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MINERAL RECONNAISSANCE OF THE BIR AL BAYDA' QUADRANGLE, NORTHWEST HIJAZ, SAUDI ARABIA

by

Robert F. Johnson and Virgil A. Trent

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 Also on open file in that office is a large amount of material, in the form of unpublished manuscripts, maps, field notes, drill logs, annotated aerial photographs, etc., that has resulted from other previous geologic work by Saudi Arabian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

A broad program of mineral investigations and geochemical sampling began in western Saudi Arabia in 1964 under the terms of an agreement between the Ministry of Petroleum and Mineral Resources and the United States Geological Survey. This report describes the results of these investigations in the Bi'r Al Bayda' quadrangle in Northwest Hijaz. The field work was done in the period from February 25 to March 9, 1964.

Officials of the Ministry of Petroleum and Mineral Resources were most helpful in supplying the needs of the field party and providing a guide, drivers, and a laborer. Mr. Shahta Omar Khatieb, a geologist of the Ministry of Petroleum and Mineral Resources accompanied us for part of the trip.

The Bi'r Al Bayda' quadrangle lies between 26°30' and 27° North latitude and between 36° and 37° East longitude. It extends from the Red Sea eastward nearly to the Arabian Plateau. The topography is subdued in the west, except for the granite mass of Jabal Liban which forms a sharp prominence in the southwestern part of the area. The topography becomes more rugged in the north and east where northwest-trending ranges of hills are separated by broad valleys. The altitude increases to the northeast and the Bi'r Al Bayda' basin is surrounded by steep hills that locally form scarps more than 500 meters high.

More than two-thirds of the quadrangle lies in a single drainage system. The Bi'r Al Bayda' basin is drained by two wadis into the valley of Wadi Aba Al Qazaz which has cut through the hills that border the valley to the west and drains into the large

basin of Wadi As Sirr. This basin, more than 50 kilometers long and as much as 30 kilometers wide, collects the drainage from a wide area and is itself drained by Wadi Thalbah which extends southwest through the coastal hills to the sea. Wadi Al Qurr near the southeastern corner of the map leads south into Wadi Miyah. Several small wadis drain directly into the Red Sea from the coastal hills.

The only permanent settlement in the area is at the oasis of Bi'r Al Bayda'. The nearest source of supplies is at Al Wajh on the coast which is connected with Bi'r Aba Al Qazaz by a graded road 70 kilometers long. Bi'r Aba Al Qazaz is the water supply for Al Wajh. The main travelled road in the area extends along the coast a few kilometers inland from the sea. Tracks extend from Bi'r Aba Al Qazaz northwest to Duba on the coast, northeast through Bi'r Al Bayda' to Wadi Jizl and the plateau, and southeast to Bi'r Al Qurr. Except for the rugged hills along the eastern margin of the quadrangle and north of Bi'r Aba Al Qazaz, most of the area is accessible to 4-wheel drive vehicles.

Field work for this report was confined largely to the eastern half of the quadrangle. Some observations were made near the coast road, but the geology shown on the western half of the accompanying map was compiled by Brown and others (1963) and has been only slightly modified on the basis of our observations. In additon to the above published map, unpublished material in the files of the Ministry of Petroleum and Mineral Resources contain information on the size and grade of several gold prospects that were worked in ancient times. The deposits are not of economic interest and only two of the largest were visited during our field work.

Field examinations were made of granite contacts, prominent fault lines, and areas of altered rocks. Target areas were selected from the study of aerial photographs or on-the-spot during our traverses of nearly all of the wadis accessible to vehicles. Geochemical samples of wadi sediments for trace-element analysis were taken from small drainage basins that contained the above features and in addition showed some evidence of being mineralized.

The results of both the visual examination and the sampling were discouraging; wadi sands from an area in Wadi Hayyan where scattered small bodies of magnetite and small displays of secondary copper minerals were observed, contain geochemically

anomalous amounts of zinc and other elements. We saw no evidence of potentially economic mineral deposits.

