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EXPLORATION AND EVALUATION OF THE HAJRAH-HAMDAH GROUP OF ANCIENT GOLD MINES, KINGDOM OF SAUDI ARABIA

by

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ABSTRACT

The Hajrah-Hamdah group of ancient mines includes the Hajr mine, the largest in southern Saudi Arabia, and several lesser deposits. Gold at the Hajr mine is widely disseminated along the contact between an overlying serpentinite and an underlying hornblende schist. Two parallel northwest-trending areas contain erratically distributed higher grade zones of metallization averaging 3 to 5 grams per metric ton (g/t) gold, but locally as much as 10 g/t. Serpentinite and hornblende schist are generally altered along the contact, and aplite and granite dikes and quartz-carbonate stringers are common in the contact zone. Gold at the Jabal al Hajrah, Hajr Gharb, and Bi'r al Hamdan ancient mine sites is in close proximity to aplite and granite dikes. The gold is in quartz stringer zones, and along the footwall of shallow-dipping aplite or granite dikes. Metallization is erratically distributed and generally of low grade, although one surface sample contained 63 g/t gold.

The ancients mined a considerable amount of gold from the area. Waste dumps comprising 200,000 tons of material in the Hajr mine area contain an average of 3.8 g/t gold and may constitute a resource to accompany higher grade primary ore.

Metallization in the Hajrah-Hamdah area probably is too low in grade and too erratically distributed to be of present economic potential. Two areas are worthy of limited future exploration: the northwest and southeast extensions of the two northwest-trending zones of metallization in the Hajr mine area, and mineralized rock along felsic dikes in the Hajr Gharb and Jabal Hajrah areas. Also, the possibility of disseminated gold within one of the lithologic units of the layered or ultramafic sequence should be tested on regional and local scales.

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INTRODUCTION

Location and description

The Hajrah-Hamdah group of ancient gold mines, lat 18°52'N. to 18°57'N.; long 43°34'E. to 43°53'E. (fig. 1) is one of 38 separate groups of mines defining the Jabal Ishmas-Wadi Tathlith gold belt (Worl, in press). The general area is known locally as Hajrah (transliterated in a number of ways, such as Hijrah and Higera in previously published reports), the name applied to the ancient mines by earlier workers. Unfortunately, Hajrah is a common place name in southern Arabia, and several ancient mines with the name of Hajrah are on record. Therefore, the name of a local landmark, Hamdah, a nearby village, was added to alleviate confusion. The Hajrah-Hamdah group consists of four areas with a concentration of ancient mines and numerous scattered ancient workings (pl. 1). The Hajr mine area (pl. 2) has the largest concentration of ancient workings and is in fact one of the largest ancient mines in Saudi Arabia. Jabal Hajrah, Hajr Gharb, and Bi'r al Hamdan (pl. 1) are lesser occurrences.

The Hajrah-Hamdah area, hereafter known as the area, is in low rolling hills along the northern edge of a large plain, Sahl al Amk, approximately 20 km south of the present village of Hamdah. The old village of Hamdah as shown on the map of the Asir quadrangle (Brown and Jackson, 1959) was destroyed by flood waters in 1968. Elevation in the area ranges from 1350 m along Wadi Tathlith to 1444 m on the highest peak. Rainfall probably averages less than 15 cm per year, and comes as heavy rains with accompanying sheet flooding and wadi flooding in winter months. The village of Al Amwah, the local Emirate, is 20 km south and Tathlith, the major commercial center for the region, is 80 km north. The major desert track from Najran to Tathlith and Bishah is directly east of the Hajr mine. East-west travel by vehicle is difficult in this region because the mountain ranges are elongate north-south.

Previous investigations

Serpentinites in the general area have been investigated for their asbestos and magnesite potential on several occasions, the latest by Rooney and Al-Koulak (1974), who include a review of previous studies. Warden (1969) has mapped the Markas 30-minute quadrangle at a scale of 1:100,000 for the Directorate General of Mineral Resources (DGMR). The previous serpentinite studies did not include mapping or regional studies, and there have been no previous studies of the ancient mine sites. Schaffner (1957) briefly mentions the ancient mines in a report on nearby serpentinites and

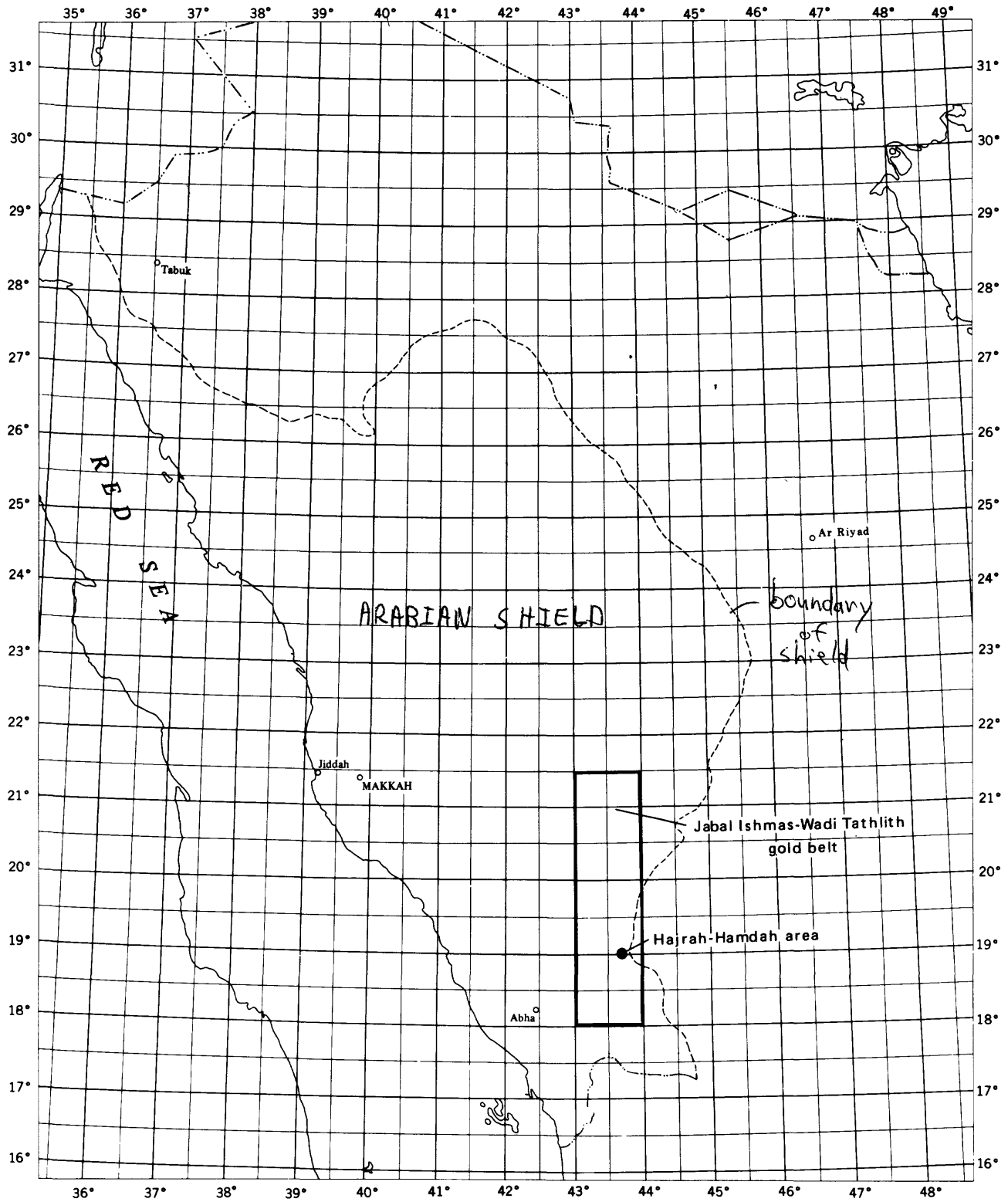

Figure 1.––Index map showing location of Jabal Ishmas–Wadi Tathlith gold belt and Hajrah–Hamdah area.

suggests that the commodity sought may have been gold. Overstreet (1978) and Warden (1969) mention ancient workings but did not map or sample them.

Present investigation

Preliminary investigations of deposits in the Jabal Ishmas-Wadi Tathlith gold belt indicated that the Hajr mine (pl. 2) is the largest in southern Arabia and that the potential for economic concentrations of gold is high. The purpose of this study was to define the geologic setting of the mineralization, not to outline potential orebodies.

The general Hajrah-Hamdah area was mapped at a scale of 1:10,000 (pl. 1) and the Hajr mine area at a scale of 1:2,000 (pl. 2) directly on enlarged aerial photographs. Data was later transferred to topographic base maps. Low-altitude aerial photography and 1:2,000- and 1:100,000-scale topographic maps were provided by Roy Nixon and Fred Fuller of the U.S. Geological Survey Saudi Arabian Mission. Field work was conducted intermittently from March 1976 through November 1976.

Fourteen vertical diamond drill holes tested the mineralized zones. Drilling was by the Arabian Drilling Company during the period 23 June 1976 through 16 December 1976. Diamond drill holes Hr-1 through Hr-12 were in the Hajr mine area (pl. 2), Hr-13 was in the Hajr Gharb area (pl. 1), and Hr-14 was a reconnaissance test hole in an altered zone 6 km S. 70° E. of the Hajr mine area (fig. 2).

Analysis of all geochemical samples was by the DGMR-USGS laboratory in Jiddah under the direction of Joe Curry. All work was performed in accordance with a work agreement between the U.S. Geological Survey and the Ministry of Petroleum and Mineral Resources, Kingdom of Saudi Arabia.

GEOLOGIC SETTING

Regional geology

The ancient gold mines in the Hajrah-Hamdah area are part of the Jabal Ishmas-Wadi Tathlith gold belt that extends 250 km north and 100 km south of the Hajrah-Hamdah area. The north-south belt is aligned along a major fault system, the Jabal Ishmas-Wadi Tathlith fault zone, and many of the

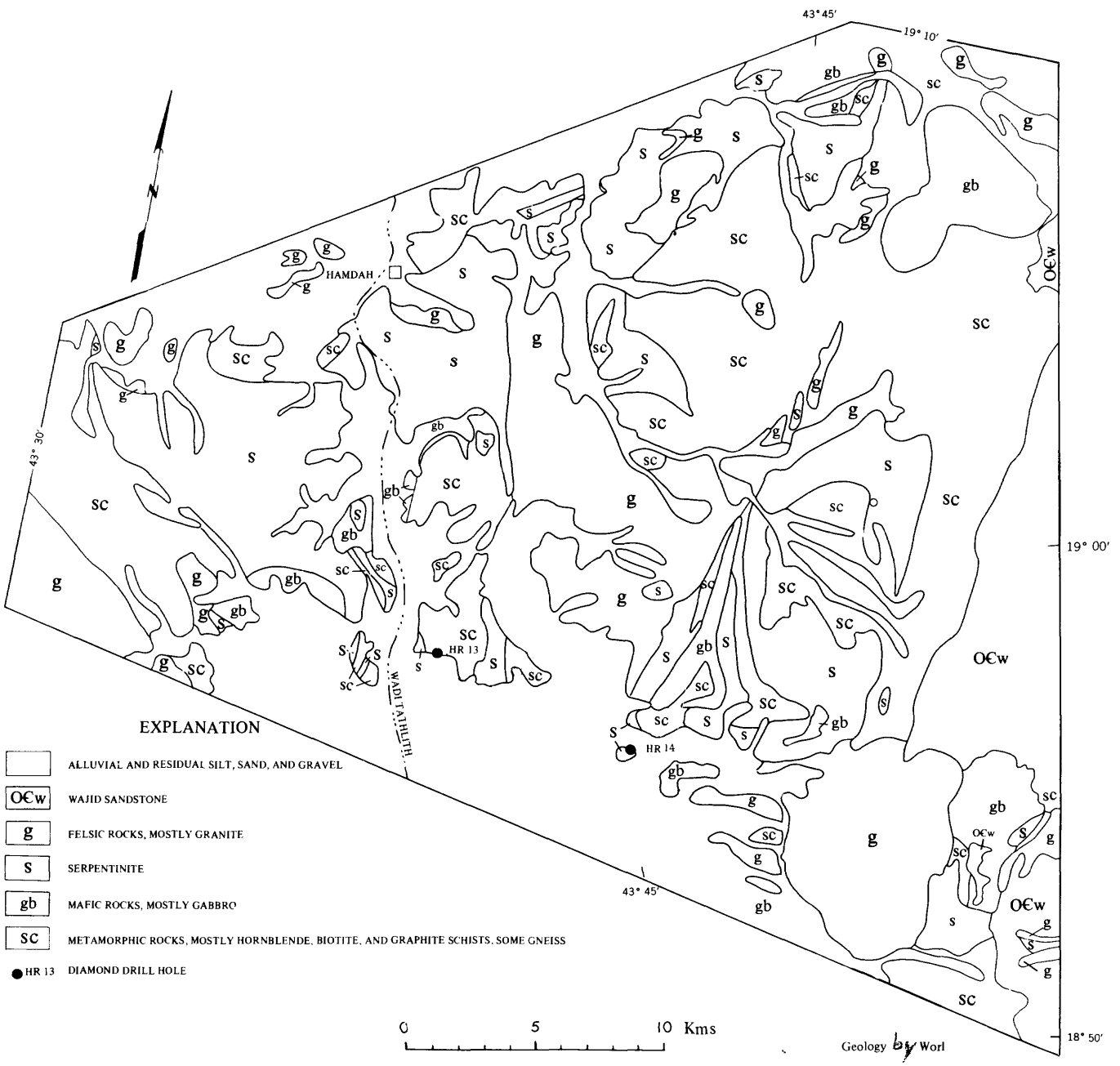

Figure 2.——Geologic map of the Hajrah–Hamdah area showing the locations of drill holes Hr-13 and Hr-14 (after Rooney and Al-Koulak, 1979; geology by R.G. Worl).

deposits within the belt are in second- and third-order fractures of this fault zone. The ancient gold mines are within greenschist-facies, metavolcanic, and metasedimentary rocks that occupy arcuate north-trending belts in crystalline metamorphic and igneous rocks. The layered rocks are largely andesites and volcanic wackes; massive volcanic flow rocks and coarse clastic sedimentary rock predominate in the northern and southern parts of the belt, and finer grained volcaniclastic and clastic rocks predominate in the middle parts, where the Hajrah-Hamdah area is located. Serpentinites are common along the zone from lat 18°45'N. northwards, but are not present south of this latitude.

