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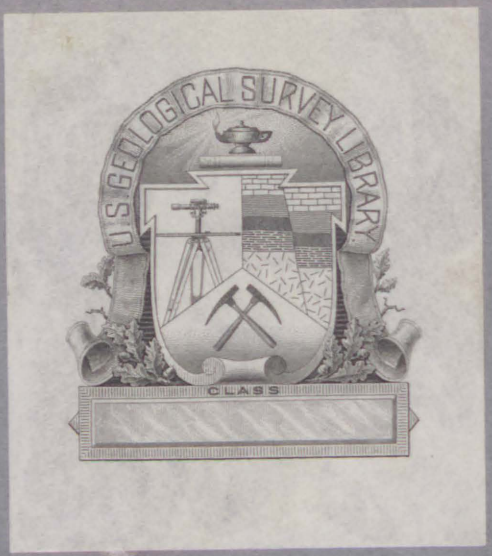
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Saudi Arabia Investigation Report
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SUMMARY OF FIELD TRIP MARCH-APRIL 1964

TO THE SOUTHERN TUWAYQ QUADRANGLE

SAUDI ARABIA

by

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U. S. Geological Survey

and

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Directorate General for Mineral Resources

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1. Magnetometer survey in the Jebel Idsas area, Saudi Arabia, by W. E. Davis, R. V. Allen, and M. N. Akhrass. 8 p., 2 figs.

2. Preliminary report on the ancient mines and mineral occurrences in northeastern Hijaz quadrangle 205 and the southwest part of Wadi Ar Rimah quadrangle 206, Saudi Arabia, by C. L. Hummel, Abdullah Ankary, and Hashim Hakim. 45 p. (incl. 1 fig.), 6 tables, 1 pl.

3. Evaluation of a diamond drilling program at the Samrah Mine near Ad Dawadimi, Kingdom of Saudi Arabia, by T. H. Kiilsgaard. 77 p., 13 figs., 3 tables.

4. Report on the field trip in the northwestern Hijaz quadrangle, Saudi Arabia, during the period February 21 to March 28, 1965, by Robert F. Johnson and Virgil A. Trent. 3 p., 1 fig.

5. Summary of field trip March-April 1964 to the southern Tuwayq quadrangle, Saudi Arabia, by William C. Overstreet, Jesse W. Whitlow, and Abdullah O. Ankary. 7 p.

6. Summary of trip during May-June 1964 to the southern Tuwayq quadrangle, Saudi Arabia, by William C. Overstreet and Jesse W. Whitlow. 4 p.

7. Geologic log and chemical data, diamond drill hole 1, Samrah, Kingdom of Saudi Arabia, by Paul K. Theobald, Jr., Charles E. Thompson, and Henry D. Horn. 61 p., 15 figs., 5 tables.

8. Geology of Samrah and vicinity, Kingdom of Saudi Arabia, by Paul K. Theobald, Jr. 24 p., 2 figs.

9. Mineral investigations in the Bir Al Bayda-Al 'Ula area, Saudi Arabia, by Virgil A. Trent. 2 p.

10. A mineral reconnaissance of the Jabal Sahah quadrangle, Kingdom of Saudi Arabia, by Jesse W. Whitlow. 16 p., 3 figs.

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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
GEOLOGICAL SURVEY

Saudi Arabian Mineral
Exploration - 16

SUMMARY OF FIELD TRIP MARCH-APRIL 1964 TO THE SOUTHERN TUWAYQ QUADRANGLE, SAUDI ARABIA

by

William C. Overstreet , Jesse W. Whitlow , and Abdullah O. Ankary

Introduction

The purpose of the trip was to make an economic geologic, geochemical, and heavy-mineral reconnaissance of the Precambrian rocks exposed in the extreme western part of the Southern Tuwayq Quadrangle, sheet I-212A prepared by R. A. Bramkamp, R. D. Gierhart, G. F. Brown, and R. O. Jackson. Attention was to be given to the following features:

