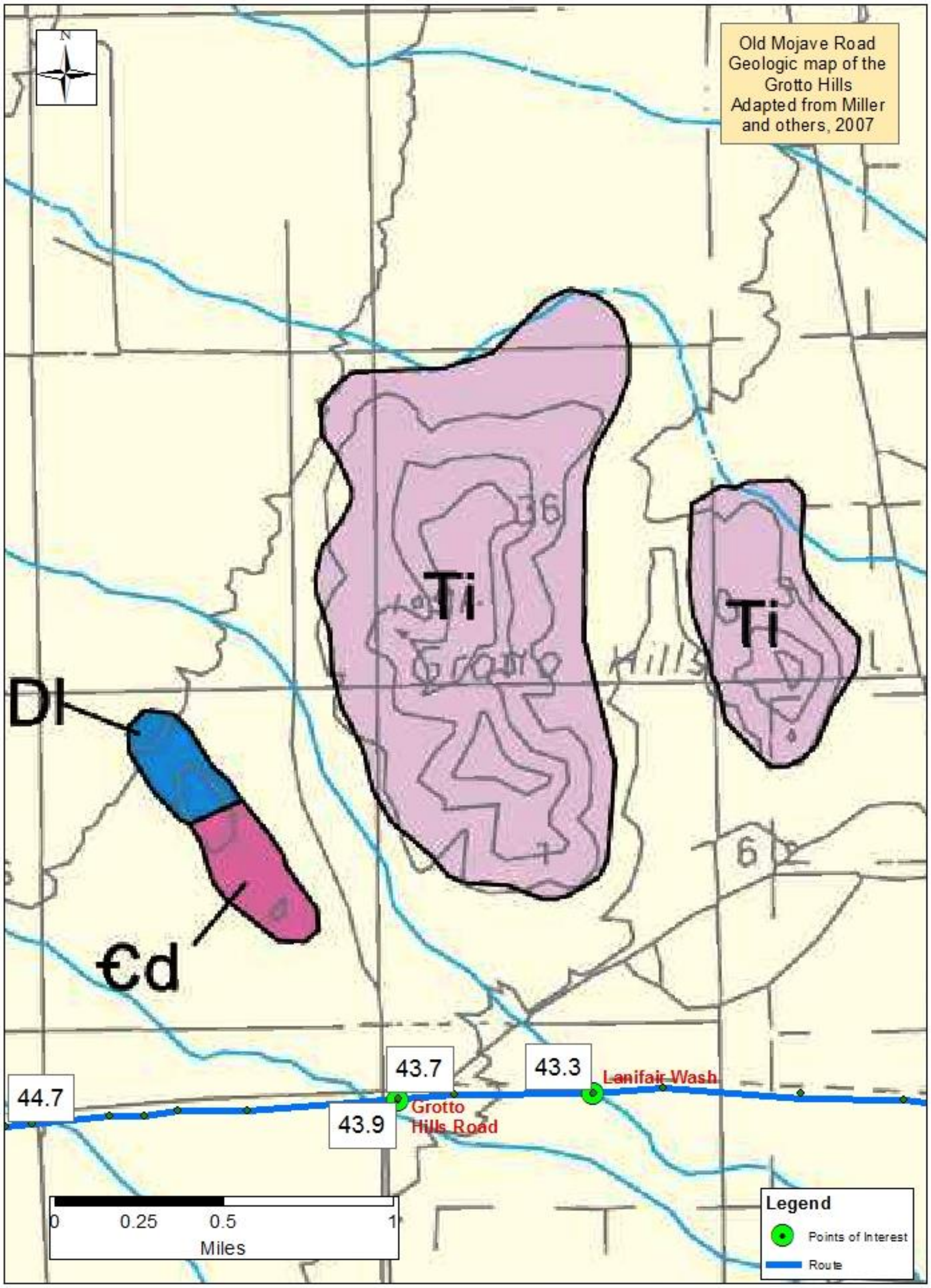


Figure 30. Geologic map of the Grotto Hills. Adapted from Miller and others, 2007.

43.3 Lanfair Wash

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

At this point, the direction of flow for this ephemeral stream is to the southeast. Storm waters drains from here through the town of Lanfair, then through the corral in lot 86 (Section 17 of T.12N, R.17E, SBM), and thence to a confluence with the Sacramento Wash in Section 23 of T.12N, R.17E, SBM. From that confluence the Sacramento Wash drains northeastward through Mile 37 on the OMR, curving northeast and then southeast (around the northeastern flank the Vontriegger Hills) and through Mile 33.5 on the OMR. From there storm waters of Sacramento Wash flow south-southeastward until they hit the southern end of the Piute Mountains where they make a 90-degree bend and flow to the southwest to the southwestern tip of the Piute Mountain. From there the storm waters flow south to a point east of Goffs, crossing the Santa Fe Railroad in a zone of wide braided streams in Section 36 of T.10N, R.19E, SBM. From their storm waters drain eastward passing near Bannock, and Arrowhead Junction. The Sacramento Wash merges into Piute Wash in T.10N, R.21E, Section 3, SBM. From there water drains south to Klinefelter Siding thence passing north of Java Siding to reach the Colorado River at Needles (USGS Topographic maps). This drainage system is 53.5 miles in length. See map in Appendix 43.3.

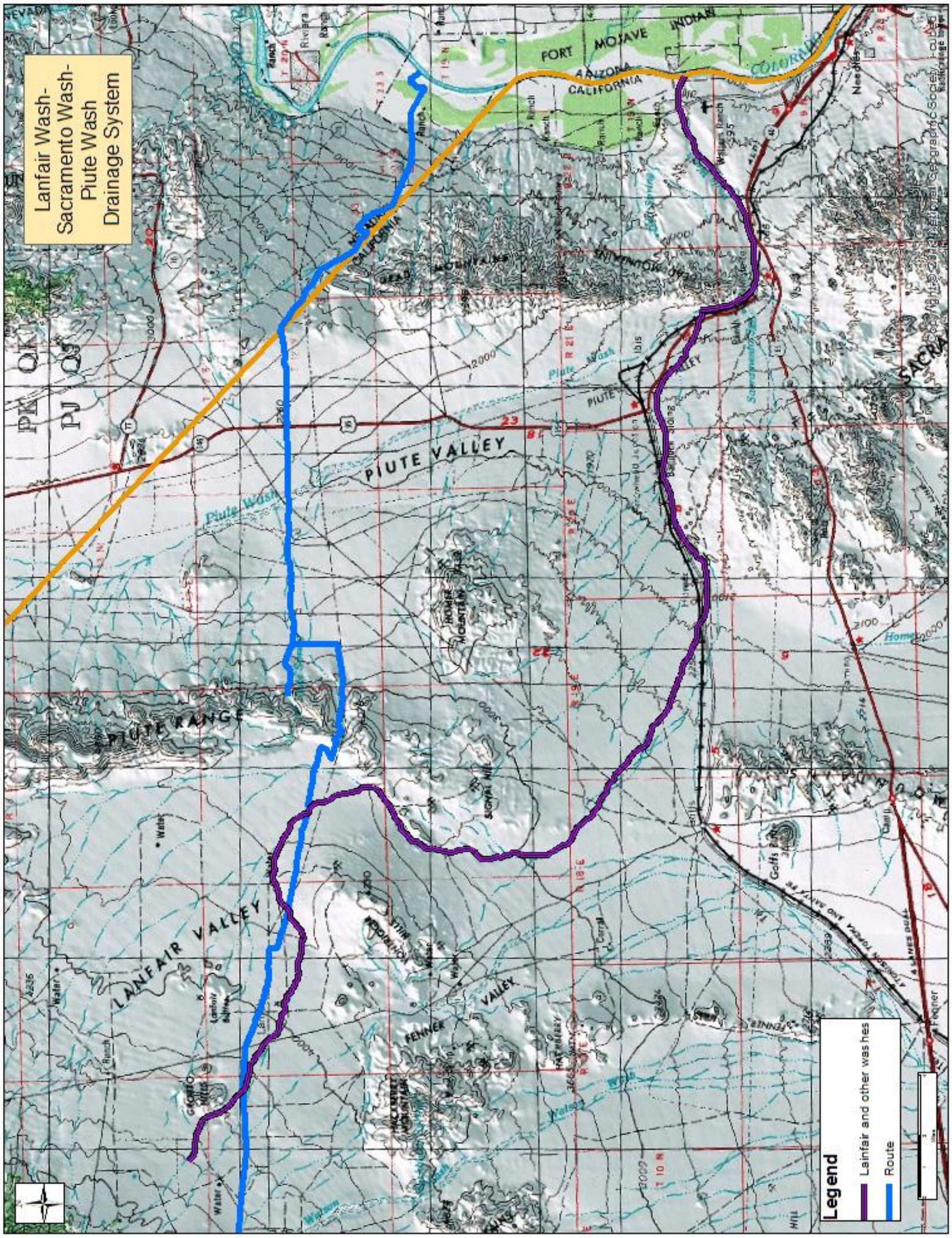


Figure 31. Lanfair-Sacramento-Piute wash drainage systems.

43.7 to 48.6: GROTTO HILLS TO MID HILLS

From the Grotto Hills to the Mid Hills, the OMR is atop Quaternary Alluvium (Qal of Jennings, 1961) and Quaternary Fanglomerate (Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

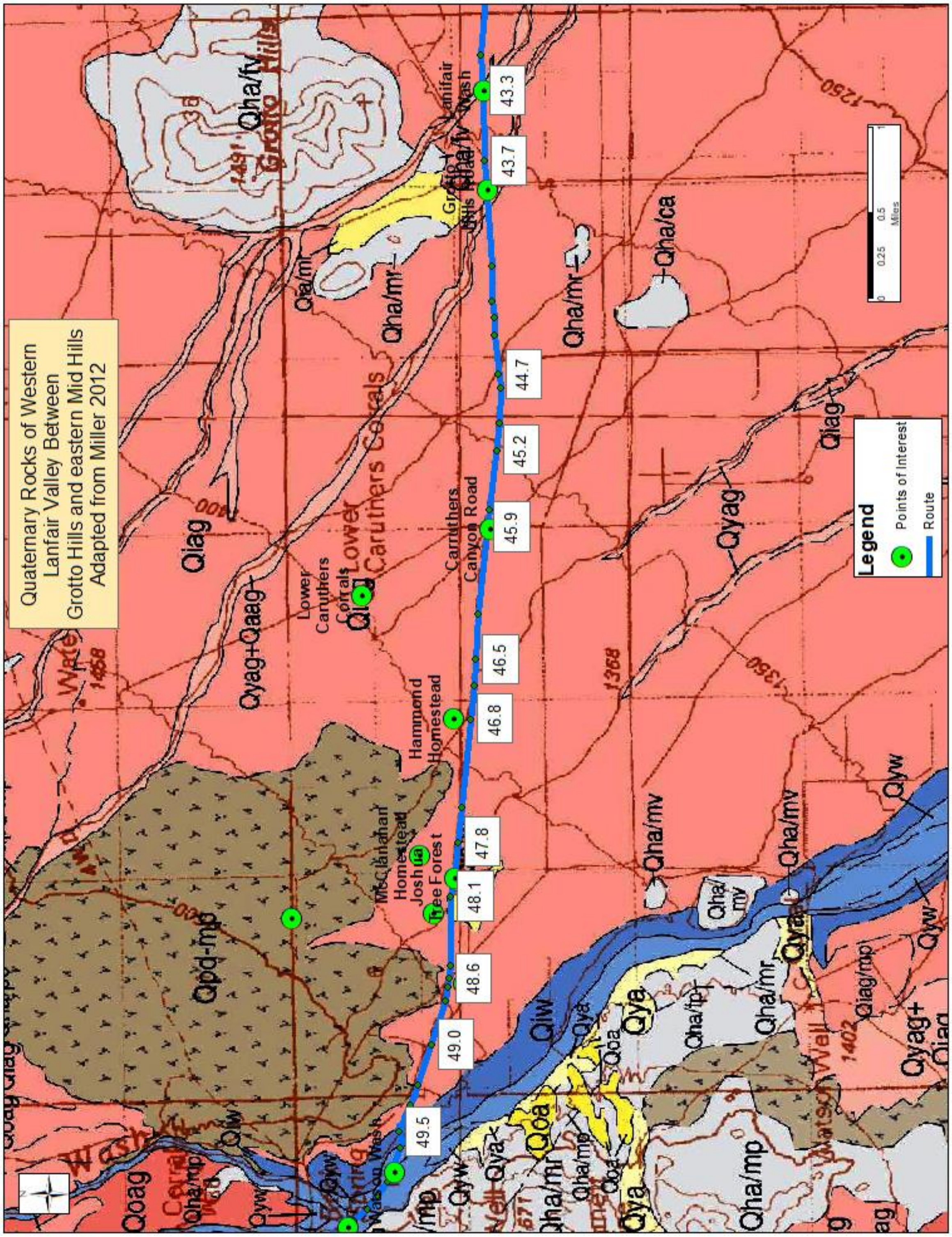


Figure 32. Quaternary geologic map of Lanfair Valley between Grotto Hills and Mid Hills. adapted from Miller, 2012.

43.7 Junction of the Mojave Road and El Dorado Canon Road

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

AREA MAP A-08

43.9 Intersection with Grotto Hills Road

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

44.0 Unnamed Wash and Viewpoint for New York Mountains

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

The southeast flank of the New York Mountains are cut by the Cedar Canyon Fault which extends from the East Providence Fault Zone near Mile 58.3 (Section 36, T.13N, R.14E, SBM) thence to the valley separating Pinto Mountain from the New York Mountains and on to the southern end of Caruther's Canyon (Section 7, T.13N, R.16E, SBM). Most of the southwestern New York Mountains and the Mid Hills are Cretaceous Mid-Hills Adamellite (Kmh). These rocks are part of the Teutonia Batholith. The central part of the New York Mountains are Permian-Devonian Limestone (PDL) and Cambrian Dolomite (€d). The northeastern end of the New York Mountains is Early Proterozoic Migmatite (Xm) and Early Proterozoic Younger Granitoids (Xg1, 1,6660-1,695 m.y.). To the southeast of these rocks are Miocene Andesite and Basalt (Tab), Pliocene and Miocene Gravel (Tg) and Pleistocene and Pliocene Gravel (QTg) on the southeast flank (Miller and others, 2007).

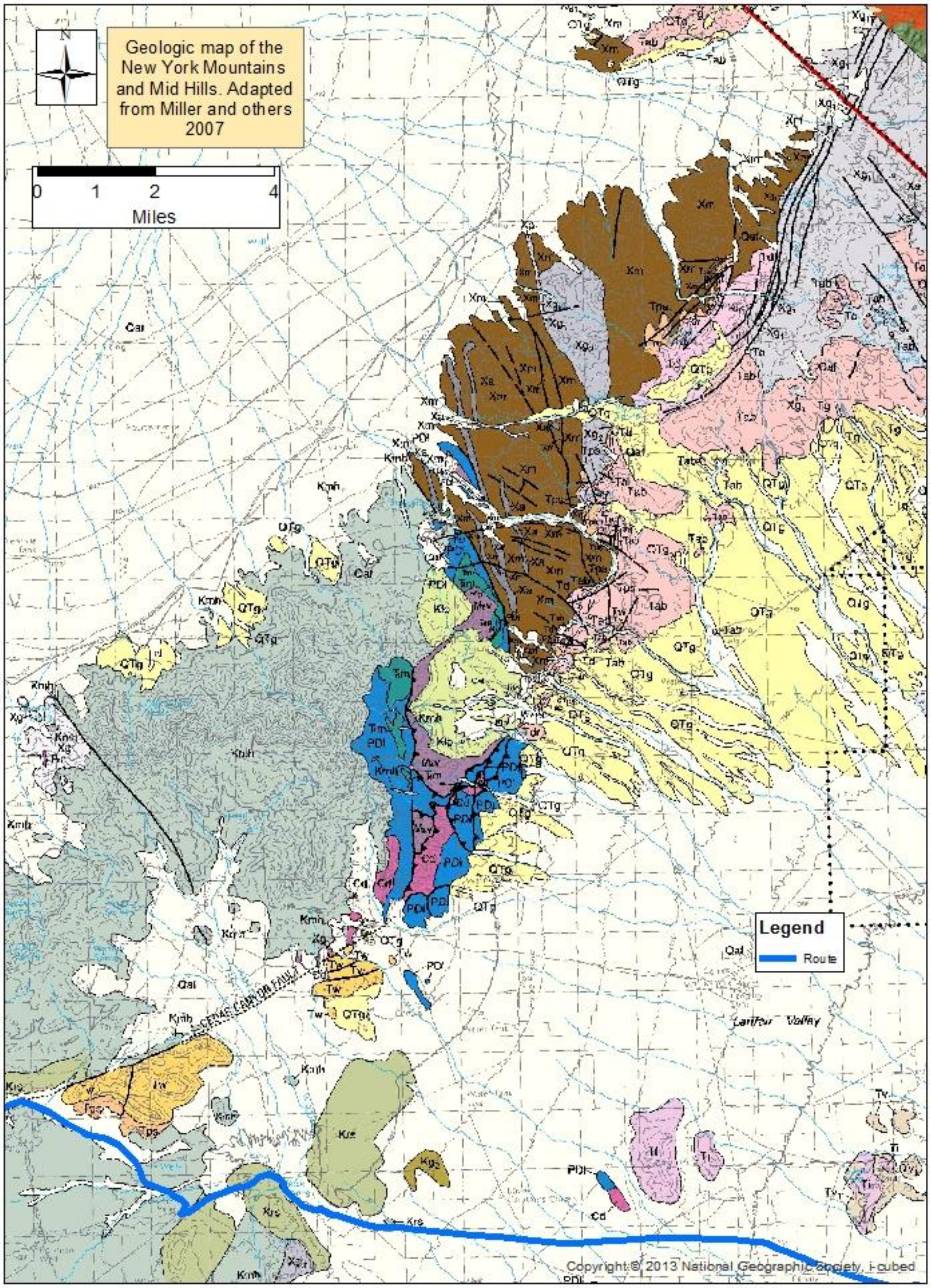


Figure 33. Geologic map of the Southwestern flank of the New York Mountains. Adapted from Miller and others, 2007.

The Pinto Mountains, to the east of the central New York Mountains, and southeast of the Cedar Canyon Fault are underlain by Rhyolite Tuff of Wild Horse Mesa (Tw of Miller and others, 2007).

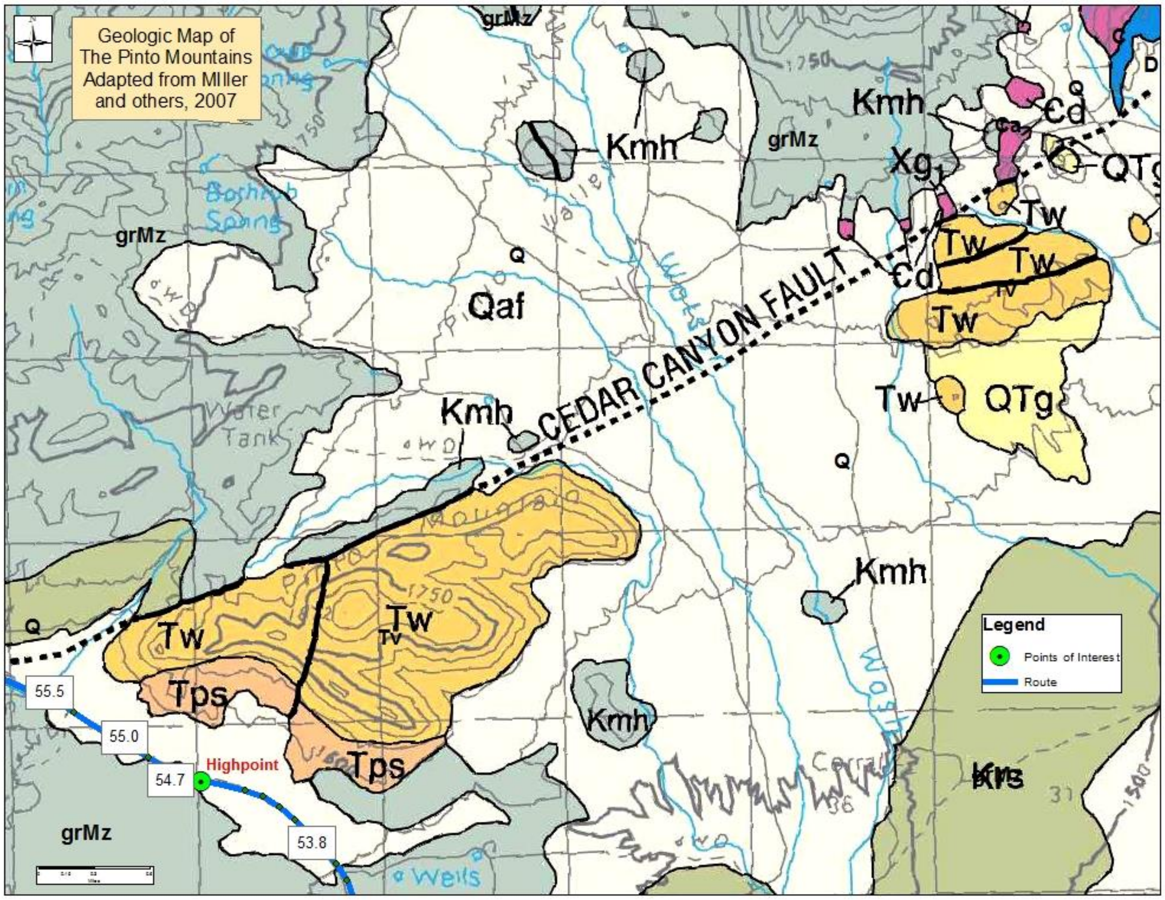


Figure 34. Geologic map of the Pinto Mountains. Adapted from Miller and others, 2007.

44.7 Deep Cut on Old Mojave Road

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

44.9 Ashwell Road Intersection

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

45.2 Homestead of Jacob Halley

The Jacob Halley Homestead (Patent No. 999472) was granted on May 1, 1927 for 320,0 acres under provisions of the May 20, 1862: Homestead Entry Original Act (12 Stat. 392). This patent covered lands in T.12N, R.16E, NE ¼ of Section 9 and NW1/4 of Section 10, SBM. That patent was signed by President Calvin Coolidge.

For a copy of the patent, see
https://glorecords.blm.gov/details/patent/default.aspx?accession=999472&docClass=SER&sid=2jjcf0cx.g41 and Appendix 45.2.
Casebeir (2016, p. 81) relates that land in this area was homesteaded, but not patented, by Harry Truman Ford in 1913.

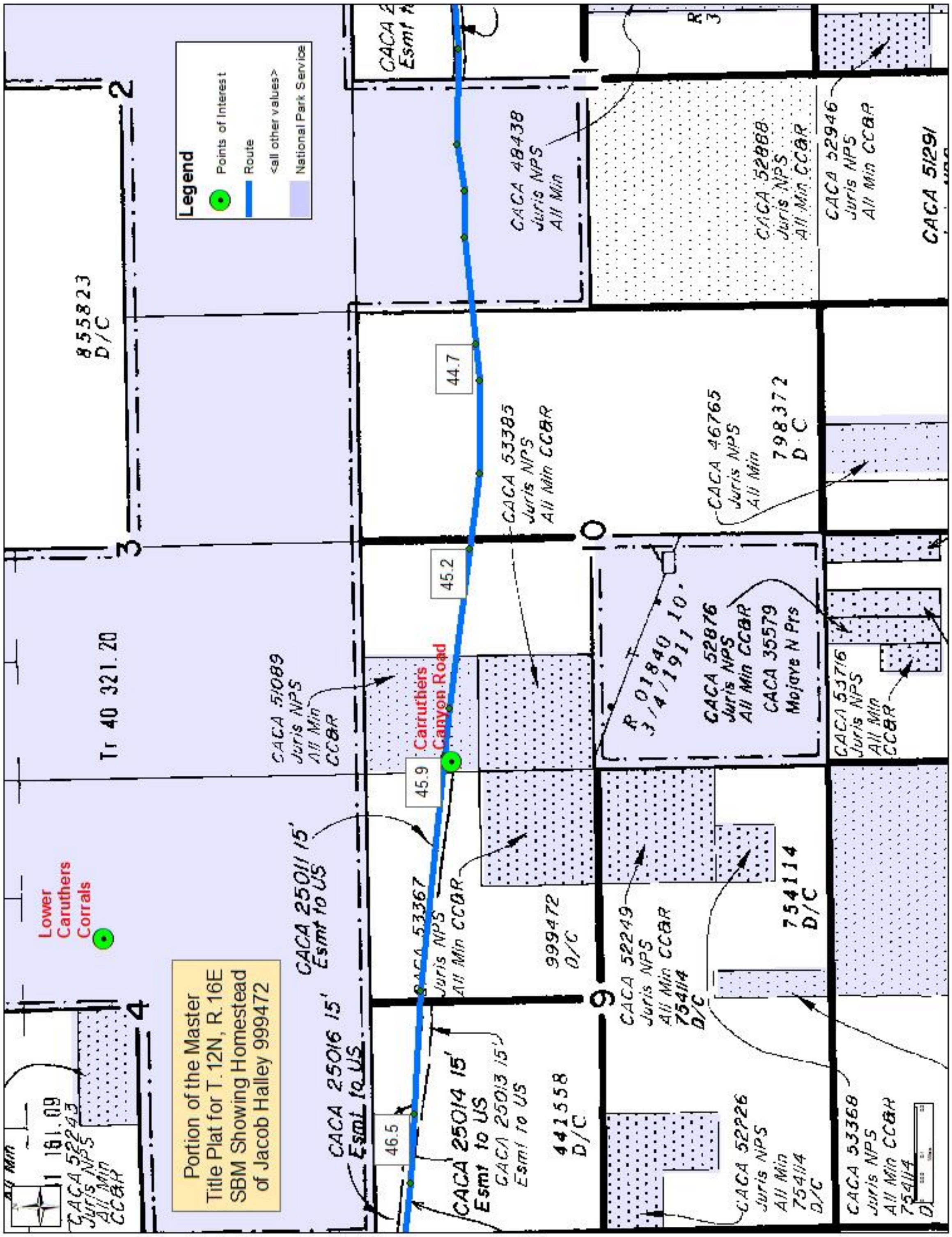


Figure 35. Portion of the Master Title Plat for T.12N, R.16E, SBM showing the Jacob Halley Homestead.

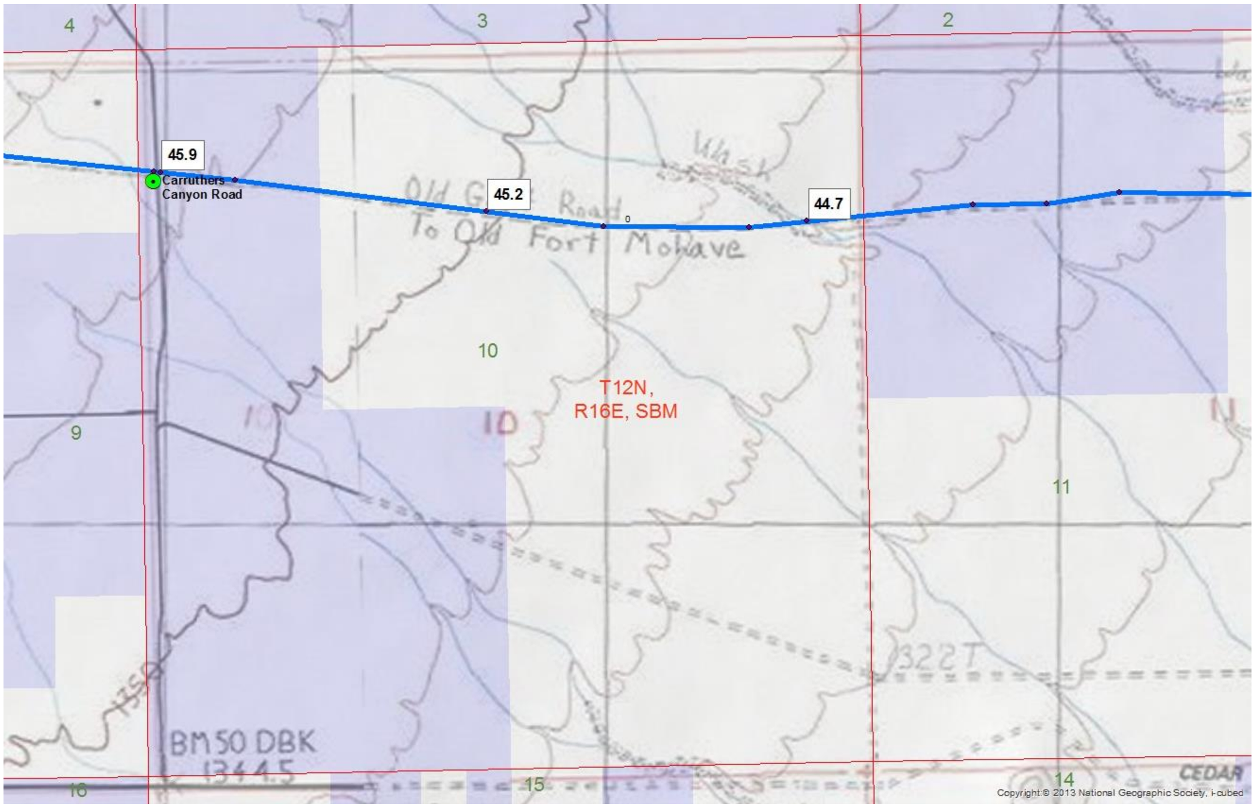


Figure 36. Present land ownership in T.12N, R.16E, Section 10. White is private, purple is NPS.

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

45.9 Intersection with Carruthers Canyon Road.

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

46.8 Welch and Hammond Homestead

For information about the Welch Homestead see Casebier (2016, p. 83-84).

The aerial photograph for T.12N., R.16E, Section 5, SW1/4, SBM shows trace disturbance.

Figure 37. Aerial photograph of Welsh-McClanahan Patent.

The Thomas B. Hammond (Patent No. 844712) was granted on January 23, 1922 for 160.0acres under provisions of the May 20, 1862: Homestead Entry Original Act (12 Stat. 392). This patent covered lands in T.12N, R.16E, SE ¼ of Section 5, SBM. That patent was signed by President Warren Harding.

For a copy of the patent, see https://glorecords.blm.gov/details/patent/default.aspx?accession=844712&docClass=SER&sid=4t2fdgaw.v5i#patentDetailsTabIndex=0 and Appendix 46.8. A map of the patents is shown in Figure 28.

