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VULTURE (F) MARICOPA CO.

# Geology of the Vulture Gold Mine

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The Vulture mine in the Vulture Mountains of west-central Arizona is one of Arizona's largest historic gold mines. The mine yielded approximately 340,000 ounces of gold and 260,000 ounces of silver from 1863 to 1942 (White, 1988). The approximately 1 million tons of ore mined had an average grade of 0.35 ounces per ton of gold and 0.25 ounces per ton of silver. In spite of significant gold production, the deposit has received little geologic study until recently (Reynolds and others, 1988; White, 1988). Recent geologic mapping and laboratory studies by the authors of this article, drilling, and deposit evaluations have led to a much better understanding of the geologic characteristics, age, origin, and evolution of the deposit.

New mapping in the Vulture Mountains was partially supported by the U.S. Geological Survey and Arizona Geological Survey Cooperative Geologic Mapping (COGEOMAP) program. Results of these investigations have implications for exploration strategies in the Vulture mine area and in similar highly extended areas elsewhere in Arizona.

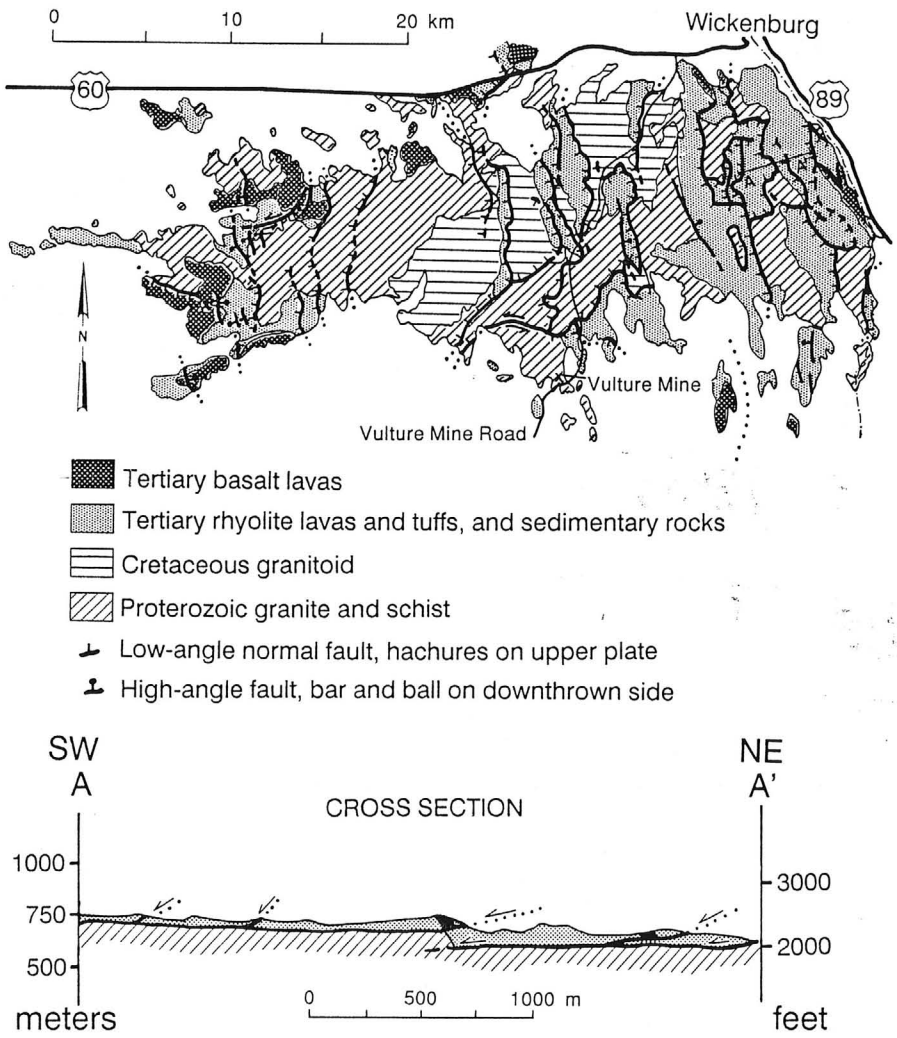



*Figure 1. Simplified geologic map and cross section of the Vulture Mountains (from Grubensky and others, 1987; Grubensky and Reynolds, 1988; and M.J. Grubensky, unpublished mapping).*

## Geologic Setting

Rocks in the Vulture Mountains consist of a variety of Proterozoic metamorphic and igneous rocks, a Cretaceous granite or granodiorite pluton, and lower to middle Miocene volcanic and sedimentary rocks. Large-magnitude, middle Miocene extension, common to most of western Arizona, was accommodated in the Vulture Mountains by movement on numerous listric and planar normal faults. Normal faults and fault blocks were tilted to the east or northeast during extension. Miocene strata now typically dip steeply or are locally overturned to the east or northeast and faults dip gently to the west or southwest (Figure 1).

## Geology of the Vulture Mine

Mineralization and alteration at the Vulture mine occurred primarily within and directly adjacent to a north-dipping quartz porphyry dike that extends eastward from a Late Cretaceous pluton and intrudes Proterozoic crystalline rocks (Figures 2 and 3). Moderate to severe alteration of the dike and wall rocks has converted feldspar and mafic miner-

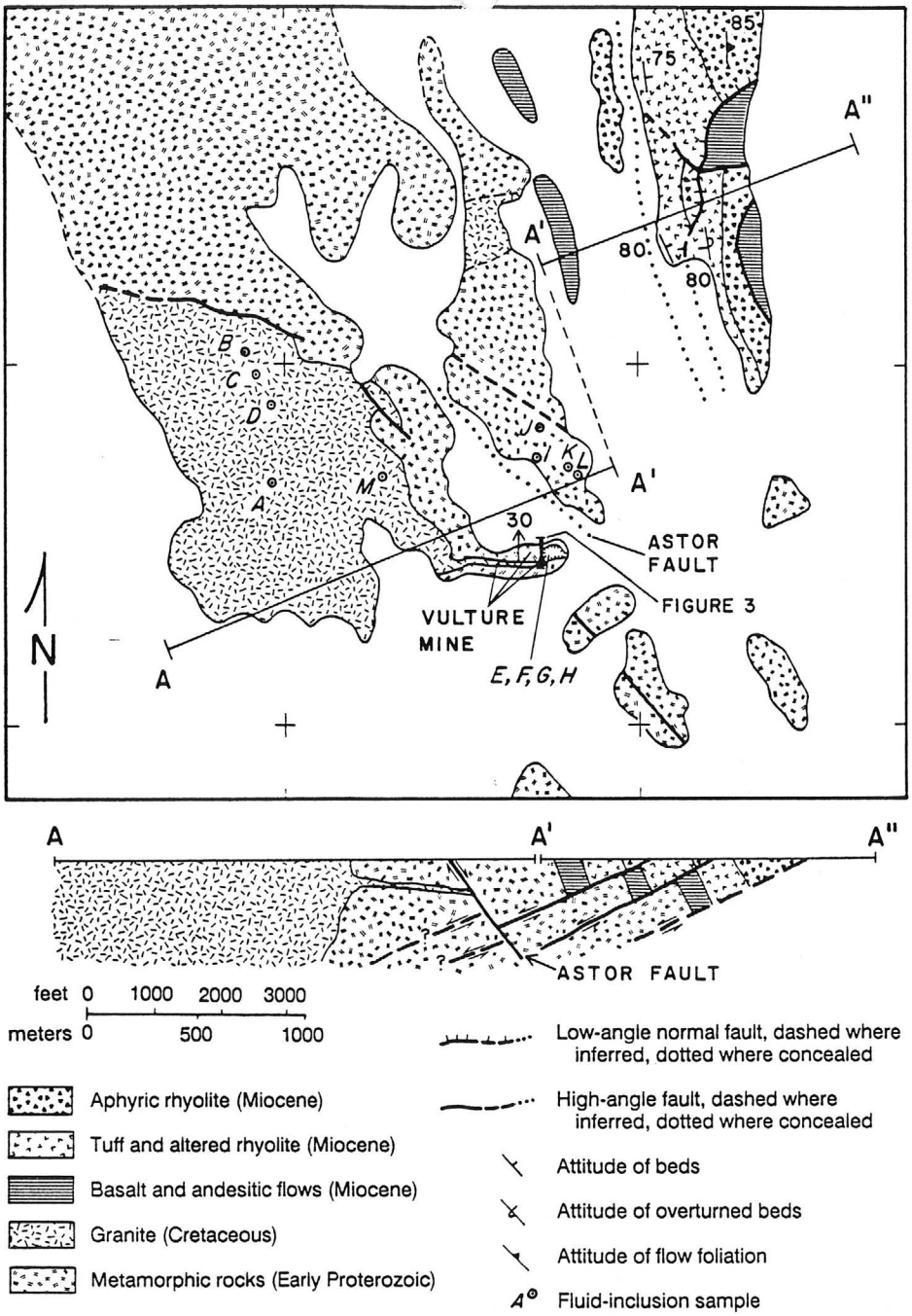



*Figure 2. Simplified geologic map of the Vulture mine area and fluid-inclusion sample locations.*

als to fine-grained sericite, hematite, and clay minerals. Altered dike rocks commonly consist of quartz "eyes" in a fine-grained matrix of alteration minerals. Gold is concentrated in quartz veins and in silicified and altered rocks within and adjacent to the dike (Figure 3). Gold is present as either native metal or electrum and is associated with pyrite, argentiferous galena, and minor amounts of chalcopyrite and sphalerite. There is a positive correlation among abundances of secondary silica, sulfides, and gold (White, 1988).