Most of the gold deposits in the gold belt are within or along quartz veins or quartz-rich breccia zones, but the deposits in the Hajrah-Hamdah area and those in the Jabal Mahanid area 17 km north are unique in that they are aligned along the altered contact between an overlying serpentinite and an underlying hornblende schist (pl. 4). Quartz stringers are present locally as are felsic dikes, but much of the mineralization is in altered rock containing no quartz or felsic dikes.

Five separate major groups of deposits can be delineated along the gold belt. The deposits within each group are similar types in similar geologic settings, and are probably genetically related. The deposits of the group that includes the Hajrah-Hamdah deposits are genetically related to the late phases of quartz monzonite-to-granite plutons and dikes (Worl, 1979).

Layered rocks

Three layered rock units are recognized in the area: quartz-biotite schist, hornblende schist, and carbonaceous schist. The quartz-biotite schist is thought to be the oldest unit, but relationships are not clear. This unit is mostly medium grained, highly foliated, and sheared, and contains local calc-silicate zones and magnetite-rich lenses. Foliation is defined by oriented biotite and lithologic layering, and pods and stringers of quartz are common. Relict layering, where present, is parallel to the foliation. Lenses of metasiltstone, mudstone, quartzite, marble, quartz porphyry, amphibolite, and hornblende schist as much as 100 m thick are intercalated with the schist. Light-brown metasiltstones within the unit are thin or rhythmically bedded and contain ripple marks, whereas greenish-black mudstones are massive, have faint layering, and contain detrital fragments of quartz and feldspar in many places. Quartzites generally contain a few percent of biotite, sericite, or hornblende. Medium- to dark-gray marbles are

often boudinaged, as are many of the amphibolite bodies. Hornblende schist lenses, in many places showing layering, are common, and are gradational into the quartz-biotite schist.

The hornblende schist unit includes a variety of metavolcanic and metasedimentary rocks. Most of the exposures contain relict layering and textures that suggest that the parent rocks were crystal lithic tuffs and volcanic wackes. Massive rocks showing the texture of vesicules are present but not abundant. Some of the very fine-grained massive rocks in this sequence may represent later dikes. Epidote is a locally abundant constituent in the hornblende schist. Volcanic flow rocks and agglomerates are minor constituents of this unit. Lenses and intercalations of quartz-biotite schist, biotite schist, and dark-gray marble are common within the hornblende schist. Also included are zones of chlorite and chlorite-sericite schist that seem to be developed mainly along the major north-trending fault zones.

Carbonaceous schist is composed of intercalated lenses of carbonaceous chlorite schist, carbonaceous sericite schist, carbonaceous phyllite, quartz-sericite schist, and thinly bedded marble in the northwestern part of the area. Exposures are highly foliated; tight folds show wisps, and thin bands and layers of carbonaceous material. X-ray and chemical studies by Mohammad Naqvi and John Matzko, USGS Saudi Arabian Mission, found no evidence of graphite. These rocks are physically and mineralogically similar to carbonaceous schists in the Wadi Bidah district where studies indicate that the carbonaceous material probably was of algal origin (Kiilsgaard and others, 1978, p. 72).

Serpentinite

Serpentinite in the area makes up approximately 40 percent of the exposure. Structural and lithologic relations between serpentinite and the other lithologies are complex. Contacts with layered rocks are generally conformable with layering, even where the layered rocks are complexly folded, as in the area north of the Hajr mine (pl. 1). Elsewhere in the Hamdah area, but outside the map area, the serpentinite contact cross-cuts layering and foliation in the layered rocks and serpentinite occurs as cross-cutting dikes. The contact of serpentinite with hornblende schist is in places gradational across several meters whereas that with the carbonaceous schists is sharp. Pods of serpentinite ranging from one to several meters in diameter are common in hornblende schist and carbonaceous schist. These pods are generally close to large masses of serpentinite.

The outward appearance of the serpentinite varies considerably, and includes massive coarse-grained, massive fine-grained, rubbly, streaked, and blocky textures. Colors include buff, green, gray green, purple, brown, and reddish brown. Most of the serpentinite is sheared and is altered to asbestiform minerals, magnesite, calcite, and magnetite, and is commonly silicified along fractures. Talc and tremolite are locally abundant along alteration zones. Most exposures are a punky, rubbly, fine-grained mass that contains scattered trains of chromite grains a millimeter thick and networks of calcite-quartz veinlets surrounding halos of calcification or silicification. Fine-grained, massive mafic dikes showing boudinage, which may be several meters apart, cut the serpentinite.

Intrusive rocks

Layered rocks in the area are cut by an extensive system of felsic and mafic dikes, and the northeastern part of the map area is underlain by diorite and granodiorite-granite. The mafic dikes are fine-grained, massive andesite as much as 3 m in width. These generally north-trending dikes cut all layered rocks, but are cut by dikes ranging from dioritic and granodioritic to granitic composition. Only the larger dikes are shown on the map (pl. 1). Many are cataclastically deformed and schistose, and within serpentinite they are commonly boudinaged.

Diorite exposed in the northeastern part of the area is part of a large north-trending body. Small irregular plutons and dikes cut the layered rocks throughout the area. Inclusions of serpentinite and schist are common in the large diorite bodies. The diorite is generally medium to coarse grained and foliated and contains phenocrysts of amphibole and plagioclase aligned parallel to the foliation. Hornblende, biotite, and quartz diorite are the varieties present.

The youngest intrusive rocks range from granodiorite to granite and are in a large pluton, part of which underlies the northeastern corner of the map area. These rocks form an extensive system of dikes of which two distinct phases are recognized, an older, gray, coarse-grained, porphyritic granodiorite and a younger, white to red, medium-grained, equigranular granite. The dikes are similar in mineralogy to the plutonic rocks, the granite being most abundant. A distinct red garnet can be found through plutonic and dike rocks of this phase and in related quartz veins. The dikes include white, pink, or red granite, graphic granite, felsite, aplite, and pegmatite, which in many places grade from one to another along strike.

Structure

Regional structural trends in this part of the Arabian Shield are dominantly oriented north and dip steeply. The Jabal Ishmas fault zone and parallel belts of metamorphic rocks, gneissic rocks, and batholithic rocks [illegible] north. These features, along with numerous ancient gold mines, define the Jabal Ishmas-Wadi Tathlith gold belt (Worl, 1979). Many internal structures within the individual metamorphic belts are consistent with regional structural trends. Structure within the belt of serpentinite, metavolcanic rock, and metasedimentary rock that underlies the Hajrah-Hamdah area is at variance to the regional, steeply dipping, northerly trends. Much of the hornblende schist contains relict bedding whereas much of the quartz-biotite schist is highly foliated and sheared. Relict bedding and foliation are generally parallel in both rock types. Layering in hornblende schist and quartz-biotite schist define open flexural folds on megascopic and macroscopic scale (pl. 1). Structurally homogeneous subareas, where layering is folded around shallow, generally north-plunging fold axes, are defined by equal-area stereonet plots of poles to foliation (Worl, unpub. data). Structurally homogeneous subareas were not definable at map scale in a zone 200 to 500 m wide in the hornblende schist below the contact with serpentinite. Structural complexity in the layered rocks increases toward the contact where doubly plunging, warped, macroscopic and megascopic folds were found. Poles to layering from this zone and poles to the contact plotted on the lower hemisphere of a Schmidt equal-area net show an extremely wide scatter indicating that the folding is not homogeneous. Attitudes of minor fold axes plotted on the lower hemisphere also show a wide scatter, but they appear to have been rotated around a nearly horizontal east-trending axis.

The nature of the structures along the contact between hornblende schist and serpentinite is a consequence of the great difference in competence between the two rock types. The structures may have developed during emplacement of the serpentinite or during later deformations. The differing elastico-viscous behavior of the two rock types probably set up local stress fields that, in addition to altering the regional field, varied considerably through time and space.

Faults in the area, both high angle and thrust, are local features; the regional structures fall outside the map area. Many of the fractures may be second- and third-order systems related to the major Jabal Ishmas-Wadi Tathlith fault zone, the main strands of which are approximately 20 km west. Many of the fractures, especially those of low angle, may be

directly related to the emplacement of a large pluton that lies just northeast of the area.

High-angle faults trend north, northwest, and northeast, and most of the northwest- and northeast-trending faults are filled by felsic dikes. Healed breccias within the dikes and slickensides and gouge along the edge of the dikes indicate that dike formation in part accompanied, and in part preceded, faulting. Low-angle thrust faults in the area (pl. 1) also developed contemporaneously with the dikes. The older dike phases are cut by the low-angle faults and are highly brecciated, whereas the younger phases, although fractured, cut across the faults. Much of the contact between hornblende schist and biotite schist in the central and western parts of the area is brecciated and may in fact be bedding plane faults. These contacts are not hydrothermally altered, in contrast to the low-angle fault zones. Many of the alteration zones cutting hornblende schist are along low-angle fractures that parallel bedding. There is no brecciation, divergence of attitudes, or juxtaposition of different rock types along these alteration zones as there is along the thrust faults.

GOLD DEPOSITS

Ancient workings

The four major groups of ancient mines are: the Hajr mine, Jabal Hajrah, Hajr Gharb, and Bi'r al Hamdan. In addition, small isolated workings in the general area (pl. 1) are numerous. The ancient workings at the Hajr mine are the most extensive in southern Saudi Arabia and cover an area of approximately 1.5 km^2 (fig. 3) Three types of workings have been recognized: long strings of linear trenches (fig. 4), inclined shafts (fig. 5), and vertical shafts (fig. 6). The trenches are 1 to 3 m in width and 1 m to several meters in depth. Because most of the trenches are now partly filled with silt and sand, an estimate of depth is difficult. The size of associated waste piles suggests that some of the trenches may have been as much as 20 m deep. Forty-six of the trenches are approximately 10 m in length, twenty are 20 to 60 m in length, and three are more than 100 m in length. All of the trenches are along the contact between serpentinite and hornblende schist (fig. 7). The inclined shafts are irregularly lens shaped and follow the contact of serpentinite and hornblende schist, or the footwall of aplite dikes that intrude the contact. Most of the inclines are partly closed by sand and silt; some of those that remain open are more than 10 m deep. The vertical shafts are approximately 1 m square and cut through serpentinite to the contact with hornblende schist. Narrow stopes lead off from

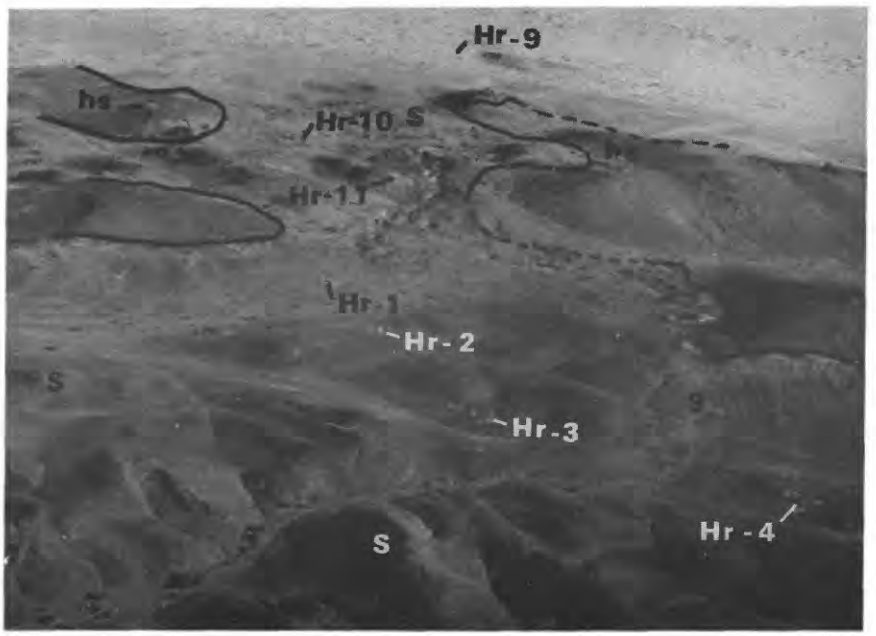

Figure 3.——Aerial view, looking south, of the eastern part of the Hajr mine area. s, serpentinite; hs, hornblende schist; Hr-3, location of drill site.

Figure 4.——Ancient workings along contact of serpentinite (s) and hornblende schist (hs). View looking southwest from a point 260 m southwest of drill hole Hr-4.