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

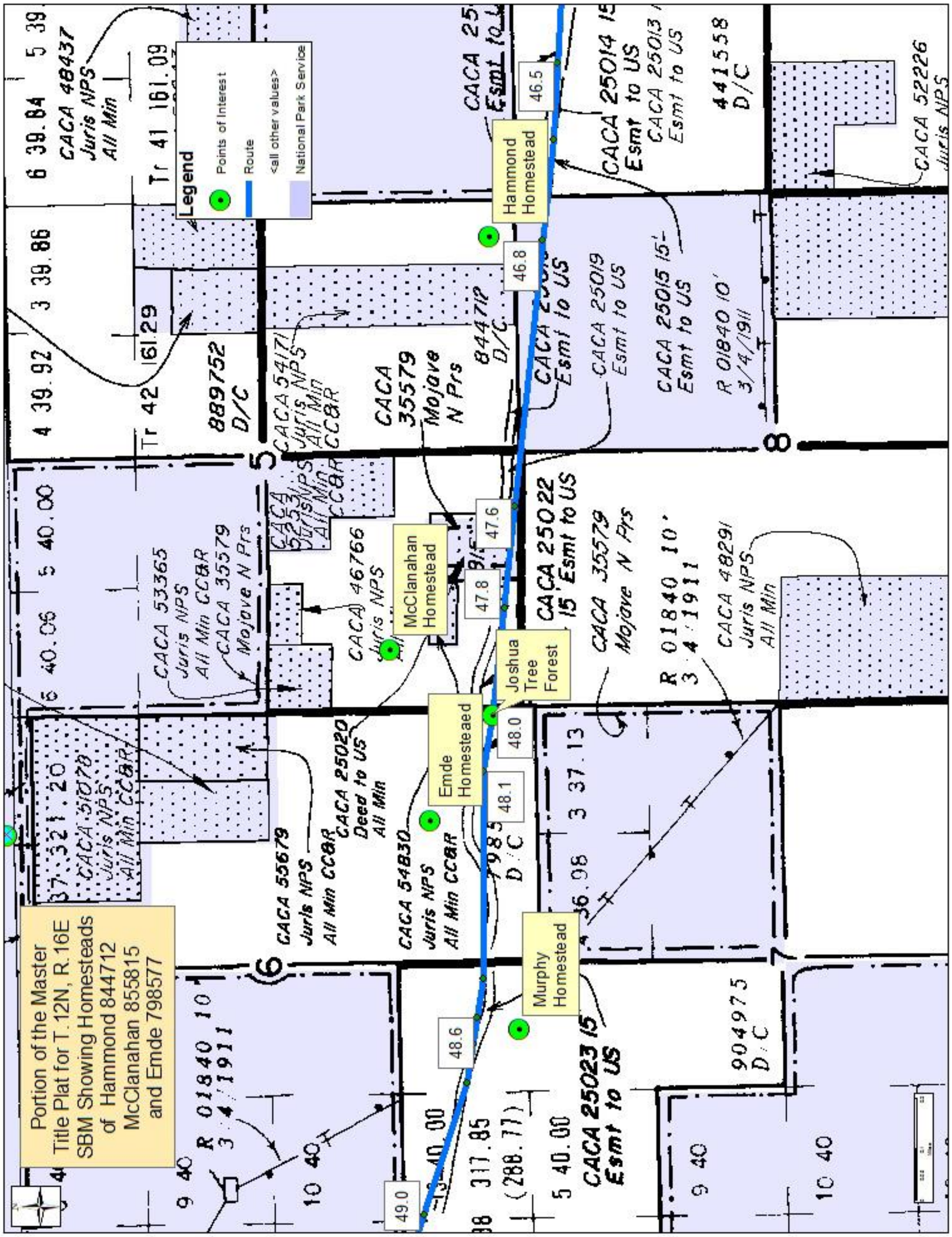


Figure 38. Portion of the Master Title Plat for T.12N, R.1E showing the Hammond, McClanahan, Emde and Murphy Homesteads.

47.6 Blackbush

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

47.8 McClanahan Homestead

The land in this area (T.12N, R.16E, Sec 5, SE1/4) was homesteaded by Lee W. McClanahan (patent No. 855815) on May 23, 1922 for 160.0 acres under provisions of the May 20, 1862: Homestead Entry Original Act (12 Stat. 392). This patent was signed by President Warren Harding. The land was subdivided and some is still in private ownership. Some parcels in the original patent were later acquired by the National Park Service.
For a copy of the patent document, see https://glorecords.blm.gov/details/patent/default.aspx?accession=855815&docClass=SER&sid=4t2fdgaw.v5i and Appendix 47.8. A map of the patents is shown in Figure 28.

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). A low hill can be seen 1.1 miles to the north. It is made of Older Granitoid Rocks of Cretaceous age (Kg2) (Miller and others, 2007).

48.0 Joshua Tree Forest and Emde Homestead

The land in this area (T.12N, R.16E, Section 6, NE1/4, N1/2SE1/4) was homesteaded by Lewis Emde (patent No. 79577) on March 3, 1921 for 321.2 acres under provisions of the May 20, 1862: Homestead Entry Original Act (12 Stat. 392). This patent was signed by President Woodrow Wilson. The land is still in private ownership.
For a copy of the original patent, see https://glorecords.blm.gov/details/patent/default.aspx?accession=798577&docClass=SER&sid=rg2wckrc.se3 and Appendix Mile 48.0. For the MTP information about this patent, see figure 28.

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

48.1 Old Livestock Watering Pond

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

From this point at Mile 48.1 to Mile 50.2, to the north and east, is a low hill of Cretaceous Rock Springs Monzodiorite (Krs) (Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

48.6 Cactus on the Murphy Homestead

The land in this area was homesteaded by Frank D. Murphy (patent No. 904975) on May 3, 1923 for 317.85 acres under provisions of the May 20, 1862: Homestead Entry Original Act (12 Stat. 392). This patent was signed by President William Harding.
For a copy of the patent, see https://glorecords.blm.gov/details/patent/default.aspx?accession=904975&docClass=SER&sid=rg2wckrc.se3 and Appendix 48.6. A map of this and other patents is shown in Figure 28.

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

48.6 to 58.4: MID HILLS

The Mid Hills are mostly Cretaceous Mid Hills Adamelite (Kmh). There are two major faults in the Mid Hills. The northern one is the Cedar Canyon Fault. It strikes north-northeast in the middle-eastern part of the Mid Hills. On Jenkin's map (1961) this fault extends 27 miles southwest from Caruther's Canyon in the south-central New York Mountains to the town of Kelso (See Appendix 48.6B). Miller and others (2007) do not extend the Cedar Canyon Fault that far west. Instead, they show the East Providence Fault zone cropping out along the centerline of the southern Mid Hills. This fault crosses, but does not off-set, the Cedar Canyon Fault at Mile 58.4. There is a band of Early Proterozoic Intermediate-age Granitoids (Xg2, 1,7000 -1,715 m.a.) that follows the strike of the East Providence Fault in the southern part of the Mid Hils. South of the Cedar Canyon Fault, in the northern Mid Hills (Pinto Mountains) is Miocene Rhyolite Tuff of White Horse Mesa (Tw, 15.8 m.a.), Between the Mid Hills Campground and Table Top Mountain is a mass of Cretaceous Black Canyon Hornblende Gabbro (Kbc). The flanks of Table Top Mountain are Cretaceous Rock Springs Monzodiorite (Krs). The summit of Table Top Mountain is capped with Miocene Rhyolite Tuff of White Horse Mesa (Tw). See map in Appendix 48.6A.

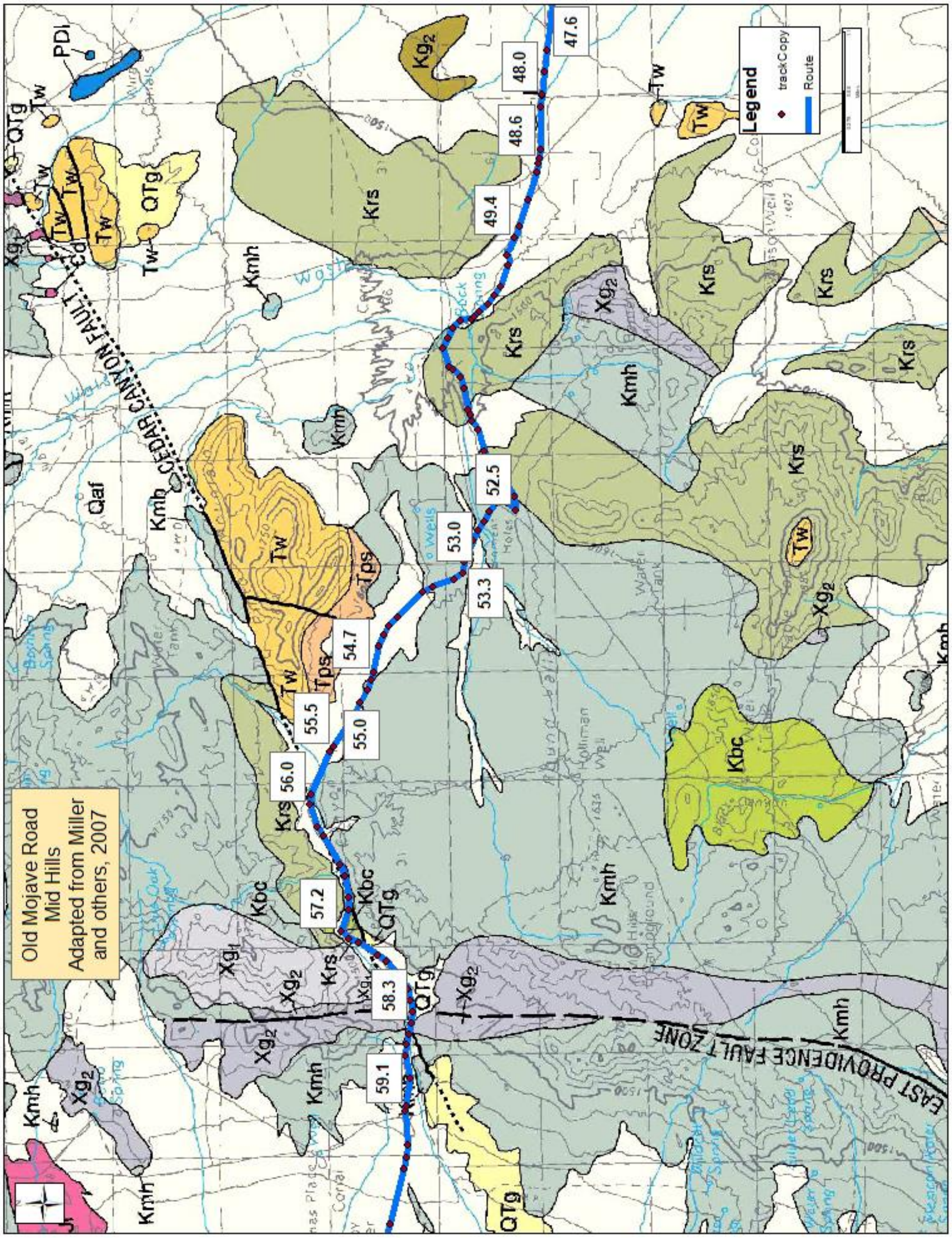


Figure 39.Mile 48.6 to 58.4: Geologic map of the Mid Hills

48.65 Intersection with the Cable Road

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

49.0 Merge with Cedar Canyon Road

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

49.4 Depart Cedar Canyon Road

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these rocks as Qiag.

49.5 Drop down to Watson Wash

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these as Qiw.

AREA MAP A-09

49.8 Bottom of Ridge

The geologic materials at this mile location are Quaternary Alluvium (Qal of Jennings, 1961; Qaf of Miller and others, 2007). Miller (2012) mapped these as Qiw.

50.2 Rock Spring Canyon

Historical information about this area is found in Casebier (2016, p. 92). The rocks at Rock Springs are Cretaceous Rock Spring Monzodiorite (Krs). This area is the type locality for the Rock Spring geologic formation. (Miller and others, 2007).

Figure 40. Rock Springs. Photo from http://image.fourwheeler.com/f/9380455+w600+cr1/0709or_10_z%2Bmojave_road_adventure%2Brock_springs.jpg accessed Dec. 20, 2017.

The following is from Reynolds and Weasma, 2005, p. 8:

We are traveling on the Mojave Road, first pioneered by Lieutenant Edward Beale in 1856 and well established by 1858 (Casebier, 1974; Vredenburgh, 1995). After Mojave Indians forced emigrants to turn back in 1858 and prospector Moses Little was killed in 1866 (Casebier, 1973; Vredenburgh, 1995), troops were sent to man outposts at springs that were one day's travel apart; the route then became known as the Government Road (Casebier, 1974). This area along the Mojave Road was originally called the Providence Mountains and was later divided into the New York Mountains (north), Mid Hills (ahead), and Providence Mountains (south). The Rock Spring mining district is the oldest district in this area (April 1863: Vredenburgh and others, 1981; Vredenburgh, 1995), established after Beale opened the Mojave Road. The Rock Spring mining district was large, including Macedonia Mountain in the New York Mountains. The eastern New York Mountains (New York, Manvel district, April 1870) contained deposits of copper, lead-silver-zinc, and iron/manganese tungstates along with a system of mule trails to haul lumber and charcoal (Reynolds and Reynolds, 1995). The Columbia (Macedonia) district, organized August, 1865 near Columbia Mountain to our east-southeast, produced lead-silverzinc and minor gold; scheelite (calcium tungstate) is also recognized in the district.

Camp Rock Spring. Indian attacks in 1866 claimed the lives of troops and civilians at Soda Lake, Marl Spring, and Camp Cady. Moses Little, a miner, was killed at Macedonia Mountain in the New York Mountains northeast of Rock Spring on June 12, 1866. In response, government troops built and occupied redouts or small fortified camps at springs one day's travel apart along the Mojave Road. Immigrants and mail stages entered California at Fort Mojave on the Colorado River, continued westward to Fort Piute, Camp Rock Spring, Marl Spring, and passed Seventeen Mile Point to reach Fort Soda (Zzyzx). The Mojave (Government) Road continued up the sandy outwash of the Mojave River, through Afton Canyon, joined a branch of the Old Spanish Trail, and proceeded west to Camp Cady. It continued from Fish Ponds on the Mojave River (between Daggett and Barstow) to the Drum Barracks in Los Angeles. Mining in the Rock Spring area preceded the military camp. Camp Rock Spring was established on a cold December 30,1866 (Casebier, 1973) by soldiers that were under-supplied and nervous; petroglyphs around the spring indicated heavy Indian usage. They chose the site for its water and defensible position, and they stored supplies in mine adits dug previously (Casebier, 1973)(from Reynolds and Weasma, 2005, p. 8).

The following information about the Rock Springs Loop Trail by Christina Mills is found at https://www.nps.gov/moja/planyourvisit/rock-spring-loop-trail.htm accessed Dec. 20, 2017:

If you were wondering how anyone could-or would want to live in the remote desert that is now Mojave National Preserve, take a walk along the Rock Spring Loop to find some answers (Mills, 2016).

The Rock House was constructed by Bert Smith in 1929. He came to this area to recover from poison gas exposure suffered during World War I. Doctors told him he didn't have long to live, but the dry desert air proved so beneficial to Smith's health that he lived here for 25 more years! The second long-term resident was artist Carl Faber, who lived and worked at the rock house in the 1980s, selling his artwork to passing travelers (Mills, 2016).

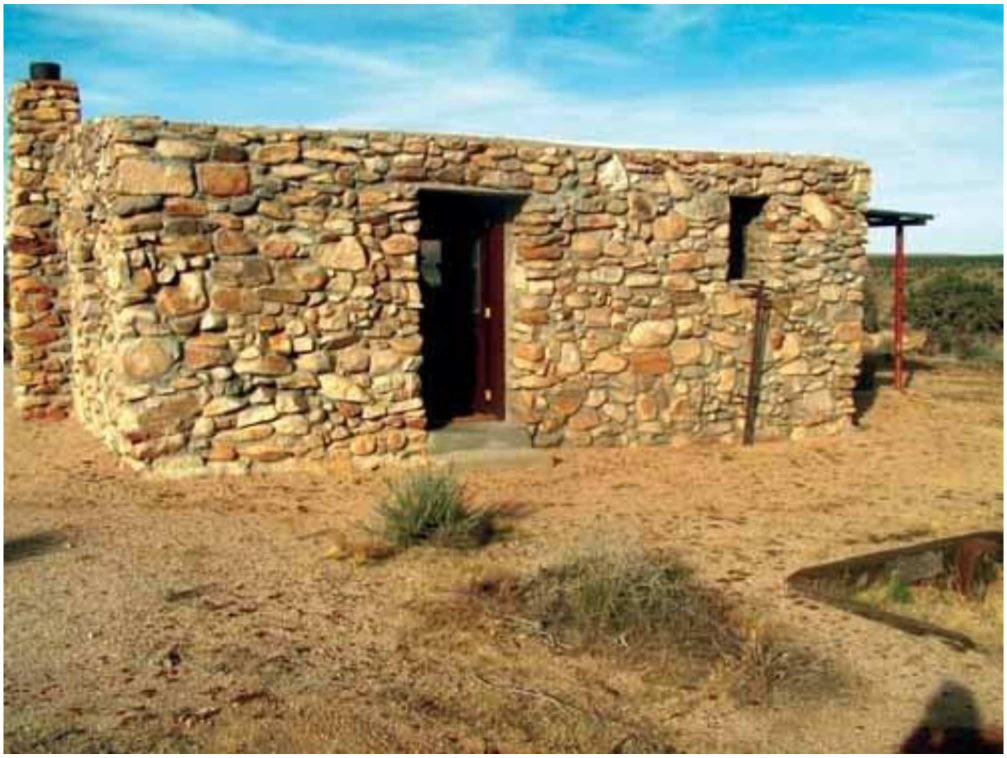


Figure 41. Rock House. From Mills, 2016.

A few minutes into the hike, the remains of a milling operation from the 1930s are visible near the trail. Rich mineral deposits of gold, silver, copper, and other precious metals have been found across this region. Rock from nearby Watson Wash was hauled here and crushed to release the copper. The project met with little success and didn't last long. Prospectors often just walked away from such sites, leaving everything behind (Mills, 2016).

The trail continues to Rock Spring, one in a series of springs that dot t the Mojave Desert every 20 to 30 miles, forming a natural travel corridor. This route eventually became known as the Mojave Road. Water means life in the desert, so humans and wildlife depended on this spring, as did the livestock later introduced by miners and ranchers. Exhibits near the spring describe the Mojave and Chemehuevi Indians who formerly lived in the area, and Camp Rock Spring, an army outpost active briefly in the 1860s to protect mail and early travelers that passed along the route. Water is almost always present here, but rainfall determines if it's a slow trickle or several deep pools (Mills, 2016).

From the spring, the trail climbs a ridge overlooking Watson Wash with expansive views of the Hackberry and New York Mountains to the north and east. If you look carefully, you can also see portions of the Mojave Road, now a popular four-wheel-drive route. This section runs parallel to Cedar Canyon road. Leaving the ridgeline, you enter a small copse of juniper and pinyon trees that provide welcome shade as the trail leads you back to the Rock House (Mills, 2016).

This trail was constructed by a Volunteer Vacations crew in April 2009. Five volunteers from around the country contributed a week of their time to improve the grounds at the Rock House, install the picnic table, and establish this trail (Mills, 2016).

50.2 Leaving Rock spring.

Drum peak lies on the north side of the Cedar Canyon Fault and is underlain by Cretaceous Mud Hill Adamellite (Kmh, Miller and others, 2007).

51.0 Bert G. Smith Homestead, Barnett and Beverly Glen Mines

The land in this area was homesteaded by Bert G. Smith (patent No. 1047070) on June 16, 1931 for 319.64 acres under provisions of the May 20, 1862: Homestead Entry Original Act (12 Stat. 392). The homestead is in portions of T.12N, R.15E, Section 2, SBM This patent was signed by Herbert Hoover.

For a copy of the patent, see https://glorecords.blm.gov/details/patent/default.aspx?accession=1047070&docClass=SER&sid=tqatp0s1.c5v and Appendix 51.0. Casebier (2016, p. 95) has and interesting biography of Bert Smith. The homestead was later acquired by the National Park Service as case CACA 31009.

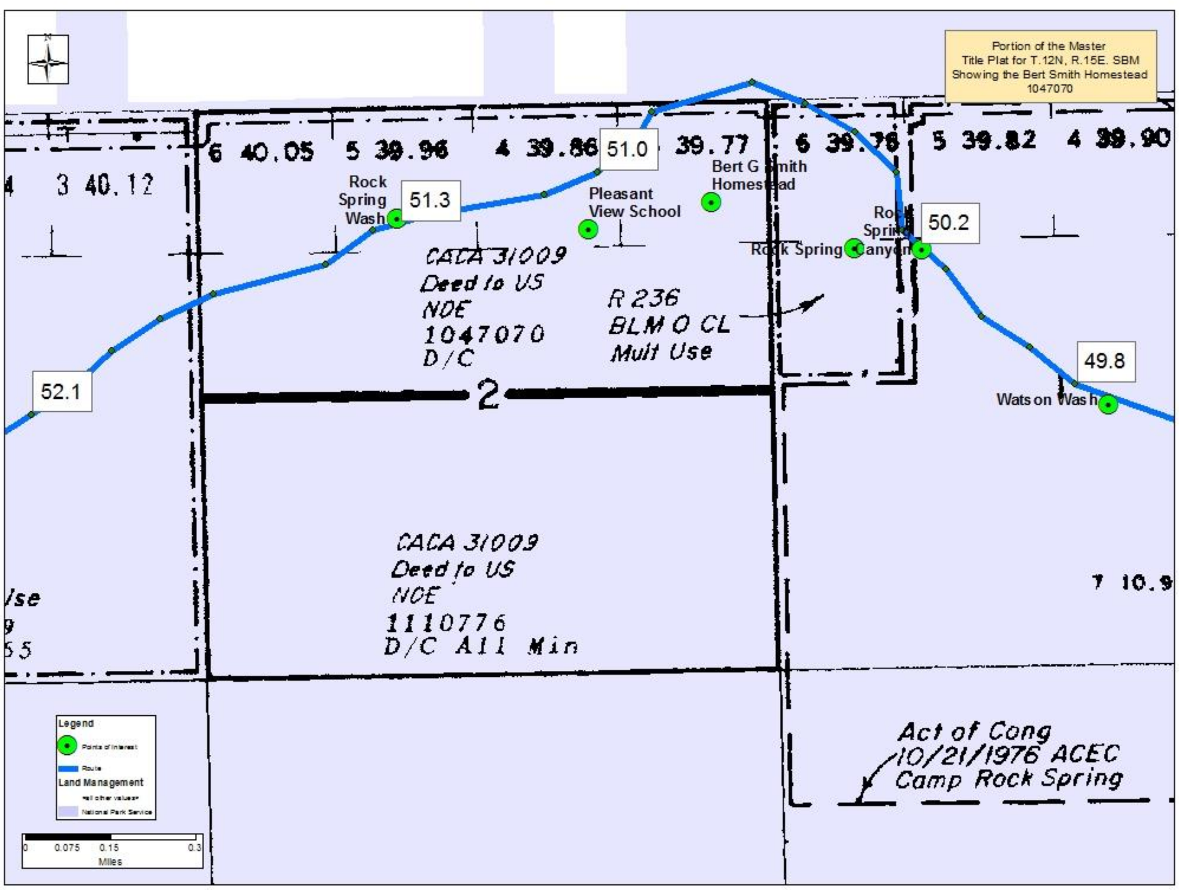


Figure 42. Portion of the Master Title Plat for T.12N, R.15E, SBM showing the Bert Smith Homestead 1047070.

51.0 Barnett and Beverly Glen Mines

The road to the south leads to the Pleasant View School Site and 1.8 miles further are the Barnett Mine and Beverly Glen Mine. These are listed in the USGS MRDS database, and are also shown on the USGS topographic map. The Beverly Glen is a classified as a past producing gold mine (Goodwin, 1957, p. 61), and the Barnett as a prospect (U.S. Bureau of Mines, 1990a, Table 2, No. 424, p. 154).

The Beverly Glen was owned by Thomas E. Creed of Cima, California in 1948. The mine is in 12N 15E Sec. 11 SBM; N35.12834; W-115.33273. Goodwin classified it as a Class D gold mine located 15 miles from Cima. The sulfide deposit was developed by a 40-foot shaft and 55 feet of drifts. Average smelter recovery on ore shipped between 1941 and 1948 was 2.34% lead, 0.442% copper, 1.65 ounces of silver and 0. 548 ounces of gold per ton (Goodwin, 1974, p. 61).

The Barnett mIne is listed with the Beverly mine in (U.S..Bureau of Mines, 1990a, Table 2, No. 424, p. 153). The following is from that report:

The property is underlain by a gray property quartz monzonite that is cut by a N.20^{o}W striking, 66^{o}NE dipping shear zone. The shear zone includes 2 to 7 ft of brecciated sericitized quartz monzonite, chloritized and kaolinized gouge, and quartz stringers up to 6 inches thick which carry small amounts of fine to coarse pyrite and trace amounts of chalcopyrite and galena (U.S. Bureau of Mines, 1990a).

Property development consist of six vertical shafts, two adits, and three pits. The main shaft is reported by Tucker and Sampson (1931) to be 32 feet deep with drifts at the 100, 200, and 300-foot levels, aggregating about 1,000 feet of workings. Intermittent production from 1911-1954 is about 150 oz gold, 475 oz silver, 12,500 lbs lead and 1,600 lbs copper (U.S Bureau of Mines records) (U.S. Bureau of Mines, 1990a).

Four samples (CTN 27-30) of brecciated quartz monzonite with quartz stringers contained 1,1060 ppb to 15,000 ppb gold (average 0.10 oz/ton) and 140 ppm to 391 ppm chromium. The vein can e traced in shallow workings for about 2,000 feet (U.S. Bureau of Mines, 1990a).

Casebier (2017, p. 96) has some interesting descriptions of the people who operated the Barnett Mine.

From Mile 50.5 to 51.3 the OMR cuts across Cretaceous Resting Spring Monzodiorite (Krs, Miller and others, 2007).

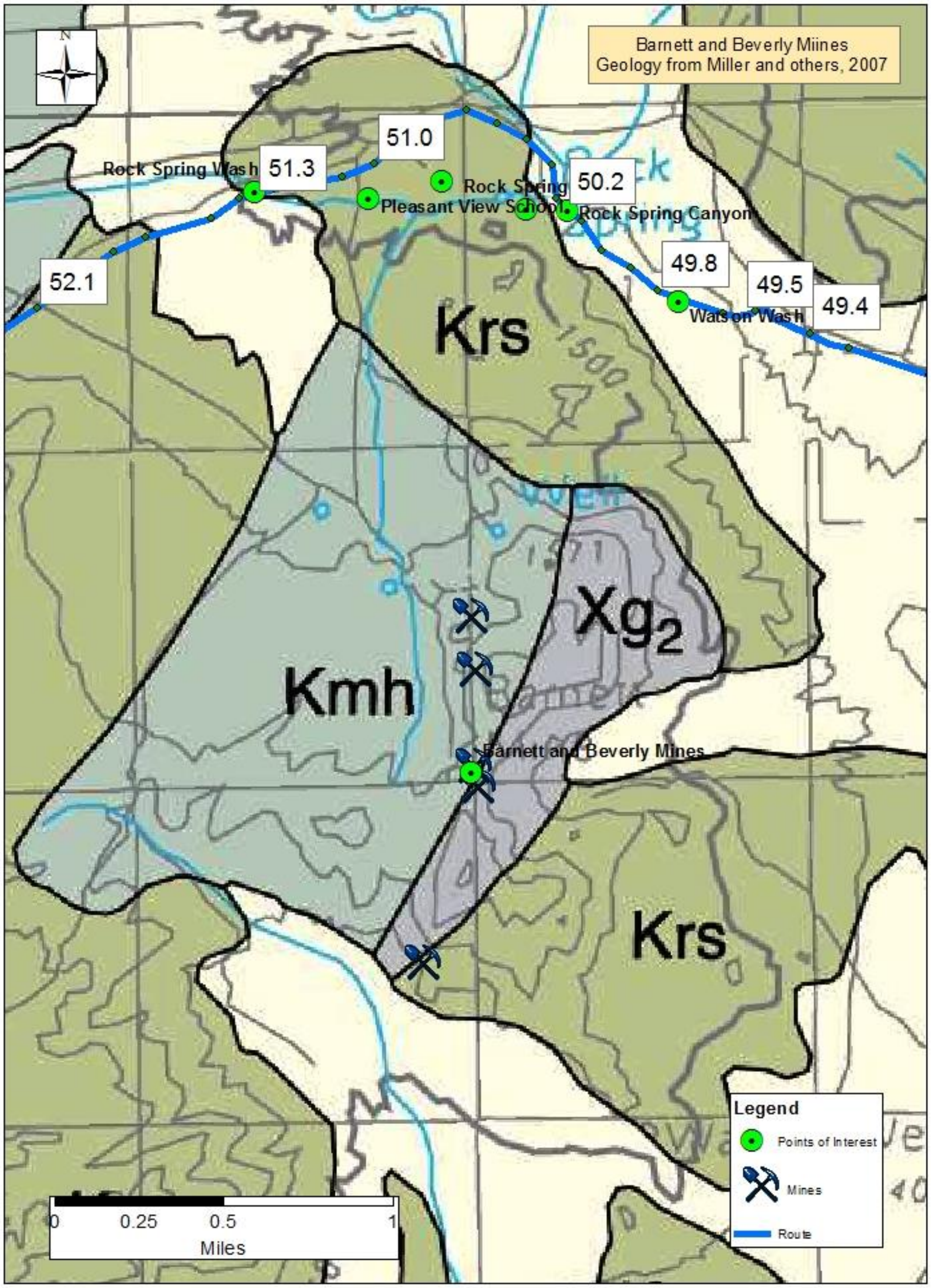


Figure 43. Geologic map of the Barnett and Beverly Mines. Adapted from Miller and others, 2007.