The Miocene volcanic rocks northeast of the Vulture mine were deposited on the Proterozoic crystalline rocks that host the Vulture mine gold deposit (Reynolds and others, 1988). The originally horizontal volcanic strata and their crystalline substrate have been rotated 70° to 90° so that bedding is now almost vertical. Rocks exposed in the Vulture mine area, therefore, represent an originally vertical cross section that has been tilted approximately 80° to the east by rotational normal faulting. The map view (Figure 2) represents what was originally a vertical cross-section view; what is visible in a north-south cross section (Figure 3) was originally horizontal.

Conceptual restoration of the rocks of the Vulture mine area to their pre-rotation orientation reveals the approximate geometry of the ore deposit at the time of mineralization. Mineralization and alteration originally occurred along a north-northeast-trending subvertical dike that projected upward from the structural top of a Cretaceous granitoid pluton (Figure 4A). The association of gold with the dike (Figure 3) and gradation of the dike into the granitic rocks of the pluton indicate that gold mineralization was intimately related to Cretaceous magmatism and dike emplacement. Later erosion and subsequent burial by lower Miocene volcanic rocks (Figure 4B) was followed by structural dismemberment and tilting (Figure 4C) and eventual uncovering by late Cenozoic erosion. The Astor fault (Figure 3), which is probably one of the youngest faults in the area, cuts the deposit and has displaced its down-dip continuation by an unknown amount (White, 1988).

## Fluid-Inclusion Characteristics

Fluid inclusions are bubbles of liquid and gas that are trapped inside minerals during mineral formation. The composition of fluids in inclusions that were trapped in mineral deposits at the time of deposit formation reflects the composition of the aqueous fluids from which the deposits formed. One can determine the salinity of the inclusions by measuring the freezing temperature of the trapped fluid. The minimum temperature of the fluid at the time it was trapped can be determined by heating the sample until the two phases (liquid and gas) in the inclusion become one. (This is called the *homogenization temperature.*) Fluid inclusions that formed during precipitation of host minerals are called *primary*, whereas those that formed later along fracture planes are called *secondary*.

Quartz veins are numerous over a broad area around the Vulture mine. Samples of veins were collected from an area (Figure 2) that represents an originally vertical cross section through the Vulture mine and that includes more than 1 kilometer of paleodepth range. Homogenization temperatures of primary and secondary fluid inclusions vary from approximately 200°C to 320°C and calculated salinities vary from approximately 1 to 18 percent NaCl equivalent by weight. Homogenization temperatures and salinities generally decrease with decreasing paleodepth (Figure 5). These fluid-inclusion data reveal the temperatures and salinities of the hydrothermal fluids that were probably undergoing convective circulation above the Cretaceous intrusion and that were respon-

sible for much or all of the mineralization and alteration at the Vulture mine. Greater fluid temperatures at greater depths probably reflect heat from the magma intrusion (now the granitoid pluton) that lay beneath the Vulture mine deposit. Downward-increasing fluid salinities may reflect a downward increase in the proportion of aqueous fluid expelled by the magma during crystallization.

## Conclusion

Recent geologic mapping of the Vulture Mountains and adjacent ranges has established that the area has undergone large-magnitude extension as a result of rotational normal faulting (Grubensky and others, 1987; Stimac and others, 1987; Grubensky and Reynolds, 1988; see also Rehrig and others, 1980). Geologic mapping in the Vulture mine area indicates that this area has been faulted and tilted like most of the range and that the Vulture mine gold deposit has been tilted approximately 80° (Reynolds and others, 1988). Drill-hole assay data show that mineralization is associated with a dike that extends from the structural top of a Cretaceous pluton (White, 1988). Fluid-inclusion studies indicate that mineralization at the Vulture mine deposit occurred within a larger system of circulating aqueous fluids in which temperature and salinity increased downward toward a crystallizing magma body.

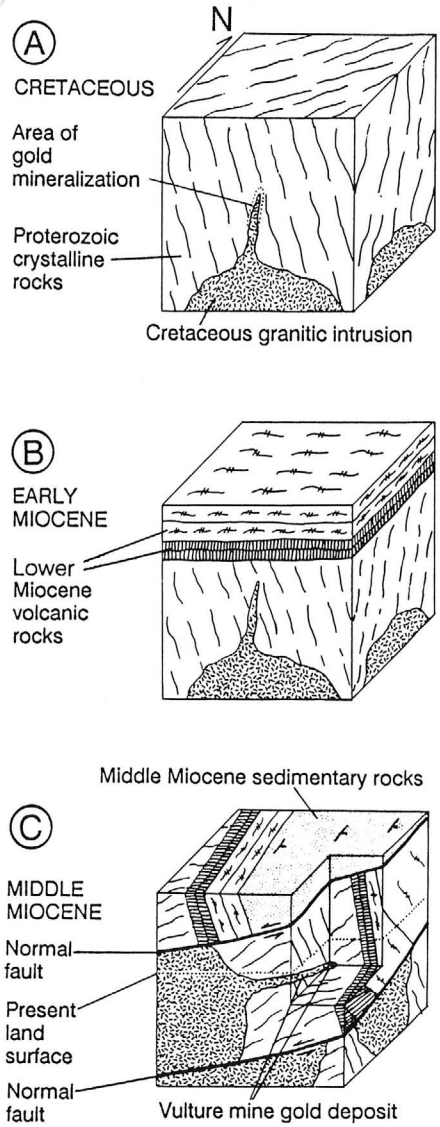



*Figure 3 (below). Geologic cross section through the Vulture mine (modified from White, 1988 and unpublished data). See Figure 2 for location.*

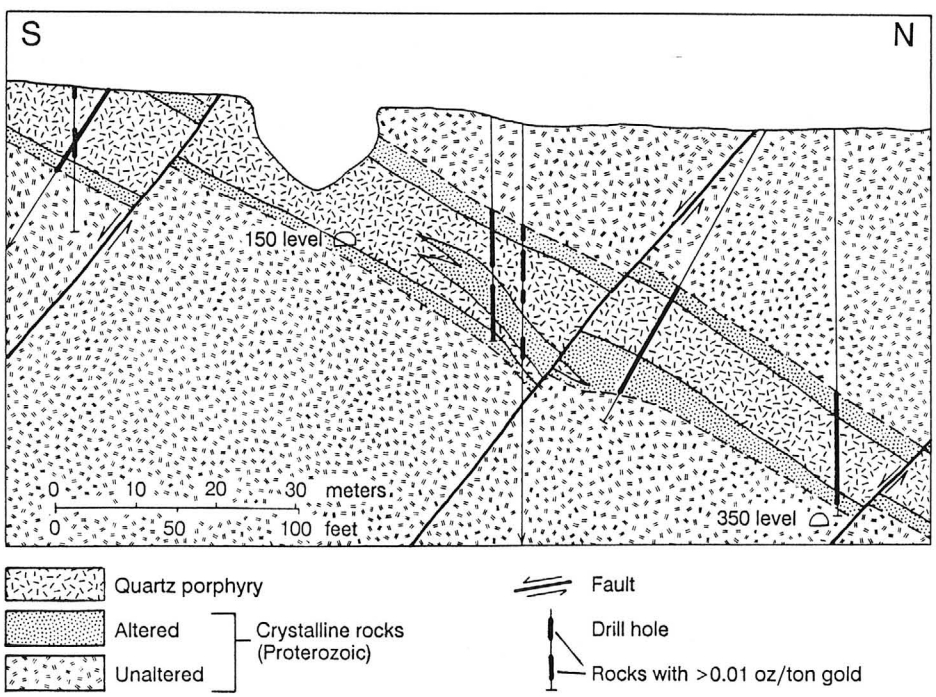
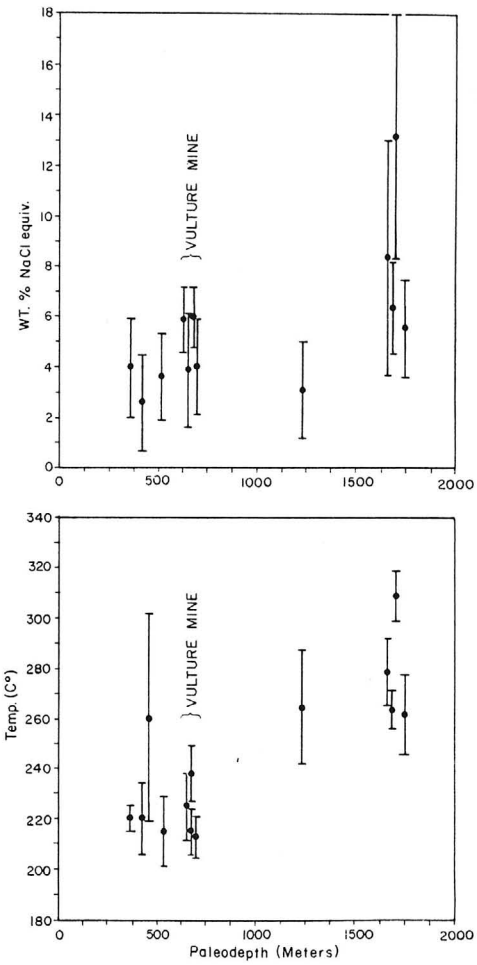



