

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Technical Letter
Saudi Arabian Mineral
Exploration - 67
June 20, 1966

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:

TECHNICAL LETTER NUMBER 67
MINERAL RECONNAISSANCE OF THE
QAL'AT AS SAWRAH QUADRANGLE,
KINGDOM OF SAUDI ARABIA

by

Robert F. Johnson* and Virgil A. Trent*

Sincerely,

Glen F. Brown

Glen F. Brown, Chief
Saudi Arabian Mineral Exploration Project

* U. S. Geological Survey, Jiddah, Saudi Arabia

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Robert F. Johnson* and Virgil A. Trent*

Contents

	Page
Introduction.....	2
Geology.....	3
Halaban andesite.....	3
Shammar rhyolite' (?).....	4
Intrusive rocks.....	4
Paleozoic and younger rocks.....	5
Structure.....	5
Economic geology.....	5
Geochemical reconnaissance.....	6
Recommendations.....	7
References.....	8

Illustrations

- Fig. 1 Index map of Arabian Peninsula showing location of quadrangle..In pocket
- Fig. 2 Geology of the Qal'at as Sawrah quadrangle.....In pocket

* U. S. Geological Survey, Jiddah, Saudi Arabia

Introduction

The Qal'at as Sawrah quadrangle is located in the Hijaz, Kingdom of Saudi Arabia, (fig.1) at the edge of the Hisma plateau (Brown, 1960, p. 152; Brown and others, 1963), and includes the heads of several wadis that drain southward into Wadi al Hamd.

The quadrangle was examined under the terms of an agreement between the Saudi Arabia Ministry of Petroleum and Mineral Resources and the United States Geological Survey which provides for a mineral reconnaissance of Western Saudi Arabia. An area with higher than average trace amounts of copper, zinc, and molybdenum was found in the southwest corner of the quadrangle (fig.2). Additional work is recommended to determine the significance of the anomaly.

Access to the area is relatively good. The eastern edge of the quadrangle is about 40 kilometers from the paved highway that extends from Medina to Tayma'. A truck road from the paved highway to Al 'Ula crosses the southern part of the quadrangle. The old abandoned railroad from Medina to Damascus, now being rehabilitated, also crosses the southwest corner of the area.

Much of the area is mountainous, but the larger wadis provide access nearly to the Hisma plateau and one pass permits vehicles to reach the plateau. Most places the sandstone underlying the plateau is bordered by an erosional scarp that is impassable for vehicles.

Previous geological work in the area is limited to a photogeologic compilation prepared by Brown and others (1963). Our work has resulted in changes in some of their contacts and in the revision of some rock names. In the present work we spent 16 man-days in the area looking for evidence of mineral deposits and collecting samples of wadi sediment for trace-element analysis. Aerial photographs were used to plan traverses and to locate features suggestive of mineralized areas for subsequent examination on the ground.

The work was made possible through the cooperation of officials of the Directorate General for Mineral Resources, Ministry of Petroleum and Mineral Resources, who made

arrangements for the trip and provided field assistants and equipment.

Geology

Rocks of Precambrian age underlie about three-fourths of the Qal'at as Sawrah quadrangle. The northern one-fourth is underlain by sandstone of Cambrian age that lies unconformably on the older rocks. Remnants of basalt flows of Tertiary or Quaternary age lie on the Precambrian rocks near the southern border of the quadrangle.

Halaban andesite.

Except for a small area of unmetamorphosed bedded rocks north of Qal'at as Sawrah, metavolcanic and metasedimentary rocks shown as Halaban andesite on the map of Brown and others (1963) are the only layered rocks of Precambrian age in the mapped area. Brown and others (1963) show two areas of Shammar rhyolite (?) and one area of schist on their map. The Shammar rhyolite (?) appears to be felsitic metavolcanic rock interlayered with the more abundant meta-andesite. It is not a younger unit. The schist may be a dominantly metasedimentary portion of the Halaban andesite. With more detailed study the Halaban andesite will undoubtedly be subdivided into several formations.