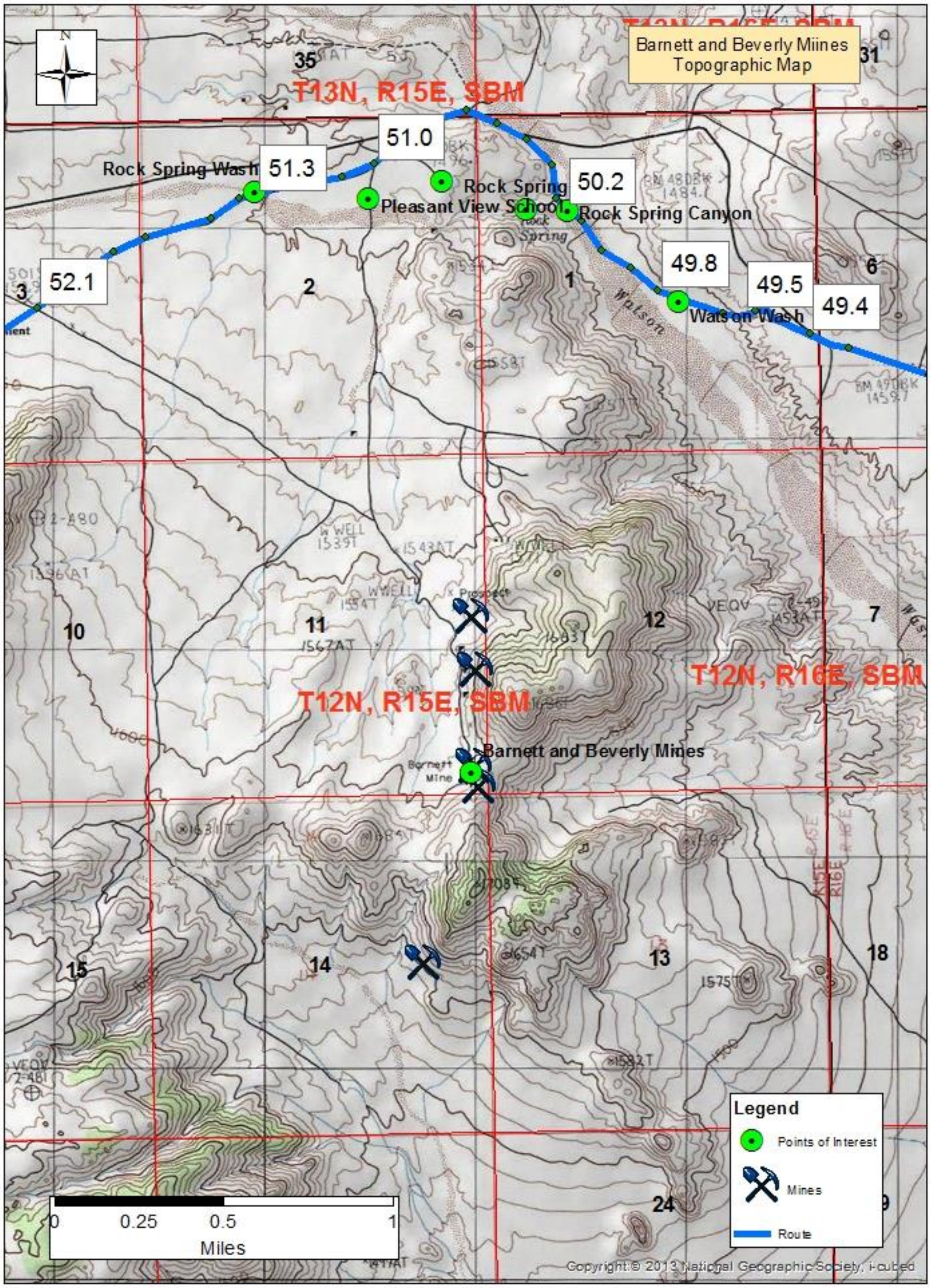


Figure 44. Topographic map of the Barnett and Beverly Mines with PLSS data.

51.3 Geologic Contact

Here the OMR crosses a contact between Resting Spring Monzodiorite (Krs) to the east and Quaternary fanglomerate (Qaf) to the west. Pinto Mountain is to the northwest. It is made mostly of Miocene Wild Horse Rhyolite Tuff (Miller and others, 2007). See Figure 24.

51.6 Geologic Contact

Here the OMR crosses back on to Cretaceous Resting Spring Monzodiorite (Krs) to the west, leaving Quaternary fanglomerate (Qaf) to the east (Miller and others, 2007).

52.1 Road Intersection

Rocks here are Cretaceous Resting Springs Monzodiorite (Krs of Miller and others, 2007). Turn right and head south to Government Hole.

52.5 Government Hole

Rocks here are Cretaceous Mid Hills Adamellite (Kmh). Read about the history of Government hole in Casebeir (2017, p. 97-101). A You Tube Video is accessed at https://www.youtube.com/watch?v=Cl8Kkb6884I

Figure 45. Government Holes. Photo by Graham Crackers, http://johnandautumnsadventures.blogspot.com/2014/06/flashback-mojave-road-january-2009-part_25.html accessed Dec. 20, 2017.

The Destination 4x4 website has the following information about Government Holes: https://www.destination4x4.com/government-holes/ accessed Dec. 20, 2017.

The tale of the Old Mojave Road is the story of water, the more important resource in the desert. Along the Old Mojave Road trail is the Government Holes water stop. Long abandoned, the site still contains a wind mill, a corral and a few watering holes. This quiet remote location was even the site of a gunfight (Destination 4x4, 2016) .

The story of the American West is the story ongoing and continued conflicts between the Native Americans and settlers and this was also true for the Mojave desert. In 1858 the Mohave tribe attack various wagon trains, which prompted a military response from the U.S. Government. Major William Hoffman and over 600 men were dispatched to the Colorado River which is the homeland of the Mohave Tribe. Major Hoffman demand the Mohave surrender to which the tribe relented. Major Hoffman next established a post on the eastern bank of the Colorado

River which developed into Fort Mojave. To support this new fort, regular supply wagon trains from Los Angeles were required to travel east through the Mojave Desert until the Civil War. Improvements to the wagon trail included a water stop which became known as Government Holes (Destination 4x4, 2016).

By the 1870s, steamboats on the Colorado supplied Fort Mojave and the Mojave Road became a highway for miners, prospectors, and ranchers. In 1883 the Southern Pacific / Atlantic & Pacific Railroad took up the majority of traffic. Throughout the 1800's the Mojave was an open range, and cattle and livestock grazing was a source of money and food. As with many human endeavors, smaller operations consolidate into larger companies. These companies worked to claim ownership of land and most importantly water rights (Destination 4x4, 2016).

Homesteaders were in conflict with the Cattle Companies, when the homesteaders stake claims on the best grazing territory. Homesteaders crops were trampled by the cattle, and the cattle companies denied the homesteaders access to water. The homesteaders responded by taking their portion of beef from the herd. All of this came to a head when a gun fight broke out between Matt Burts and J. W. "Bill" Robinson on November 8th, 1925. Both men died in the fight, and may be one of the last of the "old west" gunfights and the plot of a lot of Hollywood movies (Destination 4x4, 2016).

Figure 46. Government Holes. Photo by Destination 4x4, 2016.

The road to the west goes over to the Mid Hills Campground.

52.7 Road intersection

Rocks here are Cretaceous Mid Hills Adamellite (Kmh of Millere and others, 2007). Turn left and go northwest toward the Cedar Canyon Road.

52.9 Cross Rock Spring Wash

The bedrock here is Cretaceous Mid Hills Adamellite (Kmh of Millere and others, 2007).

53.0 Cedar Canyon Road

At this road intersection, we drop into a wash of Quaternary alluvial materials (Qaf). The rocks on either side of the wash are Cretaceous Mid Hills Adamellite (Kmh of Miller and others, 2007).

53.1 Wash

Cross wash of Quaternary Fanglomerate (Qaf of Miller and others, 2007).

53.3 Cattle Guard

Rocks here are Quaternary Fanglomerate (Qaf of Miller and others, 2007).

53.8 Geologic Contact

We leave Cretaceous Mid Hills Adamellite (Kmh) and drive northwest on to Quaternary alluvial fanglomerates (Qaf of Miller and others, 2007).

54.7 Cattle Guard and Geologic Contact

To the west of the cattle guard is a geologic contact. Here we drive up onto Cretaceous Mid Hills Adamellite (Kmh) and leave Quaternary alluvial fanglomerates (Qaf of Miller and others, 2007) behind us. Pinto Mountain is to the north. The southern flank of these mountains is Miocene Peach Springs Tuff (Tps), an important chonostratigraphic marker in the region. Most of the Pinto Mountains are made of Miocene Rhyolite Tuff of Wild Horse Mesa (Tw of Miller and others, 2007).

55.0 Geologic Contact

Here, heading west, we drive off Cretaceous Mid Hills Adamellite (Kmh) and return to Quaternary alluvial fanglomerates (Qaf of Miller and others, 2007).

55.5 Road to Cedar Springs

Rocks here are Quaternary alluvial fanglomerates (Qaf of Miller and others, 2007).

56.0 Cedar Canyon Fault

The road meets the center of Cedar Canyon Wash which marks the location of the Cedar Canyon Fault. This fault separates Cretaceous Rock Spring Monzodiorite (Krs) to the north of Cedar Canyon from Cretaceous Mud Hills Adamellite (Kmh) to the south (Miller and others, 2007).

AREA MAP A-10

The Cedar Canyon Fault is depicted in Area Map "A-10 Cedar Canyon Fault".

56.3 Road Intersection to Holloman Homestead and Black Canyon Hornblende Gabbro

The road to the south goes to the Hollowman well in NW1/4 Section 8, T.12N, R.15E, SBM and Black Canyon (Sections 18 and 18 of T.12N, R.15E SBM),

The Robert H. Holloman Homestead (Patent No. 1032464) was issued on November 29, 1929 for 610.0 acres in portions of Section 8, T.12N, R.15E, SBM under the authority of the December 29, 1916 Homestead Entry-Stock Raising Act (39 Stat. 862). The patent was signed by President Herbert Hoover.
See
https://glorecords.blm.gov/details/patent/default.aspx?accession=1032464&docClass=SER&sid=auqpeh5i.4zb and Appendix Mile 56.3. Much of this patent is still in private ownership.

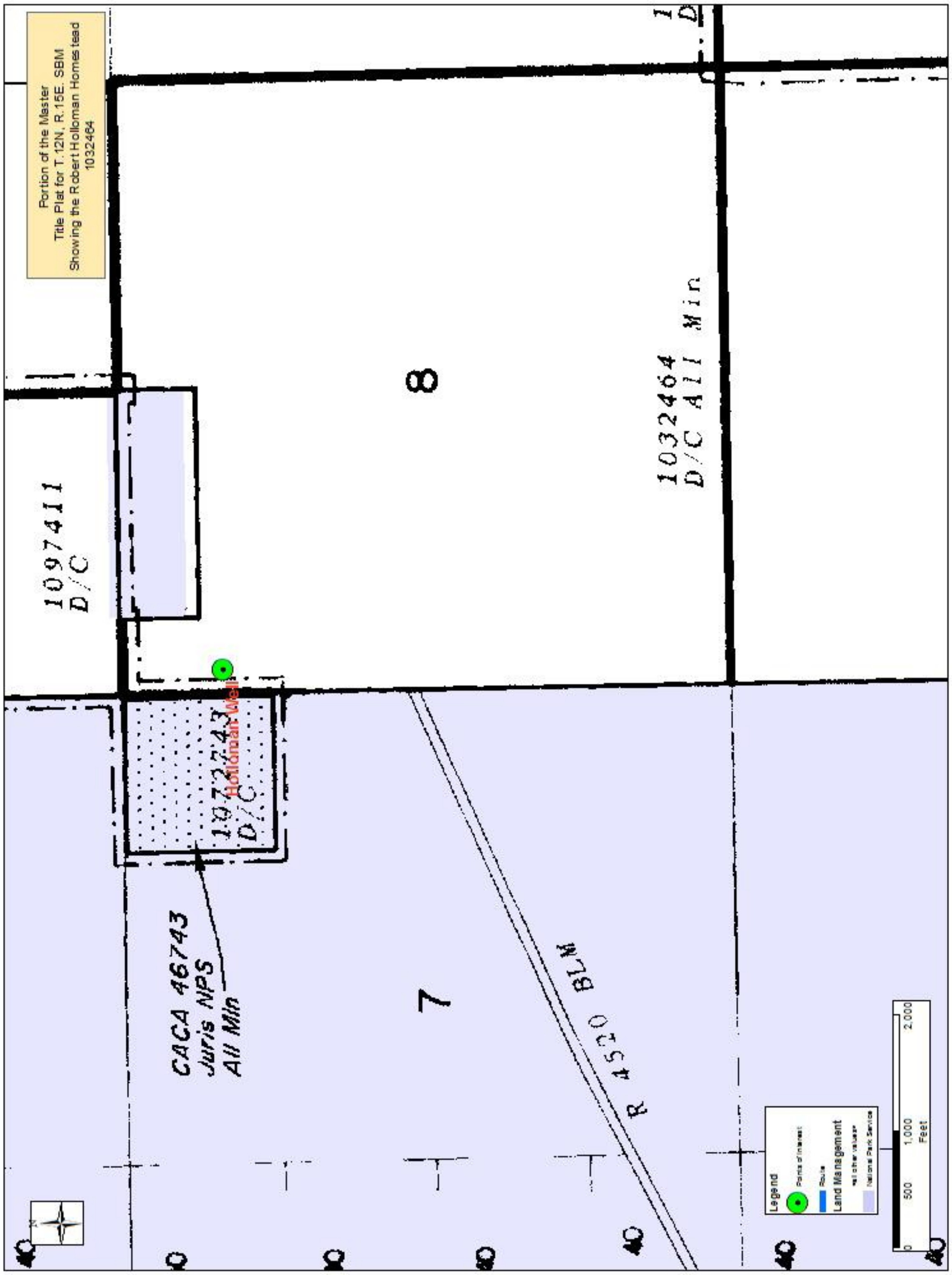


Figure 47. Portion of Master Title Plat for T.12N, R.15E, SBM showing the Holloman Homestead 1032426

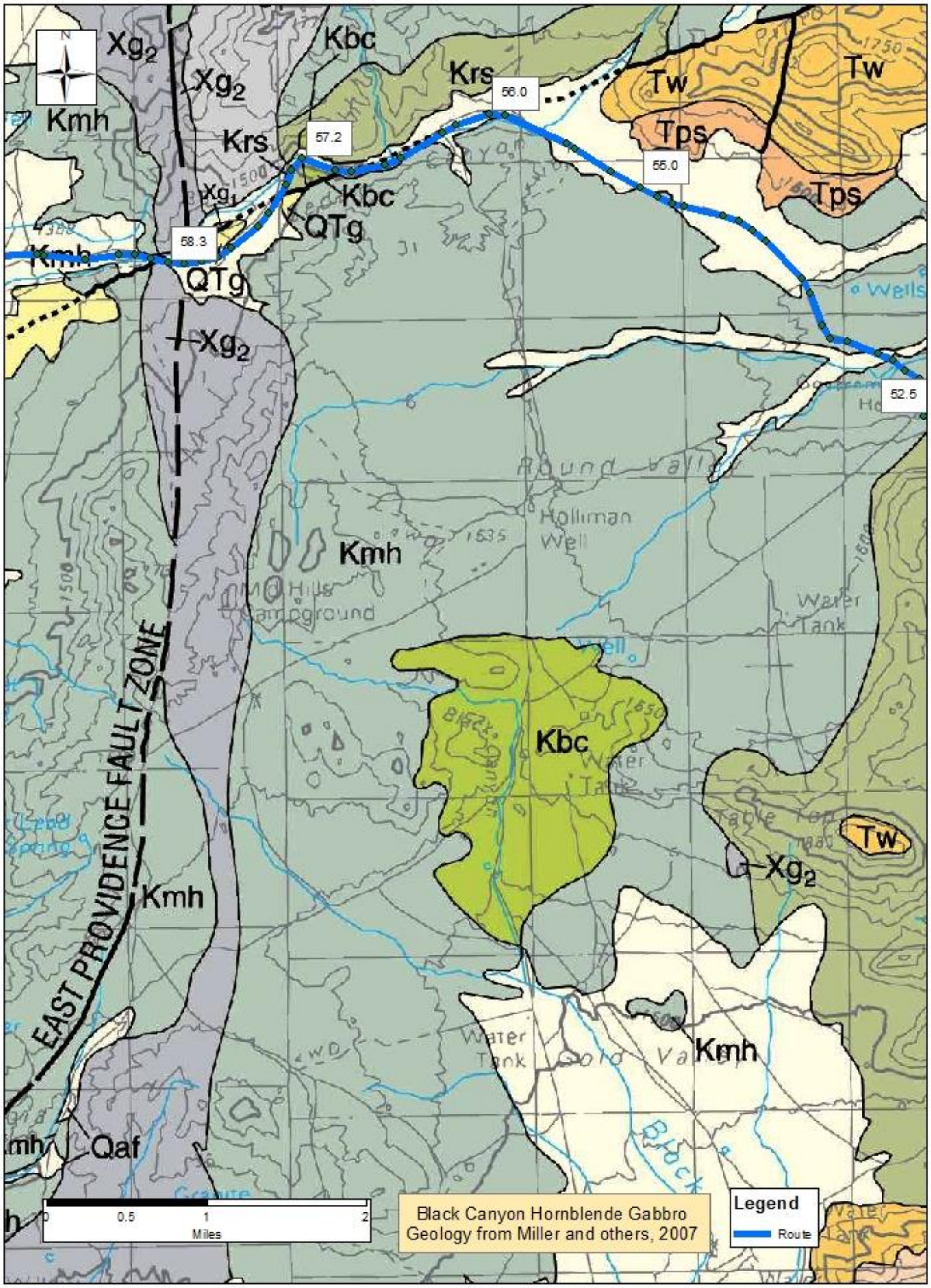


Figure 48. Figure 37. Black Canyon Gabbro. Adapted from Miller and others, 2007.

Black Canyon. 3.5 miles to the south, is a good place to see exposures of the Cretaceous Black Canyon Hornblend Gabbro (Kbc)(Miller and others, 2007).

57.2 Sharp Turn and Black Canyon Gabbro

At the point where the OMR makes a sharp bend to the left (southwest) when heading west are outcrops of Cretaceous Black Canyon Hornblend Gabbro (Kbc) on either side of the wash (Miller and others, 2007).

57.4 to 58.3 Pliocene and Pleistocene Gravels

Here we cross the OTp Pleistocene-Pliocene Playa and pluvial-lake deposit unit of Miller and others (2007).

58.3 Precambrian Rocks in Cedar Canyon Fault Zone and Eastern Providence Fault Zone

Here in Cedar Wash the wash narrows and we drive through outcrops of Early Proterozoic Intermediate-age granitoids of augen gneiss (Xg2 of Miller and others, 2007). This is the point of intersection of the Cedar Canyon and Eastern Providence faults.

58.4 to 66.9 CEDAR WASH BETWEEN MID HILLS AND UNNAMMED HILL AT MILE 66.9

Between the Mid Hills and an unnamed hill south of Mile 66.9. the OMR traverses Quaternary fanglomerate (Qaf of Miller and others, 2007) of the Cedar Wash drainage.

58.4 Geologic Contacts

Here we cross from Early Proterozoic granitoid gneiss (Xg2) to Cretaceous Mid Hills Adamelite (Kmh). As the wash widens, we return to Quaternary fanglomerate (Qaf of Miller and others, 2007). Here we leave Cedar Wash.

The Quaternary rocks between the Mid Hills and the Marl Mountains are mostly

Qyag Holocene and Latest Pleistocene Young alluvial fan deposit composed of grus.

Qiag Late to Middle Pleistocene Intermediate alluvial fan deposit composed of grus.

Qyw Holocene and Latest Pleistocene Young wash deposit.

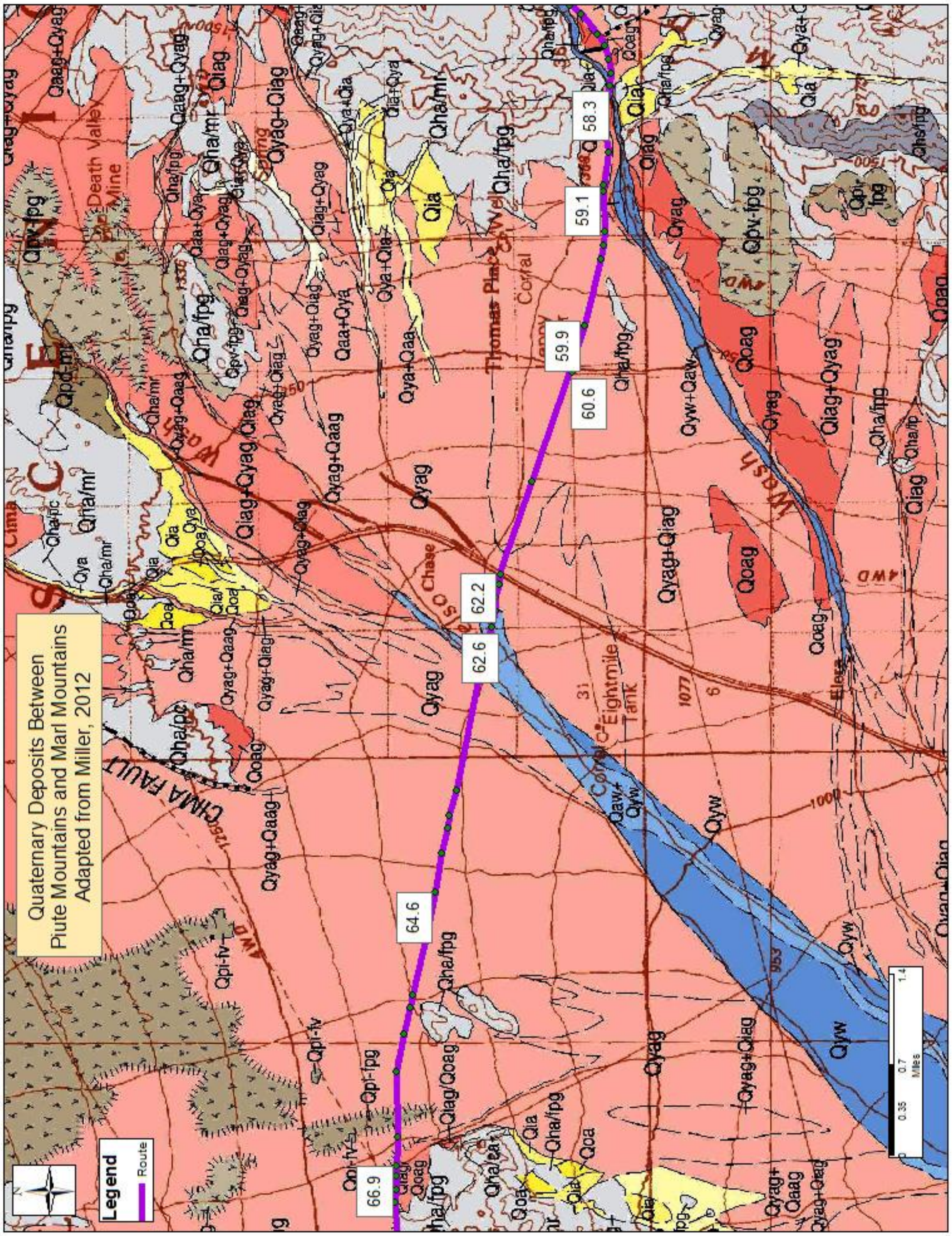


Figure 49. Quaternary rocks between Mid Hills and Unnamed Hill at Mile 66.9. Adapted from Miller, 2012.

58.5 Road Intersection
Rocks here are Quaternary fanglomerate (Qaf of Miller and others, 2007).

59.1 Road Intersection: Death Valley Mine Road
This road goes north to the Thomas Place Corral and well. To the northwest is Cima Dome and to the far southwest are the Kelso Sand Dunes. Cima Dome is composed of Cretaceous Teutonia Adamellite (Kt). Kelso Dunes are Pleistocene and Recent sand (Qes). In the 1989 the Kelso dunes were explored for platinum group metals (Wilkerson, 2013).

59.9 Blacktop Roadway
Rocks here are Quaternary fanglomerate (Qaf of Miller and others, 2007).

60.6 Leppy Water
Rocks here are Quaternary fanglomerate (Qaf of Miller and others, 2007).

62.2 Intersection: Kelso Road
Rocks here are Quaternary fanglomerate (Qaf of Miller and others, 2007). This road heads south to the Kelso Railroad Depot or north to Baker, California.

62.6 Kelso Wash
Rocks here are Quaternary fanglomerate (Qaf of Miller and others, 2007).

AREA MAP A-11

The Club Peak Volcanic Field is depicted on Area Maps “A-11 to A-15 Club Peak Volcanic Field” and “A-11 to A-15 Club Peak Volcanic Field Topographic Map”

63.5 West Bank of Kelso Wash
Rocks here are Quaternary fanglomerate (Qaf of Miller and others, 2007).

64.6 Scenic View: Cima Dome
Rocks here are Quaternary fanglomerate (Qaf of Miller and others, 2007). To the north-northwest is Cima Dome. It is composed of Cretaceous Teutonia Adamellite (Kt of Miller and others, 2007). To the southwest of Cima Dome is an unnamed hill underlain by Early Proterozoic Gneiss and Granitoids and (Xg of Miller and others, 2007).

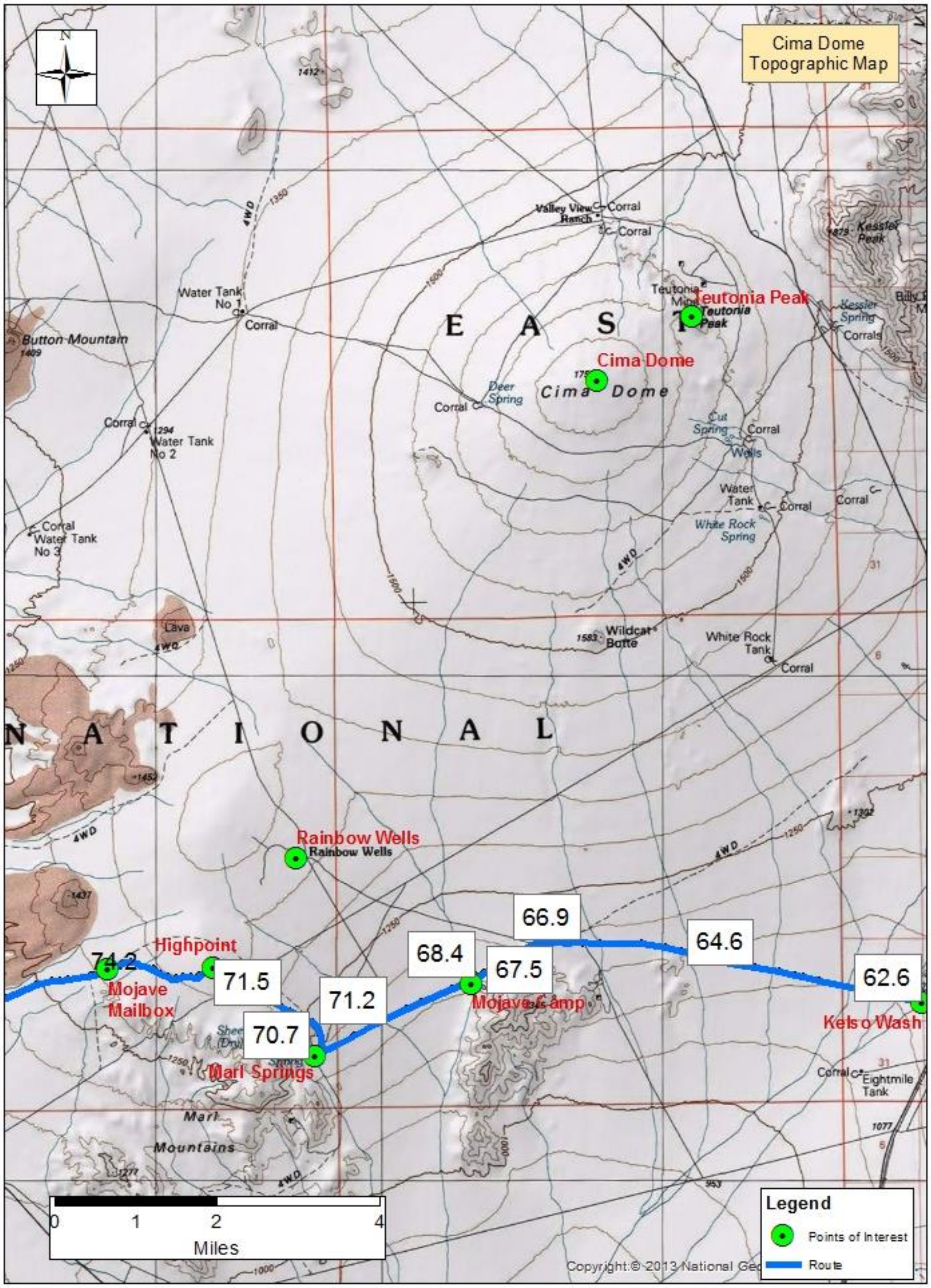


Figure 50. Cima Dome Topographic Map.

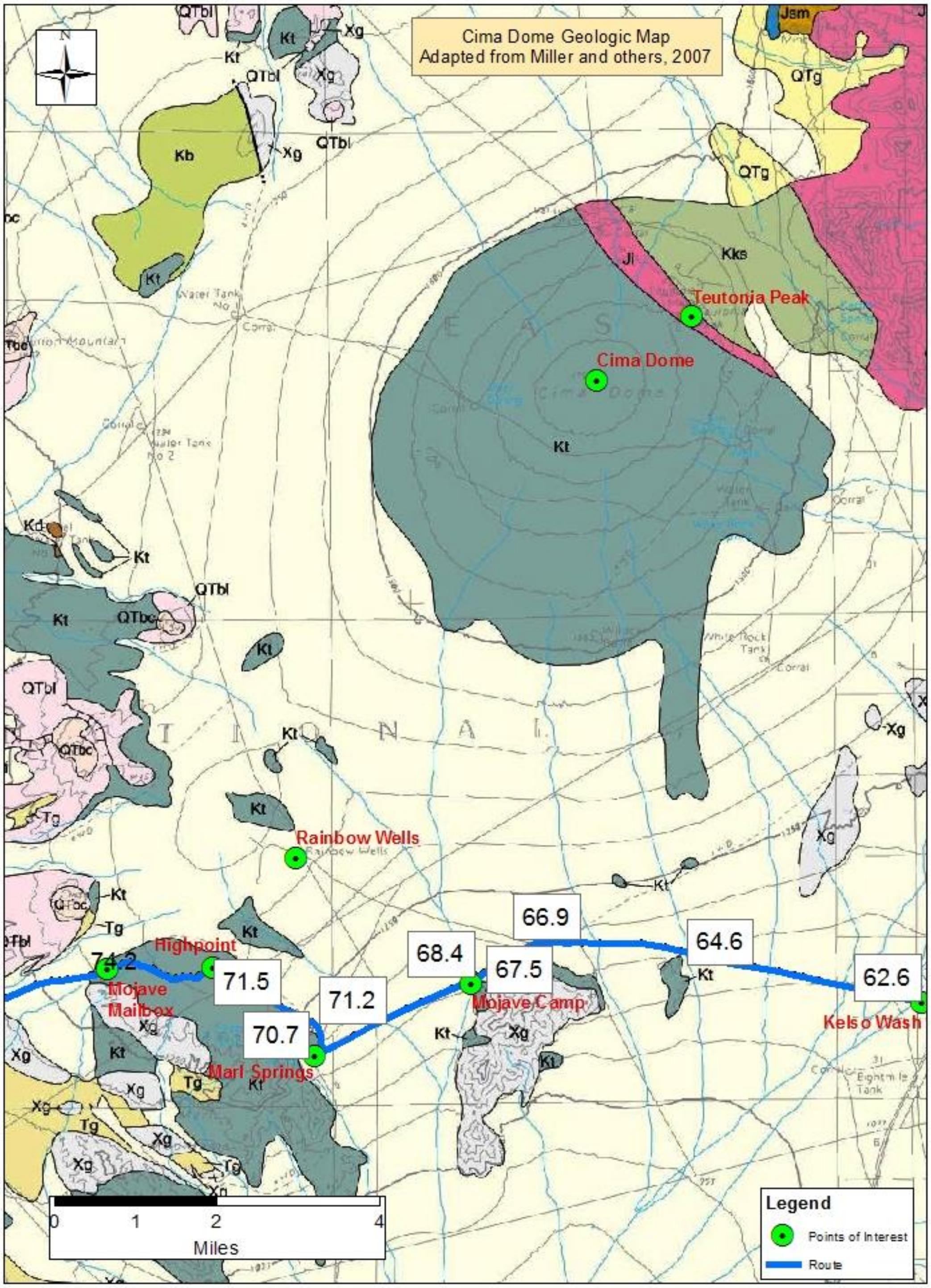


Figure 51. Cima Dome Geologic Map. Adapted from Miller and others, 2007.

