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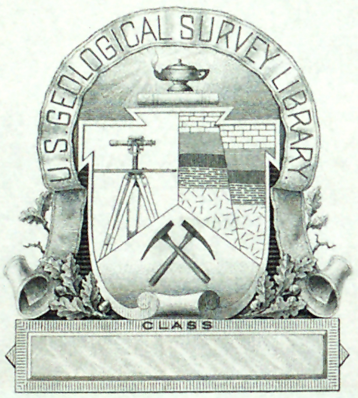
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Saudi Arabia Investigation Report
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A GEOLOGIC AND MINERAL RECONNAISSANCE BY HELICOPTER IN A PART OF THE TIHAMAT ASH SHAM QUADRANGLE, SAUDI ARABIA

by

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U. S. Geological Survey

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1. Mineral investigations in the Al Aqiq area, Saudi Arabia, by Virgil A. Trent. 4 p.

2. A geologic and mineral reconnaissance by helicopter in a part of the Tihamat Ash Sham quadrangle, Saudi Arabia, by Virgil A. Trent. 10 p.

3. Section of the Fatima Formation near Bahrah, Saudi Arabia, by Richard Goldsmith. 6 p., 1 fig., 1 table.

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4. Tectonic map of the central and southern Appalachians, by John C. Reed, Jr. 1 map, scale 1:2,500,000.

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PREFACE

In 1963, in response to a request from the Ministry of Petroleum and Mineral Resources, the Saudi Arabian Government and the U. S. Geological Survey, U. S. Department of the Interior, with the approval of the U. S. Department of State, undertook a joint and cooperative effort to map and evaluate the mineral potential of central and western Saudi Arabia. The results of this program are being released in USGS open files in the United States and are also available in the Library of the Ministry of Petroleum and Mineral Resources. Also on open file in that office is a large amount of material, in the form of unpublished manuscripts, maps, field notes, drill logs, annotated aerial photographs, etc., that has resulted from other previous geologic work by Saudi Arabian government agencies. The Government of Saudi Arabia makes this information available to interested persons, and has set up a liberal mining code which is included in "Mineral Resources of Saudi Arabia, a Guide for Investment and Development," published in 1965 as Bulletin 1 of the Ministry of Petroleum and Mineral Resources, Directorate General of Mineral Resources, Jiddah, Saudi Arabia.

UNITED STATES
DEPARTMENT OF THE INTERIOR
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Saudi Arabian Mineral
Exploration - 30

A GEOLOGIC AND MINERAL RECONNAISSANCE BY HELICOPTER IN A PART OF THE TIHAMAT ASH SHAM QUADRANGLE, SAUDI ARABIA

by

Virgil A. Trent

Introduction

This report is a summary of field operations in the plateau portion of the Tihamat Ash Sham Quadrangle from June 14 to August 21, 1965. Our task was to survey approximately 1100 sq. miles for mineral deposits in a short period of time. Much of the area, being mountainous, is inaccessible to motor vehicles. Under such conditions helicopters are particularly useful in expediting the work. The primary goals were to scout the area for signs of mining, gossan, and alteration zones; collect samples for a geochemical survey; and map the geology as closely as possible using the geologic map prepared by Brown and Jackson (1958) as a guide. In addition, W. E. Davis and Rex Allen ran concurrent geophysical surveys at some of the ancient mines and near favorable structures where copper mineralization was found.

During our work we met many people, both villagers and Bedouin, and we inquired about mines, mineral occurrences, and smelter sites and we followed up many leads. In this sort of investigation caution is necessary because the tip may be misleading.

Mineral investigations

Al Muckahal (3-216-6100).

During the first three days Dr. Brown and I worked together examining the rocks in and around an ancient silver-lead mine (Al Muckahal) which is located on the Tihama 65 KM. east of Qunfidhah at 19°17'N. Lat. and 41°41'E. Long. It is the subject

of a technical letter written by Dr. Brown to H. E. Sheikh Abdullah Sulaiman, Minister of Finance July 21, 1954.