*Figure 4 (left). Evolutionary block diagram of the Vulture mine area. Although only one generation of normal faults is shown, rotation probably occurred by movement on two or more generations of normal faults and is more complex than is shown here.*

*Figure 5 (below). Paleodepth versus salinity (upper diagram) and homogenization temperature (lower diagram) for fluid inclusions from quartz veins in the Vulture mine area. Paleodepth is the distance perpendicular to the approximately vertical disconformity at the base of Miocene volcanic rocks in the Vulture mine fault block. The actual depth of Vulture mine rocks at the time of mineralization was probably 1 to several kilometers.*




Recognition of this type of ore-deposit tilting and possible structural dismemberment has implications for exploration strategies in extended areas. Specifically, mineral exploration in highly extended areas characterized by rotational normal faulting may be facilitated by the knowledge that mineral deposits may have been tilted 80° from their original orientation. Such rotation provides a natural laboratory for the study of mineral deposits because the

deposits are exposed in what was originally a near-vertical cross section. This type of extensional faulting may also cut an ore deposit into two or more pieces and leave them in shinglelike imbricate fault blocks separated from each other by several kilometers (e.g., Lowell, 1968).

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# State Geological Survey - U.S. Geological Survey Meeting Held in Tucson

*Figure 1. Representatives from the AZGS and USGS discuss the Cooperative Geologic Mapping (COGEOMAP) program. Left to right: Larry Fellows (AZGS Director and State Geologist), Steve Reynolds (AZGS Research Geologist), Ben Morgan (USGS Chief Geologist, Reston), and Dave Russ (USGS Assistant Chief Geologist for Programs, Reston).*

The annual meeting of the directors of western State geological surveys and key U.S. Geological Survey (USGS) staff was held in Tucson October 22-25 at the Ghost Ranch Lodge. The purposes of the meeting were to improve communication between staff of the State and Federal surveys; learn about current activities, projects, and concerns (Figure 1); and explore ways of fulfilling the respective statutory mandates more effectively through improved coordination and cooperation. Ten of the 13 western State geological surveys were represented; approximately 20 USGS staff members, primarily from the Office of Mineral Resources, were also present.

Western State geologists held an all-day business meeting at the Arizona Geological Survey (AZGS) on October 21 (Figure 2). USGS geologists held a variety of postmeeting functions at their Arizona Field Office.

Two major discussion sessions were held at the joint meeting: (1) the Mineral Resources Data System (MRDS), a computerized database maintained by the USGS, and (2) outreach activities in earth science education. A half-day field trip was taken to observe detachment-fault geology and the impacts of groundwater withdrawal, subsidence, and earth fissures in the Picacho basin (Figure 3).

The 1990 meeting will be cohosted by the USGS and Idaho Geological Survey in Moscow, Idaho.

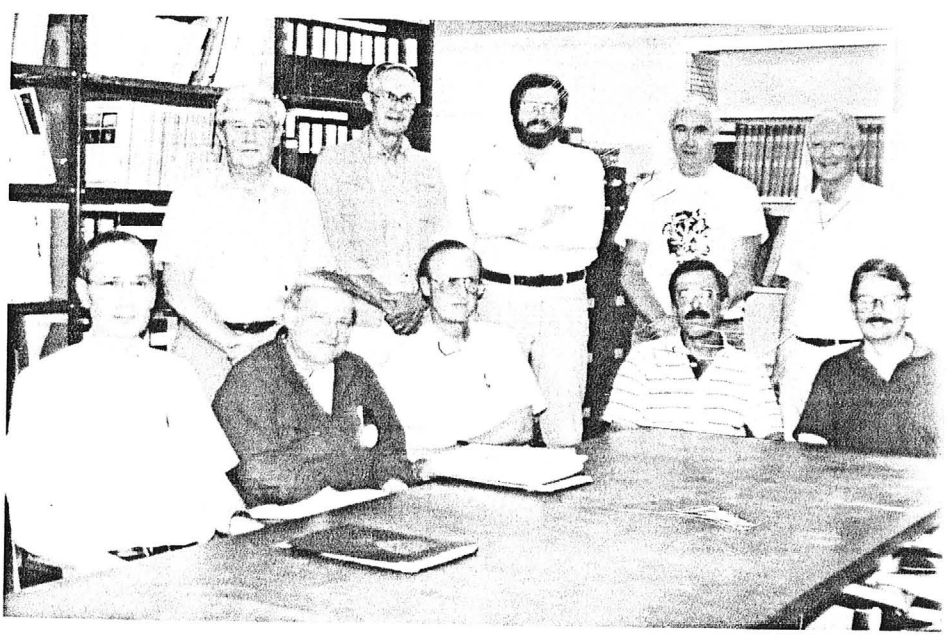
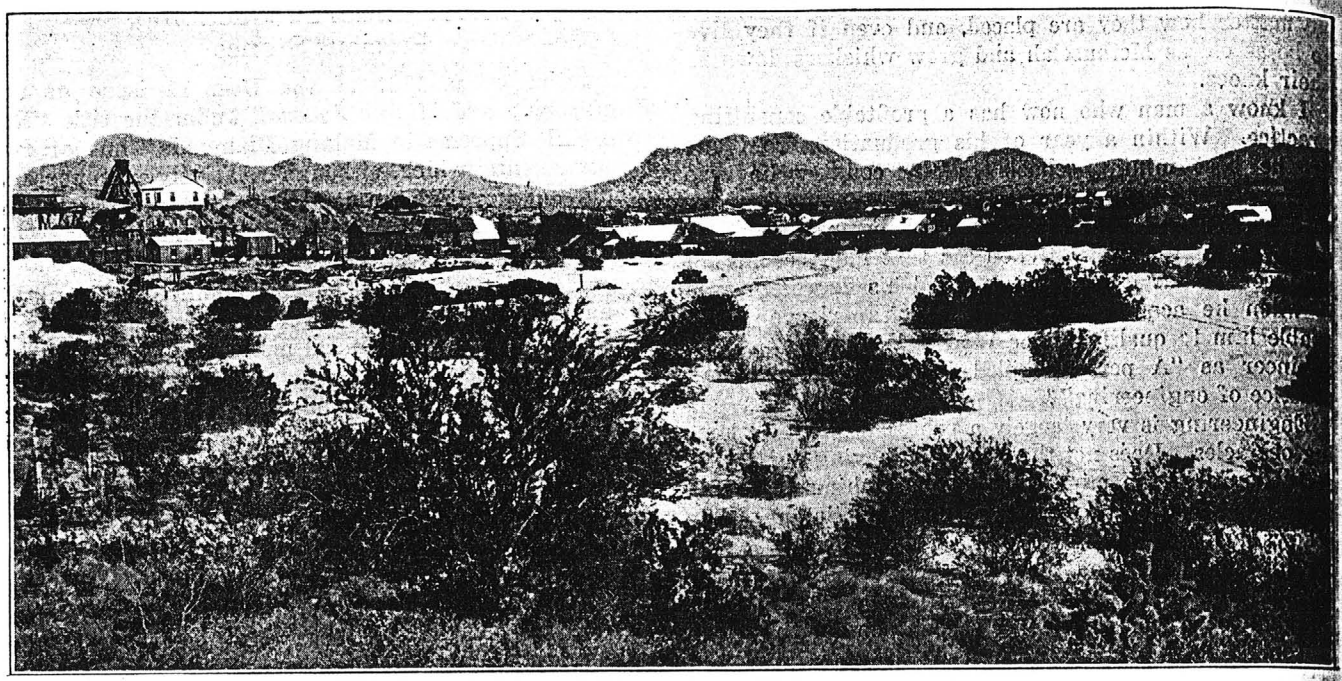


