

GEOLOGY AND MINING HISTORY OF THE MORNING STAR MINE, IVANPAH MOUNTAINS, SAN BERNARDINO COUNTY, CALIFORNIA

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Abstract

The Morning Star Mine is a 1000 acre mine in the Ivanpah Mountains, north of Kewanee camp in San Bernardino County 65 miles southwest of Las Vegas in The Mojave National Preserve. It was first opened in 1907 and was an episodic producer. Extensive development began in the early 1940's but was curtailed by the War Production Board Order L-208. The Vanderbilt Gold Corporation obtained the property in 1964, conducted an exploration program in 1974 and began underground mining in 1979. At this time ores were trucked to the Vanderbilt mine, across the Ivanpah Valley for processing. Additional drilling discovered larger low-grade reserves in a zone 104 feet thick with ore grades ranging from 0.1 to several oz/ton Au. Studies were conducted to determine if this generally low grade material could be developed through solution mining. Instead, in 1984 open pit mining began and lasted until 1993. Today mine is owned by Vanderbilt Gold Mining Company of Las Vegas, Nevada. The claims were not patented and today the mine area is managed by the National Park Service. Regional geology around the mine is mainly made up of several large plutons and igneous dikes intruding into the bedrock. The major tectonic feature in the area and ore-localizing feature is a thrust fault striking North 20 degrees west and dips 32 degrees to the southwest. The Ivanpah Granite is the host rock of the mine was intruded by the dacite or diorite dikes. There were two periods of mineralization. Remaining mining improvements or features including a water-filled deep and steep-sided open pit, a collection pond, leaching pads and waste rock piles. There is a stratification in the heap leach piles reflecting variations in heap leach technique. During the early heap leaching phase, the ore was agglomerated with cement. It was later learned that this was not economically advantageous and later heaps are constructed using run-of-mine (untreated) ores. Main ore minerals at the Morning Star are gold and silver. There were also secondary sulfides and oxides of copper, zinc, and lead. Historic production (1907-1943) was from \$2 to \$15 per ton in gold, average grade \$4 to \$6 per ton. The ore has 25% gold and 75% silver. In 1990, reserves were estimated at 4,700,000 tons with a grade of 0.05 oz/ton Au. The remaining unmined portions of the deposit likely contain significant minable precious and base metals at current commodity prices.

Acknowledgement and Disclaimer

The information in this paper is taken largely from published and public sources. I have reproduced this material and present it pretty much as we found it, not trying to harmonize discrepancies in mine or geologic descriptions. I have changed verb tenses for readability and have used some paraphrase. I have expanded abbreviations or special characters with full text (e.g. feet instead of ft., inches instead of ") *Italics indicate quotations*. Authors of the original information are indicated at the end of each paragraph. Paragraphs without a citation are MY own materials. The maps in this report have been compiled and rectified from digital and paper copies of original sources that were made at different scales and in different geographic projections. Therefore, many of the maps had to be adjusted or stretched. They do not fit perfectly. Most are accurate to within 100 feet, but reproduction and projection errors can be as

much as 300 feet for some maps. PLSS means Public Land Survey System. That survey data was obtained from the U.S. Bureau of Land Management website.

MRDS, 2011, Mineral Resources Data System, U.S. Geological Survey, <https://mrdata.usgs.gov/mrds/>. This database relies on records that, in many cases, are inaccurate or imprecise. For example, if a report describes a mine as being in "Section 9", with no other information, MRDS plots the mine location in the center of the section. If a mine is reported in "SW ¼" of a section, MRDS plots the mine in the center of that SW quarter-section. Where I could confidently adjust an MRDS location of a mineral deposit to features identifiable in aerial photographs or topographic maps, I did so.

Help me make this report better. If you have any photographs, memories or reports for this mine that you can share, please send them to yosoygeologo@gmail.com so that we can incorporate that material into this paper.

PREVIOUS NAMES:

Ivanpah Silica

MINE LOCATION (MRDS)

TRS	Latitude	Longitude
15N 14E Sec. 21, 27, 28 and 33 SBM	35.36168	-115.49084
15N 14E Sec. 21, 27, 28 and 33 SBM	35.36171	-115.49224

1943

Morning Star mine, comprising 12 claims, is in secs. 27, 28, 33, and 34, T. 15 N., R. 14 E., S. B., on the east slope of the Ivanpah Mountains, 8 miles north of Cima, a station on the Union Pacific Railroad ; elevation 4400 feet (Tucker and Sampson, 1943, p. 456).

1940, 1953

It comprises a group of 18 claims, situated in Sections. 27, 28, 33 and 34, T. 15 N., R. 14 E., S. B. M., on the east slope of the Ivanpah range of mountains, in Mescal Mining District, 8 miles north of Cima. Elevation 4400 feet (Tucker and Sampson, 1940, p. 71; Wright and others, 1953, Gold Table, No. 148, p. 49).

1953

Southwest slope Ivanpah Mts (Wright and others, 1953, Gold Table, No. 148, p. 49).

2020

Located in the Ivanpah Mountains, the Morning Star Mine is a gold / silver mine located near to California / Nevada border near Mountain Pass. The mining district enjoys amazing views and lots of wild life and wild flowers during the spring of each year, which are easily accessible from a grade dirt road. Numerous lower traffic side trails will allow access of other places to explore (Destination4x4, 2020)

HISTORY

12 claims explored mainly in late 1920'S and in 1930'S (The Diggins, 2022)

The Morning Star Mine, west of the Kewanee was also first active about 1901, but was mainly active between 1927 and 1939. Since 1970 the mine has been intermittently active, developing the 100,000 ounces of gold the property was estimated as containing in 1953. 154 (Shumway and others, 1991, p. 110; Tucker and Sampson, 1943, p, 456).

The following history is adapted from Vredenburgh, 1996 and Destination 4x4, 2020:

The location was first worked in 1907 and was known as the Clansman mine. Operations were initially quite small and in 1931 only two miners were on location. In 1937 the owner J. B. Mighton and Brown optioned the property to Richard Malik, who worked the location significantly until 1938 (Destination4x4, 2020)

Erle P. Halliburton worked the mine with ten men, starting in April of 1939. Halliburton known today, as the founder of his name sake company, Halliburton Oil. Mr. Halliburton made his fortune in Duncan Oklahoma where he borrowed a wagon, a team of mules and a pump, he built a wooden mixing box and started an oil well cementing business. The Halliburton efforts at this site where forced closed in 1942 by the War Productions Board order to close gold mining for the war effort (Destination4x4, 2020)



Figure 1. Erle P Halliburton 1940 – SMU Central University Libraries @ Flickr CommonsSouthern Methodist University, Central University Libraries, DeGolyer Library. From Destination4x4, 2020.

Following Halliburton's death in 1957, the property was acquired by the Vanderbilt Gold Corporation in 1964, where upon the location was drilled and sampled. Fifteen years later, in 1979 the company finally complete a capital raise the in Morning Star mine was again on operation as an underground mine utilizing trackless mining equipment and the ore processed in nearby Vanderbilt, California. Due to the time period, this was probably the Goldome Mill and not within the town of Vanderbilt (Destination4x4, 2020).