1. Fault zone from Al Amar to Jabal Idsas, thence southeastward as far as it could be traced. Reference to Victor Kahr's report of April 28, 1962, to Directorate General for tectonic features at Jabal Idsas.
2. Map units labelled granite (g), amphibolite (a), and amphibolite schist with mafic undifferentiated intrusive and extrusive rocks (as) were to be examined for possible copper, and in the mafic rocks possible chromium, nickel, platinum, olivine, diamond, and asbestos.
3. Map unit labelled diorite and related rocks (d) was to be examined for magnetite and copper.
4. Map unit labelled andesite and fine-grained dioritic rocks, flows, and intrusives (m) was to be examined for possible ultrabasic rocks and related ores.
5. Possibility of lead or zinc in Khuff formation of Permian age.

Camps and route:

1. March 7 — 1 km south of Zaymah
2. March 8 — 30 km west of Zalim
3. March 9 — 33 km northeast of Afif
4. March 10 — 2 km northwest of Ar Ruwaydah
5. March 11 — 4.5 km south of Al Quway'iyah
6. March 14 — Al Amar
7. March 15 — Wadi Ar Rayn at point 7 km west of Ar Rayn
8. March 20 — Jabal Idsas
9. March 29 — Locality 61 km southeast of Jabal Idsas
10. April 11 — Locality 46 km southwest of Zalim. April 12 reach Jiddah at 3 p.m.

Kilometers travelled: 4557

Number of samples collected: 329

General geology

Six major features in the general geology of the region were observed:-

1. The unit designated granite gneiss (gg) on map I-212A, and extending southward from Wadi al Hamid to Ayn al Minjur, appears to be a gneiss dome with core of younger massive, quartz-poor granite similar to map unit granite (g). The general area of outcrop of the granite-cored gneiss dome is well represented on map I-212A, but an error in printing south of 23°15'N. misidentifies swarms of rhyolite and andesite dikes, showing them as form lines. Minor exposures of mafic phyllite and rhyolite lie between the gniess and the Khuff Formation on the east. Planar structures in these non-granitic crystalline rocks, in the gneiss itself, and in amphibolite, volcanic rocks, and sedimentary rocks on the west side of the area of granite gneiss suggest the body is a north-trending antiform, probably a dome. The granite gneiss (gg) makes up the limbs of the antiform; granite (g) makes up the core, which actually occupies the larger part of the mass. The granite gneiss on the limbs is overlain by, or intruded by, all other rocks units. It contains, however,

boudins of schistose mafic dikes, and, more important from a stratigraphic viewpoint, inclusions of layered paragneiss which represent relicts of a sedimentary sequence older, possibly much older, than the granite gneiss.

The granite forming the core of the antiform is younger than the older rocks except dikes of rhyolite and andesite. Essentially no contact metamorphism is to be found where this granite intrudes even the most unstable mafic hosts. Possibly the granite is re-mobilized granite gneiss brought to an intrusive phase during metamorphism reaching no greater intensity than the albite-epidote amphibolite facies. The granite appears to have been very dry and free of volatiles when emplaced. Perhaps this is further evidence that it actually formed from the granite gneiss instead of from magma or sedimentary rocks, either of which might be expected to be richer in volatiles than the granite gneiss.

Structures associated with the granite in the core of the antiform and the major fault to the west of the gneiss (shown on map I-212A as a possible normal fault with upthrown side on east) may be interpreted to indicate that the doming of the granite gneiss and accompanying formation of the granite occurred slightly earlier than the faulting, and that the fault is related to the same deformational episode. The evidence is not clear, however.

