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MINERAL EXPLORATION DIVISION

COPPER MINERALIZATION IN KHIRBET EL-NAHAS - JARYIA AREA

(PRELIMINARY EVALUATION)

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CONTENTS

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SUMMARY

This is the third report on Wadi Araba exploration program, which concerns the central part of the area, conducted by the Mineral Exploration division/Geology Directorate.

The investigated area covers more than 115sq. kms and located between Wadi El-Hassiya and Wadi Dahel in the north, and Jabal Madsus El-Dahel and Wadi Fidan in the south, and from Jabal El-Marzuka and Ras Ghuweib in the east, to Jabal Hamrat Fidan and Jabal El-Minshar in the west.

This report covers the copper mineralization in two formations in the central part of wadi Araba. The first formation is The Burj-Dolomite-Shale Formation which embraces the lower copper mineralization horizon, and the second formation is The Abu-Khusheiba Sandstone Formation,which contains the upper copper mineralization horizon.

The mineralization of the lower horizon occurs in the form of thin films of copper oxides along the fractures, joints, and as pockets and spots on the bedding surfaces.

In the upper horizon, the copper mineralizations in most of the outcrops are patchy and not persistant, and occur as nodules, veinlets and lenses with green-dark green colour.

During the foot prospecting, two areas with high copper mineralization were discovered. A lot of representative samples taken from the outcrops and the drifts were chemically analyzed. The results show high values of copper content and the mineralized beds in the main horizon are also increased.

The cosistancy and the thickness of the mineralization in this area could be considered of high economic interest, especially with respect to the lower horizon in Kherbit El- Jariya-Jabal Marzuka.

1. INTRODUCTION

1.1- Aim of The Report

The aim of the report is to give a preliminary idea about copper mineralization in the Burj-Dolomite-Shale Formation, to study the lateral and vertical extent, and to carry out a detailed analyses on these mineralizations from an economic point of view.

It is also aimed to study the previous activities carried out in the area of Kherbit El-Nahas/Wadi El-Jariya in order to evaluate the occurrances of copper in the Burj-Dolomite-Shale formation.

1.2- Location

The area of study is located in the central part of wadi Araba, about 50 kms south-southeast of Safi village and between Wadi El-Hassiya and Wadi Dahel in the north and Jabal Madsus El-Dahel in the east. The area covers more than 115sq. kms (fig. 1&2) and is bounded by the following coordinates in Palestine Grid.

N 008,50 - 017,50.

E 185,00 -197,75.

1.3- Topography

The investigated area is rugged, mountainous, and locally forms steep cliffs, and it is traversed by deep wadies. The highest point is about 600m a.s.l, and the lowest point is about 100m below sea level.

In general, the folding axes are parallel to the main Wadi Araba direction, which trends north-south with a little rotation to the west, except in some places where the folds are affected by major faults.

There are two main wadies in the area draining toward the west:

- Wadi Ghuweib which is a main wadi flowing from southeast to northwest and has five tributaries, namely: Wadi Madsus, Wadi Jariya, Wadi Ghuweib El-Hamr, Wadi Atshana, and Wadi Abu-Risha.

- Wadi Fidan which flows from the southeast to the northwest. It is supported by small wadies as Wadi Madsus Ed-Dahel, Wadi Khalid, and Wadi Ratiya.