After just three years of operations, mining operations were again halted in 1983, due to the dropping price of Gold, however underground explorations continued with long hole drilling and testing. From 1984 – 1993 saw increased gold and silver production to the amount of about 75,000 tons per month. Water supply problems plagued the operation, however, with the price of gold between \$350 and \$500 per ounce the Vanderbilt operation made a return Vanderbilt (Destination4x4, 2020).

The mine was finally closed in 1993 after the gold prices dropped and several environmental violations and animal deaths caused by cyanide poisoning. With the creation of the Mojave Nation Preserve in

1994 from the California Desert Protection act, the NPS inherited an environmental problem and it slowly continues to clean up the site. At this point, access to the location is blocked with a locked gate. It was noted that several building and a milling foundations remain from this relatively modern mining endeavor (Destination4x4, 2020).

OWNERS

1931

Owners, J. B. Mighton and H. T. Brown, Cima, California (Tucker and Sampson, 1931, p. 304).

1940

Owners, J. B. Mighton, Cima, Calif., and H. T. Brown, Los Angeles; under option to Erie P. Halliburton, Inc., 907 National City Bank Bldg., Los Angeles; E. P. Halliburton, president and manager; H. V. Hughes, superintendent. During 1937 and 1938, the property was under option to Richard W. Malik, Los Angeles, during which period a number of crosscuts and winzes were made on tunnel level. In April, 1939, Mr. E. P. Halliburton started operations on the property (Tucker and Sampson, 1940, p. 71).

1943

Owner J. B. Mighton, Cima, California; under lease to Earl P. Halliburton, 1709 West Eighth Street, Los Angeles (Tucker and Sampson, 1943, p. 456).

1954

Owner J. B. Mighton, Cima, California (1943). Leased to E.P. Halliburton 1709 W. 8th St. , Los Angeles (Wright and others, 1953, Gold Table, No. 148, p. 49).

2022

Vanderbilt Gold Corporation, Nevada (The Diggins, 2022).

GEOLOGY

1930, 1931

The vein occurs as a rhyolitic-porphyry intrusive in quartz-diorite, which strikes north and south and dips 34 degrees west. The width of this porphyry dike is about 350 feet. The vein material is highly silicified and the mineralization occurs along a series of more or less parallel east and west fractures in the dike itself. The ore is quartz, heavily mineralized with pyrite, of which it is stated 20 to 40 per cent of the values are in free gold, the remaining values being in the pyrite. The values vary from \$3 to \$15 per ton. Samples taken by different engineers across a width of 280 feet are said to have an average value of \$4.37 per ton in gold (Tucker and Sampson, 1930, p. 244; Tucker and Sampson, 1931, p. 304).

1940

The vein occurs as a rhyolite-porphyry intrusive in quartzdiorite which strikes N.-S. and dips 34° W. The width of this porphyry dike is about 350 ft. The vein material is highly silicified and the mineralization occurs along a series of more or less parallel east and west fractures in the dike itself. The ore is quartz, heavily mineralized with pyrite. The values vary from \$2 to \$15 per ton in gold, with averages said to be \$4 to \$6 per ton, 25% is in fine gold, the remaining values being in the pyrite (Tucker and Sampson, 1931, p, 304)

1943

The country rock is monzonite which has been fractured and mineralized with auriferous pyrite across widths up to 175 feet. Both east-trending and north-trending fractures occur in this rock. These fractures

are filled with quartz and it is here, particularly in the north-trending fractures, that the better grade of ore is found. (Tucker and Sampson, 1943, p. 456).

1953

Gold-bearing quartz veinlets along fractured contact zone-between coarse-grained granitic rock and finer -grained, darker granitic rock (Wright and others, 1953, Gold Table, No. 148, p. 49).

1990

This mine is in the Ivanpah Granite. Mineralization is in the hanging wall of the Morning Star fault which has been described as a thrust fault by Hewett (1956) and as an oblique right-lateral strike-slip fault by Byington and others (1989). The alteration is weak argillic with or without sericite alteration. Base and precious mineralization is associated with quartz (with or without calcite), occurring both as cement in stockwork and as veins subparallel to the Morning Star fault (USBM, 1990, Table 2, Deposit No. 178, p. 100)

1994

Shear zone mineralization is characterized by a pinch-and-swell type structure that define pods of sheared and brecciated strongly altered diorite, 2 to 4 feet wide and about 10 feet in diameter (USGS, 1994).

2022

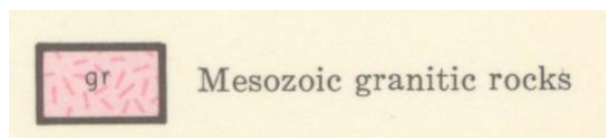
Veinlets along a fractured contact zone. Auriferous pyrite mineralized up to thickness of 175 feet. Vein is in fine-grained (rhyolite) intrusive dike which is up to 350 feet thick. Mineralization principally occurs along set of E-W and N-S trending fractures in the dike (The Diggings, 2022)

MAPPING

Scale 1: 250,000

1961

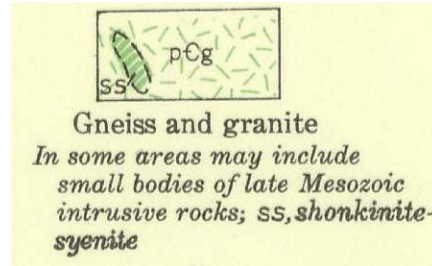
Jenning's 1961 Kingston 1:250,000 scale sheet shows the area of the Morning Star Mine as underlain by Mesozoic granite (gr).



125,000 scale

1956

Hewett's (1956) map of the Ivanpah 125K quadrangle shows the area of the Morning Star mine as underlain by pre-Cambrian gneiss and granite (p€g),



125,000 scale
2007

Miller and others, (2007) produced a map of the East Mojave Scenic Area. The area of the Morning Star mine was mapped as Jurassic Ivanpah granite (Ji).

Ji	Ivanpah granite of Beckerman and others (1982) (Jurassic) —Informally named unit. Dark-pink to tan, coarse-grained, porphyritic biotite syenogranite to monzogranite that crops out in the Ivanpah Mountains and east of Cima Dome. Weakly developed magmatic foliation defined by aligned feldspar and biotite is common. Minor hornblende or muscovite is present. K–Ar ages of 136–138 Ma (Sutter, 1968) interpreted here as minimum ages; preliminary U–Pb data for zircon suggest crystallization age of 145 Ma (J.D. Walker, 1991, oral commun.)
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Scale 100,000
2012

Miller's (2012) map of the surficial geology of the Ivanpah 30° x 60° Quadrangle shows the Morning Star Mines to be underlain by Hillslope deposits composed of carbonate rocks (Qha/ca)

HILLSLOPE DEPOSITS	
Qha	Abundant hillslope deposits (Holocene and Pleistocene)
SUBSTRATE MATERIALS	
ca	Carbonate rocks
fp	Felsic plutonic rocks
fpg	Felsic plutonic rocks that weather to grus
fv	Felsic volcanic rocks
mp	Mafic plutonic rocks
mv	Mafic volcanic rocks
mr	Metamorphic rocks
pc	Partly consolidated materials
sl	Siliciclastic rocks

