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RECONNAISSANCE GEOLOGY OF THE SABKHAT MURAYSIS QUADRANGLE

KINGDOM OF SAUDI ARABIA

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 Also on open file in that office is a large amount of material, in the form of unpublished manuscripts, maps, field notes, drill logs, annotated aerial photographs, etc., that has resulted from other previous geologic work by Saudi Arabian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

The Sabkhat Muraysis quadrangle covers an area of 2843 sq km in the central part of the Kingdom of Saudi Arabia. In the northwestern quarter of the area Precambrian rocks are exposed. They are overlain toward the south and east by sedimentary formations of Permian and younger age.

Four main units of Precambrian rocks were identified in this area. From oldest to youngest they are: hornblende-biotite granite gneiss; amphibolite and rhyolite of the Halaban Group; graywacke and chlorite-sericite schist of the Bi'r Khountina Group; and biotite-hornblende granite.

The hornblende-biotite granite gneiss unit and the biotite-hornblende granite unit are both poorly exposed and largely covered by veneers of sand. Owing to these factors the boundaries between the granitic rocks are obscure. Much of what is shown as hornblende-biotite granite gneiss may actually be biotite-hornblende granite.

The Halaban Group is represented by an older amphibolite unit called the Umm Mushraha Formation and by a younger rhyolite unit called the Wadi al Jifr Formation. Layered and massive components in the Umm Mushraha Formation represent metamorphosed andesite and graywacke, and metamorphosed diorite, gabbro, and pyroxenite. The Wadi al Jifr Formation consists of virtually unmetamorphosed to strongly sheared and metamorphosed rhyolite, rhyolite porphyry, and rhyolite tuff which at many places has been metamorphosed to quartz-sericite schist and biotite-muscovite schist. These schists retain porphyroclasts of blue quartz which also form conspicuous phenocrysts in the unsheared rhyolite. Locally, the sheared rhyolite has been hydrothermally altered resulting in the formation of quartz-chlorite-ankerite veins and a sparse impregnation of pyrite.

The Bi'r Khountina Group consists of a unit of graywacke and argillite with interbedded andesite that is metamorphosed to chlorite-sericite schist near the contacts of intrusive biotite-hornblende granite. This unit is called the Abu Sawarir Formation. It is intruded by massive gabbro and pyroxenite.

No ancient mines or old prospects were found in the Precambrian part of the quadrangle. Three alteration zones in rhyolite near the northwestern corner of the quadrangle tend to have threshold amounts of molybdenum and tungsten, but they have only background amounts of the base metals and silver. Pyrite is more common in the altered rhyolite than in adjacent rocks. Geological mapping plus geochemical

and electro-magnetic surveys of this area are recommended to explore for sulfide minerals.

INTRODUCTION

Location

The Sabkhat Muraysis quadrangle covers an area of 2843 sq km in central Saudi Arabia (fig. 1) at the eastern edge of the Arabian Shield. Precambrian rocks occupy the northwestern part of the area; they are unconformably overlain to the east by sedimentary rocks of Permian and younger age.

Relatively low relief prevails, which is interrupted principally by the cliffs eroded along the western edge of the Khuff Formation. The Precambrian rocks project as low hills above sand plains. Altitudes are between 600 m and 700 m above sea level.

A main road crosses the quadrangle from southwest to northeast, and most of the region in the northwestern quarter of the quadrangle is accessible across country.

Previous investigations and present work

The area covered by the Sabkhat Muraysis quadrangle was shown at 1:500,000 scale by Bramkamp and others (1956). The present investigation consisted of a brief geological reconnaissance of the Precambrian rocks on April 4 and 5, 1964, conducted as part of the investigations made under the agreement reached in September 1963 by the Ministry of Petroleum and Mineral Resources, Kingdom of Saudi Arabia, and the United States Geological Survey to explore the

