Geologist. Baker Khudeira
ASHGILL AUSTRALIA PTY.LTD
PO Box 700 BRENTFORD SQUARE VIC 3131 AUSTRALIA || E: geology@geologist.com || **M**: + 61 410 963 855

Mahd Ad Dahab Gold Mine

Mahd Ad Dahab Mine is situated at an elevation of 1,060m above sea level in the Western Region of Saudi Arabia the mine located about 380 Km by road North East of Jeddah.

The project consists of an underground mine with a total tunnel development in excess of 47 Km. Mill and Refinery, Power Station with a capacity of 10 M Watts, Water Treatment Plant, Maintenance Workshop and Stores.

There is a Township and General Camp on the project for all employees. The Project provides meals, recreation such as swimming, tennis, squash, badminton, volleyball, basketball, football, gym and in addition a playground, a library, bakery, laundry, and a clinic for routine medical care and emergency cases.

Location map of Mahd Ad Dahab Gold Mine

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HISTORY
There is a long history of mining at the deposit, which can be divided into four main periods:

1). **961 - 922 BC**
An extensive ancient mine was in operation, using probably tens of thousands of people in forced labor.

The site is reputed to be King Solomon's Mine, and certainly had the mineral wealth available to be one of the main, and possibly, the main producer during his reign.

2). **750 - 1250 AD**
A second period of ancient mining took place during the Abbasid Caliphate.
The ancients were able to extract the oxidized ore near surface, but had to stop at the base of the weathered zone.
They treated their ore by breaking, crushing and grinding on surface, using hammers first, and then heavy grinding wheels made from local basalt. Many fragments of these wheels are seen around the northern end of the mountain, and occasionally an intact one is found.
After grinding, the ore would have been smelted in small hilltop furnaces.
From the volume of ancient workings, it is estimated that around 30 t of Au were produced.

3). **1939 - 1954**
The deposit was rediscovered in 1932 by K.S. Twitchell.

The Saudi Arabian Mining Syndicate (SAMS) (a joint venture between the Government of Saudi Arabia and the American Smelting and Refining Company) started production in 1939, treating at first manly the ancient tailings.

SAMS produced 22 tons of Gold and 28 tons of Silver.

The workings are now flooded, but extensive exploration, drilling and development work is underway to access them from the present mine, as there are significant potential reserves.

4). **THE PRESENT MINE**
During the early 1970's a program of exploration identified a new ore body about 1/2 Km south of the old workings.

According to the feasibility study completed in 1983, the ore reserve of this new area, which is now the present workings, was estimated to be 1,200,000 tons grading 26.0 g/t Au.

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Geology

This is an Epithermal, Low Sulphidation, Adularia type, Polymetallic Deposit, the total production of which, including that by the Ancients, has been estimated at over 100 tons of Gold (Doebrich et al., 1999). The reserves before the last stage of exploitation were around 1.2 Mt at 24 g/t Au, 92 g/t Ag, 0.65% Cu and 3.11% Zn.

Systematic rock geochemistry over a 50 m x 50 m grid discovered new reserves (Roberts et al., 1978) in the meta-volcanic rocks hosting the old workings in rich Quartz Veins.

The Polymetallic mineralization of Chalcopyrite, Sphalerite, Galena, Gold and Silver tellurides, and rare electrum occurs in a dense vein network. The veins were filled in successive stages, are ribboned, and contain cockade breccias that cut felsic agglomerate and crystal tuffites. The mineralization is older than 709Ma, the age of the intersecting dikes (Huckerby et al., 1983).

Mahd Ad Dhahab Location – Arabian Shield

Zinc grades increase to the North and at depth. But Au grades decrease commensurately. In Nov 1999, the remaining 0.65 Mt were estimated to contain 12 g/t Au and 3.11% Zn. Four successive alteration stages are observed: early alteration with Quartz, Sericite, Pyrite, an intermediate stage with Chlorite, Sericite, Microcline, Sphalerite, Pyrite; the Gold bearing stage with Quartz, Chlorite, Sphalerite, Galena, Pyrite, Gold, Tellurides, and accessory Siderite-Calcite-Hematite and a final stage with Quartz, Calcite, and Barite. Minor (apparently) Gold indications are known from near Mahd adh Dhahab, as Lahuf.

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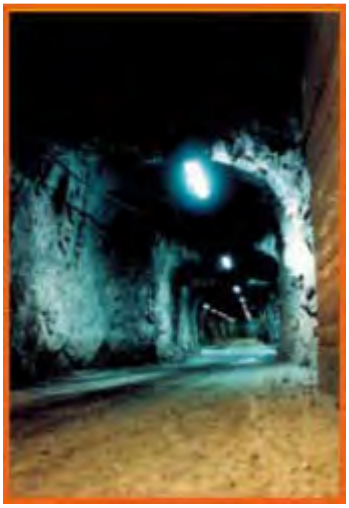
Commercial production commenced in mid 1988
Along with production activities at Mahd Ad Dahab Mine, management has also initiated an exploration program to search for new mineral deposits in the concession areas. Results to date have been extremely successful and have resulted in a doubling of the initial ore reserves thus prolonging the mine's life and resulting in a reduction of unit capital costs.

