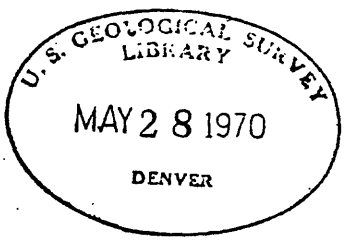
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Saudi Arabia Investigation Report
(IR) SA-106

EVALUATION OF A DIAMOND DRILLING PROGRAM AT THE SAMRAH MINE NEAR AD DAWADIMI, KINGDOM OF SAUDI ARABIA

by

T. H. Kiilsgaard



U. S. Geological Survey
OPEN FILE REPORT
This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards or nomenclature.

1970

EVALUATION OF A DIAMOND DRILLING PROGRAM AT THE SAMRAH MINE, NEAR AD DAWADIMI, KINGDOM OF SAUDI ARABIA

by

T. H. Kiilsgaard

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 Also on open file in that office is a large amount of material, in the form of unpublished manuscripts, maps, field notes, drill logs, annotated aerial photographs, etc., that has resulted from other previous geologic work by Saudi Arabian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

TABLE OF CONTENTS

ILLUSTRATIONS

(In pocket)

ABSTRACT

The Samrah mine, near Ad Dawadimi, Kingdom of Saudi Arabia, has been explored by 18 diamond drill holes, aggregating 3,624.3 meters in length. The holes demonstrate that the Samrah vein zone follows premineral andesitic dikes. Smaller veins split away from the main Samrah vein zone. The Samrah vein zone is known to be mineralized at the surface for at least 400 meters and to a depth of at leas 220 meters below the surface. Within this mineralized part of the vein zone diamond drilling has indicated ore reserves of approximately 204,000 metric tons, the average value of which is estimated at $67 per ton.

INTRODUCTION

Purpose of study

This report evaluates a diamond drilling project at the Samrah mine, near Ad Dawadimi, Kingdom of Saudi Arabia. The drilling was designed primarily to test the Samrah vein system beneath ancient mine workings that are believed to have been worked principally for silver several hundred years ago. The project wa based on unpublished work of R.G. Bogue in 1954. The U. S. Geological Survey, sponsored by the Ministry of Petroleum and Mineral Resources, Kingdom of Saudi Arabia, began the drilling project in August 1965. Nine holes, numbers 1 through 10 (fig. 1), were drilled during this phase of the project. An additional nine holes, numbers S-1 through S-9, were drilled by the Arabian Drilling Company. A total of 3,624.3 meters were drilled in the 18 holes. Four holes were drilled to test targets away from the Samrah workings. The last hole was completed in the spring of 1967.

Location and accessibility

The Samrah mine is about 15 kilometers south of Ad Dawadimi, at lat. 24°22' N., long. 44°22'E. Elevation at the mine workings is about 1020 meters (aneroid barometer).

The mine is accessible by truck trail from Ad Dawadimi. A macadam-surfaced two-lane highway connects Ad Dawadimi and Jiddah, which is about 1200 kilometers to the west. Approximately 14 hours of driving time is required to make the trip from Jiddah to Ad Dawadimi by truck.

Terrain in the vicinity of the Samrah mine is rather flat, except for a few rocky hills and ridges that rise 10 to 20 meters above the surrounding countryside. Only sparse desert vegetation grows in the area, which, in general can be crossed at will by truck or Landrover.

Precipitation is sparse in area. A limited supply of water is available at B'ir Samrah, about 1 kilometer to the east, and at Ad Dawadimi.

Previous work and acknowledgments

Mr. K. S. Twitchell examined the Samrah mine in 1932 and sampled some of the ancient dumps. Three of his samples assayed 4.00, 7.50, and 6.70 ounces silver per ton; however, his report was not available to the present writers. The deposit was studied in more detail by R.G. Bogue (1954, unpub. data), who recommended that ancient tailings dumps of the property be sampled and that diamond drilling be done to determine the persistence and grade of the veins at depth. Harold A. Quinn (1964) studied the Samrah mine and nearby deposits and laid out a proposed diamond drilling project. The geology of the Samrah mine and vicinity was mapped by P. K. Theobald, Jr. (1966a). Theobald also laid out Drill Hole No. 1 and prepared a detailed

description of the findings in that hole (Theobald and others, 1970b). Mr. J. W. Reinhart, U. S. Geological Survey arrived at the project after 12 of the 18 holes had been drilled. He prepared maps of the area, and logged and sampled all of the holes except Hole No. 1 and Hole S-9.

The present writer has drawn heavily from the notes, logs, and other data assembled by Reinhart and wishes to acknowledge the assistance he provided in the preparation of this report. Thanks also are due to G. F. Brown, F. V. Tompkins, W. J. Dempsey, W. C. Overstreet, and others of the Geological Survey who aided in one way or another in collecting the data and assembling the report.

Present work

This report is based on a 3-day field trip to the Samrah mine (May 9-11, 1968). The purpose of the trip was to check previously prepared maps and data that had been compiled on the drilling project. Outcrop features of the deposit, mine workings, and drill sites were mapped by plane table during the May trip (figs. 1 and 2). In addition, about 4 weeks were devoted to study of the drill logs, sample data and other unpublished information, and to the calculation of reserves, and preparation of the report. The drill logs (app. 1) were condensed considerably from Reinhart's original versions in order to present only the more pertinent geologic information. Measurements in the logs and in the sample data also were converted from feet and inches to meters.

GEOLOGY

Precambrian igneous rocks, ranging in type from gabbro to pegmatite, underlie the Samrah mine and vicinity. These rocks are described in detail by Theobald (1970a), hence only brief information taken from field exposures and hand specimens is presented here.

Gabbro

Gabbro crops out in a large elliptical area a few kilometers north of the Samrah mine. Only one exposure of gabbro was seen at the mine, however, and it consisted of a few large rounded boulders and spalled slabs north of the western open cut. These boulders are coated with black desert varnish, but fresh surfaces are lighter and show feldspar laths, a black amphibole, and probably pyroxene. The rock is difficult to break and large slabs emit a clear and distinctive bell-like tone when struck near thin edges by a hammer. Theobald (1970a) considers the gabbro to be the oldest rock in the Samrah area.

Metadiorite (amphibolite - foliated granodiorite)

Theobald mapped a broad band of amphibolite extending southeast across the Samrah deposit. He describes fresh surfaces of the rock as having a uniform gray color and notes that the rock consists of essentially equal amounts of plagioclase and amphibole. He explains why he used the term amphibolite rather than "hornblende gabbro or diorite" and calls attention to the schistose cleavage exhibited by fine-grained granular masses within the amphibolite. In the log of Drill Hole 1, Theobald (1970b) describes most of the core as consisting of amphibolite.

Reinhart, who logged most of the other drill holes, called attention to relatively few exposures of amphibolite. He preferred the term metadiorite, and under this classification he included most of the rocks mapped by Theobald as amphibolite as well as those mapped as foliated granodiorite. The present writer found xenoliths or inclusions of fine-grained schistose rocks in coarser textured dioritic rock in the Samrah mine area and assumes the schistose xenoliths to be the amphibolite of Theobald and the dioritic rock to correlate with his foliated

granodiorite. The dioritic rock is by far the more common in the mine area and is the rock logged by Reinhart as metadiorite, thus the western and northern surface areas of the mine were mapped as metadiorite (fig. 2), in order to correlate outcrops with drill cores. The fact that metadiorite engulfed amphibolite, leaving only zenoliths of unaffected amphibolite remaining, is clear evidence that the metadiorite is the younger of the two.

Granite

Granite is the common country rock at the eastern end of the Samrah deposit. It is described by Theobald (1970a, p. 10) as usually massive, equigranular and light colored. Fresh granite in drill cores has a characteristic red color formed by the potash feldspar. Biotite is the most common minor constituent. The texture tends to be even-granular, although fine-grained red to light colored aplitic varieties are common in dikes and tongues that cut older rocks. Near contacts with other rocks the granite has a chilled fine-grained rhyolitic texture. Pegmatite dikes, probably offshoots from the granite, occur in the mine area, but are not common.

The granite is clearly younger than the metadiorite. Dikes of granite cut the metadiorite and the amphibolite inclusions in the metadiorite.

Lamprophyre

Theobald (1970a, p. 11) describes dark-gray to black, massive, and aphanitic lamprophyre dikes that usually are less than a meter in width and have an irregular sinuous trend to the north. No north-trending dikes were seen at the deposit; however, lamprophyre dikes are common in the drill core and there is much lamprophyric

material in the easterly-trending andesitic dikes. No attempt was made to map the lamprophyric material in these dikes as positive identification would have required more than the visual hand specimen identification that was made.

Andesitic dikes

Aside from metadiorite and granite, andesitic dikes are the most common country rock at the Samrah deposit. The rock is dark gray to black, and massive to aphanitic in texture. Locally, the rock is porphyritic, containing elongate feldspar phenocrysts, although more commonly individual grains are small and cannot be identified by the unaided eye. Theobald (1970a, p. 16) calls attention to other field terms given the dike rock, ranging from basalt to rhyolite. Petrologic study of the rock may very well prove that more of it should be classed as basalt than as andesite.

The andesitic dikes have a strong easterly trend and dip steeply to the south. The more conspicuous dikes extend along the trace of the Samrah veins. Other, somewhat parallel dikes, extend to the south of the main vein (fig. 2).

The dikes are older than the veins, which cross them, extend within them, or follow along the dike walls. Where they are cut by veins or where veins follow along the dike wall, particularly the footwall, the dike rock commonly is badly fractured. Brecciated dike rock, the fragments cemented by quartz and forming a hard resistant tabular mass, is a common outcrop feature. An excellent brecciated exposure is to be seen in the footwall of the Samrah vein zone, at the east end of the large West pit. Quinn (1964, p. 27) presents an excellent photograph of black brecciated dike rock adjoining a dike. Within and near veins, the dike rock commonly is altered and strongly silicified, often so extensively that the original

rock type cannot be identified. Ore minerals in this dark silicified rock can be identified only with difficulty. In fact, sample S-2, taken across a dike 70 cm thick at the western end of the West pit, contained 2.72 percent zinc, yet no zinc minerals were identified in the dike outcrop.

The andesitic dikes are the youngest host rocks at the deposit. The cut all other observed rock types.

Veins

Veins are conspicuous geologic features at the Samrah mine. All of the ancient mine workings are on vein that strike easterly and dip steeply to the south. They are essentially quartz veins that follow fracture zones along the walls of andesitic dikes. At the outcrop, the veins range from a centimeter to 1-1/2 meters in thickness. Frequently the rock adjoining the veins is so silicified that it is difficult to determine the true thickness of the vein.

The main vein forms the footwall of the Samrah vein zone and passes along the north side of the two large pits. The vein zone is not a strong single vein but consists of closely-spaced strands of veins. A section across the vein at the westernmost trench, station F (fig. 2), from footwall to hanging wall, is as follows: 40 cm of black andesitic dike; 80 cm of vein, mostly silicified dike material, vuggy quartz, small limonite-filled pits that are oxidized remnants of sulfides; 10 cm of angular, brecciated fragments of andesite cemented into a tabular mass by quartz; 50 cm of quartz vein; 10 cm of brecciated andesite fragments cemented by quartz; 70 cm of silicified andesitic dike; 1.20 meters of sand-filled pit, probably vein material that had been mined; 40 cm of heavily silicified andesitic dike; more than 1.5 meters of andesite dike, the hanging wall area of which is covered by mined debris from the pit.

Many of the vein strands split away from the main vein and extend southeast into the hanging wall block of the main vein zone (fig. 2). The longest of the splits may be traced for almost 200 meters, but most of them pinch out within 60 meters of the main vein. Like the main vein, the splits usually follow andesitic dikes. Some of the splits have been mined. To aid in correlation the more conspicuous splits are numbered on Figure 2. Of these, the No. 4 split, which passes along the south side of the West pit, is the strongest and appears to have been mined more than the others.

At the western end of the East pit, the main vein continues on strike, extending north of the pit as a barren quartz vein. Hanging wall strands of the Samrah vein zone continue through the pit but diminish in thickness and in mineral content at the eastern end.

Ore minerals are difficult to identify at the vein outcrops as the sulfides are almost completely oxidized and the remaining vein material is heavily stained by limonite. Residual pits left behind from oxidized sulfides are small, suggesting that the sulfides themselves were small in grain size. Thin coatings of a heavy, white to yellowish-white, secondary mineral on rock fragments and in fractures probably are cerussite or anglesite. Films and powdery material in voids may be the secondary zinc mineral smithsonite. In one specimen, tiny hair-like, discontinuous stringers of a metallic mineral may be native silver. Most of the vein material, however, consists of heavily gossan-stained quartz, carbonate (possibly ankerite), and rock fragments. This is to be expected, as the deposit was extensively mined at and near the surface by hand methods, and all visible ore was plucked out. Cored sections of the vein, from the drill holes, show the ore to

consist of pyrite, sphalerite, and galena. Tiny stringers and blebs of chalcopyrite are common in the sphalerite. Pyrargyrite is reported in some of the core samples, but the mineral has not been positively identified. It may be hematite.

The veins are along premineral faults that follow the fracture pattern filled previously by the andesitic dikes. Quartz, ranging in texture from cryptocrystallin to coarse quartz crystals in vugs, was the first mineral introduced into the fractured rock. The introduced quartz cemented the brecciated rock fragments, forming the breccias so plainly evident along the outcrop. Finer textured quartz permeated the nearby country rock and formed the silicified zones so common along the veins, especially in the hanging wall blocks. It is the abundance of silica in and near the veins that makes the host rocks resistant to erosion, thereby holding up the hill on which the deposit crops out. The ore minerals were introduced into the veins after the initial period of silicification, as proven in sections of drill core by veinlets of ore minerals that cut quartz.

STRUCTURE

No attempt was made to study regional structure in the vicinity of the Samrah mine. Quinn (1964a, p. 40) and Mytton (1967) discuss regional folding in the area, and Theobald (1970a, p. 21) describes intense regional fracturing. No faults were mapped at the Samrah mine other than the major fracture zone occupied by the andesitic dikes and the veins. This zone has a general strike of N. 80° E., and dips 70-80° S. Smaller fractures split away from the zone, especially to the southeast, into the hanging wall block. Some of these splits are shown and identified by number on Figure 2.

THE SAMRAH MINE

History

No one knows when mining began at the Samrah mine. Quinn (1964a), in referring to earlier work by Twitchell, notes that mining at Samrah probably began before 900 A.D. and may have continued well beyond 1000 A. D. This estimate is based on fragments of green slip pottery found at Samrah and at other ancient mines in Saudi Arabia that are believed to have been worked during that period. Tailings piles at Samrah also contain small fragments of thin green glass that is found at other ancient mines believed to have been worked in the 10th century.

Mine workings

There are no records of metal production at the Samrah mine. Mining activity appears to have been centered at two large open pits, marked on Figure 2 as the West and the East pits, and in underground areas between the pits (fig. 13). In addition, there are a number of trenches along splits, most now filled with sand below a depth of 1 or 2 meters from the surface, but all believed to have been quite shallow. Also there are many small shafts of unknown depths along the veins. None of these were entered by the present writer as he had no underground equipment with him. Reinhart reports that he went underground and mapped many stoped areas. Reinhart's underground maps are not available; however, some of the underground workings as described by him are projected on section L-L' (fig. 13). They extend to greater depths than would be expected. Diamond drill hole No. 3 crossed an 80 cm void in the main vein at a vertical depth of 72 meters below the surface. Whether this is an ancient working place is unknown, although it could be. Reinhart notes that mine workings are narrow and that only the ore was mined. This contrasts with

the two large open pits, where much waste material obviously was removed. This undoubtedly was done in order to mine the veins and veinlets that split from the main vein. It was easier to mine the waste material between the splits, thereby gaining access to the ore along the veins across the surface area of the pit than to mine the individual veins by underground methods. The depths to which the pits were mined can only be estimated as the bottoms of both pits are now filled with debris.

The reasons why ancient mining ceased at Samrah is unknown. It may have been that the ancients mined only oxidized ore and that they could not handle the sulfide ores they encountered with depth. They may have encountered water, with which they could not cope. Or it may have been because of other reasons. Certainly, it was not because the ore terminated, as drill cores show good ore well below the lowest known mine workings.

Only rough estimates may be made of the volume of material excavated at the Samrah mine. On the basis of the size of the pits and size of waste dumps near them, Bogue (1954) estimated production of at least 60,000 or 70,000 tons of material. Reinhart (written commun.) measured underground workings he was able to enter, as well as the open pits, and computed a total of about 60,000 tons.

THE DIAMOND DRILLING PROJECT

Background information

Bogue (1954) recommended diamond drilling at the Samrah mine to determine the persistence and grade of the veins at depth. He proposed six holes, to be drilled from three drill sites 400 feet (122 meters) apart, to intersect the vein 150 and 300 feet (46 and 91 meters) below the surface. Quinn (1964b) also proposed a plan

for drilling the Samrah deposit. He proposed ten diamond drill holes, the locations of which he plotted on Figure 1 of his report. On the basis of these recommendations, the U. S. Geological Survey, sponsored by the Ministry of Petroleum and Mineral Resources, Kingdom of Saudi Arabia, began drilling in August 1965. Nine holes, Nos. 1-10, were drilled by the U. S. Geological Survey, under the supervision of Henry D. Horn. Seven of these holes were drilled beneath the ancient Samrah workings. Two holes, Nos. 7 and 8, were drilled about 600 meters to the west, to test a geophysical anomaly. Hole No. 9 was scheduled but not drilled. All of the Geological Survey holes were drilled to test the Samrah veins at rather shallow depths (see enclosed cross and longitudinal sections). While Geological Survey drilling was underway, the Arabian Drilling Company began drilling a series of 9 holes, shown on Figure 1 or Figure 2 as holes S-1 through S-9. Seven of these holes were drilled under the Samrah mine workings, one hole (No. S-7) was drilled near the site of Holes 7 and 8, to test the previously mentioned geophysical anomaly, and another hole (S-8) was drilled about 1 kilometer east of the Samrah mine, to test what might be an east continuation of the Samrah vein system. Holes drilled by the Arabian Drilling Company were designed to test the Samrah veins at deeper elevations (see enclosed cross and longitudinal sections). A total of 3,624.3 meters were drilled in the 18 holes. The last hole, S-9, was completed during the spring of 1967.