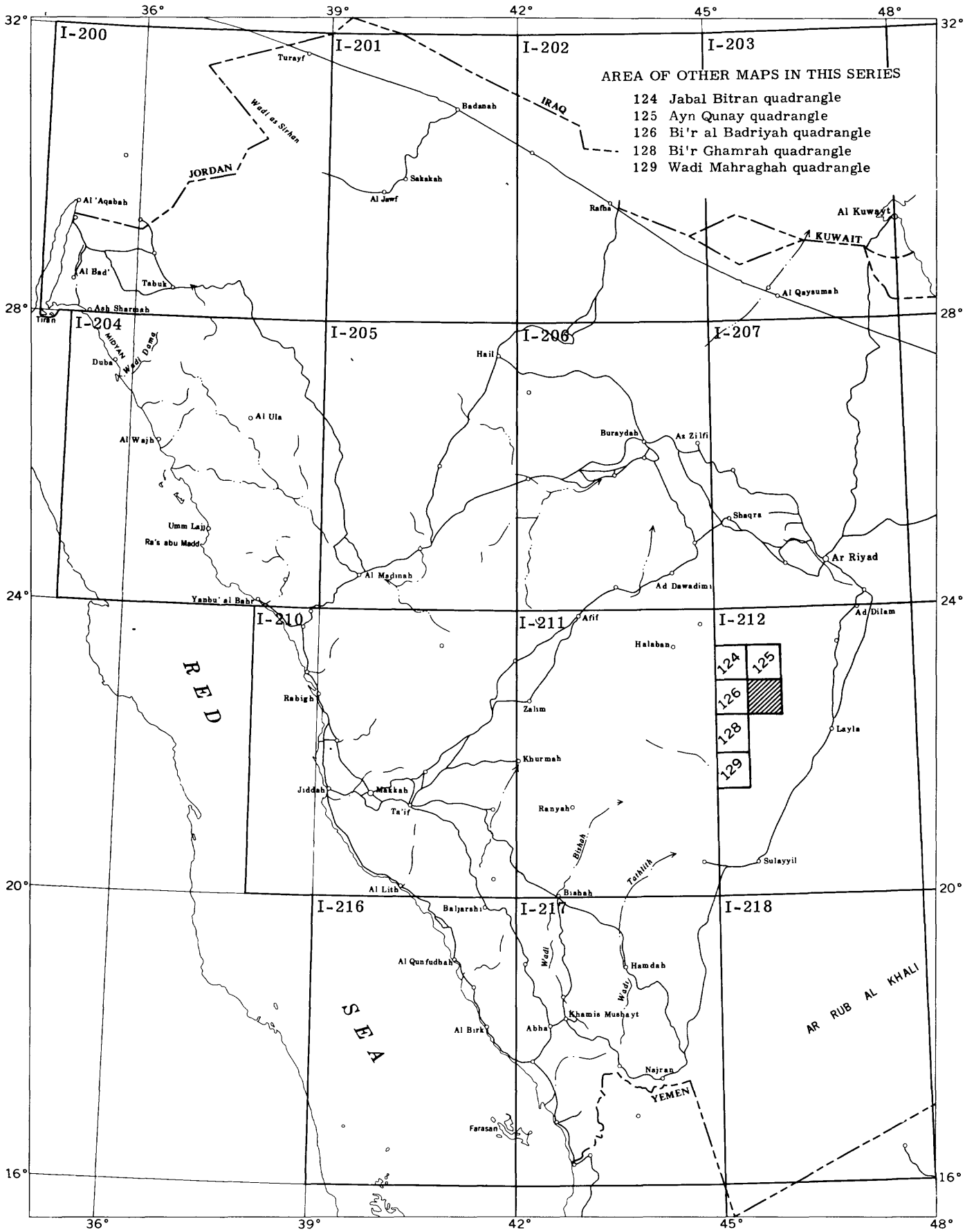

Figure 1.- Index map showing the location of the Sabkhat Muraysis quadrangle

mineral potential of the Precambrian Shield in Saudi Arabia.

Acknowledgement

The writers wish to acknowledge the assistance received from officials of the Ministry of Petroleum and Mineral Resources and of the Directorate General of Mineral Resources, Kingdom of Saudi Arabia for their help in the conduct of this investigation.

Artifacts

Fresh Precambrian rhyolite is exposed just west of the Khuff Formation at a locality 22 km N. 10° E. of Bi'r Hafa'ir an Tafaiiti; the rhyolite was the source of rock fragments worked by Paleolithic man into large, heavy hand-axes of the type called Acheulean. Countless flakes from the manufacture of the axes are scattered around the low outcrops of rhyolite, and a few hand axes are lying on the outcrops. Several hand axes are on top of the adjacent cliff of Khuff Formation, where they may have been carried by much later people who built stone walls and houses, now in ruins, from blocks of limestone at the top of the cliffs. Inasmuch as a factory site for manufacture of Acheulean hand axes is adjacent to limestone cliffs, it is likely that in the neighborhood further and more meaningful relicts of Acheulean man may be present.

GEOLOGY

Much of the distribution of the Precambrian rocks shown on the geologic map (plate 1) is interpreted from aerial photographs, and the relations of the post-Precambrian sedimentary rocks are adapted from Bramkamp and others (1956)

Rock types and stratigraphic succession

Most of the west edge and the northern quarter of the Sabkhat Muraysis quadrangle is underlain by Precambrian metamorphosed sedimentary and volcanic rocks that unconformably (?) overlie older Precambrian hornblende-biotite granite gneiss. Two groups, the Halaban Group and the Bi'r Khountina Group, are represented among the metamorphic rocks. Intrusive into the old granite gneiss and overlying sequences of metamorphic rocks are several masses of biotite-hornblende granite. Owing to the extensive cover of sand, the actual contacts between the biotite-hornblende granite and the earlier hornblende-biotite granite gneiss are difficult to define, and much of what is called granite gneiss may actually be the younger granite.