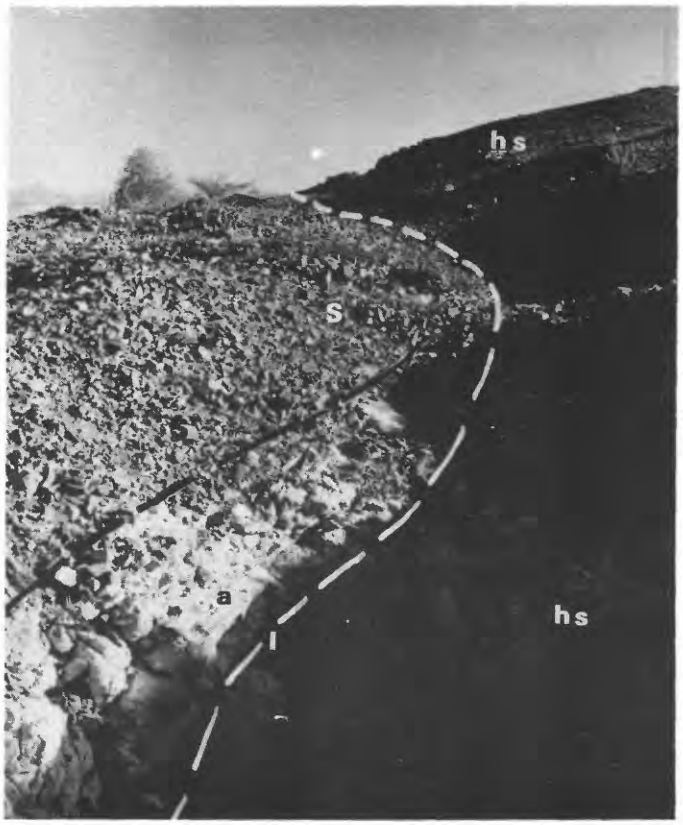

Figure 5.——Ancient incline (I) and pits along footwall of aplite dike (a) at contact of serpentinite (s) and hornblende schist (hs). View looking southeast from a point 140 m southwest of drill hole Hr-4.

Figure 6.——Ancient shaft in serpentinite, 80 m southeast of drill hole Hr-1.

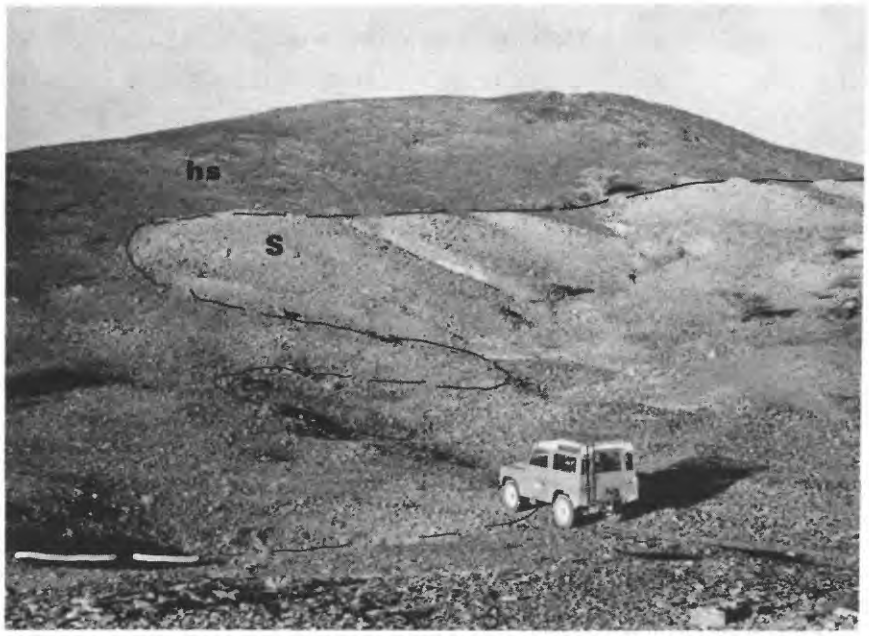

Figure 7.––Ancient waste dumps and open pits along contact of serpentinite (s) and hornblende schist (hs). View looking northeast from a point 75 m northwest of drill hole Hr-7.

Figure 8.––Aerial view, looking east, of the eastern part of the Hajr Gharb ancient mine area. d, waste material from ancient mining; g, granite dikes; x, ancient shafts and pits.

the bottoms of the shafts in all directions along the contact. The shafts are as much as 20 m deep. Waste dumps associated with the Hajr mine are extensive, especially in the northeastern part of the workings. At the southwestern corner lie the ruins of a large ancient village. Tailing piles of fine-grained material, minor slag, and grindstones in the village site give evidence of the former milling and smelting activity.

The most extensively mined areas are between drill holes Hr-1 and Hr-11 and in the vicinity of drill hole Hr-7 (pl. 2). In the northeastern part of the area much of the mining was by deep shafts and inclines. The serpentinite cover is thin there and the ancients sank through the serpentinite to the contact, and then drifted along the contact in all directions. In the southwestern part of the area, south of drill hole Hr-7, the serpentinite cap must have been very thin. The ancients apparently stripped the serpentinite to the contact and backfilled their workings as they progressed. The trenches in this area are filled with sand and silt.

The ancient workings at Jabal Hajrah consist of numerous small pits along bedding in hornblende schist in a highly fractured area along a thrust fault. Most are less than 20 m in length and less than 2 m deep. One deep incline is along the footwall of a dike in the southern part of this group. The ancient workings at Hajr Gharb are along bedding in the quartz-biotite schist, but within 50 m, and generally within 20 m, of granite dikes (fig. 8). The workings are generally narrow inclines along the bedding or deep shafts along the edge of dikes, both types often in excess of 10 m deep. One incline in the southern part of this group is along the footwall of a granite dike. Extensive waste dumps in wadis leading away from Hajr Gharb suggest that a considerable amount of mining was done underground. The ancient workings at Bi'r Hamdan are shallow trenches, now filled by sand, along one layer in quartz-biotite schist.

Mineralization

Mineralization is simple and consists of gold disseminations along selvages of aplite dikes, in or along quartz-carbonate veinlets, in altered serpentinite--commonly with magnetite--and in silicified quartz-biotite schist. Sulfides are not common. In the Hajr mine arsenopyrite occurs as flat plates along fractures in altered serpentinite, and pyrite is a minor mineral in quartz-carbonate veinlets. At Jabal Hajrah locally abundant sphalerite, chalcopyrite, pyrite, and galena are in a quartz vein on the footwall of a granite dike. Pyrite, common throughout the area as fine disseminations in altered and

veined quartz-biotite schist and along bedding in hornblende schist.

Hydrothermal alteration associated with gold mineralization is widespread, but is most noticeable in the serpentinites. Two types are present: calcification, which is most pronounced in serpentinite, and silicification, which is most pronounced in quartz-biotite schist. Calcification of serpentinite produced light reddish-tan to brick-red rocks composed largely of carbonate, talc or chlorite, and magnetite, and is centered on fractures or on the contact between serpentinite and hornblende schist. In many places granite dikes and quartz-carbonate veinlets are associated in the same fracture, either within the altered zone or along strike. Calcification is much more pronounced in serpentinites but is also present in hornblende schist, especially along low-angle faults. Silicification in the serpentinites is only of previously calcified rock, and is best developed in quartz-biotite schist. In the Jabal Hajrah, Hajr Gharb, and Bi'r al Hamdah areas silicification is associated with stockworks of quartz veinlets.

Localization of orebodies

Ancient workings in the Hajrah-Hamdah area are in one of two geologic settings: either along the contact of hornblende schist and serpentinite, or along bedding or layering in quartz-biotite schist in close proximity to granite dikes. Ancient workings in the contact zone are all in hydrothermally altered rock, in many places along the footwall of aplite dikes that intrude the contact. Ancient workings in quartz-biotite schist are close to large granite dikes and are larger and more numerous close to the dikes. Most of the dikes are nearly vertical, but some are shallow dipping and have workings along the footwall.

The many granite dikes in the area are not so large, abundant, or well developed in serpentinite as they are in hornblende schist and quartz-biotite schist. Small aplite dikes are along much of the contact between serpentinite and hornblende schist, but generally do not extend very far into the serpentinite. Hydrothermal alteration zones similar to those that surround the aplite dikes that do cut the serpentinite are common along many of the fractures in the serpentinite.

The association of the ancient workings and geochemical gold values to hydrothermal alteration zones, quartz veinlets, stockworks, and granite dikes and related pegmatites and aplites suggests a genetic relationship. The nearly flat serpentinite acted as an impervious cap to

ascending magmas and hydrothermal solutions, which spread out along the contact and into receptive host beds in the underlying layered rocks. The source of the gold and silver transported and deposited by these solutions is unknown. It is possible that the gold was derived from a local source, for example from the serpentinite complex, quartzitic beds in the quartz-biotite schist, or carbonaceous schist.

EXPLORATION PROGRAM

Geochemistry

Several types of samples were collected for analyses: dump, channel, exploration pit, rock chips or gravels gathered along traverses, grab, and split core. All analyses were performed by the DGMR-USGS laboratory in Jiddah under the guidance of Joe Curry. Each sample was analyzed by semi-quantitative spectrographic methods and by atomic absorption methods for gold and silver. Analytical results for gold are listed in the appendix. Samples for determination of gold by atomic absorption were prepared by: digesting a 10-gram sample split, first in HCl, then in HNO_3; adding HBr and Methyl Iso Butyl Ketone (M.I.B.K.) to the washed and centrifuged solution; washing the resultant organic layer in a weak HCl, HBr, and water solution to remove interfering elements; and collecting the organic layer in a test tube sealed with a polyethylene stopper (Joe Curry, written commun., 1978). Results of analytical work are stored by RASS sample number in computer files on permanent storage at DGMR, Jiddah.

Dump samples consisted of approximately 3 kg of rock chips 1-5 cm in diameter taken from ancient waste dumps. The samples were collected in areas 3 m in diameter from the top 20 cm of dump material. The ancient mine dumps are extensive in both the Hajr mine and Hajr Gharb areas, and may constitute a resource. Waste dumps in the Hajr mine area contain an estimated 200,000 tons and those in the Hajr Gharb area 50,000 tons of material. Dump samples from the Hajr mine average 3.8 g/t gold and range from 0.01 to 74.0 g/t, and from Hajr Gharb average 2.04 g/t gold and range from 0.05 to 15.0 g/t. These values must be considered rough estimates only because of the preliminary nature of the sampling. The thickness of waste material is unknown but is estimated to average between 1 and 2 m.

Channel samples were taken across the altered, veined, and, in places, gold-bearing contact between serpentinite and hornblende schist. The samples were altered serpentinite and hornblende schist and, where present, aplite. The length of channel varies with the width of alteration and exposure, but

was generally 50 cm to 1 m in length. Samples were made up of 1 to 3 kg of chips 2 to 5 cm in diameter taken from outcrops along a continuous strip. Samples from the Hajr mine average 1.25 g/t gold, and range from nil to 12.8 g/t. Channel samples from Jabal Hajrah contain 0.05 to 2.30 g/t gold and those from Bi'r al Hamdan and drill hole Hr-14 all contain less than 0.04 g/t gold.

In the Hajr mine area 10 exploration pits were dug across the contact between serpentinite and hornblende schist to expose the contact for sampling. Most were within ancient mining trenches that had been filled with silt, one was on the contact where there had been no ancient mining, and one was in wadi fill. All were less than 2 m deep and all reached bedrock. Samples taken were channel or grab samples from zones 10 to 50 cm in width that the ancients mined. These samples average 3.31 g/t gold and range from 0.02 to 40.0 g/t gold.

Traverse samples were taken along two lines in the Hajr mine area (pl. 3), one along the north-south base line and one along the east-west base line. Each sample consisted of 2 to 3 kg of chips 2 - 5 cm in diameter. In areas of no outcrop, samples of gravel weighing 2 to 3 kg and averaging less than 5 cm in diameter were collected along the traverse line. The sample interval was either 10 m or 20 m. These samples average 1.67 g/t gold and range from nil to 87 g/t. The higher gold values are in samples collected from ancient waste dumps, from wadis that drain the ancient dumps, and from chip samples within or next to the ancient workings. A few chip samples of hornblende schist and serpentinite away from the ancient workings contain anomalous amounts of gold.

Grab samples consisted of 1 to 2 kg chips taken from the outcrop within or next to ancient workings. An attempt was made to sample the material that was mined. Most of the grab samples were taken in the Hajr-Gharb area, and several contain anomalous amounts of gold, one a significant amount. This sample consists of quartz breccia from the footwall of a large felsic dike. Grab samples from drill site Hr-14 (fig. 2) and other sites (pl. 1) all contain less than 0.12 g/t gold.

Diamond drill core was split, one half retained, and one half submitted for analyses. All analytical results are listed in the appendix. Metallized zones encountered in the diamond drilling are listed in table 1.