GEOLOGY

Except for a narrow discontinuous belt of limestone and bedded rocks of Tertiary age near the Red Sea all of the rocks of the quadrangle are thought to be Precambrian in age. A northwest-trending belt of schist and gneiss extends through the center of the quadrangle. These moderately high-rank metamorphic rocks are flanked on the north and south by slightly metamorphosed volcanic rocks and interbedded clastic rocks. Unconformably overlying the metavolcanic rocks south of the gneiss belt are conglomerate and sandstone. All of the above rocks have been intruded by dikes that range from rhyolite to lamprophyre in composition and by numerous plutonic intrusions of granitic, intermediate, and mafic rocks. The most prominent structural feature of the area is a belt of large northwest-striking faults that coincides with the area of schist and gneiss.

Hornblende gneiss and biotite gneiss that locally contain garnets, quartz-mica schist, chlorite schist, and sericite schist crop out in a belt that crosses the Bi'r Al Bayda' quadrangle in a northwesterly direction. In the southeastern corner of the area the belt is 30 kilometers wide but it narrows to 6 kilometers at the north edge of the quadrangle. The stratigraphic succession and origin of these rocks is not known as they are confined to a zone of intense faulting. In places slightly metamorphosed volcanic rocks appear to grade into rocks of higher metamorphic rank where a major fault is approached, but elsewhere fault slices of garnet-bearing gneiss lie without gradation adjacent to volcanic rock of low metamorphic grade. It seems likely that rocks of different ages are represented in the fault zone. For this reason the lithologic symbol "sc" used by Brown and others (1963) is retained on our map for these rocks of indeterminate stratigraphic position.

Slightly metamorphosed volcanic flows and breccias underlie broad areas on either side of the belt of faulting. Mafic flows and breccias predominate, but light-colored felsic rocks are common. In places the rocks are schistose but in general the metamorphism consists of clouding of the plagioclase and the partial

to complete conversion of the ferromagnesian minerals to chlorite. Adjacent to intrusions the rock may be converted to a dense black hornfels. Interbedded with the metavolcanic rocks are conglomerate, wacke, and more rarely recrystallized limestone.

Brown and others (1963) show the metavolcanic rocks of quadrangle I-204 as greenstone with the symbol "gd", and they separate the greenstone from a unit they call the Halaban andesite. We are following their usage and are showing the metavolcanic rocks with the symbol "gd" but it should be noted that we were not able to make a satisfactory separation of greenstone and Halaban andesite elsewhere in quadrangle I-204 and it seems likely that they are at least in part correlative.

Argillite and sandstone of the Hadiyah formation unconformably overlie the metavolcanic rocks in the Al 'Ula quadrangle east of Bi'r Al Bayda', but only a small tongue of these rocks projects into the Bi'r Al Bayda' quadrangle southeast of Bi'r Al Bayda'. The argillite and sandstone appear to strike into schistose metavolcanic rocks on the north and west and to be in fault contact with gneissic rocks on the south.

The metavolcanic rocks southwest of the belt of schist and gneiss are unconformably overlain by conglomerate and sandstone whose stratigraphic position is unknown. The thick conglomerate beds contain pebbles and cobbles of various granitic rocks as well as metavolcanic rocks, but the beds are intruded by granite and dike rocks. They could correlate with the Hadiyah formation or they could be younger.

The conglomerate and sandstone are the youngest bedded rocks in the area that we examined. Limestone and associated clastic rocks crop out near the Red Sea and are thought to belong to the Raghama formation of Miocene age. The Raghama formation is known to contain large gypsum deposits but none have been reported in the Bi'r Al Bayda' quadrangle. The areas in the Wadi As Sirr basin shown as questionable Raghama formation on the geologic map of quadrangle I-204 (Brown and others, 1963) were found to be unconsolidated boulders from dissected terraces.

Intrusive rocks

More than 25 intrusions of plutonic rocks are shown on the accompanying map. Granitic rocks are the most abundant, but monzonite, diorite, and gabbro also occur.

Dikes lacking preferred orientation are common throughout the area, and locally swarms of parallel dikes crop out. The dikes range in composition from rhyolite to lamprophyr Precise petrographic names cannot be given to the dike or plutonic rocks because they have not been examined microscopically.