A great unconformity separates the Precambrian rocks from the overlying Permian Khuff Formation and younger sedimentary rocks. These post-Precambrian formations dip gently east to southeast.

Hornblende-biotite granite gneiss

Gray, nonlayered, hornblende-biotite granite gneiss grading to gneissic granodiorite is intruded by masses of diorite, gabbro, and pyroxenite, and by small stocks and dikes of gray to pink biotite-hornblende granite. The composition of the gneiss is variable, and at many places it lacks hornblende. Strong lineaments, as observed on the aerial photographs, in the hornblende-biotite granite gneiss in the northwestern part of the quadrangle may be swarms of rhyolite

dikes related to the rhyolite of the Wadi al Jifr Formation of the Halaban Group, but as the actual outcrops were not visited, the identity of the feature is uncertain. At the contacts between the hronblende-biotite granite gneiss and the schistose phases of the rhyolite and rhyolite porphyry flows of the Wadi al Jifr Formation, the most prominent planar feature is the schistosity, which conforms to the contact. Original bedding features in the rocks above the gneiss are absent, and in the area of the quadrangle, the unconformity between the hornblende-biotite granite gneiss and overlying rocks observed to the west (Jackson and others, 1963), was not seen.

Halaban Group

The name Halaban Group was assigned in the Bi'r al Badrīyah quadrangle (Overstreet, Whitlow, and others, 1972) to an old sequence of Precambrian layered rocks including in large part the Halaban Formation of Jackson and others (1963). Amphibolite, rhyolite, and quartz-sericite schist are the most common rocks in the Halaban Group in the Sabkhat Muraysis quadrangle. The amphibolite, composed mainly of metamorphised mafic lava and plutonic equivalents, was named the Umm Mushraha Formation in the Bi'r al Badrīyah quadrangle (Overstreet, Whitlow, and others, 1972), and the overlying unit of rhyolite and quartz-sericite schist is here named the Wadi al Jifr Formation of the Halaban Group. The lavas of the younger part of the group are thus more felsic than the older lavas, and the amphibolite of the Umm Mushraha Formation is intruded by swarms of rhyolite

dikes that are interpreted here to be in part the feeders for the thick sequences of rhyolite exposed near the Khuff Formation.

Umm Mushraha Formation.-- The Umm Mushraha Formation of the Halaban Group consists of dark green to nearly black, layered to massive amphibolite and hornblende schist formed by the metamorphism of layered andesite and massive diorite, gabbro, and pyroxenite. Large residual masses of undeformed diorite, gabbro, and pyroxenite grade by shearing and metamorphism into the amphibolite and hornblende schist. Where these residual masses are present it has been difficult to distinguish them from the unit of younger diorite, gabbro, and pyroxenite. The criteria used here to separate the two is the presence or absence of old rhyolite dikes of the Wadi al Jifr Formation. If these old dikes are absent, the diorite, gabbro, and pyroxenite is assumed to be younger than the Wadi al Jifr Formation. Owing to the resistance of the unmetamorphosed gabbroic rocks to fracture, however, they may tend to be freer of dikes of any sort than the layered amphibolites. Therefore, some masses of old diorite, gabbro, and pyroxenite may have been mapped as the younger gabbro.

The Umm Mushraha Formation in the Sabkhat Muraysis quadrangle is older than a unit of chloritic schist in the Bi'r al Badrīyah quadrangle to the west (Overstreet and others, 1972). The amphibolite is not a higher-grade metamorphic equivalent of the chlorite schist.

Wadi al Jifr Formation.-- The name Wadi al Jifr Formation of the Halaban Group is here introduced for a layered and variably metamorphosed unit composed of rhyolite, rhyolite porphyry, altered rhyolite, fine-grained biotite-muscovite schist, quartzite, hornblende schist, and quartz-sericite schist that occupies eastern parts of the Precambrian Shield in the northwestern quarter of the Sabkhat Muraysis quadrangle and the southwestern corner of the Ayn Qunay quadrangle. The name is taken from the major wadi that leads southeastward across the Ayn Qunay quadrangle and enters the Sabkhat Muraysis quadrangle where it terminates about 10 km east of the felsic volcanic unit in the Halaban Group. The Wadi al Jifr Formation is here thought to be the youngest unit in the Halaban Group in this part of Saudi Arabia.

