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UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

Technical Letter  
Saudi Arabian Mineral  
Exploration - 6  
Prepared May 15, 1964  
Issued August 15, 1965

Dr. Fadil K. Kabbani  
Deputy Minister for Mineral Resources  
Directorate General for Mineral Resources  
Ministry of Petroleum and Mineral Resources  
Jiddah, Saudi Arabia

Dear Dr. Kabbani:

Transmitted herewith are 10 copies of:

*No coords  
when?*

TECHNICAL LETTER NUMBER 6  
REPORT ON FIELD WORK IN THE MAHD  
ADH DHAHAB AREA, SAUDI ARABIA, FEBRUARY 29 TO  
APRIL 13, 1964

by

Richard Goldsmith\* and Jameel Kouther\*\*

Sincerely,

*Glen F. Brown*  
Glen F. Brown, Chief  
Saudi Arabian Mineral Exploration Project

\* U. S. Geological Survey, Jiddah, Saudi Arabia  
\*\* Directorate General for Mineral Resources, Jiddah, S.A.

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Richard Goldsmith\* and Jameel Kouter\*\*

*Where?*

Objectives:

To undertake geologic mapping in the Mahd adh Dahab and Umm ad Damar - Aquiq area of the Southern Hijaz quadrangle, Saudi Arabia. The area contains the largest gold mine in Arabia and an ancient copper mine currently undergoing exploratory drilling. The area is covered by aeromagnetic and radiometric maps prepared by the Hunting Survey. The purpose of the mapping at Mahd was to determine the geologic setting of the mineral deposits, prepare a geologic base for geochemical sampling, and evaluate the aeromagnetic maps as aids in field mapping. The possibility of there being deposits of placer gold of Tertiary age at Mahd was to be investigated.

The area to be mapped was to conform to the area covered by the Hunting Survey - Aquiq block at 1:50,000. However, it was expected that only an area about the equivalent of one 1:50,000 mosaic about 1300 km., would be mapped encompassing the Mahd and Umm ad Damar - Aquiq mines.

Work done:

Mapping was by vehicle and foot traverse using 1:60,000 photos and transferring data to 1:50,000 mosaics. Few wadi samples were taken as this was to be left until after advice from P. Theobald, geochemist. On March 15, Theobald arrived and began sampling in the newly discovered Umm ad Damar-Lahuf ancient mine and at Mahd.

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About 300 km<sup>2</sup> were mapped in 23 days of actual ground coverage. An equivalent of one or two days of this time was consumed in investigating small ancient mines and prospects reported by local people and in advising them about their water supplies. On Mar. 14 a reconnaissance trip was made to Jabal Hadb. On Mar. 23 a reconnaissance trip west and southwest of the area was made to investigate an ancient mine near Jabal Rayan reported by a local person. On Mar. 30, 31, and April 1, a reconnaissance trip was made to the area west of Wadi Umq, the rtp at Jabal Thatarakum, Jabal Rokham, and return through Umm ad Damar-Aqiq. April 11 to 13 was spent travelling from Mahd to Jiddah via the old SAMS road from Al Birkah through Madrasah to Jiddah to check on possible clay and iron deposits. Most Sundays were spent in compilation or reconnoitering in the Sufaynah area while picking up water.

Summary of Results:

Mahd adh Dhahab area:

Southeast and south of Mahd is a plutonic complex containing rocks ranging from granite to diorite and laced with dikes ranging from andesite to felsite. Some of the plutonic rocks appear to be younger than others on the basis of degree of deformation and contact relationships. Some of the rocks of the complex are foliated, particularly to the northwest near the fault contact with the Haliban Formation and show evidence of penetrative deformation and recrystallization not shown by the overlying rocks.

The extensive area shown as Haliban and Fatima Formations on the map overlies the older plutonic complex and represents a sedimentary and volcanic pile in which a clastic sequence, and pyroclastic largely of volcanic debris is intruded by dikes, sills, stocks, and laccoliths of andesite to rhyolite. Numerous disconformities are present. The whole sequence appears to be tilted toward the north so that the younger sediments are in general in that direction.