Slightly metamorphosed flow rocks and pyroclastics of andesitic composition are the most common rock types in the Halaban andesite in the mapped area. The flows are light-to dark-brown or greenish-black in color; the pyroclastic rocks show a reddish-violet tinge. Quartz-carbonate veins with epidote are common in the volcanic rocks. Some flows are amygdaloidal with calcite amygdules. The ferromagnesian minerals in the volcanic rocks are now largely chlorite and the feldspars are clouded, but there is little other evidence of metamorphism except near some intrusions where the rocks have been converted to hornfels.

Volcanic rocks predominate in most of the area underlain by the Halaban andesite and are interlayered with beds of graywacke, conglomerate and, locally, limestone or dolomite. In the northeastern outcrop area south of the sandstone of Cambrian age, phyllite and mica schist derived from rocks of sedimentary origin are the most abundant rocks. Amphibolite schist possibly derived from volcanic rock is a minor

constituent. The reason for the higher metamorphic grade of rocks in the north-eastern part of the quadrangle is not known.

Shammar rhyolite(?)

A small area of unmetamorphosed siltstone, arkosic sandstone, and conglomerate north of Qal'at as Sawrah lies unconformably on the Halaban andesite and is tentatively correlated with the Shammar rhyolite of Brown and others (1963). The northernmost outcrop of these rocks is a hill mapped as late alkalic granite by Brown and others. Close inspection of the hill showed it to be made up of a coarse conglomerate of granite boulders cemented by arkosic sandstone. From the air or from a distance it closely resemble nearby intrusive rocks.

Intrusive rocks.

Plutonic intrusive rocks that range in composition from monzonite or diorite to quartz syenite underlie nearly one half of the area of Precambrian rocks in the Qal'at as Sawrah quadrangle. The granite and quartz syenite are shown with the symbol gr and gu on the map and the more mafic rocks with the symbol dg. A syenitic rock with a distinctive suite of anomalous trace elements north of Qal'at as Sawrah is shown with the symbol gp.

Brown and others (1963) show the granitic rocks of the central and southeastern parts of the quadrangle as late alkalic granite or syenite (gp). Several kinds of granite and quartz syenite crop out in this area, and they are shown on the accompanying map as granite undivided (gu). The southeastern intrusion is a porphyritic hornblende-biotite granite. The adjacent body of granite to the northwest is largely red granite with rare ferromagnesium minerals, with some areas of hornblende granite. The large area of granitic rocks in the west central part of the quadrangle is made up of hornblende granite and quartz syenite. Samples from the southern portion of this granitic area have a trace-element content suggestive of the late alkalic granites with anomalous amounts of lanthanum, niobium, yttrium and zirconium.

Age relations of the intrusive rocks were not determined in detail. All of the intrusions examined show sharp contacts with the Halaban andesite. In places granite dikes occur in the monzonite or diorite indicating that at least some of the

granite is younger. The quartz syenite north of Qal'at as Sawrah probably is part of a later intrusive cycle although direct evidence for this is lacking in the mapped area. The contact of this intrusion with the sedimentary rocks of the Shammar rhyolite (?) is not exposed.

Dikes that range in composition from lamprophyre to rhyolite are common throughout the area underlain by Precambrian rocks. Only the larger dikes are shown on the map. Some of the rhyolitic dikes contain scattered crystals of pyrite but most are not mineralized.

Paleozoic and younger rocks.

The Precambrian rocks in the northern part of the area are overlain unconformably by gently dipping unmetamorphosed reddish sandstone and pebble beds. These rocks are called the Si sandstone by Brown and others (1963) and are reported to be of Cambrian age.

Remnants of basalt flows of Tertiary or Quaternary age occur on the sides of wadis in the southern part of the area. The flows seem to have followed the present drainage and to have come from the north. They may be of local origin as there are no flood basalts to the north from which they could be derived.

Structure.

Northeast- and northwest-striking faults are the most prominent structural features of the area. The quadrangle is nearly bisected by a large northeast-striking fault that can be traced into the Cambrian sandstone indicating post-Precambrian movement. Similar movement is indicated on some northwest-trending faults. Both sets of faults appear to be unmineralized.