66.9 TO 70.7: UNNAMED HILL AT MILE 66.9 TO MARL SPRINGS

Traversing the Unnamed Hill at Mile 66.9 westward to the Marl Springs in the Marl Mountains, the OMR crosses more Quaternary Alluvial Fanglomerate (Qaf of Miller, 2007). The Quaternary Geologic map for the Ivanpah Quadrangle (Miller and others, 2012) shows these rocks as Qyag+Qiag (Holocene and Latest Pleistocene Young Alluvial fan deposit composed of gruss and Late to Middle Pleistocene Intermediate alluvial fan deposit composed of gruss).

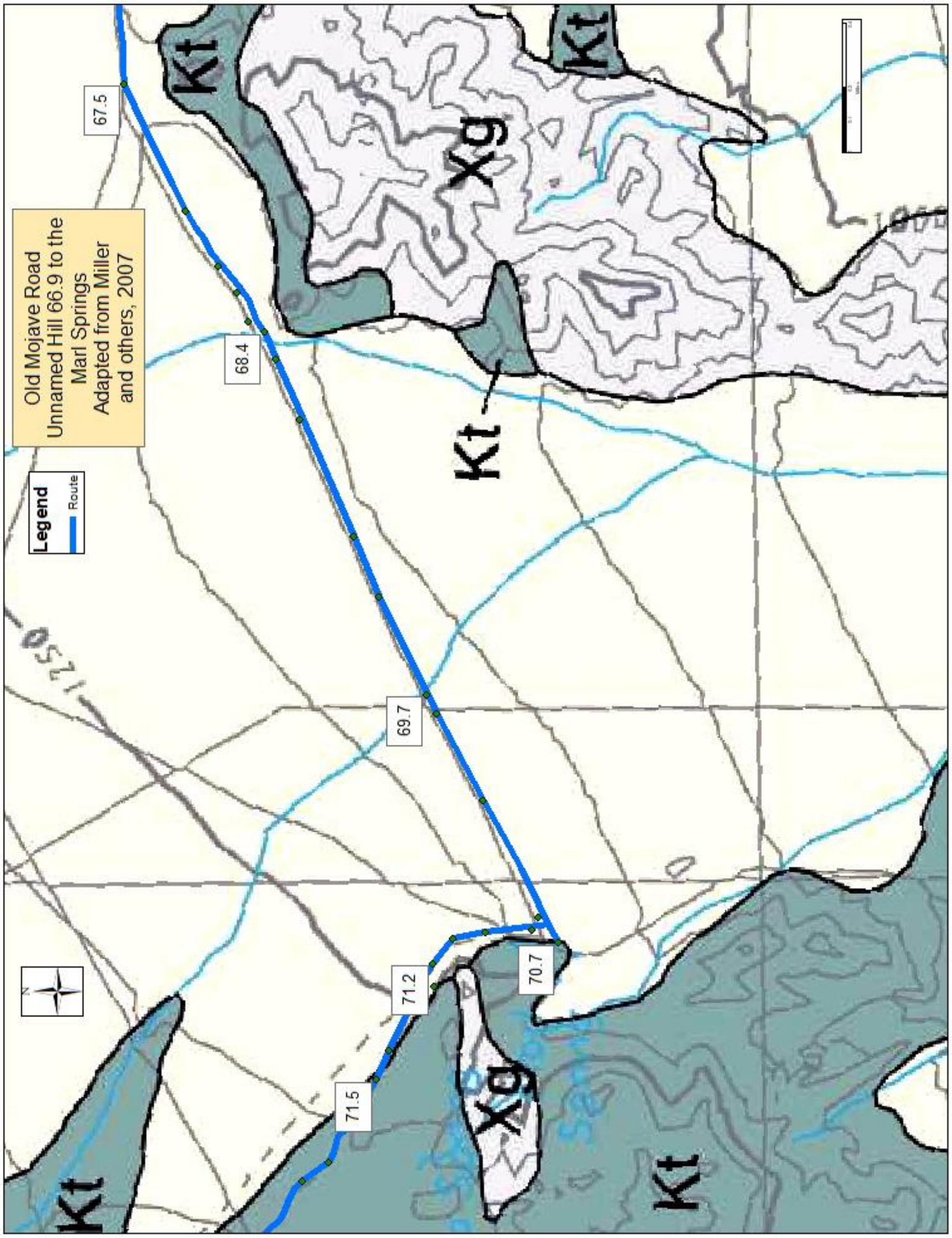


Figure 52. Mile 66.9 TO 70.7: Unnamed Hill at Mile 66.9 to Marl Springs. Geology adapted from Miller and others, 2007

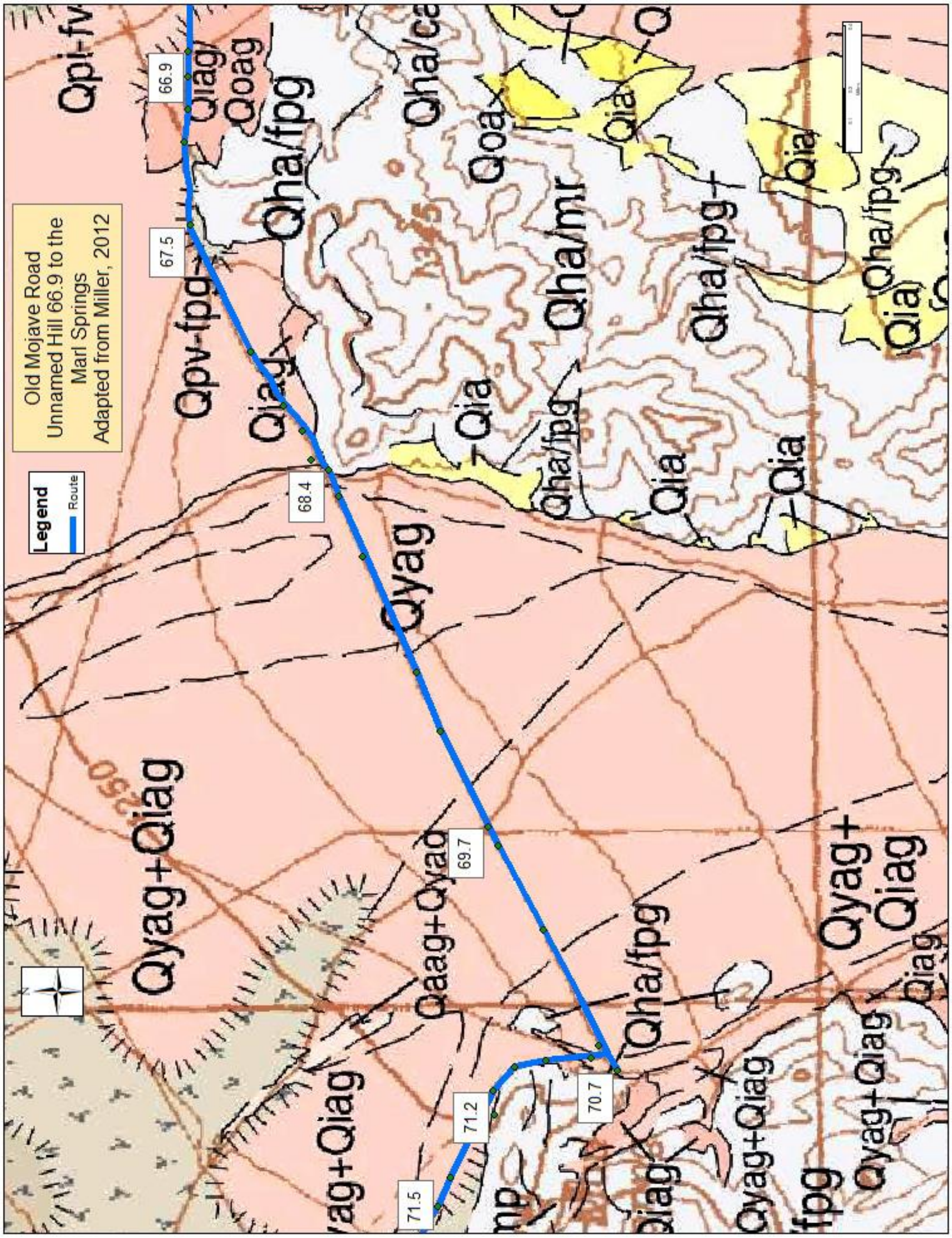


Figure 53. Mile 66.9 TO 70.7: Unnamed Hill at Mile 66.9 to Marl Springs. Geology adapted from Miller and others, 2012.

66.9 Road Intersection and Unnamed Hill

Rocks here are Quaternary fanglomerate (Qaf of Miller and others, 2007). The Unnamed Hill is on our left (south between Mile 66.9 and 68.4).

67.5 Road Intersection

Rocks here on the OMR are Quaternary fanglomerate (Qaf of Miller and others, 2007). To the south, is an unnamed hill. The northern flank of this hill is Cretaceous Teutonia Adamelite (Kt). The central part of this hill is Undivided Proterozoic Gneiss nd Granitoids (Xg, Miller and others, 2007).

AREA MAP A-12

68.4 Large Wash at Mojave Camp

Rocks here are Quaternary fanglomerate (Qaf of Miller and others, 2007). The OMR website's GIS database lists this as the area for "Mojave Camp".

69.7 Pole Line Road

Rocks here are Quaternary fanglomerate (Qaf of Miller and others, 2007).

70.7 to 74.0: MARL MOUNTAINS

The Marl Mountiains are mostly Cretaceous Teutonia Adamellite (Kt), and Pliocene and Miocene gravels (Tg) with large masses of Early Proterozoic Gneiss and Granitoids (Xg of Miller and others, 2007).

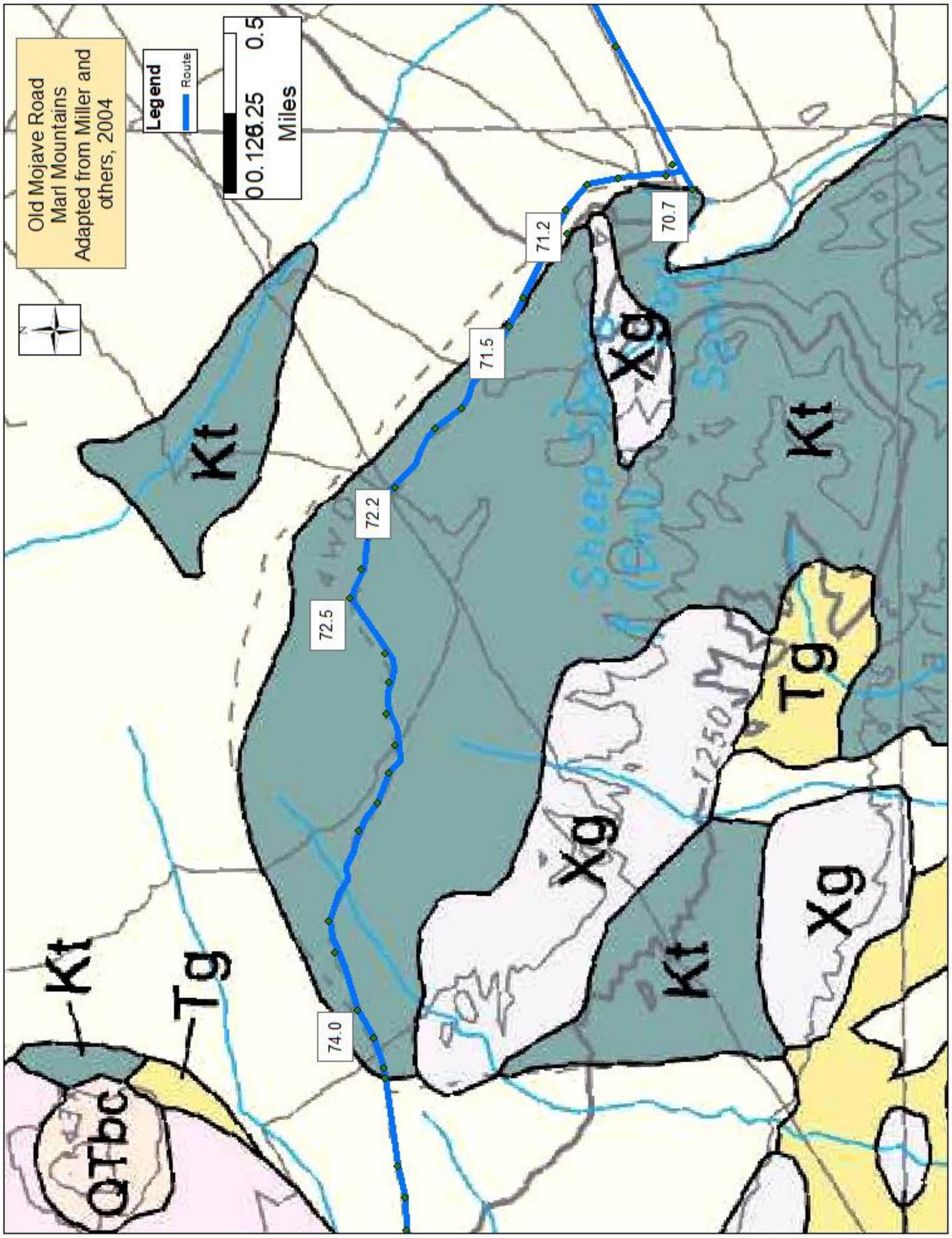


Figure 54. Mile 70.7 to 74.0: Marl Mountains

70.7 Upper Marl Springs

For a historical description of Marl Springs, see Casebier (2016, p. 110-119). You can also get a description at http://mojavedesert.net/military/camp-marl-springs.html. That website states:

The post at Marl Springs in the Mojave Desert was first garrisoned by the Army as an outpost by troops from Camps Cady and Rock Spring on October 5. 1867 and was occupied continuously until May 22. 1868, at which time it was abandoned permanently. The number of troops stationed there was usually minuscule. The site apparently was never given official status by the Army except as an informal outpost of Camp Cady. Marl Springs, however, continued to be an important station on the travel route across the Mojave Desert also serving as the site for several trading posts. Many deserted structures and ruins now occupy the site. Crumbling rock walls mark the site of the old Army post that was erected by John Drum and his troops in 1867.

Figure 55. Marl Springs mining arrastra. Photo from http://farm4.staticflickr.com/3687/13224188573_f222fba344_c.jpg accessed Dec. 20, 2017.

70.7 Camp Marl Springs Military History

The following is by Colonel Herbert M. Hart, USMC (retired), Executive Director of the Council on America's Military Past. His article is found at http://mojavedesert.net/military/camp-marl-springs.html accessed Dec. 20, 2017:

It may have been the last of the desert redoubts to be established, but Camp Marl Springs' history indicates it was one of the most important. Location had a lot to do with the importance. It was about halfway between Camp Cady and the Colorado River. And, more so, it was flanked on the east by a 12-mile valley that had a 1,400 foot elevation change, a torturous trail of loose gravel and sand repeatedly crisscrossed by dry washes (Hart, 2017).

Especially for the eastbound traveler, Marl Springs was a welcome sight. In 1852, John Brown later the ferry owner at Fort Mojave, found the springs a life saver. When his party had become exhausted in the blowing sand dunes of the playground,' Brown had struck out ahead for Marl Springs. The peaks of the Old Dad Mountains showed him the way out of the windswept bowl, then he marked his desperate route between the bare, rocky wastes of the Kelso Marl Mountains, on his right, and rolling lava hills on his left (Hart, 2017).

He dropped into Marl Springs without ceremony and filled his belly. After the life had returned to his joints and veins, and a keg had been filled with water, he returned to the wagon train. His keg provided enough refreshment to get the travelers and their stock to Marl Springs and a new life. A couple of dozen Piutes met Brown at the spring both times, but "they behaved well" (Hart, 2017).

Marl Springs was not one of the original Carleton redoubts across the desert. The intention was that roving patrols between Rock Springs and Hancock Redoubt (at Soda Lake) would keep the area clear of roving Indians (Hart, 2017).

The springs were an important water source on the road. The Whipple Survey party of 1854 spent a night at the site on March 7, reporting "excellent grass . . . scant wood . . windy . . . cold." They found the springs "small, not half enough water for the mules, but it constantly flowed and after a while there was enough to satisfy the mules." The flow was so regular that they were able to refill their kegs and also have enough for the camp's use (Hart, 2017).

The water that drew the traveler also drew the opposition. Fifteen or 20 Piutes were reported harassing wagon trains on the western half of the road in 1863."It is said that they killed one of the mules belonging to a citizen at Marl Springs," the Fort Mojave commander wrote to headquarters (Hart, 2017).

A year later, rumors of Indian depredations again were heard. The Mojave commander received a letter from a civil officer "stating that four horses and a bullock had been killed and eaten by

Indians at Marl Springs." But this was a false alarm; two days later the official reported that the stock had been found, neither killed nor eaten(Hart, 2017).

With traffic on the road increasing, the Army put token protection at Marl Springs in order to provide some type of cover from attack. The tiny post sat at the foot of a spur of the granite Marl Mountains. Commanded on two sides by high had to sacrifice defensibility in order to command the spring. The facts of desert life were bluntly a matter of defending from a poor spot that had water instead of a good but dry location that could prove a trap (Hart, 2017).

In 1867, the post was surrounded by hostile Indians. During a 24-hour siege, the station had a full test of its position. There were only three men there but they came out with their scalps inntact. In the true spirit of the romanticized West, just at dawn a rescue column of soldiers cut through the besieging circle of Indians to save the post (Hart, 2017).

Marl Springs are in the Marl Mountains which are a combination of Early Proterozoic Gneiss and Granitoids (Xg), Cretaceous Teutonia Adamellite (Kt), and Pliocene and Miocene gravels (Tg) (Miller and others, 2007).

The springs are on private land. The land in Section 36 of T.13N, R.13E, SBN was a school, section given to the state of California on April 18, 1857 under provisions of the March 3, 1853: California Enabling Act (10 Stat. 244). This school section was later sold to private parties. For a copy of the original conveyance, see https://glorecords.blm.gov/details/patent/default.aspx?accession=CACAAA 000001 ZM&docClass=SER&sid=tpj2m3w5.0lx

Caspier, 2016, p. 111-117 has old photographs of Marl Springs.

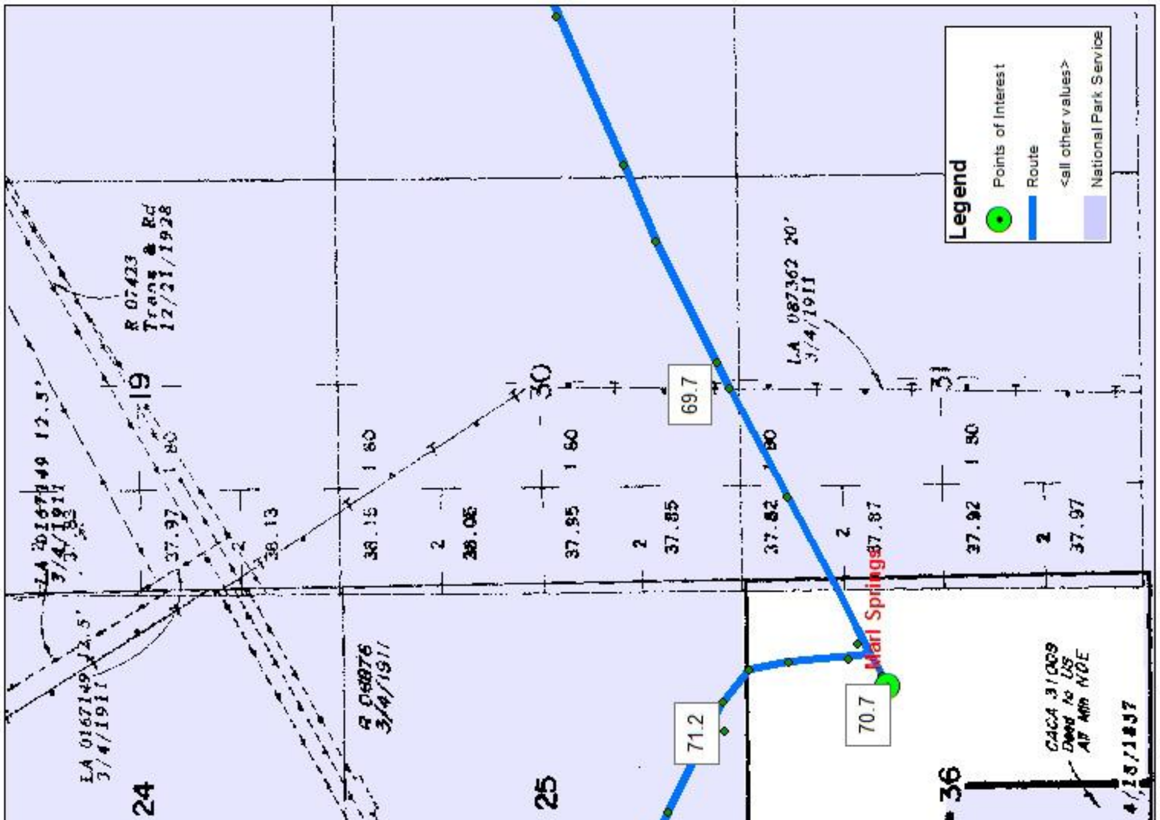


Figure 56. Master Title Plats of T.12N, R.12E and 13E, SBM showing State Section 36, now private land.

Mines of the Marl Mountains

In the northeastern Marl Mountains there are nine gold deposits listed in the USGS/MRDS database (2011).

The names and locations of these mines are given in the table, below and illustrated in Figure 42.

Mine Name	TRS	Latitude	Longitude
Jackpot	13N 12E Sec. 35 SBM	35.16778999980	-115.66945000000
Rainbow	13N 12E Sec. 36 SBM	35.17141000010	-115.65444000000
Marl Spring	13N 12E Sec. 36 SBM	35.16940999960	-115.64914000000
Oro Y Plata	12N 12E Sec. 01 SBM	35.15831000020	-115.65364000000
Unnamed Prospect	13N 12E Sec. 36 SBM	35.16441000010	-115.65164000000
Jackpot	12N 12E Sec. 02 SBM	35.15640999960	-115.66944000000
Barts Gold	12N 12E Sec. 02 SBM	35.15000999980	-115.66254000000
Green Acres	13N 12E Sec. 26 SBM	35.17561000030	-115.66304000000
Russ	13N 12E Sec. 35 SBM	35.16861000030	-115.66274000100

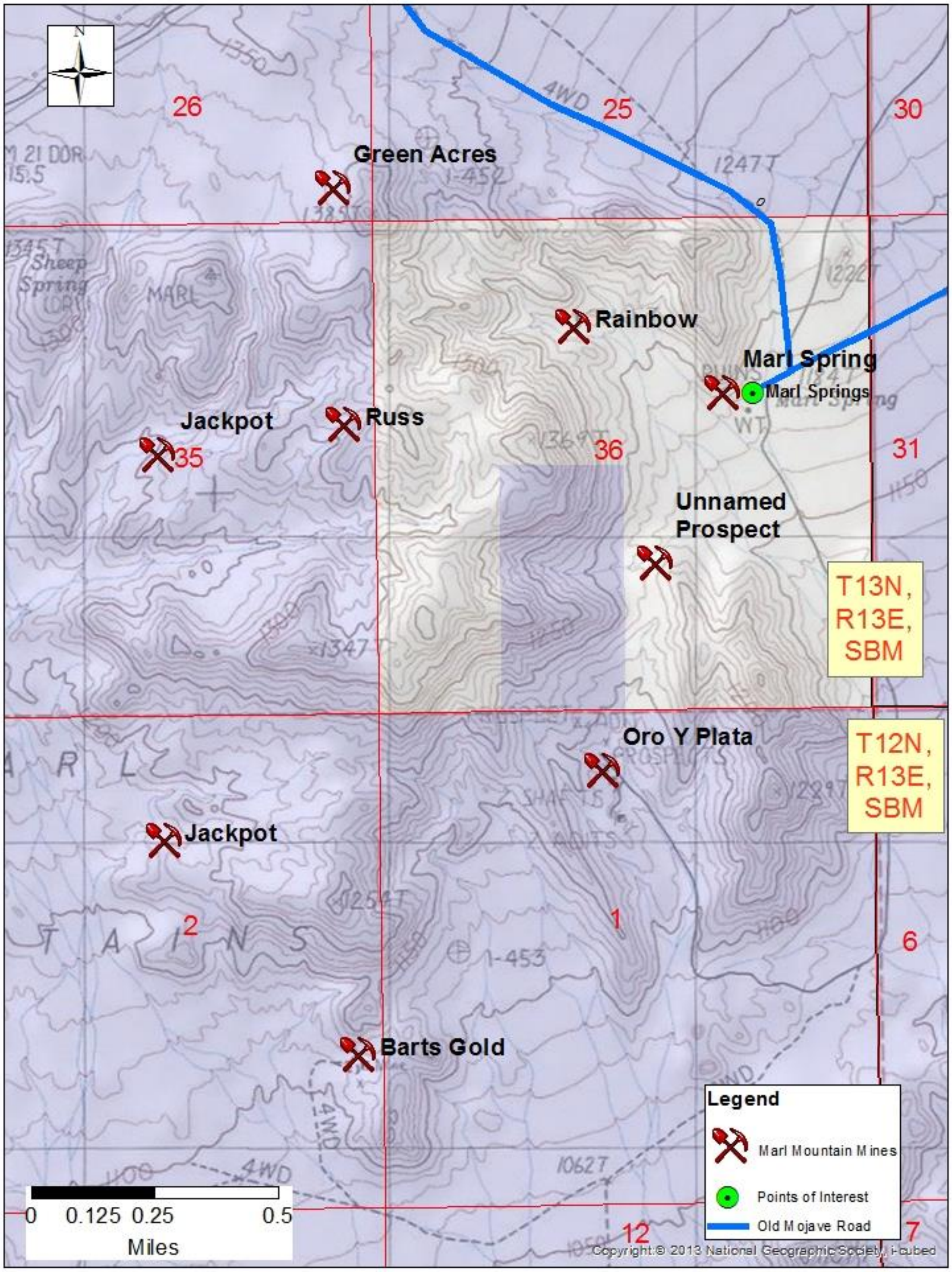


Figure 57. Land Status Map of Marl Springs and surrounding area. Purple is NPS, white is private. Data from BLM.

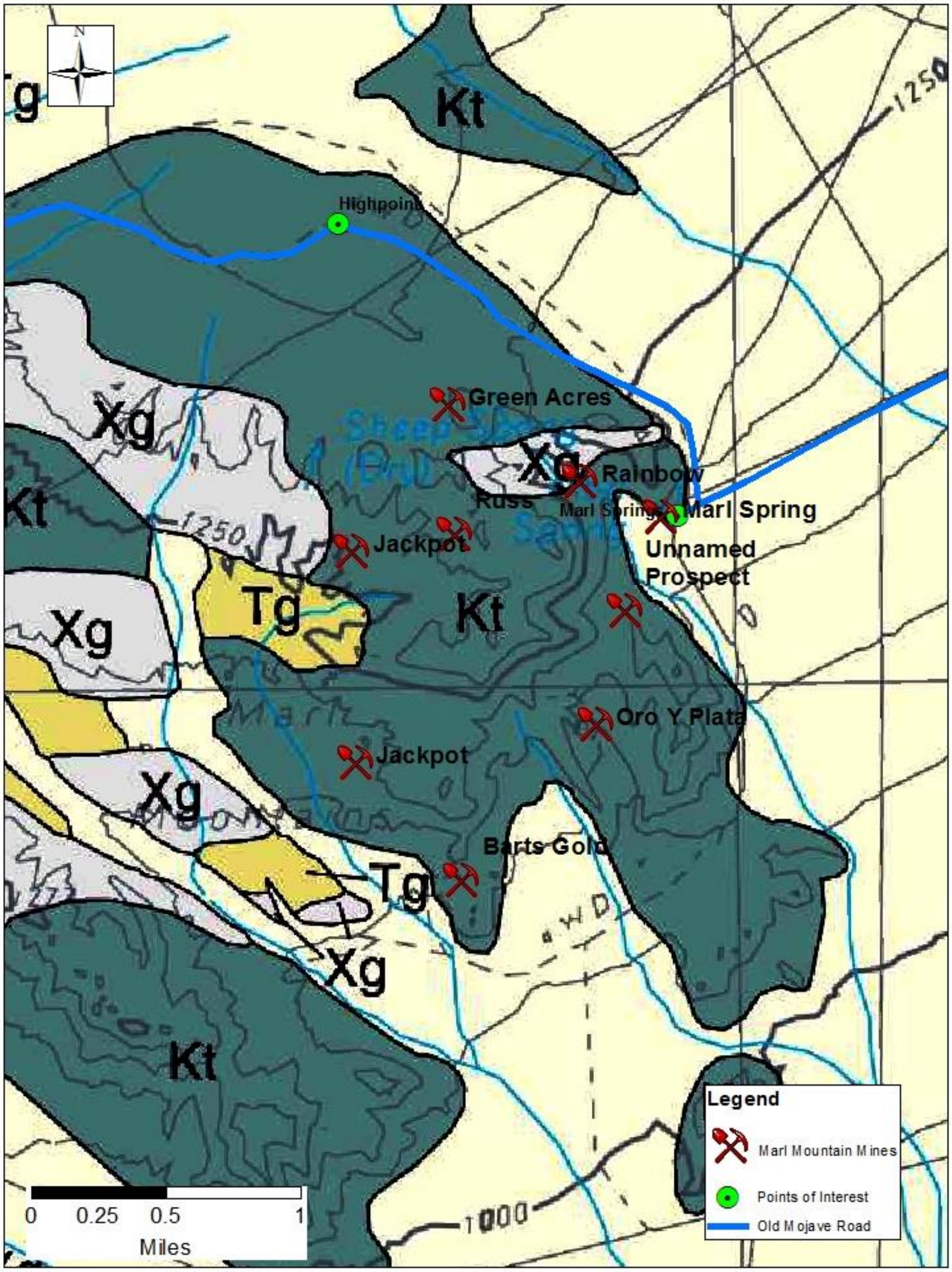


Figure 58. Geologic Map of the Marl Mountain Mines. Adapted from Miller and others (2007).