Gold is the only metal detected in both surface and split core samples in anomalous amounts. Silver values are low, generally less than 1 g/t, and only one value is greater than

Table 1.--*Zones of gold metallization in core samples from diamond drill holes Hr-1 through Hr-14*

Drill Hole	Interval (meters)		Length (meters)	Rock Type	Gold (ppm)
Hr-1	11.00	11.50	.5	Altered serpentinite with talc and limonite	1.65
Hr-2	71.50	73.00	1.5	Altered serpentinite	1.33
Hr-3	26.50	27.00	.5	Serpentinite with disseminated pyrite	1.60
	34.50	36.00	1.5	Serpentinite	1.52
	37.00	39.5	2.5	Hornblende schist, siliceous, disseminated pyrite	4.87
	42.50	43.50	1.0	Hornblende schist	3.4
Hr-5	26.50	27.50	1.0	Chlorite schist	1.37
Hr-7	22.50	32.50	10.0	Chlorite schist	2.57
	48.00	49.00	1.0	Chlorite schist	1.26
Hr-10	0	1.90	1.9	Sand and silt	3.4
	1.90	3.65	1.75	Aplite	1.1
Hr-11	15.50	21.50	6.0	Aplite and chlorite schist including contact zone	3.45
Hr-13	20.00	21.00	1.0	Quartz-biotite schist, disseminated pyrite, garnet-bearing quartz veinlets	3.68
	29.00	30.00	1.0		1.55
	37.00	38.00	1.0		2.80

Note: Analytical data of samples from Hr-4, Hr-6, Hr-8, Hr-9, Hr-12 and Hr-14 do not show a zone of gold metallization greater than 1 ppm (see also drill hole analytical data in Appendix F)

3.8 g/t. Semiquantitative spectrographic analyses of all samples did not detect anomalous concentrations of other metals.

Diamond drilling

Diamond drilling was used to test mineralization at the Hajr mine, Hajr Gharb mine, and an alteration zone 6 km southeast of the Hajr mine. Twelve holes were drilled at the Hajr mine, one at the Hajr Gharb mine, and one in the alteration zone. All holes were vertical and ranged from 50.0 to 154.3 m in depth. Diamond drilling was by the Arabian Drilling Company during the period 23 June 1976 to 16 December 1976. A total of 1248 m were drilled in the 14 holes. Core logs containing drilling information, core recovery, structure, lithology and mineralization of core sample, sample intervals, and analytical results are on permanent file in the USGS Mission, Jiddah. Summary geologic logs are given in table 2, and a listing of gold metallization in the core in table 1.

The target tested was the same for each of the 12 drill holes at the Hajr mine: the altered zone along the contact between the overlying serpentinite and the underlying hornblende schist. The objective was to prove existence of mineralization along the contact, or directly below it, not to outline the size, shape, and tonnage of orebodies. The drill holes were located in a manner to intercept the contact at not more than 50 m nor less than 10 m depth. In three of the holes--Hr-10, Hr-11, and Hr-12--the contact was intercepted at a shallower depth than predicted, and in drill hole Hr-2 the contact was intercepted at a greater depth than predicted.

Trace amounts of gold were detected in core from all drill holes, but significant amounts, greater than 5 g/t, were found in only three holes--Hr-3, Hr-7, and Hr-11. Trace amounts of gold were detected in all rock types, and the distribution of trace gold showed no relationship to the serpentinite-hornblende schist contact. Significant gold, however, was detected only in hornblende schist at or directly below the contact.

Drill holes Hr-1, Hr-2, Hr-3, and Hr-4 are sited just north of an area of major ancient mining (pl. 2). They are 80 to 150 m from the ancient workings and are located downdip from the workings in the sense that no workings are beyond them to the north. Mineralization in Hr-1 is a 0.5-m zone of 1.7 g/t gold in altered serpentinite between two aplite dikes, and trace amounts of gold in serpentinite, aplite, and hornblende schist were found in three short intervals. In drill hole Hr-2 a zone 1.5 m thick of altered hornblende schist along

Table 2.--*Summary of geologic logs of diamond drill holes Hr-1 through Hr-14*

Interval (meters)		Description
		Hr-1
0.0	0.95	Sand and gravel
0.95	8.45	Serpentinite
8.45	9.40	Aplite
9.40	13.70	Talc (altered serpentinite)
13.70	15.70	Serpentinite
15.70	16.35	Serpentinite
16.35	18.50	Aplite
18.50	24.00	Hornblende-quartz schist
24.00	104.50	Quartz-biotite schist (with minor hornblende)
		Hr-2
0.0	0.90	Sand and gravel
0.90	59.50	Serpentinite
59.50	60.00	Diorite
60.00	72.85	Serpentinite
72.85	85.45	Chlorite-hornblende schist
		Hr-3
0.0	1.50	Loose fragments of serpentinite
1.50	14.20	Serpentinite
14.20	15.90	Massive, fine-grained, altered serpentinite
15.90	36.50	Serpentinite, sparse disseminated pyrite
36.50	46.50	Hornblende schist, disseminated fine pyrite
46.50	47.05	Chlorite schist
47.05	64.60	Hornblende-chlorite schist. Local quartzite and metatuff. Fine disseminated pyrite
		Hr-4
0.0	0.80	Broken fragments of serpentinite
0.80	42.00	Serpentinite with calcite veinlets Possible lapilli fragments. Shear zone about 42.0 m
42.00	70.05	Intercalated units of serpentinite and lapilli tuff (hornblende schist?)
70.05	105.05	Hornblende schist, lenses of carbonate and of sparse disseminated pyrite
105.05	105.20	Aplite
105.20	119.40	Hornblende schist intercalated with metatuff

Table 2.--*Summary of geologic logs of diamond drill holes Hr-1 through Hr-14* [continued]

Interval (meters)		Description
		Hr-5
0.0	2.20	Serpentinite
2.20	13.10	Aplite
13.10	13.85	Sand fill
13.85	21.05	Aplite with local iron stain
21.05	24.05	Quartzite cut by gray quartz veinlets
24.05	28.70	Chlorite schist with carbonate veinlets
28.70	30.35	Chlorite-rich metatuff
30.35	34.40	Lapilli metatuff
34.40	60.75	Tuffaceous hornblende schist
		Hr-6
0.0	2.65	Sand and gravel
2.65	14.50	Serpentinite
14.50	19.30	Aplite dike
19.30	23.00	Biotite schist
23.00	32.10	Metatuff, medium-gray, fine-grained, and intercalated with biotite schist
32.10	32.65	Aplite
32.65	115.15	Tuffaceous schist
		Hr-7
0.0	19.90	Serpentinite with stringers of asbestos as much as 1 cm thick
19.90	51.10	Metavolcanic, talc-rich near contact; mostly muscovite-chlorite to biotite, antigorite-chlorite schist with hornblende locally
		Hr-8
0.0	3.40	Fine silt
3.40	17.50	Serpentinite, with carbonate veinlets, altered brown near contact
17.50	50.00	Chlorite schist, with talc near contact Contact is sheared and gouge zone. Local biotite and sericite schists and quartzite

Table 2.--*Summary of geologic logs of diamond drill holes Hr-1 through Hr-14* [continued]

Interval (meters)		Description
		Hr-9
0.0	3.20	Sand and silt
3.20	39.15	Serpentinite, disseminated hematite near top. Veinlets of carbonate and breccia healed by carbonate at 32.50
39.15	40.00	Biotite-hornblende schist, contact gradational
40.00	45.75	Diorite, coarse-grained near contact but becomes finer-grained downward
45.75	64.75	Biotite-hornblende schist, with sparse disseminated pyrite. Local concentration of biotite
64.75	66.30	Diorite
66.30	77.35	Biotite-chlorite-hornblende schist
77.35	78.25	Diorite
78.25	104.00	Biotite-chlorite-hornblende schist with biotite and chlorite forming intercalated layering in the schist
104.00	104.50	Diorite
104.50	116.55	Biotite-chlorite-hornblende schist
		Hr-10
0.00	1.90	Fine sand
1.90	3.65	Aplite dike, highly broken and altered?
3.65	4.65	Sand fill, probably ancient working
4.65	6.65	Aplite, broken
6.65	7.65	Broken core, mixture of aplite with altered (oxidized) metavolcanic rocks
7.65	21.30	Biotite-hornblende schist with decrease of biotite downward
21.30	23.85	Quartz-diorite
23.85	27.65	Biotite-chlorite-hornblende schist with interlayering of biotite and chlorite
27.65	36.05	Quartz diorite
36.05	67.30	Chlorite-biotite-hornblende schist
		Hr-11
0.0	0.40	Alluvium
0.40	2.00	Serpentinite, unaltered
2.00	3.55	Serpentinite, altered brown
3.55	5.15	Sand fill (ancient working?)
5.15	7.25	Serpentinite, altered brown
7.25	8.00	Shear zone chlorite; sericite and talc schist
8.00	16.30	Aplite with sparse pyrite
16.30	63.85	Sericite-biotite-chlorite schist with increase of biotite downward

Table 2.--*Summary of geologic logs of diamond drill holes Hr-1 through Hr-14* [continued]

Interval (meters)		Description
		Hr-12
0.00	1.90	Sand
1.90	3.10	Serpentinite intercalated with hornblende-chlorite schist
3.10	7.70	Serpentinite, gradually altered brown downwards
7.70	9.55	Aplite
9.55	10.15	Serpentinite, altered brown
10.15	12.45	Shear zone, hornblende-biotite-chlorite schist
12.45	13.05	Sand
13.05	18.20	Shear zone, hornblende-biotite-chlorite schist
18.20	19.15	Sand
19.15	64.35	Hornblende-biotite-chlorite schist with sparse disseminated pyrite. More massive and finer grained downward
		Hr-13
0.00	4.00	Sand and silt
4.00	9.50	Sand with fragments of chlorite schist
9.50	11.00	Chlorite schist, siliceous
11.00	23.00	Biotite-chlorite schist, with increase in biotite content downward, sparse disseminated pyrite
23.00	23.40	Diorite
23.40	39.50	Quartz-biotite schist, very sparse disseminated pyrite
39.50	40.05	Aplite
40.05	41.25	Biotite-chlorite schist, siliceous
41.25	42.75	Garnetiferous aplite
42.75	44.25	Biotite-chlorite schist, siliceous
44.25	57.50	Aplite
57.50	59.80	Chlorite-biotite schist
59.80	62.00	Aplite
62.00	73.25	Biotite schist
73.25	75.70	Pegmatitic granite
75.70	90.50	Chlorite-epidote-biotite schist with high biotite concentration around 79.50m.
90.50	91.00	Pegmatitic granite
91.00	117.85	Chlorite-biotite schist, increasingly more siliceous downward
117.85	121.15	Granite
121.15	126.70	Biotite schist
126.70	137.15	Granite, sparse garnet
137.15	137.75	Biotite-chlorite schist
137.75	147.25	Granite, sparse garnet
147.25	149.90	Biotite-chlorite schist
149.90	154.35	Biotite-chlorite schist

Table 2.--*Summary of geologic logs of diamond drill holes Hr-1 through Hr-14* [continued]

Interval (meters)		Description
		Hr-14
0.0	1.50	Alluvium
1.50	6.00	Serpentinite, gossan-like, altered brown
6.00	7.00	Sand
7.00	9.15	Serpentinite, altered brown, with carbonate veinlets
9.15	12.00	Sand
12.00	12.40	Aplite dike
12.40	12.90	Sand
12.90	13.50	Aplite
13.50	14.30	Serpentinite, gossan-like, altered brown
14.30	14.90	Aplite
14.90	19.30	Serpentinite, altered brown
19.30	21.00	Sand
21.00	28.00	Aplite
28.00	28.45	Sand
28.45	29.70	Aplite
29.70	31.30	Serpentinite
31.30	32.40	Metagabbro (?)
32.40	34.30	Serpentinite
34.30	35.70	Gabbro
35.70	37.10	Aplite
37.10	42.80	Serpentinite
42.80	43.60	Aplite
43.60	44.30	Sand
44.30	67.80	Chlorite schist with hornblende and biotite present in clusters; biotite increases downwards
67.80	71.20	Serpentinite, altered brown
71.20	73.20	Serpentinite, unaltered
73.20	84.00	Metagabbro
84.00	98.25	Chlorite-biotite schist
98.25	103.20	Metabasalt
103.20	130.10	Biotite-chlorite schist

the contact contains 1.33 g/t gold, and one short segment of serpentinite contains trace amounts of gold. In drill hole Hr-3 a short interval of altered serpentinite contains 1.60 g/t gold, and an interval 9 m long directly below the contact contains significant metallization. The interval 9-m-long averages 2 g/t gold and includes 1.0 m of rock assaying 8.9 g/t gold. Much of the serpentinite zone contains trace amounts of gold. Metallization in drill hole Hr-4 is only trace amounts in three long intervals in the serpentinite and one short interval in hornblende schist.

Drill holes Hr-5, Hr-6, Hr-8, Hr-9, and Hr-12 are sited away from the major areas of ancient workings. The only significant metallization is in Hr-5, and consists of an interval 1 m long containing 1.37 g/t gold in hornblende schist. Traces of gold were found in cores from all the holes, including long core segments in hornblende schist from holes Hr-5, Hr-8, and Hr-12 and several short core segments in serpentinite from holes Hr-6, Hr-8, and Hr-9.

Drill holes Hr-7, Hr-10, and Hr-11 are in close proximity to major ancient workings. In Hr-7 a 10-m interval averages 2.57 g/t gold and includes a 1-m interval containing 5.50 g/t gold. This gold is in chlorite schist close to the contact with serpentinite. Near the bottom of the hole an interval of chlorite schist contains 1.26 g/t gold, and much of the serpentinite contains trace amounts of gold. Hr-10 was poorly sited in that less than 2 m of serpentinite was penetrated. Significant mineralization is confined to the first 3.65 m of the hole where weathered serpentinite and aplite average 2.3 g/t gold. Hornblende schist along the footwall of the aplite dike in the contact zone contains trace amounts of gold. In Hr-11 a 6-m interval of hornblende schist directly below an aplite dike in the contact zone contains 3.45 g/t gold. Trace amounts of gold were detected in a short interval of serpentinite near the surface.