The following drill hole information is taken largely from the core logs. The cores of all holes, except S-9, were logged by Reinhart, whose log and sample notes have been of great assistance in preparing this report. He prepared extensive logs, measured in feet and inches, which have been condensed, converted

to metric measurement, and enclosed in the Appendix of this report. Hole No. 1 was logged and sampled by Theobald (1970b) and by Reinhart. W. P. Dempsey helped Reinhart log Hole S-2. Hole S-9 was logged by F. V. Tompkins.

The holes are not described in numerical order but in the order of cross sections A through K, shown on Figure 2, from west to east.

Drilling results at Samrah deposit

Hole S-5

Hole S-5 is the westernmost hole drilled under the old Samrah workings. The log of this hole (app.) shows that it cut a number of andesitic dikes, many of which can be correlated with the dike outcrops. At 188.34 meters the hole cut a .17 meter brecciated zone containing sphalerite, galena, and pyrite. The zone is considered to be a split from the Samrah vein. Although it is of good grade (table 1, sample No. 34,250), it is too narrow to mine. It could, however, increase in width nearer the Samrah vein zone and would warrant prospecting if mining was being done in that area.

The Samrah vein zone was intersected in the interval 210 to 214.88 m, along the hanging wall side of a brecciated andesitic dike zone. The grade of material in the vein intercept is not high, however, the geologic characteristics of the core correlate with those of core from Hole 2, to the east, where the grade is higher.

Table 1. - Assay results from mineralized sections of Samrah diamond drill core. Many samples were reanalyzed, some more than once, in which case only the last analytical result is given. The symbol "-" represents nil amount of metal, a blank space indicates no test. "Tr" is an abbreviation of trace (detected but not measured).

Drill Hole No. 1[2/]

Sample[1/] no.	Interval of sampled core (meters)	Au (ounces per ton)	Ag (ounces per ton)	Pb (Percent)	Zn (Percent)
29,171	132.82 - 133.35	-	16.00	5.32	6.10
29,172	133.35 - 133.96	-	0.46	3.63	1.11
29,173	133.96 - 134.29	-	0.42	3.38	0.72
29,174	134.29 - 135.33	-	1.50	0.35	2.30
29,111	135.33 - 136.96	0.01	58.00	7.80	13.00
29,112	136.96 - 138.46	-	2.49	4.38	3.83
29,113	138.46 - 139.98	0.30	15.90	6.48	8.60
29,180	145.26 - 145.54	0.02	10.50	0.04	42.30

1/ Sample numbers are arranged so that progressively deeper sections of core are listed for each hole.

2/ For a detailed log of Drill Hole No. 1, see P. K. Theobald, Jr., C. E. Thompson, and H. D. Horn (1970b). Sample data presented in Table 2 of that report have been reanalyzed and the reanalyzed data are shown in the present table.

Drill Hole No. 2

Sample no.	Interval of sampled core (meters)	Au (ounces per ton)	Ag (ounces per ton)	Pb (Percent)	Zn (Percent)
34,000	6.76 - 6.47	-	0.28	0.05	0.10
34,086	17.31 - 20.01	-	0.96	Tr	Tr
34,087	21.59 - 23.11	-	0.14	-	Tr
34,001	27.13 - 28.32	-	0.27	-	-
34,088	33.78 - 36.93	-	0.13	-	-
34,089	40.13 - 40.46	-	0.17	Tr	Tr
34,090	40.46 - 43.74	-	0.18	-	Tr
34,400	44.54 - 44.91	-	0.60	0.02	0.19
34,401	44.91 - 45.64	Tr	16.80	0.13	6.00
34,402	45.63 - 45.95	-	0.45	0.03	0.21
34,403	45.95 - 47.90	-	0.06	0.01	0.05
34,404	47.90 - 48.08	-	0.19	0.01	0.56
34,405	48.08 - 49.58	-	0.09	Tr	0.03
34,406	64.44 - 65.53	-	0.66	0.08	2.12
34,407	67.00 - 68.68	-	0.28	0.06	0.57
34.408	68.68 - 69.95	-	0.26	0.12	0.63
34,409	69.95 - 71.48	-	0.09	0.03	0.18
34,410	71.48 - 72.67	-	0.31	0.06	0.80
34,411	75.74 - 76.35	Tr	3.78	0.05	8.00

Drill Hole No. 3

Sample no.	Interval of sampled core (meters	Au (ounces per ton)	Ag (ounces per ton)	Pb (Percent)	Zn (Percent)
34,091	28.06 - 28.24	-	0.33	-	-
34,092	53.57 - 54.48	-	0.26	-	Tr
34,093	54.48 - 54.86	-	-	-	0.01
34,094	54.86 - 56.28	-	-	-	-
34,095	80.01 - 82.14	-	0.04	0.02	0.03
34,096	82.14 - 83.45	-	2.67	0.03	0.25
34,097	83.45 - 85.20	-	0.30	0.01	0.06
34,098	85.20 - 88.19	0.01	8.40	0.03	2.73
34,099	89.00 - 89.31	0.01	4.20	-	10.00
34,108	89.31 - 90.17	-	0.45	0.05	0.30
34,109	90.17 - 93.24	0.01	6.00	-	3.15
34,110	92.45 - 93.24	0.03	53.20	0.28	28.50
Drill Hole No. 4					
34,113	27.84 - 28.96	-	-	Tr	0.10
34,114	85.65 - 86.64	-	0.13	-	-
34,115	103.73 - 105.26	-	0.13	0.05	0.12
34,116	105.26 - 106.55	-	0.20	0.02	0.11
34,117	106.55 - 107.21	-	0.32	0.10	0.26
34,118	107.21 - 108.64	-	0.41	-	-
34,119	108.64 - 11-.13	-	0.60	0.01	0.09
34,120	110.13 - 111.40	-	0.34	0.01	0.11

Drill Hole No. 5

Sample no.	Interval of sample core (meters)	Au (ounces per ton)	Ag (ounces per ton)	Pb (Percent)	Zn (Percent)
34,121	96.00 - 98.96	Tr	0.16	-	-
34,122	99.75 -100.66	-	3.55	0.12	1.58
34,123	100.66 - 101.35	0.02	29.20	12.60	4.95
34,124	101.35 - 101.73	-	2.48	-	-
34,125	101.73 - 102.29	-	0.40	-	-
34,126	129.92 - 132.30	-	-	0.10	0.02
Drill Hole No. 6					
34,127	86.66 - 87.58	Tr	0.20	0.04	0.02
34,128	102.62 - 103.89	0.01	14.35	0.13	3.86
34,129	103.89 - 104.80	-	20.10	0.10	1.75
34,130	104.80 - 106.02	0.02	57.00	-	0.50
34,131	106.02 - 106.48	0.01	7.80	-	0.70
34,132	106.48 - 108.97	-	1.31	0.07	0.35
Drill Hole No. 7					
34,133	6.09 - 21.34	-	0.12	-	-
34,134	21.33 - 25.75	-	0.13	-	-
34,135	78.99 - 80.16	-	0.26	-	-
34,136	82.26 - 80.69	-	-	-	-

Drill Hole No. 8

Sample	Interval of sampled core (meters)	Au (ounces per ton)	Ag (ounces per ton)	Pb (Percent)	Zn (Percent)
34,137	18.64 - 21.64	-	-	-	-
34,138	21.64 - 24.69	-	-	-	-
Hole No. 9 was not drilled					
Drill Hole No. 10					
34,139	110.77 - 111.05	-	-	0.01	0.01
34,140	124.36 - 124.61	Tr	Tr	0.05	0.05
34,141	124.61 - 124.79	-	-	0.05	0.03
34,141A	136.90 - 138.71	Tr	Tr	0.01	0.04
34,142	138.71 - 140.13	-	-	-	0.04
34,143	140.13 - 141.05	-	-	0.02	0.15
34,144	141.05 - 142.82	-	0.16	-	-
34,145	142.82 - 145.18	-	-	-	-
Drill Hole No. S-1					
34,238	9.39 - 9.83	-	1.22	0.06	0.20
34,239	109.22 - 109.32	-	0.16	0.10	0.30
34,241	110.21 - 110.49	Tr	0.26	0.02	0.20
34,242	111.20 - 112.72	-	Tr	Tr	0.01
34,243	114.50 - 115.52	-	46.00	2.40	30.00

Drill Hole No. S-1 (Continued)

Sample no.	Interval of sampled core (meters)	Au (ounces per ton)	Ag (ounces per ton)	Pb (Percent)	Zn (Percent)
34,244	116.51 - 116.68	-	0.20	0.03	0.40
34,245	116.94 - 117.37	0.04	44.10	9.80	32.00
34,246	117.90 - 119.10	0.03	22.80	3.00	5.00
34,247	120.42 - 120.70	0.03	20.70	5.00	3.50
Drill Hole No. S-2					
34,229	112.09 - 112.47	-	0.15	0.01	0.02
34,230	113.31 - 113.66	-	8.00	0.08	1.00
34,231	113.66 - 114.28	-	0.47	0.01	0.03
34,232	115.31 - 116.33	-	0.08	Tr	0.01
34,233	116.33 - 118.06	-	0.38	Tr	Tr
34,234	118.06 - 119.99	Tr	0.23	Tr	Tr
34,235	120.55 - 121.11	-	0.11	0.01	0.05
34,236	121.69 - 121.87	-	0.22	0.02	0.20
34,237	123.11 - 124.15	-	1.06	0.09	0.30

Drill Hole No. S-3

Sample no.	Interval of sampled core (meters)	Au (ounces per ton)	Ag (ounces per ton)	Pb (Percent)	Zn (Percent)
34,151	93.57 - 94.89	-	-	0.01	0.05
34,152	94.89 - 95.84	Tr	Tr	-	-
34,152	98.20 - 98.65	-	-	-	-
34,153	98.20 - 98.65	-	-	-	-
34,154	98.65 - 101.78	-	-	-	Tr
34,155	101.78 - 103.68	-	-	-	Tr
34,156	144.86 - 146.43	-	0.13	0.02	0.17
34,157	146.43 - 146.53	0.02	3.40	-	4.45
34,158	146.53 - 147.37	-	0.13	0.01	0.03
34,159	147.44 - 148.84	-	-	-	0.01
34,160	167.10 - 167.94	-	-	-	Tr
34,161	167.94 - 170.18	Tr	0.60	-	Tr
34,162	170.18 - 170.41	Tr	3.80	1.15	3.25
34,163	170.41 - 171.02	Tr	0.40	-	0.30
34,164	171.02 - 174.12	Tr	0.80	0.05	0.20
34,165	178.84 - 179.70	Tr	0.20	-	Tr
34,166	179.70 - 181.53	0.05	53.55	1.50	21.10
34,214	193.68 - 194.05	-	Tr	Tr	Tr
34,215	197.03 - 199.57	-	Tr	Tr	Tr
34,216	199.57 - 200.46	-	0.11	0.30	Tr
34,217	201.19 - 202.46	-	Tr	Tr	Tr
34,218	203.23 - 203.84	-	Tr	Tr	Tr

Drill Hole No. S-3 (Continued)

Sample no.	Interval of sampled core (meters)	Au (ounces per ton)	Ag (ounces per ton)	Pb (Percent)	Zn (Percent)
34,219	203.84 - 204.70	-	Tr	Tr	Tr
34,220	206.72 - 208.74	-	Tr	0.08	0.30
34,221	208.74 - 209.85	-	Tr	0.50	0.30
34,222	212.29 - 213.13	-	Tr	Tr	Tr
34,223	223.47 - 224.16	-	0.16	Tr	Tr
34,224	224.16 - 225.73	-	0.16	Tr	Tr
Drill Hole No. S-4					
34,146	210.46 - 211.18	-	-	-	0.01
34,147	211.18 - 214.98	-	Tr	Tr	Tr
34,148	214.98 - 218.87	Tr	0.40	-	-
34,149	221.08 - 221.74	0.02	9.80	-	3.45
34,150	222.61 - 224.38	Tr	9.40	-	4.65
Drill Hole No. S-5					
34,248	54.89 - 54.94	(No data)			
34,249	119.71 - 110.89	Tr	Tr	-	Tr
34,250	188.34 - 188.77	0.02	42.80	2.05	11.75
34,289	208.48 - 210.00	Tr	0.10	-	Tr
34,290	210.01 - 212.45	0.01	4.40	-	2.80

Drill Hole No. S-5 (Continued)

Sample no.	Interval of sampled core (meters)	Au (ounces per ton)	Ag (ounces per ton)	Pb (Percent)	Zn (Percent)
34,291	212.45 - 213.59	Tr	2.20	-	2.90
34,292	213.59 - 214.88	0.02	7.60	-	5.85
34,293	217.93 - 220.30	Tr	Tr	-	-
Drill Hole No. S-6					
34,251	365.94 - 368.45	Tr	0.10	-	0.20
34,252	384.33 - 385.75	Tr	0.10	-	-
Hole No. S-7 (not sampled)					
Drill Hole No. S-8					
34,253	45.99 - 46.74	Tr	Tr	-	-

Hole No. S-9 (not sampled)

Hole 2

Drill Hole 2, penetrated 1.19 meters of brecciated quartz and interstitial quartz and carbonate, with sparse pyrite and sphalerite in the interval 27.13 - 28.32 meters. This zone is interpreted as the down-dip continuation of the No. 1 split from the Samrah vein. This split was worked downward from the surface to an unknown but probable shallow depth. Sample 34,001 (table 1) shows nil values for the vein in the penetrated interval. No reserves are calculated for the split.

The interval of hole from 44.91 to 45.64 meters contains breccia and vein material, including pyrite, sphalerite, and galena. The interval contains good assay values (table 2) and is assumed to be the No. 2 split (figs. 2 and 4). The No. 2 split was extensively mined by surface cuts above the hole penetration and it is probable that most of the ore between the penetration and the surface has been mined. No reserves are calculated for this area of the split.

The main Samrah vein zone was penetrated in the interval 75.74 to 76.35 meters, near the footwall of an andesitic dike or dikes about 12 meters thick. Assay data for the penetrated vein interval are presented in Table 2.

Holes S-1 and S-3

Hole S-1 penetrated the No. 1 split of the Samrah vein zone in the hole interval 9.39 to 9.89 meters. A sample of the core (Table 1, sample 34,238) contained a sparse amount of silver and explains why the vein was mined at the outcrop east of the hole. To the northwest, in Hole 2, the vein contained no metal values.

The No. 2 split from the main zone was intersected about 70 meters down the hole. An altered area, containing many quartz and calcite veinlets was cut at about this distance. No ore minerals were seen in core from the split, although to the northwest, near the main vein, the split was mined. Hole S-1, like Hole 2, indicates that ore does not extend very far in the splits from the Samrah vein zone.

Table 2.-- True thicknesses, weighted averages, and values calculated from drill core data.

Section	Hole	Length From	Length To	Distance (meters)	True thickness (meters)	Ounces/M.T. Au	Ounces/M.T. Ag	Percent Pb	Percent Zn	Values per M.T.[1/] Ag	Values per M.T.[1/] Pb-Zn	Total
A	S-5	210.01	214.88	4.87	2.45	.010	5.21	--	3.64	$12.76	$10.43	$23.19
B	2	44.91	45.64	.73	-	.008	18.52	0.13	6.00	$45.37	$17.57	$62.94
		75.74	76.35	.61	.54	.003	4.17	.06	8.00	$10.21	$23.10	$33.31
C	S-1	114.50	120.70	6.20	3.90	.010	17.61	1.88	8.29	$43.14	$29.15	$72.29
	S-3	179.70	181.53	1.83	1.02	.050	59.04	1.50	21.10	$144.64	$64.78	$209.42
D	1	132.82	139.98	7.16	4.95	.066	20.46	4.98	6.50	$50.13	$32.91	$83.04
		145.26	145.54	.28	.20	.023	11.58	.04	42.30	$28.37	$121.36	$149.73
E	S-2	113.31	113.66	.35	.24		8.82	.08	1.00	$21.61	$3.09	$24.70
F	3	90.17	93.24	3.07	2.67	.015	20.01	.07	9.67	$49.02	$27.92	$76.94
	4	No ore										
G	S-4	221.08	224.38	3.30	2.01	.004	7.72	--	3.18	$18.91	$9.11	$28.02
H	S-9	No ore										
	5	99.75	101.73	1.98	1.58	.01	13.54	4.45	2.45	$33.17	$19.78	$52.95
I	S-6	No ore										
J	6	102.62	106.48	3.86	2.87	.008	31.50	.06	1.91	$77.18	$5.64	$82.82
K	10	No ore										

1/ Calculated at June, 1968 metal prices of $2.45 per ounce silver, and 0.13 per pound for lead and for zinc. No values were calculated for the minor gold content.

The main vein was cut in the interval 114.50 to 120.70 meters (fig. 5, section C). The vein is not mineralized throughout this 6.20 meter interval but contains a number of strands of waste. Higher grade sections of the vein, such as the rich ore between 114.50 and 115.52 meters (sample 34,243) could be mined separately; however, prudent mining practice would suggest mining the entire zone, which has a true thickness of 3.90 meters, the weighted assay values of which are shown in Table 2.

The geologic intercepts in Hole S-1 projects easily to S-2, thus the two holes are plotted in the same section (fig. 5). In Hole S-3, an andesitic dike is encountered in the vicinity where the No. 1 split should project, but no evidence of ore was recorded in the core. A narrow, mineralized breccia zone was cut in the interval 146.43 to 146.53, which is considered to be the No. 2 split. This split did not contain ore in Hole S-1, although it did in Hole 2. The presence of ore in this hole is further evidence that the splits contain significant ore only near the main vein zone.

The black andesitic dike along which the main zone follows was cut at 163.5 meters, although strong sulfide mineralization was not penetrated until the interval 170.18 to 170.41 meters. The grade and thickness of material in this interval is too low to be considered ore. The Samrah vein zone extends from 179.70 to 181.53 meters. The calculated thickness of this sampled interval (table 1, sample 34,166) is 1.02 meters of high-grade ore (table 2).