MINERALOGY

Free gold and auriferous pyrite are the primary ore minerals at the Morning Star Mine

Two stages of mineralization have been described by Sheets and others (1989, p. 224-226). The first stage contains quartz, calcite, pyrite, hematite, chalcopyrite, galena, sphalerite, silver-bearing tetrahedrite, and electrum. The second stage contains pyrite, covalite, digenite (Cu₉S₅), hematite, acanthite, uytenbogaardtite, native bismuth and electrum (USBM, 1990, Table 2, Deposit No. 178, p. 100)

ASSAYS

1990

Four select (CDC-21 and CTP-67 to -69), four random (CDC-18, -20, -27, -31) and one 34-inch chip (CDC-19) sample were taken. The samples contain 6 to 9,230 ppb gold, as much as 11 ppm silver and 24 to 2,840 ppm lead. About 8 million tons of 0.06 oz/ton gold reserves are at the Morning Star Mine (1988-89 E&MJ Mining Directory, p. 139; Sheets and others, 1989, p. 220)(USBOM, 1990, Table 2, Deposit No. 178, p. 100).

2022

Grade varies from \$2 to \$15 per ton in gold, average grade \$4 to \$6 per ton. 25% is fine gold (The Diggings, 2022).

DEVELOPMENT

1930, 1931

Development consists of a tunnel driven 600 feet along the footwall of the dike, which is 350 feet vertically below the outcrop. At a point 185 feet north of the portal, No 1 crosscut is driven west 96 feet. Channel samples cut at 5-foot intervals in this crosscut, it is stated, carried an average value of \$4 per ton in gold. At 450 feet north of portal of the tunnel, No. 2 crosscut is driven west 285 feet. From this point the course of the tunnel is changed to N. 20° W. and is in the vein-dike for the remaining distance of 150 feet. At 550 feet north of portal, No. 3 crosscut is driven east 40 feet to the footwall. About 30 feet north of this crosscut, a winze has been sunk to a depth of 50 feet below the tunnel level and at this depth the winze encounters the footwall. The ore extracted in sinking this winze is reported to have an average value of \$15 per ton in gold. Estimated tonnage of ore above tunnel level is said to be 2,000,000 tons with an average value of \$4.37 per ton in gold. About one mile south of the Morning Star tunnel, on the Kewanee Claim, there is an outcrop of quartz 20 to 50 feet wide, strike north and south, dip 34° W. A shaft has been sunk to a depth of 125 feet on a 65° incline. Equipment consists of Gardner-Denver compressor driven by Lozier automobile engine. Air drills and blacksmith shop. Two men employed (Tucker and Sampson, 1930, p. 244; Tucker and Sampson, 1931, p. 304-305).

1940

Development consists of a tunnel driven 600 ft. north along the footwall of the dike which is 350 ft. vertically below outcrop. Crosscuts have been driven at intervals to determine width of ore body. These crosscuts indicate an average width of 300 ft. Present development work is confined to shaft sunk on the footwall to a depth of 250 ft. Equipment consists of gas-driven hoist and Gardner-Denver compressor. Ten men are employed (Tucker and Sampson, 194, p. 71).

1943

Development consists of tunnel driven north about 600 feet, 350 feet below the outcrop. At 185 feet north of the portal, there is a crosscut west 175 feet; also a winze sunk on 32° inclination, to the west 240 feet, with drifts at 200-foot level, south 100 feet and north 640 feet, with a crosscut west at 400 feet and a crosscut west 100 feet at 40 feet south of face. At 400 feet north of this winze, another winze has been sunk on the same inclination 420 feet. This work was done on a north-trending fracture. Also several diamond drill holes were fanned out into the rock from the crosscuts. The lessees estimate that this work has developed 500,000 tons of ore which will average \$7.00 per ton in gold. Operations ceased in accordance with the War Production Board's Order L-208, closing gold mines. (Tucker and Sampson, 1943, p. 456).

1953

Explored by north-trending, 600-ft. drifts and adit, joined to winzes, cross-cuts and drifts totaling 1700 ft. In 1942 said to have developed 500,000 tons of gold ore valued at \$7 per ton . Explored mainly in late 1920 '3 end in 1930's. Little or no ore shipped. Idle since 1942 (Wright and others, 1953, Gold Table, No. 148, p. 49).

1956

Of the group of small mines that lie in a basin along the east slope of Ivanpah Mountain, about 9 miles north of Cima, the Morning Star (Hewett, 1956, no. 92, pl. 2) has the most extensive explorations. The principal work is a tunnel that extends northwest about 600 feet, from which there are three drifts aggregating 400 feet. According to Tucker and Sampson, in 1943 two winzes had been sunk from two of the crosscuts, 240 feet and 400 feet respectively at 32° W. The tunnel follows a zone of gouge that dips 34° W. and separates an overlying block of granite gneiss from an underlying intrusive quartz monzonite. Similar blocks of granite gneiss crop out and are explored by mine workings nearby. The granitic gouge contains a little galena, but the gneiss is cut by many quartz veins that carry pyrite and a little gold. This material, which is reported by the owners (Myton and Brown) to contain \$3.00 to \$5.50 worth of gold (1956 values) to the ton (0.6 oz/ton Au), was the basis for the explorations. (From Hewett, 1956, p. 126).

1990

The mine began as an underground operation after discovery in 1907. By 1943 the mine had a 600 foot tunnel with over 1,300 feet of drifts and two winzes (240 and 420 feet; Tucker and Sampson, 1943, p. 304). The mine was turned into an open-pit operation by Vanderbilt Gold Corporation (Sheets and others, 1990, p. 220). Extensive underground development and calculation of reserves occurred prior to World War II and also between 1980 and 1982 (Tucker and Sampson, 1930, p. 305; Tucker and Sampson, 1943, p. 456; Sheets and others, 1989, p. 220). According to a company report to shareholders, an estimated 44,035 oz of gold has been produced (USBM, 1990, Table 2, Deposit No. 178, p. 100).