KEY MAP SHOWING APPROXIMATE LOCATION

Scale 1 2,500 000

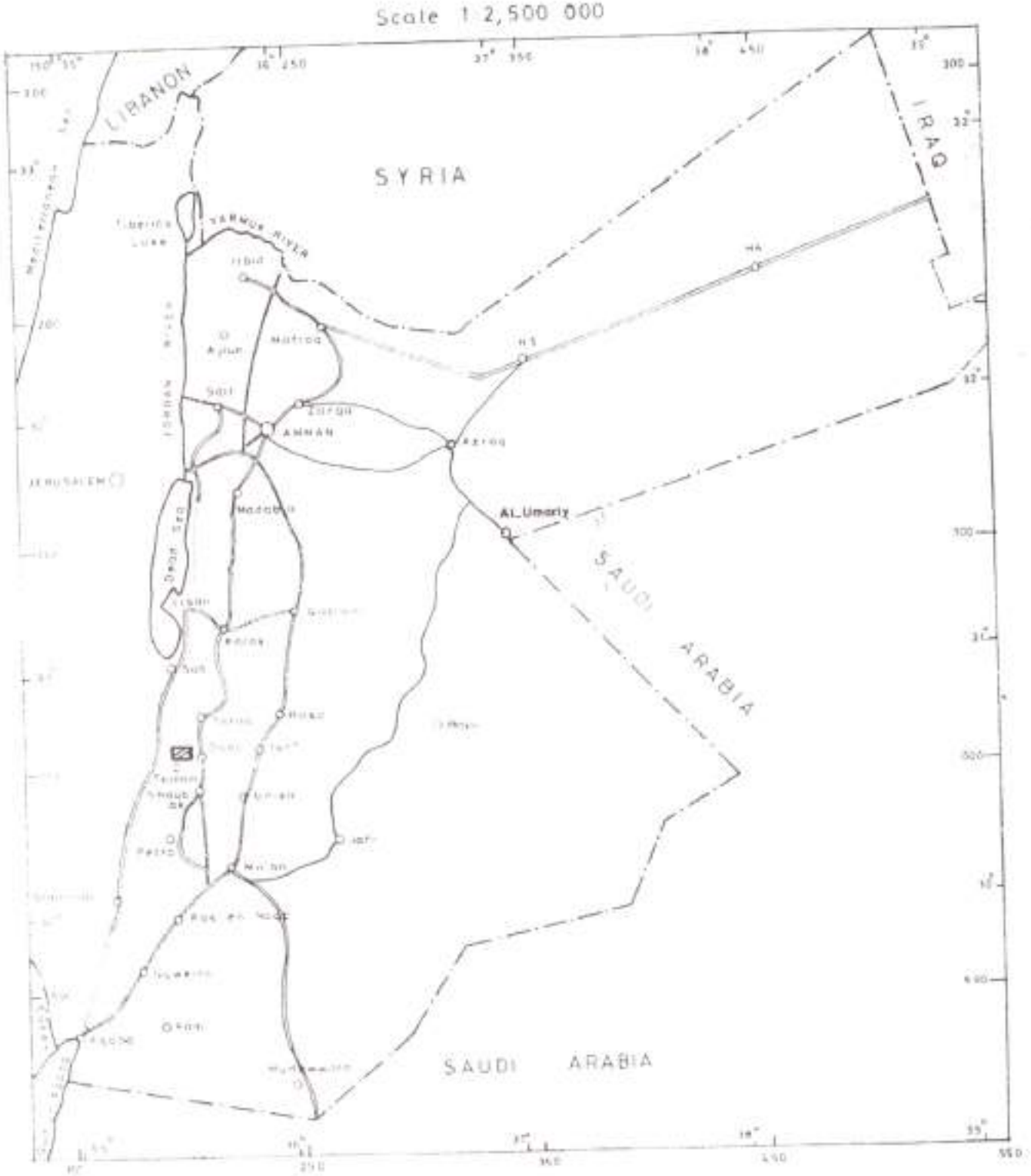


Fig. 1

Border line (International boundary)

Highway

Dirt road

area of study

2. GEOLOGY

The study area is situated along the eastern side in the central part of wadi Araba. There are large exposures of basement complex in the area. These exposures consist of intermediate and acidic intrusives, such as Quartz-Diorite, Granodiorite, Granite, and accompanied by dykes crossing these intrusions.

2.1- Stratigraphy

The following rock formations are exposed in the study area.

2.1.1- Salib Arkosic Sandstone Formation, (Lower Cambrian)

It is the oldest formation exposed in the area, which overlies the Precambrian basement rocks with irregular erosional surface.

The thickness of this formation ranges from 50m in the west to about 70m in the east and northeast.

The Salib Arkosic Formation consists of sandstone, pink-brown in colour, superimposed by thin layers of white and violet sandstone, medium-coarse grained, characterized by cross-bedding and parallel bedding, especially in the lower-most and upper-most portions of the formation. There are intercalations of shale, green in colour, silty and rich in mica.

This formation is also characterized by scattered quartz pebbles and feldspar fragments of different colours and widespreaded in the lower part.

Due to differential weathering of well and poorly cemented sandstones, the profile exhibits numerous projections and indentations, and abundance of deep reddish-brown weathered colours,(Nimry, 1973).

2.1.2- Burj-Dolomite-Shale Formation, (Uppermost Lower-Middle Cambrian)

This formation overlies the Salib Arkosic Sandstone unconformably, where a conglomerate bed 80cm thick (composed of fragments of igneous rocks with matrix of sandstone) occurs between the two formations (east of Kherbit El-Jariya).

The formation is exposed all over the area and forms a set of hills. The maximum thickness is about 40 m in the northern part, and thins out towards the south, due to the paleogeography of the area. Two sections are taken in (BDS formation), one is in Wadi Abu-Risha (fig. 3), and the other is in Wadi Ghuweib (fig.4).

The Burj-Dolomite-Shale Formation is subdivided into three members:

a. Tayan Member

This member forms the lower part of the formation, and attains about 6m thickness. It is composed of sandstone, brown-beige in colour, partly violet, medium grained, thin bedded, intercalated with claystone and shale, brown and green in colour, fissile, silty. It contains spots of manganese and copper in places (Fig. 5).

b. Nomayrah Member

It forms the middle part of the formation, and occupies the crest of the hills in the study area with a 30m thickness.

Nomayrah member consists mainly of dolomite, and dolomitic-limestone, beige to grey in colour, dark grey to black, in places due to mineralization of manganese. It is characterized by thin and fractured beds in the lower part, and massive, vuggy, sandy-dolomite in the upper part, where the mineralizations of copper and manganese, especially the upper two meters are traced.

c. Hannah member

This member forms the uppermost part of the formation with athickness of about 4m.

It consists of siltstone, red-brown in colour thin bedded, with shale, dark brown and green in places, fissile, intercalated with claystone, brown-black in colour, and thin beds of dolomite, beige in colour, hard, sandy. It is the main copper-bearing horizon, nominated as the Lower Horizon (fig. 6&7).

2.1.3- Abu-Khusheiba Sandstone Formation, (Uppermost lower-Middle Cambrian)

The Abu-Khusheiba Sandstone Formation, in stratigraphic position is equivalent to The Burj-Dolomite-Shale Formation. In particular, the upper section interfingers with The Burj-Dolomite- Shale Formation due to the transgression and regression of the sea.

The formation is thickening towards the south, while The Burj Formation thining out in the same direction. The thickness of Abu-Khusheiba formation in this area is about 50m.

Abu-Khusheiba Formation consists of Sandstone, beige-white in colour and brown in places, very coarse grained, and friable in the lower part, and fine-medium grained, fractured, thin bedded in the middle and the upper parts. These sandstones are intercalated with thin beds of brown and green silty shale.