The granitic rocks are those that contain an appreciable amount of quartz, as much as 30 percent in some intrusions. In the mapped area they include alaskite, granite, adamellite, and probably tonalite. They are commonly medium-to coarse-grained The mafic minerals are biotite, hornblende, or both except for one muscovite-biotite granite. Magnetite may be an abundant accessory mineral. Some granitic intrusions have sharp contacts with the enclosing rocks, others have broad contact zones of granitized country rock and contaminated granite. More than one period of granite intrusion took place as shown by the "rs" conglomerates that contain granite pebbles and are themselves intruded by granite. Also, the larger granitic bodies are composite We were unable to find fresh intrusive material for age determination.

Medium-to coarse-grained monzonite is the predominant rock in the intrusive that underlies the Bi'r Al Bayda' basin and in the adjacent intrusion to the northwest; both are shown as "dg" on the map. Diorite occurs at the Umm Harb gold deposit mixed with minor amounts of tonalite.

The gabbro of Wadi Hayyan as well as that east of Wadi Thalbah occurs with diorite in ring structures. The ring structure of Wadi Hayyan is of interest becuase it contai several small bodies of massive magnetite as well as geochemically anomalous amounts of several metals.

Structure

Structurally the area is characterized by a series of large subparallel northwest-trending faults. The major faults lie within the belt of gneiss and schist. Parallel faults to the northeast do not have as strong surface expression, but they are of interest in that they have a higher metal content than the major northwest-trending faults.

All of the layered rocks have been folded and they now commonly dip at high angles. The folding is complex and more detailed work is needed to work out the structure.

ECONOMIC GEOLOGY

Gold appears to be the only metal that has been mined in the area. The mining was probably done during the period of widespread mining activity from 120 to 520 A. H. (700 to 1100 A.D.). The Saudi Arabian Mining Syndicate (SAMS) prospected the area in the 1930s and reported the location of 11 gold prospects in the Bi'r Al Bayda' quadrangle. R. G. Bogue (written communication 1953) visited three of the prospects and we examined two. The earlier reports and assay data show that the prospects are not economic at present, therefore we did not take the time to search for deposits whose location was not well defined. Most prospects are in the coastal hills and six are in the northwest corner of the quadrangle. The following summaries of the deposits are taken from the unpublished reports of SAMS engineers in the files of the Ministry of Petroleum and Mineral Resources supplemented by observations of R. G. Bogue in 1953 and ourselves.

Hawawit

The Hawawit prospect is located in the northwestern part of the area on a small tributary of Wadi Azlam. It was examined and sampled by T. P. Larken and E. Csisko of SAMS in 1936; we visited the deposit in 1964. Massive white quartz veins as much as 2 meters thick cut metavolcanic rocks in both northerly and easterly directions. The veins were mined by means of shallow pits and trenches. The deepest opening, a pit at a vein intersection, reaches a depth of about 8 meters. The ancients left the massive white quartz in place wherever possible and mined narrow zones on each wall of the vein.

Larken took 26 samples of vein outcrops and float. The best sample was from 1 meter of vein quartz that included a wall of the vein and contained 0.44 ounce of gold per ton ($15.40 at the present price of gold). Only four samples contained more than 0.15 ounce per ton. Csisko took an additional 44 samples from trenches dug to test vein extensions. Most samples contained traces of gold, the best contained 0.2 ounce per ton.

Al Buwaydah

This prospect lies about 8 kilometers west of the Hawawit prospect and 3 kilometers from the sea. It was examined and sampled by T. P. Larken and E. Csisko of SAMS in 1936. The deposit is reported to be in granite with volcanic rocks, probably metavolcanic, to the north, east, and south. Old workings follow a vein in a prominent northwest-trending shear zone as well as other veins in the vicinity. Larken took 138 samples from the deposit, sampling veins, dumps, tailings in the ruined houses, and gravels in the wadi. Csisko took 61 samples from trenches he had dug across the principal veins. The results were uniformly low except for a sample of a 30 centimeter quartz vein that contained 7.0 ounces of gold per ton and another that contained 0.71 ounce; all the rest were below 0.25 ounce per ton.

Nabagah

The reported location of the Nabagah prospect is uncertain. Coordinates given for the deposit place it well inland on Wadi Marra but the description states that it is in diorite 1.6 kilometers from the sea. The coordinates may have been based on a different grid. The unnamed wadi north of Wadi Marra seems to fit the description.