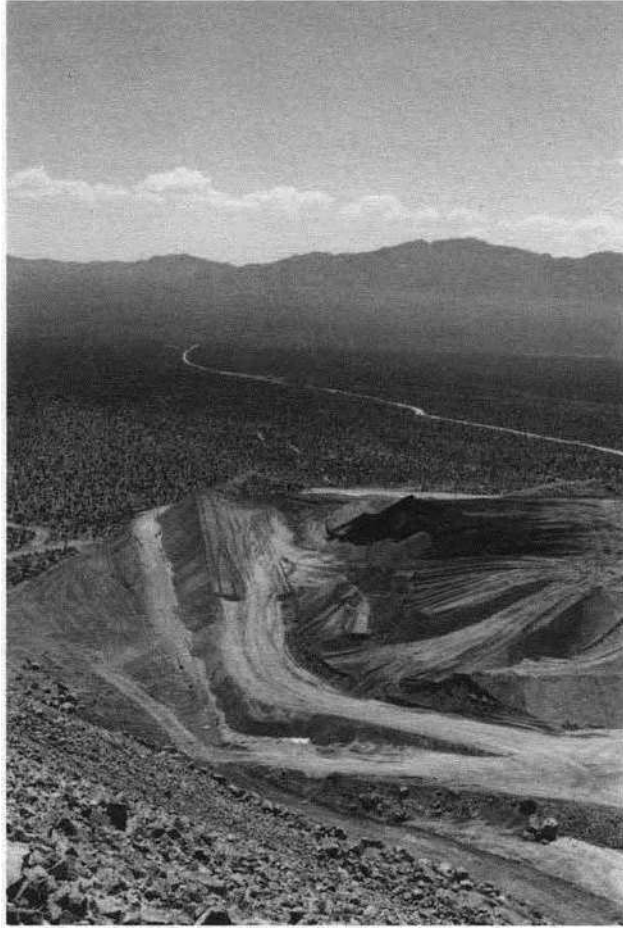


Figure 2. , Morning Star Leach Pad showing the buffer of sterile rock to guard against slumping or slipping of the crushed ore laden with cyanide solution. Photo from Bureau of Land Management. From Vredenburg, 1996.

2022

North-trending 600-feet adit, joined to winzes, crosscuts and drifts. Grade varies from \$2 to \$15 per ton in gold, average grade \$4 to \$6 per ton. 25% is fine gold (The Diggings, 2022).

RECLAMATION

There are no tailings. All material remains on leach pads which are lined (The Diggings, 2022).

SUMMARY AND CONCLUSIONS

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FIGURES

MAPS

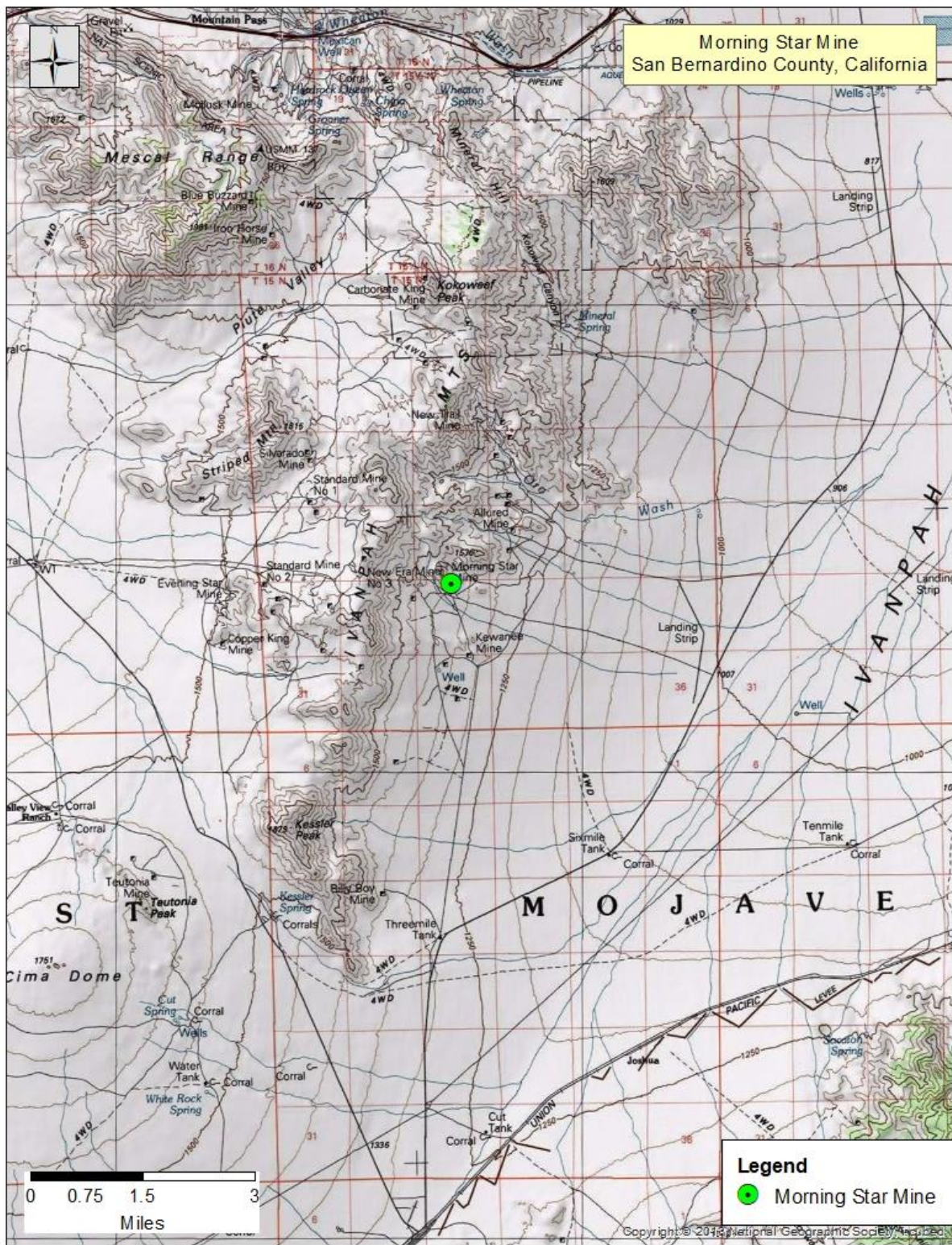


Figure 3. Regional topographic map of the Morning Star Mine and surrounding areas.