Gray, red, and dark brown rhyolite and rhyolite porphyry of the Wadi al Jifr Formation form dikes and dike swarms in the Umm Mushraha Formation. Similar rhyolite and rhyolite tuff, but most commonly rhyolite porphyry with phenocrysts of blue quartz, form massive to schistose layers in and above the Umm Mushraha Formation. Thin quartzite and beds of pelitic schist are interlayered with the rhyolite above the Umm Mushraha Formation. The volcanic rocks of the Halaban Group are here thought to become progressively more felsic in the younger parts of the formation, and the rhyolite dikes in the amphibolite of the Umm Mushraha Formation are thought to be feeders for the massive to schistose rhyolite flows overlying the amphibolite.

Where the rhyolite has been extensively sheared and metamorphosed, it is converted into quartz-sericite schist and fine-grained biotite-muscovite schist. In these sheared and schistose rocks the blue quartz phenocrysts are preserved as prophyroclasts. Some fine-grained hornblende schist, possibly representing mafic flows or dikes, is locally present in the schistose parts of the rhyolite and rhyolite porphyry of the Wadi al Jifr Formation.

The rhyolite porphyry containing blue quartz phenocrysts in this quadrangle is thought to be genetically related to, but possibly a little younger than, the unit of quartz porphyry with blue quartz phenocrysts in the Halaban Group in the Bi'r al Badrīyah quadrangle (Overstreet, Whitlow, and others, 1972). Possibly the quartz porphyry of that quadrangle is the hypabyssal equivalent of the rhyolite with blue quartz in the Sabkhat Muraysis quadrangle.

Bleached, yellow to reddish brown, iron-stained pyritiferous rhyolite, rhyolite tuff, rhyolite porphyry with blue quartz, fine-grained biotite-muscovite schist, quartzite, hornblende schist, and quartz-sericite schist occupy three rectilinear and adjacent areas up to 2 km long and 0.6 km wide near the northwestern corner of the quadrangle. Smeared-out blades of quartz and streaks of mica form a lineation that strikes and plunges northward in the sheared rocks of the altered zones, but the elongation of the zones is more toward the northeast. The long sides of the altered zones tend to conform to

the foliation, but the short ends of the zones are strongly athwart the strike of the foliation. Mainly the alteration consists of sericitization and kaolinization of feldspar on which is superimposed strong iron stains. A pyroxenite dike 4 m thick is chloritized and partly changed to vermiculite. The iron staining is probably related to the weathering of disseminated pyrite, which makes up 0.1-0.3 percent of the surface rocks. No copper stain is present, and other sulfides were not seen. Also, analyses of sand, concentrate, and magnetite from the altered zones disclosed no anomalous metals.

The northernmost of the three zones is the most altered. At the center of this zone are short, thick, massive milky white quartz veins containing ankerite and sparse small particles of pyrite. These veins lack copper sulfides. No ancient prospect pits or openings were seen in the veins.

The easternmost of the three zones is the least altered. Many relicts of unaltered rhyolite, quartz-sericite schist, and fine-grained biotite-muscovite schist are preserved. Small pyrite-bearing quartz veins are present, but copper minerals are absent.

The altered zones are thought to have a complex geologic history. Felsic pyroclastic rocks and associated pelitic sediments (the source-rock of the quartz-sericite schist) of the Wadi al Jifr Formation seem to have been strongly sheared along north-trending axes in Halaban time and a pervasive lineation was developed. Following the shearing, the rocks were sparsely impregnated with pyrite, and quartz-ankerite-pyrite

veins were formed. When the rocks were exposed by erosion prior to the deposition of the Khuff Formation, a weathered mantle of variable thickness was developed on the Wadi al Jifr Formation. Locally the weathered rocks were preserved under the Khuff. After the Khuff Formation was removed by erosion, the relict weathered mantle on the Precambrian rocks was stripped away also at most places. At the localities shown on plate 1 as altered rhyolite, however, it appears possible that small graben of basement and Khuff Formation were dropped enough so that the relict weathered mantle has been protected from erosion.

Bi'r Khountina Group

The term Bi'r Khountina Group is here extended into the Sabkhat Muraysis quadrangle from the Bi'r al Badrīyah quadrangle (Overstreet, Whitlow and others, 1972) to the southwest to describe bedded andesite and graywacke younger than the Halaban Group. In the Sabkhat Muraysis quadrangle the only mapped units of the Bi'r Khountina Group are the graywacke, argillite, and chlorite-sericite schist of the Abu Sawarir Formation.