*Figure 2 (left). Western State geologists meet to discuss mutual concerns. Top row, left to right: Bob Forbes (Alaska), Ed Ruppel (Montana), Jon Price (Nevada), Don Haney (Kentucky; President of the Association of American State Geologists), and Larry Fellows (Arizona). Seated, left to right: Eric Schuster (Deputy Director, Washington), Jim Davis (California), Earl Bennett (Idaho), Jamie Robertson (Deputy Director, New Mexico), and Lee Allison (Utah).*

*Figure 3 (above). AZGS geologists Phil Pearthree and Steve Reynolds discuss areas of subsidence and earth fissures in the Picacho basin with field-trip participants.*



THE VULTURE MINE AND CAMP, FROM THE MILL, IN 1914

# The Vulture Mine

## An Excellent Example of the Effect of Faulting Upon the Development Of a Southwestern Gold Deposit—Discovered in the Sixties, the Property Had a Good Record of Production Until 1917, When It Was Closed Down

By W. Spencer Hutchinson
Written for *Engineering and Mining Journal*

THE VULTURE, a gigantic tooth of gold-threaded quartz on the rim of the desert, watched century by century the seasonal migration of the Apaches, who crossed the mountains and the forty miles of desert between the waters of the Hassayampa and the Gila. In the sixteenth century it beckoned the adventurous Spaniard from the beaten trail to reveal its gold and to take his brass-poled and steel-edged axe for a token. It was not until 1862 that any attempt was made thoroughly to explore central Arizona; no one had before essayed more than a hurried passage through the country, although all believed it to be rich in minerals. The Territory of Arizona was organized by act of Congress, Feb. 24, 1863, and about the same time Weber, Walker, Wickenburg, and other veteran pioneers came into the district.

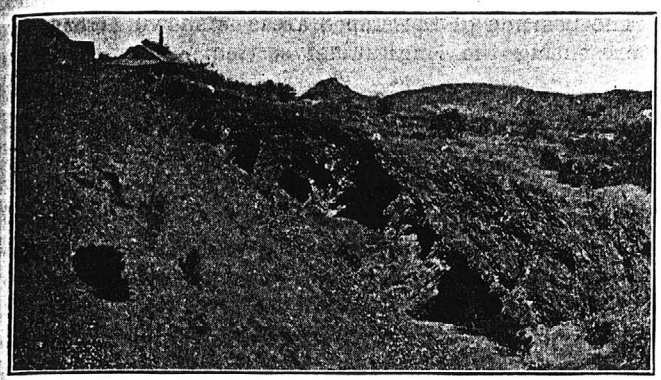
Henry Wickenburg, with several companions, was prospecting upon the Hassayampa in October, 1863, and discovered a butte or small isolated mountain of quartz which they recognized as containing gold, but to which they attached no great value at first, so that all but Wickenburg were reluctant to go to even the small trouble of posting notices, claiming the lode. It was, however, taken up, and the Vulture mine by 1867 became the best-known and most profitable property in central Arizona, if not in the entire territory. The main quartz outcrop, a tooth-like butte, was 500 ft. long, 400 ft. wide, and 100 ft. high.

The Vulture mine is in Maricopa County, fourteen miles south of Wickenburg, a station on the Prescott & Phoenix branch of the Santa Fé Ry. about fifty miles northwest of Phoenix. The mine is reached by automobile road, which surmounts a pass at an altitude of 2,700 ft., just north of Vulture Peak. The mine itself is at an altitude of 2,000 ft. It was not so accessible in the early days before the railways were built, when Ehrenburg, on the Colorado River, was the nearest supply point and whence all the machinery for the first mill was hauled 168 miles across the desert. In 1880 the railroad reached Phoenix and in 1893 it was extended to Wickenburg. The Hassayampa is a "dry" river the greater part of the year, but its sub-channel stream is unfailing, and at Wickenburg abundant water is found by shallow wells. Of these waters, it is alleged, "He who drinks thereof shall never afterward tell the truth, have a dollar, or leave Arizona."

The first mills for working the Vulture ore were built on the Hassayampa, one a short distance above Wickenburg, and sixteen miles from the mine, the other considerably further down the river and ten miles from the mine. Wells were drilled at the mine in 1909, and a watercourse in gravel was found under the lava at 400 ft. depth. Two wells were equipped with pumps, but the water nearly failed in 1912, and one of the wells was deepened to 1,003 ft., where more water was found. This water rises to 450 ft., whence it is pumped with a standard well rig, and for four years, as long as the well was used, the flow showed no diminution, and there was never any lack of water for the mill at the mine or for other needs.

Wickenburg himself seems to have been possessed of initative, for within six months of his discovery he had built arrastras on the Hassayampa River, to which he hauled ore yielding $80 to $100 in gold per ton, and

in 1865 built a five-stamp mill, which he worked steadily until 1867, when he sold the mine to an English company. The new owners built a new mill of forty stamps about a mile above the town of Wickenburg. Tailings in excess of 200,000 tons accumulated here from the ores hauled from the Vulture mine. The treatment at this early time was, of course, by amalgamation, and although the accounts refer to some concentration by bumping tables, it appears that the concentrates were not shipped away, but were piled up for future treatment. At any rate, after the cyanide process was



THE VULTURE MINE, SHOWING THE VEIN IN THE WEST END OF THE EASTERLY OPEN CUT

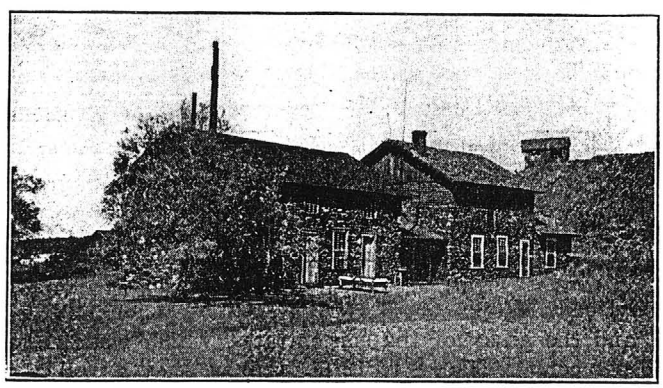
developed and in the early 90's, this tailing pile was worked over by cyanidation with great profit.

The ownership of the mine was divided, and this fact accounts for another mill of twenty stamps built in 1871 at a point on the river known as Smith's mill, ten miles east of the mine and fifteen miles below Wickenburg. There was a third mill at Seymour some time later, about three miles above Smith's mill and about the same distance from the mine and on the old stage road between Vulture and Phoenix. Frequent mention is made of the excessive cost of operation, due to the long wagon haul from the mine to these mills, which made it necessary to sort the ore at the mine and put into stockpiles for later treatment everything that yielded less than $20 per ton. The practicability of building a mill at the mine and also of laying a pipe line from the Hassayampa River was considered early in the progress of the work. This plan, however, waited until 1879 for its realization, when the Arizona Central Mining Co. acquired all of the different claims on the deposit. An eighty-stamp mill was then built at the mine and a six-inch pipe line was laid from Seymour, whence water was pumped from wells sunk in the bed of the river. Power was provided by a steam plant burning wood, and during the operation of the mill, which continued for seven or eight years, all of the scanty growth of desert trees was cut off for twelve miles around the mine.

During the twenty years from 1888 to 1908, the mine was worked only in a small way by lessees. In 1908 it was reopened by the Vulture Mines Co. The mine was pumped out and the shaft sunk deeper. Milling began in 1909 from ore mined in the upper levels and milled in twenty stamps of the old mill repaired for that purpose. The ore was amalgamated in the mortars and on plates in approved California style, with very good results and a metallurgical efficiency of 70 to 80 per cent. The tailings were piled for later treatment by cyanide. Water was developed by the deep wells, and a new mill built in 1910. The latter was of twenty heavy stamps, with supplementary grinding pans, having a capacity of 100 to 120 tons of ore daily, and was driven by a gasoline engine. The mill worked steadily, with the exception of an interruption of a few months, until the end of 1915. All activity ceased in 1917. The mine was allowed to fill with water, and in 1919 the equipment was advertised for sale.