A quartz stockwork vein system in beds of marble (interbedded with quartzite) contains argentiferous galena. One sample assayed by Mr. Dan F. Schaffner contained 17 ounces of silver per ton. One of the samples Dr. Brown collected from a prospect pit assayed 17.5 ounces of silver per ton. The sample was taken from a 2 to 4 inch parting filled with black earthy material which he believes contains argentiferous galena or argentite-finely divided. There are several caved openings in a fault valley near the ancient mine. A stockwork system of quartz veins generally strikes north-south and many are either vertical or dipping steeply to the west. In these openings galena and malachite occur along east-west vertical and horizontal joints. They do not appear to be as extensive as the Muckahal mine workings. The main opening here is 100 feet long with several narrow stringers stoped (see Technical Letter by Dan F. Schaffner titled Al Muckahal September 1956).

Some additional detailed field work will be worthwhile and has been recommended by Dr. Brown. Samples now being analyzed in the laboratory will provide guide lines for planning the work. The structure is very complex in this area and should be worked out. A detailed geologic and geochemical survey of this area (1:12,500) could be completed by a two-man mapping team with helicopters in two to three weeks.

Abu Bier

The Abu Bier mine is located at 19°52'N. Lat. 41°48'E. Long. (25 Km east of Biljurshi). It has been examined in the field, previously, by Dr. Kahr and located on his preliminary map of the area. Two sheared quartz veins, roughly striking parallel and 100 yards apart have been "deep mined" and prospected up the side of the mountain. The country rocks are meta-volcanic rocks (rhyolite, dacite and andesite) cut by a mafic dike swarm. The veins are variable in width from 0.1 to 1.0 meter; at the main shafts they are 1 meter wide. The upper quartz vein and shaft is between 50 and 80 meters deep along 20 meters of vein - 1 meter wide. It has been prospected by trenching higher up the hill and a small quantity of galena and secondary copper are in the quartz. The lower vein has been prospected

and mined for 150 yards (from 1/2 to 1 meter wide) to a depth of about 50 meters. The quartz veins have been introduced along a secondary fault system. No slag piles or grinding stones were found in the area and the amount of copper mineralization seen in the quartz veins or wallrock does not account for the amount of rock mined. Analysis of vein quartz material from the lower shaft submitted by J. W. Mytton to Mr. Matouq assayed 7.5 ounces of Ag/ton with a trace of gold so this may have been an ancient silver-lead (?) mine.

There are additional sample results to consider before recommending further work on this prospect. Some of the spectrographic analyses of wadi sand material are disappointing for this area. It would seem profitable to run a geophysical check here; however, the country is very rugged.

We will not make any further recommendations about Abu Bier until we have the analyses of our samples collected in this area.

Wadi Tha.

Several old adits and small pits near the top of a gossan hill at 19°56'N. Lat. and 42°01'E. Long. were studied and sampled. Dr. Brown and I collected hand samples for trace element and wet chemical analysis here on June 17. C. L. Hummel who had worked in this area last summer sent his wadi sand, heavy mineral and jasper trace element analyses for three samples. Later, I did some additional mapping and sampling in conjunction with W. E. Davis and Rex Allen, who ran an EM geophysical survey over the prospect.

There was a village near the top of the hill with slag piles close by. The top of the hill is a black ridge-forming clinker-like rock, bearing N.10°E., along which some trenches and pits were dug in a sheared, narrow veinlet system of chrysocolla, malachite and melonite (?). The clinker rock is vuggy, siliceous, has a fired appearance and usually is associated with jasper quartz. It has been oxidized locally to ocherous limonite and hematite. The mine openings are small adits up the side of the hill in another fracture striking N.50°E. with veinlets containing copper carbonates, chrysocolla and possibly smithsonite. The largest prospect is an adit 18 meters into the hill, 3 meters wide and 2 meters high. Aplite is being replaced by a boxwork structure of iron oxide within which crystals of malachite

occur. The mineralization is along a thin shear zone in the rock. Just north of the lowest prospect pit, there are remains of 3 or 4 buildings or hearths with slag piles and outcrops of silicified carbonate nearby. These pods of meta-carbonate are common to a series of mine prospects farther south in this area. In addition, jasper and chalcedony are abundant and closely associated with the copper mineralization and the carbonate. The country rocks are metamorphosed andesite and andesite porphyry.

Wadi Tha' seems to be part of a fault system which strikes generally N.45°W. and provides the structural control for a series of wadis that are tributaries to Wadi Taballah.