Abu Sawarir Formation.--Small areas underlain by gray, green, and brown graywacke and siltstone grading into dark argillite of the Abu Sawarir Formation (Overstreet, Whitlow, and others, 1972) are exposed at the extreme southwestern edge of the Precambrian rocks in the Sabkhat Muraysis quadrangle. Thin calcareous layers are locally present, and the fine-grained sedimentary rocks locally display

excellent rhythmic bedding. Toward the northeast the formation is intruded by biotite-hornblende granite. In the contact aureole the graywacke and argillite are converted to dark-gray to dark-green, fine- to coarse-grained chlorite-sericite schist.

Diorite, gabbro, and pyroxenite

Very massive, dark diorite, gabbro, and pyroxenite intrude chlorite-sericite schist at the western edge of the quadrangle. Where these mafic plutonic rocks are intruded by the biotite-hornblende granite, they become schistose or amphibolitic and are difficult to distinguish from the amphibolitic rocks of the Umm Mushraha Formation.

Biotite-hornblende granite

Dominantly gray, locally pink, massive to faintly gneissic, medium- to coarse-grained biotite-hornblende granite intrudes the younger diorite, gabbro, and pyroxenite and the amphibolite of the Umm Mushraha Formation. Where this granite intrudes amphibolite in the southwestern part of the quadrangle, the granite also cuts across the swarm of rhyolite dikes in the amphibolite, but the dikes do not intrude the granite. Andesite dikes, possibly related to a late phase of the Bi'r Khountina Group, intrude the granite. From these relations the granite is regarded here to be younger than the Halaban Group and younger than at least the middle part of the Bi'r Khountina Group. It resembles the biotite-hornblende granite in the Bi'r al Badrīyah quadrangle (Overstreet, Whitlow, and others, 1972); therefore the term biotite-hornblende granite is used here for this rock.

A faint gneissic banding, possibly a primary flowage feature, is present at most exposures, but it tends to be obscured by exfoliation.

Locally the granite is rich in biotite. Where biotite is particularly abundant the rock is coarse-grained and dark gray. The rock is locally granodioritic.

Owing to the cover of sand, contacts between the biotite-hornblende granite and the older hornblende biotite granite gneiss are hidden. In much of the areas underlain by these rocks, exposures are absent. The old gneiss characteristically is intruded by many varieties of dikes, mainly equivalent in age to the volcanic rocks of the Halaban and Bi'r Khountina Groups. Ordinarily, traces of the older dikes show through the sand-covered pediments on the hornblende-biotite granite gneiss, but in the areas in this quadrangle shown as hornblende-biotite granite gneiss, very few dikes were seen. Therefore, the possibility exists that more of the rock is biotite-hornblende granite than is shown. The unit called biotite-hornblende granite in this area was identified as late Precambrian granite by Bramkamp and others (1956).

Andesite dikes

Scattered dark dikes of andesite, dacite, and lamprophyre intrude the biotite-hornblende granite at a few places. A group of east-trending andesite dikes were observed in the granite near the southwestern edge of the quadrangle, and several north-northeast

trending andesitic dikes are in the granite and its wallrocks at the northern edge of the quadrangle. The ages of the dikes are not known with certainty; they are tentatively correlated with similar dikes of late Bi'r Khountina age in the Bi'r al Badrīyah quadrangle.

Post-Precambrian sedimentary rocks

Eleven units of post-Precambrian sedimentary rocks are shown on the geologic map (plate 1). They are described in the map explanation, adapted from Bramkamp and others (1956).

Structure

The main Precambrian structural features of the quadrangle are the north-trending axes of folds in the Halaban Group and hornblende-biotite granite gneiss. These folds are pierced by later plutons of diorite, gabbro, pyroxenite, and biotite-hornblende granite. A west-northwest-trending fault younger than the biotite-hornblende granite is inferred to be present on the northern edge of the quadrangle from evidence seen north of the Sabkhat Muraysis quadrangle, but if so, it is concealed by sand. This fault is parallel to and probably contemporary with the early faults in the Najd fault zone to the southwest (Jackson and others, 1963; Overstreet and Whitlow, 1972). The greatest structural feature in the quadrangle is the downwarp to the southeast of the Permian and Triassic sedimentary formations and the underlying Precambrian basement.

Weathering

Exposures of the base of the Permian Khuff Formation and the underlying Precambrian rocks at the west edge of the outcrops of

Khuff disclose many areas of weathered rock (saprolite) at the top of the Precambrian rocks. The saprolite is quite variable in thickness, being as much as 10 m thick in some places, and absent elsewhere. At most places where it is present the saprolite is 2-4 m thick. Where the saprolite is thickest the upper part is red and it grades vertically downward through yellow to white weathered rock. Ordinarily the upper red part of the saprolite is absent. Where the original rock is granite, the granitic texture is preserved in a porous saprolite, but the saprolite of rhyolite is fine grained, punky, and textureless.