Only the most meager records of the production of the Vulture mine between 1864 and 1908 are to be found, but it is known to be very large. Published reports credit it with as much as $16,000,000, and some claims are made of even larger production. In *Mineral Resources* for 1869 a record is given of 15,474 tons milled at Wickenburg, which yielded $399,743, which is at the rate of $25.83 per ton. Whatever uncertainty there may be regarding early production, there is none concerning that since 1908, which amounted to a total of $1,839,375, of which about 30 per cent came from concentrates shipped to smelters and the remainder was from bullion derived in nearly equal proportion by amalgamation and cyanidation. Complete records of tonnage are not at hand, but there was milled during the years 1912 to 1914, inclusive, 82,091 tons of ore of an average assay of $18.94 per ton, which was treated with a metallurgical efficiency of about 82 per cent.

The mine is in the foothills of the Vulture Mountains at the edge of a broad, gently sloping desert valley. The country rocks are schists, probably pre-Cambrian, with dikes and irregular masses of granite, all antedating the mineralization. Vulture Peak, at an altitude of 3,500 ft. and five miles northeast of the mine, is a volcanic neck with radiating dikes whose prominent outcrops form striking topographic features. This neck and the dikes are assumed to have been the



THE OFFICE AND ASSAY LABORATORY AT THE VULTURE MINE

These buildings date back to the very beginning, and are built of mine boulders, some of which show free gold. This picture was taken in 1908. The buildings are still standing.

source of the lavas which filled an old valley and buried the easterly extension of the Vulture mineral zone.

The vein strikes east and west and dips northerly 42 deg. It presents two characters: next to the foot wall, a vein five to six feet thick of rich mineralized quartz but without admixture of schist, and above this, and separated from it by chloritic schist, a big quartz vein thirty to fifty feet thick. In some parts this vein is of clean, white quartz, which is invariably low-grade and cannot be worked at a profit. In other parts, the body of this vein is made up of fragments of schist with quartz between, and is rich. The hanging wall is of chloritic schist, the foot wall being of sericitic schist. The outcrop was 1,000 ft. long, but it has all disappeared

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now, the upper parts of the vein having been quarried in two large open pits. The westerly pit is 300 ft. long and the easterly one 500 ft., with low-grade vein matter, which consists mostly of white quartz too poor to mine, remaining between them.

In the oxidized zone the quartz is stained with iron oxide, and some wulfenite in characteristic tabular crystals with razor-sharp edges is found in openings in the quartz. Vanadinite is reported to have been found, but it must be rare, for none was seen during the recent operations. Below the zone of oxidation the vein minerals, other than quartz, are pyrite, galena, blende, and chalcopyrite. The proportion of these is indicated by the ratio of concentration, which was about 30 to

extensive outcroppings of granite are found, occurring as an intrusive mass in the schist. The vein extends into the granite, but pinches out within a short distance after splitting up into several smaller veins, which have, however, yielded some high-grade ore. Granite of identical character was encountered in the westerly end of the 950 level, in the easterly end of the 1,550 level, and in a diamond-drill hole put down from the latter. These points of exposure of granite in the zone of mineralization indicate a probable easterly pitch of the contact and perhaps also an easterly pitch or rake to the ore zone.

The position of the stoped areas is shown in Fig. 1, representing the longitudinal section. Characteristic

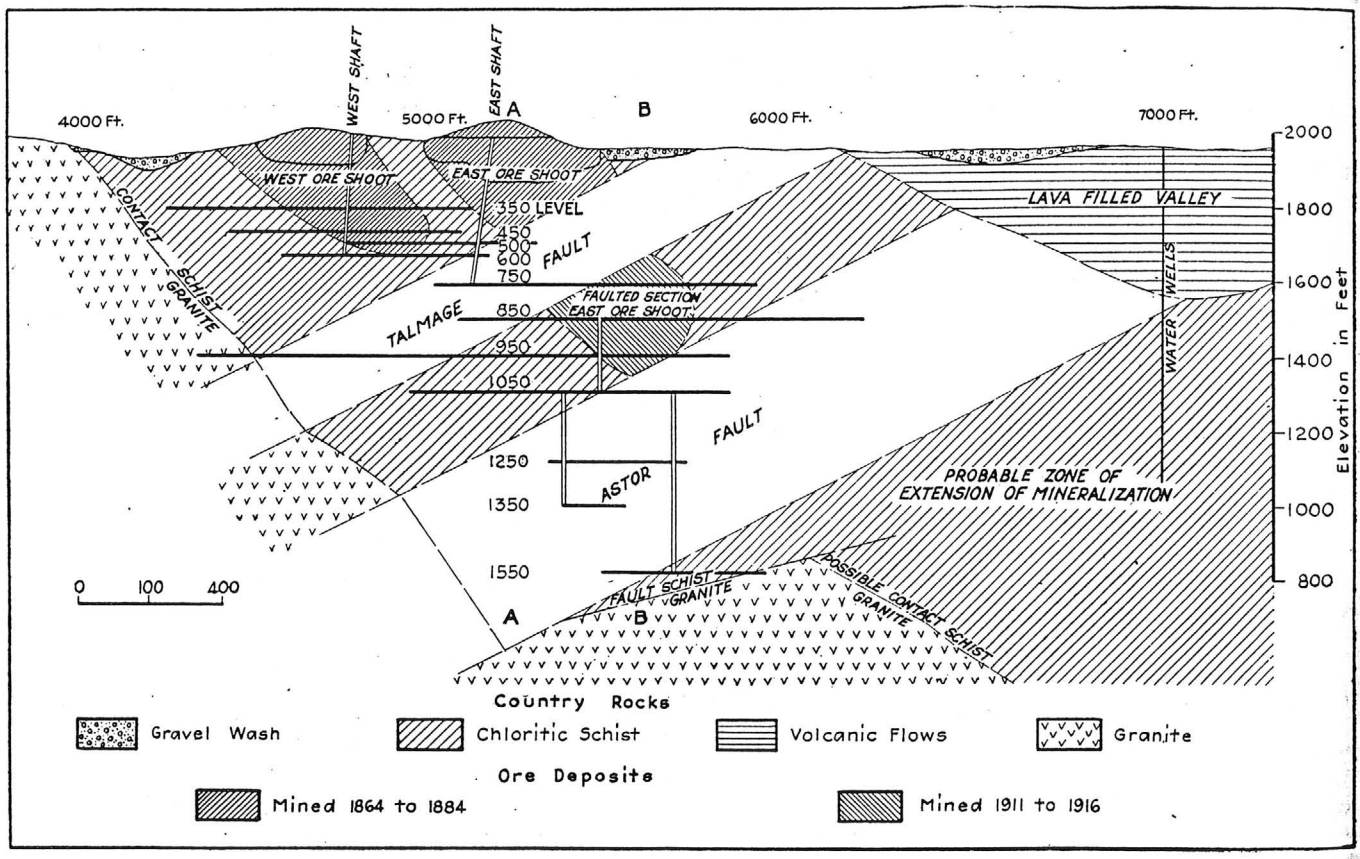


FIG. 1. LONGITUDINAL VERTICAL PROJECTION OF THE VULTURE MINE WORKINGS

1, and the assay of the concentrates, which was 12 to 15 per cent of lead, 8 to 12 per cent of zinc, 1 to 2 per cent copper, and from $120 to $200 in gold. Metallic gold was found in all parts of the mine, and even in the deeper workings, where the ore was not oxidized but was made up of characteristic quartz with associated sulphides, coarse gold was present, and thus some pieces weighing half an ounce or more accumulated in the mortars of the stamp batteries. This gold had a fineness of 760 to 780.

The association of gold with galena is an interesting characteristic. The gold thus associated appeared not to be metallic, and proved, upon experiment, to be peculiarly obstinate to cyanidation, but the galena was usually rich, so that when the average mill concentrates assayed $150 per ton the clean galena concentrate assayed $600. These characteristics of the ore led to the adoption of a rather unusual metallurgical treatment, a combination of amalgamation, concentration, and cyanidation.