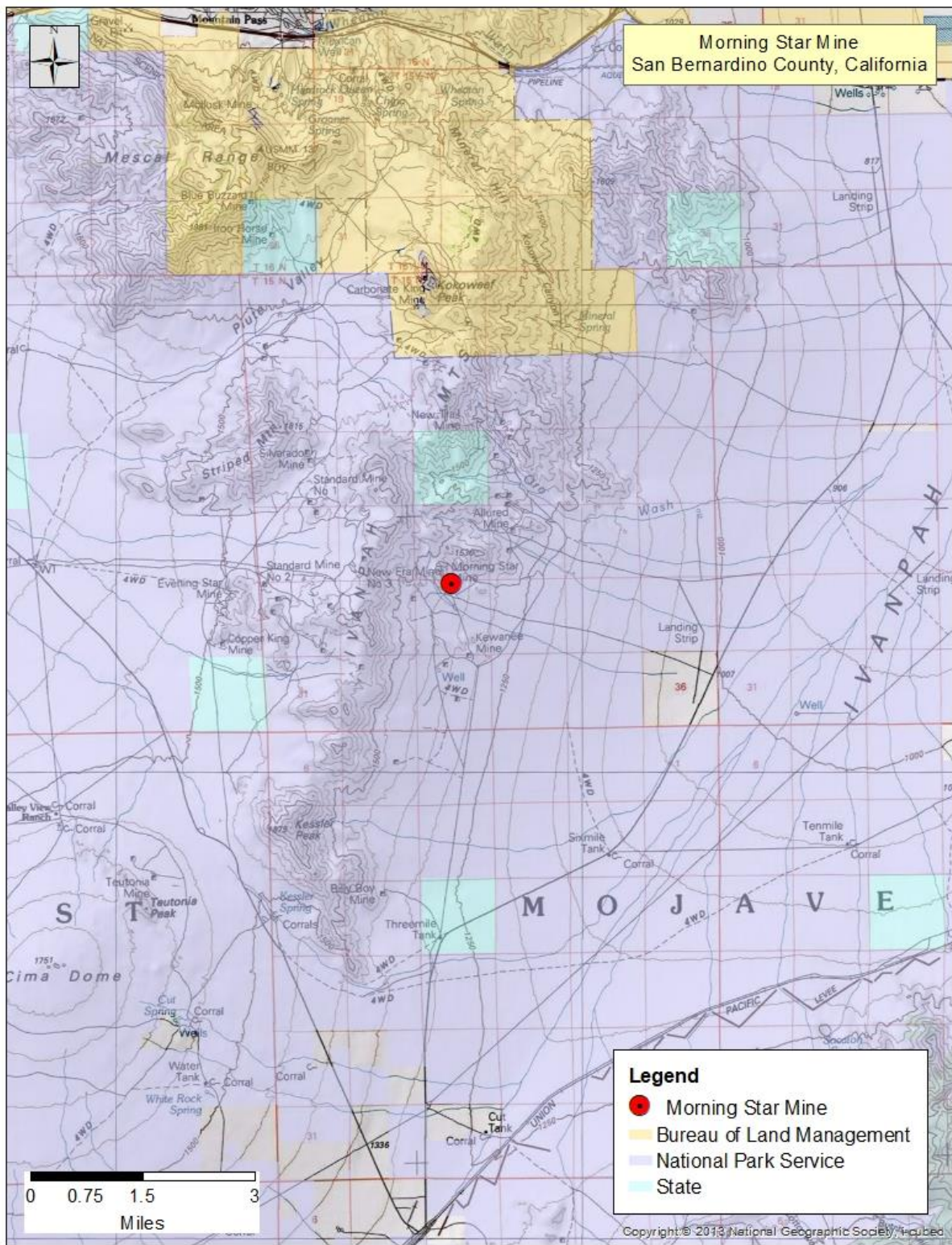
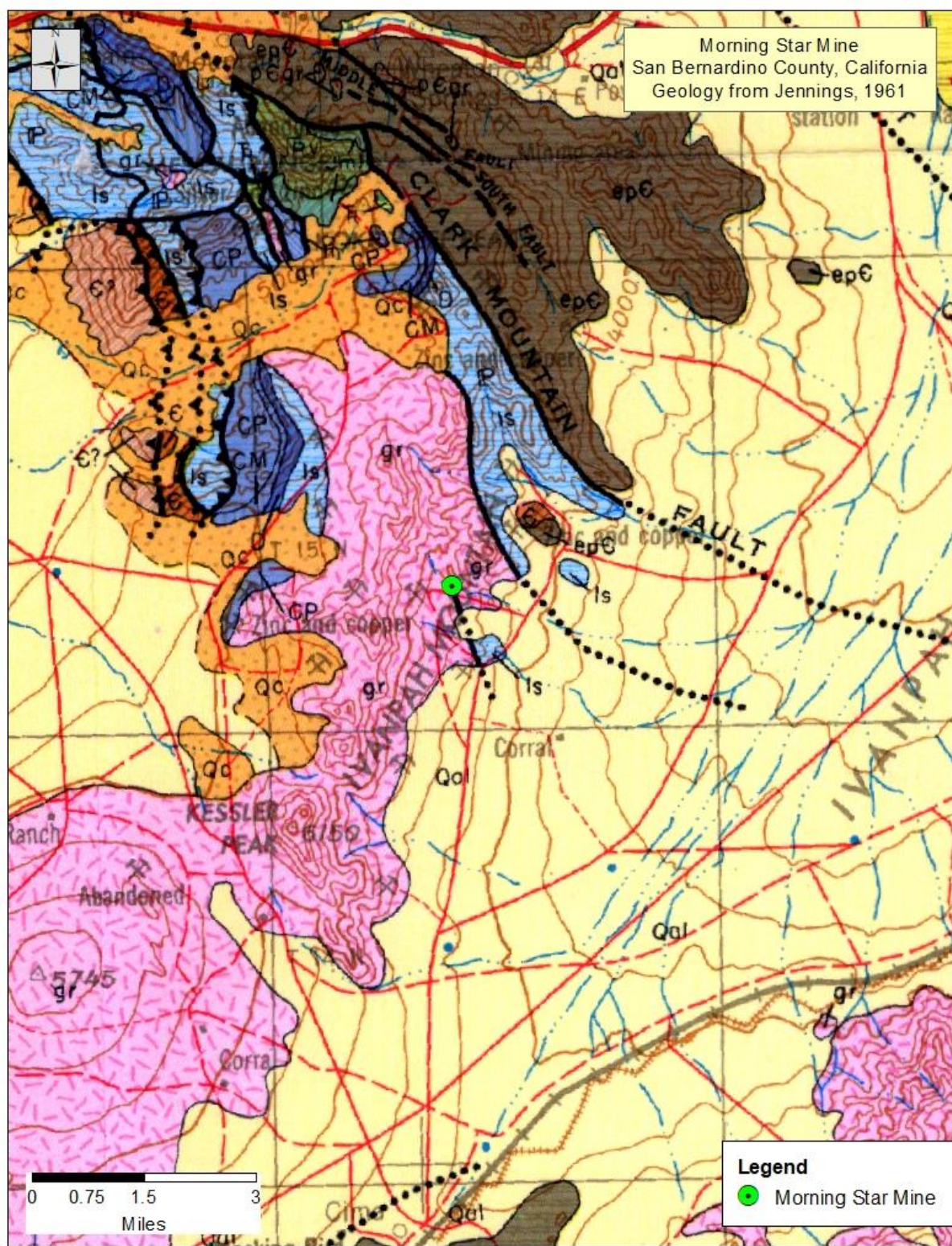