The saprolite is here interpreted to be a subaerial weathering product that formed before the deposition of the Khuff Formation. The saprolite is thought to have been partly eroded prior to the deposition of the Khuff. Evidence for the erosion is the highly variable degree of saprolization, relicts of deep saprolite being interspersed with shallow saprolite or fresh rock from which the saprolite was stripped before the Khuff was deposited.

GEOLOGIC RELATIONS OF SELECTED ELEMENTS

Eleven samples of wadi sand were collected in the area of Precambrian rocks in the Sabkhat Muraysis quadrangle. The samples were analyzed in the Jiddah Laboratory of the Directorate General of Mineral Resources to determine in reconnaissance fashion the abundances of selected elements.

Procedure

The eleven samples of wadi sand, weighing 10 kg each, were dug from the upper 30 cm of water-laid Holocene sediments in small wadis. Each sample was sieved on stainless steel screens, and 100 g of -30+80-mesh sand was taken. The residue from sieving was panned to make a heavy-mineral concentrate, and magnetite was removed from the concentrate. At each locality, therefore, three samples were obtained: -30+80-mesh wadi sand; concentrate; and detrital magnetite.

Wet chemical analyses were made by C. E. Thompson, U. S. Geological Survey, and L. Al Dugaither, Directorate General of Mineral Resources, for copper, zinc, and molybdenum in the sand and magnetite, and for copper, zinc, molybdenum, and tungsten in the concentrate. The sand was also analyzed by C. E. Thompson and Kamal Shahwan, Directorate General of Mineral Resources, for 27 elements by semi-quantitative procedures; the method used was modified from procedures of the U. S. Geological Survey (Theobald and Thompson, 1968).

Results

The results of these analyses are shown on histograms (figs. 2 and 3) and selected data are given on the geologic map (plate 1). No large amount of metal was found in any sample; 11 elements were below the limits of spectrographic detection in all samples of sand. These elements, and their limits of detection are: silver, 1 ppm; beryllium, 2 ppm; bismuth, 20 ppm; cadmium, 50 ppm; germanium 20 ppm: lanthanum, 20 ppm; niobium, 50 ppm; antimony, 200 ppm; tin, 10 ppm;