Hole 1

Hole 1 was collared to coincide with Quinn's (1964b) proposed Hole No. 7. The bearing of the hole was rotated from that proposed by Quinn so that the hole would intersect most of the andesitic dikes, the Samrah vein zone and vein splits

from it, and would pass under the West pit (fig. 2). The hole, a log of the core, and analytical data on samples of the core are described by Theobald (1970b). A description of the hole therefore will not be repeated here, but a summary of core log information suggests that all veins plotted on Figure 2 as crossing the projected trace of the hole were cut. The No. 1 split appears to have been intersected at an inclined distance of 57 meters, the No. 2 split at a distance of 80 meters, and the No. 3 split at a distance of 96 to 99 meters. All interceptions project quite clearly to outcrops shown on figure 2. Ore minerals were not reported in any of these core interceptions, and nil amounts of metal are indicated in samples of the intersected veins. The Samrah vein zone was intersected in Hole 1, in the interval 132.81 to 145.54 meters. Theobald (1970b, p. 17) presents analytical data on core from this interval of hole. As a means of checking the analytical data, Reinhart had some of Theobald's core samples reanalyzed, some of them reanalyzed twice. The reanalyzed data are presented in Table 1.

Core between the interval 139.98 and 145.26 meters contained only sparse amounts of ore metals, the quantities of which are shown in Table 2 (Theobald, 1970b), samples 29,175 to 29,179. This interval of the vein was not considered to be of mineralized grade in ore calculations in this report; however, the interval could be ore elsewhere along the vein.

The mineralized core, from 132.81 to 139.98 meters, is calculated to represent an ore body the true thickness of which is 4.95 meters. The grade is shown in Table 2. This ore body lies 3.68 m in the hanging wall from a .20-meter thick segment of ore cut in the hole between 145.26 and 145.54 meters, which assays 11.50 oz. of silver per metric ton, .04 percent lead, and 42.3 percent zinc, the most

zinc encountered in any of the drill holes. Hole 1 penetrated a greater thickness of ore than any other hole drilled at the Samrah mine. The thickness probably represents a downward continuation of the ore mined in the West pit. Not to be ignored, however, is the fact that the hole penetrated the vein at a 50-degree angle to the strike of the vein, a poor angle of intersection. Because of this acute angle, a greater length of ore was penetrated in the hole, thereby creating the impression that the ore body is much thicker than it really is. Also, because of the acute angled penetration, it is possible that the hole was diverted along the strike of the vein rather than passing through it on the bearing set at the collar of the hole.

Hole S-2

Hole S-2 is one of the most perplexing holes drilled at the mine. No material was logged in the core that can be correlated with any of the splits from the Samrah vein. The No. 2 and 3 splits, which crop out 20 to 30 meters west of the projected trace of the hole, and which show strongly in Hole 1, do not crop out along the surface trace of Hole S-2, nor are they found in the core. The No. 3 split, which was mined above the hole, apparently merges with the Samrah vein zone above the hole intersection (fig. 6, section E). The hole intersected the andesitic dike zone along which the Samrah vein follows at 109.6 meters, almost exactly at the locality the dike projects to from the surface. A thin vein containing moderate values was penetrated at 113.31 meters (table 2), but a sampled interval of core across the projected location of the Samrah vein contains only traces or minor amounts of metals. The impoverished nature of the vein is emphasized by the fact that at approximately the same elevation and only about

25 meters to the west, where cut by Hole 1, the vein contains the thickest ore drilled in the project.

Holes 3 and 4

Holes 3 and 4 were drilled from the same site, with Hole 3 drilled more northerly and to a shallower depth (fig. 7). Hole 3 is collared in granite and continues in granite for about 50 meters. Near the contact with the older metadiorite, the hole passes through varying thicknesses of granitic material, probably irregular intrusives, tongues, or offshoots of the granite into the older metadiorite. At 54.5 meters the hole cuts a basaltic dike, and weakly mineralized breccia zone, which probably is the downward continuation of the No. 4 split. The Samrah dike and vein zone was penetrated at 80 meters. At 88 meters the hole crossed a 71 cm void, which could be a mine excavation. However, the void is 72 meters vertically below the surface, a rather deep working place for the ancient miners to have excavated. Thickness of the vein and weighted average of samples from it are presented in Table 2.

The findings in Hole 4 were much like those in Hole S-2: the andesitic dike along which the Samrah vein zone follows was penetrated in the interval 101 to 120.5 meters. Vein breccia, carbonate and quartz, and possibly some faint sulfides were seen in the core, but the assay data from the sampled interval (samples 34,115 34,120) contains only trace amounts of metals.

Hole S-4

Hole S-4 (fig. 8) is collared in metadiorite and should have intersected the same body of granite cut in Holes 3 and 4. The fact that it did not suggests that the keel of the granite embayment shown on Figure 2 plunges east. The hole

cut a number of andesitic dikes but no vein splits. The Samrah vein and dike zone were intersected at 218.8 meters. A weighted average of sample data from the vein is shown in Table 2. Grade of the material is not high but the vein is strong and core information from it is comparable in all respects to core taken from holes to the west.

Hole S-6

Hole S-6 (fig. 10) is the deepest hole drilled in the project. It was laid out to test the downward continuation of the good ore intersected in Holes 5 and 6. The hole passed through a number of andesitic dikes but no vein splits. At 312.4 and 318.7 meters the hole passed through small brecciated quartz veins. A narrow strand of andesitic dike was cut at 366.4 meters, below which is a weakly mineralized quartz-calcite breccia zone. A second breccia zone was cut at 384.3 meters. The narrow dike and the two breccia zones are believed by the present writer to be in the Samrah vein zone. Samples from the zone (table 1, samples 34,251 and 34,252) contain only trace amounts of metal.

Reinhart did not believe the breccia zones and the dike could be correlated with the Samrah vein zone. Instead, he assumed that the vein had not been intersected in the hole. He reasoned that the vein had reversed in dip and that it would be further to the north at lower levels. Hole S-9 was drilled to test the reversed-dip of the vein concept.

Holes 5 and S-9

Hole 5 cut a substantial thickness of good ore, as is shown in section H (fig. 9). The hole penetrated granitic material and some dark dike rock, and cut the andesitic dike zone of the Samrah vein at 98.86 meters (see log of hole in

Appendix). This intersection of ore was not found in Hole S-6, leading to the interpretation that the hole did not cut the vein because the dip of the vein had reversed.

Hole S-9 was collared in granite, but at 37.3 meters it passed into dioritic rock in which it remained throughout most of its length. Although it did not cut andesitic dike rock near the bottom of the hole, it did cut a sheared, serpentinized, and lithified but barren breccia zone between 344 and 372 meters. This is in all probability the Samrah vein zone which is shown in Section H. It lies about 15 meters in the footwall of its projected position based upon the intercepts in Holes 5, S-4, and S-6, which are themselves uncertain.

Hole S-9 was surveyed by the Tro-Pari method, the only hole of the project that was surveyed. The wander of the hole is shown in Figures 2 and 9. The fact that the hole did wander is evidence that Hole 1 also may have wandered, thus accounting for the thick segment of ore.

Holes 6 and 10

Hole 6 intersected the Samrah vein zone beneath the western end of the East pit (fig. 11, section J). It is the most eastern hole to intersect good ore. Hole 10 cut the dark dike rock of the Samrah vein zone, but no evidence of ore was reported in the core and none is suggested by sample data in Table 1. The footwall strand of the Samrah vein zone, shown on Figure 2 as a barren quartz vein, was intersected at 136.9 meters, but it also was barren of ore.

Other drilling results

Holes 7, 8, and S-7 were drilled about 300 meters southwest of the western end of the Samrah mine (fig. 1). The drilling was done to test an anomaly identified by an electromagnetic survey of the Samrah area by M. N. Akhrass, geophysicist, Saudi Arabian Mineral of Petroleum and Mineral Resources. Mr. Akhrass' map shows an arcuate anomaly, the northeast limb of which is aligned roughly with a westward projection of the Samrah vein. A resistivity profile by Akhrass, along line 500 West of his map, supports his interpretation of the anomaly, which, indeed is strong enough to justify drilling.

Hole 7 was aimed to pass under a high point of the anomaly; however, the country rock penetrated by the drill was found to be intensely weathered and core recovery to a depth of 33 meters was very poor. No evidence of mineralized vein was found in the remainder of the hole, and it was assumed that whatever caused the anomaly must have been at shallow depth in that part of the hole from which poor core recovery was made. For this reason, Hole 8, drilled at a slightly different bearing from Hole 7 and at a slightly steeper angle, was put down to test the anomaly but it too penetrated highly weathered country rock throughout most of its length and showed no evidence of ore mineralization. Good core recovery was made from a third hole, S-7, which was drilled to test the anomaly, but no ore was found. Mr. W. J. Dempsey (verbal commun.) states that drilling results of the three holes suggest the anomaly may be caused by clays, dissolved salts, or water content in the highly weathered country rock that underlies the area.

At a later date, the Arabian Geophysical and Surveying Company (ARGAS) made several geophysical maps of the Samrah vicinity. A resistivity map confirmed the anomaly mapped by Akhrass. An induced polarization survey did not pick up an anomaly under the Samrah deposit and suggests that this type of a survey may not be helpful in exploring vein deposits of the Samrah type. A self potential map of the area also did not reveal any significant anomalies.

Hole S-8 was drilled about 430 meters east of the eastern end of the Samrah mine to test a vein that may be an eastward continuation of the Samrah vein zone (fig. 1). The hole intersected the vein at about 46 meters, although only altered granite and quartz veinlets were found. Beyond the vein intersection, the hole continued in granite to the end.

Summary of drilling

Diamond drilling and surface mapping at the Samrah mine indicate that the Samrah vein zone follows pre-existing andesitic dikes. Smaller veins split away from the main vein and these splits contain narrow thicknesses of ore for distances up to 100 meters away from the main vein; however, the splits are not considered to be worth mining except possibly close to the main vein.

The Samrah vein is known to be mineralized at the surface for at least 400 meters. Drilling results indicate the vein is mineralized over a strike length of at least 270 meters at a depth of 100 meters below the surface. The deepest penetration of ore (Hole S-4) is about 220 meters below the surface, although the vein is believed to continue at least to a depth of 375 meters.

Neither thickness of ore nor grade is constant in the drill holes (table 2). Furthermore, ore is not continuous in the vein, as shown by the barren findings in Holes 4, S-6, S-9, and 10. This is not, however, an unusual geologic feature

in a vein deposit, and it is likely that mineralized areas may exist at no great distances from the hole penetrations.

Core from the western part of the vein zone is higher in zinc content than core from the east, although there appears to be no variation in silver content. The fact that ore was not found in Hole S-6, cannot be taken as proof that ore pinches out with depth. There is every reason to believe that had the hole been drilled farther to the west it would have intersected ore.

ORE RESERVES

Ore reserves estimated from drilling results and surface mapping are tabulated in Table 3 under two classifications, indicated and inferred, the standard U. S. Geological Survey - Bureau of Mines definitions of which are as follows:

Indicated ore is ore for which tonnage and grade are computed partly from specific measurements, samples, or production data and partly from projection for a reasonable distance on geologic evidence. The sites available for inspection, measurement, and sampling are too widely or otherwise inappropriately spaced to outline the ore completely or to establish its grade throughout.

Inferred ore is ore for which quantitative estimates are based largely on broad knowledge of the geologic character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on an assumed continuity or repitition for which there is geologic evidence; this evidence may include comparison with deposits of similar type. Bodies that are completely concealed may be included if there is specific geologic evidence of their presence.

Table 3. -- Reserves and values

Section	DDH	Metric tons	Value per M.T. (dollars)	Value per block (thousand dollars)
		Indicated Ore		
C	S-1	19,700	72	1,418
C-1/2	S-3	6,100	209	1,275
D	1	27,500	83	2,283
	1	1,200	150	180
F	3	12,700	77	978
H	5	26,300	53	1,394
J	6	39,800	83	3,303
Total		133,300-		10,831-
		Inferred Ore		
B	2	27,300	33	301
C	2	6,700	33	221
E	S-2	2,600	25	65
G	S-4	12,700	28	356
H	5	8,100	53	429
	S-4	3,400	28	95
J	6	10,300	83	855
Total		71,100		2,922
Total Ind. & Inf. Ore		204,400		13,753
		Indicated Material		
A	S-5	76,300	23	1,755
		Inferred Material		
B	S-5	17,800	23	410
C-1/2	S-5	2,800	23	64
Total		20,600		474
Total Ind. & Inf. Material		96,900		2,229

In addition, a third classification, mineralized material, is presented in Table 3. This is material defined as below ore grade cut-off, arbitrarily set at $25 per ton of contained metal values. There is no basis on which to justify the $25 cut-off other than a general comparison of mining costs at similar veins in mines of the Western United States. It is possible that costs would be much higher than estimated, in which case much of what is classed as indicated ore could more properly be placed in the mineralized material category. On the other hand, mining costs may be lower than estimated, in which case much of what is classed as mineralized material might properly be placed in the reserve category.

All reserve and mineralized material values are based on weighted averages of core samples (table 2 and cross sections). The computed metal content of material in the various categories is for total contained metal. No allowance has been made for metal that will be lost during mining, concentrating, or smelting of the ores. In computing values of the ores, June 1968 metal prices of $2.45 per ounce for silver, .13 per pound lead, and .13 per pound zinc were used. No values were computed for the gold content of the ore as gold is present only in trivial amounts.

Longitudinal sections L-L' (fig. 13), on the plane of the vein, was used in the computation of ore reserves. The error from projecting the vein directly to the section did not seem significant and no attempt was made to account for its slight curvature. The average dip length of the vein between 100 meter levels is 104 meters, with a maximum deviation of 2.5 meters. Each drill hole intersection of the center of the vein was plotted, and other intersections were related to it. The locations of transverse sections A through J were controlled by the intersections of diamond drill holes at the center of the vein. The limit of a block was in most cases one half the distance between drill holes. A distance of 25 meters from a drill hole

was the usual limit of the block when ore was not terminated by an adjacent hole with waste.

The volume in cubic meters for each block one half section wide was the product of the width, the average thickness, and the average height. Metric tons were the product of cubic meters and a specific gravity of 3.2. When adjacent blocks had substantially different material, either in value or indicated vs. inferred ore, the block of higher quality was sometimes wedged to zero at the common boundary. The material remaining after substracting the wedged portion was assigned the value of the lower quality block. Blocks on either side of a cross section were combined and assigned the average value of ore cut by the drill hole on that section. The metric tons and value of ore in the combined blocks are shown in Table 3.

Indicated ore

The upper limit of indicated ore is marked by the line shown on longitudinal section L-L' (fig. 13). This arbitrary line delimits the area that might have been worked by the ancient miners. There is certainly ore remaining above this line and should mining resume at the deposit it is entirely possible that a substantial tonnage would at this point be purely conjectural.

There also is a good possibility that a fair tonnage of ore could be mined from the splits leading from the Samrah vein. Drilling indicates that ore in these splits does not extend very far from the main vein, nevertheless, near the vein, the splits shown on Figure 2 and others unknown or unmapped may be sites for ore. We have not, however, attempt to compute tonnages in these off-split veins.

Not to be overlooked in considering ore estimates at the Samrah mine is the vein-dike relationship. The andesitic dike zone along which the Samrah vein zone follows is strong and while it varies in thickness, it is persistent. Drill holes show the Samrah vein zone to be generally along the footwall of the dike zone, but also to cross to other areas of the zone. As the dike zone is far thicker than the vein, it is possible that lenticular ore shoots or veins may be found in the zone during mining which would increase the tonnage now computed for the ore blocks.

Inferred ore

We consider the estimated inferred reserves to be realistic but conservative. The inferred blocks are shown in Figure 13 reasonably close to drill hole intercepts. No attempt has been made to project large blocks to extended depths below the lower intercepts. Drill-hole data, however, suggests that the Samrah vein is strong at least to the 800 meter level, thus there is reason to believe that ore will extend well below that level. The fact that Hole S-6 cut the vein but did not find ore is discouraging, but Hole 4 also was barren and the vein in nearby Hole S-2 was thin, all of which suggests that a shoot of waste material may rake from Hole 4 easterly through S-6. This would not, however, rule out the possibility of ore extending below the area penetrated by S-5, S-3, and S-4, or even under the eastern part of the deposit.

Mineralized material

Hole S-5 indicates there is a considerable tonnage of material at the west end of the deposit, which, by itself does not meet the cut-off limit we have fixed for ore. A good thickness of vein (2.45 meters) was penetrated by the drill hole, however, and the grade is so close to ore grade that it likely would be mined if the

deposit is ever brought back into production. The material could be blended with higher grade ore to produce an acceptable mill feed.

Surface dumps

There are many scattered dumps of hand-sorted material and slag at the Samrah mine. Reinhart assembled information on analytical tests that have been made of the dumps and identified the samples. His information follows:

Sampler	Year	No. of samples	Method of averaging	Oz. Au	Average analyses		
					Oz. Ag	%Pb	%Zn
Twitchell	1932	3	Numerical	Tr.	6.07		
Bogue	1954	7	Numerical	.02	12.31		
Quinn	1964	131	Weighted	.01	7.77	1.57	2.16
Reinhart	1966	3	Numerical	--	7.03	.18	1.0

Quinn (1964a) has made the most thorough examination of the dumps and the data shown on page 5 of his report is probably as good an estimate as can be made of the metal content in the dumps. Using his data and June 1968 metal prices, the value per metric ton of dump material would be:

Metal	Content	Value M. T. (dollars)
Au	0.01 oz./ton	0.38
Ag	7.77 oz./ton	20.99
Pb	1.57%	4.49
Zn	2.16%	6.19
	Gross value.....	$32.05/M.T.

On the basis of 23 pits dug into the dumps, Quinn (1964a, p. 6) estimates the average thickness of dump to be 3.99 feet (1.22 meters).

Reinhart estimates a minimum of 20,000 tons (short tons) in the mine area. Converting this estimate to metric tons (18,149) the dumps may be estimated to contain about $582,000 in metal values. Reinhart notes that the dump material is similar to the ore and has not been treated chemically or changed physically except for reduction in size. He also believes the material can be recovered cheaply by use of scrapers or loaders.

CONCLUSIONS

Diamond drilling at the Samrah mine has indicated ore reserves of approximately 204,000 metric tons valued at $67 per ton. These reserves lie beneath the ancient mine workings in an area about 270 meters in strike length and extending to about 250 meters below the surface.

The Samrah vein zone has a known strike length of approximately 400 meters, with no strong surface indications of the vein beyond this length either to the east or west. The deepest drill hole cut the vein about 350 meters below the surface, although the vein contained no ore at the point of intersection. No changes in the mineralogy of the ores or in geologic environment were recorded in the drill cores that suggest that the ore shoots would not continue in depth.

The Samrah deposit has been adequately drilled for purposes of preliminary evaluation. Further diamond drilling might be warranted by a mining company interested in bringing the property into production, but further governmental drilling for exploratory evaluation purposes is not warranted.