Figure 4. Land Status map of the Morning Star Mine and surrounding areas



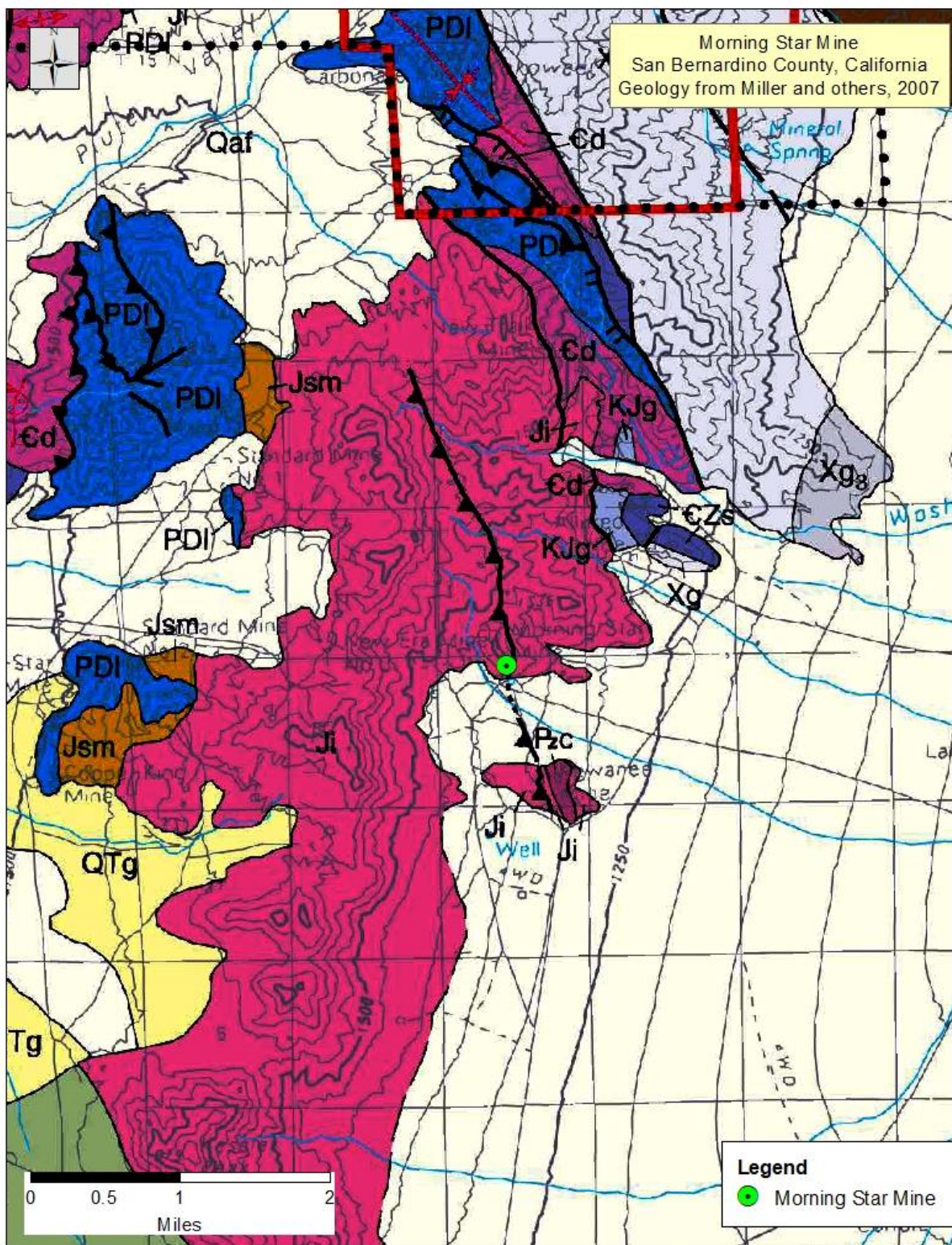


Figure 6. Regional geologic map of the Morning Star Mine and surrounding areas

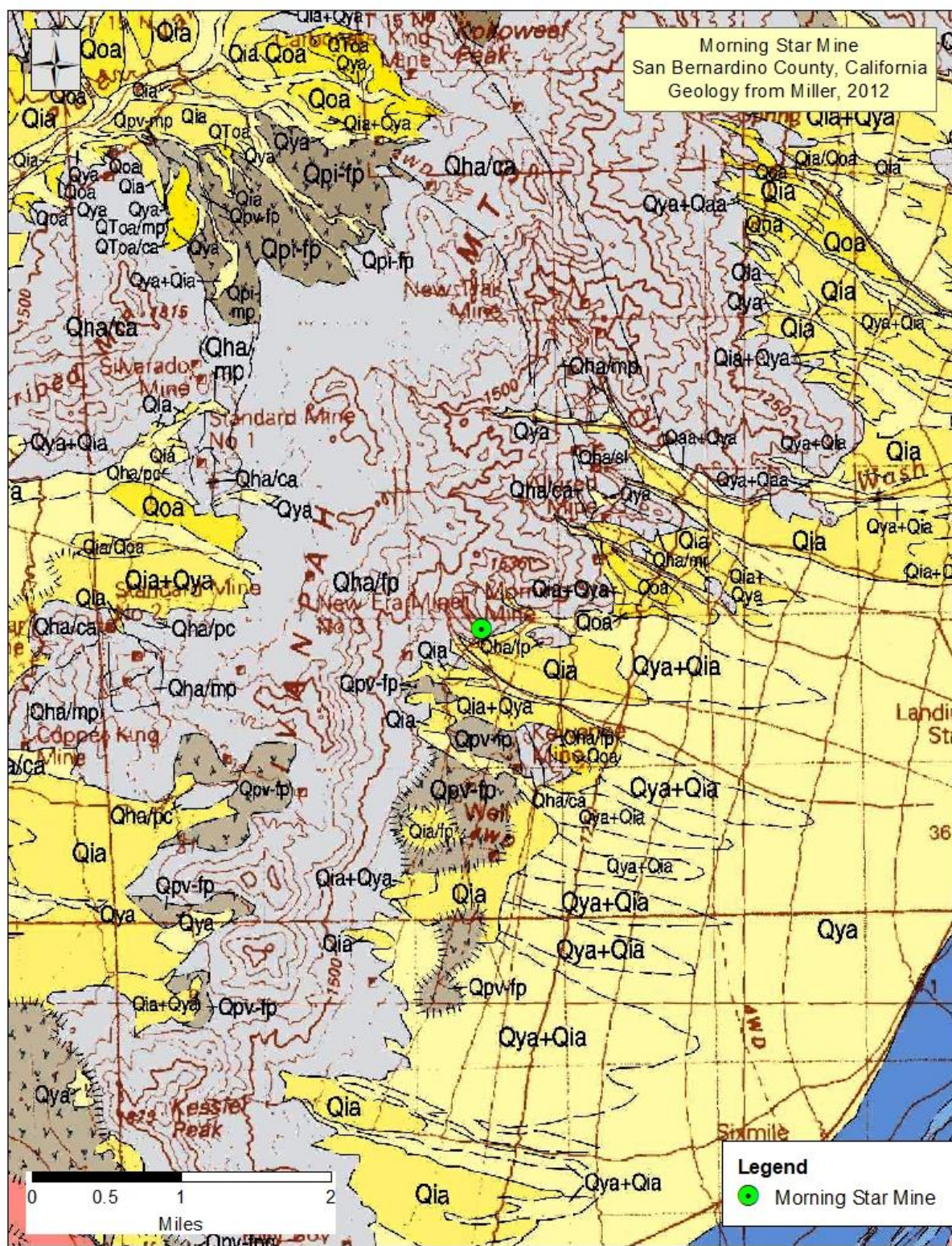


Figure 7. Regional surficial materials map of the Morning Star Mines and Surrounding areas.