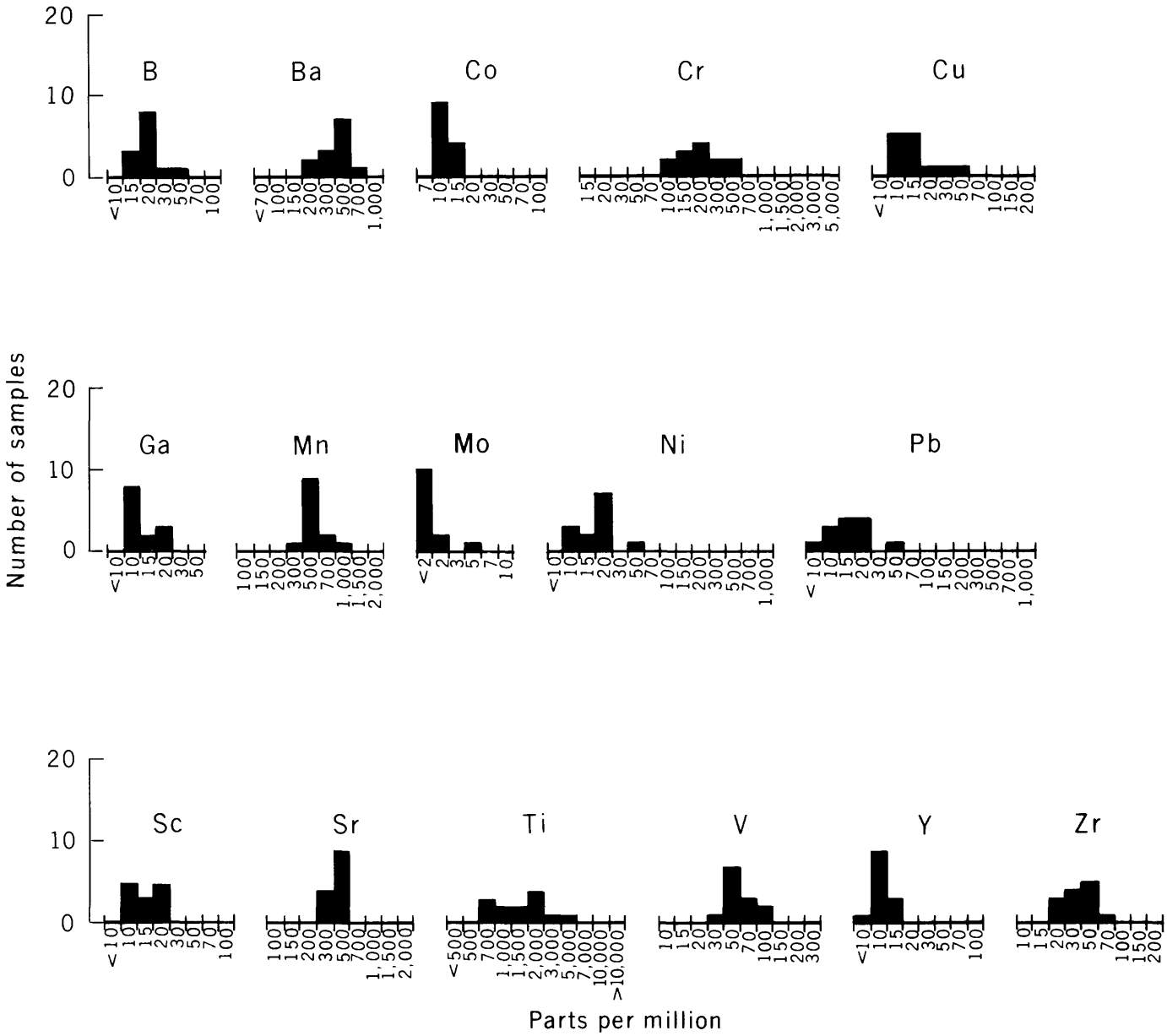

Figure 2. Histograms of 13 spectrographic analyses of wadi sand, Sabkhat Muraysis quadrangle