REFERENCES

Mytton, J. W., 1967, Geology of the Jabal Al Urd quadrangle, Kingdom of Saudi Arabia: Saudi Arabia Mineral Exploration Project.

Quinn, H. A., 1964a, Geology, silver mines and lithium minerals of Ad Dawadimi Area: Progress Report No. 2 to the Saudi Arabian Ministry of Petroleum and Mineral Resources.

_____, 1964b, Geology, silver,mines, and pegmatites of Ad Dawadimi ahd Halaban areas: Kingdom of Saudi Arabia, Ministry of Petroleum and Mineral Resources, Directorate General of Mineral Resources, Jiddah, unpublished report, 70 p.

Theobald, P. K., Jr., 1970, Geology of Samrah and vicinity, Kingdom of Saudi Arabia: U. S. Geol. Survey open-file rept. SA-42, 24 p.

Theobald, P. K., Jr. and others, 1966, Geologic log and chemical data, Diamond Drill Hole 1, Samrah, Kingdom of Saudi Arabia: U. S. Geol. Survey open-file rept. SA-86, 61 p.

APPENDIX

Geologic logs of diamond drill hole cores, Samrah mine

Samrah No. 1

Diamond Drill Hole Log

Direction: N. 24° E. Angle: - 45°

For a complete description of core from this hole, see geologic log of Samrah Diamond Drill Hole No. 1 (Theobald, 1966b, pp. 21-62).

Samrah No. 2

Diamond Drill Hole Log

Direction: N. 10° W. Angle: - 45°

Depth meters	% core recovery	Description
0	8	Weathered metadiorite
5.28	57	Granite
6.15	100	From 6.15 to 6.29 m altered and brecciated vein material with some oxidized mineralization (hematite, possibly smithsonite, and cerussite) contaminated with cement, Country rock granite.
6.76	100	Brecciated, carbonate-sealed mylonite and granite; iron and manganese oxides on fractures; numerous irregular quartz-carbonate veinlets. (Sample No. 34,000, 6.76 - 7.47 m).
9.29	100	Weathered fine-grained metadiorite locally granitized and quartz rich pegmatite, thin quartz vein at 10.39 m, carbonate veinlet at 10.59 and 10.85 m, 2.5 cm vuggy quartz veins at 10.92 m and 10.95.
3.64	100	Metadiorite.
5.21	100	Quartz veinlet at 15.21
5.62	100	Granite, with relict bands and pods of metadiorite. Sample No. 34,086 (17.31 - 20.01 m).

Samrah No. 2 (continued)

Depth meters	% core recovery	Description
20.07	100	Aphanitic andesite or lamprophyre.
21.51	100	Mottled granite.
27.13	100	Fine brecciated quartz, interstitial quartz and minor carbonate, with weak and sparse pyrite and sphalerite. Sample No. 34,001.
28.32	100	Dark-gray aphanitic dike.
33.78	100	Metadiorite, some fine pyrite. Sample No. 34,088 (33.78 - 36.93 m).
36.93	100	Aplite dike.
37.13	100	Metadiorite; granitization to 37.26 m and with silicification near old healed fractures; brecciated from 38.13 to 38.35 m.
38.63	100	Black basic dike with fine quartz and carbonate veinlets.
40.13	100	Metadiorite, some pyrite. Sample No. 34,089 (40.13 - 40.46 m). Sample No. 34,090 (40.46 - 43.74 m).
44.54	100	Altered and crushed basic dike, Sample No. 34,400 (44.54 - 44.91 m).
44.91	100	Breccia and vein material, mineralized from 45.11 - 45.19 and 45.52 - 45.64 m with euhedral pyrite, sphalerite, galena, and covellite. Sample No. 34,401 (44.91 - 45.64 m).
45.63	100	Aplitic granite. Sample No. 34,402 (45.63 - 45.95 m).
45.95	100	Aphanitic dark-gray basic dike, with carbonate and quartz veinlets. Sample No. 34,403 (45.95 - 47.90 m).
47.9	100	Brecciated and weakly mineralized with sphalerite and pyrite but little or no galena. Sample No. 34,404 (47.90 - 48.08 m).
48.08	100	Metadiorite. Sample No. 34,405 (48.08 - 49.58 m).

Samrah No. 2 (continued)

Depth meters	% core recovery	Description
49.58	98	Metadiorite mineralized at 56.26 and from 56.59 to 56.97 by pyrite and other sulphides.
57.33	100	Metadiorite, widely scattered pyrite, breccia zone 58.22 - 59.39 m; pyrite in a quartz-carbonate breccia 63.45 - 63.55 m.
64.44	100	Metadiorite, brecciated with scattered pyrite and definite seams of sphalerite and pyrargyrite (?) at 64.64, 64.69, 64.79, 65.43, and 65.46 m. Sample No. 34,406 (64.44 - 65.53 m).
65.53	100	Dark-gray basic dike rock.
65.86	100	Breccia, filled with quartz and carbonate, in aphanitic dark-gray basic dike.
67	100	Brecciated, rare quartz and galena, with thin seams of sphalerite at 67.39 and 68.12 m. Sample No. 34,407 (67 - 68.68 m). Sample No. 34,408 (68.68 - 69.95 m). Sample No. 34,409 (69.95 - 71.48 m).
71.48	100	Quartz vein and breccia.
71.55	100	Breccia of dark dike with scattered mineralization and carbonate veinlets. Sample No. 34,410 (71.48 - 72.67 m).
72.67	100	Dark aphanitic dike, veinlet of sphalerite at 73.8, 1.25 cm vein at 74.55 m, brecciated 74.55 - 74.74 m, scattered quartz-carbonate veinlets.
75.74	100	Altered breccia zone of dark aphanitic dike, strongly mineralized by pyrite, chalcopyrite, bornite, and sphalerite. Sample No. 34,411 (75.74 - 76.35 m).
76.14	100	Altered metadiorite, crushed and brecciated; zones of carbonate veinlets, hematite, limonite, and manganese oxides.
82.66	100	Quartz breccia vein, slight mineralization.

Samrah No. 2 (continued)

Depth meters	% core recovery	Description
82.94	100	Strongly silicified mottled metadiorite.
97.08	100	Metadiorite with flowage structure, sparse pyrite.
110.5		Core lost in hole.
111.38		Bottom of hole.

Samrah No. 3

Diamond Drill Hole Log

Direction: N. 08° W. Angle: - 45°

Depth meters	%core recovery	Description
0-2.34	0	Drillers report: decomposed granite.
2.34	80	Weathered aplite to fine-grained granite; a few quartz stringers. Sample No. 34,106 (7.44 - 8.41 m), a 5 cm piece for age determination.
8.50	95	Black dike material with a few fine carbonate veinlets, altered and limonite stained.
10.19	95	Granite, with altered biotite, Sample No. 34,107 (11.18 - 11.23 m), 5 cm piece for age determination.
12.6	98	Granitized metadiorite.
13.36	98	Granite.
18.29	100	Partially granitized metadiorite and a few thin quartz veinlets.
25.68	100	Biotite granite banded with metadiorite.
27.23	100	Metadiorite breccia zone with quartz and some mineralization 28.07 - 28.24 m (Sample No. 34,091). Breccia 29.46 - 29.59 m with quartz filling and veinlets.

Samrah No. 3 (continued)

Depth meters	% core recovery	Description
32.26	100	Granite.
33.02	100	Quartz vein with calcite.
33.27	100	Granite.
37.44	100	Metadiorite, some quartz and carbonate veinlets.
42.67	100	Metadiorite.
49.73	100	Fine-grained metadiorite(?) quartz veinlet at 49.73 m and several others scattered through this section of core.
53.57	100	Mottled granitic material. Sample No. 34,092.
54.48	100	Very fine-grained basaltic dike with breccia from 54.48 - 54.56 m (carbonate filling), mineralization very weak. Sample No. 34,093.
54.86	100	Chiefly gray biotite granite with stringers and veinlets of quartz and/or carbonate. Breccia zone 74.09 - 74.17 m. Thin pyrite veinlet at 74.27 m. Sample No. 34,094 (54.86 - 56.79 m)
80.01	100	Sheared, brecciated, and highly altered zone of granite in a very fine-grained dark brown altered dike rock, locally weak pyrite and carbonate. Sample No. 34,095 (80.01 - 82.14 m), Sample No. 34,096 (82.14 - 83.45 m), Sample No. 34,097 (83.45 - 85.20 m).
85.19	98	Very strongly brecciated and silicified zone in aphanitic gray to dark gray dike with pyrite and sphalerite. Sample No. 34,098.
88.19	0	Void reported by driller (possible old mine workings?).
89.0	97	Strongly brecciated, silicified, altered, vuggy in dark basic aphanitic dike rock; some scattered sulfide minerals but especially strong from 89 - 89.31 m, at 92.3m, and from 92.46 - 93.24 m including pyrite, sphalerite, and galena. Sample No. 34,099 (89.0 - 89.3m). Sample No. 34,108 (89.0 - 90.17 m). Sample No. 34,109 (90.17 m - 93.24 m). Sample No. 34,110 (92.46 -93.27 m).

Samrah No. 3 (continued)

Depth meters	% core recovery	Description
93.24	90	Brecciated rock healed with quartz, hard granitic rock with quartz seams and veinlets; 3.75 cm quartz vein at 93.19 m.
93.57	85	Mottled dark-gray, light-gray and pink granitic rock with a 5 cm carbonate-quartz vein at 96.67 m.
98.5	100	Aphanitic gray dike material.
98.68	85	Metadiorite very weak pyrite.
99.21	98	Dark, aphanitic dike with some amphibolite breccia as inclusions.
100.13	100	Metadiorite.
101.19	100	Dark aphanitic dike.
101.39	100	Metadiorite.
102.26	100	Dark aphanitic dike.
102.72	100	Metadiorite.
103.48	100	Dark aphanitic dike.
103.68		Bottom of hole.

Samrah No. 4

Diamond Drill Hole Log

Direction: N. 20°W. Angle: - 60°

Depth meters	% core recovery	Description
0-2.87	90	Weathered granite.
2.87	100	Weathered granite.
4.11	100	Weakly altered granite

Samrah No. 4 (continued)

Depth meters	% core recovery	Description
5.84	100	Mottled gneissic granite.
10.26	100	Fine-grained lamprophyre.
12.29	95	Aplite.
12.93	100	Dark, aphanitic basic dike; 3.75 cm quartz breccia seam at 14.35 m.
14.48	100	Biotite granite.
19.86	100	Epidotized zone with 0.75 cm quartz veinlet at 19.89 m and 2.5 cm quartz at 20.07 m.
20.09	98	Biotite granite.
27.84	100	At 27.84 m epidotized, silicified, weakly brecciated zone with weak mineralization. Sample No. 34,113 (27.84 - 28.96 m).
28.96	100	Mottled biotite granite with small quartz veinlets at 29.36, 30.07, and quartz vein at 31.17 m.
38.4	100	Mottled granite.
43.56	100	Metadiorite.
85.65	100	Quartz vein; Sample No. 34,114; appears barren.
86.64	100	Dark, sugary grained lamprophyre.
90.04	100	Metadiorite with some intruded granite, quartz veinlet, and silicified breccia 98.96 - 99.06 m.
99.16	100	3.75 quartz vein at 99.16 m in metadiorite.
101.09	100	Fine-grained dark basic dike, with 2.5 cm quartz vein at 101.09 m.
103.73	100	Brecciated, extremely fine-grained altered dark basic dike with carbonate filling in fractures; Iron oxides masks mineralization. Sample No. 34,115.

Samrah No. 4 (continued)

Depth meters	% core recovery	Description
105.26	100	Fine-grained dark basic dike material, somewhat serpentinized and altered, strongly brecciated fine carbonate and quartz filling in fractures. Sample No. 34,116.
106.55	100	Quartz vein 106,55 - 106.65 m; very highly altered dark basic dike breccia and mylonite; carbonate and quartz filling; weakly mineralized. Sample No. 34,117 (106.55 - 107.21), and Sample No. 34,118 (107.21 - 108.64), Sample No. 34,119 (108.64 - 110.13 m), and Sample No. 34,120 (110.13 - 111.4 m).
111.4	100	Sugary-grained lamprophyre with fine quartz stringers at 112.75 and 112.9 m, 5 cm of quartz at 113.08, 113.74 m healed quartz breccia from 113.13 to 113.44 m; 5 cm quartz and feldspar breccia at 115.16 m.
120.47	100	Carbonate and quartz vein.
120.55	100	Metadiorite.
122.17	100	Fine-grained dark-gray lamprophyre.
125.12	100	Granitized amphibolite; 5 cm carbonate seam at 125.53 m.
129.54	100	Fine-grained lamprophyre.
132.54	100	Aplite dike, fractured.
132.74	100	Fine-grained lamprophyre.
137.24		Bottom of hole.

Samrah No. 5

Diamond Drill Hole Log

Direction: N. 15° W. Angle: - 55°

Depth meters	% core recovery	Description
0	34	Aplitic biotite granite.
3.04	98	Aplitic granite; local bands and concentrations of biotite; rare epidote along fractures; talc in fracture at 9.19 - 9.39; 1.25 cm carbonate and quartz veinlet at 19.79.
20.09	100	Black dense aphanitic dike rock with banded dark-red and dark-green tinge and several hair-thin carbonate filled fractures.
20.45	100	Biotite aplite, 2.5 cm quartz breccia at 24.46, breccia zones at 32.28 - 32.31 m and 32.44 - 32.46 m; contains numerous quartz-filled fractures (33.27 - 33.55 m; 1.8 cm irregular quartz veinlets at 33.6 and 33.68 m, numerous small healed quartz filled fractures 33.68 - 37.13 m; 2.5 cm mylonite and fine breccia perpendicular to core at 38.56.
45.16	100	Pink fresh aplitic granite, 6.25 cm multiple quartz vein at 49.94 m.
50.65	100	Fine-grained dark gray dike.
51.5	100	Pink aplitic granite.
51.92	100	Mottled weakly gneissoid granite.
56.03	100	Pink aplitic granite.
61.26	100	Gray biotite granite.
64.31	100	Darker granitized material (amphibolite?).
66.65	100	Highly altered granite with very strong epidote, numerous quartz and carbonate veinlets, some brecciation and crushing.

Samrah No. 5 (continued)

Depth meters	% core recovery	Description
67.16	100	Dark biotite granite.
67.44	100	Lamprophyre dark-gray.
67.61	100	Dark biotite granite.
67.84	100	Pink aplitic granite.
68.15	100	Mottled granite, somewhat gneissoid with 1" quartz-feldspar vein at 68.75.
71.45	100	Pink aplitic granite.
73.2	100	Fine-grained dark gray dike.
73.36	100	Metadiorite with some alteration to 83.8 m, quartz breccia.
96	100	Metadiorite; altered with serpentine, epidote, many mylonitic seams, fractures healed with carbonate, sparse magnetite, possibly some weak sulfide mineralization. Sample No. 34,121 (96 - 98.9 m).
98.96	100	Black, dense dike material.
99.74	100	Metadiorite with less serpentine, etc., but brecciated and mineralized throughout. Sample No. 34,122 (99.75 - 100.66 m).
100.66	100	Heavily mineralized breccia zone. Sample No. 34,123 (100.66 - 101.35 m).
101.35	100	Dense dark basic dike, altered to green or maroon tinge with fine carbonate seams, weakly mineralized. Sample No. 34,124 (101.35 - 101.73 m).
101.73	100	Altered and slightly mineralized amphibolite; brecciated. Sample No. 34,125 (101.73 - 102.29 m).
102.29	100	Dense dark basic dike material altered to deep maroon color.

Samrah No. 5 (continued)

Depth meters	% core recovery	Description
102.44	100	Metadiorite; brecciated to 106 m and fractured to about 113.44 m; 5 cm quartz carbonate vein at 113.64 m; breccia with strong quartz 116.33 - 116.66 m; 2.50 cm quartz vein at 118.47; silica and carbonate breccia 120.62 - 120.65 m, 5 cm quartz-carbonate vein at 122.5, 2.5 cm quartz-carbonate veinlet at 122.75.
126.18	100	Pink aplitic granite.
126.49	100	Metadiorite; chloritic(?) alteration.
126.74	100	Pink aplitic granite.
129.92	100	Metadiorite, some alteration, sparse pyrite and chalcopyrite (?). Sample No. 34,126 (129.92 - 132.3 m).
140.1		Bottom of hole.

Samrah No. 6

Diamond Drill Hole Log

Direction: N. 15° W. Angle: - 55°

Depth meters	% core recovery	Description
0	0	No core recovery
1.83	100	Weathered granite.
3.05	100	Aplitic granite, quartz veinlets between 16.81 m and 17.02 m. 2.5 cm quartz veinlets at 72.34, and 75.23 m, strong epidote 87.07 - 87.27 m.
87.27	100	Silicified breccia zone, weakly mineralized, Sample No. 34,127 (86.66 - 87.58 m).
87.58	100	Altered granite, epidotized.

Samrah No. 6 (continued)

Depth meters	% core recovery	Description
88.11	100	Aplitic granite, 2.5 cm quartz veih at 90.53 m.
94.06	100	Strongly epidotized and silicified granite, possible weak mineralization 97 - 97.41 m and 98.42 - 100.41 m; sheared and brecciated 93 - 97.41 m.
100.41	100	Dark gray-black dike, locally brecciated.
102.46	100	Brecciated and silicified granite, altered and mineralized. Sample No. 34,128 (102.62 - 103.89 m).
103.89	100	Brecciated, highly altered, mineralized, dark dike. Sample No. 34,129 (103.89 - 104.80 m).
104.57	100	Breccia, strong mineralization. Sample No. 34,130 (104.80 - 106.02 m).
106.02	100	Mineralized breccia. Sample No. 34,131 (106.02 - 106.48 m).
106.48	100	Breccia, weakly mineralized. Sample No. 34,132 9106.48 - 108.97 m).
108.97	100	Metadiorite.
114.05	100	Light-pink aplite.
115.52	100	Metadiorite.
124.26	100	Aplitic granite.
125.7	100	Metadiorite
126.31	100	Quartz breccia 137.29 - 137.36 m.
137.61		Bottom of hole.