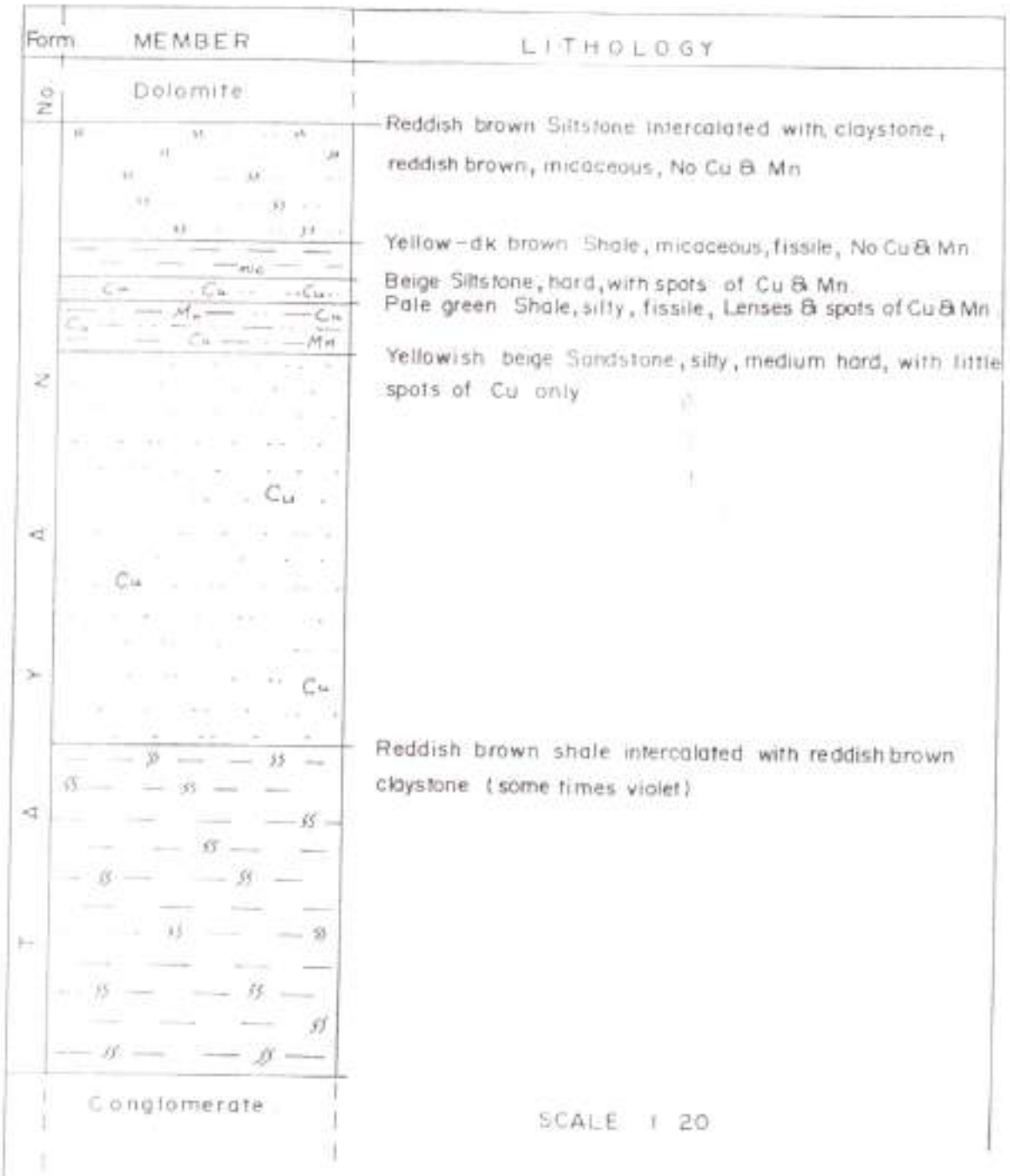


Fig No (5) Lithological Section Measured in Tayan member South east Kh el Jariya

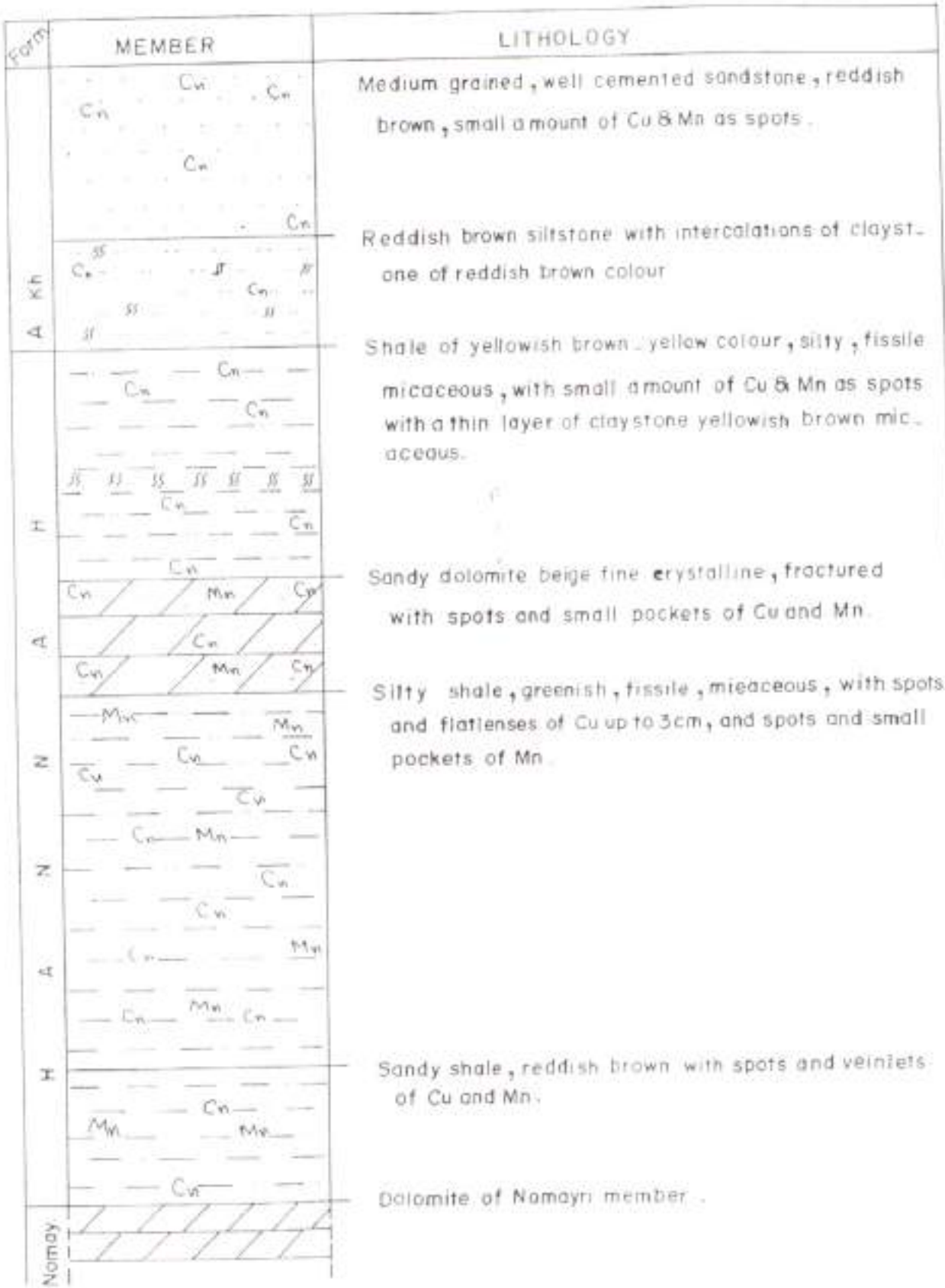
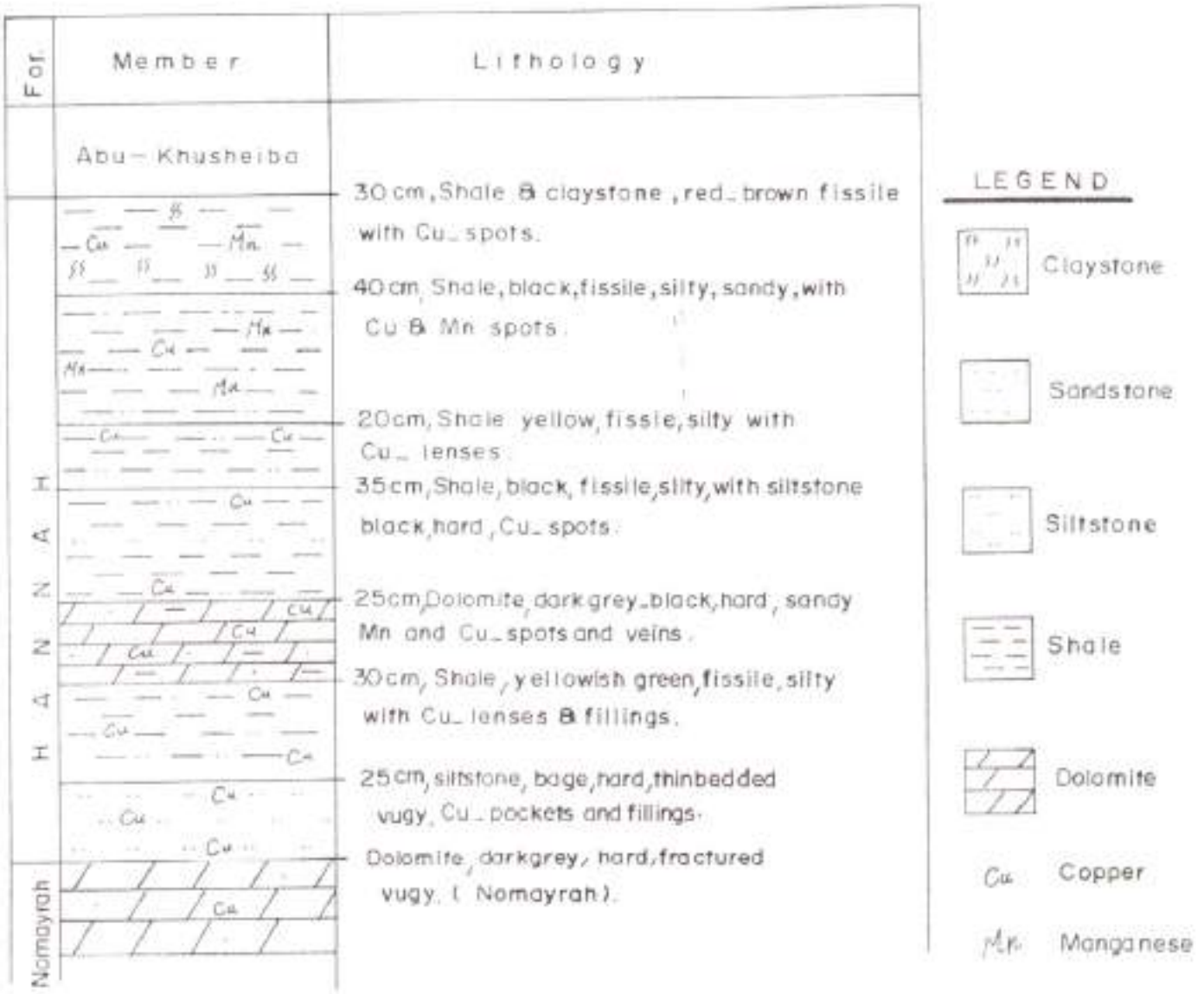


Fig. (6) Lithological Section Measured in The Main Horizon (Hanneh Member) West Kh. El Nahas Area.

SCALE 1:20



SCALE 1 : 20

Fig. No(7) Lithological Section Measured in the Main Horizon in Jabal Marzuka.

The formation contains the second copper bearing horizon, nominated as the Upper Horizon.

2.1.4- Umm Ishrin Sandstone Formation, (Middle-Upper Cambrian)

Siltstone bed is the contact between this formation and Abu-Khusheiba formation It is red to brown in colour and 0.25-2m in thickness.

Umm Ishrin formation consists of light grey to brown sandstone, medium grained, thick bedded in the lower part, and brown to red sandstone, coarse grained massive, with local cross-bedding in the upper part.

The upper part of this formation is characterized by widely spreaded quartz pepples. The thickness of the formation is more than 250m in the area.

2.2- Structure and Tectonism

The studied area is situated just east of the main faults of the Wadi Araba rift valley. Therefore, it has been strongly affected by the main tectonic, which is responsible for the formation of the Wadi Araba Graben. The central part of this wadi is highly faulted and folded.

There are three major systems of faults acting in the area.

East-west system which divides the area into major blocks. An example for this system is Wadi Dana fault and Wadi Ghuweib Complex Fault. The faults of this system are thrust faults and accompanied by strike-slip displacement.

Northeast-southwest system which strikes about N45E.

Northwest-southeast system which strikes about N45W.

Most of these two systems are tension faults, and are accompanied with other faults branching from them (Nimry,1973).

There is no genetic relationship between the faulting and the mineralization of copper and manganese and all the faults are postmineralization. There are few fault planes filled by copper and/or manganese mineralizations. These mineralizations are introduced into them at later stage, due to percolation of mineral bearing solutions.

The area is highly folded forming, in general, steep cliffs, and the general dip is towards the rift valley ranging between 4-15 degree to the northwest. Generaly, the folding axis is parallel to the rift valley, except in few places, where the folding is affected by major faults.

2.3- Geology of the Copper Bearing Horizons

The copper mineralizations in the investigated area occur in two formations: The Burj-Dolomite-Shale Formation and The Abu-Khusheiba Formation.