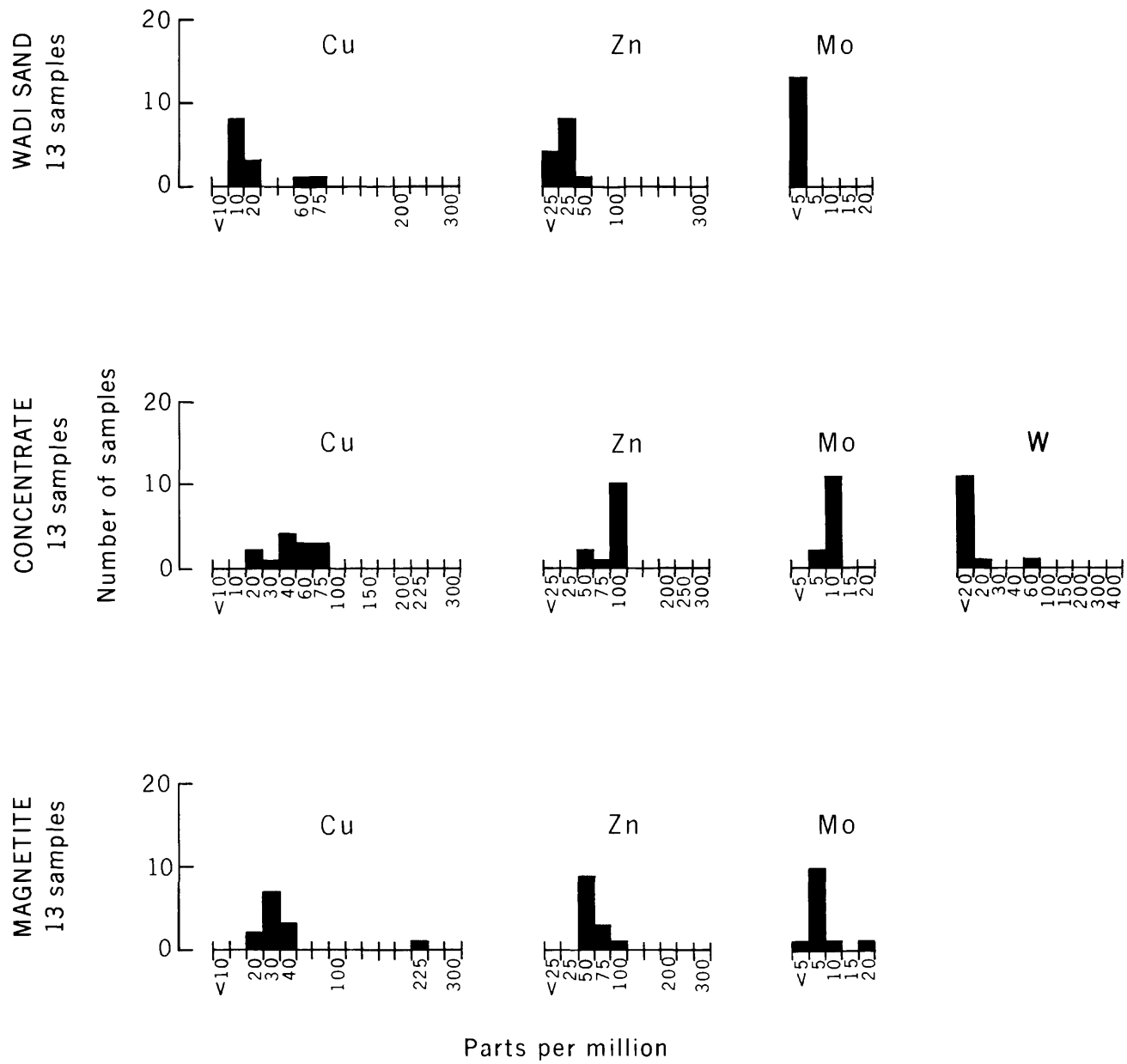

Figure 3. Histograms of wet chemical analyses of magnetite, concentrate, and wadi sand, Sabkhat Muraysis quadrangle

tungsten, 50 ppm; and zinc, 100 ppm. A comparison of the results of analyses of samples from the Precambrian area of this quadrangle with results of analyses of 321 similar triplet samples from the Precambrian area of the Southern Tuwayq quadrangle disclosed that threshold 1/ amounts of tungsten were detected in one heavy-mineral concentrate, and that threshold quantities of boron, lead, molybdenum, and titanium were found in four specimens of wadi sand (plate 1). Each of these threshold values is from a different sample locality, and two, the boron and lead, molybdenum, and titanium were found in four specimens of wadi sand (plate 1). Each of these threshold values is from a different sample locality, and two, the boron and lead, are at the lower limits set for threshold values; they probably represent normal variation in laboratory results (Theobald and Thompson, 1968). The threshold quantities found in the wadi sand samples are as follows:

Element	Threshold value in Southern Tuwayq quadrangle (ppm)	Number of samples from Sabkhat Muraysis quadrangle at or above threshold
Boron	50	1 (a)
Lead	50	1 (a)
Molybdenum	3	1 (b)
Titanium	3000	1 (a)

(a) At threshold

(b) 5 ppm

1/ Threshold is defined by Hawkes and Webb (1962, p. 31) as the analytical value exceeded by only 2½ percent of the observations.

The threshold value of 5 ppm for molybdenum was determined for sand from the northern of the three zones of alteration in rhyolite of the Wadi al Jifr Formation. The value of 5 ppm molybdenum is present in only one other sample in the 321 sand samples from the Southern Tuwayq area; therefore it can be regarded as high for the region.

The southeastern of these three zones was the source of a scheelite-bearing concentrate that had 60 ppm tungsten. Threshold for tungsten in concentrates is 30 ppm in the Southern Tuwayq area. This concentrate contained more grains of scheelite than any other in the Sabkhat Muraysis quadrangle (plate 1), and it was the only concentrate in which tungsten was detected chemically. Thus, the analysis confirmed the result obtained from examination of the concentrates with ultra-violet light.

The sand with threshold titanium came from layered amphibolite of the Umm Mushraha Formation in the Halaban Group at the western edge of the quadrangle. Such a moderate amount of titanium is compatible with the composition of the source rock.

Most of the analysed samples in this quadrangle came from Wadi al Jifr Formation of the Halaban Group. The distribution of the trace elements in this rhyolite is quite different from that in the much younger Shammar Rhyolite(?) exposed in the Bi'r Ghamrah quadrangle (Overstreet and Whitlow, 1972) to the southwest, sand from which is distinctly high in beryllium and silver. These elements

are below the limit of detection in sand from the rhyolite of the Wadi al Jifr Formation in the Sabkhat Muraysis quadrangle.

MINERAL DEPOSITS

No ancient mines or prospects were found in this reconnaissance of the Sabkhat Muraysis quadrangle, nor were reports received from bedouin to indicate the presence of ancient workings.

Possible mineralization may be associated with the three altered rhyolite zones in the Wadi al Jifr Formation, where threshold values for tungsten and molybdenum were obtained, and concentrates contain a little scheelite.

RECOMMENDATIONS

Owing to the possibility that some of the alteration at the three zones of altered rhyolite is of hydrothermal origin, and the fact that a very minor amount of tungsten and molybdenum is associated with the zones, a further exploration should be made for sulfide minerals. The altered zones should be mapped geologically and sampled geochemically. A ground electro-magnetic survey should be made.

The margins of the Wadi al Jifr Formation, and beds within the formation, may be favorable locations for large deposits of massive pyrite. However, no gossan was seen. When further work is done in this quadrangle, the areas of rhyolite should be scanned from helicopter or light aircraft for gossan.

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