71.2 Road Intersection

Here the rocks are Quaternary alluvial fanglomerate (Qaf of Miller and others, 2007).

71.5 Geologic Contact

Moving west we cross from Quaternary fanglomerate (Qaf) to Cretaceous Teutonia Adamelite (Kt of Miller and others, 2007).

72.2 Power Line

Rocks here are Cretaceous Teutonia Adamelite (Kt of Miller and others, 2007).

72.5 High Point Vista

We are at Bench Mark B31 at an elevation of 4,556 feet.

74.0 to 85.7: CINDER CONES AND LAVA FLOWS OF SOUTHERN CLUB PEAK VOLCANIC FIELD

After exiting the Marl Mountains, the OMR crosses a wash and then skirts the southern flank of the Club Peak Volcanic Field, a collection of Pleistocene to Miocene basalt cinder cones (QTbc) and lava flows (QTbl). There are several abandoned cinder mines in the volcanic field as well as some lava tubes. The volcanic rocks lie above Cretaceous Teutonia Adamelite (Kt) and Undifferentiated Proterozoic Gneiss and Granitoids (Xg of Miller and others, 2007). The geology of the Club Peak Volcanic Field mapped at a scale of 1:24,000 is included in the Wilshire, 2002 (“Digital …Geologic Map of the Indian Spring Quadrangle”).

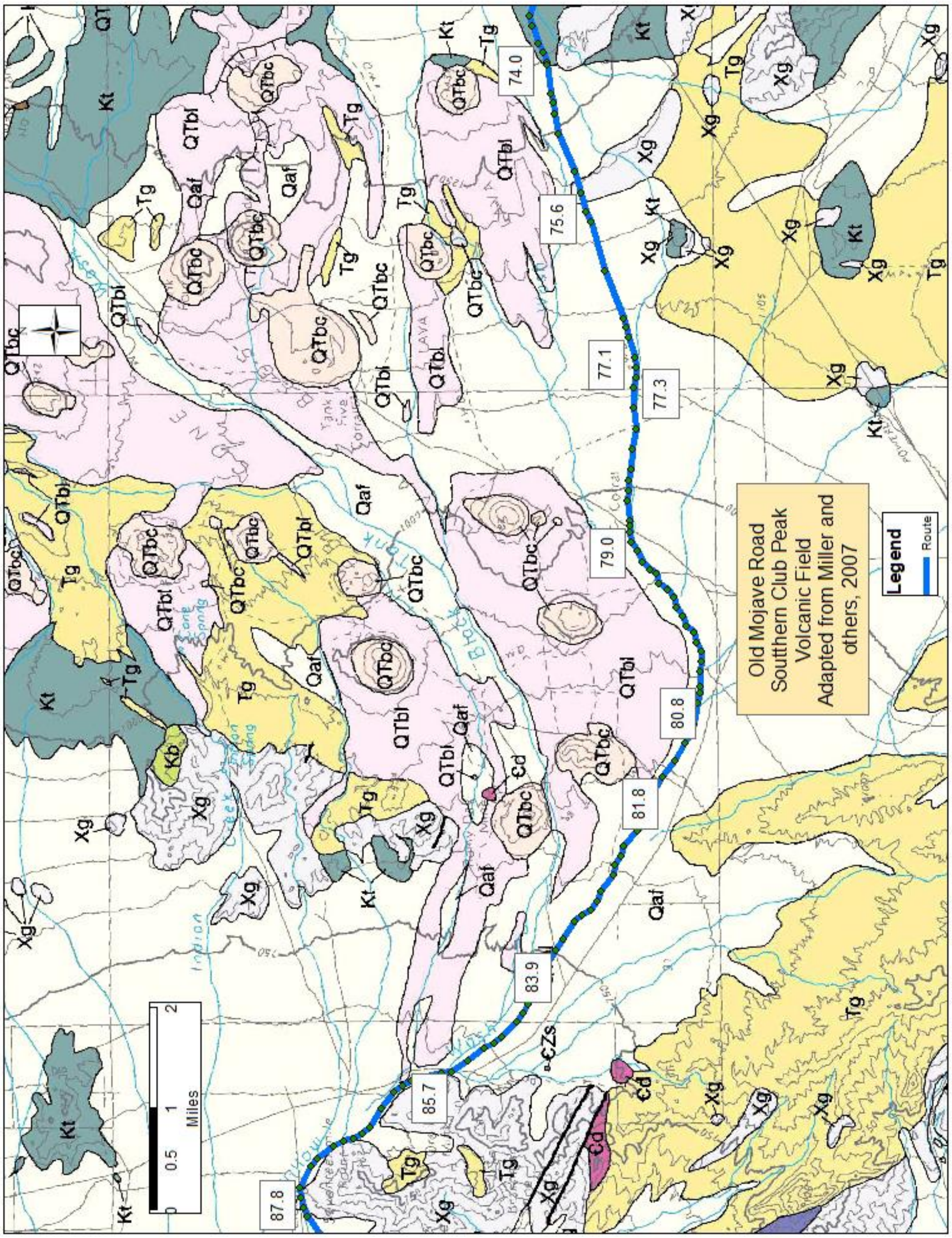


Figure 59. Mile 74.0 to 85.7: Cinder cones and lava flows of the southern Club Peak Volcanic Field

74.0 Mojave Mail Box

Rocks here are Cretaceous Teutonia Adamelite (Kt of Miller and others, 2007). There is a history of this mail box in Casebeir (2016, p. 121). Photos and a description of the phenomena are at https://www.atlasobscura.com/places/the-mojave-desert-mailbox

Figure 60. Mojave Mail Box. From http://www.theadventureportal.com/the-mojave-road-a-journey-through-the-desert/#prettyPhoto/7/ accessed Nov, 10, 2017.

74.2 Geologic Contact

Moving west, we cross from Cretaceous Teutonia Adamelite (Kt) back on to Quaternary alluvial fanglomerate (Qal). To the northwest are Pleistocene to late Miocene basalt lava flows of the QTbl unit of Miller and others (2007). To the north are Pleistocene to late Miocene basalt cinder cones flows of the QTbc unit of Miller and others (2007).

AREA MAP A13

75.6 Early Proterozoic Gneiss and Granitoids

Here the OMR crosses a 1,250 foot section of Xg rocks of Miller and others (2007). To the north are Pleistocene to late Miocene Basalt lava flows (QTbl).

77.1 U.S.G.S. Benchmark

Rocks here are Quaternary alluvial fanglomerate (Qaf of Miller and others, 2007).

77.3 Vista of Mining Activities on Cinder Cones

The rocks beneath our wheels are Quaternary alluvial fanglomerate (Qaf). To the northwest you can see traces of old roads and flattened cinder cones on the Pleistocene to late Miocene Basalt lava flows (QTbl) and cinder cones (QTbc of Miller and others, 2007).

79.0 Road Intersection and Corral

This is the Aiken Cinder Mine Road. A historical description of this area is in Casebeir (2016, p. 123-125). Rocks here are Quaternary alluvial fanglomerate (Qaf of Miller and others, 2007). From this point to mile 85.7 the ORM follows Willow Wash, not the 4x4 trails shown on the U.S Geological Survey maps for this area. The rocks to the north of the OMR in this segment are Pleistocene to late Miocene lava flows (QTbl of Miller and others, 2007).

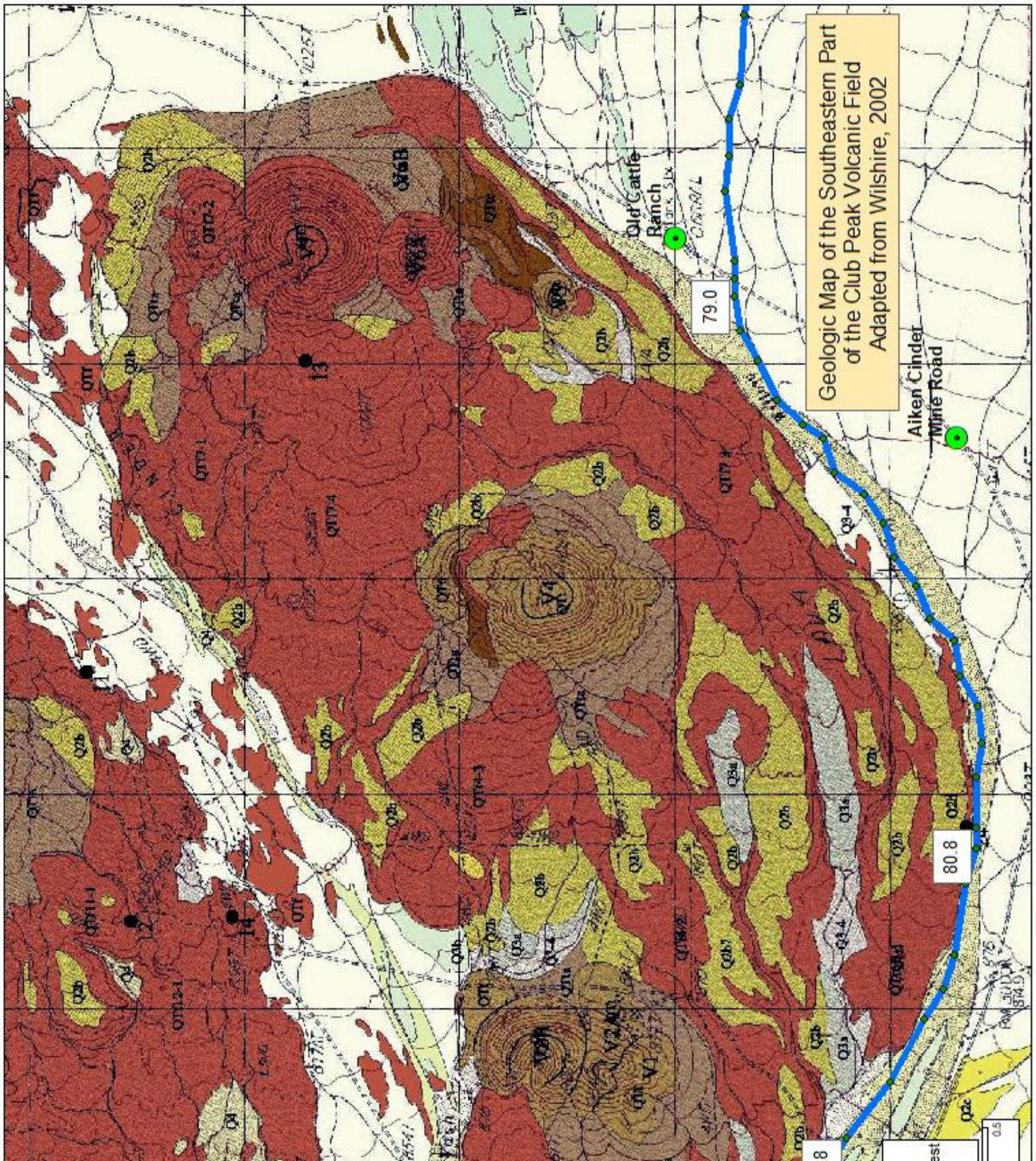


Figure 61. Southeastern part of the Club Peak Volcanic Field. Adapted from Wilshire, 2002.

80.8 Outcrop of Lava

Here, to the north is an excellent spot to see the Pleistocene to late Miocene lava flows (QTbl of Miller and others, 20007). The Carrere Quarry is to the 0.3 miles northeast of this point.

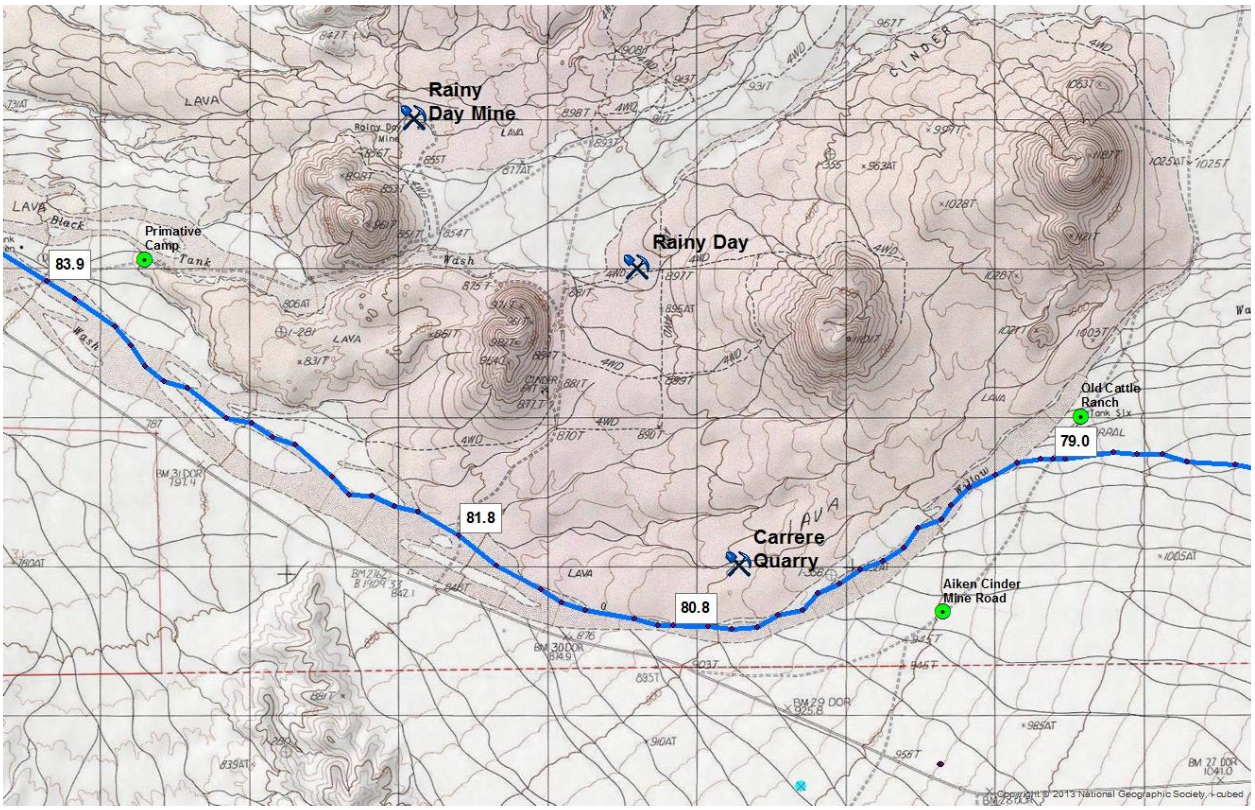


Figure 62. Cinder cone mines near the OMR. Map and data from USGS.

AREA MAP A14

81.8 Road Intersection

The rocks beneath us are Quaternary alluvial fanglomerate (Qal of Miller, 2007).

82.9 Outcrop of Lava

Here, to the north is another excellent spot to see the Pleistocene to late Miocene lava flows (QTbl of Miller and others, 2007).

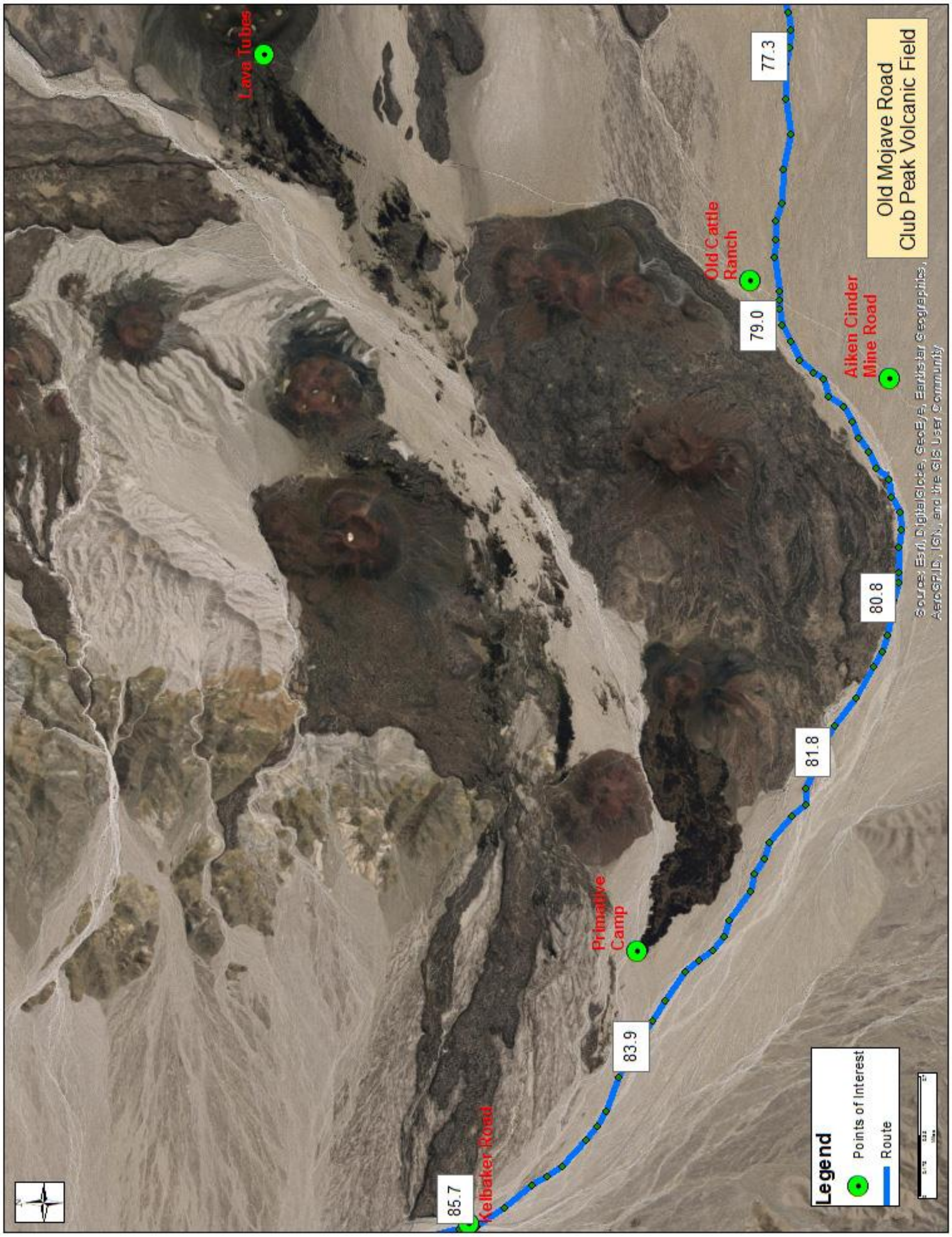


Figure 63. Aerial photograph of lava and cinder cones near the OMR. Data from ESRI and USGS.

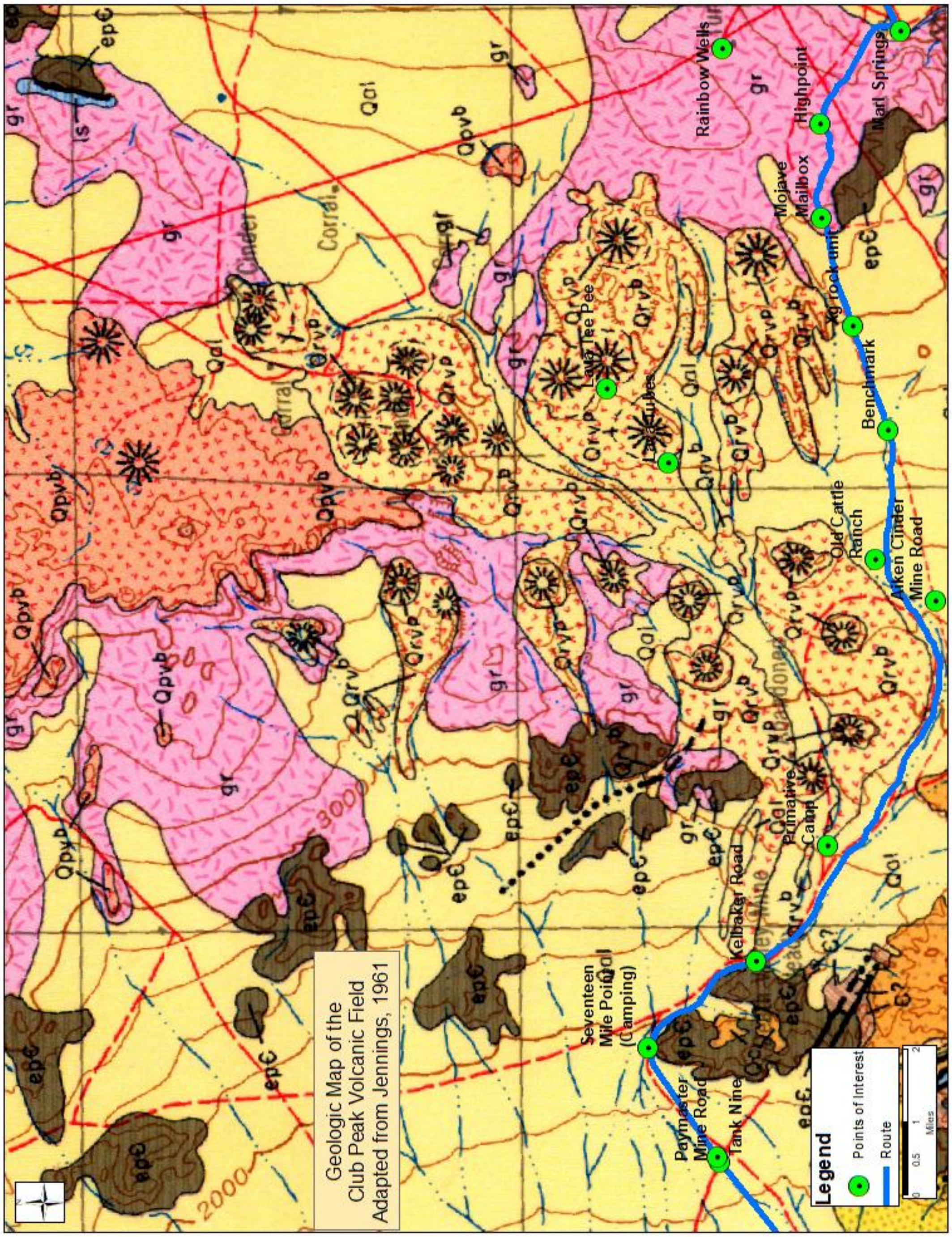


Figure 64. Geologic map of lava flows and cinder cones in the Club Peak Volcanic Field. Adapted from Jennings, 1961.

83.9 Road Intersection

The U.S. Geological Survey Topographic map shows this road going east to service several mine sites on the cinder cones. The OMR website GIS database file plots a "Primitive Camp" site to the east.

85.7 to 89.4 SEVENTEEN MILE POINT

Seventeen Mile Point is the northern tip of the Old Dad Mountain. Vredenburgh (2017 p. 120) described the geology of the Old Dad Mountains:

No single rock type dominates Old Dad Mountain and its surrounding area. Rock types include Early Proterozoic gneiss and granitoid rocks (Xg), Jurassic Aztec Sandstone (Ja), Mesozoic volcanic and sedimentary rocks (Mzv), Late Proterozoic and Cambrian siliciclastic rocks (PZs), and Tertiary volcanic rocks (Tv1). Old Dad Mountain is underlain by a resistant knob of limestone which is part of the Devonian to Permian limestone (PDl). Hewett (1956) reported the presence of granite, schist, and quartzite intruded by syenite dikes in the Proterozoic rocks in this general area (Theodore, 2007, p. 111). The oldest structure is a Lower (?) Jurassic unconformity overlain by Aztec Sandstone. The northwesttrending Powerline Canyon shear zone is exposed just south of Jackass Canyon. The Playground thrust fault truncates these older structures. Extensional tectonics during Miocene time resulted in the Old Dad normal fault. The steep slopes that formed on both sides of the Old Dad Mountain fault block by erosion or downfaulting became the source of numerous landslides of brecciated rock, as well as glide blocks, during Neogene time (Dunne, 1977). Hewett (1956, p. 113) surmised gold mineralization at mines in the north of Old Dad Mountain may be related to the intrusion of the Sands granite. At the Paymaster Mine, a massive quartz vein occurs in pre-Cambrian gneiss. Gold bearing quartz veins at the Brannigan and Oro Fino Mines occur in quartzite, shale, and dolomite of the Upper Precambrian to Lower Cambrian Wood Canyon formation, Stirling quartzite and Johnnie formation (Hewitt, 1956, p. 38; from Vredenburgh, 2017).

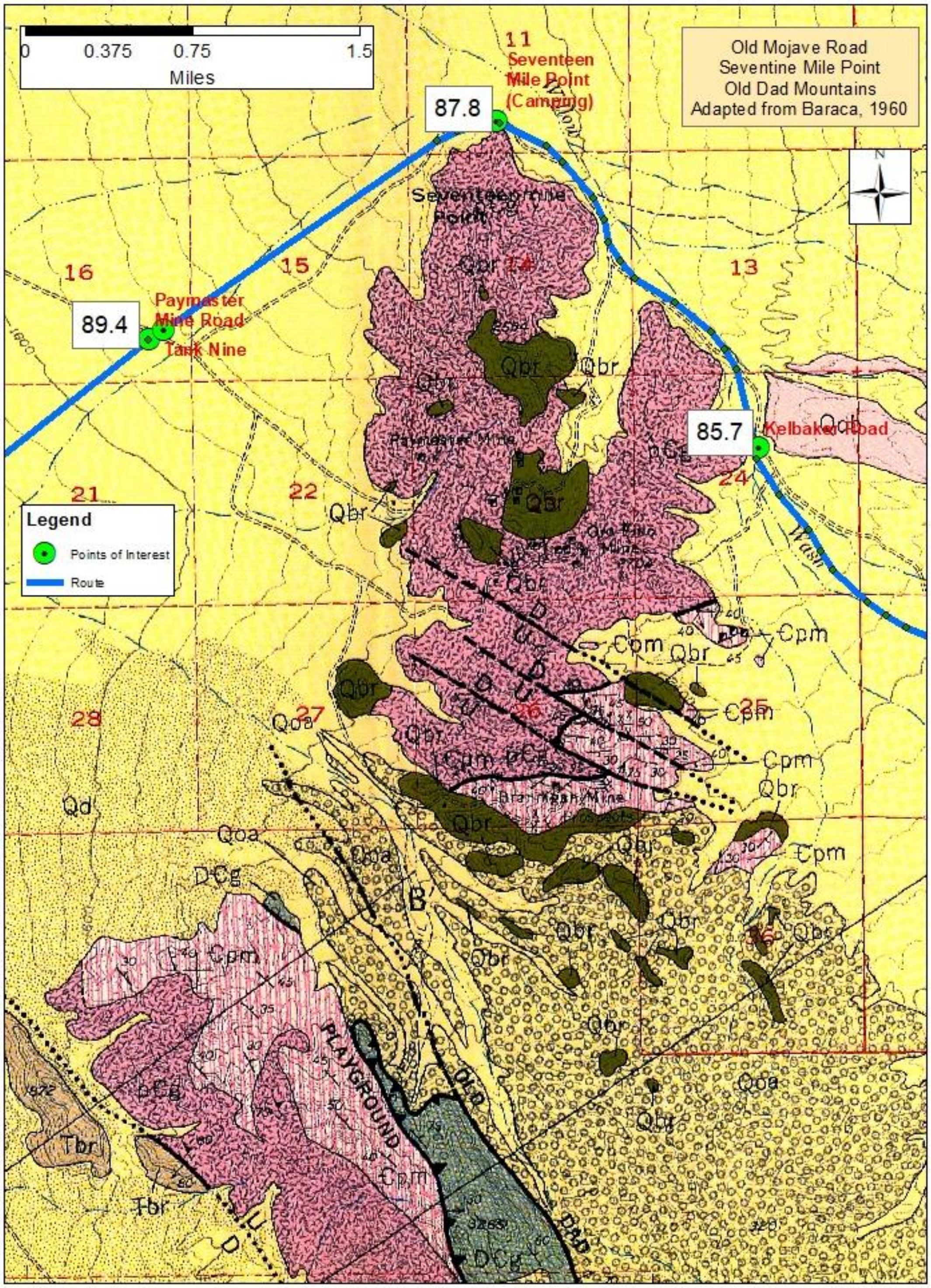


Figure 65. Mile 85.7 to 89.4: Seventeen Mile Point

85.7 Geologic Contact

To the right are PreCambrian Upper Proterozoic (Xu of Miller and others, 2007) rocks, some of the oldest rocks in California. To the left are Quaternart-Tertiary lava flows (QTf) which are some of the youngest rocks in California (Wilshire, 2002). Here we leave the KelBaker Road and follow the Old Mojave Road along the northeastern foot of Seventeen Mile Point Peak.

AREA MAP A15

87.9 Seventeen Mile Point

Turn left and go to the southwest. We are at the northern tip of a ridge trending south to Seventeen Mile Point Peak. To the south are Pre-Cambrian granite (p€g of Barca (1960) and p€g of Hewett (1956); Xg, Protolithic Granite of Miller and others (2007). The crest of Seventeen Mile Point has Recent Basalt Flows (Qbr, Baraca, 1960) or Tertiary Gravel (Tg, Miller and others, 2007) or Quaternary Older alluvium (Qoa, Hewett, 1956).