Ancient workings lie on the north side of a wadi on a strong northwest-trending quartz vein that is cut by the wadi. An iron-stained portion of the vein assayed 1.6 ounces of gold per ton but a detailed sampling program carried out by T. P. Larken and E. Csisko of SAMS in 1936 did not indicate a mineable ore body. More than 700 samples were taken. Only 30 of the samples assayed more than 0.15 ounce per ton and only 4 were as much as 0.7 ounce of gold per ton.

Al Khadra

Shallow trenches on quartz stringers are reported about 6.5 kilometers west or northwest of the Hawawit prospect in rocks called an igneous complex. Samples taken by T. P. Larken and E. Csisko show only traces of gold; one sample contained 0.25 ounce of gold per ton.

Silaila

T. P. Larken reports that this prospect lies about 3 kilometers north of the Hawawit deposit. Workings consist of two pits about 3 meters deep on quartz stringers that are about 15 centimeters wide and exposed for a length of 3 meters. No ruins or tailings were seen. A sample from the north vein contained 0.23 ounce of gold per ton and one from the south vein 0.11 ounce.

Al Marra

T. P. Larken reports that this prospect lies about 3 kilometers south of the Hawawit deposit. A quartz outcrop about 20 meters long and 5 meters wide has a trench on its east margin that is 6 meters long and less than 2 meters deep. Larken took six samples from the outcrop the highest of which contained 0.19 ounce of gold per ton.

Antar vein

The Antar vein, nearly 1,400 meters long, lies beside the Al Wajh - Duba road about 46 kilometers north of Al Wajh. G. A. Shaw and E. Csisko of SAMS report it to be one of the longest veins in the area. Csisko took more than 200 samples of the vein, but they showed only traces of gold.

Abu An Naam

This deposit was examined by SAMS engineers in 1936. They report 3 parallel veins lying nearly due east of Jabal Liban and about 25 kilometers northwest of the ancient mine at Al Qubba. We did not visit the deposit and the location shown on the map is only approximate. The veins strike northwesterly extend more than one kilometer, and range from 3 to 12 meters in width. Ancient workings extend for 400 meters along the veins. Of eight samples taken five showed only traces of gold and the best contained 0.3 ounce of gold per ton.

Umm Harb

The Umm Harb deposit lies between Wadi As Sirr and Wadi Rabigh near the southern end of the broad valley of Wadi As Sirr. The deposit seems to fit the description of Bogue's Umm Harat deposit except that we found the vein to dip northwest rather than southeast as stated by Bogue. The vein strikes northeasterly, is more

than 100 meters long, and ranges from 2 to 8 meters in thickness. The vein is largely massive white quartz that contains sparse sulfides. The massive quartz was either left in place or thrown away by the ancient miners who apparently were looking for thin veinlets of high grade material in and along the walls of the vein. SAMS engineers took 31 samples at the deposit. A sample from the bottom of a stope contained 0.35 ounce of gold per ton but all the others were less than 0.05 ounce.

Aba Al Qazaz

Bogue reported pits and trenches on small quartz veins in the hills east of the well at b r Aba Al Qazaz. No sulfide minerals or gold were seen by Bogue.

Bi'r Bayda' (An Naal)

Pits and trenches dug on quartz vines are reported by Bogue in 1953 to be located about 8 kilometers north of Bi'r Al Bayda'. S. C. Bullock of SAMS sampled old workings in the same area in 1936. Bullock took eight samples of vein material and adjacent bank gravels. The gravel was barren and the best vein sample assayed 0.28 ounce of gold per ton.

GEOCHEMICAL PROSPECTING

The present investigation was broader in scope than the earlier work in that an entire area was covered for a broad spectrum of minerals rather than spot investigations for gold. Most areas in the eastern half of the Bir al Bayda' quadrangle that were accessible by car were visited and any area that showed evidence of mineralization was sampled for trace-element analysis. Complete aerial photo coverage of the area was available and proved indispensible in planning routes and selecting targets for spot examinations on the ground. Features not visible from a car or not accessible by car could thus be examined to provide a better coverage of the area. The geologic features of possible economic significance that could be located on the aerial photographs were faults and fault intersections, dikes, granitic or mafic intrusive contacts, bleached areas, and unusually dark areas. Additional features looked for on the traverses and too small to show on the photographs were veins, gossan zones, and subtle color variations such as iron-staining from disseminated pyrite.