The whole sequence can be roughly divided into two parts; the lower contains dark volcanic wackes, argillites, chert, tuff, to minor sandstone,

calcareous sandstone and conglomerate as well as much andesite, andesitic and felsitic agglomerate, and felsite; the upper sequence consists of coarse pyroclastics and conglomerate and subordinate siltstone and sandstone. Dikes, sills, laccoliths and plugs are much less abundant than in the lower part of the section and are either of andesite or red felsite. The lower sequence, well displayed in the Mahad adh Dhahab area, is tentatively called the Mahad adh Dhahab from exposures northeast of Mahd around Jabal Al Mogiah. The boundary between the two sequences is clear in places, but obscure elsewhere and may represent merely a general change from fine-grained sediments with much intrusive volcanics to coarser sediments with less volcanics. The Mogiah sequence represents a higher and younger level or perhaps the outer flank of the volcanic pile where there was less intrusive volcanism, but a thick accumulation of clastic debris derived from the center. The Mogiah sequence is much less intruded by dikes hypabyssal bodies than the Mahd sequence and in general is flatter lying than the Mahd sequence.

Some of the conglomerates low in the Mogiah sequence contain pebbles and cobbles of granite and of green andesite and gray and tan porphyritic felsite dikes that cut the granite and the Mahd sequence. The dikes in the granite complex to the southeast are apparently feeders for the intrusive rocks in the Haliban. On the basis of the stratigraphic relations in the Haliban to the dikes and other intrusives, they can be divided into an older and younger set. The older include andesite, gray and tan porphyritic felsite dikes, and intrusive (?) felsitic agglomerates. The younger plutonic rocks in the Haliban include andesite and red felsite plugs and laccoliths.

Identification of any part of the sequences at Mahd as Fatima will have to wait until the Fatima is seen elsewhere.

#### Structure :

Evidence from primary structures in the sediments of the Haliban shows that the rocks are right side up. The dips are generally northward, although southward dips, locally steep, seen in a few areas indicate some folding.

The Mogiah sequence, as mentioned above, is more gently dipping than the Mahd. Irregularities in attitudes are caused both by intrusive bodies and by drage along faults. Complex folding in the Mahd sequence is present at Mahad adh Dhahab and northeast of Mahd. This seems to be related mainly to faulting. The Mogiah sequence is much less folded.

A northeast-trending fault system that focuses on Mahd is apparent in the area northeast of Mahd. A major fault lying along Wadi Ghediera and Shaib Ben Agoshia separates from the plutonic complex to the southeast. The Mogiah sequence lies in a complex graben with the Mahd sequence brought up on the northwest side, and along which the Mahd and Mogiah sequences in turn strike into the plutonic complex. The northeast trending faults are present in the area north of Mahad adh Dhahab also but are less well displayed. Faults of northwest trend are subordinate and of minor displacement although northwest-trending joints are common.

The Wadi Ghediera fault seems to have had a more complex history than the faults to the northwest. Brecciation and silicification occur along it east of Mahd and locally thin zones of mylonite and a partially recrystallized pervasive cataclastic foliation can be seen in the granitic rocks near the fault. The mylonite and foliated rocks are cut by discrete fractures with some development of epidote along fracture planes. The cataclastic foliation was not seen in the rocks east of the fault. The faults in the Haliban show only localized crushing with minor epidotization or development of quartz or more commonly, carbonate veins.

#### Metamorphism:

In the Mahd area the grade of metamorphism is low and rocks are hardly more than hornfelsed. The Mogiah sequence is less recrystallized than the Mahd sequence. Locally toward Wadi Aquiq, the rocks begin to develop a slaty cleavage. At Umm ad Damar-Aqiq, this was more sidespread. In the Haliban north of Wadi Aquiq, and north of Jabal Sayid Aswab, the rocks are generally metamorphosed with extensive development of slaty cleavage and with some development of small porphyroblasts.