2. The fault on the west side of the Jabal Idsas range is part of a fault that extends southward at least to latitude 22°45'N., and probably much farther. It does not terminate at latitude 23°05'N. as shown on I-212A. This interesting structure is thought by us to be a high-angle reverse fault with the eastside moved up and to the west. Tear faults of small displacement, but of remarkable frequency and regularity, are associated with high-angle reverse fault. The tear faults trend about N.70°E. more or less normal to the axial plane of the gneiss dome. They may be nearly vertical, and they show westward displacement of the north side. Accumulated westward movement on the tear faults may be considerably greater than the actual movement on the high-angle reverse fault. Westward movement on the reverse fault and on the tear faults seems to be considerably greater opposite the central part of the granite gneiss dome (from

Jabal Bitran to Jabal Khuwar) than it is in the southern part of the dome where the limbs begin to close.

Had the significance of these features been recognized early enough in the field work, we would have looked for tear faults in the mafic schists and rhyolite peeking out under the Khuff limestone on the eastern side of the gneiss dome. Tear faults trending about N.70°E., but with the north side displaced toward the east on the eastern flank of the dome could be expected if volume change accompanied transformation of granite gneiss to granite in the core of the dome. They were not observed, but a specific search was not made. Study of the aerial photos may disclose them.

3. The stratigraphic sequence shown on I-212A for the Precambrian rocks west of the gneiss dome may need to be revised to place the sericite and chlorite schist unit (S) above the unit called andesite and fine-grained dioritic rocks, flows, and intrusives (m). These schists, and possibly equivalent but lower-grade, practically unmetamorphosed graywacke, appear to overlie the mafic volcanic rocks. In any event, the stratigraphic sequence is quite complex.

4. Weathered Precambrian rocks underlie the Khuff Formation. Generally the weathering is weak, and some gabbro is unweathered, but locally rhyolite and granite gneiss are weathered to saprolite. Near Al Quway'iyah the saprolite is several feet thick and gives way downward to reticulate mottling which grades from red to yellow, to white. The pattern resembles saprolitic weathering in temperate humid climate. Saprolite itself is said by Dorothy Carroll (oral communication, 1963) to require at least 30 inches of rain a year for its formation. Possibly a humid temperate to sub-tropic climate prevailed in immediate pre-Khuff time.

A small graben structure about 20 km west of the Khuff limestone was tentatively identified from weathering features northwest of Ayn al Minjur.

No observed weathering products are of economic importance.

5. Alteration zones are less common in the sericite and chlorite schist unit than in the other rocks.

6. Olivine-bearing ultrabasic rocks were not observed, but olivine-free ultrabasic rocks are common. Thus, the association of gabbro and pyroxenite was general, but the association of gabbro and peridotite was absent.

Economic geology

A number of ancient gold and copper mines and prospects are shown in the extreme northwestern corner of sheet I-212A, but through lack of data at the time of compilation, none is shown south of Al Amar (23°45'N.). The Directorate General presently knows the location of similar ancient workings in fair detail as far south as Jabal Idsas (ca.23°20'N.) and in lesser detail possibly to 23°00N. Few ancient workings are known below that point. We found six ancient workings thought by the guide to be unknown to the Directorate General and located south of 23°N. They seem to persist to the south, and they may be expected to turn up even farther south. The concentration of mines along the north-trending fault just west of Al Amar may be more closely related to the lithology than to the fault. These ancient workings are mainly in andesite; they are very scarce in the sericite schist.

The segregated magnetite in granodiorite at Jabal Idsas appears also to have attracted the attention of the ancients. Formerly a great heap of magnetite was present on one of the alluvial fans west of the Idsas range, but it has been trucked away for use in the manufacture of cement. This heap of magnetite, which shows up well on old aerial photographs, has been referred to as a placer. No evidence was found elsewhere of placer concentrations of magnetite boulders and pebbles remotely resembling the former pile. The pile is interpreted by us to have been a spoilage dump made by laborers at a time when the ancient village about 2 1/2 km to the south was occupied. This dump is inferred to have been accumulated to supply ore to an iron furnace, but it seems that either the furnace was never built, or it operated only a short while. No slag was observed. It is inferred that the Idsas iron operation was abandoned upon the discovery of copper at Al Amar, and available fuel and labor diverted to Al Amar because copper ore smelts at lower temperatures than iron, and copper was worth more.