The locations of the samples taken for trace-element analysis are shown on the accompanying map. The samples are from wadi sediments. The size fraction taken is between 30 and 80 mesh. Most samples were taken from wadis with small drainage basins for better control of the source material. In places where wadi sediment sample was not satisfactory rock samples were taken directly from veins or altered rocks. The rock samples are not all shown on the map but are discussed below.

The samples were taken to test features that, in our opinion, showed the most promise of containing economic minerals. Certain large areas are unsampled or only sparsely sampled where we thought there was little worth sampling. An example of a large area without samples is the region underlain by schist and gneiss southeast of Wadi Rabigh. Areas underlain by "rs" conglomerate were given only a sparse sample density. This procedure seems to be justified in the area underlain by schist and gneiss by the uniformly low trace-element content of samples taken elsewhere in that belt. The "rs" conglomerates, however, do contain slightly anomalous amounts of copper and boron in samples taken along faults. Traces of secondary copper minerals were seen at one locality in andesite flows interbedded with conglomerate, but other veins, dikes and granite contacts in the "rs" rocks appear to be barren, and the possibility of finding a minable deposit seems poor.

The wadi sediment and rock samples were analyzed spectrographically for trace amounts of 27 elements in the Ministry of Petroleum and Mineral Resources laboratory in Jiddah. Charles E. Thompson of the U. S. Geological Survey was the analyst. The location and significance of anomalous values of the various elements are discussed in the following paragraphs. A threshold value for each element was determined by a method suggested by Hawkes and Webb (1962, p. 31) and only those samples whose analyses rise above this threshold are discussed.

Silver in anomalous amounts was found only in three rock samples that came from a small area in and west of Wadi Jarasah near the north border of the map. This is within a larger area that is recommended for more detailed study. Silver may be an indicator of base-metal deposits.

Boron in anomalous amounts occurs in two wadi samples taken along a northeast-trending fault in "rs" conglomerate just south of the mapped area.

Barium is of possible use as an indicator because of its association with lead and zinc deposits (Hawkes and Webb, 1962, p. 360). A sample (4248) in hornblende-biotite granite with a pronounced ring structure about 16 kilometers south southeast of Bi'r Al Bayda', and another (4263) 6 kilometers toward Al Bayda' from the first on the margin of the Bi'r Al Bayda' monzonite in a pegmatite-rich area, are high in barium.

Beryllium occurs in high amounts only in a rock sample (4285) from a quartz vein 17 kilometers northwest of Bi'r Al Bayda', where it is associated with anomalous amounts of silver, molybdenum, and lead.

Cobalt is found in anomalous amounts in the gabbro and diorite ring structure of Wadi Hayyan.

Chromium is anomalous in two wadi samples in gabbro, one on the eastern edge of the Jabal Liban granite and the other in the small gabbro body 12 kilometers southwest of Bi'r Al Bayda'.

Copper is shown for all the sample localities on the map. Abnormal samples are widely scattered and only slightly above threshold.

Lanthanum is anomalous in two samples from coarse-grained biotite granite, one (4273) near Wadi Al Bayda' southwest of Bi'r Al Bayda', and the other just north of the mapped area. A sample from altered rock (4277) within the Bi'r Al Bayda' monzonite, northwest of the well, is also high in lanthanum.

Manganese in anomalous amounts occurs in the gabbro ring structure of Wadi Hayyan associated with high cobalt and zinc.

Molybdenum is a useful guide in geochemical prospecting. The anomalous samples are shown on the map. Most are in the gabbro ring-structure of Wadi Hayyan and in the area to the east.

Nickel in stream sediments has been used successfully in prospecting for nickel deposits (Hawkes and Webb, 1962, p.370). We took four wadi samples from a small area south of Bi'r Al Bayda' that contained abnormal amounts of nickel.

(4260, 4261, 4263, 10389). The rocks of the area are granitic to intermediate in composition which is unusual as nickel is normally associated with the more mafic rocks. A-omalous nickel, together with chromium, also occurs in the small gabbro southwest of Bi'r Al Bayda'.

