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HEAVY-MINERALS RECONNAISSANCE IN THE FATIMAH FORMATION NEAR JIDDAH, SAUDI ARABIA

by

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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 Also on open file in that office is a large amount of material, in the form of unpublished manuscripts, maps, field notes, drill logs, annotated aerial photographs, etc., that has resulted from other previous geologic work by Saudi Arabian government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.

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ABSTRACT

Near Jiddah, Saudi Arabia, a heavy-minerals survey was made in the Precambrian sediments of the Fatima Formation. Samples measuring 0.25 cubic meters were taken in a net related to the drainage system and washed in a sluice. The concentrates were tested for 29 elements which included precious and base metals, rare earths, and radioactive elements. Only 17 elements were detected in the samples and all values were normal. The concentrates contained only common species of heavy density resistate minerals. The survey showed that the area is not a favorable one in which to search for ores of the elements tested.

INTRODUCTION

There is no known occurrence of mineralization or evidence of past mining activity in the Fatima Formation east of Jiddah. The area is reached by the Jiddah-Mecca highway and all parts of the area are accessible by numerous dirt roads and trails that crisscross this zone. Its geology has been mapped by Brown and others (1962) as part of the 1:500,000 scale geologic map of Saudi Arabia and by Al-Shanti (1966) who mapped part of the area at a scale of 1:50,000 in connection with a study of ore reserves in the oolitic iron beds of the Shumaysi Formation (Tertiary). Karpoff (1957) and Goldsmith (1968) have described sections of the Fatima Formation of this area.

This study of the areal distribution of heavy-minerals had the aim of delineating favorable places for detailed search of ore deposits. The Fatima Formation in this area was believed to be of interest because it contains abundant conglomerate beds that could be favorable for mineralization. This investigation is part of a long-range, heavy-minerals exploration program for mineral deposits in the sedimentary formations of the Precambrian Shield of Saudi Arabia.

The map accompanying this report shows the pattern of sampling and outlines the Fatima Formation.

GEOLOGIC SETTING

Precambrian crystalline and sedimentary rocks together with minor Tertiary sediments underlie this area. The crystalline rocks range from early to late Precambrian and are mostly granite, diorite, andesite, granodiorite, rhyolite and amphibolite. The Precambrian sediments, which are the object of this study, belong to the Fatima Formation. Goldsmith (1968) during an investigation of a 1000-meter section of this formation identified a lower member composed of limestone, shale, and siltstone and an upper member composed of conglomerate, agglomerate, and lava flows. The formation crops out on the northwestern flank of lower Wadi Fatima in a series of fault-block ranges that have steep escarpment faces and gentle dip slopes. The Tertiary sediments belong to the Shumaysi Formation and are composed of shale, siltstone and oolitic iron beds. In front of the escarpment, alluvial fans of coarse rubble have been laid and the wadi floors are filled with recent deposits of gravel, silt, and eolian sand.

The area shown on the accompanying map measures nearly 2800 square kilometers of which the crystalline rocks occupy 50 percent, the Fatima Formation about 10 percent, the Shumaysi Formation less than 1 percent, and alluvial deposits cover the rest of the surface.

ANALYTICAL METHODS

Samples of sluice concentrates were analyzed by semiquantitative emission spectrographic methods for the following elements. These elements are shown with their lower limits of detection in parts per million: Ag 1, Ba 50, B 10, Be 2, Bi 20, Cd 50, Co 5, Cr 5, Cu 10, Ga 10, Ge 20, Mn 20, Mo 2, Nb 50, Ni 5, Pb 10, Sb 100, Sc 10, Sr 50, Ti 10, V 20, W 50, Y 10, Zn 100, Zr 20. The concentrates were panned

to "black sand" and examined for colors and then fire assayed for Au and Ag with detection to 0.1 part per billion. Radioactivity was tested with a scintillometer. The analytical work was done at the Jiddah laboratories of the Directorate General of Mineral Resources. The spectrographer was Mohammed Jambi and the fire assayer Sayyid Matouq Bahijry, Director of the Chemical Laboratory.

MINERAL SAMPLED

Twenty-two samples were taken from the present channels of wadis and one from an alluvial fan. Each sample measured 0.25 cubic meters (about 850 pounds) and was taken at single spots at depths to 50 cm. The nature of most samples was a sandy gravel consisting of poorly sorted angular to subangular phenoclasts ranging in size from 2 to 254 mm in a matrix of sand and silt. The greater than 2 mm fraction usually constituted more than 50 percent of the volume and was composed of fragments of sandstone, shale rhyolite, quartz and feldspar; the matrix consisted of rounded eolian quartz grains, small rock fragments, feldspar grains and silt. These sediments were derived from the Fatima Formation and its underlying quartz monzonite; however, a few gravel samples with sediments from other formations, especially of crystalline rocks, showed better sorting and more quartz both in the grains and the matrix.