Folding in the metasedimentary rocks of the Halaban andesite is well marked with the beds folded on north- to northeast-trending axes. The metavolcanic rocks commonly show steep dips but the direction of folding is not apparent.

Economic geology

Neither evidence of ancient mining activity was found in the area, nor are there reports of ancient workings. Other than a few traces of secondary copper minerals,

we did not see any mineralized areas. Samples from the southwest corner of the area contain anomalous amounts of copper, zinc, and molybdenum and a more detailed study of that area seems warranted.

Geochemical reconnaissance.

In the course of traverses along the major wadis of the quadrangle samples of wadi sediment were collected from tributary wadis that drained faults, granite contacts, altered rocks, or prominent veins and dikes. The samples were screened to a size range of from 0.175 to 0.495 millimeters and were analyzed for their trace-element content of 27 elements by means of emission spectrography in the laboratories of the Directorate General for Mineral Resources in Jiddah. Charles E. Thompson of the U. S. Geological Survey analyzed the samples. Both the samples and a magnetite fraction from them were also analyzed for copper, molybdenum, and zinc by standard wet laboratory procedures. L. Al Dugiather of the Directorate General for Mineral Resources made the analyses.

The sample localities and their copper content are shown by circles on the map. Filled circles indicate samples that contain 20 ppm (parts per million) copper or less, open circles represent samples having from 30 to 70 ppm copper. Samples with anomalous amounts of molybdenum and zinc are shown by squares and triangles respectively, placed adjacent to the sample site. The one sample with anomalous zinc and the highest molybdenum anomaly (10 ppm) occur in the southwest corner of the area. Samples with anomalous amounts of lead are shown by the symbol Pb with the lead content in ppm. All the samples with anomalous lead contain anomalous manganese (1,000 ppm). The anomalies for lead and manganese are from 2 to 3 times the average metal content of the samples.

A sample from the quartz syenite (gp) north of Qal'at as Sawrah and two from the large body of granite 20 kilometers to the northeast contain anomalous amounts of beryllium, lanthanum, niobium, yttrium and zirconium. This suite of elements does not occur in enough abundance to be of commercial interest but may be useful in correlation of the granitic intrusions.

The sample located 8 kilometers northwest of Qal'at as Sawrah contains anomalous amounts of cobalt (70 ppm) and titanium (more than 10,000 ppm) as well as copper (70 ppm), molybdenum (3 ppm) and zinc (300 ppm).

The magnetite fraction of wadi sediment samples in the southwest corner of the quadrangle contain anomalous amounts of zinc, as much as 2,500 ppm in the sample locality 10 kilometers north of Qal'at as Sawrah. The significance of this high zinc content in magnetite is not known but anomalies of this magnitude are, in places, indicative of zinc deposits (oral communication: P. K. Theobald, Jr., U.S.G.S., 1965).

No other elements are in significantly anomalous amounts in the samples.

Recommendations

The sparse sample density makes it difficult to assess the importance of samples with anomalous trace-element content. The dispersion halos from individual mineralized areas appear to be very local, for example the copper content of rock specimen 10743, near the south edge of the map, is 2000 ppm whereas the wadi sediment sample taken in the same drainage basin less than 1 kilometer to the west is 15 ppm. Either the amount of copper is extremely small or the rate of dilution very rapid. Individual samples of wadi sediment that do show anomalous trace-element content may be very close to an insignificant deposit or may indicate the presence of a larger deposit at a greater distance. This could be determined by additional sampling.

An area in the southwestern corner of the Qal'at as Sawrah quadrangle and adjoining areas in adjacent quadrangles should be examined in more detail. We did not see any mineralized areas, but the anomalous trace-amounts of copper, molybdenum, and zinc are of interest. A systematic geochemical sampling program may reveal target areas for examination. Beds of recrystallized limestone or dolomitic limestone occur in metavolcanic rocks north of the railway in this area and may be of interest.

An ancient gold working visited by A. O. Fakhry in 1941 is located south of Qal'at Zumurrud a few kilometers west of the mapped area. Fakhry (1941) mentions two veins each about 120 meters long. He took a grab sample from one vein that assayed 1.06 ounces of gold per ton. Additional sampling of this vein may be of interest.

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