Over 47.5Km of tunneling have been mined and 2,731,000 tons of ore at an average grade of 21.89 g/t Gold have been extracted from underground since start up.
Total waste rock mined to date is 946,444 tons. About 216.5 Km of exploration diamond drilling to prove more in-situ reserves has been completed.

OPEN PIT
To encourage the Saudi private sector, the management awarded an open pit project to a Saudi private company under guidance from H.E. the Minister of Petroleum and Mineral Resources in 1992. This involved drilling, blasting and excavation of the ore from the pit. 158,000 tons of ore were extracted at a Gold grade of 50 g/t.

This high grade made Madh Ad Dahab open pit the richest mine (for its size) in the world (Gold quantity = 8 t and Silver = 25 t).


Adit at Mahd Ad Dhahab Mine

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MINING OPERATIONS

The Mine is accessed by a 1 in 9 decline to five main levels, the deepest being 190 meters below the general desert surface. A sixth main level is entered via a mountainside adit.

The Mine is trackless, the ore is loaded, hauled and dumped by the use of diesel-powered equipment.

Most development and stope drilling is by the use of rubber tired electro-hydraulic drills rigs. Rock is fractured by the use of modern explosives and detonators.

One of the most significant gold mines in the Kingdom is Mahd Ad Dhahab. Commercial production at this mine started in 1988.

Ma'aden holds the mining license for Mahd Ad-Dhahab.

According to Ma'aden, to date, over 47.5km of tunneling have been mined, and 2.7 million tons of ore been extracted from Mahd Ad-Dhahab at an average grade of 21.89 g/t Gold.

Two methods for the extraction of the ore are presently in use, Sub Level Open Stopping and Mechanized Cut and Fill:

a) Sub Level open stopping is used where veins are generally less than 2m wide. With this method small tunnels are driven along the vein between near vertical raises mined on dip.

The ore is drilled from each sub-level and blasted in vertical slices that fall to the bottom level where loading takes place.

b) Cut and Fill stopping is used in the wider Ore Bodies, which may be up to 30m wide. Horizontal slices of 2.5 - 3m thickness were mined.

Cut and Fill accounts for approximately 80 percent of underground production.

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ORE PROCESSING (PROCESS CYCLE)

Ore is loaded from underground direct to the crusher where it is crushed in three stages to 10 mm in size. The crushed ore is conveyed to a blending stockpile. The blended ore is reclaimed and ball milled at a rate of 24.5 wet t/h to 72% passing 75 micron size.

Chemicals are added to the ground slurry to condition it for the flotation stage.

The ore slurry is passed into flotation cells. The resultant froth (concentrate) formed in this process floats to the top of the cell.

The froth is removed and dried to form the saleable concentrate product. The concentrate grading approximately 150 g/t Gold, 1,500 g/t Silver, 19% Copper, 12% Zinc.

The slurry remaining after flotation (flotation tailings) passes to the leach section where cyanide is added to dissolve the remaining Gold and Silver. From there, the slurry is pumped to the carbon adsorption section where carbon granules are added and precious metals adsorbed from solution onto the granules. The carbon granules are separated from the slurry and given a hot caustic cyanide wash to remove the Gold and Silver back into solution. This solution is sent to the electrolytic section where, after passing an electric current through the solution, Silver and Gold are electro deposited on stainless steel sheets.

Exploration perspectives

This district has a high potential for various types of mineralization. Epithermal, volcano-sedimentary, and porphyry occurrences merit a systematic geochemical coverage with the aim of finding other mineralized structures, in particular near interruptions in the volcanic activity.

The last are indicated by the presence of Breccia, Epiclastic Rock, and Black Shale.
Other areas of potential interest are around Rhyolite Domes and sub-volcanic micro-granites.

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STUDY AND RESEARCH

Metallurgical research is essential to providing plant design criteria and information for feasibility studies. Current metallurgical research activities at Mahd Ad Dahab Mine include:

a) Plant scale test on Al-Amar ore to provide design criteria for Al-Amar Au Mine.
b) Flotation test work on the existing plant operations to optimize conditions and set guidelines for future projects.
c) Metallurgical test work optimizing the Gold leach circuit of present and future projects.

Aerial view of the Mahd ad Dhahab Gold mine

Artisans in Mesopotamia and Palestine probably obtained their supplies from Egypt and Arabia. Recent studies of the Mahd Adh Dhahab (meaning "Cradle of Gold") mine in the present Kingdom of Saudi Arabia reveal that gold, silver, and copper were recovered from this region during the reign of King Solomon (961-922 B.C.).

An air view of the Mahd ad Dhahab Gold Mine in Saudi Arabia. Swarms of Gold bearing Quartz Veins (seen as long irregular trenches at a) have been mined for Gold and Silver for more than 3,000 years.

Some of the veins have been followed downward to depths as much as 300 feet. Similar quartz veins lace the hill to the right (b), but these veins are not rich enough to mine, Geological Survey using the Carbon 14 dating method.

Some of the charcoal is as much as 3,000 years old indicating that the mine was active during the reign of King Solomon.