I believe this prospect is the same type as those farther south, because the mineralization, host, and associated rocks are all similar. The texture of the clinker rocks and the closely associated jasper seem to indicate a high temperature origin for this mineralization. The associated carbonate is a puzzle, but I believe it is also high temperature vein carbonate rather than sedimentary carbonate.

W. E. Davis and Rex Allen ran an EM geophysical survey over several points in the area and their data did not indicate the presence of anomalous conductors. Until I have some sample analyses submitted from this locality there is no basis for recommending additional work at Wadi Tha'. Spectrograph and wet chemical analyses of wadi sand and heavy mineral samples collected by C. L. Hummel are above background for Cu, Pb and Zn.

It is recommended that if more work is scheduled for this area that it be done as a part of the work on the series of mines farther south discussed next.

Esh Kamp and Al Wacaban ancient mine locality.

Along the eastern border of quadrangle I-216 from 19°45'N. Lat. to 20°00'N. Lat. and near 41°58'E. Long. there is a series of ancient mines and prospects found in volcanic country rocks. The names according to a local Bedouin guide are, from north to south Al Wacaban, El Kuthain, Esh Kamp, Shaib esh Saut and Wahadid. All the mines were for copper and are similar in mineralogy and geologic occurrence.

Chrysocolla, malachite, azurite and possibly some chalcocite are the main minerals occuring along shear zones. These minerals are usually associated with pods of meta-carbonate and jasper quartz. Some of the locations may have been shaft mined, as Esh Kamp and Al Wacaban, where villages and large slag piles are found.

The largest appears to be Al Wacaban at 19°55'N. Lat. and 41°59'E. Long. There are 3 pits about 12 feet deep and 20 feet square in this shear zone. Chlorite-sericite schist striking N.10°E. is the west boundary and there is a grano-diorite plug 3 Km southwest. There is a caved winze or shaft in one pit where most of the ore was extracted. As at the other locations, samples were collected for wet chemical and trace element analysis.

At the southern pit mine just northeast of Demah several small diggings were found along and slightly above the wadi. Small slag piles were found nearby, apparently left from smelting for copper. Lenses and pods of carbonate crop out close to the mined veinlet material. Wadi and rock samples were collected for analysis. W. E. Davis and Rex Allen did not identify anomalies here during an EM geophysical survey.

The Esh Kamp mine located at 19°51'N. Lat. and 41°58'E. Long was a copper mine having a village, slag piles and the same type of occurrence - mineralized shear zone with associated meta-carbonate rocks and jasper quartz. There is a caved opening at the bottom of one pit which is probably a shaft.

There are a whole series of pits and prospects in this general area. All are of the same type.

There is no field evidence that the mineralization in these mines and prospects is associated with the intrusive granodiorite plug southeast of the Al Wacaban mine. This intrusive mass has a system of young faults cutting across it bearing northeast-southwest which we scouted and sampled near their junctions with Wadi Taballah. The intersections of these young faults with older north-south major faults further west were sampled and scouted. The geophysical surveys run at several of these locations were negative.

It will be necessary to have sample results before considering more work in this area. I have discussed this area with J. W. Mytton and we believe that a two-man team could detail sample and map the geology (1:12,500) in a block 6 Km wide and 18 Km long in 2-3 weeks.

Geologic notes

Ancient mine.

Near the northeast corner of the map there is an ancient copper mine with slag piles along a major north-south fault in schist. The mine consists of a trench 10 meters long, 1 meter wide and 2 meters deep, with slag piles located 75 meters south. Copper mineralization is in jasper and in thin veinlets in the schist. Clinker-rock borders isolated masses of jasper and is silicified. This mine is different only in that it may be controlled by one of the older north-south faults and is found in schist. Samples where collected here for trace analysis.

Prospect(?).

About 7 Km SSW of Abu Bier an opening 15m. long and 15m. deep is located in granitic dike rock. No mineralization was found here to explain the pit. It may be a prospect. A sample was collected for trace analysis.

Shaqiq slag.

North of our Bashutah camp 10 Km there are several large slag piles near the village of Shaqiq. Two faults intersect nearby, and J. W. Mytton found a small bit of copper mineralization in a wadi. There are no signs of caved or accessible openings and the local people have no idea about the location of the source rock. The slag piles apparently considerably pre-dates the village. The source rock probably came from close-by.

Gossan on hilltops.

Dr. Brown requested that I inspect the gossan on the hilltops north of Bashutah. All that I recognized was a purple weathering product which may or may not have been a gossan.