Just beyond the ore shoot on its westerly extension silicification is found throughout, but mineralization, instead of being uniform, is segregated in two well-defined ore shoots. The easterly orebody, which is the one furthest from the granite, was the larger in every dimension, and the position of the two suggests the conception of a succession of ore shoots *en echelon*. Thus, the next one should be further east and deeper, and the faulting would have carried it to some such position as is indicated on the drawing as "probable zone of extension of mineralization." Evidence of easterly extension of the ore zone would naturally be looked for on the surface, but near-by exposures are lacking, for the reason that the schists are buried by volcanic tuffs and lavas. The schists emerge again 3,000 ft. to the east, where they show characteristic structures and some mineralization.

The geological feature which has been a controlling factor in the history of the Vulture mine is the extraordinary development of faulting. There are a great number of small faults, with displacement, however, of a few feet only. These have been of little conse-

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quence and have interfered neither with development nor mining. Besides these, there are two major faults, which are known as the Talmadge and Astor faults. The Talmadge fault cuts the orebody off on the easterly end and on the dip, crossing the vein on its strike at an acute angle. The dip of the fault is 80 deg. to the northeast, which compares with the dip of the vein, 42 deg. to the north. The displacement of the vein is 300 ft. vertically. This fault does not outcrop at the surface, but is buried by gravel wash, a circumstance tending to conceal its true character, which was consequently not recognized until 1911. That this fault was encountered early is shown by the sketch, Fig. 3, and a quotation from a letter[1] written in 1872 by the superintendent of the mine to Rossiter W. Raymond, then U. S. Mining Commissioner:

"At a depth of 232 ft. below the surface of the mesa the fissure is found to change from a dip of 45 deg. north-northeast to an almost vertical position. . . . After sinking 50 ft. behind the foot wall, from the 232-ft. level, the fissure was crosscut and found to be 47 ft. in width, and having on the hanging wall a seam of blue clay some 12 or 15 in. thick. Outside of this was the hanging-wall rock peculiar to the mine above; but the fissure, throughout its width, was found to be filled with a hard black rock full of fine iron pyrites and some galena, and similar in character to the cap or barren filling which is found in many Colorado lodes."

It is interesting to find the correct interpretation of this puzzling geological structure by comparing the sketch, made in 1872, with the cross-section of the orebody as developed in 1918. So far as is known, no work was done deeper than that shown in the old sketch until 1911.

It is not easy to show these faults and their relation to the vein clearly and fully without a series of cross-sections or a model, but the two accompanying sketches, Fig. 2, will give an idea of the disastrous results of the faulting. The fault was encountered during the recent working of the mine on the 500 level near the plane of section *A-A*, and here it was from five to six feet wide between the walls and was filled with gouge and broken fragments of schist and quartz. For a short distance, in some places fifty or sixty feet, below the point where the vein was cut off, the fault contained so much crushed vein matter that the fault was profitably stoped for a considerable distance. The fault is mineralized discontinuously by calcite, which appears

[1]Mineral Resources West of the Rocky Mountains, 1874.

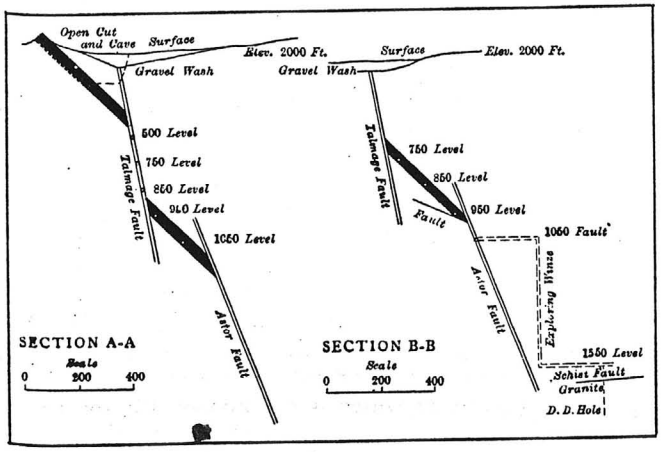


FIG. 2. CROSS-SECTIONS ON *A-A* AND *B-B* OF THE VULTURE MINE, SHOWING THE EFFECT OF FAULTING

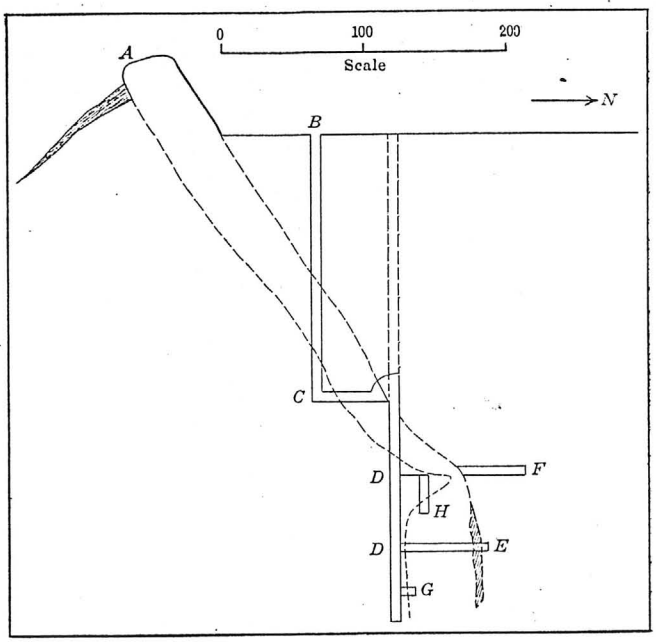


FIG. 3. SECTION OF VULTURE MINE

Drawn by Peter Taylor, superintendent, in 1872, published in report of the U. S. Commissioner of Mining Statistics, 1874, page 348. *A*, outcrop; *B*, mouth of main shaft at surface of mesa; *C*, 182-ft. level; *D-D*, interior shaft; *E*, crosscut at 282-ft. level, showing vein 47 ft. thick, with seam of clay on hanging wall; *F*, north property drift, at 232 ft.; *G*, crosscut (unfinished) at 312-ft. level; *H*, small winze.

in lenses a few feet in length, sometimes a foot in thickness, dark colored, and containing here and there crystals of galena. The calcite is comparatively plentiful near the surface and is not found in the deeper parts.

When the position of the fault was determined by the extension of the underground work, its apex was projected and staked on the surface, and it was found that it cut through an area of old dry-placer workings about 700 ft. southeast of the orebody. A working hypothesis was developed based upon the idea that the old placer marked the position of the faulted outcrop of the vein, and exploration was thereafter directed by a drift on the 750 level southeasterly along the fault and by a vertical winze from the same level on the northeasterly side of the fault. This work resulted in cutting the vein on both the 750 and 850 levels exactly where the hypothesis indicated. The orebody, when rediscovered, was 35 ft. thick, and the best part of the ore shoot 200 ft. long.

At this stage it was thought that nothing could interfere with the realization of the most sanguine expectations entertained for the mine, but before many months had gone by the Astor fault was cut on the 1,050 level, at a place where it was expected to find ore. This new fault is parallel, or nearly parallel, to the Talmadge fault, and the displacement is in the same direction—that is, downward on the northeasterly side. The amount of that displacement is not known, for the reason that neither the vein nor any other correlating features have been found beyond it.

The physical condition of the fault-filling does not suggest displacement greater than that of the Talmadge fault, but the winze 500 ft. vertically below the 1,050 level did not find the vein, although it did find stringers of quartz which yielded good assays, a condition which is characteristic of mineralization in the schists beyond the ends of the ore shoots. It is believed that the drifts might wisely have been carried further east before the work was stopped, but, in any case, if the vein should

some day be found in the east end, a new shaft from the surface would be necessary for economical working, and any further explorations had probably best be done by diamond drilling.

The purpose of this account is to put on record the facts concerning a remarkable gold mine, with the hope that it may be of service to others who may harken to the call of the Vulture.

# Iron-Ore Production in 1920

THE iron ore mined in the United States in 1920, exclusive of that which contained more than 5.5 per cent of manganese, is estimated by the U. S. Geological Survey at 67,773,000 gross tons, an increase of 12 per cent as compared with the output in 1919. The shipments of ore from the mines in 1920 are estimated at 69,558,000 gross tons, an increase of nearly 24 per cent as compared with shipments in 1919. The stocks of iron ore at the mines, mainly in Michigan and Minnesota, apparently decreased from 12,986,000 gross tons in 1919 to 11,145,000 tons in 1920, or 14 per cent.

The production of iron ore in 1920 was less than 2,000,000 tons below that of 1918 and is exceeded only by that of the war years 1916, 1917, and 1918. In 1920 shipments exceeded production by approximately 1,785,000 gross tons, but in 1919 production exceeded shipments by about 4,147,000 tons.