The target for drill hole Hr-13 was a quartz veinlet and alteration zone next to a large granite dike. Ancient workings are along quartz veinlet zones that follow bedding planes in the quartz-biotite schist country rock. Most of the ancient workings are within 50 m of dikes ranging from aplite to granite. The first 55 m of core average 0.28 g/t gold; each sample has detectable gold. Significant mineralization in this zone is an interval 1 m long assaying 3.68 g/t gold and an interval 1 m long assaying 2.80 g/t gold.

The target for Hr-14 was the contact between serpentinite and hornblende schist in a zone of alteration close to a large dike ranging from aplite to granite. Only trace amounts of gold were detected in serpentinite and aplite in

the first 28 m of core. Gold was not detected at the contact.

CONCLUSIONS AND RECOMMENDATIONS

Ancient mining at the Hajrah-Hamdah group probably ceased when the readily available gold in weathered rock at and near the surface was depleted. The ancients did not have the technology to mine or process unweathered primary ore. It is difficult to estimate the amount of gold taken from this group of mines, but it was considerable and probably in excess of 3,500,000 g. Prior to mining by the ancients, mechanical and chemical weathering had enriched the surface and the near surface zone. Thus, the original ancient mining operations were relatively easy and consisted of hand-picking free gold, and hand-cobbing gold out of soft friable weathered rock on the surface. As this source of gold was depleted, deep trenches and underground workings requiring much more labor became the source. None of the workings extend below the zone of weathering, and all are in the more highly weathered rock along fractures, dikes, or the contact between serpentinite and hornblende schist.

A considerable amount of gold remains in the waste dumps, especially in the Hajr mine and Hajr Gharb areas. The average gold value for all waste material in the Hajr mine area is 3.8 g/t and in the Hajr Gharb area 2.2 g/t. Approximately 775,000 g of gold remains in the larger waste dumps, but the waste material is widely scattered, of irregular and generally shallow thickness, and of low and erratic grade.

The exploration program at the Hajr mine indicated that metallization is confined to altered rock along the contact between overlying serpentinite and underlying hornblende schist. Trace amounts of gold were detected in all rock types as much as 50 m above or below the contact, however, significant metallization is confined to a narrow zone in hornblende schist below the contact. The size of the Hajr ancient workings and the analytical results of surface and core samples indicate two main centers of metallization. The largest is an elongate northwest zone, 500 m long and 80 to 200 m wide, in the northeastern part of the area. This zone includes drill holes Hr-1, Hr-2, Hr-3, Hr-10, and Hr-11 and the area of most extensive ancient mining. Much of the gold in this zone was probably mined out by the ancients, but the northwest and southeast extensions were not tested. The second main center of metallization is in the southwestern part of the area and includes drill hole Hr-7. This zone, 350 m long and 80 m wide, is also elongate northwest. High analytical values from surface samples suggest that this zone

may extend at least another 300 m southeast. Much of this zone was also mined out by the ancients. Alignment of higher grade metallization along northwest trends probably reflects structural control and the trace of felsic dikes below the serpentinite cover. Northwest-trending felsic dikes and alteration zones are common in the vicinity of the Hajr mine.

Metallization at Jabal Hajrah, Hajr Gharb, and Bi'r al Hamdan is in quartz-biotite schist next to felsic dikes. Trace amounts of gold were detected at most of the ancient workings and in drill hole Hr-13. Significant analytical gold values are widely scattered. Trace metallization only was detected at drill site Hr-14.

Gold metallization in the Hajrah-Hamdah group of ancient mines is genetically related to a system of aplite and granite dikes and accompanying alteration zones. Deposition from hydrothermal solutions generated by the dikes was along bedding in quartz-biotite schist close to the dikes and along the contact between serpentinite and hornblende schist. Metallization along the contact is of low grade, 1 to 5 g/t gold, although some zones are as much as 10 m thick. The highest grade zone intersected by drilling is 1 m thick and contains 10 g/t gold but the higher grade metallized zones are irregularly distributed in pockets and lenses. Metallization in quartz-biotite schist is also generally of low grade and erratic distribution. The highest analytical value obtained in this rock was 63 g/t gold in a grab sample from the face of a small inclined shaft in the Hajr Gharb area.

The results of the exploration program do not indicate any economic orebodies, but do suggest that further limited exploration is warranted. In the Hajr mine area the widely spaced drill holes and selected sampling design limited the size of the target, but did not adequately test much of the area. The extensions of both northwest-trending zones of major metallization should be tested to the northwest and southeast. This testing would best be accomplished by shallow percussion drilling on a grid. A closely spaced geochemical sampling program in the Jabal Hajrah and Hajr Gharb areas would better define the areas of metallization and perhaps outline zones of higher grade gold. This program should not have high priority and should not be undertaken unless significant metallization is found in future work at the Hajr mine.

The source of the gold deposited by the ore-forming solutions is unknown. It is probable that the gold came from a local source within the layered rock or ultramafic sequence

and was mobilized, concentrated, and redeposited by the felsic dikes and related solutions. A regional and locally detailed geochemical survey may detect a lithologic unit containing an anomalous, and perhaps a significant, concentration of gold.

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APPENDIX

Gold and silver analytical results summarized by sample type

[Surface sample locations are given on plates 1 and 3, and diamond drill hole locations on plates 1 and 2, and figure 2. Complete analytical data are stored by sample number in the RASS computer file, Directorate General of Mineral Resources. Gold and silver values listed below were determined by atomic absorption. (-), not detected]

A. Dump samples

Sample Number	Gold (g/t)	Silver (g/t)
1) Hajr Mine		
100,465	4.60	0.80
466	0.10	1.10
467	0.44	0.60
468	74.00	2.60
469	24.60	2.20
470	1.60	0.50
471	4.40	1.10
472	3.40	0.50
473	3.80	0.90
474	1.00	0.30
475	3.60	0.40
476	3.00	0.50
477	3.20	0.60
478	8.68	1.10
479	7.20	1.00
110,393	1.90	1.30
394	6.80	1.60
395	12.80	2.20
396	0.48	1.50
397	2.04	1.00
398	0.76	1.30
657	0.03	-
661	0.81	2.30
662	0.20	-
663	0.07	-
664	0.14	-
665	0.13	-
675	2.00	-
676	0.50	1.30
677	0.47	0.90
683	0.26	1.80
684	0.05	-
686	0.10	1.30
688	0.02	-
689	0.17	0.80
690	0.11	-
691	5.00	0.30
110,694	0.01	0.30
695	0.08	1.40
698	1.64	0.80
699	< .04	2.50
700	< .04	2.30
701	0.15	3.60
705	0.11	-
706	< .04	0.40
708	0.16	1.30
709	0.04	-
710	0.87	0.30
(2) Jabal Hajrah		
117,017	1.26	0.8
021	1.16	9.0
(3) Hajr Gharb		
115,195	0.22	1.00
196	1.40	1.00
197	0.20	-
198	0.08	1.00
199	0.12	-
117,046	0.02	0.8
049	0.27	-
068	15.00	1.0
(4) Bir al Hamdan		
110,759	-	0.20

B. Channel samples

Sample Number	Gold (g/t)	Silver (g/t)
1) Hajr mine		
100,480	-	0.40
481	0.34	0.30
482	-	-
483	0.19	0.70
484	0.51	0.60
485	0.27	0.50
486	-	0.60
487	1.00	0.50
488	0.91	0.50
489	2.24	0.40
490	0.08	0.50
491	0.07	-
492	0.07	-
493	1.40	0.90
494	0.74	0.80
495	6.60	0.80
496	-	1.00
497	1.20	0.90
498	1.20	1.10
499	8.68	0.80
500	1.60	0.20
501	0.62	0.50
502	-	0.80
503	5.52	0.20
504	7.00	0.30
505	5.92	0.40
110,652	0.97	2.50
653	0.12	1.00
654	12.80	17.40
658	0.17	2.26
659	0.30	1.60
660	0.56	0.90
666	0.17	1.70
667	0.54	1.20
668	0.38	1.20
669	1.00	2.10
670	0.26	-
671	2.12	0.50
672	0.05	-
673	3.08	-
674	0.06	0.90
678	0.09	-
679	0.08	-
680	0.04	-
110,681	3.04	0.70
682	0.02	-
685	0.26	1.60
687	0.08	1.50
692	0.05	0.50
693	0.06	2.00
696	-	2.00
697	< .04	1.60
702	0.14	3.30
703	0.15	0.40
704	0.07	0.20
707	0.13	2.30
711	0.33	1.40
712	0.42	1.40
713	0.21	1.20
714	1.30	0.50
715	1.00	1.30
716	0.26	2.00
717	0.06	-
718	0.25	1.40
719	4.24	1.00
Average	1.25	1.13
Range of values	0-12.80	0-17.40
(2) Jabal Hajrah		
117,016	0.12	2.6
018	2.30	3.3
020	2.12	1.1
022	0.16	1.8
025	0.05	0.9
(3) Bi'r al Hamdan		
110,563	< .04	0.70
564	< .04	0.20
(4) Drill Site Hr-14		
110,746	< .04	0.3
747	< .04	2.2
748	< .04	1.7
749	< .04	1.6
751	< .04	2.4
752	< .04	1.6
753	< .04	.9
754	< .04	1.6
755	< .04	1.2
756	< .04	2.4

C. Continuous traverse samples, Hajr mine

Sample Number	Gold (g/t)	Silver (g/t)	Sample Number	Gold (g/t)	Silver (g/t)
117,802	< 0.05	1.0	117,842	1.41	1.0
803	0.06	1.1	843	0.35	1.0
804	0.06	1.0	844	0.52	1.1
805	< 0.05	0.8	845	2.52	1.0
806	< 0.05	1.0	846	1.70	1.0
807	0.09	0.9	847	1.13	1.0
808	0.09	1.0	848	0.11	1.0
809	0.05	1.0	849	0.72	1.0
810	0.05	0.8	850	0.76	1.0
811	0.11	0.8	851	0.59	0.9
812	0.14	1.2	852	0.51	1.1
813	0.32	0.9	853	0.36	1.3
814	0.49	1.2	854	0.69	1.4
815	0.34	1.0	855	< 0.05	1.2
816	0.23	0.9	856	< 0.05	0.9
817	0.37	0.8	857	< 0.05	1.2
818	0.41	0.8	858	0.13	0.5
819	1.41	1.0	859	< 0.05	0.8
820	7.91	1.1	860	0.08	1.0
821	0.54	0.9	861	0.08	0.6
822	0.46	0.7	862	1.40	0.9
823	0.25	0.8	863	1.50	0.8
824	0.08	< 0.5	864	3.40	0.7
825	0.08	< 0.5	865	1.56	1.1
826	0.08	< 0.8	866	2.70	1.1
827	0.08	0.8	867	1.16	1.0
828	0.08	0.8	868	2.50	0.8
829	0.08	0.7	869	87.0	10.0
830	0.08	< 0.5	870	0.71	0.8
831	0.17	0.5	871	< 0.05	0.6
832	0.15	0.6	872	< 0.05	0.7
833	0.19	< 0.5	873	< 0.05	< 0.5
834	0.49	< 0.5	874	0.18	0.7
835	0.17	< 0.5	875	1.03	0.8
836	0.08	-	876	0.18	0.5
837	0.32	0.9	877	0.50	< 0.5
838	0.23	1.0	878	0.37	0.8
839	0.15	1.0	879	0.27	< 0.5
840	0.09	1.0	880	0.13	0.5
841	0.43	0.9	881	0.56	< 0.5

C. Continuous traverse samples, Hajr mine [continued]

Sample Number	Gold (g/t)	Silver (g/t)
117,882	< 0.05	0.6
883	< 0.05	1.0
884	0.16	0.5
885	< 0.05	0.7
886	0.28	< 0.5
887	0.28	0.5
888	0.90	0.5
889	0.38	< 0.5
890	0.35	0.5
891	0.93	0.7
892	0.08	1.0
893	0.07	1.0
894	0.07	0.9
895	1.70	0.7
896	1.70	0.6
897	2.06	0.6
898	2.06	0.5
899	2.48	0.9
900	2.06	0.8
901	3.99	1.0
902	12.40	1.1
903	38.40	3.0
904	0.08	1.1
905	< 0.05	0.8
906	< 0.05	1.0
907	< 0.05	1.0
908	1.52	1.0
909	< 0.05	1.0
910	0.84	0.9
911	0.08	0.9
912	0.69	0.8
913	0.08	0.7
914	0.08	0.9
915	0.08	0.8
916	< 0.05	0.5
917	0.23	0.5
918	1.50	0.8
919	0.08	0.8
920	0.08	0.8
921	0.08	0.8
117,922	0.80	0.8
923	0.08	0.8
924	0.08	1.0
925	0.08	1.0
926	0.12	0.8
927	0.13	0.8
Average	1.67	0.88
Range	< 0.05-87.0	0-10.0
Sample standard deviation	8.49	0.88
Population standard deviation	8.46	0.88

D. Samples from exploration pits, Hajr mine

Sample Number	Gold (g/t)	Silver (g/t)	Sample Number	Gold (g/t)	Silver (g/t)
100,400	0.27	0.50	100,415	1.00	0.70
401	7.08	1.00	416	2.12	0.90
402	3.80	0.80	417	4.68	1.00
403	40.00	1.20	418	0.14	-
404	3.20	0.80	419	0.14	-
405	2.52	0.70	110,390	0.05	0.60
406	1.20	1.00	391	1.40	2.10
407	0.42	1.90	392	0.82	1.40
408	5.12	0.70	399	2.00	1.10
409	0.10	0.30			
			Average	3.31	0.87
410	0.10	1.20			
411	0.37	0.10	Range	0.02-40.00	0-2.10
412	0.27	1.00			
413	2.64	0.90			
414	< 0.04	1.00			