Dr. Kahr's map.

We checked on the copper mineralization on Wadi Ranya located on Dr. Kahr's map and I believe a north-south fault runs through this section. Rex Allen ran a EM geophysical survey over the bottom of the wadi but the results were negative.

Wadi Fig.

Although Wadi Fig is a prominent fault valley no mineralization was observed in or near it. I did not locate Dr. Kahr's copper occurrence on Wadi Fig but he directed Rex Allen to it. Allen picked up a small anomaly - the first for the area.

Iron Formation.

On the east side of the Tertiary lava flow at 19°43'N. Lat. and 48°58'E. Long. a thin bedded, weakly magnetic black rock crops out with variable strike and a vertical dip. The rock has a dark siliceous ground-mass. I believe it is a large remnant of meta-sedimentary iron formation isolated in the older "gg" granite. The rock has been mineralized by younger acid dikes which cut it. Just below the main outcrop there is a prospect pit in fractured quartzite where chrysocolla and malachite occur in veinlets and along fractures. These sedimentary beds probably have been drag folded. A sample was collected for wet chemical and trace analysis.

Thurayban slag piles.

Several small slag piles were pointed out to us by local people near Thurayban along the bottom of the scarp. No one knows the source material for these smelting spots but believe the rock must come from the volcanic rock sections exposed in the scarp face. The smelting was for copper.

Biljurshi granite.

The Biljurshi hornblende-biotite granite is the predominent rock in that area. It is being quarried in several localities for building stone. The granite would be a good ornamental stone. At Jabal Hozna southwest of Biljurshi a sample of the granite was collected for age determination.

Jabal Athrub.

Jabal Athrub is the most impressive mountain in the area. Located south of Gizzana it is being quarried for building stone and would also be a very attractive polished stone. A sample of this red, alkalic granite was taken for age determination.

Ablah Formation.

J. W. Mytton and I flew north to the Ablah Formation section and traced it south into Quadrangle I-216. It continues south off the scarp and down through the coastal plain.

Kamdan aeromagnetic anomaly.

We checked the aeromagnetic anomaly northeast of Bani Sar and found it to be due to a large mass of amphibolite. The rock registered on the magnetometer more than enough to account for the 600 gamma anomaly.

Sample types

The primary sample type collected was wadi sand concentrate screened to -30 +80 size fraction. A total of 137 were taken. At each locality where a wadi sand sample was collected a separate magnetite sample was taken, if available; at some places only magnetite was collected. A total of 145 magnetite samples were obtained. In addition 25 heavy mineral samples were panned from bulk wadi sand. Most of these were collected from major wadis draining the scarp and which may be too inaccessible to get to by car. Fifty-five specimens of rocks were taken for spectrographic and wet chemical analysis. Most of these are gossan, mine, jasper, and slag samples; twelve are granitic rocks for age determination.

The sample results will provide the data for compilation of a geochemical map indicating locations of anomalous quantities of Cu, Pb and Zn if present.

The average time per sample stop is estimated to be 25 minutes. This includes checking the rocks as well as taking the sample.

Operating procedure

The helicopters used in this survey are identical Bell Model 47G's, 3 passenger with a 270 H.P. Lycoming engine that is super-charged to operate up to altitudes

as high as 20,000 feet. The fuel capacity is 57 gallons of 100/130 octane aviation gasoline, which is just short of 3 hours cruising range at about 20 gallons per hour consumption.

If the weather conditions are variable with gusty winds and the work is in rugged country the pilot may prefer to have only one passenger. The added weight of a second passenger may require drawing maximum manifold pressure past the red warning line on instrument in order to take off and gain altitude. One geologist covering an area on a reconnaissance basis will see more, have greater mobility in the cabin with maps and photos, burn less gasoline and cover more ground per trip if he is the only passenger. However, if a detailed net of samples and geology is required in an area two geologists can use the leap-frog method of sampling and checking geology which makes more economical use of the helicopter.

Major maintenance checks are every 100 hours and an engine overhaul at 600 hours.

References

Brown, G. F., and Jackson, R. O., 1958, Geologic map of the Tihamat Ash Sham quadrangle, Kingdom of Saudi Arabia: U. S. Geol. Survey Misc. Geol. Inv. Map I-216A.

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