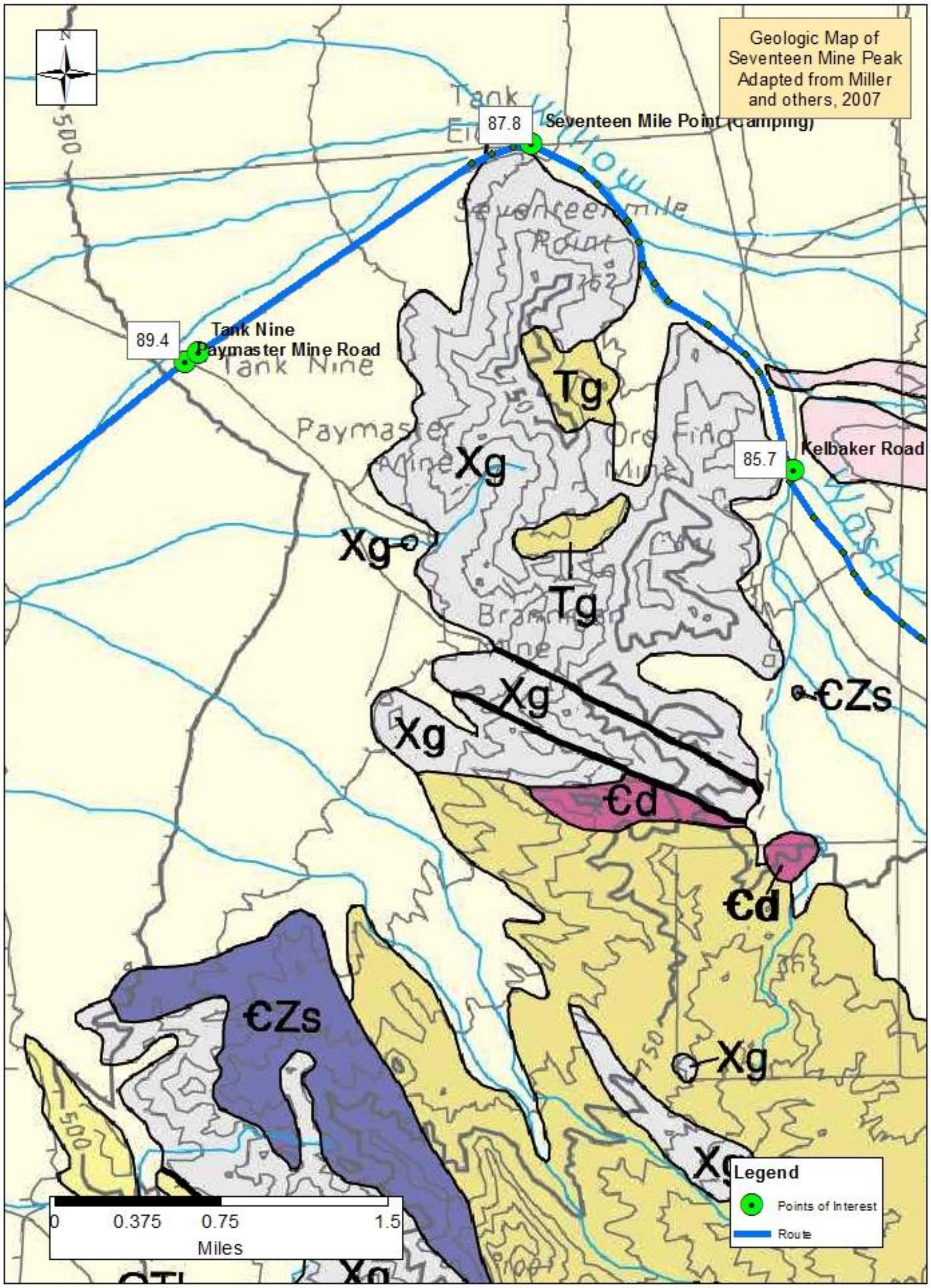


Figure 66. Geologic map of Seventeen mile peak. Adapted from Miller and others, 2007.

89.3 Site of Tank Nine

This is the former location of a water tank. We are on Quaternary Alluvium (Qal, Hewett, 1956) and the Holocene and Latest Pleistocene Young aeolian sand/Intermediate alluvial fan deposits (Qya/Qia) unit of Miller (2012). There is a pipeline here that connects the Paymaster mining area with Indian Springs (Vredenburgh, 2017).

89.4 to 94.8: DEVIL'S PLAYGROUND BETWEEN SEVENTEEN MILE POINT AND COWHOLE MOUNTAINS

Between Seventeen Mile Pine ant the Little Cowhole Mountains, the OME traverses Quaternary Alluvium and Lake deposits. These were mapped by Miller (2012). From east to west these are:

Qia	Late to Middle Pleistocene Intermediate alluvial fan deposit
Qya/Qia	Holocene and latest Pleistocene Young alluvial fan deposit/ Late to Middle Pleistocene Intermediate alluvial fan deposit
Qia	Late to Middle Pleistocene Intermediate alluvial fan deposit
Basinal Contact	Between alluvial and debris flow deposits to the east and eolian deposits to the west
Qyae/Qiae	Holocene to Latest Pleistocene Young mixed alluvial and eolian sand deposit / Late to Middle Pleistocene Intermediate mixed alluvial and eolian sand deposit
Qiae	Late to Middle Pleistocene Intermediate mixed alluvial and eolian sand deposit
Qiea	Late to Middle Pleistocene Intermediate mixed eolian sand and alluvial deposit
Qyea+Qaed	Holocene and Latest Pleistocene Young Mixed alluvial and aeolian sand Deposit + Holocene and Latest Pleistocene Young Eolian Sand Dune Deposit.

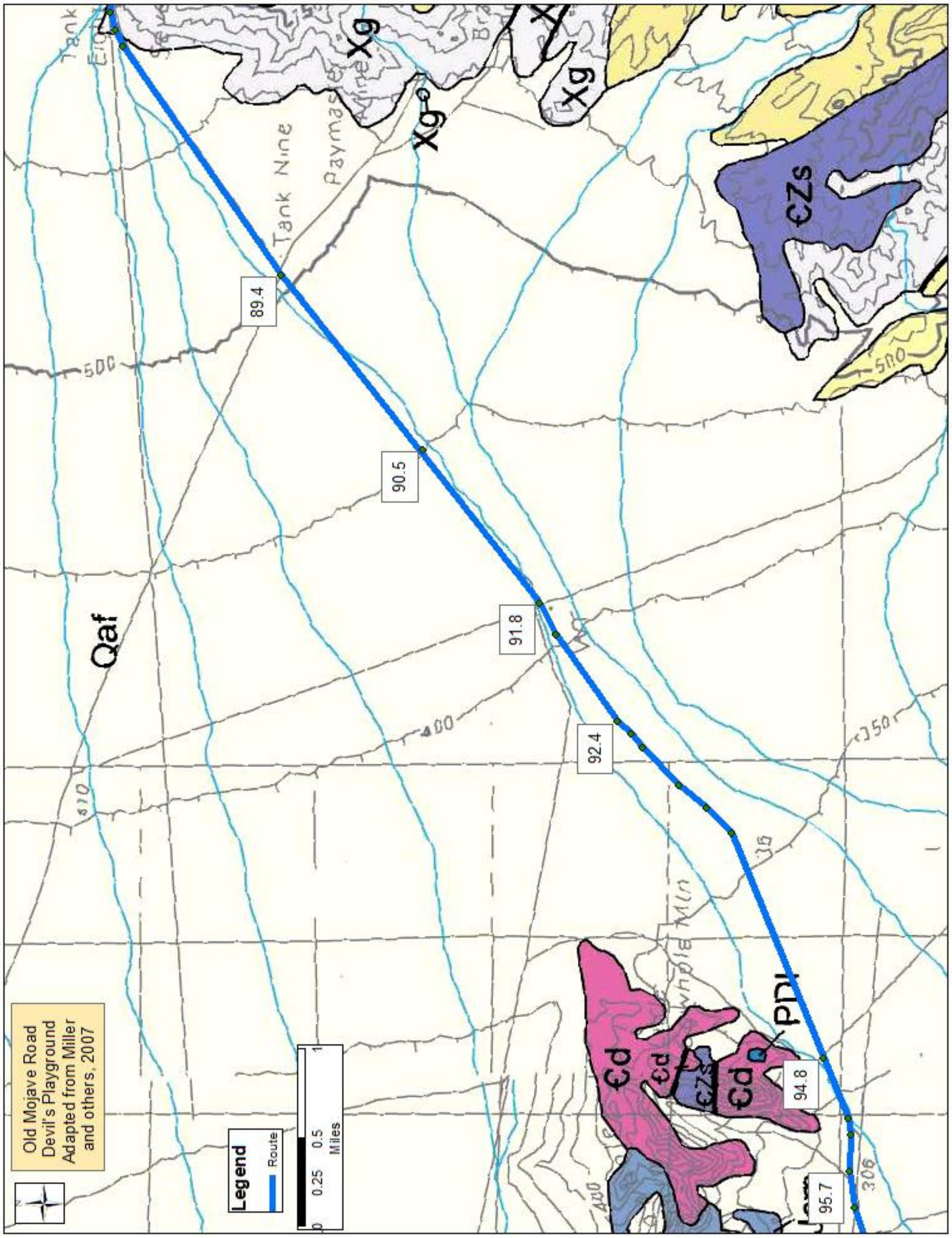


Figure 67. Mile 89.4 to 94.8: Devil's Playground between Seventeen Mile Point and Cowhole Mountains.

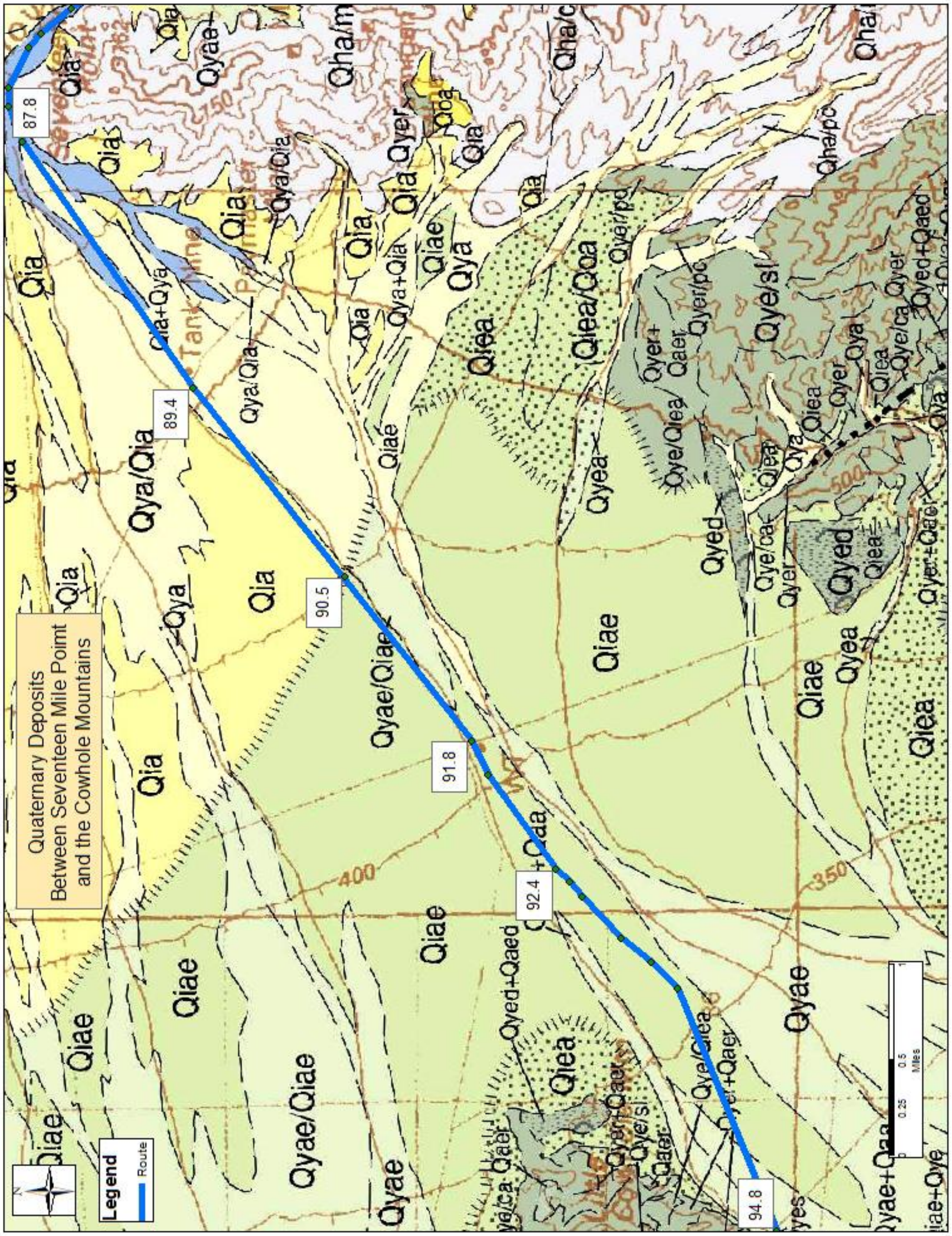


Figure 68. Surficial Geology between Seventeen Mile Point and Cowhole Mountains. Adapted from Miller, 2012.

89.4 Road Intersection: Paymaster Mine Road

Information about the Paymaster Mine is found in Vredenburgh (2017) which is also posted at http://vredenburgh.org/mining_history/pages/EastMojave.html.

Hewett (1956, p. 113) surmised gold mineralization at mines in the north of Old Dad Mountain may be related to the intrusion of the Sands granite. At the Paymaster Mine, a massive quartz vein occurs in pre-Cambrian gneiss. Gold bearing quartz veins at the Brannigan and Oro Fino Mines occur in quartzite, shale, and dolomite of the Upper Precambrian to Lower Cambrian Wood Canyon formation, Stirling quartzite and Johnnie formation (Hewitt, 1956, p. 38 cited by Vredenburgh, 2017).

Mile marker site 89.4 is underlain by Quaternary Alluvial Fan deposits (Qal, Miller and others, 2007).

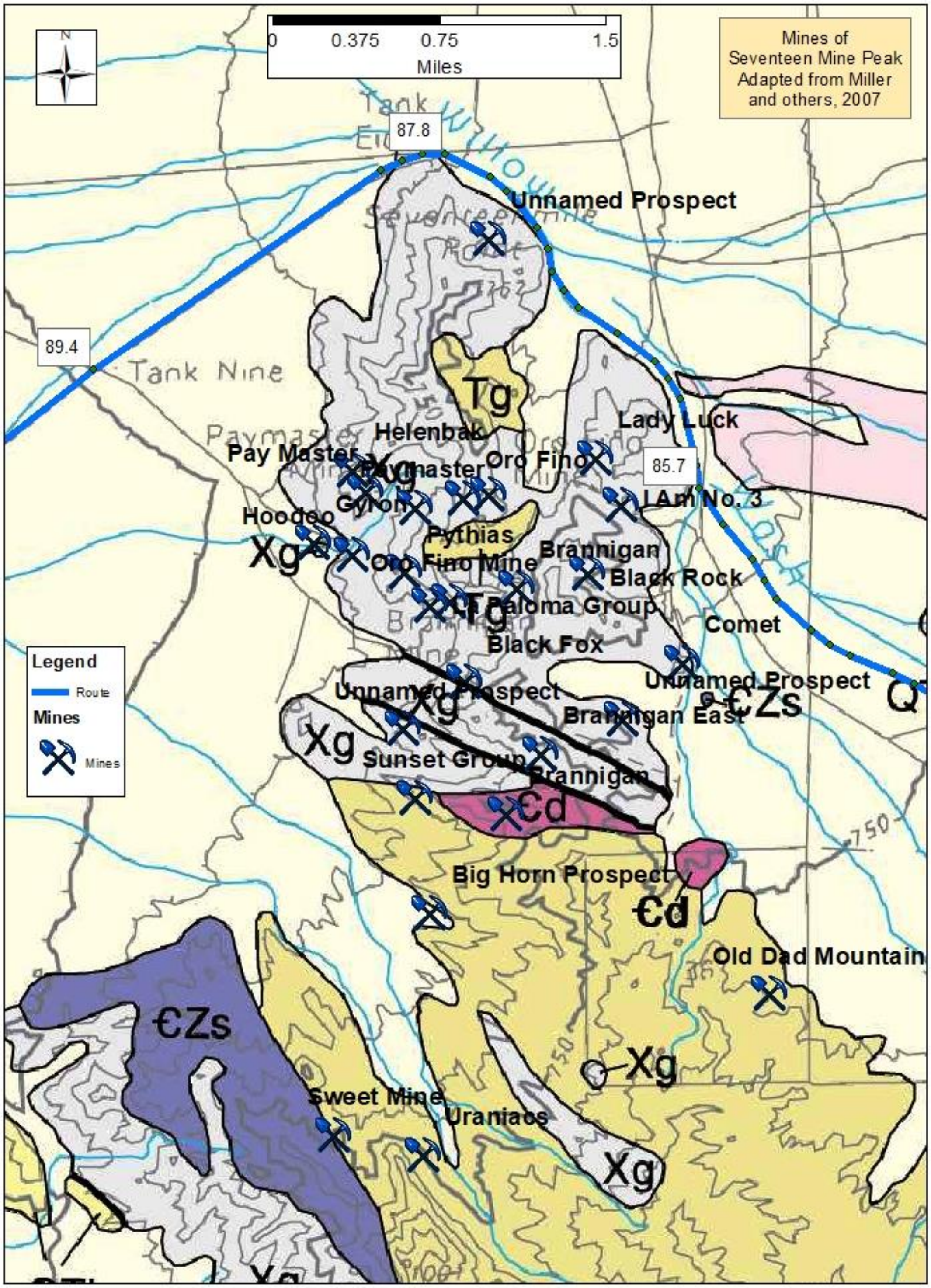


Figure 69. Mines of Seventeen Mile Point

89.5 Depositional Boundary

Here marks a basinal line between two depositional rock groupings (Miller, 2012). The eastern deposits are mostly alluvial or debris flows and the western ones are eoline. See Figure 50.

91.8 Road Intersection: Jackass Canyon Road

The roadway here is underlain by Quaternary Alluvium (Barca, 1960).

92.4 Devil's Playground

This is an area of sand dunes (Barca, 1960).

94.8 to 96.6: COWHOLE AND LITTLE COWHOLE MOUNTAINS

The Cowhole mountains are south of the OMR and the Little Cowhile Mountains are north of it.

The east side of the Little Cowhole Mountains are (KJcm) and the eastern side is €d and (€Zs, Milller and others, 2007).

The Cowhole Mountains have a northern, central and southern portions delineated by faults.

The northern block has:
TKf = Felsite dikes (Tertiary or Cretaceous)
KJcm = Granitoid Rocks of Cowhole Mountain (Cretaceous or Jurassic)
PD = Permian and Devonian
€d = Dolomite (Cambrian)
€Zs = Siliciclastic rocks (Cambrian and Late Proterozoic)
Xg = Granitoids (Proterozoic)

The central block has:
TKf = Felsite dikes (Tertiary or Cretaceous)
KJcm = Granitoid Rocks of Cowhole Mountains (Cretaceous or Jurassic)
Ja = Aztec Sandstone (Jurassic)
Jd = Diorite (Jurassic)
Mzv = Volcanic and Sedimentary Rocks (Mesozoic)
PDl = Permian and Devonian limestone
€d = Dolomite (Cambrian)

The southern block has
TKf = Felsite dikes (Tertiary or Cretaceous)
KJcm = Granitoid Rocks of Cowhole Mountains (Cretaceous or Jurassic)
Ja = Aztec Sandstone (Jurassic)
Jd = Diorite (Jurassic)
Mzv = Volcanic and Sedimentary Rocks (Mesozoic)
PDl = Permian and Devonian limestone
€d = Dolomite (Cambrian)

AREA MAP A-16

94.8 Road Intersection: Cowhole Mountains (to the southeast).

The Little Cow Hole Mountains are to the north and the Cowhole Mountains are to the southeast.

NAME	COMMODITIES	DEVELOPMENT STATUS	TRS	Latitude	Longitude
Anthony	Copper, Uranium	Prospect	13N 9E Sec. 34 SBM	35.17421000040	-116.01415000000
Bernice	Gold	Prospect	12N 10E Sec. 18 SBM	35.13111000000	-115.96945000000
Cronese	Asbestos	Occurrence	12N 9E Sec. 14 SBM	35.12940999960	-116.00145000000
El Lobo Mine	Copper,Gold, Lead	Occurrence	13N 9E Sec. 35 SBM	35.17531000020	-116.00115000000
Little Cowhole Mountain	Marble, Dimension	Occurrence	13N 9E Sec. 35 SBM	35.16721000020	-115.99915000000
Michele	Gold	Prospect	12N 9E Sec. 10 SBM	35.14001000010	-116.00585000000
Mosaic Queen	Lead, Silver, Marble, Dimension, Stone,	Prospect	12N 9E Sec. 13 SBM	35.12640999960	-115.98395000000
Unnamed Prospect	Copper, Cobalt, Gold, Zinc	Prospect	12N 9E Sec. 14 SBM	35.13001000040	-115.99255000000
Unnamed Prospect	Gold	Prospect	13N 9E Sec. 33 SBM	35.16921000000	-116.02585000000
Unnamed Prospect	Iron	Prospect	12N 9E Sec. 10 SBM	35.14280999980	-116.00775000100

Figure 70. Mines of the Cowhole and Little Cowhole Mountains. Data from MRDS, 2011.

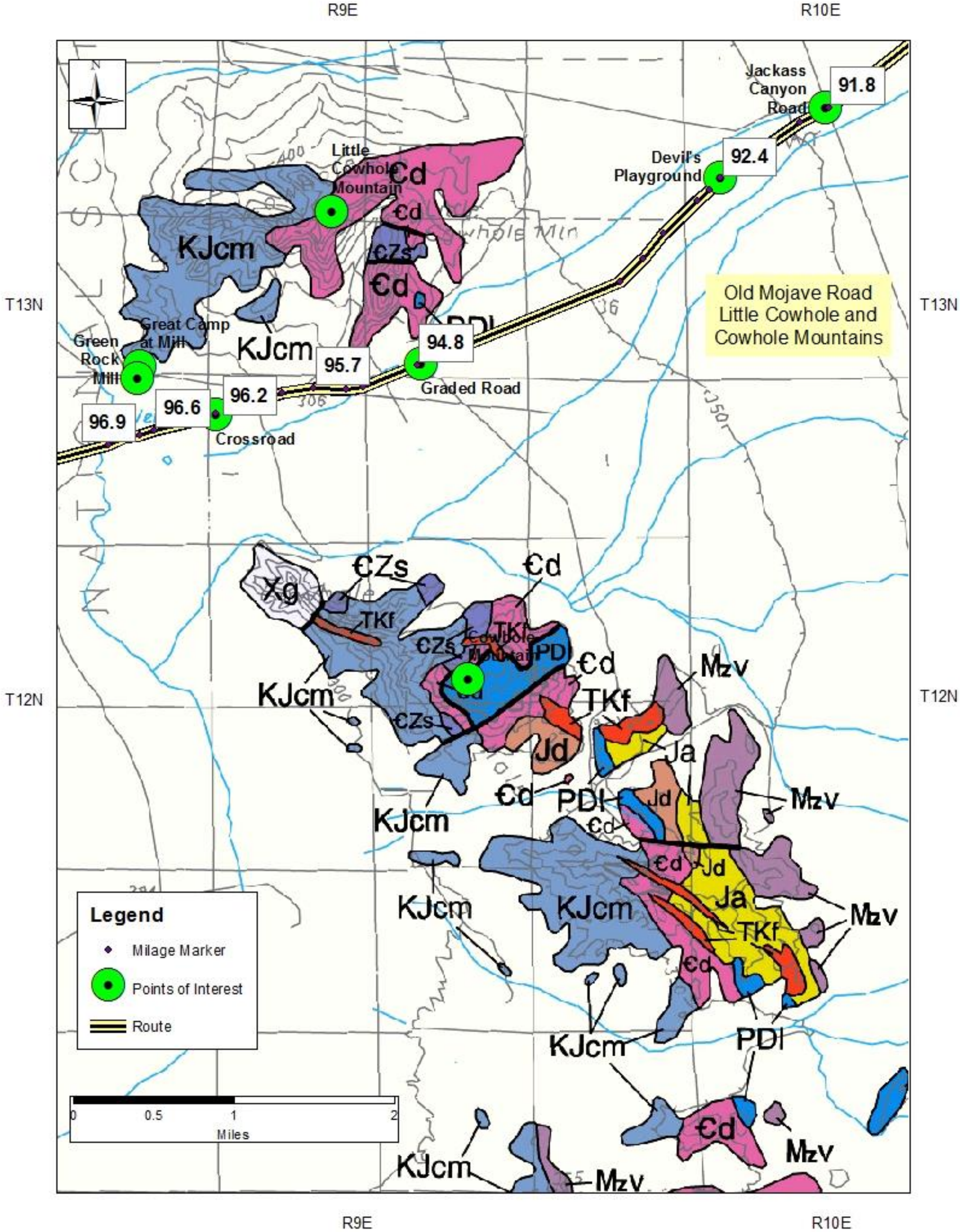


Figure 71. Geologic map of the Little Cowhole and Cowhole Mountains. Adapted from Miller and others, 2007.

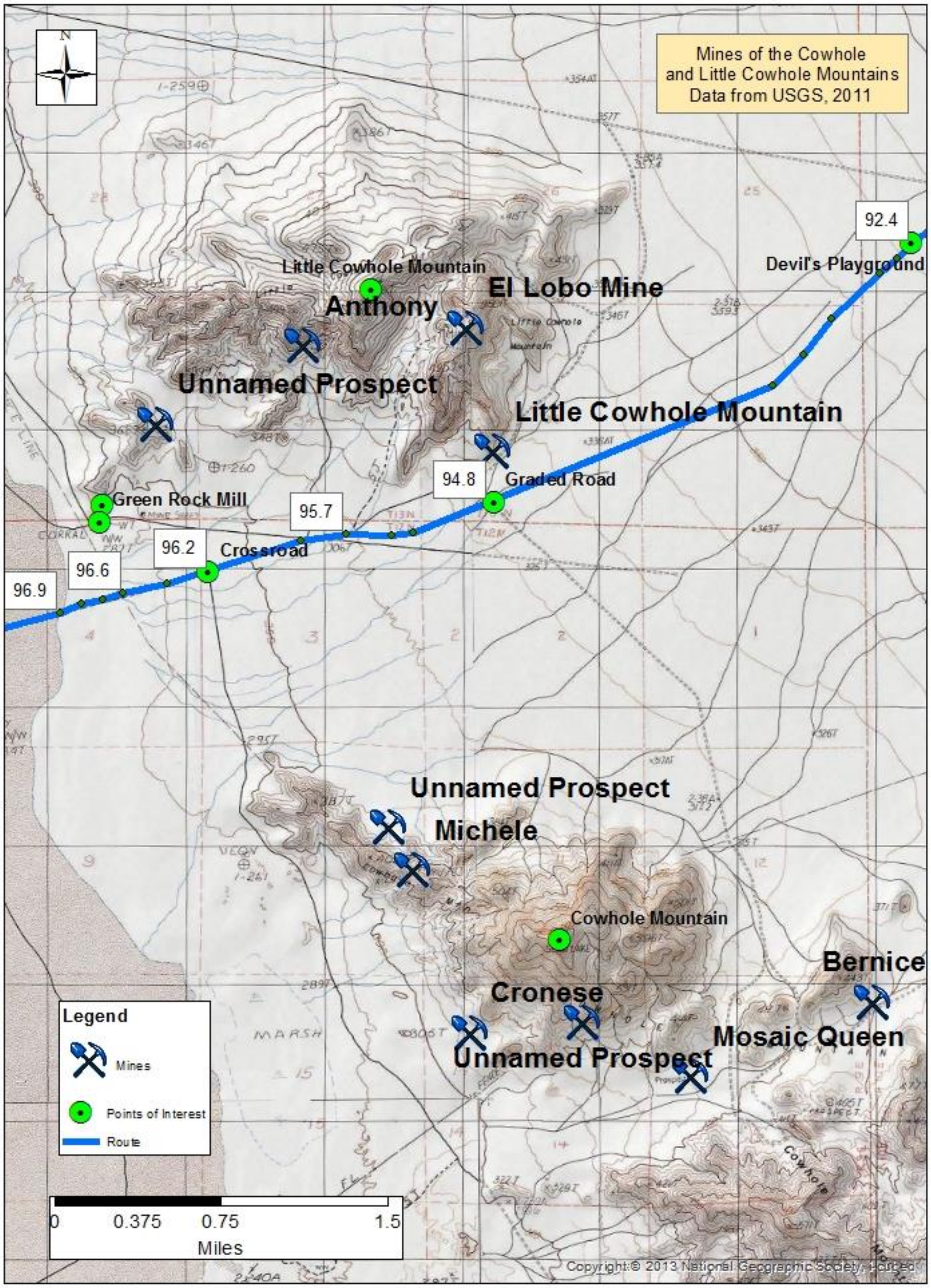


Figure 72. Mines of the Little Cowhole and Cowhole Mountains.

95.7 Road Intersection: Green Rock Mill

The road to the west-northwest goes over to the Green Rock Mill.
The Little Cowhold Mountains have the following mines listed in the MRDS database:

NAME	COMMODITIES
Anthony	Copper, Uranium
Bernice	Gold
Cronese	Asbestos
El Lobo Mine	Copper,Gold, Lead
Little Cowhole Mountain	Marble, Dimension
Michele	Gold
Mosaic Queen	Lead, Silver, Marble, Dimension, Stone, Dimension, Zinc, Copper, Gold
Unnamed Prospect	Copper, Cobalt, Gold, Zinc
Unnamed Prospect	Gold
Unnamed Prospect	Iron

The U.S.G.S. topographic map for this area shows a mine shaft at the Green Rock Mill, but there is no listing for it in MRDS, 2011. The mine may be mis-plotted in MRDS,

The road here is underlain by Quaternary alluvial fanglomerate (Qaf, Miller and others, 2007).

96.2 Road Intersection

The road here is underlain by Quaternary alluvial fanglomerate (Qaf, Miller and others, 2007).

96.6 to 102.5: SODA LAKE

Soda Lake has sand dunes along it's eastern edge. There is a clay central section surrounded by a halo of alkali materials. There is a 2-mile long section of brown-black clays at the western edge of Soda Lake along the OMR. The lake was mapped as Qaf by Miller and others (2007).