2.3.1- Burj-Dolomite-Shale Formation

The copper mineralizations in this formation are known as The Lower Copper Horizon. The mineralizations of copper, and locally manganese, are concentrated in the uppermost part of the formation (Hannah member) with a maximum thickness of 4m.

This horizon consists of about 0.5m of white- beige siltstone, hard, thin bedded vugy and fractured, overlain by 1.5- 2.5m of green- black, and in places brown-yellow silty and sandy shale intercalated with 0.5-1m of sandy dolomite, dark grey-black, hard, fractured.

In some places, as in El-Jariya area, the horizon ends with about 0.5m of darkbrown-black claystone. Two lithological sections are measured in this horizon, one is in the southwest of Kherbit El-Nahas (Fig. 6), and the other is in Kherbit El-Jariya (Fig. 7).

In general, the thickness of shale is increasing towards the north and the northwesten parts of the area (about 3m in Khirbet El-Nahas).

The copper mineralization is exist all over the horizon, with local concentration in the middle, and decreases towards the top and bottom. In places, the mineralization penetrates the dolomite layers (Nomayrah member) down to more than 2m as in Khirbet El-Jariya and Jabal El-Marzuka.

The concentration of copper mineralization, is confined to the shale and siltstone beds, while the manganese mineralization is confined to the claystone (and partly siltstone) beds (Nimry,1973).

The mineralizations occur as disseminations pockets, and lenses with a maximum thickness ranges between 2-2.5m (3m in few places), also presents as fillings in fractures and bedding planes.

The most abundant copper minerals in this horizon are Malachite and Chrysocolla, with less amount of other copper minerals as Atacamite, Planchite, Azurite and others. The dominant manganese mineral present is Pyrolusite with less significant amount of Psilomelane, Cryptomelane and Wad.

In Khirbet El-Jariya area it is noticed that there is a local copper mineralization, with a very low grade and thickness in the lower part of the formation (Tayan member). It is confined mainly to the shale and dolomite beds.

2.3.2- Abu-Khusheiba Formation

The copper mineralization in this formation is known as the Upper Horizon. It is exist in two levels, the lower level and the upper level.

The lower level represents in the lowermost part of the formation which occurs immediatly above the lower horizon of Hannah member. The level consists of sandstone, grey to white, sometimes green-blue in colour due to mineralization, very coarse grained-conglomeratic, fractured, and jointed. This level is discontinuous, and the thickness ranges from 0.5-1m. The mineralization is spreaded in the matrix coating the grains and filling fractures.

The upper level is located in the middle of the formation, (about 20-25m from the bottom). It is the main mineralized part in Abu-Khusheiba formation, and consists of sandstone, white-beige, in places pale green colour, fine to medium grained, thin bedded. The thickness of this level varies from 0.5-3m. The mineralization occurs as lenses up to few meters, nodules, and veinlets, with darkgreen colour. It consists mainly of malachite and cuprite. Black spots and veins of manganese oxides are observed in this level.

These two level are discontinuous, and have been erodded in many parts of the area.

3. PROJECT ACTIVITIES

The work in the study area started at the beginning of 1991, and finished at the end of 1993. But in a limited time Feb.92-Apr.92 and Apr.93-June 93, the work was with the economic geology project.

The activities are divided into the following parts:

3.1- Office work

The office work comprised the following activities:

- Studying of all the previous reports and documents about the area.

- Preparation of the topographic maps of the area at scale 1:50,000 to be used in the office and field.

- Preparation of the geological maps of Khirbet El-Nahas and Wadi El-Hamr at scale 1:10,000.

- Studying the arial photographs at scale 1:10,000 to distinguish the different rock formations, and to plot the faults and to check the office works in the field.

- Studying the satellite image of the area at scale 1:50,000, and transfer the lineaments on special map.

- Presenting a plan of work for the area including drilling boreholes, pits and trenching to follow up the lateral and vertical continuity of the copper horizon.

- Preparation and classification of the representative samples, and sending them to the laboratories for chemical analyses.

- Preparation and drawing of the lithological sections which were taken in the field.

- Writing a report on the history of copper prospecting in Wadi Araba.

- Preparation of two tables about the main minerals of copper and manganese, their occurrences, chemical composition etc.

- Writing two reports about the new discoveries of copper mineralization in Wadi Araba.

3.2- Field Work

The field work started in Jan.1991, and covered the whole area of study. More comprehensive work was carried out on cambrian sediments, especially The Burj-Dolomite-Shale Formation and in later stage, on the Abu-Khusheiba Formation where the two main horizons of copper mineralization were exist.

The topographic maps of Hamrat Fidan and Shoubak on scale 1:50,000 were used as base maps for work. Geological maps at scale 1:50,000 of Al-Qurayqira (Jabal Hamrat Faddan) and Ashshawbak were used. Another geological map of Khirbet El-Nahas prepared by the mining division at scale 1:33,000 was also used.

Aerial photographs at scale 1:10,000 and sometimes at scale 1:25,000 were used to define the rock units and the copper horizons, and to correlate between the different parts of the area. The satellite image of Hamrat Fidan at scale 1:50,000 was also used to study the regional structure and nature of the area.

The field work was to define the rock units which includes the copper mineralizations, to study their lateral extent and thickness, to take representative samples from the mineralized beds, and then to study the mode of ocurrences and origin of copper mineralization.

Foot prospecting was undertaken in the inaccessible and the rugged area (fig.8) during the field prospecting, new discoveries of copper mineralizations, have been found in the Ghuweib-Abu-Risha area, and in Jabal Marzuka area (Discovery of new copper mineralization: Abu-Snoubar, Nov.1992).

The samples taken from the outcrops (and from the drifts in Jariya area), are most of them grab samples and part of them channel samples.