### Mineralization:

Centers of mineralization in the area mapped to date are located at Mahad adh Ihahab and at Umm ad Damar - Lahuf, eight kilometers southeast of Mahd. Gold mineralization is in brecciated quartz veins in the two localities, however copper mineralization is much more widespread and except in the Mahd mine, the copper is in the form of carbonate rather than sulfides. Both Mahd and Lahuf were sampled by Theobald and extensive anomalies for copper, zinc, and a minor anomaly in molybdenum were found. The quartz veins in the Lahuf area strike north to northwest but the mineralization trends northeast across the strike of the veins. Most of the mineralization occurs where veins cut andesitic and felsic intrusive rocks. The weak molybdenum anomaly occurs at the boundary between intrusive rocks and overlying sediments and tuffs. At Mahd mineralization is in north-south trending quartz veins cutting felsic agglomerate and andesitic rocks. Again the molybdenum anomaly occurs at the base of the sediments. The southwest and northeast limits of the anomalies are not yet reached by Theobald in his sampling. According to Theobald, the deposit at Lahuf appears to be marginal. The deposit at Mahd might have values in copper if worked for other minerals also.

In the area north of Mahd traces of malachite were observed in rare thin quartz veins, quartz carbonate veins, and carbonate veins cutting the Haliban, and in small shears and fault zones, and locally in altered zones with no visible evidence for fractures. The copper mineralization in this area is slight and it is most likely that the copper was derived from the andesitic country rocks and concentrated by migrating solutions in structurally favorable environments. Brecciated quartz veins of the Mahad and Lahuf type are rarely present north of these mines. Scattered outcrops of brecciated quartz showing slight copper mineralization occur near the Ghedeira fault east of Mahd.

Scattered leached zones some of which are associated with brecciated felsite plugs are present north of Mahd but these have no visible mineralization. They have not yet been sampled geochemically.

Reconnaissance trip to Jebel Hadb:

The day was spent mostly in traversing across the gd and dg units southeast of Mahd. Most of area shown as gd here should be perhaps dg. or gg. Haliban type rocks overlie this complex on the east side. Little time was spent at Hadb. Soil samples and specimens for age determinations were collected. A sample of galena was taken from a pegmatitic pocket near the west side of the body. Two other samples were collected for Rb/Sr whole rock isochron work and one more is needed, but a sufficiently fresh sample could not be obtained. Another trip will be made back here for further collection. Mineral composition of rock is different from that at Jabal Sayid.

Reconnaissance trip to Wadi Aquiq, Jabal Sayid, Wadi Umq, Jabal Pokham:

- a) RTP NW of Wadi Jurashayah proved to be a breccia dike cutting sediments of the Moglah type.
- b) Shammar NE of fault on west side of Jabal Sayid Aswab looked like Haliban of the Mahd area: largely green wackes (breccia and conglomerate) and green andesitic rock with hornblende phenocrysts, minor microdiorite. Not greatly metamorphosed.
- c) Gruss and rock samples were taken at Jabal Sayid and at north and eastern margin of body. Rock mapped as Shammar on west looked again like Haliban, and the gg near Jabal Hadb ash Sharar looked like some of rocks in the unit mapped as gd SE of Mahd.
- d) Haliban SW of Bir Umq is more metamorphosed than elsewhere seen. Rocks similar to clastics in the Mahd area but converted to slate and phyllitic slate with development of porphyroblasts. Intrusive rocks much less abundant than in the Mahd area. The Mg shown on the quadrangle sheet SW of Bir Umq is located on an elongate body at least 10 km long of magnesian (?) marble flanked on the north margin, at least, by serpentine. Small local pockets of asbestos and some talcose rocks were observed. Some magnesite may be present. A felsite locally intruding the marble on the south side takes on the same

weathering characteristics as the marble. A more detailed investigation of this belt of rocks seem to be warranted.

e) RTP at Jabal Thatarakum was sampled.

f) Time available for only a brief look at the magnesite and dolomitic marble at Jabal Fokham.

g) Very late in day, we had a one hour tour of Umm ad Damar - Aqiq. Cleavage better developed than at Mahd. Some discussion of comparison of vein system here with that at Mahd and Lahuf, but time insufficient to get to grips with area.