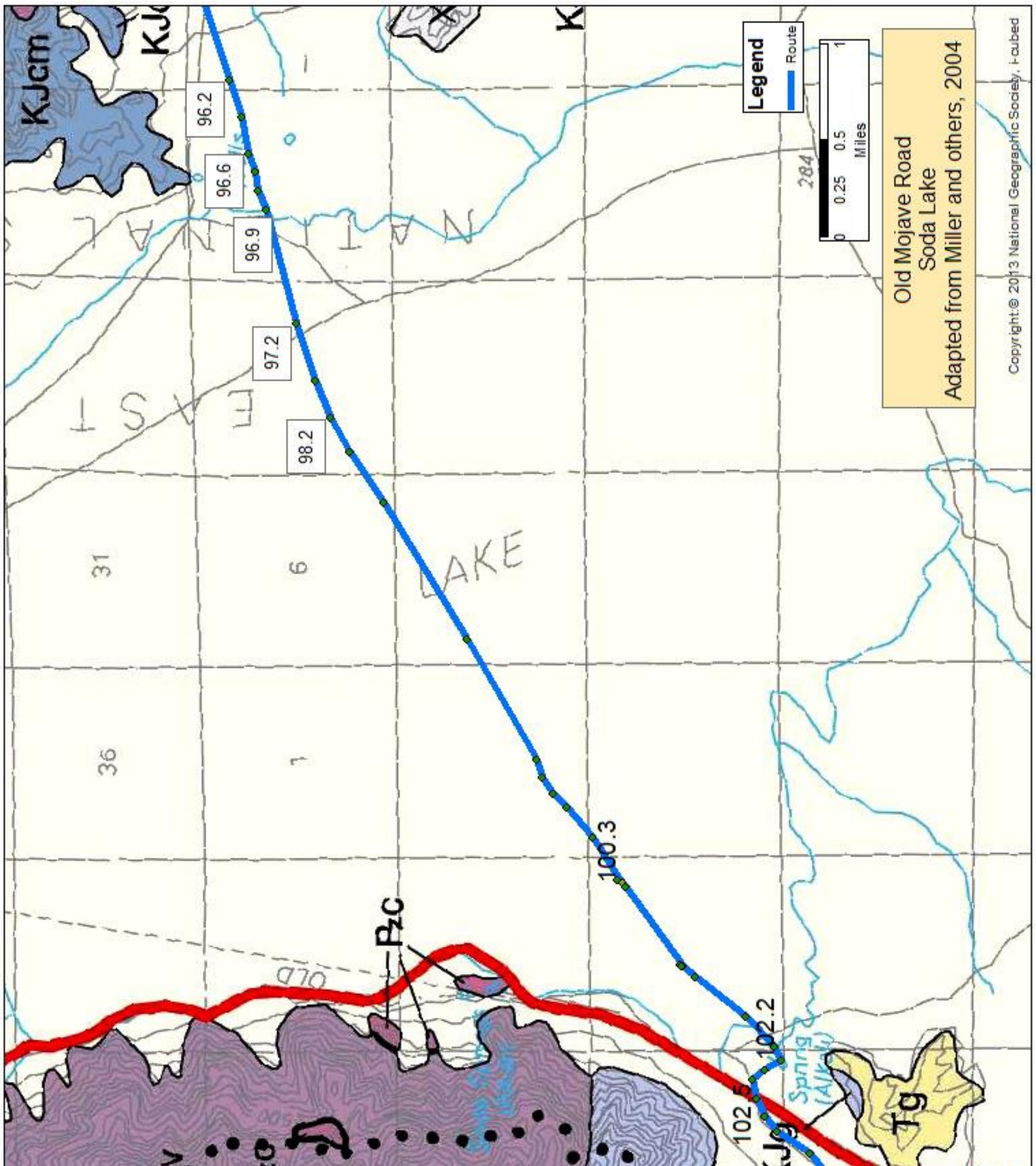


Figure 73. Mile 96.6 to 102.5: Soda Lake

Figure 74. Aerial photograph of Soda Lake.

96.9 Eastern Edge of Soda Lake

The road here is underlain by Quaternary alluvial fanglomerate (Qaf of Miller and others, 2007).

97.2 Soda Lake

Soda Lake (or Soda Dry Lake) is a dry lake at the terminus of the Mojave River. The lake has standing water during wet periods, and water can be found beneath the surface. Soda Lake along with Silver Lake are what remains of the large, perennial, Holocene Lake Mojave. The waters of the lake, now with no outlet, evaporate and has left alkaline evaporites of sodium carbonate and sodium bicarbonate. The road here is underlain by Quaternary alluvial fanglomerate (Qaf of Miller and others, 2007).

AREA MAP A-17

98.2 Narrow Channel and old road to Zzyzx.

At this point, the historic OMR goes west to Zzyzx. The current OMR goes to the southwest to Traveler's Monument. The road here is underlain by Quaternary alluvial fanglomerate (Qaf of Miller and others, 2007).

Zzyzxx

Wickipedia has this to say about Zzyzzx:

Curtis Howe Springer gave the made-up name Zzyzx to the area in 1944, claiming it to be the last word in the English language. He established the Zzyzx Mineral Springs and Health Spa in 1944 at the spot, which was federal land, after filing mining claims for 12,000 acres (49 km2) surrounding the springs. He used the springs to bottle his water and provide drinks for travelers through the hot desert. Springer also imported animals from around the country to attract more families to visit his ranch. He used Zzyzx until 1974, when the land was reclaimed by the government. Since 1976, the Bureau of Land Management has allowed California State University to manage the land in and around Zzyzx. A consortium of CSU campuses use it as their Desert Studies Center. (Wickipedia, https://en.wikipedia.org/wiki/Zzyzx,_California accessed Nov. 9, 2017).

An uncomplimentary description of the Springer's eviction by BLM is told in Casebier (2016, p. 143-146).

Figure 75. Zzyzxx - Soda Springs. From https://upload.wikimedia.org/wikipedia/commons/thumb/1/11/Soda_Lake_030913.JPG/600px-Soda_Lake_030913.JPG accessed Nov. 9, 2017

100.9 Traveler's Monument

It is traditional for travelers of the OMR to add a rock to this large cairn. The road here is underlain by Quaternary alluvial fanglomerate (Qaf, Miller and others, 2007).

102.2 Soda Springs and the Granites

Caspier (2016, p. 139-147) gives a history of Soda Springs.

Here is the Wickipedia description:

Soda Springs is the former site of the Zzyzx Mineral Springs and Health Spa[1] and now the site of the Desert Studies Center. The site is also the location of Lake Tuendae, originally part of the spa, and now a refuge habitat of the endangered Mohave tui chub fish . Soda Springs, a natural spring, has long seen human activity. The area was a prehistoric quarry site, and projectile points and rock art can be found in the area. The Mojave Road ran past the spring which was guarded by the Hancock Redoubt in 1860, during the Bitter Spring Expedition and by Camp Soda Springs, garrisoned by the U. S. Army from 1867 to 1870. Later Soda Springs was the name of the station of the Tonopah and Tidewater Railroad that passed there. Remnants of a wagon road stop and railroad artifacts are readily seen. Evaporative salt mining and mill sites can be found here as well. (Wickipedia, https://en.wikipedia.org/wiki/Zzyzx,_California accessed Nov. 9, 2017).

The road here is underlain by Quaternary alluvial fanglomerate (Qaf, Miller and others, 2007). To the southwest is an exposure of Cretaceous-Jurassic Granite (KJg, Miller and others, 2007).

102.5 to 110.6: SOUTHERN SODA MOUNTAINS

The southern Soda Mountains have the following mapped units:

Formation Name	Age	Symbol	Author
Alluvium	Holocene or Pleistocene	Qa	Dibblie, 2008a
Clay or Mud Playa Deposits	Holocene or Pleistocene	Qc	Dibblie, 2008a
River Terrace Gravel	Holocene or Pleistocene	Qg	Dibblie, 2008a
Non Marine	Pleistocene	Qc	Jennings and others, 1962
Older Fanglomerate	Pleistocene	Qof	Dibblie, 2008a
Older Gravel	Pleistocene	Qog	Dibblie, 2008a
Non-Marine	Pliocene to Pleistocene	QP	Jennings and others, 1962
Undifferentiated Mafic Volcanic Rocks	Pliocene?	Tv	Dibblie, 2008a
Gravel	Pliocene and Miocene	Tg	Miller and others, 2007
Andesite	Tertiary	Tva	Jennings and others, 1962
Rhyolite	Tertiary	Tvr	Jennings and others, 1962
Granitoid Rocks	Cretaceous and Jurassic	KJg	Miller and others, 2007
Quartz Monzonite	Late Jurassic or Early Cretaceous	qm	Dibblie, 2008a
Granite to Quartz Monzonite	Late Jurassic or Early Cretaceous	gqm	Dibblie, 2008a
Metavolcanic Rocks	Jurassic-Triassic	JTrv	Jennings and others, 1962
Granite	Mesozoic	Gr	Jennings and others, 1962
Volcanic and Sedimentary Rocks	Mesozoic	Mzv	Miller and others, 2007
Metavolcanic Rocks	Mesozoic or older	mv	Dibblie, 2008a
Carbonate Rocks	Paleozoic	Pzc	Miller and others, 2007

The oldest rocks are Paleozoic carbonates roof pendants followed by Mesozoic sediments and volcanics, Jurassic and Triassic metavolcanics. These are preserved in pendants in slightly younger Late Jurassic and Early Cretaceous granitoid rocks. These were eroded and upon them were deposited Miocene and Pliocene volcanic rocks of andesitic or rhyolitic composition. Erosion and uplift of all these rocks produced Miocene to Holocene gravels and other continental clastic deposits. The most recent Holocene and Pleistocene sediments are related to Lake Manix and evolution of the Mojave River.

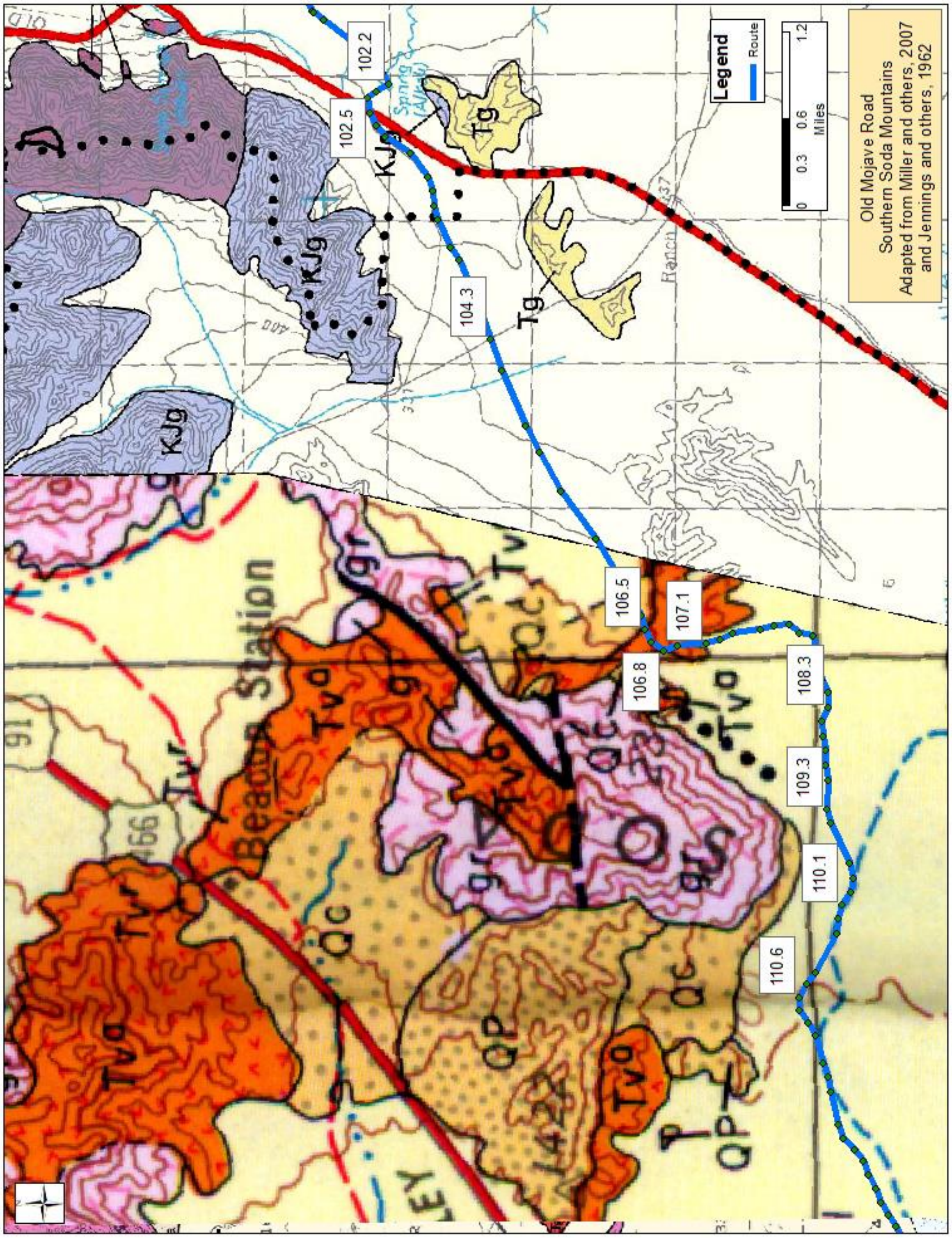


Figure 76. Geology of the Southern Soda Mountains. Adapted from Jennings and others (1962) and Miller and others (2007)

102.5 Tonopah and Tidewater Railroad (Grade at Zzyzx)

Pages 153 to 157 of Caspier (2017) has an article by John Fickewirth giving a history of the T&T Railroad with several interesting photographs. Phil Serpico wrote a hardcover book about the railroad in 2013 (Tonopah & Tidewater Railroad: The Nevada Short Line). You can buy that book at https://www.amazon.com/Tonopah-Tidewater-Railroad-Nevada-Short/dp/0884180174

Figure 77. Engine of Tonopah and Tidewater railroad. Photo from University of Las Vegas, http://d.library.unlv.edu/cdm/singleitem/collection/pho/id/18605/rec/2 accessed Nov.11, 2017.

Figure 78. Tonopah and Tidewater railroad bed at Zzyzx. From https://upload.wikimedia.org/wikipedia/commons/5/5b/TonopahTidewaterRailroadBed.jpg accessed Nov. 9, 2017.

The Tonopah and Tidewater railroad did not connect Los Angeles (the tidewater Pacific) with central Nevada (Tonopah), but did unite other rail lines to form a network of railroads that made it possible to take trains from Los Angeles to Mojave, Baker, Death Valley Junction, and Beatty. From Beatty a line was built west to the boom town of Rhyolite. The "T&T" was owned by the Pacific Coat Borax Company and built as a standard gauge railroad from 195 to 1907. When completed it connected at Beatty with the Bullfrog-Goldfield Railroad which in turn connected with the Tonopah & Goldfield Railroad and provided a through railroad link which, via the Southern Pacific, ran all the way up into western Nevada east of Reno. It was part of a railroad "war" between Francis Marion Smith of the Pacific Coast Borax Company and Senator W.A. Clark. Smith's railroad started from Ludlow and was built the north with Beatty and the mining town of Rhyolite as it's destination. Clark's line was built from Las Vegas where a line was built to Salt Lake. Clark's plan was to have his own railroad to Rhyolite. Smith built narrow gauge line from Death Valley Junction to the Lila C Borax Mine. When the giant borax deposit at Boron, California was discovered and developed, mining was discontinued in the Death Valley area. The line was torn up for scrap during WWII. I hope they rebuild the "T&T" someday…..

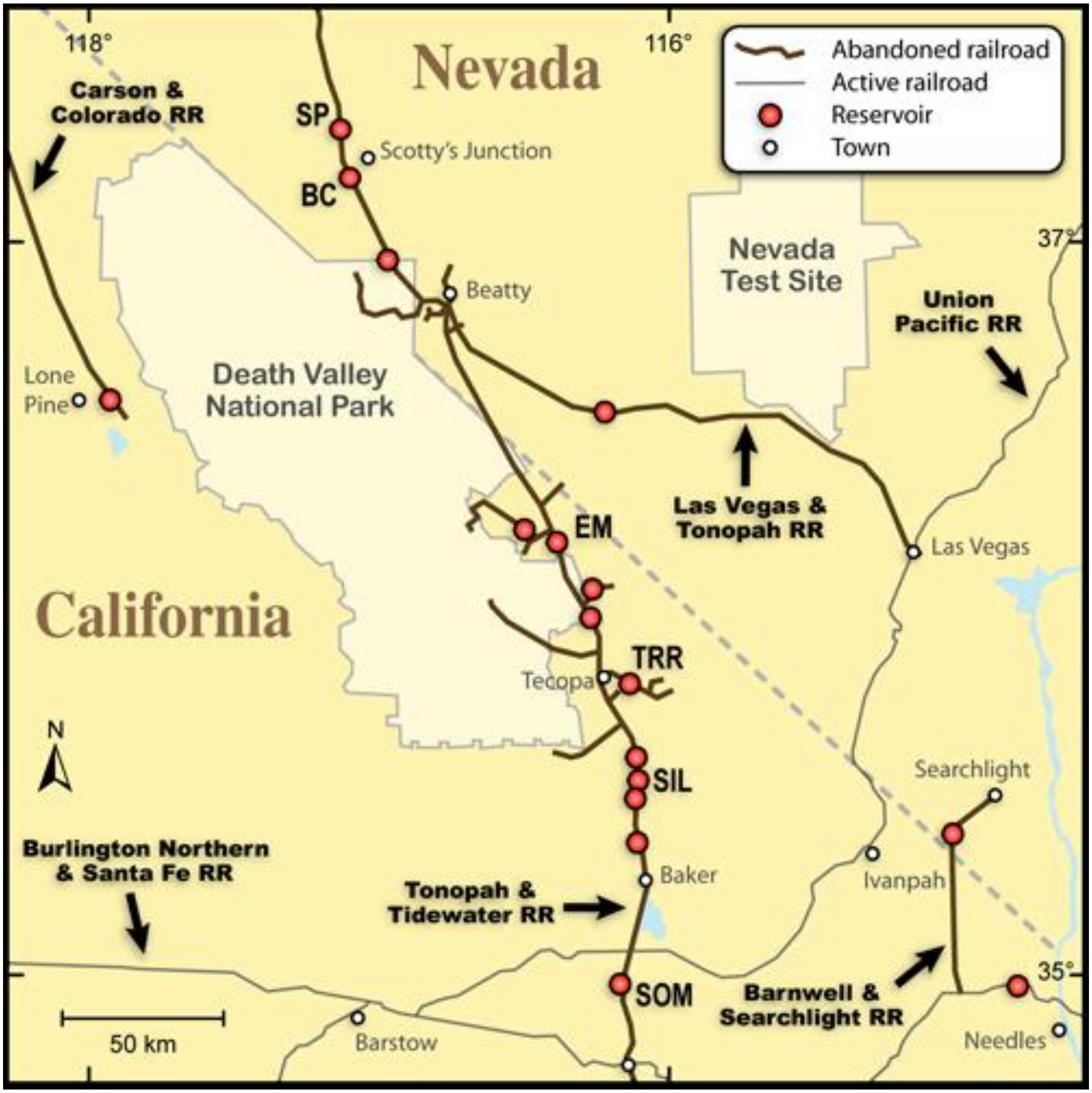


Figure 79. Railroad Routes in the Death Valley Area. From Griffith and others, 2006, Figure 3.

At mile 102.5 the OMR is underlain by Quaternary Alluvial fan deposits (Qaf). To the north is a hill composed of Cretaceous-Jurassic granitoid rocks (KJg), and north of them are undivided Mesozoic metamorphic rocks (MzV, Miller and others, 2007).

104.3 Road Intersection: Rasor Road

The road to the north will eventually tie into Highway I-15. Here the OMR is on Quaternary alluvium (Qal, Jennings and others, 1962). To the north is a hill of Cretaceous-Jurassic granite (KJg) and to the south are Miocene to Pliocene gravels (Tg, Miller and others, 2007).

AREA MAP A-18

106.5 Shaw Pass

The reason this pass has it's name and a story about an Indian attack are given in Casebier, 2016, p. 158-159. The OMR at Shaw Pass is underlain by Tertiary Volcanic Andesite (Tva, Jennings and others, 1962). We are in the southern Soda Mountains. There there is a campground and a geologic contact between Pleistocene non-marine rocks (Qc) to the east and Tertiary Volcanic Andesite (Tva, Jennings and others, 1962) to the west. We now head west and will be descending Afton Canyon along the Mojave River.

107.1 Geologic Contact

Here we pass from Tertiary Volcanic Andesite (Tva) to Quaternary Alluvium (Qal, Jennings and others, 1962).

108.3 Blow Sand

This area is mapped as Qal by Jennings and others (1962). He mapped sand dunes (Qs) one mile to the south.

Figure 80. Aerial photograph of blown sand at Mile 108.3

109.3 Road Intersection and Hummocky terrain

The landscape here is one of bushes that form “stacks” where underlying soils have been eroded. The area is mapped as Qal by Jennings and others (1962). The south tip of the Soda Mountains is on our right (north). From this point we see Mesozoic Granite (gr of Jennings and others, 1962).

Figure 81. Aerial photograph of plant haystacking near Mile 109.3.

110.1 Wide Wash

This area of the OMR was mapped by Jennings and others (1962) as Qal.

110.6 to 114.8: MOJAVE RIVER WASH

This segment of the OMR traverses Quaternary alluvium shed from the southeastern Cave and southwestern Soda Mountains. The main channel of the Mojave River Wash is to the south.

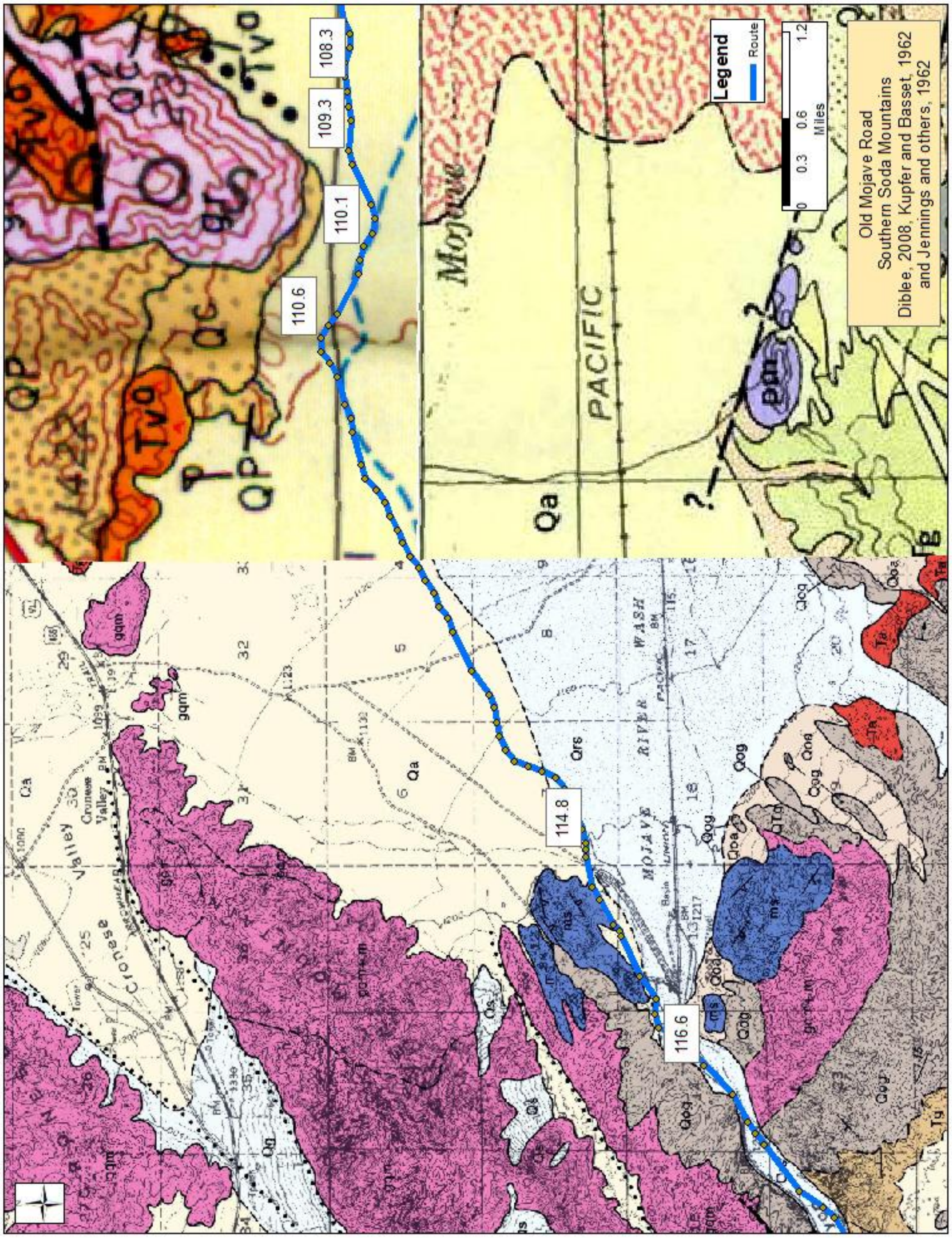


Figure 82. Geologic Map of the Mojave Wash.

110.6 Quaternary Alluvium

The area to the south between Mile Posts 110.6 and 106.8 is labeled “Mojave River Sink” in the USGS topographic map for this area. Jennings and others (1962) mapped this area of the OMR as Quaternary Alluvium (Qal). To the north are Pleistocene non-marine rocks (Qc of Jennings and others, 1962).

114.8 to 120.5: CAVE AND NORTHERN CADY MOUNTAINS

Cave Mountains

Cave Mountain Geology

The northern boundary of Cave Mountains is the Cronese Valley through which Interstate 15 passes. A splayed fault system marks Cronese Valley. This fault is traced 23 miles westward all the way to Coyote Lake.

The Cave Mountains were mapped by Dibblee (2008a). They are mostly granite-quartz monzonite (g-qm) in the northeast with Older Quaternary gravel (Qog) in the southwest. There is a roof pendant of Mezosoic sedimentary rock (ms) between two west-southwest-east-northeast trending faults at the Cave Mine in the southeastern part of the mountains. The southern boundary of the Cave Mountains is the Manix fault. This fault controls the location of eastern Afton Canyon and can be traced westward to the town of Manix (T.10N, R.04E, Section 5) (Wilkerson, 2013).

A map of the Cave Mountains is provided in Appendix 114.8

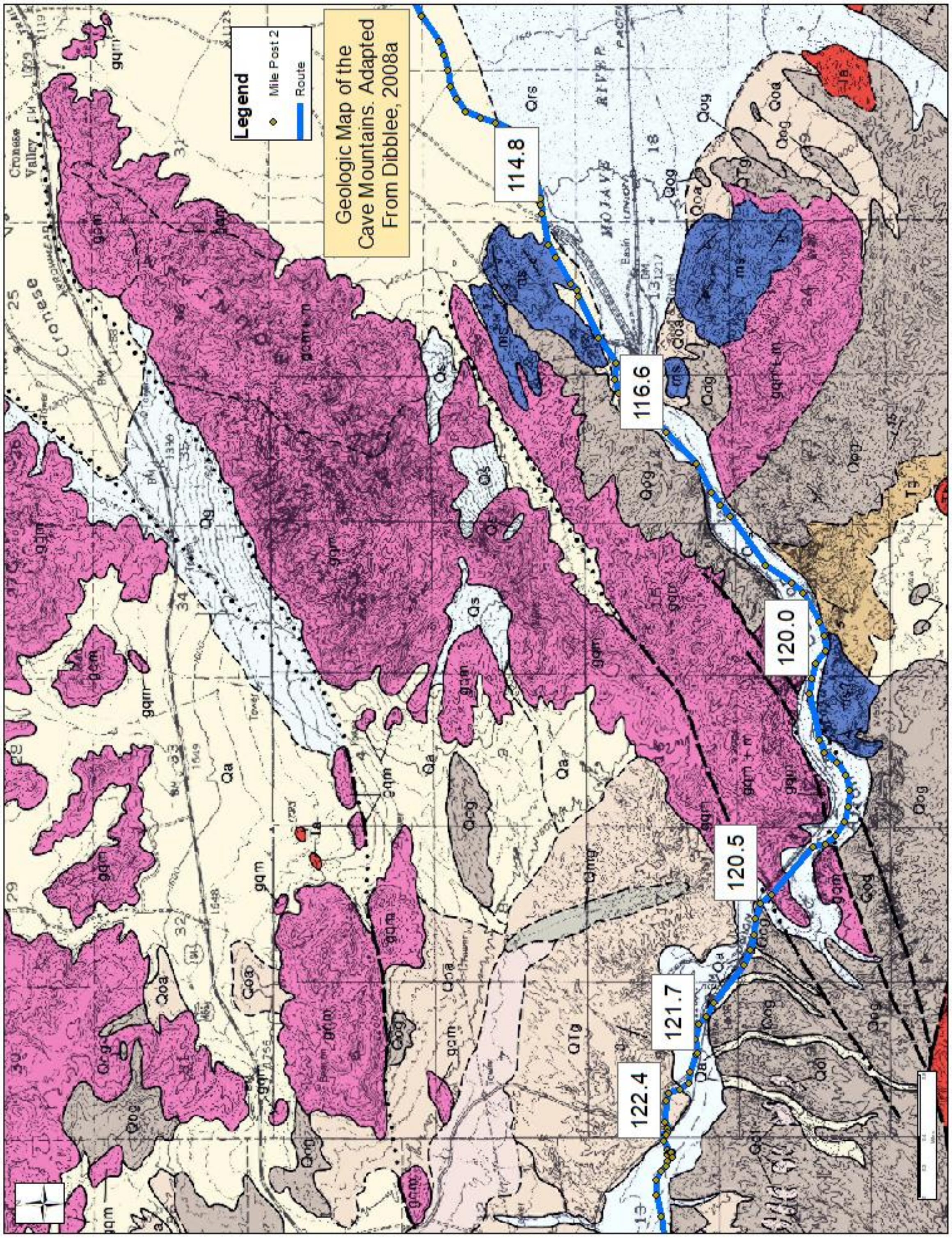


Figure 83. Geologic map of the Cave Mountains. Adapted from Dibblee, 2008a.

AREA MAP A-19

114.8 Road Intersection: Basin Road and Cave Mountains

We are at the east side of the Cave Mountains, and at the eastern end of Afton Canyon. Here the Mojave River cuts through the Cave Mountains. Rocks to the north and south of us are Metasediments that are Pre-Cambrian, Paleozoic or older (ms of Dibblee, 2008a).

Cave Mountain Mining

The MRDS database locates 15 mines in the Cave Mountains. These are summarized in the table, below and in Table 1 in the Appendix Section.

There are five commodities in the Cave Mountains. The are:

Commodity	**Number of mines and prospects**	**Major deposits**	**Comments**
Gold and Gold-Copper	5	Smith	
Iron and Iron-Copper	6	Baxter, Cave Canyon	
Mica	1	Unnamed	Prospect
Stone	1	Cave Canyon	Iron mine converted to stone mine
Uranium	1	Cave Mountain Group	

114.8 to 115.8: Cave Canyon Mines and Baxter Mines

The Cave Canyon Iron Mines and Baxter Mine are on the right (north).