### Lake Superior District

About 86 per cent of the iron ore mined and shipped in 1920 came from the Lake Superior district, in which 58,173,000 gross tons was mined and 60,056,000 tons was shipped, increases of about 12 and 24 per cent, respectively, as compared with the quantities mined and shipped in 1919. These totals include the ore mined and shipped from the Mayville and Baraboo mines, in Wisconsin, and ore shipped by rail as well as water from all mines, but exclude manganiferous ores that contained more than 5.5 per cent manganese. The ore is chiefly hematite. The stocks of iron ore in this district apparently decreased from about 11,887,000 gross tons in 1919 to about 10,000,000 tons in 1920, or 16 per cent.

The shipments of iron ore by water from the Lake Superior district in 1920 (including manganiferous iron ore), according to figures compiled by the Lake Superior Iron Ore Association, amounted to 58,527,226 gross tons, an increase of 24 per cent as compared with these shipments in 1919. A total of about 1,529,000 tons is thus indicated to have been shipped by rail.

The mines in Minnesota furnished 67 per cent of the total iron ore shipped from the Lake Superior district in 1920 and 58 per cent of the total of the United States. The mines in Michigan furnished 31 per cent of the Lake shipments and 27 per cent of the grand total.

### Southeastern States

The southeastern states, which constitute the second largest iron-ore producing area, including the Birmingham and Chattanooga districts, mined 6,663,000 gross tons of iron ore in 1920, an increase of 16 per cent as compared with 1919. The shipments of ore from these states to blast furnaces in 1920 amounted to 6,575,000 gross tons, an increase of 18 per cent as compared with shipments in the previous year. The ore contains about

states in 1920 apparently slightly exceeded the shipments, so that the moderate stocks at mines and furnace yards were increased.

### Northeastern States

The northeastern states, which include New Jersey, New York, and Pennsylvania, in 1920 mined 2,027,000 gross tons of iron ore and shipped 2,070,000 gross tons, an increase of 12 per cent over the quantity mined and of 36 per cent over the quantity shipped in 1919. A slight decrease in ore stocks is thus indicated. Most of this ore is magnetite, and is subjected to concentrative treatment before shipment.

### Western States

Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Washington and Wyoming, the iron-ore producing states in the West, are estimated to have mined and shipped 734,000 gross tons of iron ore in 1920, an increase of 8 per cent as compared with the quantity mined and shipped in 1919. No large stocks of iron ore are maintained at western mines. Hematite predominates in the western states, but considerable brown ore and magnetite are mined.

### Other States

Other states, including Connecticut, Maryland, Massachusetts, Missouri and Texas, in which there are small iron mines that produce chiefly hematite and brown ore, mined about 176,000 gross tons in 1920, an increase of 63 per cent as compared with the quantity mined in 1919. The shipments from mines in these states in 1920 are estimated at 123,000 gross tons, an increase of 16 per cent over the shipments that were made during the year 1919.

## Prehistoric Monsters Overran Nebraska And Wyoming

What geologists term the Oligocene formations contain the fossil bones of a great variety of strange extinct animals. These strata are among the most widespread and most regularly distributed of the Tertiary sedimentary rock formations of the Great Plains, and cover a vast area in Nebraska and Wyoming.

The lower Oligocene beds, which are believed to be over a million years old, are often called *Titanotherium* beds, because they contain great quantities of the bones of extinct mammals of that name. They were clumsy brutes of elephantine size, according to the U. S. Geological Survey, having on the front of the skull a pair of great bony protuberances, which, although hornlike in form, were probably not sheathed in horn.

The animals of Oligocene time were apparently abundant as well as varied in kind. Among those characteristic of this epoch were primitive forms of rhinoceroses, peccaries, ruminants, camels, insectivores, and opossums. The saber-toothed tiger, one of the most formidable enemies of primitive man, first appeared in the Oligocene epoch. The horses whose history began with the diminutive four-toed *Eohippus* continued in the Oligocene. Hoglike animals were rather numerous. One of these was a formidable beast with curious protuberances on its head, the use of which is not known. Rhinoceroses similar to those now found in Africa and India lived in

07/29/96 11:01

1/10
Vulture Mill
Site -

# Figure 1 – Location Map

Vulture Mill – Arizona Department of Environmental Quality

Engineering Evaluation / Cost Analysis

NOT TO SCALE

| | |
|---|---|
| Date: | 03/12/96 |
| Drawn: | K. Fewell |
| Western Technologies Inc. | |
| Job No.: 2196JH011 | Figure: 1 |

Western Technologies Inc.

07/24/98 11:57 ☎002 437 8887 WTI INC 003/003

Figure 3
Preliminary Site Map
Arizona Department of Environmental Quality
Superstition Mountain / Coor Avenue
Western Technologies Inc.
OSTRICH WELL #1
OSTRICH WELL #2
DEBIL APARTMENTS
WELL
WESTERN HILLS
TRAILER PARK
U S 89

# Figure 2 – Site Vicinity Map

Vulture Mill – Arizona Department of Environmental Quality

Engineering Evaluation / Cost Analysis


NOTES:

1. TOPOGRAPHY FROM USGS 7.5 MINUTE WICKENBURG QUADRANGLE.
2. ROAD PLACEMENT FROM MARCH, 1993 AERIAL PHOTOGRAPH.
3. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

APPROX. SCALE

| | |
|---|---|
| Date: | 03/12/96 |
| Drawn By: | E. Powell |
| Western Technologies Inc. | |
| Job No. 21861H011 | Figure: 2 |

East Vulture (see Vulture, Moon Anchor, Lost Spaniard)
T. 6 N., R. 6 W.
Maricopa County

reference: Arizona Dept. of Mineral Resources
East Vulture (file)

present owner:

minerals: gold

history of the area:
in 1940 the East Vulture Mining Company did development work. They also milled at 100 tons a day from the Glory Hole. By 1944 the mill was idle.

NAME OF MINE: EAST VULTURE

COUNTY: MARICOPA
DISTRICT: WICKENBURG
METALS: CU,PB,Au

| OPERATOR AND ADDRESS: DATE: | | MINE STATUS DATE: | |
|---|---|---|---|
| 5/1/44 | E.R.Dickie, East Vulture Minign Co, Wickenburg,Ariz. | 5/1/44<br>May 44<br>2/45 | Milling<br>Not milling<br>Idle |

See: VULTURE MINE (file)

EAST VULTURE

Au

Maricopa 7 - 3 T 6 N, R 6 W

Ernest Dickie, Hillside '44

May 26, 1942

MEMORANDUM EAST VULTURE MINE

A contact was made for J. C. Lincoln who was unable to obtain trucks for hauling 2500 tons of lead ore which he had already mined and could not move.

Arrangements were made with Mr. Hartin of 805 South Central Avenue who had 3 trucks to haul this ore. Mr. Lincoln was advised of the priority steps necessary to take and he succeeded in getting a rating. Was able to get his own truck and is now moving his own ore.

J.S.C.

Wickenburg, Arizona May 26th

Gentlemen:

Would appreciate your sending us a couple of copies of the approved bill re. suspension of assessment work for the duration, together with a half dozen of the approved filing notices of intention to hold claims; also any information as to how to attend to this part of the business.

Very truly,
East Vulture Mining Co
By Ernest L Lockie
President



5/5/42

MEMO TO J. S. COUPAL

J. C. Lincoln, operating the East Vulture and other mines, has about 3,000 tons of 12% lead ore on the dump awaiting shipment and is mining about 25 tons a day. He cannot ship because he has been unable to get trucks. He has a twenty mile haul to the railroad.

He had a serial number but it was taken away on March 2 and he has made no application for reinstatement which he should do at once.

C. F. WILLIS

DEPARTMENT OF MINER. RESOURCES.

News Items

Date July 26, 39

Mine East Vulture Mining Co

Location

Owner

Address Mickenburg, Ariz

Operating Co.

Address Tankage & mechanism near completion

Pres. Precipitation Unit

Genl. Mgr. Installed.

Mine Supt.

Mill Supt. Plant indicates

Principal Metals completion in

Men Employed 30 day's

Production Rate

Mill, Type & Capacity

Power, Amt. & Type

Signed Barth

(Over)

DEPARTMENT OF MINE. RESOURCES.

News Items

Date June 26, 39

Mine East Vulture Mining Co

Location 12 miles West of

Owner Wickenburg,

Address ..

Operating Co. Same

Address Wickenburg

Pres. E. R. Dickie

Genl. Mgr. Same

Mine Supt.

Mill Supt.

Principal Metals Au.