The samples were rated in four categories from A to D according to the provenance of their sediments: A if from 80 to 100 percent of the sediments come from the Fatima Formations, B from 50 to 80 percent, C from 30 to 50 percent, and D under 30 percent. Also, samples consisting of very immature sediments such as those from very youthful wadis or from alluvial fans were rated as C. The rating of each sample is shown in the table that accompanies this report.

SAMPLE PREPARATION

The samples were concentrated in a sluice 5 m long by 25 cm wide with the bottom fitted with a carpet and a wire screen. The ratio of contraction obtained was nearly 50 to 1. The concentrates contained about 60 percent of quartz and feldspar grains and 40 percent heavier minerals. The concentrates were split in two fractions; one was panned for gold and afterwards fire assayed; the other was used for spectrographic analysis and for examination under the binocular microscope.

RESULTS AND CONCLUSIONS

The results of the tests are tabulated and accompany this report. Of the 27 elements analyzed by spectrographic methods, only 17 were detected and no significant anomalous concentrations of any elements were found. Sample 31076 of provenance A contains 70 ppm of cobalt, an amount that is three times the median value for that element. Because of this high value, the area was revisited and searched for mineralization but nothing was found, and it was concluded that this is a non-significant anomaly. Similary, the scintillometer did not detect significant anomalies. No gold colors were seen while panning, and fire assay confirmed the absence of this metal in all samples. Silver was detected by fire assay in 18 samples, but all values are within the geochemical pattern normal for this area. Examination of concentrates under the binocular microscope showed only a normal suite of heavy minerals which included magnetite, ilmenite, hematite, zircon, epidote, rutile, garnet, hornblende, etc. The results of all the tests show that the area surveyed of the Fatima Formation is not favorable for search of ore deposits of the elements analyzed.

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Table I — Semiquantitative analysis of 23 samples of sluice concentrates from the Fatima Formation near Jiddah. Not detected by spectrographic analysis in ppm: Ag<1, Be<2, Bi<2, Cd<50, Ge<20, La<50, Nb<50, Sb<100, Sn<10, W<50; not detected by fire assay Au<0.1 ppb (parts per billion); not detected by scintillometer U_3O_8

Sample No and provenance rating	Elements by spectrographic analysis in parts per million																	Fire assay in ppb
	B	Ba	Co	Cr	Cu	Ga	Mn	Mo	Ni	Pb	Sc	Sr	Ti	V	Zn	Y	Zr	Ag
31055 A	20	500	15	100	15	15	500	2	20	15	10	300	2000	100	100	20	50	0.2
31056 B	20	200	20	150	20	15	700	3	30	15	10	200	3000	150	150	20	100	0.1
31057 A	20	300	20	100	20	15	500	3	30	15	10	200	3000	150	150	20	70	6.0
31058 B	20	150	15	50	30	15	200	3	15	10	10	300	2000	100	100	15	50	0.2
31059 A	30	150	20	100	20	15	700	3	30	15	15	200	5000	150	150	20	70	0.8
31060 B	30	300	15	70	20	15	200	5	20	50	10	300	3000	150	150	20	70	0.2
31061 C	30	700	20	15	15	15	100	7	15	10	10	150	3000	150	150	15	70	<0.1
31062 B	30	200	20	150	50	15	300	2	30	10	15	200	3000	150	150	30	70	<0.1
31063 B	30	700	15	50	20	10	150	3	20	10	7	200	2000	100	100	15	50	0.2
31064 B	30	150	20	200	30	15	500	3	30	15	10	300	3000	300	200	20	70	<0.1
31065 A	30	200	20	50	30	15	200	3	20	15	10	200	3000	150	150	20	100	0.4
31066 B	20	200	10	50	20	10	150	2	10	10	10	200	2000	100	100	15	70	0.6
31067 C	50	200	20	70	30	15	300	2	20	15	10	200	3000	200	100	20	70	0.8
31068 D	30	300	20	70	20	15	1500	7	20	<10	10	200	3000	150	150	15	100	0.6
31069 A	30	500	15	20	15	15	1000	2	10	<10	15	300	2000	70	100	20	50	0.4
31070 C	30	200	20	100	30	10	1000	3	30	<10	15	300	5000	200	150	10	100	0.3
31071 B	20	300	20	50	15	15	500	2	50	<10	15	500	2000	100	100	10	50	0.8
31072 A	20	500	15	70	20	50	300	2	15	<10	15	200	2000	100	<100	20	70	0.4
31073 B	20	200	15	70	20	15	500	3	10	<10	15	300	3000	150	150	15	100	<0.1
31074 B	20	200	20	70	20	15	700	5	30	<10	10	200	5000	200	200	15	100	<0.1
31075 A	15	30	5	20	15	10	150	2	10	<10	10	200	2000	70	100	10	70	0.3
31076 A	30	200	70	70	20	15	300	7	20	10	10	200	2000	300	200	15	100	0.3
31077 D	20	200	50	200	15	15	300	3	50	10	10	150	2000	300	150	15	50	6.4