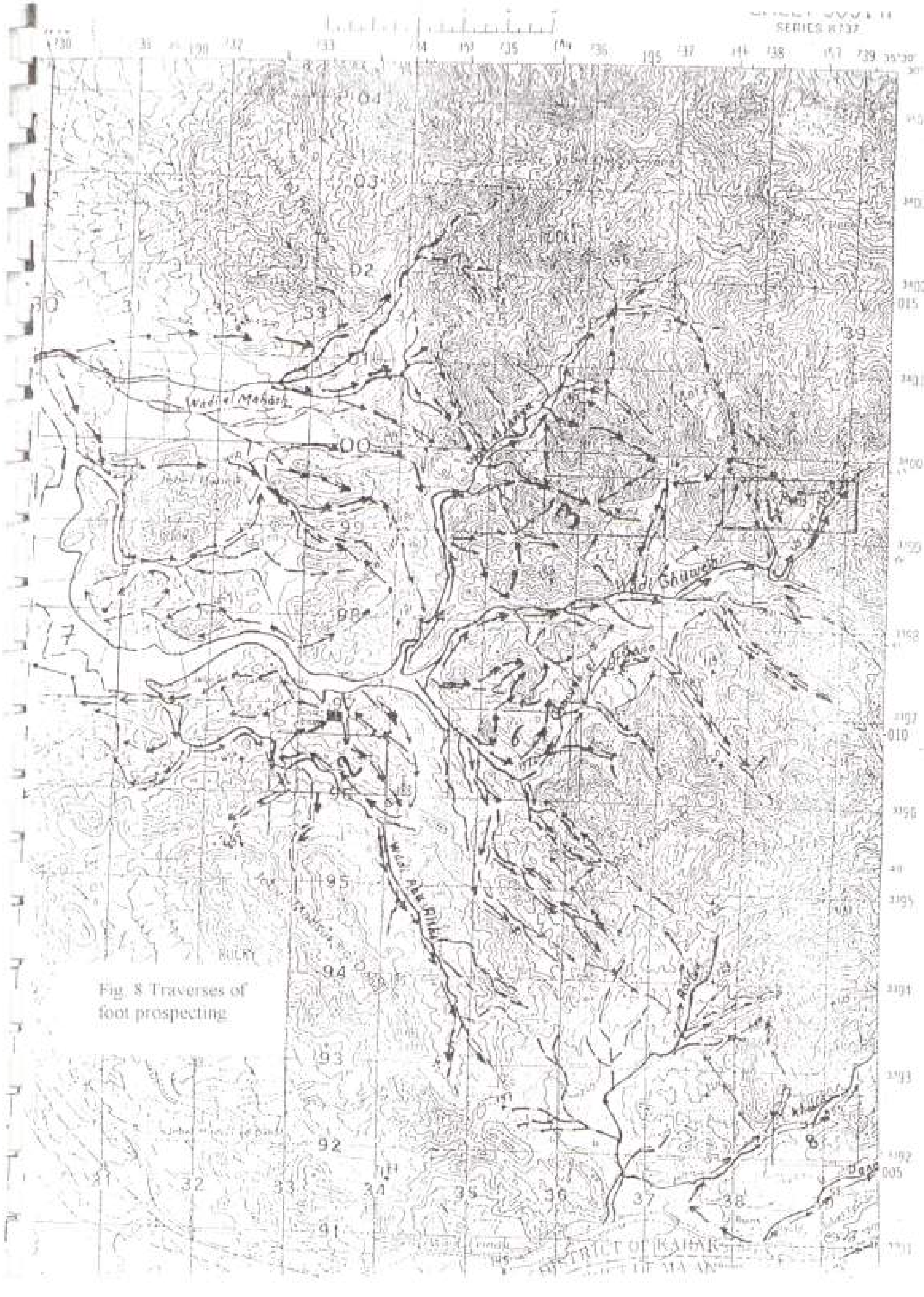


Fig. 8 Traverses of foot prospecting

3.3- Sampling and Analyses

During the field work in the studied area, a total of (136) samples were taken from the copper mineralizations in both horizons. These samples were chemically analyzed at the NRA laboratories to determine the copper percentage. Many other samples were collected for the NRA Geological Museum, Hanbo Group and others.

The samples are of two types:

- A total of (68) grab samples were collected in the begenning of the work from different outcrops of the copper mineralized beds to determine the percentage of copper (Tables 1&2)
- A total of (68) channel samples were collected from the main horizon (Hannah member). Some of them were collected from the outcrops, and the others were taken from the old drifts in Jariya and Marzuka area, (Tables 3&4).

Table No.(1): Samples taken from Wadi-Ghuweib/Mahash Area:

Samples	Cu	Coordinate	
	%	N	E
Cu /AN009/HF	0.90	013.280	190.300
Cu /AN010/HF	8.40	012.480	192.400
Cu /AN011/HF	3.59	013.000	191.200
Cu /AN012/HF	3.13	011.800	196.800
Cu /AN014/HF	1.66	013.230	190.900
Cu /AN015/HF	3.24	013.100	192.560
Cu /AN022/HF	4.98	012.000	190.770
Cu /AN023/HF	4.08	012.100	190.600
Cu /AN031/HF	8.90	012.200	189.030
Cu /AN032/HF	3.08	012.200	189.100
Cu /AN036/HF	-----	012.800	190.900
Cu /AN056/HF	0.98	011.700	196.800
Cu /AN057/HF	1.00	011.700	196.800
Cu /AN058/HF	0.42	013.000	189.300
Cu /AN059/HF	0.58	012.000	189.100
Cu /AN060/HF	1.49	011.900	188.950
Cu /AN061/HF	3.13	010.000	188.700
Cu /AN062/HF	0.02	012.150	195.800
Cu /AN192/HF	0.60	013.200	188.600
Cu /AN193/HF	1.03	012.990	188.500
Cu /AN194/HF	1.66	010.700	188.200
Cu /AN195/HF	2.80	010.150	188.550
Cu /AN196/HF	0.90	010.070	188.530
Cu /AN197/HF	5.02	009.950	188.530

Table No.(2) Samples taken from W. Jariya-J. Marzuka.