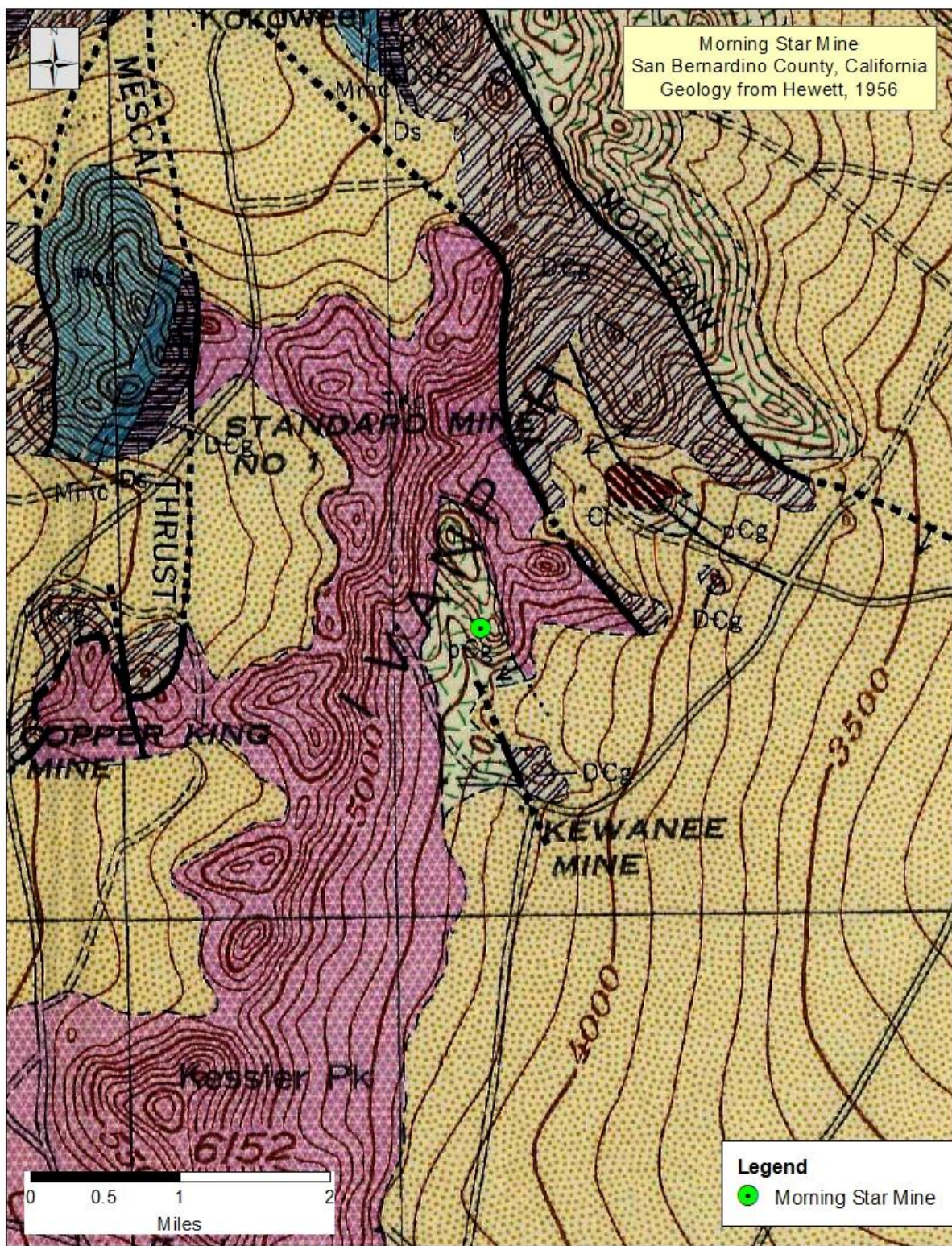


Figure 8. Regional geologic map of the Morning Star Mines and Surrounding areas

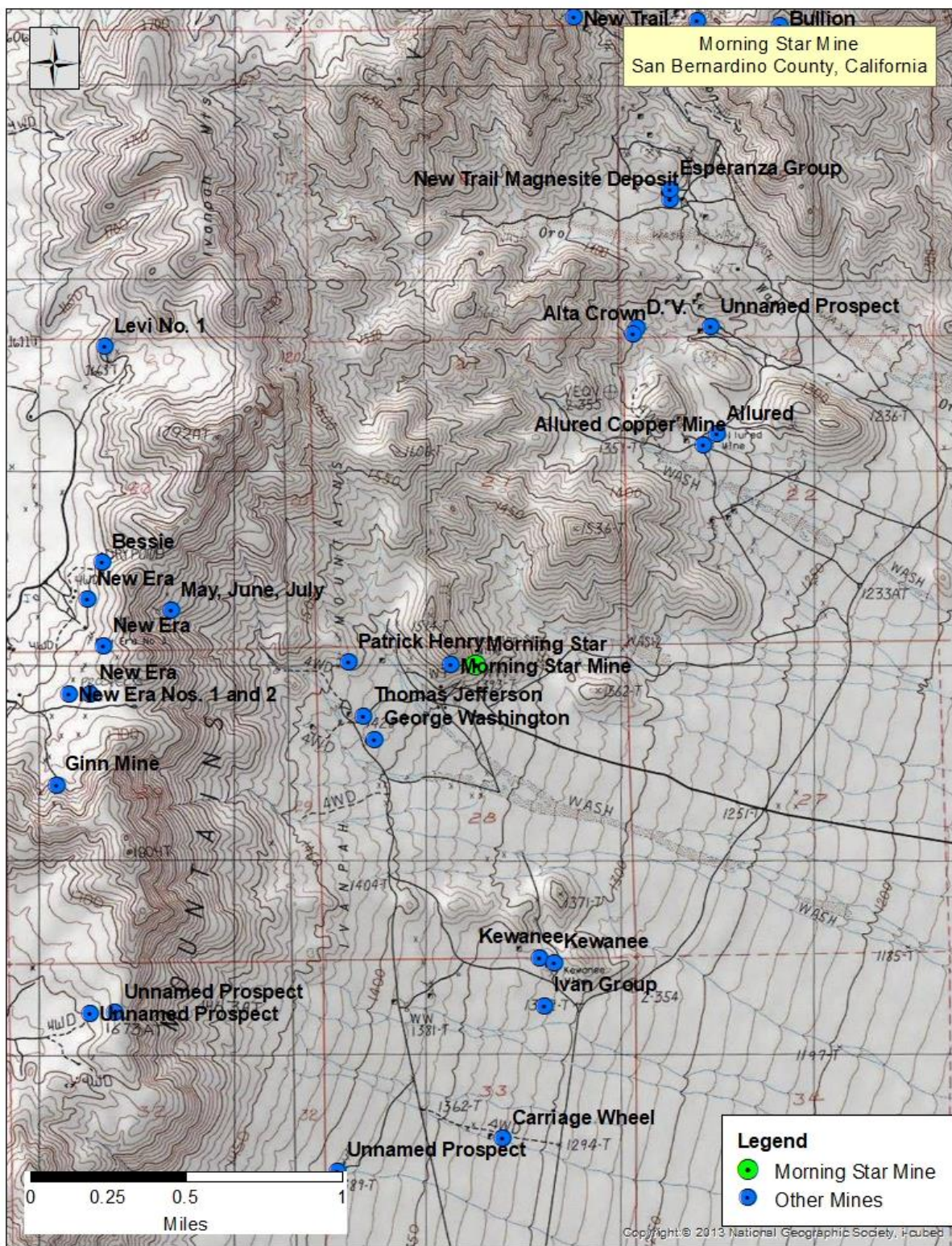


Figure 9. Site topographic map of the Morning Star Mine and surrounding areas.