Titanium in anomalous amounts occurs in varied environments. A sample from hornblende-rich gneiss (4233) contains titanium and molybednum. Another (4284) is in amphibolite northwest of Bi'r Al Bayda'. Other samples with anomalous titanium are in the gabbro ring structure of Wadi Hayyan, as may be expected.

Vanadium appears to be high or anomalous in samples with high titanium, principally in the gabbro ring structure and in the amphibolite of Wadi Jarasah.

Zinc occurs in anomalous amounts only in the gabbro ring structure as shown on the map. Samples that contain higher than background zinc are also shown.

RESULTS

The results of the mineral reconnaissance are not encouraging. The belt of northwest-trending faults is uniformly low in metal content. We did find a few crystals of kyanite and a small mass of kyanite in a sericite schist but did not find any indication of a workable deposit.

An area that contains anomalous trace amounts of base metals and other elements includes the gabbro and diorite ring structure of Wadi Hayyan near the north edge of the map and extends east and southeast to Wadi Jarasah. Small bodies of massive magnetite occur in the ring structure. They range in size from a few hundred to a few thousand tons of magnetite and appear to be most numerous near the border of the ring structure. A fault cuts off the ring structure just north of the mapped area and traces of secondary copper minerals were found along the fault. We recommend additional work in this area. The ring structure could be the target for an airborne magnetometer survey to search for larger bodies of magnetite, and the adjacent area to the east could be examined and sampled in more detail for the possible presence of base-metal ore deposits.

A quartz vein 17 kilometers northwest of Bi'r Al Bayda' contains numerous limonite-filled cavities. A sample from this vein showed a markedly anomalous trace element content of silver, beryllium, molybdenum, and lead. The vein is as much as two meters thick and about 1 kilometer long. It should be examined more

closely in conjunction with the more detailed regional survey that is recommended in that area.

REFERENCES

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Explanation

Quaternary — Qal — Alluvium and wadi fill

Quaternary & Tertiary — QT — Terrace deposits and local gravels of the Pushkin formation

Precambrian

rs — Conglomerate, sandstone, shale, and minor volcanic rocks. Conglomerate may be as much as 1000 meters thick, contains granite pebbles as well as pebbles of various volcanic rocks. Cut by numerous dikes. May be in part correlative with Hadiyah formation.

h — Hadiyah formation. Slightly metamorphosed gray argillite with minor sandstone and conglomerate.

gr — Reddish to gray biotite granite or hornblende granite. Forms discordant plutons commonly with sharp unmineralized contacts.

gb — Gabbro. Forms sill intrusions and dikes associated with diorite in ring structures.

dg — Granodiorite, diorite, or monzonite. Dark colored rocks with numerous inclusions of amphibolite rock and cut by many dikes. Contacts commonly gradational.

gg — Gray to brownish hornblende granite with numerous inclusions and dikes. Tends to be concordant in structure with enclosing rock. Contacts commonly gradational.

gl — Slightly metamorphosed andesitic to rhyolitic volcanic rocks including flows and pyroclastics. Mafic rocks are dark greenish brown. Interbedded with minor amounts of clastic sedimentary rocks and, rarely, limestone. Characterized by numerous dikes that range from porphyries to rhyolites in composition.

am — Amphibolites and hornblende-rich rocks closely associated with dg-type intrusive rocks.

sc — Hornblende-garnet gneiss, biotite gneiss, amphibolite, mica schist and phyllite occurring in the area cut by large N-trending faults. At least in part metamorphosed equivalent of gl volcanic rocks, Hadiyah formation, and granite.

Contact. Dashed where approximately located, dotted where concealed.

Fault. Dashed where approximately located, dotted where concealed.

Road

Sample of wadi sediment with less than 30 ppm (parts per million) copper.

Sample of wadi sediment with 30 to 60 ppm copper.

Sample of wadi sediment with 100 to 300 ppm zinc (small triangle); with more than 300 ppm zinc (large triangle).

Sample of wadi sediment with more than 5 ppm molybdenum.

4225 — Sample number

X — Rock sample locality.

Dike. Majority of dikes too small to show on map.

Quartz vein