E. Grab samples, Hajr Gharb; drillsite HR-14; and other sites

(1) Grab samples, Hajr Gharb

117,041	0.64	1.3	117,065	5.00	-
043	0.20	0.6	066	1.90	1.0
044	2.64	0.2	067	0.08	1.0
047	0.10	-			
048	0.46	-			
049	0.27	-			
050	0.06	-			
051	0.98	-			
053	0.06	-			
054	0.09	0.8			
055	0.06	-			
056	63.0	3.8			
057	0.02	-			
058	0.69	0.2			
059	0.89	0.2			
060	0.02	-			
061	0.02	-			
062	0.57	-			
063	0.82	1.0			
064	0.05	-			

(2) Drillsite Hr-14

110,744	< .04	1.0
745	< .04	1.4

(3) Other sites (pl.1)

117,099	0.02	-
104	0.05	-
105	0.06	-
106	0.10	0.8
133	0.12	-
134	0.06	0.7
135	0.06	1.6

F. Subsurface split drill-core samples

Drill hole Hr-1

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
115200	0.00-0.95	0.23	0.1	115240	26.00-27.00	-	0.6
201	1.50	-	0.1	241	28.00	-	0.7
202	2.00	-	0.1	242	29.00	-	0.7
203	2.50	0.03	0.1	243	30.00	-	0.7
204	3.00	0.03	0.1	244	31.00	0.02	0.7
205	3.50	-	0.1	245	32.00	-	0.7
206	4.00	-	0.1	246	33.00	-	0.6
207	4.50	-	0.1	247	34.00	-	0.6
208	5.00	-	0.1	248	35.00	-	0.5
209	5.50	-	0.1	249	36.00	-	0.6
210	6.00	-	0.1	250	38.00	-	0.6
211	6.50	-	0.1	251	40.00	-	0.7
212	7.00	-	0.1	252	42.00	0.02	0.6
213	7.50	-	0.1	253	44.00	0.29	0.7
214	8.00	-	0.1	254	46.00	-	1.0
215	8.50	-	0.1	255	48.00	-	0.6
216	9.00	-	0.1	256	50.00	-	0.5
217	9.50	-	< 0.1	257	52.00	-	0.6
218	10.00	-	< 0.1	258	54.00	-	0.5
219	10.50	-	< 0.1	259	56.00	-	0.5
220	11.00	-	< 0.1	260	58.00	-	1.0
221	11.50	1.65	< 0.1	261	60.00	-	1.0
222	12.00	-	< 0.1	262	62.00	-	1.0
223	12.50	-	< 0.1	263	64.00	-	0.5
224	13.00	-	0.1	264	66.00	-	0.5
225	13.50	-	< 0.1	265	68.00	-	0.5
226	14.00	-	< 0.1	266	70.00	-	0.4
227	14.50	-	< 0.1	267	72.00	-	0.4
228	15.00	-	< 0.1	268	74.00	-	0.7
229	16.00	-	< 0.1	269	76.00	-	0.4
230	17.00	-	-	270	78.00	-	0.6
231	18.00	0.49	0.2	271	80.00	-	0.7
232	19.00	-	-	272	82.00	-	0.4
233	20.00	0.04	0.3	273	84.00	-	0.4
234	21.00	0.07	0.7	274	86.00	-	0.4
235	22.00	-	0.5	275	88.00	-	0.7
236	23.00	0.04	0.6	276	90.00	-	0.7
237	24.00	0.56	0.2	277	92.00	-	0.6
238	25.00	0.1	0.9	278	94.00	-	1.0
239	26.00	0.04	0.6	279	96.00	-	0.5

F. Subsurface split drill-core samples [continued]

Drill hole Hr-1 [continued]

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
115280	96.00-98.00	-	0.7				
281	100.00	-	0.8				
282	102.00	-	1.3				
283	104.50	-	1.3				

Drill hole Hr-2

115284	0.00-0.90	-	1.2	115319	18.50-19.00	-	0.8
285	1.85	-	1.1	320	19.50	-	1.0
286	2.50	-	1.1	321	20.00	-	1.0
287	3.00	-	1.0	322	20.50	-	1.0
288	3.50	-	1.0	323	21.00	-	0.8
289	4.00	-	1.1	324	21.50	-	0.8
290	4.50	-	1.0	325	22.00	-	0.8
291	5.00	-	1.0	326	22.50	-	1.0
292	5.50	-	1.0	327	23.00	-	1.0
293	6.00	-	1.0	328	23.50	-	1.0
294	6.50	-	1.0	329	24.00	-	1.0
295	7.00	-	1.0	330	24.50	-	1.0
296	7.50	-	1.1	331	25.00	-	0.8
297	8.00	-	1.0	332	25.50	-	1.0
298	8.50	-	0.9	333	26.00	-	1.0
299	9.00	-	1.0	334	26.50	-	1.0
300	9.50	-	1.0	335	27.00	-	1.0
301	10.00	-	1.0	336	27.50	-	1.0
302	10.50	-	1.0	337	28.00	-	1.0
303	11.00	-	0.9	338	28.50	-	0.8
304	11.50	0.06	1.0	339	29.00	-	0.8
305	12.00	-	1.0	340	29.50	-	0.8
306	12.50	-	1.0	341	30.00	-	0.8
307	13.00	-	1.0	342	30.50	-	0.8
308	13.50	-	1.0	343	31.00	-	0.8
309	14.00	-	0.8	344	31.50	-	1.0
310	14.50	-	0.9	345	32.00	-	1.0
311	15.00	-	1.0	346	32.50	-	0.9
312	15.50	0.22	0.8	347	33.00	-	0.9
313	16.00	-	1.0	348	33.50	-	0.7
314	16.50	-	1.0	349	34.00	-	0.9
315	17.00	-	1.0	350	34.50	-	0.8
316	17.50	-	1.0	351	35.00	-	0.8
317	18.00	-	1.0	352	35.50	-	1.0
318	18.50	-	0.8	353	36.00	-	1.0

F. Subsurface split drill-core samples [continued]

Drill hole Hr-2 [continued]

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
115354	36.00-36.50	-	1.0	115394	56.00-56.50	-	0.9
355	37.00	-	1.0	395	57.00	-	0.6
356	37.50	-	1.0	396	57.50	-	0.6
357	38.00	-	1.0	397	58.00	-	0.4
358	38.50	-	1.2	398	58.50	-	0.2
359	39.00	-	1.3	399	59.00	-	0.4
360	39.50	-	1.3	400	59.50	-	0.2
361	40.00	-	1.2	401	60.00	-	0.6
362	40.50	-	1.3	402	60.50	-	0.2
363	41.00	-	1.2	403	61.00	-	0.8
364	41.50	-	1.2	404	61.50	-	0.6
365	42.00	-	1.0	405	62.00	-	0.9
366	42.50	-	1.0	406	62.50	-	0.8
367	43.00	-	1.0	407	63.00	-	1.0
368	43.50	-	1.2	408	63.50	-	0.9
369	44.00	-	1.0	409	64.00	-	0.9
370	44.50	-	1.0	410	64.50	-	1.2
371	45.00	-	1.0	411	65.00	-	1.0
372	45.50	-	1.0	412	65.50	-	0.9
373	46.00	-	0.9	413	66.00	-	0.6
374	46.50	-	1.0	414	66.50	-	0.8
375	47.00	-	0.9	415	67.00	-	0.7
376	47.50	-	0.9	416	67.50	0.13	0.6
377	48.00	-	1.3	417	68.00	-	0.6
378	48.50	-	1.3	418	68.50	-	0.6
379	49.00	-	1.5	419	69.00	-	0.8
380	49.50	-	1.5	420	69.50	-	0.4
381	50.00	-	1.0	421	70.00	0.06	0.4
382	50.50	-	1.3	422	70.50	-	1.0
383	51.00	-	1.3	423	71.00	0.09	0.3
384	51.50	-	0.8	424	71.50	0.40	0.7
385	52.00	-	0.8	425	72.00	1.16	0.8
386	52.50	-	0.9	426	72.50	1.54	0.4
387	53.00	-	0.9	427	73.00	1.24	0.6
388	53.50	-	1.0	428	73.50	-	0.4
389	54.00	-	0.9	429	74.00	-	0.5
390	54.50	-	1.0	430	74.50	-	0.4
391	55.00	-	0.4	431	75.00	-	0.3
392	55.50	-	0.7	432	75.50	-	0.2
393	56.00	-	0.7	433	76.00	-	0.4

F. Subsurface split drill-core samples [continued]

Drill hole Hr-2 [continued]

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
115434	76.00-76.50	-	0.3	444	81.00-81.50	-	0.5
435	77.00	-	0.3	445	82.00	-	0.4
436	77.50	-	0.3	446	82.50	-	0.4
437	78.00	-	0.2	447	83.00	-	0.5
438	78.50	-	0.3	448	83.50	-	0.6
439	79.00	-	0.3	449	84.00	-	0.4
440	79.50	-	0.4	450	84.50	-	-
441	80.00	-	0.4	451	85.00	0.06	0.6
442	80.50	-	0.6	452	85.50	0.06	0.8
443	81.00	-	0.4				

Drill hole Hr-3

115453	0.00-2.00	0.06	1.4	483	17.50-18.00	-	1.5
454	3.00	0.12	0.8	484	18.50	0.10	1.2
455	4.00	0.08	1.4	485	19.00	-	-
456	4.50	0.06	1.4	486	19.50	0.06	-
457	5.00	0.12	1.3	487	20.00	-	-
458	5.50	0.10	1.3	488	20.50	-	-
459	6.00	0.06	1.4	489	21.00	0.12	-
460	6.50	0.06	1.4	490	21.50	0.06	0.8
461	7.00	0.12	0.6	491	22.00	0.08	1.7
462	7.50	0.08	1.4	492	22.50	0.08	2.0
463	8.00	0.12	1.3	493	23.00	0.08	2.0
464	8.50	-	1.3	494	23.50	-	2.0
465	9.00	-	1.5	495	24.00	-	1.4
466	9.50	0.06	1.3	496	24.50	-	2.0
467	10.00	0.08	1.4	497	25.00	-	1.5
468	10.50	-	0.8	498	25.50	-	1.6
469	11.00	0.06	1.4	499	26.00	-	1.8
470	11.50	0.10	1.4	500	26.50	0.80	1.6
471	12.00	0.10	1.1	501	27.00	1.60	1.8
472	12.50	0.10	0.9	502	27.50	0.20	1.4
473	13.00	0.20	0.6	503	28.00	0.26	1.2
474	13.50	-	1.7	504	28.50	0.38	1.2
475	14.00	-	1.5	505	29.00	0.22	0.8
476	14.50	-	1.0	506	29.50	-	-
477	15.00	-	0.8	507	30.00	-	-
478	15.50	-	1.0	508	30.50		
479	16.00	-	1.6	509	31.00	-	-
480	16.50	-	1.4	510	31.50	-	-
481	17.00	-	1.6	511	32.00	0.10	0.8
482	17.50	-	1.6	512	32.50	0.22	1.1

F. Subsurface split drill-core samples [continued]

Drill hole Hr-3 [continued]

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
115513	32.50 33.00	0.34	1.1	115533	42.50-43.00	5.20	0.7
514	33.50	0.34	1.1	534	43.50	1.60	1.1
515	34.00	0.38	0.8	535	44.00	-	0.7
516	34.50	0.32	0.9	536	44.50	-	-
517	35.00	2.00	1.0	537	45.00	0.10	-
518	35.50	0.96	0.5	538	45.50	-	-
519	36.00	1.60	1.0	551	57.50-58.00	0.26	-
520	36.50	0.10	1.7	552	58.50	0.06	-
521	37.00	0.35	1.9	553	59.00	0.10	-
522	37.50	3.40	2.1	554	59.50	0.08	-
523	38.00	1.50	1.8	555	60.00	0.10	-
524	38.50	9.30	1.7	556	60.50	0.10	-
525	39.00	8.40	1.5	557	61.00	-	-
526	39.50	1.76	0.7	558	61.50	0.08	-
527	40.00	0.06	-				
528	40.50	0.06	-				
529	41.00	0.10	-				
530	41.50	-	-				
531	42.00	-	-				
532	42.50	0.10	-				

Drill hole Hr-4

115559	0.00-1.00	0.10	0.9	115605	43.00-44.00	-	1.3
560	2.00	0.06	1.1	606	45.00	0.12	0.9
561	3.00	0.10	0.7	607	45.50	0.06	0.8
562	4.00	0.06	1.0	608	46.00	0.10	0.7
563	5.00	0.06	1.5	609	46.50	0.10	0.6
564	6.00	-	1.1	610	47.00	0.06	0.8
565	7.00	0.06	1.1	611	47.50	0.08	0.5
566	8.00	0.12	1.0	612	48.00	0.12	-
567	9.00	-	0.7	613	48.50	0.12	-
568	10.00	0.12	1.2	614	49.00	0.10	-
569	11.00	0.18	0.8	615	49.50	0.12	-
570	12.00	0.12	0.7	616	50.00	0.06	-
571	13.00	0.15	1.6	617	50.50	0.16	0.8
572	14.00	0.15	1.0	618	51.00	0.16	-
599	37.00-38.00	0.28	1.4	619	51.50	0.12	-
600	39.00	0.28	1.3	620	52.00	0.12	-
601	40.00	0.12	1.3	621	53.00	-	-
602	41.00	-	1.4	623	56.00	-	-
603	42.00	0.10	1.1	624	58.00	-	-
604	43.00	0.06	1.2	625	60.00	-	-