Samrah No. 7
Diamond Drill Hole Log

Direction: N. 52° W. Angle: - 5°

Depth meters	% core recovery	Description
0	0.5	Small fragments of quartz.
6.09	1.5	2.5 cm piece which is composed of quartz and feldspar (pegmatite?), small piece of altered breccia.
9.14	1.5	Small fragments of altered material.
12.19	3	2.5 piece of highly altered granite.
15.24	5	Small fragments of quartz and highly altered material.
18.29	11	Small pieces of highly altered metadiorite, possibly light mineralization. Sample No. 34,133 (6.09 - 21.34m).
21.34	7	Pieces of highly altered metadiorite.
24.38	92	Highly altered metadiorite.
25.76	82	Highly altered metadiorite.
28.65	45	Strongly altered and brecciated metadiorite, ground up core.
32	67	Light-pink aplitic granite, and 0.3 m highly altered amphibolite.
33.22	93	Metadiorite.
34.44	100	Granite or possibly pegmatite breccia.
34.52	98	Altered metadiorite, 5 cm quartz vein at 63.53, 2.5 cm quartz veins at 69.79 and 69.98 m.
70.92	98	Dark-brown to black dense basic dike rock, with hair-thin carbonate stringers.
75.53	90	Sheared and altered metadiorite, quartz and carbonate veinlets from 78.03 - 78.84 m.
78.84	100	Dark, altered, basic dike.

Samrah No. 7 (continued)

Depth meters	% core recovery	Description
78.99	100	Possible weak mineralization in highly altered metadiorite. Sample No. 34,135 (78.99 - 80.16 m).
80.16	100	Aplitic granite dike.
80.26	100	Metadiorite. Sample No. 34,136 (80.26 - 80.69 m).
80.64	90	Partly granitized metadiorite.
87.78	100	Granite.
91.59		Bottom of hole.

Samrah No. 8
Diamond Drill Hole Log

Direction: N. 60° W. Angle: - 57°

Depth meters	% core recovery	Description
0	36	Pegmatite, milky quartz, and feldspar.
2.89	1	Small piece of very weathered metadiorite.
6.09	2	Small pieces of quartz and weathered metadiorite only recovery.
12.19		Small piece of quartz and fragments of altered metadiorite.
15.24	55	2.5 cm of quartz, 12 cm weathered metadiorite, 82.3 cm pink aplitic granite.
16.76	40	Pieces of fresh light-gray aplitic granite.
18.64	52	5 cm quartz, remainder weathered metadiorite, Sample No. 34,137 (18.64 - 21.64 m).
24.69	98	Metadiorite, 2.5 cm quartz-feldspar seam at 54.66 m, 5 cm of vuggy quartz at 64.54 m, 2.5 cm quartz at 69.67 m , 2.5 cm quartz vein 79.98 m, brecčia zone 80.01 - 80.23 m.

Samrah No. 8 (continued)

Depth meters	% core recovery	Description
81.84	100	Black dense basic dike.
84.37	100	Mottled siliceous breccia
84.52	100	Mylonite, slightly brecciated with carbonate filled openings.
84.71	100	Brecciated metadiorite.
85.15	100	Highly altered metadiorite.
85.79	100	Granite, altered from 119.83 - 120.52 m.
120.52	100	Dense basic dike, altered, hair-line carbonate filling.
121.76	100	Massive biotite aplite.
124.97		Bottom of hole.

Samrah No. 10

Diamond Drill Hole Log

Direction: N. 04° W. Angle: - 60°

Depth meters	% core recovery	Description
0	0	No core.
0.89	99	Pink aplitic granite with sparse fine biotite, slightly weathered to 3.3 m; quartz and breccia 38.73 - 66.39 m and 39.09 - 39.34 m; 2.5 cm at 44.73 m.
86.21	100	Black to greenish or dark maroon dense very fine basaltic dike.
86.99	100	Aplitic granite.
89	100	Black dense basaltic dike.
89.51	100	Mottled aplitic granite.

Samrah No. 10 (continued)

Depth meters	% core recovery	Description
107.79	100	Dark gray lamprophyrry dike.
108.99	100	Pink aplitic granite.
109.45	100	Lamprophyre.
110.62	100	Silicified lamprophyre with some mineralization. Sample No. 34,139 (110.77 - 111.05 m).
110.93	100	Granitized metadiorite, some epidote.
115.82	100	Red aplitic granite.
118.87	100	Metadiorite.
123.24	100	Quartz breccia and stringers.
123.49	100	Epidotized metadiorite.
124.36	100	Weakly mineralized breccia. Sample No. 34,140 (124.36 - 124.61 m).
124.61	100	Quartz breccia zone. Sample No. 34,141 (124.61 - 124.79 m).
124.99	100	Granitized metadiorite.
130.33	100	Red aplitic granite; 2.5 cm quartz breccia at 136.90 m.
136.9	100	Quartz breccia in granite with possible mineralization. Sample No. 34,141A (136.9 - 138.71 m).
138.71	100	Silicified breccia of dark, dense basic dike material. Sample No. 34,142 (138.71 - 140.13 m).
140.13	100	Brecciated granite, possible weak mineralization. Sample No. 34,143 (140.13 - 141.05 m).
141.05	100	Altered and brecciated granite; possible mineralization. Sample No. 34,144 (141.05 - 145.82 m).
145.18	100	Metadiorite; 12.5 cm carbonate vein at 147.04; 7.5 cm vein at 153.26.
158.52		Bottom of hole.

Samrah No. S-1

Diamond Drill Hole Log

Direction: N. 08° W. Angle: - 68°

Depth meters	% core recovery	Description
0	68	Weathered metadiorite, with 1.99 m aplite, in 3.48 to 5.08 m interval.
5.39	100	Aplite.
5.69	98	Metadiorite, mylonite and breccia 7.75 - 7.88 m, breccia zone with quartz filling 9.39 m - 9.83, mineralized. Sample No. 34,238 (9.39 - 9.83 m), quartz breccia 11.1 - 11.23 m, possible brecciated basic intrusive 12.22 - 12.27 m, thin vuggy carbonate veins 12.27, 12.32 and 13.16m, sheared zone with many carbonate veinlets 14.86 - 15.16; 2.5 cm quartz, at 22.12 quartz veinlets at 22.27, 22.38, amd 22.4 m, quartz breccia 29-29.03 m; greenish vuggy quartz 29.77 - 29.82 m.
33.09	100	Fine-grained black dike with fine carbonate-filled veinlets brecciated and cemented by quartz from 36.27 - 36.70 m).
37.03	99	Metadiorite, strongly brecciated and epidotized with quartz filling 37.09 - 37.29 m, slightly vuggy quartz with epidote 38.04 - 38.43 m, very dense fine black basaltic dike 38.6 - 38.63 and 38.66 - 38.71 m, aplite 44.29 - 44.25 m, strong alteration with numerous quartz and calcite veinlets 70.54 - 72.06; quartz vein with breccia in center 79.09 - 79.32 m, quartz vein with 2.5 cm healed breccia in center 85.74 - 85.32; quartz vein 89.69 - 90.14 m, zones of highly siliceous aplite (nearly quartz phase pegmatite) 89.71 - 89.76, 89.92 - 89.94 and 90.02 - 90.09 m.
91.4	100	Aplite, with 15 cm breccia zones at each side.

Samrah No. S-1 (continued)

Depth meters	% core recovery	Description
93.9	100	Metadiorite, fine dense greensih-black dike rock at 98.32 - 98.39 and 98.26 - 98.93 m, highly brecciated with quartz-carbonate breccia filling and considerable pre-brecciation alteration, quartz vein 105.41 - 105.46 m; very fine-grained black dike 106.93 - 107.99 with 2 cm of mineralization at 107.99 m; quartz and sulfides from 109.22 - 109.32 m, Sample No. 34,239 (109.22 - 109.32 m); shear zone with quartz stringers and weak mineralization (110.21 - 110.49 m), Sample No. 34,241 (110.21 - 110.49 m).
110.49	100	Very fine-grained dense greenish-black dike.
111.20	100	Metadiorite, possible weak mineralization to 112.72 m; Sample No. 34,242 (111.20 - 112.72 m), several vuggy quartz veinlets 113.11 m - 113.16.
114.5	100	Ore zone, strongly brecciated, appears to be highly altered dense dark dike rock. Sample No. 34,243 (114.5 - 115.52 m).
115.52	65	Dark dense greenish-black dike rock, weak mineralization 116.59 - 116.77 m. Sample No. 34,244 (116.51 - 116.68 m). Sphalerite and other sulfides 116.94 - 117.37 m. Sample No. 34,245 (116.94 - 117.37 m); strongly brecciated and weakly mineralized 117.91 - 119.1 m. Sample No. 34,246 (117.91 - 119.1m).
120.42	100	Metadiorite, strongly brecciated, silicified, and mineralized 120.42 - 120.7 and 120.98 - 121 m. Sample No. 34,247 (120.42 - 120.70 m), continues highly brecciated and silicified to 123.75 m.
128.45	100	Aplite.
129.13	100	Metadiorite, clear and unfractured, thin aplite dike 136.55 - 136.65, quartz breccia vein, 150.11 - 150.24 m.
151.13	100	Dense black aphanitic dike.
151.84	100	Metadiorite, solid and unfractured and continuous from 154.66 - 183.69 m except for aplite 177.67 - 174.52 m and 182.35 - 182.47 m; 2.5 cm shear zone and quartz at 183.67 m.

Samrah No. S-1 (continued)

Depth meters	% core recovery	Description
183.69	100	Dense black aphanitic dike.
184.10	100	Metadiorite, little alteration or fracturing.
211.15	100	Quartz-aplite breccia vein with some epidote, all tightly healed.
211.81		Bottom of hole.

Samrah No. S-2

Diamond Drill Hole Log

Direction: Due N. Angle: - 66°

Depth meters	% core recovery	Description
0	0	Cement.
2.38	60	Aplite.
2.64	90	Metadiorite, slightly weathered.
5.66	100	Lamprophyre.
5.79	75	Aplite.
5.94	100	Metadiorite with scattered small grains of pyrite and magnetite.
10.54	90	Aphanitic, black dike with pyrite and thin carbonate stringers scattered throughout.
14.09	90	Metadiorite, widely scattered quartz pyrite, and carbonate veinlets.
24.28	100	Quartz breccia, with vuggy quartz filling.
24.79	100	Metadiorite.
25.12	100	Aphanitic black dike.
25.29	100	Metadiorite.

Samrah No. S-2 (continued)

Depth meters	% core recovery	Description
25.53	100	Highly altered biotite granite.
25.66	100	Metadiorite, quartz vein 31.47 - 31.52, 2.5 cm quartz vein at 35.05 m and at 36.25 m, 2.5 cm quartz vein at 54.05 m, quartz vein with healed contacts 73.2 - 73.38; quartz breccia vein 75.08 - 75.34; aplite 77.17 - 77.34 m; quartz vein 77.52 - 77.55 m.
79.12	100	Aplite.
79.86	100	Metadiorite, 5 cm quartz vein at 100.56; aphanitic black dike 102.77 - 102.92 m, 2.5 cm quartz in sheared zone 105.94 - 105.97 m; silicified 106.27 - 106.45 m with 2.5 cm quartz at 106.4, silicified with strong epidote from 108.1 to 108.15 m.
108.15	100	Aplite dike, some epidote at 108.15 m.
108.26	100	Very dense aphanitic greenish-black dike with hair-thin carbonate veinlets scattered throughout.
109.48	100	Aplite.
109.65	100	Greenish-black dense aphanitic basaltic dike with numerous fine carbonate seams especially at 109.65 - 109.7, 110.03 - 110.24 and 110.31 - 110.44 m, strong brecciation and silicification 111.48 - 111.58 and 112.09 - 112.47 m; the latter with possible slight mineralization. Sample No. 34,229 (112.09 - 112.47 m); definite mineralization (sphalerite and other sulfides) 113.29 - 113.54 m and possibly to 114.38 m; Sample No. 34,230 (113.31 - 113.66 m), Sample No. 34,231 (113.66 - 114.28 m), strong fracturing and calcite-quartz filling, bordering on brecciation 114.38 m - 115.31; stronger brecciation, very strong silicification 115.31 - 119.99m; 15 cm quartz breccia, healed, 116.33 - 116.53 m; Sample No. 34,232 (115.31 - 116.33 m); Sample No. 34,233 (116.33 - 118.06 m); Sample No. 34,234 (118.06 - 119.99 m); lesser silicification with quartz-carbonate stringers from 119.99 - 120.55 m; strong brecciation 120.55 - 121.11 m (Sample No. 34,235: 120.55 - 121.11 m); strong brecciation 121.69 - 121.87 m (Sample No. 34,236 121.69 - 121.87); strong brecciation and silicification 123.11 - 124.15 m (Sample No. 34,237: 123.11 - 124.15).

Samrah No. S-2 (continued)

Depth meters	% core recovery	Description
124.15	100	Metadiorite, 3.75 cm quartz-carbonate vein at 129.08; thin quartz veinlets at 129.39, 129.87, 130.15, and 130.2 m.
130.35	100	Aplite, somewhat brecciated with quartz filling openings.
130.71	100	Metadiorite, grading abruptly into a very fine-grained black rock from 133.43 - 133.48 m, black dike 144.02 - 144.15 m with 1.25 cm quartz veinlet at 144.07 m, 1.25 cm black dike at 144.48 m, quartz-calcite vein 145.26 - 147.9 m with some breccia, dense black dike 163.85 - 163.98, with 2.5 cm quartz vein at 180.89.
182.85		Bottom of hole.

Samrah No. S-3

Diamond Drill Hole Log

Direction: Due N. Angle: - 71°

Depth meters	% core recovery	Description
0	43	Black, dense basalt dike material only fragments recovered.
8	30	Weathered metadiorite.
8.51	64	Pink aplitic granite.
9.7	98	Weathered metadiorite.
12.27	100	Black dense basaltic dike.
14.19	100	Metadiorite, 10 cm quartz vein at 16.76 m; 30 cm quartz vein at 17.24 m, 2.5 cm quartz veinlets at 38.51 and 41.58 m, 10 cm blackish dense basic dike at 64.21 m.
77.11	100	Black dense basaltic dike.
83.82	100	Metadiorite.

Samrah No. S-3 (continued)

Depth meters	% core recovery	Description
93.57	100	Black basic dike, fractured, filled with carbonate, Sample No. 34,151 (93.57 - 94.89 m) and Sample No. 34,152 (94.89 - 95.84 m).
95.84	100	Gneissic metadiorite, Sample No. 34,153 (98.20 - 98.65 m), Sample No. 34,154 (98.65 - 101.78 m), Sample No. 34,155 (101.78 - 103.68 m); 7.5 cm quartz vein at 112.57; 15 cm siliceous breccia at 119.35.
120.19	100	Light-pink aplite, sparse fine biotite.
121.26	100	Metadiorite; shear zone and mylonite with carbonate filling 122.22 - 127.47, breccia with quartz and carbonate filling -- serpentinized 132.72 - 132.89 m.
144.86	15	Small pieces of black dense basic dike. Sample No.34,156 (144.86 - 146.43).
146.43	100	Mineralized breccia zone, visible sphalerite and possibly pyrargyrite; Sample No. 34,157 (146.46 - 146.53).
146.53	100	Metadiorite; Sample No. 34,158 (146.53 - 147.37 m), aplite 147.37 - 147.42, Sample No. 34,159 (147.42 - 148.84 m).
148.84	100	Light-pink aplite with sparse fine biotite.
149.43	100	Metadiorite with 10 cm quartz and feldspar at 150.27 - 150.37 m.
153.25	100	Light-pink aplitic granite.
154.43	100	Metadiorite.
155.45	100	Aplitic granite with metadiorite from 158.44 - 158.47 m.
159.33	100	Aplite, brecciated 159.33 to 159.72 m and from 161.03 to 161.26 m.
161.26	100	Black aphanitic hornfels (?) or dike rock, brecciated, serpentinized.

Samrah No. S-3 (continued)

Depth meters	% core recovery	Description
163.47	100	Black aphanitic dike material, badly fractured-- locally breccia--serpentinized with hematite, slight mineralization noted: Sample No. 34,160 (167.11 - 167.94 m); Sample No. 34,161 (167.94 - 170.18 m). Stronger mineralization: Sample No. 34,162 (170.18 - 170.41 m) Lesser mineralization: Sample No. 34,163 (170.41 - 171.02 m) Scattered pyrite visible: Sample No. 34,164 (171.02 - 174.12 m).
174.12	100	Black to mottled aphanitic dike, aplite from 175.13 to 175.24 m.
178.84	95	Basic dike with considerable pyrite, possibly other mineralization, Sample No. 34,165 (178.84 - 179.7 m).
179.7	100	Highly brecciated, altered and mineralized material, Sample No. 34,166 (179.7 - 181.53 m).
181.53	100	Black aphanitic dike rock, no visible mineralization.
182.47	100	Extremely altered metadiorite.
183.16	100	Metadiorite, some silicification and epidote 185.17 - 186.08 m, broken and veined with quartz, carbonate, and hematite 186.08 - 190.55 m.
190.55	100	Dark andesite (?) dike.
190.78	100	Altered metadiorite, some silicification.
191.26	100	Fine-grained andesite (?) dike, with carbonate veinlets.
192.81	100	Metadiorite, with fine carbonate veinlets, possible mineralization: Sample No. 34,214 (193.68 - 194.06 m). Aplite dikes at 195.66 - 195.68 and 195.81 - 195.94; altered and serpentinized from 197.03 m, possible weak mineralization. Sample No. 34,215 (197.03 - 199.57 m), Sample No. 34,216 (199.57 - 200.46 m), Sample No.34,217 (201.19 - 202.46 m), Sample No.34,218 (203.23 - 203.84 m), Sample No. 34,219 (203.84 - 204.69 m), Sample No. 34,220 (206.72 - 208.74 m), Sample No. 34,221 (208.74 - 209.85m), Sample No. 34,222 (212.29 - 213.13 m), Sample No.34,223 (223.47 - 224.16 m), Sample No. 34,224 (224.16 - 225.73m).
225.73		Bottom of hole.