Samples	Cu %	Coordinates	
		N	E
Cu /AN013/HF	7.78	012.900	197.000
Cu /AN016/HF	0.95	012.600	193.000
Cu /AN017/HF	5.08	012.930	193.500
Cu /AN018/HF	2.29	012.330	193.700
Cu /AN019/HF	9.73	012.300	194.200
Cu /AN020/HF	3.70	013.300	193.000
Cu /AN027/HF	1.53	012.260	193.530
Cu /AN028/HF	0.15	012.260	193.530
Cu /AN029/HF	11.10	012.230	193.700
Cu .AN030/HF	3.75	012.230	193.800
Cu /AN055/HF	16.00	012.300	193.330
Cu /AN063/HF	2.95	012.290	195.800
Cu /AN064/HF	2.25	012.300	195.680
Cu /AN093/HF	8.00	012.540	195.000
Cu /AN144/HF	1.92	012.400	193.280
Cu /AN145/HF	7.50	012.400	193.280
Cu /AN146/HF	1.31	012.400	193.280
Cu /AN147/HF	1.78	012.300	194.060
Cu /AN148/HF	2.09	012.300	194.060
Cu /AN149/HF	2.23	012.300	194.060
Cu /AN150/HF	0.78	012.300	194.060
Cu /AN151/HF	1.44	012.300	194.060
Cu /AN152/HF	1.59	012.300	194.060
Cu /AN153/HF	1.07	012.300	194.060
Cu /AN154/HF	3.28	012.300	194.060
Cu /AN155/HF	0.58	012.300	194.060
Cu /AN156/HF	2.18	012.260	194.060
Cu /AN157/HF	4.16	012.260	194.060
Cu /AN158/HF	2.40	012.260	194.060
Cu /AN159/HF	2.30	012.260	194.060
Cu /AN160/HF	0.78	012.260	194.060
Cu /AN161/HF	2.46	012.260	194.060
Cu /AN162/HF	1.72	012.260	194.060
Cu /AN163/HF	3.80	012.260	194.060
Cu /AN164/HF	3.72	012.260	194.230
Cu /AN165/HF	0.38	012.260	194.230
Cu /AN166/HF	0.37	012.260	194.230
Cu /AN208/HF	0.91	013.400	195.000
Cu /AN209/HF	4.03	013.400	193.230
Cu /AN210/HF	1.45	013.100	193.800
Cu /AN211/HF	2.22	012.260	195.800
Cu /AN212/HF	5.28	012.260	195.800
Cu /MM036/HF	1.85	-------	-------
Cu /MM037/HF	2.35	-------	-------
Cu /MM038/HF	4.23	-------	-------
Cu /AN217/HF	4.60	013.980	194.300
Cu /AN218/HF	8.70	013.980	194.300

Table No (3) Samples taken from Kherbit El-Nahas Area:

Samples	Cu	Coordinates	
	%	N	E
Cu /AN001/HF	2.67	009.380	192.800
Cu /AN002/HF	8.00	009.600	192.600
Cu /AN003/HF	14.10	009.780	190.380
Cu /AN004/HF	10.50	009.900	190.180
Cu /AN005/HF	3.15	009.580	191.800
Cu /AN006/HF	2.14	009.400	191.500
Cu /AN007/HF	3.59	009.900	191.910
Cu /AN008/HF	13.40	009.900	190.900
Cu /AN021/HF	5.54	010.800	190.660
Cu /AN024/HF	4.16	009.800	195.000
Cu /AN025/HF	6.26	009.900	191.400
Cu /AN026/HF	18.50	009.900	191.360
Cu /AN054/HF	8.00	000.500	192.200
Cu /AN065/HF	0.03	010.800	194.400
Cu /AN066/HF	1.97	010.230	194.500
Cu /AN067/HF	1.27	010.100	194.590
Cu /AN068/HF	0.03	010.430	190.700
Cu /AN200/HF	5.42	009.700	192.300
Cu /AN201/HF	9.00	009.760	192.230
Cu /AN202/HF	3.83	009.860	192.100
Cu /AN203/HF	4.23	010.000	192.000
Cu /AN204/HF	10.90	009.760	190.660
Cu /AN205/HF	0.79	009.900	190.900
Cu /AN206/HF	10.80	009.900	190.900
Cu /AN207/HF	1.96	009.900	190.910
Cu /AN219/HF	2.60	010.600	190.900
Cu /AN220/HF	3.50	010.600	190.900
Cu /AN221/HF	8.20	010.180	190.900
Cu /AN224/HF	--------	--------	--------
Cu /AN225/HF	--------	--------	--------

Table No.(4). Groove samples from Jariya-J. Marzuka area (April & May, 1995)

Sample No.	Cu %	Locality
Cu /AN287/HF	4.07	drift no.2
Cu /AN288/HF	1.14	drift no.2
Cu /AN289/HF	0.11	drift no.2
Cu /AN290/HF	0.51	drift no.2
Cu /AN291/HF	2.17	drift no.2
Cu /AN292/HF	0.84	drift no.2
Cu /AN293/HF	0.66	drift no.2
Cu /AN294/HF	1.30	drift no.2
Cu /AN295/HF	0.94	drift no.2
Cu /AN296/HF	3.08	drift no.2
Cu /AN297/HF	1.16	drift no.2
Cu /AN298/HF	0.50	drift no.2
Cu /AN299/HF	3.59	end of W.Jariya
Cu /AN300/HF	4.93	end of W.Jariya
Cu /AN301/HF	4.00	J.El-Marzuka
Cu /AN302/HF	2.08	J.El-Marzuka
Cu /AN303/HF	1.75	J.El-Marzuka
Cu /AN304/HF	3.16	J.El-Marzuka
Cu /AN305/HF	3.91	J.El-Marzuka
Cu /AN306/HF	1.84	J.El-Marzuka
Cu /AN307/HF	1.02	J.El-Marzuka
Cu /AN308/HF	3.20	J.El-Marzuka
Cu /AN309/HF	2.32	drift no.3
Cu /AN310/HF	2.72	drift no.3
Cu /AN311/HF	2.31	drift no.3
Cu /AN312/HF	1.12	drift no.3
Cu /AN313/HF	2.46	drift no.3
Cu /AN314/HF	2.63	drift no.3
Cu /AN315/HF	7.05	drift no.3
Cu /AN316/HF	5.01	drift no.3
Cu /AN317/HF	3.64	drift no.3
Cu /AN318/HF	2.15	drift no.3
Cu /AN319/HF	2.10	drift no.3
Cu /AN320/HF	2.39	drift no1
Cu /AN321/HF	2.3	end of W.Jariya

3.4- Other activities

3.4.1- Economic Geology Project

Under the sponsering of the EEC, a consultancy services contract was signed in (1991) between NRA and BRGM of France.