F. Subsurface split drill-core samples [continued]

Drill Hole Hr-4 [continued]

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
115638	84.00-86.00	0.06	0.6	115648	104-106.00	-	-
639	88.00	0.06	0.7	649	108.00	-	0.5
640	90.00	0.06	0.5	650	110.00	-	0.6
641	92.00	-	-	651	112.00	-	0.7
642	94.00	-	0.6	652	114.00	-	0.5
643	96.00	-	0.8	653	116.00	-	-
644	98.00	0.26	0.5	654	118.00	-	-
645	100.00	-	0.5	655	120.00	-	0.6
646	102.00	-	0.5				
647	104.00	-	-				

Drill hole Hr-5

115656	0.00- 1.00	-	1.1	115688	19.00-19.50	-	-
657	2.00	-	1.2	690	20.00 20.50	-	-
658	3.00	-	-	691	21.00	-	0.6
659	3.50	-	0.8	692	21.50	-	-
660	4.00	-	-	693	22.00	-	-
661	4.50	-	-	695	22.50-23.00	-	-
662	5.00	-	-	696	23.50	-	-
663	5.50	-	-	697	24.00	-	-
664	6.00	-	-	698	24.50	-	0.5
665	6.50	-	-	699	25.00	0.32	1.7
666	7.00	-	-	700	25.50	0.52	1.6
667	7.50	-	-	701	26.00	0.26	1.0
668	8.00	-	-	702	26.50	0.10	-
669	8.50	0.05	-	703	27.00	1.52	-
670	10.00	-	-	704	27.50	1.22	-
671	10.50	0.06	0.7	705	28.00	-	1.0
672	11.00	-	-	706	28.50	0.66	1.0
673	11.50	-	-	707	29.00	-	1.3
674	12.00	0.06	-	708	29.50	-	0.9
675	12.50	-	-	709	30.00	-	1.0
676	13.00	-	-	710	30.50	-	0.6
677	14.00	-	-	711	31.00	-	0.6
678	14.50	-	-	712	31.50	-	-
679	15.00	-	1.3	713	32.00	0.06	-
680	15.50	-	-	714	32.50	0.06	-
681	16.00	-	-	715	33.00	-	1.0
683	16.50-17.00	-	-	716	33.50	-	1.2
684	17.50	-	-	717	34.00	-	0.9
685	18.00	-	-	718	34.50	-	1.0
686	18.50	0.06	-	719	35.00	-	0.8

F. Subsurface split drill-core samples [continued]

Drill hole Hr-5 [continued]

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
115720	35.00-36.00	-	1.0	115735	50.00-51.00	-	-
721	37.00	-	-	736	52.00	-	-
722	38.00	-	-	737	53.00	-	-
723	39.00	-	-	738	54.00	-	-
724	40.00	-	-	739	55.00	-	-
725	41.00	-	-	740	56.00	-	-
726	42.00	-	-	741	57.00	-	-
727	43.00	-	-	742	58.00	-	-
728	44.00	-	-	743	59.00	0.05	0.5
729	45.00	-	-	744	60.00	0.05	-
730	46.00	-	-				
731	47.00	-	-				
732	48.00	-	-				
733	49.00	-	-				
734	50.00	-	-				

Drill hole Hr-6

115745	0.00-3.00	0.08	0.7	770	16.00-16.50	-	-
746	4.00	0.05	0.5	771	17.00	0.07	-
747	5.00	0.10	0.5	772	17.50	-	-
748	5.50	0.10	-	773	18.00	-	-
749	6.00	0.14	-	774	18.50	-	0.6
750	6.50	0.08	-	775	19.00	0.05	1.3
751	7.00	0.08	0.5	776	19.50	0.05	0.5
752	7.50	0.07	0.5	777	20.00	-	1.2
753	8.00	0.10	0.5	778	20.50	-	1.0
754	8.50	0.07	0.7	779	21.00	-	0.9
755	9.00	0.07	0.8	780	21.50	-	0.9
756	9.50	0.08	-	781	22.00	-	1.0
757	10.00	0.07	0.5	782	22.50	0.05	0.7
758	10.50	0.08	-	783	23.00	-	0.7
759	11.00	0.08	-	784	24.00	0.05	0.5
760	11.50	0.08	-	785	25.00	0.05	0.5
761	12.00	0.08	-	786	26.00	0.14	0.8
762	12.50	0.07	-	787	27.00	0.05	0.5
763	13.00	-	-	788	28.00	0.05	0.7
764	13.50	0.07	-	789	29.00	0.08	-
765	14.00	0.07	-	790	30.00	-	0.6
766	14.50	0.07	-	791	31.00	-	0.6
767	15.00	-	-	792	32.00	0.07	-
768	15.50	-	-	793	33.00	0.07	0.6
769	16.00	-	-	794	34.00	0.08	0.7

F. Subsurface split drill-core samples [continued]

Drill hole Hr-6 [continued]

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
115795	71.00-72.00	-	-				
796	89.00-90.00	-	-				

Drill hole Hr-7

115798	0.00-2.00	-	1.1	834	19.50-20.00	0.12	1.5
799	2.50	0.06	1.1	835	20.50	0.14	0.7
800	3.00	-	1.0	836	21.00	0.12	0.7
801	3.50	-	1.1	837	21.50	0.12	0.8
802	4.00	-	1.0	838	22.00	0.19	1.2
803	4.50	-	1.3	839	22.50	0.34	0.8
804	5.00	0.06	1.0	840	23.00	0.67	1.3
805	5.50	0.10	1.0	841	23.50	2.40	2.1
806	6.00	0.27	2.1	842	24.50	3.40	2.1
807	6.50	0.18	1.9	843	25.50	3.20	2.1
808	7.00	0.16	1.8	844	26.50	1.40	2.1
809	7.50	0.26	1.6	845	27.50	5.50	2.5
810	8.00	0.19	1.8	846	28.50	1.00	2.2
811	8.50	0.26	1.5	847	29.50	3.40	2.1
812	9.00	0.18	1.5	848	30.50	3.06	1.2
813	9.50	0.16	1.5	849	31.50	3.50	1.5
814	10.00	0.16	1.6	850	32.50	0.78	1.7
815	10.50	0.16	1.5	851	33.50	0.16	1.9
816	11.00	0.16	1.8	852	34.50	0.12	1.4
817	11.50	0.12	2.0	853	35.50	0.09	1.9
818	12.00	0.16	2.1	854	36.50	0.09	2.1
819	12.50	0.16	1.0	855	37.50	0.09	1.5
820	13.00	0.14	0.7	856	38.50	0.09	1.1
821	13.50	0.12	0.9	857	39.50	0.08	1.0
822	14.00	0.12	0.8	858	40.50	0.08	0.9
823	14.50	0.18	1.3	859	41.50	0.08	1.1
824	15.00	0.27	1.1	860	42.50	0.08	1.1
825	15.50	0.20	0.9	861	43.50	0.09	1.1
826	16.00	0.15	0.6	862	44.50	0.08	3.7
827	16.50	0.16	0.6	863	45.50	0.09	1.0
828	17.00	0.24	0.6	864	46.50	0.09	0.8
829	17.50	0.24	0.8	865	47.50	0.09	0.8
830	18.00	0.19	0.9	866	48.50	1.26	0.8
831	18.30	0.09	0.6	867	49.50	-	0.8
832	19.00	0.09	0.7	868	51.10	0.08	0.6
833	19.50	0.19	0.5				

F. Subsurface split drill-core samples [continued]

Drill hole Hr-8

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
115869	0.00- 3.00	0.09	1.5	010	23.00-23.50	0.21	1.7
870	4.00	0.09	1.3	011	24.00	0.14	1.7
871	4.50	0.32	1.3	012	24.50	0.16	1.1
372	5.00	0.09	1.5	013	25.00	0.14	0.7
873	5.50	0.09	1.5	014	25.50	0.12	0.6
874	6.00	0.06	1.5	015	26.00	0.14	0.8
875	6.50	0.08	1.4	016	26.50	0.21	0.6
876	7.00	0.09	1.4	017	27.00	0.12	1.0
877	7.50	0.09	1.5	018	27.50	0.12	0.9
878	8.00	0.08	1.6	019	28.00	0.08	0.8
879	8.50	0.09	1.5	020	28.50	0.08	0.8
880	9.00	0.09	2.4	021	29.00	0.06	0.5
881	9.50	0.09	1.3	022	30.00	0.06	0.6
882	10.00	0.09	1.3	023	31.00	0.06	0.6
883	10.50	0.09	1.4	024	32.00	0.07	-
884	11.00	0.09	1.6	025	33.00	0.06	0.5
885	11.50	0.08	1.2	026	34.0	0.06	0.5
886	12.00	0.06	-	027	35.00	0.07	0.9
887	12.50	0.06	-	028	36.00	0.06	1.0
888	13.00	0.06	-	029	37.00	0.07	0.6
889	13.50	0.07	-	030	38.00	0.06	1.1
890	14.00	0.07	-	031	39.00	0.06	0.7
891	14.50	0.06	1.0	032	40.00	0.06	0.9
892	15.00	0.08	1.2	033	41.00	0.06	0.6
893	15.50	0.07	1.7	034	42.00	0.06	0.8
894	16.00	0.08	1.5	035	43.00	0.08	0.8
895	16.50	0.07	1.3	036	44.00	0.10	0.7
896	17.00	0.06	1.2	037	45.00	0.08	0.5
897	17.50	0.06	1.2	038	46.00	0.08	-
898	18.00	0.08	0.7	039	47.00	0.08	0.5
899	18.50	0.12	1.0	040	48.00	0.06	0.5
121001	19.00	0.10	1.0	041	49.00	0.08	-
002	19.50	0.08	0.9	042	50.00	0.10	0.6
003	20.00	0.21	0.7				
004	20.50	0.12	1.2				
005	21.00	0.08	1.1				
006	21.50	0.07	0.7				
007	22.00	0.06	1.0				
008	22.50	0.11	-				
009	23.00	0.40	1.3				

F. Subsurface split drill-core samples [continued]

Drill hole Hr-9

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
121043	0.00- 3.00	0.10	0.9	083	22.50-23.00	-	0.9
044	3.50	0.10	1.4	084	23.50	-	1.0
045	4.00	0.07	1.3	085	24.00	-	0.6
046	4.50	0.08	1.3	086	24.50	-	1.0
047	5.00	0.08	1.6	087	25.00	-	0.8
048	5.50	0.10	1.2	088	25.50	-	0.9
049	6.00	0.07	1.2	089	26.00	-	0.8
050	6.50	0.08	1.0	090	26.50	-	1.0
051	7.00	0.10	1.5	091	27.00	-	0.9
052	7.50	0.10	0.7	092	27.50	0.08	0.6
053	8.00	0.10	1.3	093	28.00	-	1.0
054	8.50	0.10	0.6	094	28.50	-	1.1
055	9.00	0.08	0.6	095	29.00	0.06	0.9
056	9.50	0.08	0.5	096	29.50	0.06	0.6
057	10.00	0.10	9.5	097	30.00	-	0.9
058	10.50	0.11	1.0	098	30.50	-	0.8
059	11.00	0.11	1.4	099	31.00	0.06	0.7
060	11.50	0.12	1.3	100	31.50	-	0.9
061	12.00	0.12	1.2	101	32.00	0.08	0.9
062	12.50	0.10	1.3	102	32.50	-	1.2
063	13.00	0.12	1.1	103	33.00	-	0.7
064	13.50	0.12	1.2	104	33.50	-	0.7
065	14.00	0.10	1.3	105	34.00	-	0.6
066	14.50	0.08	1.0	106	34.50	-	0.9
067	15.00	-	1.1	107	35.00	-	0.9
068	15.50	-	1.2	108	35.50	-	0.5
069	16.00	-	1.0	109	36.00	-	0.7
070	16.50	-	1.1	110	36.50	-	0.8
071	17.00	-	1.3	111	37.00	0.10	0.8
072	17.50	-	1.1	112	37.50	0.15	0.7
073	18.00	-	1.1	113	38.00	0.15	0.5
074	18.50	-	1.0	114	38.50	0.18	-
075	19.00	-	1.2	115	39.00	0.04	0.5
076	19.50	0.08	1.1	116	39.50	-	0.8
077	20.00	-	1.1	117	40.00	-	-
078	20.50	-	1.1	118	40.50	-	-
079	21.00	-	1.0	119	41.00	-	-
080	21.50	-	0.9	120	41.50	-	-
081	22.00	-	1.1	121	42.00	-	-
082	22.50	-	1.0	122	42.50	-	-

F. Subsurface split drill-core samples [contined]

Drill hole Hr-9 [continued]