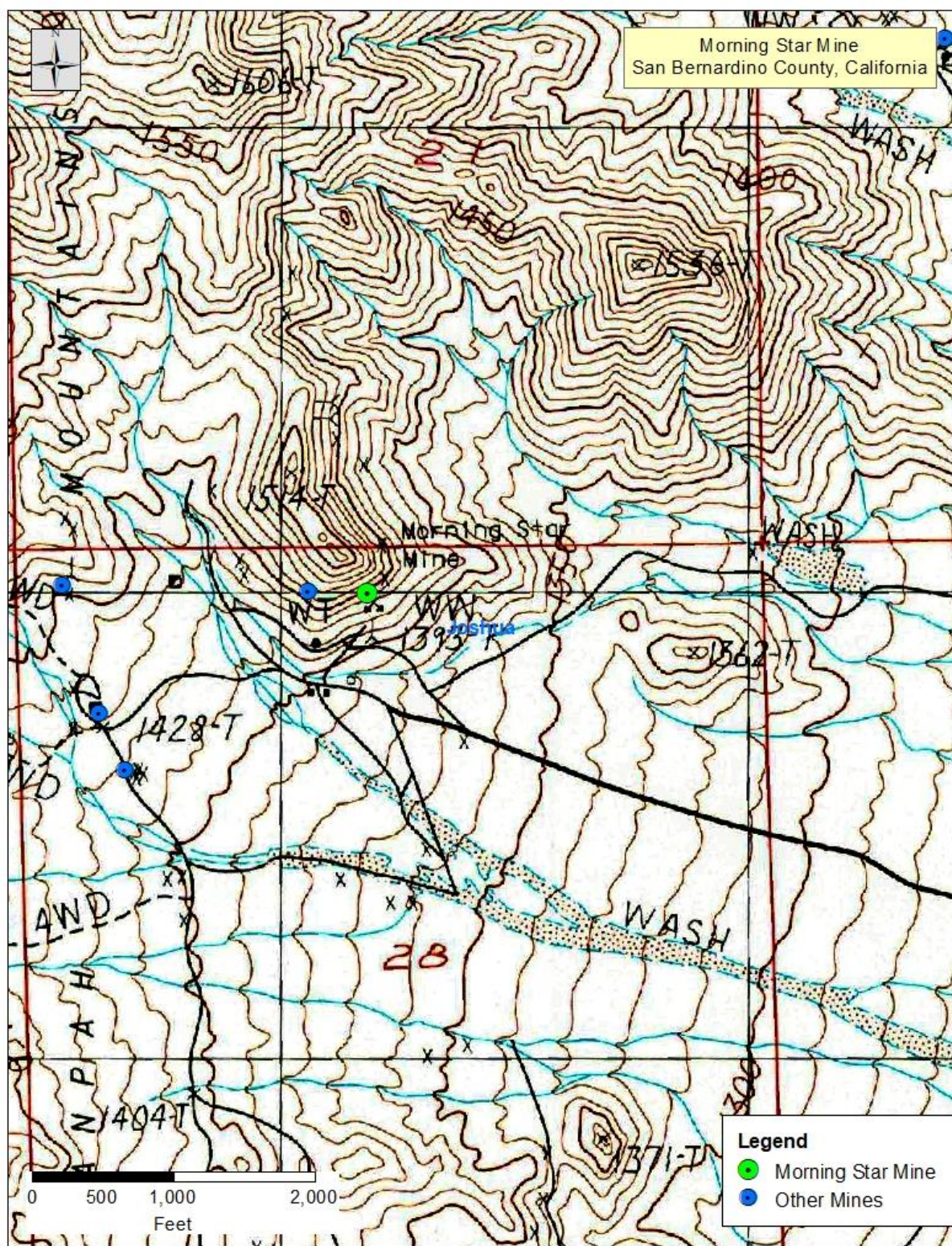




Figure 11. Aerial photograph of the Morning Star Mine and surrounding areas

PHOTOS



Figure 12. Road to Morning Star Mine. From Destinations4x4.net (2020). Accessed Sept. 13, 2022



Figure 13. Cut-off road to Morning Star Mine. From Destinations4x4.net (2020). Accessed Sept. 13, 2022.



Figure 14. Morning Star heap leach pads. From Destinations4x4.net (2020). Accessed Sept. 13, 2022.



Figure 15. Bat grate over shaft at Morning Star Mine. From Destinations4x4.net (2020). Accessed Sept. 13, 2022.



Figure 16. Adit at Morning Star Mine. From Destinations4x4.net (2020). Accessed Sept. 13, 2022

APPENDIX 01: Vredenburgh, 1996

MORNING STAR MINE

The Morning Star mine situated on the east slope of the Ivanpah Mountains, north of Kewanee camp was first active in 1907, at which time it appears to have been known as the Clansman mine. Between 1927 and 1933 the deposit was extensively explored. In 1931 two men were employed at the mine. Between 1937 and 1938 Richard W. Malik of Los Angeles optioned the property from the claim owners, J. B. Mighton and H. T. Brown. During Malik's operations 17,000 feet of crosscut drifts were driven and winzes were sunk on the tunnel level. In April, 1939, E. P. Halliburton, owner of the Halliburton oil service company, began operations. Halliburton employed ten men until the property was shut down in 1942 by War Production Board's Order L-208, closing gold mines.

The Vanderbilt Gold Corporation acquired the property in 1964, the company drilled and sampled the property. In late 1979 they had raised sufficient capital to begin development. In the early 1980s the Morning Star was reactivated as an underground mine using trackless mining equipment. Ore was processed at Vanderbilt's mill at the site of the 1890s townsite of Vanderbilt, seventeen miles away. The ore was processed by flotation with concentrates shipped for smelting. With the drop in the price of gold, mining ceased in 1982, but exploration by underground long-hole drilling continued. In 1983 the mill circuit was converted to cyanide carbon-in-leach. This allowed doré bullion to be produced at the mill,

eliminating the expense of having concentrates smelted. Drilling during this period established an 8 million ton ore reserve averaging .062 ounces of gold. In the fall of 1984 one million tons of overburden were moved and a \$500,000 heap leach facility was constructed. Full-scale leaching began October 1987, and by year end 10,000 ounces of gold and 15,000 ounces of silver had been recovered. Production of ore was 75,000 tons per month. The operation was initially plagued by inadequate water supply, and lower than expected recoveries. This dilemma was solved by abandoning the spray leaching to drip - this doubled the amount of solution leaching through the heap, by using less water. Two heaps were ultimately constructed. The operation suffered from environmental violations including bird and animal deaths in the cyanide ponds, and cyanide solution leaking from the heaps into the adjacent drainage. Mining had ceased by 1993, however the company has submitted a new Plan of Operation to the U. S. Park Service which is under review.