Men Employed 22

Production Rate To be 125 tons

Mill, Type & Capacity Cyanide all sliming

Power, Amt. & Type 240 HP C-P-Bentz Diesel Electric for Mill

Signed Carl G. Burk Jr

(Over)

Present Operations

New Work Planned

Miscl. Notes

Present Operations Bill Coats Jr.

New Work Planned

Mill Dumps 2 Tailings
Power Shovels 2
Trucks.
Drilling for water in

Miscl. Notes Hanging Wall to tap Old works
4x8 Roller Mill
Dorr Duplex Classifier
Denver Duplex Jig
14½ Kennedy Van Saun
Secondary Crusher
5 Denver Dorr Type Thickeners
3 Denver Agitators
Merrill Crowe Precip
Italian Equipment

29 April 1940

News

EAST VULTURE MINING COMPANY

| | | |
|---|---|---|
| Ernest R. Dickie, | President | Wickenburg, Arizona |
| J. C. Lincoln, | Vice President | Scottsdale, Arizona |
| J. N. Hall, | Secretary-Treasurer | Wickenburg, Arizona |

30 men employed - 6 underground, 24 in mill and on surface work.

Development work: At present working on the old Vulture shaft. Now down to the 650 ft. level, and plan to sink to 750 ft. They are drifting for ore on the 600 ft. level and have 3 raises from the 600 ft. level. On the 500 ft. level they have a raise in ore averaging $8.00. Milling 100 tons a day, straight cyaniding mainly, ore coming from the Glory Hole, which is being handled by 1/2 yd. shovel. Some ore from development work.

Have purchased a 300 HP Union Diesel engine from Veta Mine; have also purchased a 4x8 Marcey Ball Mill, which will bring the crushing capacity up to 200 tons per day. Cyanide equipment is OK for handling 200 tons per day.

Estimated that there are several hundred thousand tons of ore above the 100 ft. level which will average from $2.50 to $3.50 per ton.

Present cost for handling ore from 30 cents to 50 cents per ton to put in mill bin.

Last month's operations showed a profit on $2.15 heads.

Have churned drill hole cutting old stopes on the 800 ft. level and have installed turbin pump in the churn drill hole which furnishes necessary mill water. This pump is keeping the water below the 600 ft. level while sinking is going ahead.

The old workings reached a depth of 1550 ft. by step winzes from several levels. The vein dips about 38 deg.

Ernest R. Dickie worked for the UVX in sinking the shaft in 1931; he then took over a lease on the underground workings and shipped to Hayden; continued to work for the Peach interested until 1936 when he took over the Peach lease from the Vulture Mining and Milling Company.

DEPARTMENT OF MINERAL RESOURCES
STATE OF ARIZONA
FIELD ENGINEERS REPORT



East

Mine VOULTURE MILL

Date OCT 14TH 1944

District VULTURE

Engineer A.C.NEBEKER

Subject: VULTURE MILL

The Vulture mine and milling operations are managed by Mr Earnest Dickie. This plant was closed down for a short time due to the gold closing order but a short time ago the company got permission to go ahead with certain restriction placed on the operations.

The mill has now been running three weeks and is really doing a good job with the manpower it has. I was informed that they had only half enough men.

I found all the bosses away, but I talked with a couple of the men on the job, and did walk through the mill and over the surface, and saw things were running pretty ~~s~~smooth.

Report is on file of the operations of this company when it was running full blast, so I will not go into the details.

A C Nebeker

SURVEY OF OPERATING MINES — May 28, 1942

By: J. S. Coupal — EAST VULTURE MINING CO.

East Vulture Mining Company
Ernest R. Dickie, President
J. C. Lincoln, Vice-president
J. N. Hall Secretary and Treasurer

P. O. Box C, Wickenburg, Arizona

Vulture Mine
Located 15 miles S.W. from Wickenburg on the Vulture Road.
Maricopa County.

1941 production all in gold -- $125,000.
Unable to approximate the tonnage due to changes in plant capacity but approximately 200 tons per day.
Complete cyanide mill.
Have jigs which made a heavy iron concentrate, carrying a little lead and some gold, shipped to Magma Smelter.
1942 production at rate of about 200 tons per day.
Have sunk the 550 foot incline shaft another 200 feet to the 750 foot level where they have entered the sulphide zone and are now developing. The ore here shows 10 feet wide, carrying 4% of lead and 1% copper. The production for the past year has come from the oxidized portion of this vein at and near the surface and was mined by power shovel. Employing 18 men.

Moon Anchor Mine.
Early in 1942 a lease and option was taken on this property.
Located 21 miles south of Vulture on the Vulture Road. Have compressor and jack-hammers and are this week moving in the old ½ yard shovel used at Vulture.
The vein is 8 to 10 feet thick and dips at about 10 degrees into the hill and will be stripped and mined.
Have 2000 tons of lead ore out. The ore contains nothing else. Average 10% Pb.
There is a new ramp at the Dixie sliding, near Hassayampa on the S.P. Ry. and the ore will be shipped to El Paso, Texas.
Expect to make 1 car a day as soon as the shovel is in and will then aim to 2 cars a day.
6 men are employed. They have their own truck for hauling.

Lost Spaniard Mine.
Located 16 miles south of Vulture on the Vulture road. This property has been taken under lease and option, shortly after the first of the year.
Have a shaft down 100 feet and drifting and developing and taking out some ore in the course of this work. Shipped 1 car of ore last week to El Paso. The ore ran 16% lead, $5 to $10 in gold and 3 to 4 oz. in silver.
Equipped with hoist, headframe and compressor.
Aim to make one car a week during early development and step up to 3 cars a week as soon as possible.
Employing 4 men on only one shift and would put on two shifts if men were available.

Problems

Early in the work they obtained a serial number rating on priorities. This was on the Vulture mining work and their number was not cancelled when the 30-70 order was issued.

They have applied for bonus payments on new production and I believe have been granted a 0 quota.

Dickie has only two problems which give him concern. They both are on labor. He is unable to get skilled men and has taken to training them. His complaint is that after a 3 or 4 months training the men get partially skilled in some particular line and are then enticed away by a better pay job. He cannot compete with the wages on defense and such other jobs.

The other worry is the growing strength of the unions and how soon he will have union trouble. No trouble is actually in sight but he anticipates it will soon hit small mines.

He stated one instance. He had a bulldozer, idle, and work was being done on some government project near by for an airfield. They asked to borrow his equipment and he so arranged. When the contract was about to be signed, the man in charge called and asked if he was using union men and he said "No" and it was decided that they therefore could not use the bulldozer.

Apart from the lack of labor Dickie says he has no troubles, and is doing his utmost to step up production and hopes the new ore developing in the Vulture will put him in line to add production of essential metals from that working.

J. S. Coupal

29 April 1940

EAST VULTURE MINING COMPANY

| | | |
|---|---|---|
| Ernest R. Dickie, | President | Wickenburg, Arizona |
| J. C. Lincoln, | Vice President | Scottsdale, Arizona |
| J. N. Hall, | Secretary-Treasurer | Wickenburg, Arizona |

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May 28, 1943

Mr. Ernest R. Dickie (decd)
East Vulture Mining Company
Wickenburg, Arizona

Dear Mr. Dickie:

I am enclosing blanks for filing intention to hold mining claims.

You will note that there is space on each blank for naming twelve claims. All that is necessary is to fill in the name of the claim and the book and page where it is recorded and then file the signed paper at the County Recorder's office.

Very truly yours,

J. S. Coupal, Director

JSC:kk
Enclosures

WASHINGTON FUND.

May 28, 1942

By: J. S. Coupal

EAST VULTURE MINING CO.

Talked with Mr. Ernest Dickie, President, at the mine.

Mr. Dickie quite agreed with the need and value of the work.

He is working rather close to his belt on money and says that he does not want to make a definite committment but will try and pay $5.00 a month as I suggested to him.

He came through the same way with the ARMCA fund last year.

He appreciates our work and stated he would contribute from time to time.

J. S. Coupal

Lance

Cases

May 7, 1942

Mr. J. C. Lincoln,
Box 141,
Scottsdale, Arizona

Dear Mr. Lincoln:

You told me Wednesday that you had 3,000 tons of lead ore and were mining 25 tons a day from your East Vulture mine and that you needed to get in touch with a trucker.

Mr. G. E. Hartin, 805 So. Central Avenue, Phoenix has three trucks, 6-ton ore capacity, and is a responsible and reliable contractor. I asked Mr. Hartin to see you.

If you make some deal, please let me know so that we can get it off our list of pending jobs to be done.

Yours very truly,

CHARLES F. WILLIS, Chairman
Board of Governors

CFW:MH