Mr. A. S. Mehta was drilling Directorate General hole #39 at Jabal Idsas. His operation is very good. Between 20 and 40 feet was being drilled per 6-hour day with 95 to 100 percent core recovery. Core we observed was lean in magnetite; it could not have averaged as much as 3 percent.

The only unusual deposits observed are two ancient workings in a shear zone in pink granite exposed about 18 km west of Ar Rayn. The workings explore narrow veins of coarse barite, rhodochrosite, hematite, and psilomelane in sheared rhyolite in the granite. The larger of the two veins is about 30 m long and attains a maximum width of 1.1 m. Radioactivity of these veins is about equal to background in the region; thus, thorium and uranium are scarce. No rare earth mineral was observed, but the ore must be analysed with this possibility in mind.

Pyrite is disseminated in a thick sequence of andesite flows and pyroclastic rocks exposed about 30 km northwest of Ar Rayn. The pyrite-bearing parts culminate in a strong bleached zone which forms a white area on photo 7544-WSA-48. Copper stain is not present. Samples must be analyzed for tellurium and molybdenum before an adequate appraisal can be made. The alteration zone is large compared to other areas seen in the Southern Tuwayq quadrangle.

Absence of olivine-bearing mafic rocks probably accounts for the lack of talc, asbestos, or high quality serpentine and soapstone in the area investigated. It also probably explains why chromite was not observed in the differentiated gabbro bodies. Pyroxenite was common enough, but peridotite was lacking. Nothing resembling sperrylite or native platinum was observed in place. When the concentrates are prepared, a further test will be made. Pyrope was not found in any mafic rock; thus, primary deposits of diamond are absent. Inasmuch as the mafic rocks appear to be in part younger that the coarse conglomerate west of the granite gneiss dome, it is unlikely that diamond will be found in that conglomerate. Pyrope was absent from the conglomerate at the places examined.

Plutonic basic and ultrabasic rocks crop out in the map unit called andesite and fine-grained dioritic rocks, flows, and intrusives (m), but such ores as asbestos, talc, chromite, platinum, and diamond were not found. Some ancient prospects, doubtless for gold, are in or near the ultrabasic rocks and diorite.

Megascopic lead and zinc minerals were not found in the Khuff Formation of Permian age at the half-dozen places it was examined, but fractures in the Khuff are represented in the Precambrian. Stained and recrystallized limestone at these places was sampled for geochemical tests. Pending them, the question of metallisation in the Khuff must be kept open, but metalization seems to be unlikely.

Every night from 20 to 50 chips of rock collected during the day were examined with ultra-violet light for scheelite. None was seen in about 1100 samples. Andradite-bearing skarn exposed at two localities east of Jabal Idsas contains no scheelite.

Radioactivity at 325 localities was measured with scintillometer. Radioactivity more than 2 1/2 times background was uncommon. Such anomalous radioactivity was generally associated with rhyolite or fluorite-bearing biotite-hornblende granite. The greatest anomalies were six to nine times background; the best anomaly was in mafic volcanic and sedimentary rocks southeast of Jabal Idsas. This locality differs geologically from other radioactivity highs; hence, we regard it as of more potential interest than the others.

Plans and recommendations

We were unable to finish the area proposed for the trip. Our work extended southward from 24°N. to 22°45'N. and eastward to the Khuff Formation. We plan to finish the Precambrian area on sheet I-212A during five weeks in May and June, 1964. When the samples from this area are analyzed, we shall submit a report on this geologic and geochemical investigation.

The mineralized zone from Jabal Idsas to Al Quway'iyah should be carefully mapped at 1:50,000 scale to develop the geologic history and setting of the ore deposits. This mapping should be supplemented by geochemical surveys. At present the Directorate General has a mapping program to fill this need. When they have an independent geochemical capability a geochemical program should be undertaken.

Drilling for magnetite at Jabal Idsas should be brought under geophysical guidance. If several holes in the best anomalies do not strike a large orebody, drilling should be halted.