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
121123	42.50-43.00	-	-	121163	82.00-83.00	-	-
124	44.00	-	-	164	84.00	-	-
125	45.00	-	-	165	85.00	-	0.7
126	46.00	-	-	166	86.00	-	-
127	47.00	0.1	-	167	87.00	-	-
128	48.00	-	-	168	88.00	-	-
129	49.00	-	-	169	89.00	-	-
130	50.00	-	0.9	170	90.00	-	-
131	51.00	-	0.9	171	91.00	-	-
132	52.00	-	1.0	172	92.00	-	-
133	53.00	-	1.1	173	93.00	-	-
134	54.00	-	1.0	174	94.00	-	-
135	55.00	-	1.0	175	95.00	-	-
136	56.00	-	1.1	176	96.00	-	-
137	57.00	-	1.1	177	97.00	-	-
138	58.00	-	0.6	178	98.00	-	-
139	59.00	-	1.0	179	99.00	-	-
140	60.00	-	0.9	180	100.00	-	-
141	61.00	-	0.8	181	101.00	-	-
142	62.00	-	0.8	182	102.00	-	-
143	63.00	-	0.7	183	103.00	-	-
144	64.00	-	1.0	184	104.00	-	-
145	65.00	-	1.2	185	105.00	-	-
146	66.00	-	1.1	186	106.00	-	-
147	67.00	-	1.1	187	107.00	0.06	-
148	68.00	-	1.1	188	108.00	0.06	-
149	69.00	-	0.9	189	109.00	0.06	-
150	70.00	-	0.8	190	110.00	0.06	-
151	71.00	-	0.8	191	111.00	-	-
152	72.00	-	0.8	192	112.00	0.06	-
153	73.00	-	-	193	113.00	0.06	-
154	74.00	-	0.6	194	114.00	-	0.8
155	75.00	-	-	195	115.00	-	0.8
156	76.00	0.05	0.7	196	116.55	0.05	0.7
157	77.00	-	0.7				
158	78.00	-	0.6				
159	79.00	0.09	0.6				
160	80.00	-	0.7				
161	81.00	-	0.5				
162	82.00	-	0.7				

F. Subsurface split drill-core samples [continued]

Drill hole Hr-10

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
121197	0.00- 2.00	3.40	1.0	121227	32.00-33.00	-	0.6
198	4.00	1.10	-	228	34.00	0.06	0.8
199	4.50	0.56	0.7	229	35.00	-	0.7
200	5.50	0.16	0.9	230	36.00	-	0.6
201	6.50	0.05	0.5	231	37.00	0.06	0.9
202	7.50	0.08	0.6	232	38.00	-	0.7
203	8.50	0.07	0.5	233	39.00	-	0.8
204	9.50	0.07	0.5	234	40.00	-	0.7
205	10.50	0.10	-	235	41.00	-	0.7
206	11.50	0.12	-	236	42.00	-	0.7
207	12.50	0.10	0.6	237	43.00	-	0.8
208	13.50	0.08	0.6	238	44.00	-	0.9
209	15.00	0.21	0.9	239	45.00	-	0.7
210	16.00	-	0.6	240	46.00	-	0.8
211	17.00	0.05	0.7	241	47.00	-	0.7
212	18.00	0.06	1.3	242	48.00	-	0.6
213	19.00	0.06	1.6	243	49.00	-	0.7
214	20.00	0.06	1.3	244	50.00	-	0.7
215	21.00	0.06	1.1	245	51.00	-	0.5
216	22.00	0.06	0.8	246	52.00	-	0.9
217	23.00	-	0.7	247	53.00	-	0.8
218	24.00	-	0.8	248	54.00	-	0.7
219	25.00	-	0.8	249	55.00	-	0.7
220	26.00	-	0.6				
221	27.00	-	1.2				
222	28.00	-	1.1				
223	29.00	-	0.9				
224	30.00	-	0.7				
225	31.00	-	0.7				
226	32.00	-	0.8				

F. Subsurface split drill-core samples [continued]

Drill hole Hr-11

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
121250	0.00- 2.00	0.12	1.5	121270	18.00-19.00	0.80	1.1
251	2.50	-	1.2	271	20.00	0.84	0.9
252	3.00	-	1.2	272	21.00	1.20	1.1
253	3.50	0.06	1.5	273	22.00	-	0.8
254	5.00	0.06	1.5	274	23.00	-	1.0
255	6.00	-	1.0	275	24.00	-	0.6
256	6.50	-	0.8	276	25.00	-	0.8
257	7.00	-	1.0	277	26.00	-	0.7
258	7.50	-	1.3	278	27.00	-	0.8
259	8.00	-	1.3	279	28.00	-	0.7
260	9.00	-	-	280	29.00	-	1.1
261	10.00	-	-	281	30.00	-	0.8
262	11.00	-	-	282	31.00	-	0.6
263	12.00	-	-				
264	13.00	-	-				
265	14.00	-	-				
266	15.00	-	-				
267	16.00	0.85	0.5				
268	17.00	7.00	2.0				
269	18.00	10.00	1.5				

Drill hole Hr-12

121283	0.00- 2.00	-	1.0	121298	10.50-11.50	-	1.2
284	2.50	-	1.1	299	12.50	-	1.6
285	3.00	-	1.2	300	13.50	-	1.1
286	3.50	-	1.2	301	14.00	-	0.8
287	4.00	-	0.8	302	15.00	-	1.0
288	4.50	-	1.1	303	16.00	0.07	0.7
289	5.00	-	1.1	304	17.00	0.07	-
290	5.50	-	1.0	305	18.00	0.07	0.6
291	6.00	-	1.3	306	19.00	0.07	0.6
292	6.50	-	1.0	307	20.00	0.10	0.8
293	7.00	-	0.9	308	21.00	0.10	0.7
294	7.50	-	1.0	309	22.00	-	0.6
295	8.50	-	-	310	23.00	-	0.7
296	9.50	-	-	311	24.00	-	1.0
297	10.50	-	1.3	312	25.00	-	1.2

F. Subsurface split drill-core samples [continued]

Drill hole Hr-12 [continued]

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
121313	25.00-26.00	-	1.5	121427	53.00-55.00	0.05	0.9
314	27.00	-	1.2	428	57.00	0.07	0.7
121414	27.40-29.40	-	0.9	429	59.00	0.10	-
415	31.40	-	0.9	430	61.00	0.70	-
416	33.40	-	1.1	431	63.00	0.14	-
417	35.00	-	1.1	432	64.35	0.12	0.8
418	37.00	-	1.4				
419	39.00	-	0.9				
420	41.00	-	0.9				
421	43.00	-	0.8				
422	45.00	-	0.6				
423	47.00	-	0.9				
424	49.00	-	0.5				
425	51.00	-	0.6				
426	53.00	0.12	0.6				

Drill hole Hr-13

121433	0.00- 4.00	0.12	0.5	121453	27.00-28.00	0.24	0.8
434	7.00	0.12	-	454	29.00	0.10	0.7
435	9.50	0.16	-	455	30.00	1.55	0.8
436	11.00	0.10	0.7	456	31.00	0.20	0.5
437	12.00	0.60	-	457	32.00	0.08	0.7
438	13.00	0.06	-	458	33.00	0.06	0.6
439	14.00	0.08	-	459	34.00	0.16	-
440	15.00	0.06	-	460	35.00	0.28	0.7
441	16.00	0.08	-	461	36.00	0.08	0.6
442	17.00	0.11	0.5	462	37.00	0.08	0.8
443	18.00	0.06	0.8	463	38.00	2.80	1.4
444	19.00	0.06	0.8	464	39.00	0.10	0.7
445	20.00	0.10	1.0	465	40.00	0.06	-
446	21.00	3.68	0.7	466	41.00	0.08	0.7
447	22.00	0.06	0.5	467	42.00	0.08	-
448	23.00	0.06	-	468	43.00	0.10	-
449	24.00	0.10	-	469	44.00	0.16	0.5
450	25.00	0.10	1.1	470	45.00	0.12	0.6
451	26.00	0.10	0.6	471	46.00	0.16	0.9
452	27.00	0.10	-	472	47.00	0.34	1.0

F. Subsurface split drill-core samples [continued]

Drill hole Hr-13 [continued]

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
121473	47.00-48.00	0.08	-	121513	87.00-88.00	-	-
474	49.00	0.08	-	514	89.00	-	-
475	50.00	0.06	-	515	90.00	-	-
476	51.00	0.06	-	516	91.00	-	-
477	52.00	0.06	-	517	92.00	-	0.5
478	53.00	0.06	-	518	93.00	-	-
479	54.00	0.18	-	519	94.00	-	0.6
480	55.00	0.06	-	520	95.00	-	-
481	56.00	-	-	521	96.00	-	-
482	57.00	-	-	522	97.00	-	-
483	58.00	-	1.1	523	99.00	-	0.8
484	59.00	-	-	524	99.00	-	0.6
485	60.00	-	-	525	100.00	-	0.7
486	61.00	-	0.9	526	101.00	-	0.5
487	62.00	-	1.2	527	102.00	-	0.6
488	63.00	-	1.3	528	103.00	-	-
489	64.00	-	-	529	104.00	-	0.5
490	65.00	-	1.0	530	105.00	-	0.8
491	66.00	-	0.7	531	106.00	-	0.9
492	67.00	-	-	532	107.00	-	0.8
493	68.00	-	0.6	533	108.00	0.05	1.0
494	69.00	-	0.6	534	109.00	0.05	1.0
495	70.00	-	0.5	535	110.00	0.05	0.8
496	71.00	-	0.5	536	111.00	0.05	0.7
497	72.00	-	-	537	112.00	0.06	1.3
498	73.00	-	-	538	113.00	0.11	0.8
499	74.00	-	-	539	114.00	0.06	0.8
500	75.00	-	-	540	115.00	0.06	0.6
501	76.00	-	-	541	116.00	0.11	0.6
502	77.00	-	-	542	117.00	0.07	0.8
503	78.00	-	0.5	543	118.00	0.06	0.9
504	79.00	-	0.6	544	119.00	0.05	0.5
505	80.00	-	-	545	120.00	0.05	-
506	81.00	-	-	546	121.00	0.05	0.6
507	82.00	-	-	547	122.00	0.05	0.8
508	83.00	-	-	548	123.00	0.05	0.7
509	84.00	-	-	549	124.00	0.05	1.5
510	85.00	-	-	550	125.00	0.05	0.5
511	86.00	-	-	551	126.00	-	-
512	87.00	-	-	552	127.00	-	-

F. Subsurface split drill-core samples [continued]

Drill hole Hr-13 [continued]

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
121553	127-128.00	-	-	121568	142-143.00	-	0.9
554	129.00	-	0.7	569	144.00	0.07	-
555	130.00	-	-	570	145.00	-	-
556	131.00	-	-	571	146.00	-	-
557	132.00	-	-	572	147.00	-	0.5
558	133.00	-	-	573	148.00	-	1.4
559	134.00	-	-	574	149.00	-	-
560	135.00	-	-	575	150.00	-	0.7
561	136.00	-	-	576	151.00	-	1.1
562	137.00	-	-	577	152.00	-	0.6
563	138.00	-	3.4	578	153.00	-	0.8
564	139.00	-	0.9	579	154.00	-	0.5
565	140.00	-	-				
566	141.00	-	-				
567	142.00	-	-				

Drill hole Hr-14

121315	0.00- 1.50	0.18	1.3	121340	23.00-24.00	-	0.5
316	2.50	0.06	1.6	341	25.00	-	0.5
317	4.00	0.08	1.7	342	26.00	0.06	0.5
318	4.50	0.08	1.7	343	27.00	0.06	-
319	5.00	0.10	1.2	344	28.00	0.06	-
320	5.50	0.08	1.5	345	29.00	-	3.2
321	6.00	0.20	1.2	346	30.00	-	1.0
322	7.00	0.06	1.3	347	31.00	-	1.9
323	8.00	0.06	1.4	348	31.50	-	1.6
324	8.50	0.08	1.6	349	32.50	-	0.7
325	9.00	0.06	1.5	350	33.50	-	1.2
326	10.00	0.10	0.8	351	34.50	0.06	1.0
327	11.00	0.08	0.7	352	35.50	-	1.0
328	12.00	0.08	0.7	353	37.00	-	0.9
329	13.00	0.06	0.5	354	38.00	-	1.4
330	13.50	0.06	-	355	39.50	-	1.3
331	14.50	0.06	2.5	356	40.50	-	1.4
332	15.00	0.06	0.9	357	41.50	-	1.0
333	16.00	0.06	1.7	358	42.50	-	1.0
334	17.00	0.06	1.8	359	43.50	-	0.7
335	18.00	0.06	2.1	360	44.50	-	-
336	19.50	0.06	2.5	361	45.50	-	-
337	20.50	0.06	1.2	362	46.50	-	-
338	22.00	0.06	0.5	363	47.50	-	0.6
339	23.00	0.08	-	364	48.50	0.08	0.7

F. Subsurface split drill-core samples [continued]

Drill hole Hr-14 [continued]

Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)	Sample Number	Interval (meters)	Gold (g/t)	Silver (g/t)
121365	48.50-49.50	-	0.5	121390	83.00-84.00	-	1.0
366	50.50	-	0.5	391	85.50	-	0.8
367	51.50	-	-	392	87.50	-	0.6
368	52.50	-	-	393	89.50	-	0.5
369	53.50	-	0.6	394	91.50	-	0.6
370	54.50	-	-	395	93.50	-	0.6
371	55.50	-	1.0	396	95.50	-	0.6
372	56.50	-	1.0	397	97.50	-	-
373	57.50	-	0.6	398	99.50	-	0.7
374	58.50	-	-	399	101.50	-	0.7
375	59.50	-	0.5	400	103.50	-	0.9
376	60.50	-	0.6	401	105.50	-	-
377	62.00	-	0.6	402	107.00	-	0.6
378	63.00	-	-	403	109.00	-	0.6
379	64.00	-	0.5	404	111.00	-	-
380	65.60	-	0.5	405	114.00	-	0.6
381	67.50	-	0.5	406	117.00	-	-
382	69.50	-	1.0	407	119.00	-	1.1
383	71.50	-	0.6	408	121.00	-	0.8
384	73.50	-	1.5	409	123.00	-	1.0
385	75.50	-	0.8	410	125.00	-	0.9
386	77.50	-	1.1	411	127.00	-	-
387	79.50	-	1.6	412	128.00	-	0.5
388	81.00	-	0.7	413	130.10	-	0.9
389	83.00	-	0.7				