Samrah No. S-4

Diamond Drill Hole Log

Direction: N. 10° W. Angle: - 68°

Depth meters	% core recovery	Description
0	4	Weathered metadiorite and basic dike material.
4.17	16	Aphanitic dike.
6.12	20	Metadiorite, dark basic dike; 100% core recovery from 20.11 - 22.31 m.
22.31	100	Metadiorite.
25.48	98	Black aphanitic dike.
26.18	100	Metadiorite, quartz breccia 34.72 - 34.98 m.
39.74	100	Black aphanitic dike.
40.87	100	Metadiorite.
44.48	100	Black aphanitic dike.
45.4	100	Metadiorite.
46.18	100	Black aphanitic dike.
46.69	100	Metadiorite.
61.62	100	Lamprophyre, 5 cm quartz vein at 62 m and metadiorite 62.18 - 62.33 m.
62.76	100	Dark aphanitic dike.
62.94	100	Metadiorite.
64.49	100	Lamprophyre, with quartz healed breccia to 65.3 m.
65.99	100	Metadiorite.
75.64	100	Lamprophyre.
88.04	100	Metadiorite.
89.36	100	Black aphanitic dike.

Samrah No. S-4 (continued)

Depth meters	% core recovery	Description
89.87	100	Metadiorite.
91.39	100	Fine-grained lamprophyre.
93.42	100	Metadiorite, quartz vein 102.69 - 102.79 m, brecciated with quartz-carbonate veinlets 102.79 - 103.17 m.
103.17	100	Black aphanitic dike.
105.89	38	Quartz and pegmatite.
106.88	100	Metadiorite, 2.5 cm quartz at 121.18 m.
150.9	100	Quartz breccia vein.
151.1	100	Metadiorite, 5 cm quartz vein at 156.83 m, 10 cm quartz vein at 165.3 m, 3.75 cm quartz at 168.35 m, 5 cm quartz at 186.69 m.
187.91	100	Aplite.
188.52	100	Metadiorite.
189.48	100	Lamprophyre.
190.25	100	Metadiorite, brecciated and silicified 195 - 195.33 m.
197.26	100	Lamprophyre.
198.58	100	Metadiorite.
200.05	100	Aplite.
200.43	100	Metadiorite, quartz breccia 211.18 - 211.32 m, mineralized, Sample No. 34,146 (210.46 - 211.18 m), Sample No. 34,147 (211.18 - 214.98 m). Sample No.34,148 214.98 - 218.87 m).
218.87	100	Dark aphanitic dike.
221.08	100	Brecciated and mineralized basic dike, Sample No.34,149 (221.08 - 221.74 m).
221.74	100	Aphanitic dike.
222.61	100	Brecciated and altered metadiorite, mineralized, Sample No. 34,150 (222.61 - 224.38 m).

Samrah No. S-4 (continued)

Depth meters	% core recovery	Description
224.38	100	Lamprophyre.
237.79	100	Metadiorite.
248		Bottom of hole.

Samrah No. S-5

Diamond Drill Hole

Direction: N. 05° W. Angle: - 71°

Depth meters	% core recovery	Description
0-5.61	9	Highly altered metadiorite with 1 cm quartz veinlet at 5.44 m.
5.61	28	Altered metadiorite.
7.49	84	Metadiorite, 2.5 cm quartz vein at 8.56 m.
10.57	237	Metadiorite, variable texture, local minor silicification.
11.66	90	Metadiorite, with 16 cm of siliceous breccia and mylonite at 12.37 m and very fine quartz veinlets and silicification from 13.79 to 14 m.
20.75	82	Metadiorite, with quartz veinlets at 22.86m, 23.57 m, and 25.07 m and brecciated quartz veins at 33.93 m and 34.89 m.
36	91	Black, dense, aphanitic dike.
37.24	100	Metadiorite.
39.47	100	Black, dense, aphanitic dike.
39.55	100	Metadiorite with segregation banding.
40.69	100	Black, dense, aphanitic dike.
40.89	100	Metadiorite with 25 cm quartz vein at 46.46 m and 10 cm quartz at 46.61 m.

Samrah No. S-5 (continued)

Depth meters	% core recovery	Description
49.12	100	Black, dense, aphanitic dike.
50.22	100	Coarsely crystalline metadiorite, 2.5 cm healed quartz vein at 52.63 m; considerable chlorite and locally garnetiferous; segregation banding common.
54.46	100	Greenish-black mottled metadiorite partially assimilated by basic dike.
54.74	100	Dark basic dike, 5 cm breccia at 54.89 m mineralized by pyrite, sphalerite and pyrargyrite(?). (Sample No. 34,248 - specimen sample of sulfides). Fracturing with fine calcite filling 54.94 - 55.04 m; brecciated with fine calcite and quartz filling 55.04 - 55.22 m with no distinguishable sulfides.
56.16	100	Metadiorite, some segregation banding with augen-like inclusions.
65.3	100	Black, dense, aphanitic dike.
66	100	Metadiorite.
67.92	75	Black aphanitic dike, altered, broken especially at contacts, with alteration and 7 cm of quartz breccia at 71.45 m.
71.92	100	Metadiorite.
74.55	100	Black, dense, aphanitic dike.
76.91	100	Metadiorite.
78.99	100	Metadiorite; four quartz veinlets with fine breccia between 80.31 - 80.47 m.
83.49	100	Black, dense, aphanitic dike; 2.5 cm brecciated quartz vein at 83.59 m.

Samrah No. S-5 (continued)

Depth meters	% core recovery	Description
84.12	100	Metadiorite, heavy silicification 86.59 to 86.87 m, quartz breccia, 86.87 to 87 m, with vuggy quartz from 86.99 to 87 m.
89.48	100	Black, dense, aphanitic dike.
90.8	100	Metadiorite.
92.25	100	Black, dense, aphanitic dike.
93.47	100	Metadiorite.
95.78	100	Granular brecciated aplite.
96.06	100	Black to greenish-black, dense, aphanitic dike.
96.82	100	Metadiorite, local silicification near quartz veinlets.
98.78	100	Balck, dense, aphanitic dike.
99.24	100	Metadiorite, 2 cm quartz veinlet at 106.73 m, 2.5 cm black aphanitic dike at 107.47 m, 1.25 cm quartz veinlet at 113.79 m.
114.7	100	Black, dense, aphanitic dike with irregular sploches of partially assimilated quartz.
115.09	100	Metadiorite, 0.75 cm quartz veinlet at 115.29 m.
119.53	50	Breccia and mylonite.
119.71	100	Mineralized breccia zone (pyrite, chalcopyrite?) Sample No. 34,249 (119.71 - 119.89 m).
119.89	100	Metadiorite.
120.17	100	Aplite.
120.37	100	Metadiorite.
120.95	100	Aplite.

Samrah No. S-5 (continued)

Depth meters	% core recovery	Description
121	98	Variable-textured metadiorite, 0.75 cm quartz veinlet at 125.48 m, 2.5 cm lamprophyre at 141.02 m, 2.5 cm quartz veins at 145.64 m.
152.15	100	Aplite dike with 1.25 cm quartz at both contacts.
152.5	90	Metadiorite; 0.75 cm quartz veinlet along core at 153.21 m, fracture zone from 167.82 - 167.94 m, 2.5 cm breccia at 167.43 m, brecciation and mylonite from 169.67 to 170.03 m and 173.28 - 173.42 m.
174.4	100	Aplite.
174.77	100	Metadiorite.
175.39	100	Lamprophyre.
175.59	100	Metadiorite.
175.74	100	Aplite.
175.97	100	Metadiorite.
179.09	100	Mylonite and quartz breccia.
179.35	100	Altered, dark-brown, aphanitic basic dike.
179.53	100	Metadiorite.
183.24	100	Lamprophyre dike, quartz veins and breccia 184.38 - 184.43 m and 184.53 - 184.58 m.
185.12	100	Metadiorite, quartz and breccia 186.06 to 186.28 m.
186.44	100	Black, dense, aphanitic dike, altered to very dark green color, fine calcite veinlets throughout.
188.32	100	Mineralized zone of sphalerite, pyrite, and galena in brecciated metadiorite. Sample No. 34,250 from 188.34 to 188.77 m.

Samrah No. S-5 (continued)

Depth meters	% core recovery	Description
188.77	100	Metadiorite and intruded granite.
189.48	100	Brown-black dense aphanitic dike.
189.69	100	Metadiorite, 189.92 - 190.04 m.
190.93	100	Dense, green-black aphanitic dike.
191.41	100	Metadiorite, numerous quartz veinlets, 7.5 cm quartz vein at 200.58 m.
208.17	100	Massive breccia zone with no discernable mineralization. Sample No. 34,290 (210 - 212.44 m); Sample No. 34,291 (212.44 - 213.46 m); Sample No. 34,292 (213.46 - 214.88 m); Sample No. 34,293 (217.93 - 220.30 m). Zone appears to be jumbled dense basic dikes and metadiorite except for granite from 219.94 - 220.47 m strongly silicified (estimated 75 percent quartz from 208.17 to 220.49 m, and near 50 percent from 220.49 - 233.58 m).
233.58	100	Metadiorite, considerable silicification.
237.19	100	Barren quartz vein.
237.69	100	Metadiorite.
238.53	100	Quartz vein.
238.76	100	Metadiorite, 7.5 cm quartz vein at 240.82 and 2.5 quartz vein from 240.94 - 240.97 m.
242.75	100	Black dense dike.
244.32	100	Metadiorite.
251.03		Bottom of hole.

Samrah No. S-6

Diamond Drill Hole Log

Direction: Due N

Angle: - 71°

Depth meters	% core recovery	Description
0	2	Granite.
16.84	25	Black, dense basic dike.
16.92	26	Granite.
17.22	25	Intrusive basic dike with granite fragments.
17.32	100	Granite.
23.95	100	Granitized amphibolite.
24.54	100	Granite.
28.45	100	Granitized metadiorite.
28.93	100	Granite.
31.14	100	Metadiorite.
32.16	100	Granite.
60.45	100	Metadiorite.
76.45	100	Quartz-mica breccia zone in metadiorite.
76.86	100	Lamprophyre.
76.84	100	Metadiorite.
80.65	100	Granite.
80.75	100	Fine-grained, dense black dike.
81.48	100	Metadiorite.

Samrah No. S-6 (continued)

Depth meters	% core recovery	Description
89.18	100	Granite.
89.48	100	Metadiorite, quartz vein 116.1 - 116.2 m.
116.38	100	Aplitic granite.
116.99	100	Metadiorite, .38 m micaceous pegmatite at 117.5 m.
121.99	100	Granite.
122.28	100	Metadiorite.
124.28	100	Black aphanitic dike.
124.89	100	Metadiorite.
142.35	100	Dense, black dike.
143.23	100	Fine-grained metadiorite.
144.98	100	Granite.
145.69	100	Dense black dike.
148.84	100	Granite.
148.29	100	Dense black dike rock.
151.08	100	Granular black metadiorite, quartz vein 154.89 - 154.97 m.
159.18	100	Dense black dike.
159.59	100	Gray granite, pink along healed fractures; local very mildly brecciated and epidotized.
167.69	100	Black dense dike.
168.45	100	Granite.
169.34	100	Black dense dike.
169.75	100	Gray granite.
180.59	100	Black dense dike.

Samrah No. S-6 (continued)

Depth meters	% core recovery	Description
181.53	100	Gray granite.
189	100	Lamprophyre.
195.05	100	Gray granite.
212.59	100	Dense black dike.
216	100	Gray granite.
220.09	100	Dense black dike.
220.59	100	Gray granite.
222.4	100	Dense black dike.
223.65	100	Gray granite.
236.49	100	Dense black to gray dike.
239.04	100	Gray granite.
266.29	100	Metadiorite.
303.09	100	Gray granite, metadiorite 308.38 - 309.19 m.
310.79	100	Fine-grained dark gray metadiorite, 5 cm quartz vein at 312.39 and 313.39 m, brecciated quartz vein 318.74 - 318.99 m; 5 cm quartz vein at 324 m; brecciated granite and quartz vein from 328.63 - 329.08 m.
331.19	100	Granite, mottled pink and gray, 5 cm of black dike at 366.09 m, strong epidote from 367.59 - 369.94 m.
367.94	100	Quartz-calcite breccia zone, vuggy, weakly mineralized. Sample No. 34,251 (367.94 - 368.45 m).
368.40	100	Granite, epidote from 384.58 - 384.76 m, 5 cm quartz vein at 375.08, 7.5 cm quartz vein at 383.54.
384.58	100	Quartz breccia, dark quartz and sparse pyrite. Sample No. 34,252 (384.33 - 385.75 m).
385.75	100	Granite, vuggy quartz veins 403.45 - 403.5 m, and 403.73 - 403.81 m; 2.5 cm quartz veinlet 408.1 m, 7.5 cm of breccia and quartz weakly mineralized at 411.99 m.
418.49		Bottom of hole.

Samrah No. S-7

Diamond Drill Hole Log

Direction: N. 55° W. Angle: - 45°

Depth meters	% core recovery	Description
0	0	Drilling mud.
12.11	2	2.5 cm of quartz only recovery.
13.41	25	Drilling mud and highly altered metadiorite.
18.31	10	35 cm metadiorite recovered; remainder drilling mud.
71.79	100	Metadiorite; 5 cm quartz vein at 45.79, 1.25 cm quartz veins, at 75.9 m, 76.2 m, 76.23 m, 77.17 m, and 77.22 m.
92.96	100	Black, dense aphanitic dike.
96.44	100	Granite; black aphanitic dike material 96.98 - 97.05 and 126.09 - 126.14 m.
220.11	100	Lamprophyre; granite inclusion 220.93 - 220.95 m.
221.08	100	Granite.
230.07		Bottom of hole.

Samrah No. S-8

Diamond Drill Hole Log

Direction: N. 42° W. Angle: - 45°

Depth meters	% core recovery	Description
0	0	No core recovery.
3.09	49	Weathered granite.
6.5	100	Brecciated granite cemented by quartz
8.64	100	Altered and silicified granite.
11.35	65	Very strongly altered granite .28 m of quartz only recovery.

Samrah No. S-8 (continued)

Depth meters	% core recovery	Description
13.59	0	No recovery.
14.6	100	Granite with profuse quartz-filled fractures from 14.6 - 21.92 m, highly altered from 21.92 - 22.96 m, mildly brecciated from 22.96 - 31.39 m, scattered thin quartz veinlets 38.5 - 43.89 m.
45.99	100	Strongly altered granite, quartz veinlets, Sample No. 34,253 (45.99 - 46.74 m).
46.74	100	Granite.
95.68	100	Biotite granite with small aplite dikes.
168.48	100	Aplitic granite and local incompletely assimilated metadiorite.
201.02		Bottom of hole.

Samrah No. S-9

Diamond Drill Hole Log

Direction: S. 10° E. Angle: - 45° (Average)

Depth meters	% core recovery	Description
0-3.00-	0	Sand.
3.00-	38	Dark-gray medium-grained granite, abundant biotite.
6.06-	46	Black fine-grained basic dike.
9.15-	98	Light-gray medium-grained granite, pink feldspars locally discontinuous 1 cm basic stringer 15.40 m, 10 cm dark gray granite 37.00 m.
37.30-	99	Dark-gray medium-grained to coarse-grained metadiorite with abundant biotite, a few grains of pyrite locally, several thin (5 cm or less) siliceous stringers 52.00 to 61.00 m, 20 cm white-gray siliceous zone 62.15 m, 70 cm white-gray siliceous zone 63.90 m, 45 cm white-gray siliceous zone 85.30 m, 10 cm fragment black fine-grained basic dike breccia(?) 90.50 m.

Samrah No. S-9 (continued)

Depth meters	% core recovery	Description
98.20-	94	Black fine-grained basic dike, a few grains of pyrite locally, 25 cm siliceous breccia 100.75.
100.75-	99	Dark-gray medium-grained to coarse-grained metadiorite with abundant biotite, a few grains of pyrite locally, 120 cm black fine-grained basic dike 105.80.
120.20-	100	White gray silicified zone with medium-grained quartz and local biotite.
123.35-	98	Dark-gray medium-grained metadiorite with abundant biotite, a few grains of pyrite locally, grades into black dike below last 100 cm.
130.85-	99	Black fine-grained basic dike, sparse pyrite.
135.35-	95	Dark-gray medium-grained metadiorite with biotite, a few scattered grains of pyrite, a few thin (5 cm or less) siliceous stringers, black fine-grained basic dikes: 20 cm at 162.70 m 30 cm at 172.50 m 40 cm at 174.50 m 60 cm at 181.75 m 15 cm siliceous zone 187.70.
193.00-	98	Black fine-grained basic dike.
195.10-	100	Dark-gray medium-grained metadiorite, a few scattered grains of pyrite, a few thin siliceous stringers.
258.95-	99	Black fine-grained basic dike.
259.75-	100	Dark-gray medium-grained metadiorite with biotite and (locally) chlorite, scattered grains of pyrite, thin fractures with serpentine increasing in width and frequency downward, moderate serpentine below 342.00 m, several zones (100 cm maximum width) of fine-grained metadiorite with fine-grained biotite, 60 cm fine-grained metadiorite 321.20.
343.90-	95	Zone of shearing, dark-gray metadiorite heavily sheared, serpentinized, and locally brecciated. Scattered grains of pyrite and limonite after pyrite.

Samrah No. S-9 (continued)

Depth meters	% core recovery	Description
372.15-	99	Dark-gray medium-grained metadiorite, with a few zones (100 cm or less) of fine-grained metadiorite, serpentine on moderately frequent fractures to 375 and on thin infrequent fractures below, scattered grains of pyrite.
381.70-	98	Dark-gray coarse-grained metadiorite with prominent biotite and chlorite, scattered grains of pyrite.
391.00-	100	Dark-gray to light-gray fine-grained metadiorite with lineation at ±45° to core, scattered grains of pyrite.
393.95-	100	Dark-gray medium-grained metadiorite with biotite and chlorite, a few scattered grains of pyrite.
399.45-	94	Light-gray medium-grained granite, scattered grains of pyrite.
400.60-	99	Dark-gray medium-grained metadiorite, scattered grains of pyrite, zones (50 cm or less) of fine-grained metadiorite, 9 cm pink granite 414.05 m.
419.35-	100	Pink to light-gray medium-grained granite, a few scattere grains of pyrite, 50 cm dark gray fine-grained metadiorit 474.05.
425.50-	100	Dark-gray medium-grained to fine-grained metadiorite more or less metamorphosed, scattered grains of pyrite.
427.70-	95	Light-gray medium-grained granite, a few scattered grains of pyrite.
428.30-		Bottom of hole.