Reconnaissance trip Mahad adh Ihahab - Jiddah

a) Sampled units along SAMS road. Noted gradational mineral composition of dg unit SE of Sufaynah, grades from quartz monzonite to quartz diorite. Body of gr? N. of Jabal Sukayr was not reached to see whether it is a more granitic phase, or a discrete and younger plutons. The gr pluton SW of Jabal Sukayr is not gradational but appears to be a distinct pluton in sharp contact with the dg. Possibly it is a late discordant pegmatitic phase?

b) Noted lithology of Murdama Formation north of Jabal Umm Chiran. Dips are toward granite to south.

c) Sample at Umm Ghiran unit taken earlier proved to be barren of Cu, Zn, and Moly.

d) Haliban S. of Umm Ghiran (Al Habid) similar to lower part of sequence in Mahd area.

e) On Harrat from Al Birkah to Madnakah noted deep accumulation of soil below layer of rounded to subrounded cobbles and boulders of basalt and grading downward into weathered sed. rock. The boulders on the surface are perhaps air deposited along with ash. In deeper cuts, spheroidally weathered basalt can be seen in various stages of decomposition. Deep dissection at Wadi Hammah shows older less weathered flows. However, near Madrakah, road cuts show one at least of the lower flows was weathered and stream sediment deposited on it before the higher flows were laid down.

f) Investigation of red wash on hill slope beneath lava west of Madrakah proved to be from a thin (one foot) layer of iron stained gravel lying below

a little-weathered basalt flow and above a spheroidally weathered porphyritic basalt which in turn rested on gneiss and soil formed on granite. This is the same relationship observed above near Madrasah. Sample of weathered material on the flow taken.

g) At Barzah looked at some of red beds near town. These were merely iron stained sandstones. One conglomeratic sandstone distinguished by presence of scattered hematite nodules which have locally been concentrated by weathering. Time was insufficient to explore the red beds further from town.

#### Report of ancient mine near Sufaynah:

Local sheikh reported an ancient mine on the Harrat southeast of Sufaynah. An attempt was made to reach the spot but rains forced the expedition to turn back. The locality was pointed out at the farthest point reached and appeared to be a low ridge with three knobs rising above the general level of the Harrat 13 to 15 kms SSW of Sufaynah.

#### Placer gold at Mahad adh Dhahab:

The possibility of finding placer gold near Mahd concentrated during the Tertiary is not considered promising. The Mahd mine lies near the head of two drainage systems and former drainage would seem to have been much the same as at present. Bedrock is near the surface of the Wadis which are merely young shallow channels in extensive pediments. Material derived from Jabal Mahad adh Dhahab and carried down Shaleb Ben Agoshia must have been always spread out on the broad plain formed on the gr unit. It is possible that at some earlier time part of Jabal Mahad may have been drained by the head of Wadi Maaden, i.e. the branch heading northeast of Mahad. Prospecting where the valley of Wadi Maaden narrows north of Bir Maaden might be of some value in proving or disproving this possibility.

#### Comments:

a) Mapping at 1:50,000 was insufficient to best show relation of mineralization to stratigraphy and structure near the mines. A better scale would be 1:20,000 or 1:24,000. The 1:50,000 scale is satisfactory to show the regional relationships.

b) Value of aeromagnetic map - Aeromagnetic map was not useful at scale mapping. Units in the plutonic complex are shown better than in the Haliban. There is a general difference in pattern between the major units, and maps might be useful at 1:500,000. Highs and lows in Haliban so broad that don't conform to geology seen on ground. Late felsite plugs do not show. Individual faults do not show Mahad adh Dhahab mineralized area does not show up well at all. Umm ad Damar - Lahuf was outside the area of the survey. It is possible that more might be obtained from the aeromagnetic map after consultation with a geophysicist.

c) Much could be learned by continued mapping at the same scale toward the Umm ad Damar area in order to catch the swing of structural elements around to northwest near the Wadi Aquiq faults. Reconnaissance indicates that there might be a metamorphic discordance in the Haliban on either side of the Wadi Aquiq faults. The stratigraphy is by no means clear to us as yet, particularly the relation of the Fatima to the Haliban and the Haliban to the Shammar. Investigating these relationships would mean reconnaissance work northwest and west, of the Mahad area, perhaps even west of the Harrat near As Sidr.

d) Investigation of the serpentine and marble in the Wadi Umq area seems warranted.

e) Geochemical sampling needs to be extended away from the centers of mineralization, to determine background in units and delimit anomalies.