The generalized mine location is:
T.11N, R.06E, Sec. 11, 12, SBB&M -116°18'18.36"W ; 35o03'12.02"N

The Cave Canyon mine, on the south flank of Cave Mountain, has been the second largest source of iron in San Bernardino county (Wright and others, 1953:65, 87). This was also known as the Basin, or Baxter Mine.

The Cave Canyon Mine is one-half mile north of Basin (formerly Baxter) siding on the Union Pacific Railroad, and about 20 miles southwest of Baker.

The mine was owned by the California Portland Cement Company, 601 West 5th Street, Los Angeles, California in 1953. They owned 11 patented claims.

The Cave Canyon deposits, intermittently mined since 1930, were a source of iron ore used in the manufacture of cement. The most complete description of the deposits has been furnished by Lamey (1948; cited by Wright and others, 1953:93).

The iron-bearing minerals, principally magnetite and hematite with subordinate limonite, occur in bodies that lie largely within an eastnortheast trending belt about one mile long. The deposits are enclosed in a complex of metamorphic rocks (limestone, gneiss, quartzite, and schist) of possible pre-Cambrian age (Dibblee, 2008a, 2008b, ms unit). The complex also contains intrusive bodies of acidic to basic igneous rocks (Wright and others, 1953:93; Dibblee, 2008a, gqm unit) (Wilkerson, 2013).

Fragments of wall rocks are commonly abundant within the iron-bearing deposits. In general, the deposits and the enclosing rocks trend east-northeast and dip at gentle to steep angles. Intricate faulting, brecciation, and simple to complex folding are characteristic. The deposits are exposed along the south side of a small valley with a relief of about 200 feet. Their width and lateral extent are obscured by Quaternary alluvial valley fill, talus and an older Quaternary fanglomerate. The exposed iron-bearing material lies in two principal areas, one at each end of the belt. The two bodies thus indicated are each at least 1,800 feet long and as much as 300 feet wide. A few much smaller deposits lie within a few thousand feet of the principal zone. The mineralized zone appears to be of contact metamorphic origin and largely a replacement of limestone (Wright and others, 1953:93) (Wilkerson, 2013).

Nearly all of the mine's output was obtained from an open cut on the west body. Early in 1952 the cut, tadpole-shaped in plan, was about 800 feet long, 200 feet in maximum width and had faces mostly in the range of 30 to 70 feet high. Other workings included several shafts, adits and trenches. The maximum shaft depth was about 150 feet. The maximum adit length was about 580 feet. Mining operations were being confined to periods of a few weeks spaced at about two-year intervals Wright and others, 1953:93) (Wilkerson, 2013).

Wright and other (1953) identify additional information about the Cave Iron Mine is Aubury (1906:299); Bailey (1902:13); Boalich (1923:112); Burchard (1948: 220); Cloudman and others (1919:818); Hewett (1936:78); Hodge (1935, vol. l, d : 44; vol 3, ap. E- 5:4); Jones (1916:pp.8); Lamey (1948:69-83); Leith (1906:198); Lyon (1914:40); Powell (1948:3-4, tbl. 2); Thompson (1929: 32, 509); Tucker (1930a); Tucker (1931a:333-334; 43: 468, pl. 7) (Wilkerson, 2013).

There are seven special mineral surveys of the Cave Mine:

M4235
M4238

M4240
M4241
M4604
M6805
M6839

Plats for these mineral surveys are available at

http://www.glorecords.blm.gov/default.aspx

The Cave Mine has two mineral deposits and two periods of operation. A rock quarry operation for white limestone (Marble Mine) was there prior to development of the Cave Mountain Iron Ores.

The rock quarrying operation still has relics of its rail system which loaded cars in series. There are mill and crusher foundations extant at the south side of the mining district (Wilkerson, 2013).

The Cave Mountain Iron mine is still in operation.

A generalized geologic map of the Cady Mountains is provided in Area map “A19 to A23 Cady Mountains”

116.8 Union Pacific Railroad Bridge

The OMR goes under the bridge.

Northern Cady Mountains

The northwestern Cady Mountains are bounded to the north by the Manix Fault. We cross it at mile 118.7, 119.6, 129.1, 135.0 and 138.5.

Northern Cady Mountain Geology

South of the Manix fault, between the northwest branch of Baxter Wash and the upper reaches of Afton Canyon, the northern Cady Mountains expose, from west to east, expose Tertiary gravel (Tg), Older gravel (Qog), granite-quartz monzonite, and a metasedmentary roof pendant (ms). At the southeast end of the northern Cady Mountains, the older gravels surround Tertiary andesite (Ta). The western northern Cady Mountains are a fault blocks of granite (gr) to the east, Tertiary tuff (Ta) and Tertiary andesite (Ta) in the middle, and Tertiary andesite (Ta) to the east. These fault blocks are up to the west. The middle block has some Tertiary basalt (Tb) on top of the Tertiary andesite (Ta). In the eastern part of the western northern Cady Mountains, there are exposures of Tss. These sandstones (Tss) are in depositional and in fault contact with Tertiary andesite (Ta) and Tertiary basalt (Tb). The southern boundary of the northern Cady mountains, for this report are Wilhelm Wash and Baxter Wash (Wilkerson, 2013).

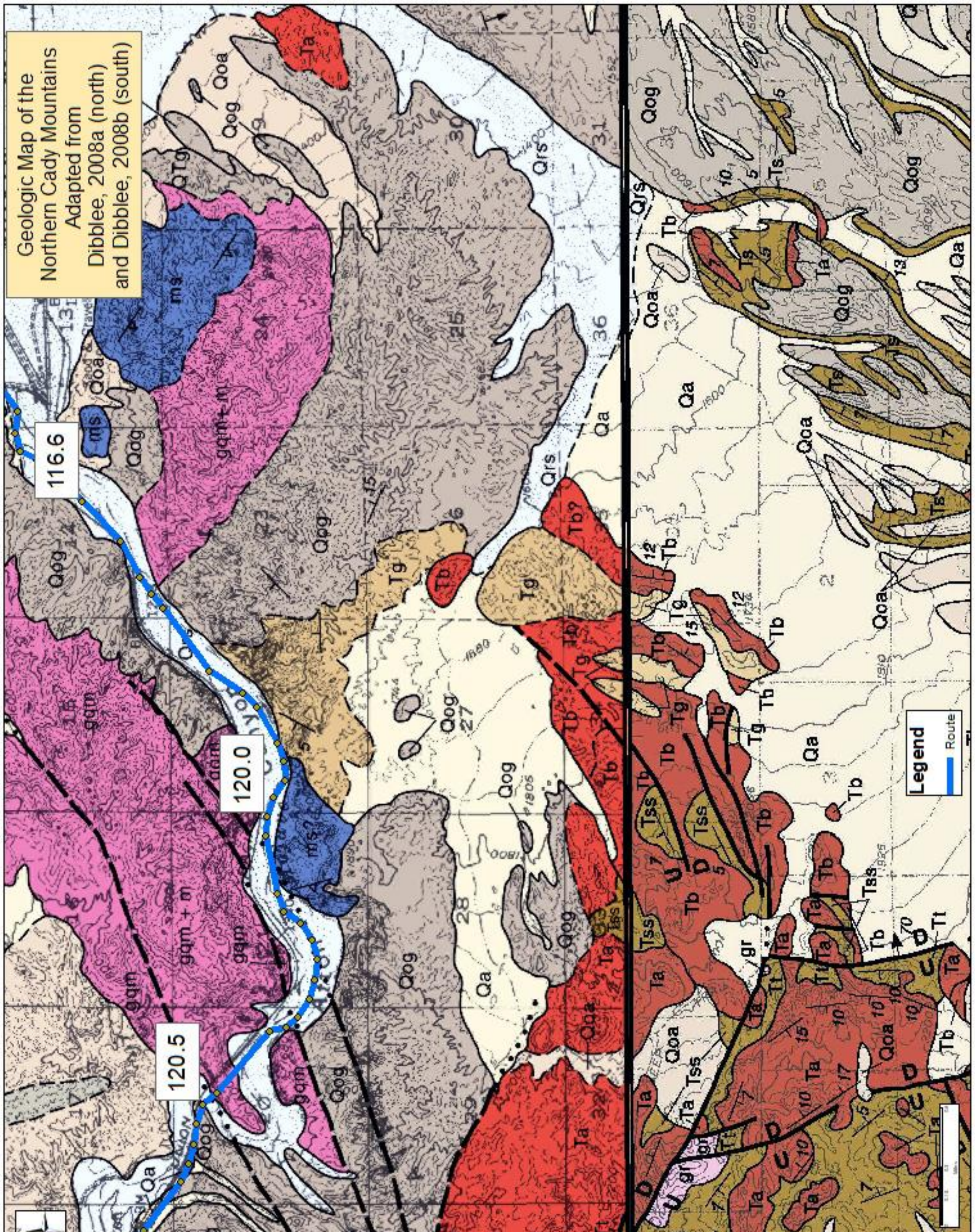


Figure 84. Geologic map of the Northern Cady Mountains. Adapted from Dibblee, 2008a and 2008b.

Northern Cady Mountain Mines

There are 23 mines in the MRDS database located in the Northern Cady Mountains. These are summarized in Table 2. The distribution of commodities among these 23 mines and prospects is shown below:

Commodity	**Number of mines and prospects**	**Major deposits**	**Comments**
Barium-Barite	1	Massen	Occurrence
Bentonite and Clay	4	Stacsite Mine	Occurrence
Fluorine-Fluorite	3	Afton Canyon	Prospect
Gold, Gold-Cu, Gold-Cu-Pb	6	Overlook, Unnamed No. 1, Unnamed No. 2	Overlook was Past Producer
Limestone	2	Marble Placer	Occurrence
Manganese	2	Afton Canyon	Past Producer
Pumice	1	Unnamed Pumicite	Occurrence
Sand and Gravel	3	Basin	Past Producer
Silica	1	Southern Pacific	Occurrence

Afton Canyon Fluorite Mines

T.10N, R.06E, Sec. 7, SBB&M -116°23'29.23"W ; 34°58'58.72"N

The Afton Canyon fluorite deposi includes numerous fluorite occurrences referred to under the names Afton, Bighorn Number 9, King R , and Massen (Wilkerson, 2013).

Fluorspar, with quartz, calcite and siderite, occurs in veins in andesite and basalt. One zone, about one-eighth mile wide and one mile long contains abundant veins from one-half inch to 8 inches wide; most strike N. 70°E and dip vertically. In area 1 1/2 miles west-southwest, small fluorite tonnage obtained from vertical vein, 4 ft . in maximum width, along a granite-andesite contact. Vein followed by 150-foot shaft. (Wright and others, 1953, Table , Fluorospar, No. 424, p.146) (Wilkerson, 2013).

Wright and others (1953, Table, Fluorospar, No. 424, p. 146) identify additional information about the Afton Canyon fluorite mines in Burchard (1934:373, 374); Crosby (1951:633-636); Hewett (1936: 171 and 172); Tucker (1920:343); Tucker (1930:301-302); Tucker (1931:375,376); Tucker (1943:513,514, pl. 7.) (Wilkerson, 2013).

Afton Canyon Magnesite Mines

(Cliffside or Van Deventer Mines)

T.11N, R.06E, Sec. 21, SW1/4 SBB&M -116°21'27.36"W ; 35°03'17.75"N

These magnesite mines are on the south side of Mojave River in Afton Canyon east of Afton. They are bedded, white to pink, with fine- grained magnesite, 30 to 75 ft. thick. The magnesite crops out for a horizontal distance of 400 to 500 ft, in a steep canyon wall and parallel to overlying conglomerate and underlying conglomeratic siltstone and thin basalt flow (Wright and others, 1953, Table , Magnesite, No. 465, p.159) (Wilkerson, 2013).

Dibblee (2008a, 2008b) mapped the area as being associated with a fault that downdropped Tertiary andesite (Ta) against granite (gr) and Tertiary tuff (Tt). The mine is between two granite bodies (Wilkerson, 2013).

Wright and others had this to say about the Afton Canyon Mine in 1958:

South aide Mojave River in Afton Canyon east of Afton. Bedded, white to pink, fine- grained magnesite, 30 to 75 ft . thick, crops out for a horizontal distance of 4oo to 500 ft . in steep canyon wall and parallel to overlying conglomerate and underlying conglomeratic siltstone and thin basalt flow. A few car loads of ore mined from short adits by Cliffside Magnesite Co. in 1917-1918. Carried by 1900-ft. aerial tram across river to railroad, and shipped to International Magnesite Co. , Chula Vista. Reserve of 100,000 to 200,000 tons of ore above canyon floor with 301, MgO content but silica and lime content high . Idle. (Bradley 1925:72-75; Hewett 1936:117- 118; Schlocker 1942:6-7; Tucker 1921:353-354; Tucker, 1930:314; Tucker and Sampton, 1931: 390; Tucker, 1943:532, pl.7; ·Vitalian 1950,365.)

For additional information, see Dibblee and Bassett, 1966, p. 4 and Wilkerson, 2013.

Black Stone Mine

T.11N, R.06E, Sec 28, SBB&M -116°20'59.56"W ; 35°00'43.49"N

This mine is east of the Mojave River 3 miles southeast of Afton (Wright and others, 1953: 88, 114). Lenses of manganese oxides occur along a 1000 ft. contact between granite and limestone. There was no production in 1953. This claim was owned by J.H. Massen. The location noted by Wright and others (1953, p. 88, Manganese Table, Map 283) was placed by the U.S.G.S. in the center of Section 28 in the MRSD database. The nearest limestone-granite contact in the area is 1.0 mile north in Afton Canyon (Wilkerson, 2013).

Wright and others (1953, Table, Magnesite, No. 464, p. 149) identify additional information about this mine in Bradley (1925:72-75); (Hewett 1936:117- 118); Schlocker (1942:6-7); Trask (1943:62,66, 84, and 160); Trask (1950 :194), Tucker (1921:353-354); Tucker (1930c:264, 314); Tucker (1931:390); Tucker (1943:532, pl.7); Tucker (1950:365) and Tucker and Sampson (1931d:337) (Wilkerson, 2013).

Massen Mine

T.11N, R.06E, Sec 20, SBB&M -116°22'03.28"W ; 35°01'37.93"N

This mine is southeast of Afton in Afton Canyon. The mine occurs in granite-quartz monzonite between two faults that cut Older Quaternary gravel (Qog). It has small stringers of "good quality" barite, 2 to 6 inches wide, occur on limestone-schist contact. This claim was owned by J.H. Massen. Wright and others (1953, Barite Table, p. 134) identify additional information about this mine in Tucker, 1921:334; and Tucker, 1930:298; 372 (Wilkerson, 2013).

Midway Green Quarry

T.12N, R.05E, Sec. 22, SE1/4 -116°25'55.89"W ; 35°06'38.13"N

This quarry was noted in the U.S. Bureau of Mines report of 1989 for expanding the U.S. Army Training center. The quarry is shown as being in granite-quartz monzonite, projected from the U.S.G.S. NRSD database, but is probably in gneissoid rocks (gn) (Wilkerson, 2013).

Silver Sericite #1 Mine

T.12N, R.05E, Sec., 22, SW1/4 -116°26'398.13"W ; 35°06'38.25"N

This talc-soapstone deposit was inventoried by Anctil and others (1957). The deposit is in gneissoid rocks (gn) (Wilkerson, 2013).

118.6 Geologic Contact

To the north (right) are Late Jurassic to Early Cretaceous granite-quartz monzonite (gqm) and to the south are Metasediments (ms, Dibblee, 2008b).

118.7 Manix Fault

Here we cross the Manix Fault for the first time.

119.6 Two Faults of the Manix Fault Zone

Here are two parallel faults that trend from west-southwest to east-northeast. These mark the Manix Fault Zone which we will cross again at mile 129.1, mile 135.0 and mile 138.5 (Dibblee, 2008b). Jennings and others (1962) extended the Manix Fault westward to the eastern Calico Mountains.

120.5 The Caves and Middle Railroad Bridge

Here we cross the Middle Railroad Bridge for Afton Canyon. At this point on the OMR in Afton CanonThe bridge marks a third fault in the Cady Mountains that trends from southwest to northeast. The caves are 1,900 feet to the southwest

The following description of a hike to The Caves is given at http://www.backroadswest.com/MonthTrips/BreezeAfton.htm:

The hike to the Caves section of Afton Canyon is easy, short and includes passing through some wetlands. In this part of Afton Canyon, the Mojave River makes a wide, 180° curve that the road does not follow. There are two caves here and, although the History section above says that one was large enough for horse-drawn wagons to fit into, today neither cave is that big. (www.backroadswest.com, accessed Nov. 11, 2017).

Start the hike by parking your vehicle near the second bridge, off the main road, and follow the river, not the road, as you hike south (down-river). The size of the wetlands area here will, of course, vary with the seasons and amount of recent rainfall. This means that the path you follow into the canyon will depend on where the driest route is on that day. Test any soil that looks soggy with a gentle touch of your shoe before taking a step and possibly sinking into water up to your ankle (www.backroadswest.com, accessed Nov. 11, 2017).

The caves are located on the right side of the canyon at about 0.3 miles (0.5 km) from the second bridge and are near each other. We walked to about the middle of the 180° curve and turned around ankle (www.backroadswest.com, accessed Nov. 11, 2017).

AREA MAP A-20

120.0 to 120.5 Afton Canyon Magnesite Mine

Between mile posts 120,0 and 120.5 look to the south. High on the bluff is the Afton Canyon Mine. Former names were Cliffside; Van Deventer Mine; and Afton Magnesifte Deposit.

See discussion below.

120.5 to 139.3: MOJAVE RIVER AND LAKE MANIX SEDIMENTS

Beginning at mile 120.5 and continuing to the end of this field guide at Camp Cady (mile 139.3), we will be following the Mojave River and its associated clastic sedimentary rocks. On our left, to the south are the northeastern Cady Mountains. Here is a list of the Tertiary sediments we will see on this journey (from Dibblee, 2008a and 2008b):

Formation	**Age**	**Symbol**
River Sand	Holocene	Qrs
River Gravel	Holocene	Qrg
Windblown Sand	Holocene	Qs
Clay	Holocene	Qc
Alluvium	Holocene	Qa
Alluvial fan gravel	Holocene	Qf
Manix Lake Gravel	Pleistocene	Qmg
Manix Lake Sand	Pleistocene	Qms
Manix Lake Clay	Pleistocene	Qmc
Older Alluvium	Pleistocene	Qoa
Older Gravel	Pleistocene	Qog
Older Lake Sediments	Late Pleistocene	Qol
Older Fanglomerate	Late Pleistocene	Qof
Coarse Breccia	Pliocene	QTbr
Gravel	Pliocene to Miocene	QTg
Clay	Pliocene to Miocene	QTc
Cobble Gravel	Miocene	Tg

Volcanic, sedimentary and metamorphic rocks of the northwestern Cady Mountains to the south of our field trip route are (from Dibblee, 2008b):

Formation	**Age**	**Symbol**
Volcanic Fanglomerate	Miocene	Tvf
Andesitic Fanglomerate	Miocene	Tva
		Tfb
Basalt	Miocene	Tb
Basalt Breccia	Miocene	Tbb
Fanglomerate of basaltic detritus	Miocene	Tfa
Andesite	Oligocene	Ta
Tuff Breccia	Oligocene	Tt
Sandstone	Oligocene	Tss
Andesite porphyritic	Oligocene	Tap

Dioritic Dike	Post-Early Cretaceous	d
Granite	Late Jurassic and Early Cretaceous	gr
Metavolcanics	Paleozoic or Older	mv

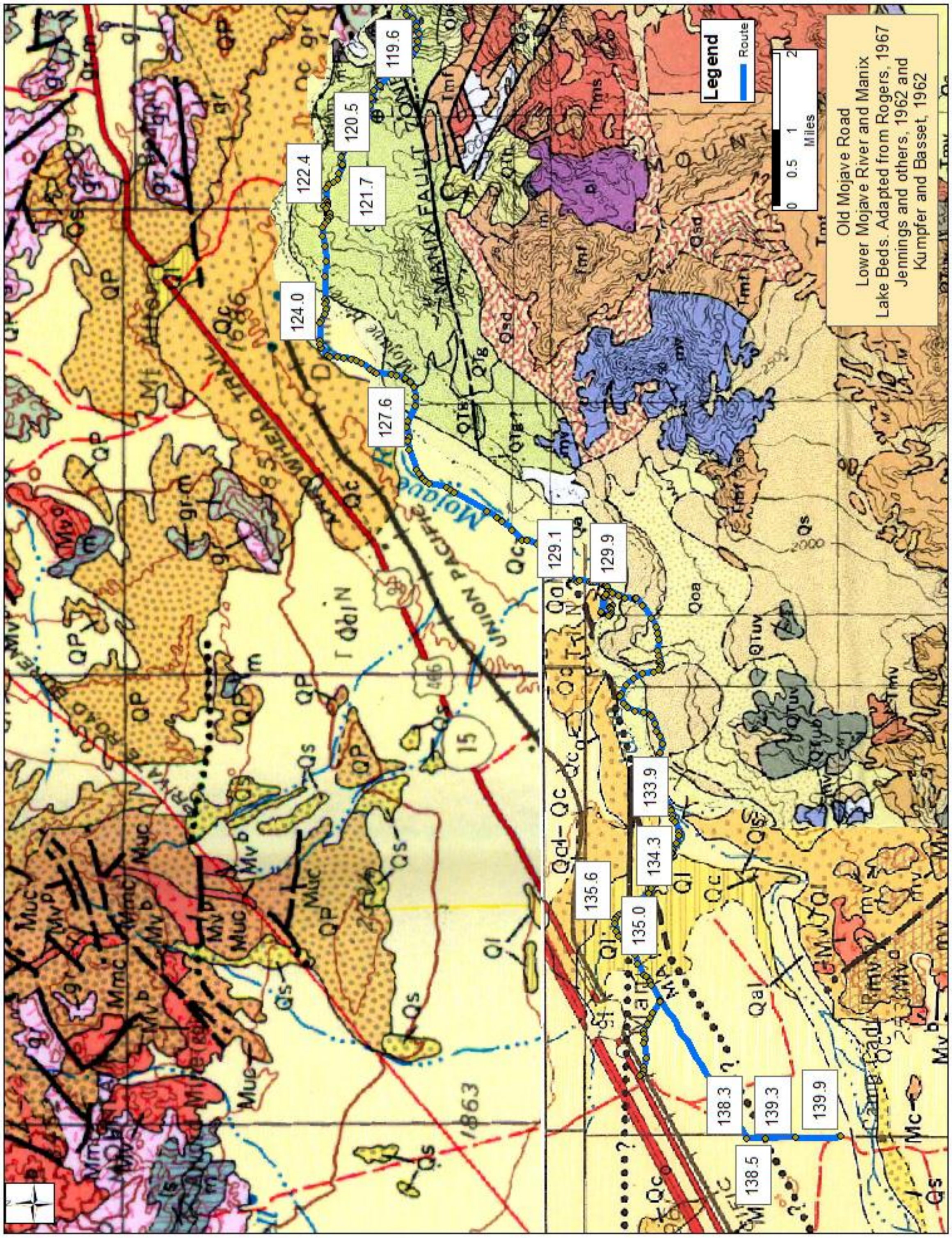


Figure 85. Lower Mojave River and Manix Lake Beds.

120.5 Middle Railroad Bridge

The bridge is built on a fault that trends east-northeast to west-southwest. Rocks to the north are Quaternary-Tertiary gravels (QTg), to the east are Granite-Quartz Monzonite (gqm) and to the west, on the southwest side of the Mojave River, is Quaternary Older Gravel (Qog, Dibblee, 2008a).

Reynolds and others, 1989, p. 24-25 commented on this outcrop:

PARK near the railroad bridge underpass at turnout to south. We can see Cady Mountains gravels against Miocene red gravels and Miocene black volcanics.

HIKE. Afton Canyon meander knob crest.
Climb to the top of the ridge immediately to the east. This point provides a good view of Afton Canyon. The meander knob crest lies > 50 m below the lake bottom in this area. The initial canyon cut may have been to approximately this level. New (unpublished) dating of varnish on this crest is only slightly younger than the age of the highest shoreline. Note the soil profile and pavements on the crest (not the exhumed paleosol-carbonate layers on the meander-knob walls).

121.1 Afton Station

This is the site of a former railroad construction camp (Casebeir, 2017, p. 169).

121.7 Afton Campground

Information about this BLM campsite is at https://www.blm.gov/visit/afton-canyon

122.4 Road Intersection and Railroad Bridge

The road north goes up to Interstate Highway 15. The OMR continues to the west down the course of the Mojave River.

Reynolds and others, 1989, p. 24-25 commented on this outcrop:

Walk across the Mojave River and hike up the trail on the ridge immediately west of the large wash entering the river at the bridge. This is the only passable path in this area to the south Afton beach exposures. Climb up the section, passing south of the lake clay outcrops. About 200? meters beyond the final outcrop of lake clays, watch the ground for a change in cobble roundness and pavement texture. This is the high shoreline. Shells have been discovered and are being dated which were found in this beach two canyons to the west. The crest of this beach is 1.6 m lower than the crest of beach ridges north of the Mojave River (see Meek, herein).

Return to the cars via the canyon to the east

Note the Gray and Brown Fanglomerate sections, and the post-lacustrine fault. This is not the Manix Fault, just a minor splinter? fault. The Manix Fault can be viewed less than 1 km farther south (beyond south Afton beach) at the fanglomerate-bedrock contact.

124.0 Road Intersection: Dunn Siding

Take the road to the north which will take you up on the mesa of Quaternary older alluvium (Qoa, Diblee, 2008a) and to the Dunn Siding plant.

Dunn Siding Mill
T.10N, R.05E, Sec 15, NE1/4, SBB&M -116°26'13.23"W ; 35°02'45.05"N

Talc was hauled by truck via Valley Wells to Dunn siding on the Union Pacific Railroad and thence to grinding mills in Los Angeles, and in Ogden, Utah. (Wright and others, 1953: 204)(Wilkerson, 2013).

The Anexx Silver Mine shipped ore from the Dunn Siding (Wright and others, 1953: 139)(Wilkerson, 2013).

Dunn Siding is in the old Mojave River floodplain, underlain by Older Quaternary Alluvium (Qoa, Dibbllee, 2008a)(Wilkerson, 2013).

AREA MAP A-21

127.6 Private Structures on former Southern Pacific property

The land ownership pattern in this area is checkerboarded with BLM and private lands. Almost all the private lands in this area were originally patented to the Southern Pacific Railroad. The SP was awarded odd-numbered sections in a 6 mile swath on either side of the railroad right-of-way as recompense for building the railroad in the national interest. Those patents were made under the Land Grant Act of July 27, 1866. As determined by the Supreme Court in Burke v. Southern Pacific Railroad Company (234 U.S. 669 (1914)), these patents did not include mineral rights if, at the time of patent, the lands were determined to be "mineral in character."

We are in the floodplain of the Mojave river on Quaternary Alluvium (Qa). Above this floodplain on both sides of the Mojave River is a terrace of Older Alluvium (Qal) and above that a layer of Quaternary Older Lake Deposits (clay, silt Qol). These are the lake beds of Pleistocene pluvial Lake Manix. The Lake Manix Beds, on the northeast side of the OMR, are overlain by Quaternary gravel (Qg) deposits (Dibblee, 2008b).

AREA MAP A-22

129.1 Road Intersection: Field Road and Manix Fault

The road to the west-northwest goes up to Field Siding on the SP Railroad. This intersection also marks the location of the Manix Fault. It trends east-northeast and is up to the north, down to the south. Now we are driving over Mojave River sand (Qrs, Dibblee, 2008b). Rogers (1967) extends the Manix Fault eastward 16 miles to the eastern Calico Mountains.

129.9 Intanglios "Triangle"

The Old Mojave Road website has this to say about "The Triangle" intanglio site

The "Triangles" are located on a mesa overlooking the Mojave Road. These intaglios are from an ancient peoples we know nothing about. They were created by removing rocks from the desert pavement. They are easily visible and may be accessed by a side road that climbs up the back of the mesa. There is a barricade of posts preventing driving to close but you can walk right up to the "Triangles". (http://www.mojave-road.com/triangles.htm accessed Nov. 12, 2017).

132.2 Cliffs

The Cliffs are made of Quaternary River gravel (Qrg) above the flood plain Quaternary River Sediments (Qrs, Dibblee, 2008b).

133.9 Fence Line (former location)

At this location we continue to drive on Quaternary River Sediments (Qrs) to the north is a bench of Quaternary Older Fanglomerate (Qof). To the south, above the Qrs is Quaternary Alluvium (Qa) with small masses of Quaternary River Gravel (Qrg) above that (From Dibblee, 2008b).

134.3 Red Outcrops of Manix Lake Beds and Manix Fault.

The rocks to the north are the Manix Lake Beds (Qmc)unit of Dibblee, 2008b.
At this point we leave the Mojave River and climb up out of it along Manix Wash on the power line service road.

AREA MAP A-23

135.0 Cross the Manix Fault.

The arroyo to the west marks the location of the fault.

135.6 Road Intersection

Turn left and go west at this intersection. The road follows Manix Wash in Quaternary River Sand (Qrs). On the terraces on either side of the was are Quaternary Manix Lake Beds (sand, Qms of Dibblee, 2008b).

136.6 Geologic Contact

Going west, at this point we cross over from Manix Lake Beds (Qms) to Quaternary Alluvium (Qa, Dibblie, 2008b).

136.8 Road Intersection

If you turn right at this intersection you will go up to the settlement of Manix. The area is underlain by Quaternary Alluvium (Qal, Dibblee, 2008b). To go to Cady Camp, stay of the Power Line Road to the southwest.

137.4 Road Intersection: Vortac Facility

Taking this road to the left (south) will bring you to a Vortac Facility. A Vortac is a navigational aid for aircraft pilots consisting of a co-located VHF omnidirectional range (VOR) beacon and a tactical air navigation system (TACAN) beacon. The area is underlain by Quaternary Alluvium (Qal, Dibblee, 2008b).

138.3 Road Intersection: 5-Way

At this intersection, leave the Power Line Road and go south. The area is underlain by Quaternary Alluvium (Qal, Dibblee, 2008b).

138.5 Manix Fault

We cross the Manix Fault for the last time.

139.3 Road Intersection

Continue south. The area is underlain by Quaternary Alluvium (Qal, Dibblee, 2008b).

139.8 End of Road

The road is blocked by a fence. From here you walk east over to Old and New Cady Camps. Casebeir (2016, p. 179-183) has and interesting history of Cady Camp with several old photographs. The GPS coordinates in Casebeir do not agree with the U.S.G.S topographic map, which puts the site ½ mile further east. Dibblee (2009b) maps all three sits in Quaternary River Sand (Qrs).

END OF ROAD LOG

To return to civilization, back track to the Manix exit to the north.

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