70-180

U.S. GEOLOGICAL SURVEY

KINGDOM OF SAUDI ARABIA
DIRECTORATE GENERAL OF MINERAL RESOURCES

IR 106

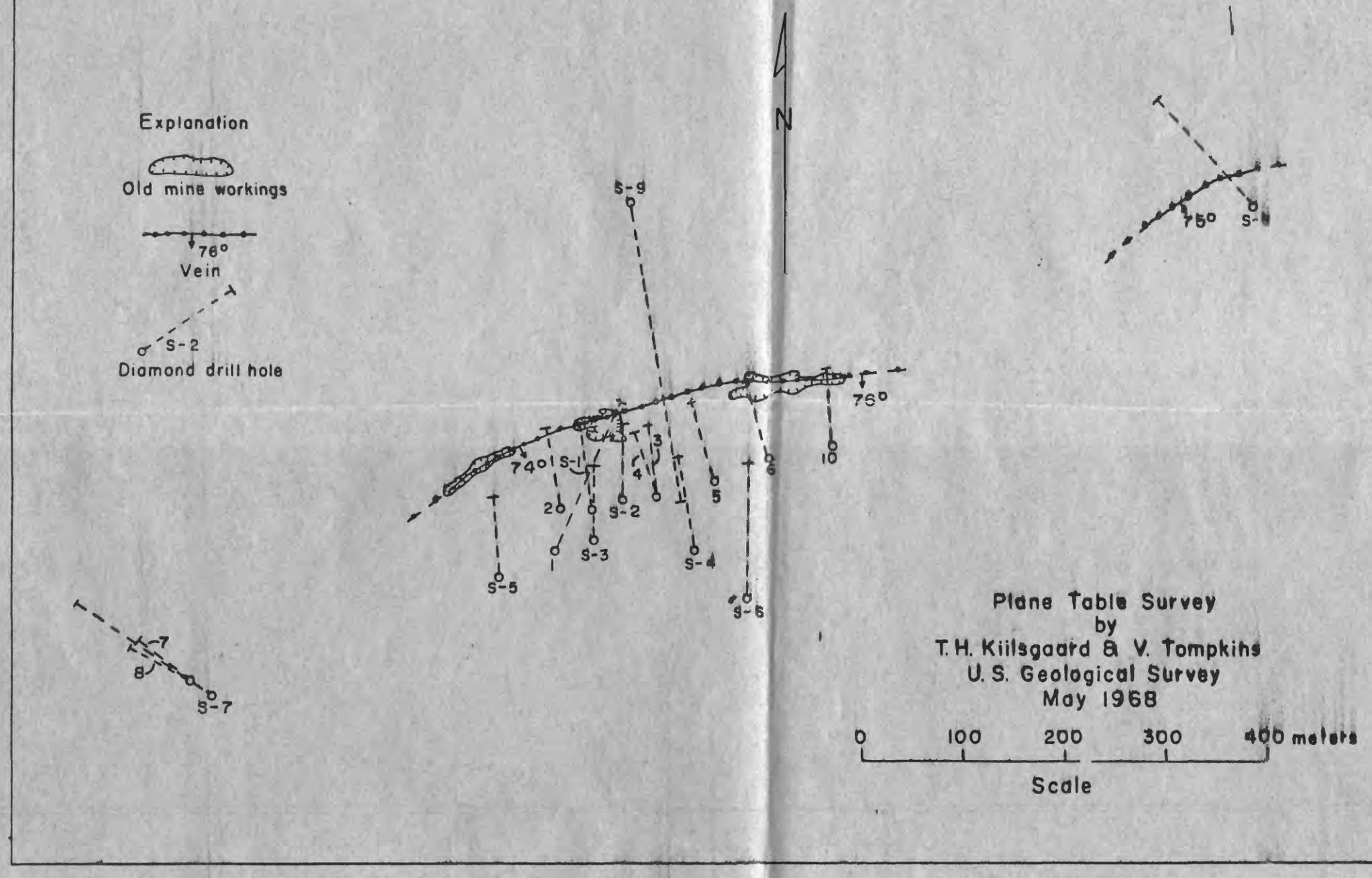
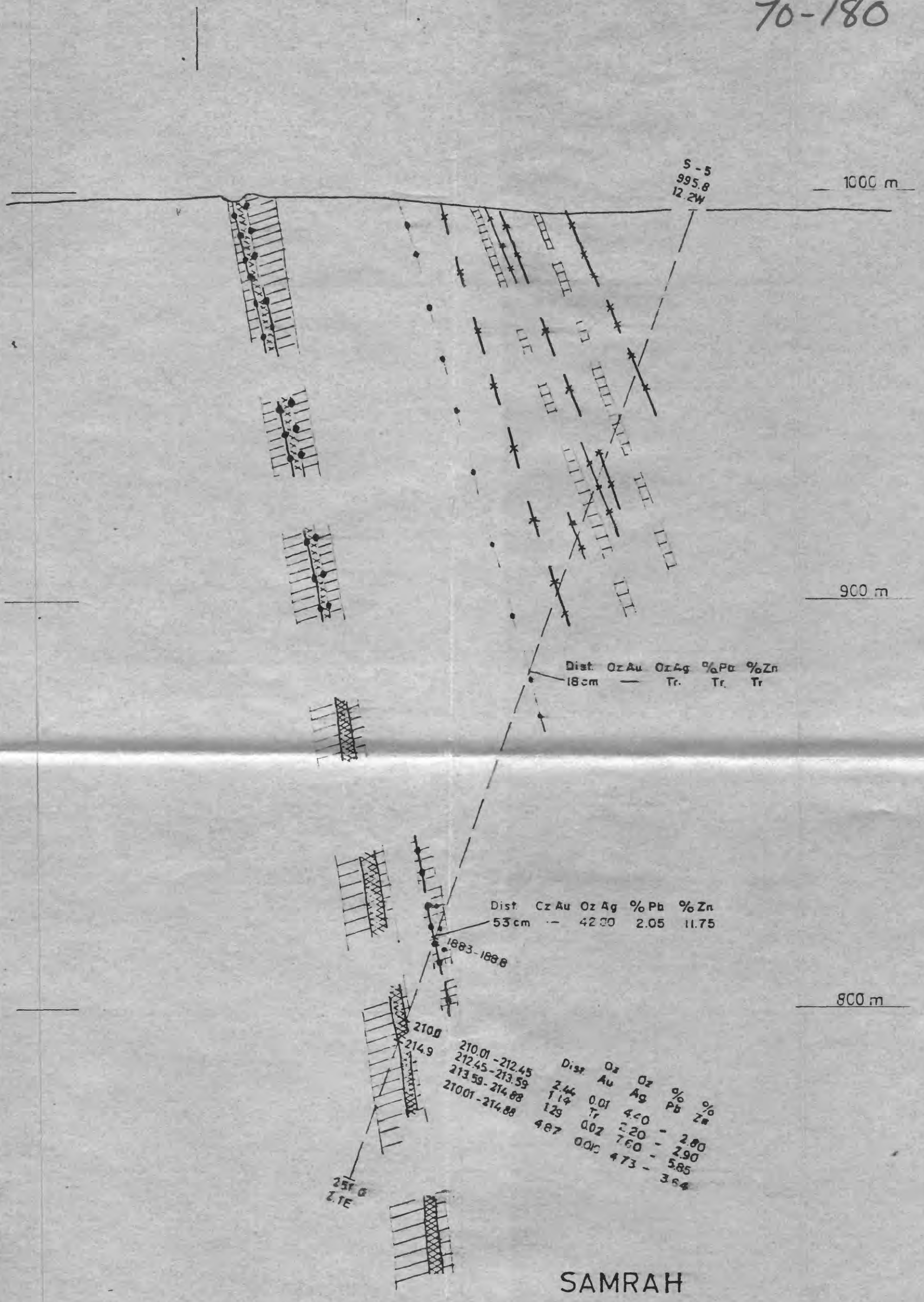


Fig. 1 Location of diamond drill holes, Samrah

70-180



SAMRAH

SECTION A
Looking N 75° E
Scale = 1:1000

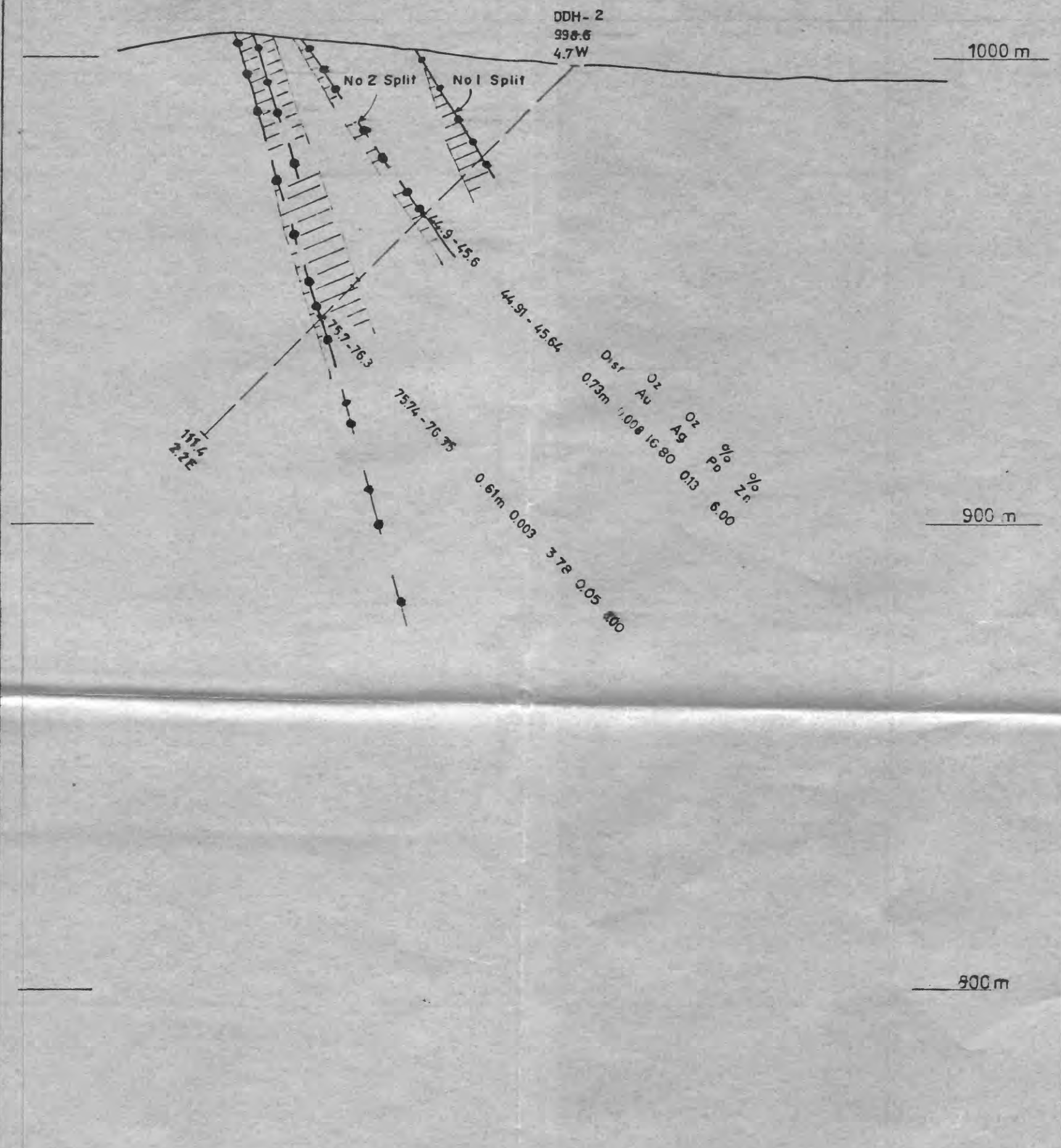
DDH S-5: Direction N 05° W
Inclination -70°

Figure 3

KINGDOM OF SAUDI ARABIA

U.S. GEOLOGICAL SURVEY DIRECTORATE GENERAL OF MINERAL RESOURCES IR 106

70-180



SAMRAH

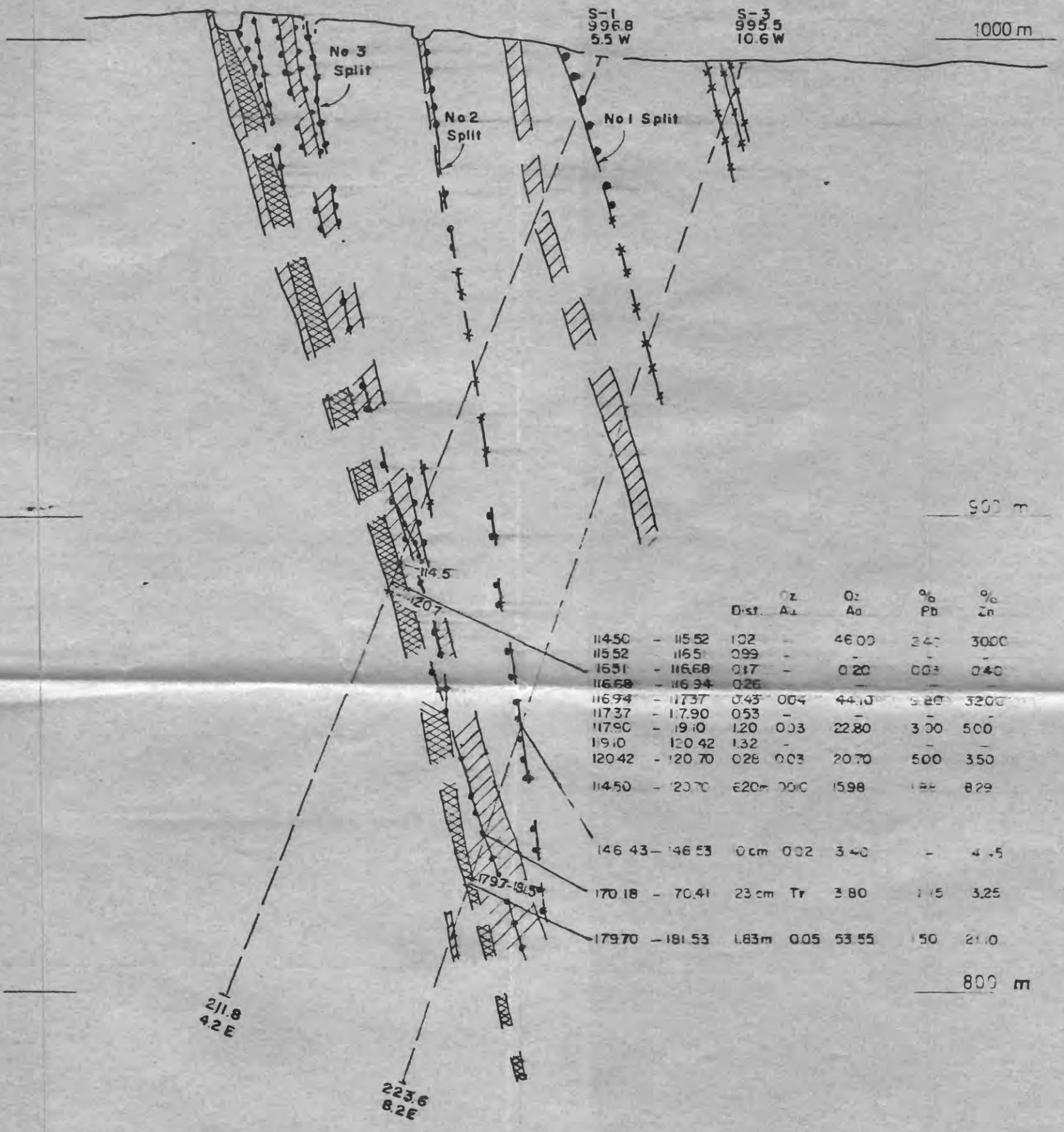
SECTION B
Looking N 75°E
Scale = 1:1000

DDH-2 : Direction N 10°W
Inclination -45°

Section L-L'

Figure 4

70-180



		Dist.	Oz A.t	Oz Au	% Pb	% Zn
114.50	- 115.52	1.02	-	46.00	2.40	3.000
115.52	116.51	0.99	-	-	-	-
116.51	- 116.68	0.17	-	0.20	0.03	0.40
116.68	- 116.94	0.26	-	-	-	-
116.94	- 117.37	0.43	0.04	44.10	5.20	3.200
117.37	- 117.90	0.53	-	-	-	-
117.90	- 119.10	1.20	0.03	22.80	3.00	5.00
119.10	120.42	1.32	-	-	-	-
120.42	- 120.70	0.28	0.03	20.70	5.00	3.50
114.50	- 120.70	6.20m	0.00	15.98	1.86	8.29
146.43	- 146.53	0 cm	0.02	3.40	-	4.15
170.18	- 70.41	23 cm	Tr	3.80	1.15	3.25
179.70	- 181.53	1.83m	0.05	53.55	1.50	21.0

Section L-L'