The contract has covered the implementation of three sub-projects, one of them is to update the earlier technical-economic appraisal of the copper mineralization in Wadi Araba.

The work in this sub-project was started in January 1992, but after two months of work, the staff of the project noticed that a simple updating of the study would not lead to any little progress. For this reason, the project was changed to a Target Study and the begenning of this work was delayed to April, 1993 and endded in May of the same year. The final report of the project was handed in September, 1993. The report concluded the following results and recommendations:

A- The volume of copper reserves that were discovered up to now in Wadi Araba, are not sufficient to build up a unit to produce copper because they are small and of high cost.

B- The price of copper (in the time of the study) is not suitable, and very low.

C- In regard to the thickness and the grade of copper mineralization, the area of Khirbet El- Nahas- Jariya is a promising area for copper occurrences.

D- To carry out a complete exploratory work, several boreholes should be cored in Kherbit El-Nahas-Jariya area. This is will help to understand the depositional and structural situation, and may lead to discover small basins rich in copper mineralizations as that the case present in timna.

3.4.2- Cooperation with HANBO Group

Based on the cooperation between NRA and Hanbo Group of south Korea. They took a lot of samples from the area for chemical analyses, and proposed a program in Wadi Araba including one year for exploration and two years for the feasibility study. Jordan Goverment and Hanbo Group signed a contract at the end of 1993 to carryout this program, but nothing happened up to the time of this report.

4. Preliminary Evaluation of The Deposit

The evaluation of the deposit in this report is limited to a ristricted area (Khirbet El-Jariya-Jabal Marzuka area), which is bounded by the following coordinates in Palestine grid:

N: 012,000- 014,300
E: 191,000- 197,500

It covers an area of about 5 sq. km, (fig. 9).

An exploratory program was planned for copper mineralization in this area (Dec.1995), to undertake a complate exploratory work.

The copper mineralization occur in two horizons, which are the upper horizon and the lower horizon.

4.1- The Upper Horizon

The copper mineralizations occurs in two layers, one of them is immediately above the lower horizon and in contact with it, attainihg a thickness between 0.5-1m.

This layer consists of medium-very coarse (in some places conglomeratic), brown-whitish grey, well cemented sandstone, highly fractured and jointed. In places where the copper mineralizations are present, it has green to deep blue colours. The mineralizations become as coating, filling fractures and as disseminations.

The second layer lies in the middle of the formation (20-25m from the bottom) and attains a thickness between (1-3m). It is made of fine to medium, grey to white sandstone with green shades indicating the copper oxide minerals. The mineralization occurs as lenses, disseminations and filling the bedding planes, and the copper content is about (0.8%).

The dominant copper minerals in both layers are Malachite and Cuprite, and the host rocks are silicates. Porphyry fragments are common in this horizon, where in many places the malachite appears associated with these fragments.

The mineralizations in both layers are discontinuous, hetrogenuos and lens like or patchy, and are eroded in a wide parts of the area, especially the upper layer. For this raeson, and because the copper content is very low, the horizon is excluded from the evaluation.

4.2- The lower Horizon

The copper mineralization starts at the top of the horizon, with an average grade increases downwards, and pentrates the upper part of the dolomite layers. It seems that the lateral distribution of copper content is not affected by the presence of manganese, while the vertical distribution of copper is directly proportional to the manganese content (Nimry, 1967).

The predominant host rocks in this horizon are alumina-silicate, and limestone-dolomite groups. Quartz and clays are also dominant. Iron oxides as (hematite, limonite and geothite) are present, where feldspar and pyrite are present in negligible amount.

The most aboundant copper minerals are Malachite and Chrysocolla. Malachite occurs either disseminated or as replacement and filling the rock mass. It presents in its soft earthy form (pale green colour) or as hard crystalline form (light green colour). Chrysocolla occurs in its a morphous or earthy form, or as staining in the fractures.

There are other copper minerals occur in this horizon with less amount, such as atacamite, planchite and azurite.

Based on the preliminary work and results in the area which gives a thickness of 2m and an average copper grade of 2.3% over an area of 5sq km. The expected copper ore reserve is about 25.40 million tons and the expected copper content in this ore is 0.58 million tons.

5. Conclusions and Recommendations

The results of the analyses indicate that Kherbit El-Nahas-Jariya area is promising and should be subjected to detailed investigation.

In general, the results of analyses indicate good percentages of copper in the area, and continuity of mineralized beds especially in the lower horizon (Burj-Dolomite-Shale Formation).

It worth to mention that the upper horizon is eroded in a wide parts of the area, but when it is not, the thickness, the copper content and the copper occurrence of this horizon is not sufficient to be of economic value.

The results of investigations carried out in the study area (Kherbit El-Nahas-Jariya area) have shown that the area is promising and the following conclusions can be raised.

1. At the beginning of the 1980's, alot of field activities were conducted in the area. It includes drifts, pits boreholes and trenches, but without any recorded documents or reports on the area.

2. The upper copper horizon, (Abu-Khusheiba Formation) is not always mineralized, and eroded in many places.

3. The shale layer (in the main copper horizon Hannah Member) in this area is thicker than the shale in the pilot area. It increases towards the north (from1m in Wadi Khalid to about 2m in Kherbit El-Jariya).

4. The percentage of copper content of the main horizon in the study area is higher than the copper content in the pilot area (58 groove samples give more than 2.3% as an average.

5. In addition to that the upper part of dolomite (Nomayrah Member), which is in contact with the shale layer, has a good copper content (2.0%) with a thickness of about 1m in Jariya and Marzuka areas. Also the last 0.5 m of Abu- Khusheiba Formation has a copper content more than (2.5%). This means that the main horizon in some places becomes thicker and attains about 4m.

The following recommendations are put forward

The track roads in the area should be reconstructed to be accessible again.
In order to calculate the reserve, the following is recommended.

1- It is recommended to drill 6- 8 boreholes to follow up the mineralized horizon.
2- It is suggested to dig 8- 10 pits to depth less than 7m in the mineralized beds near the surface.
3- It is suggested to work 4- 6 trenches in the surface mineralized beds.
4- To follow the Copper horizon, 4- 6 drifts must be driven in Jabal El- Marzuka and Jariya area to a suitable depth.
5- A prefeasibility study is recommended depending on the results.
6- At last, a feasibility study is also recommended.

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