Figure 5

SAMRAH

SECTION C
Looking N 75° E
Scale = 1:1000

DDH S-1 : Direction N 06°W
Inclination -68°

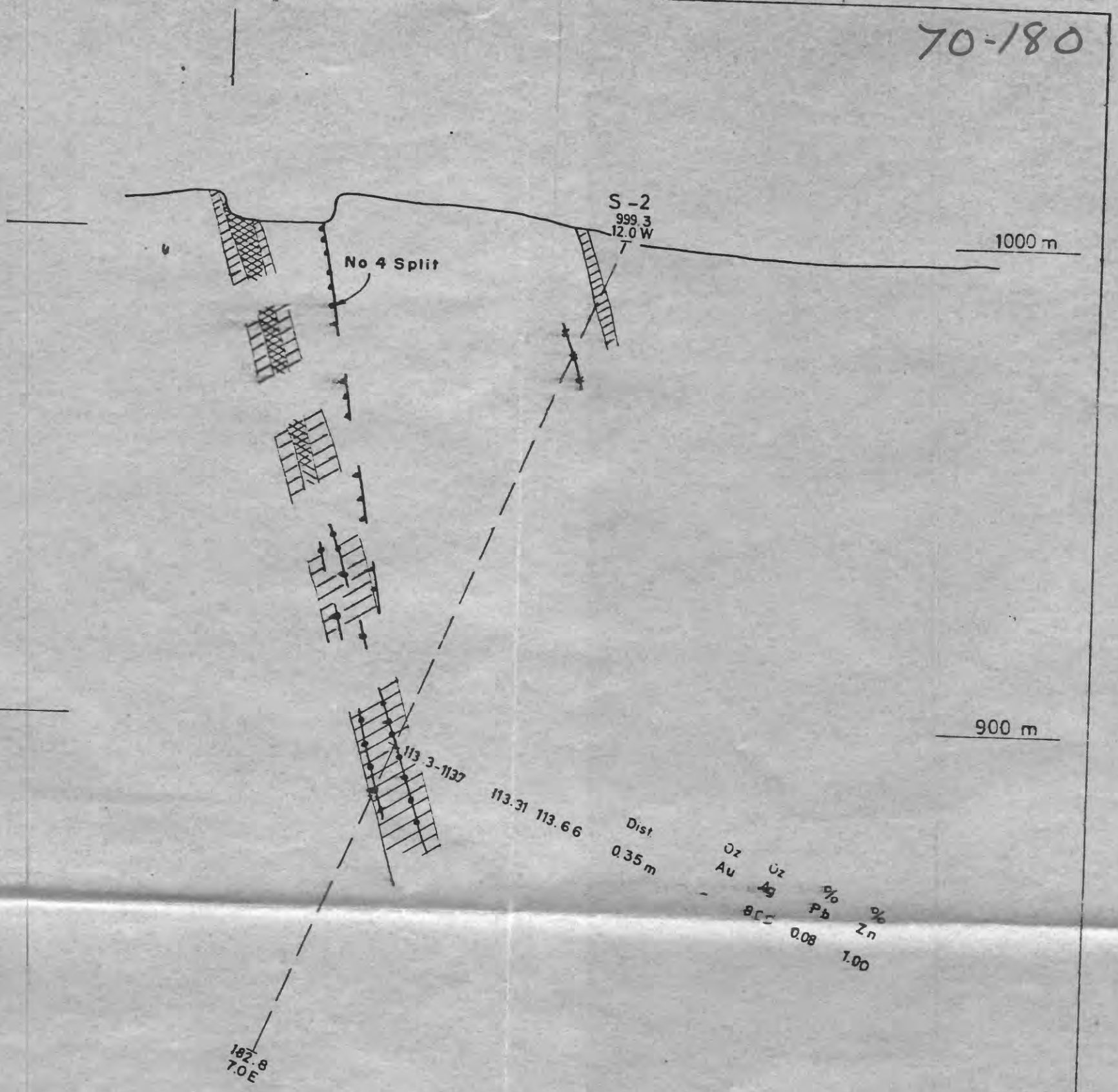
DDH S-3 : Direction Due N
Inclination -71°

U.S. GEOLOGICAL SURVEY

KINGDOM OF SAUDI ARABIA
DIRECTORATE GENERAL OF MINERAL RESOURCES

IR 106

70-180



SAMRAH

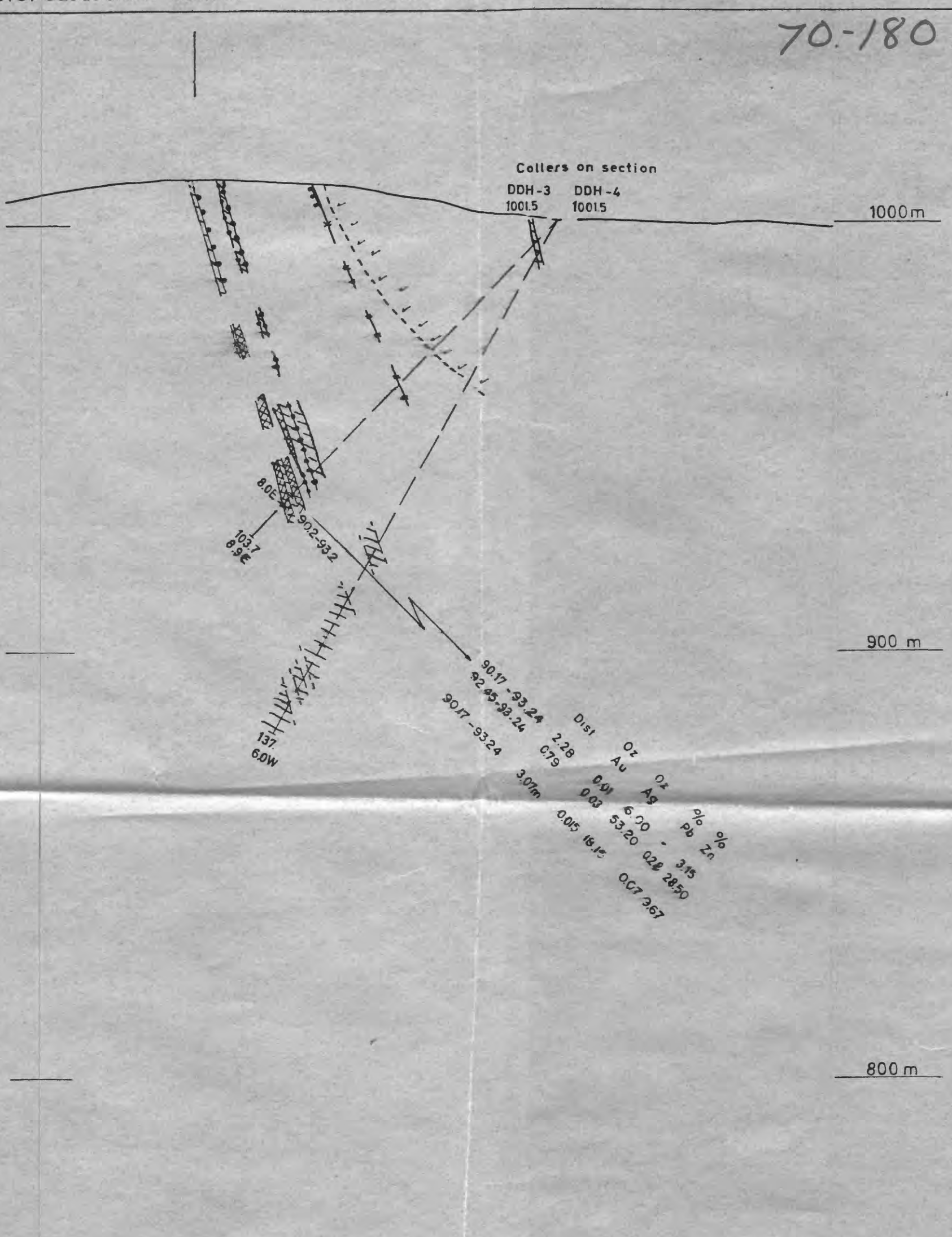
SECTION E
Looking N 75° E
Scale = 1:1000

DDH S-1 : Direction Due N
Inclination - 68°

Section L-L'

Figure 6

70-180



Section L-L'

Figure 7

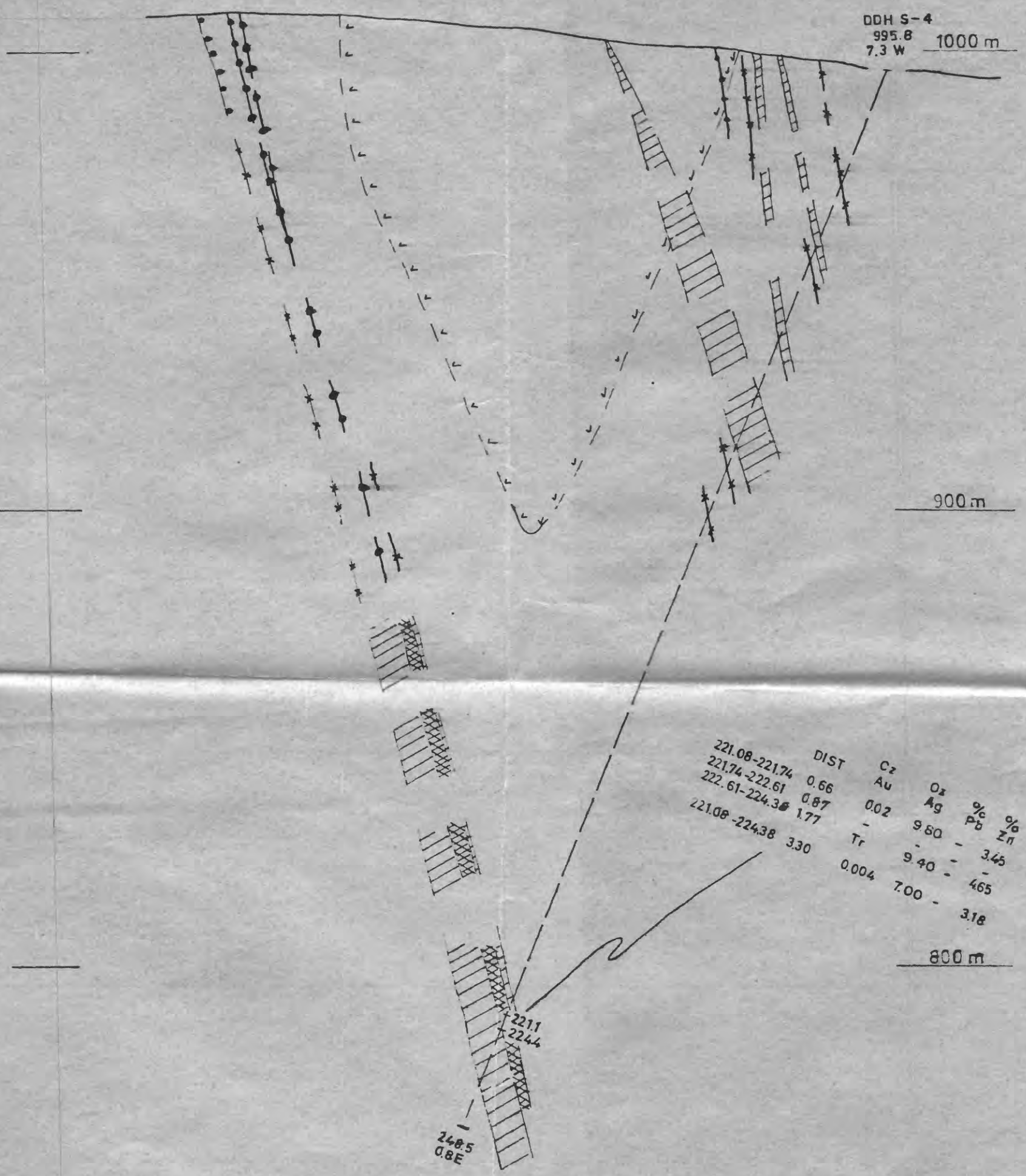
SAMRAH

SECTION F
Looking N 75°E
Scale = 1:1000

DDH-3 : Direction N 8° W
Inclination -45°

DDH-4 : Direction N 20°W
Inclination -60°

70-180



Section L-L'

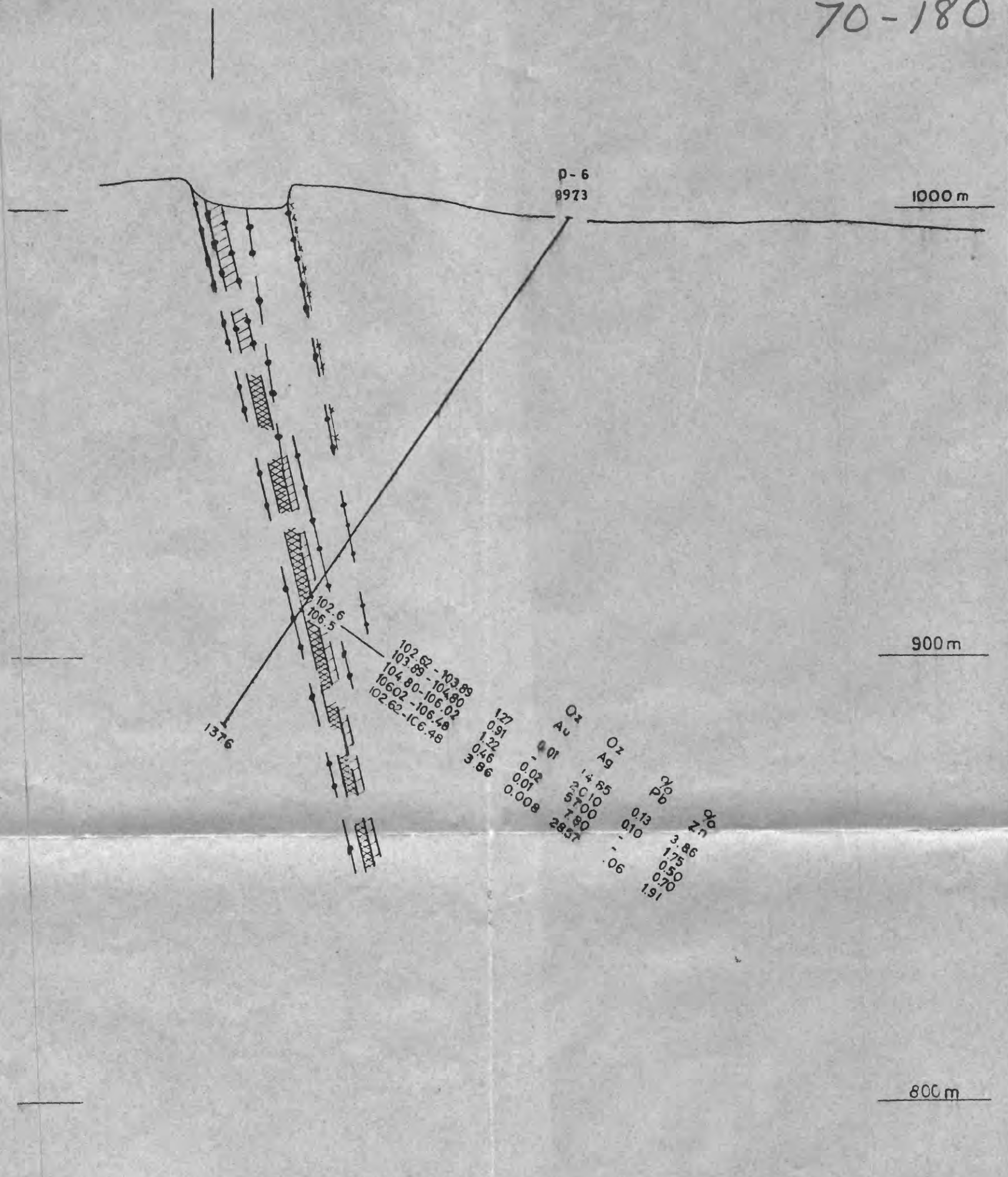
SAMRAH

SECTION G
Looking N 75° E
Scale = 1:1000

DDH S-4 : Direction N10° W
Inclination -68°

Figure 8

70-180



SAMRAH

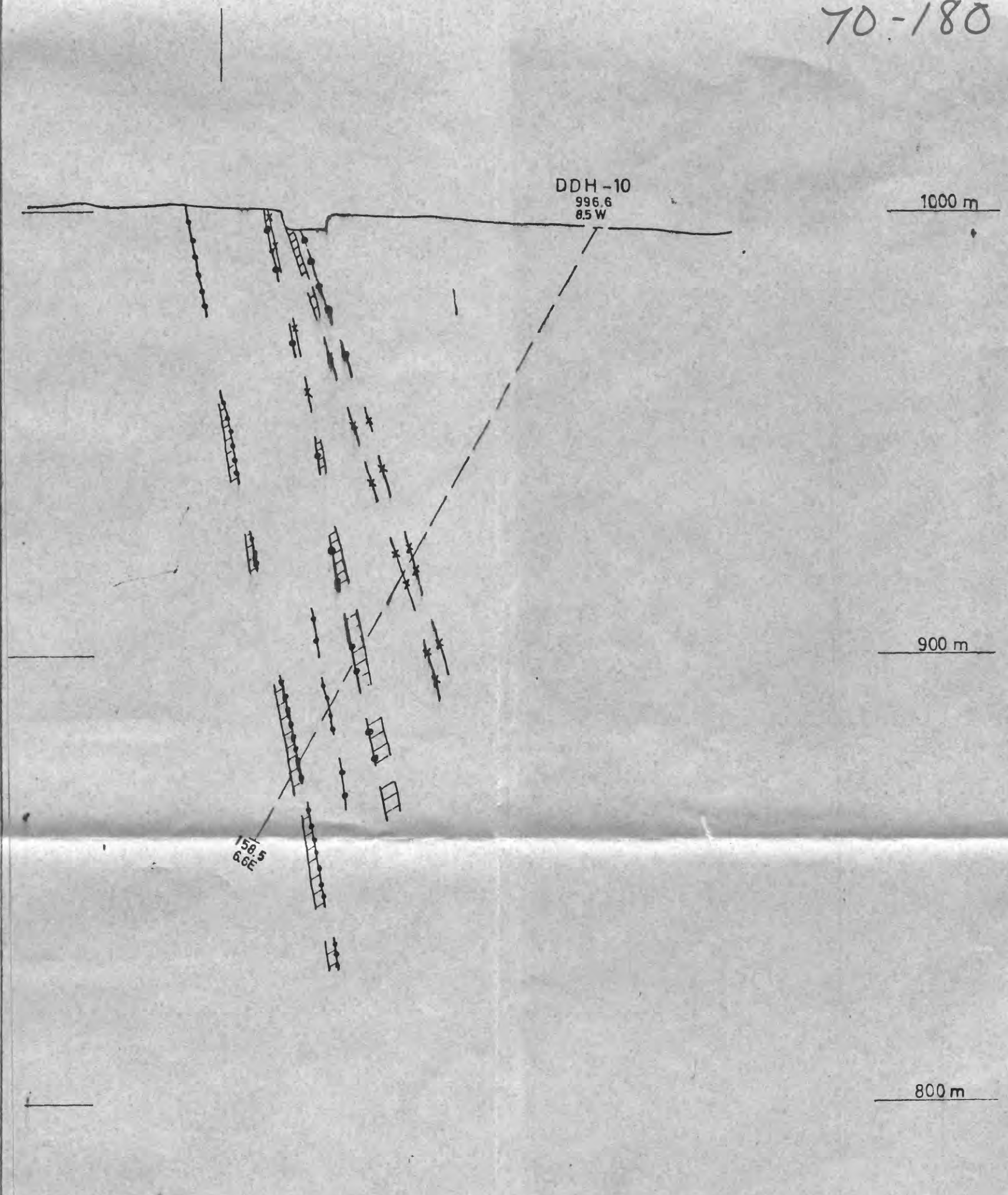
SECTION J
Looking N 75° E
Scale = 1:1000

DDH-6 : Direction N 15° W
Inclination -55°

Section L-L'

Figure 11

70-180



SAMRAH

SECTION K
Looking N 75° E
Scale = 1:1000

DDH-10 : Direction N 04°W
Inclination -60°

Section L-L'

Figure 12