REPORT
ON
THE COOPERATIVE MINERAL EXPLORATION
IN
THE CENTRAL BATINAH COAST AREA
SULTANATE OF OMAN

CONSOLIDATED REPORT

MARCH 1997

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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PREFACE

In response to the request of the Goverment of the Sultanate of Oman, the Japanese Goverment decided to conduct a Mineral Exploration Project in Central Batinah Coast Area and entrusted the project to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

This project was carried out in two years from 1995 to 1996 and completed on schedule with good collaboration of the relevant governmental agencies of the Sultanate of Oman, especially the Ministry of Petroleum and Minerals. This report is a summary of the survey results conducted during these two years.

We hope that this report will serve for the development of the mineral resources and contribute to the promotion of friendly relations between Japan and Oman.

We wish to express our deep appreciation to the officials concerned of the Government of Oman for their close cooperation extended to the team.

March, 1997.

Kimio Fujita
President
Japan International Cooperation Agency

Shozaburo kiyotaki
President
Metal Mining Agency of Japan

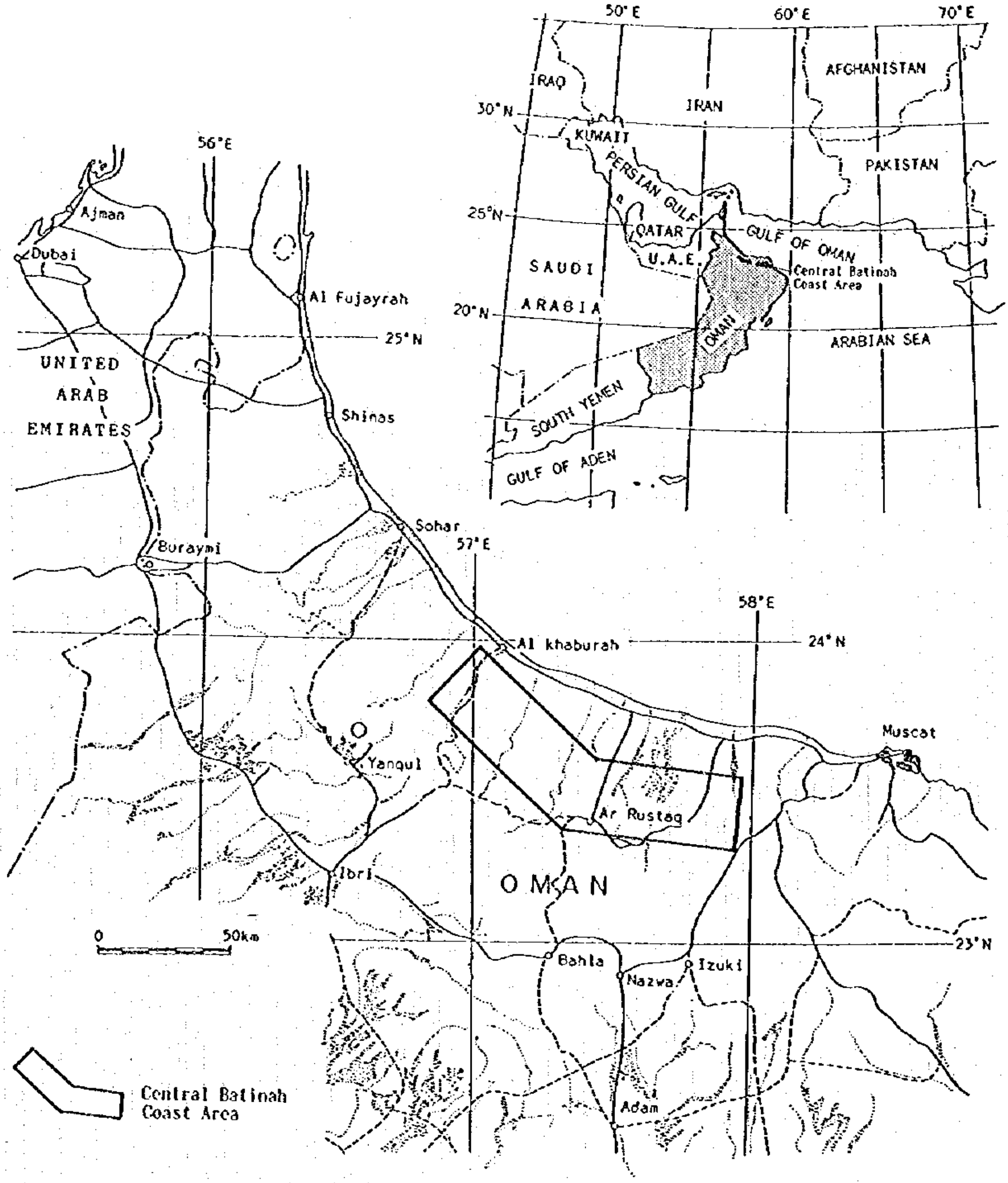

Fig.1 Location Map of the Central Batinah Coast area

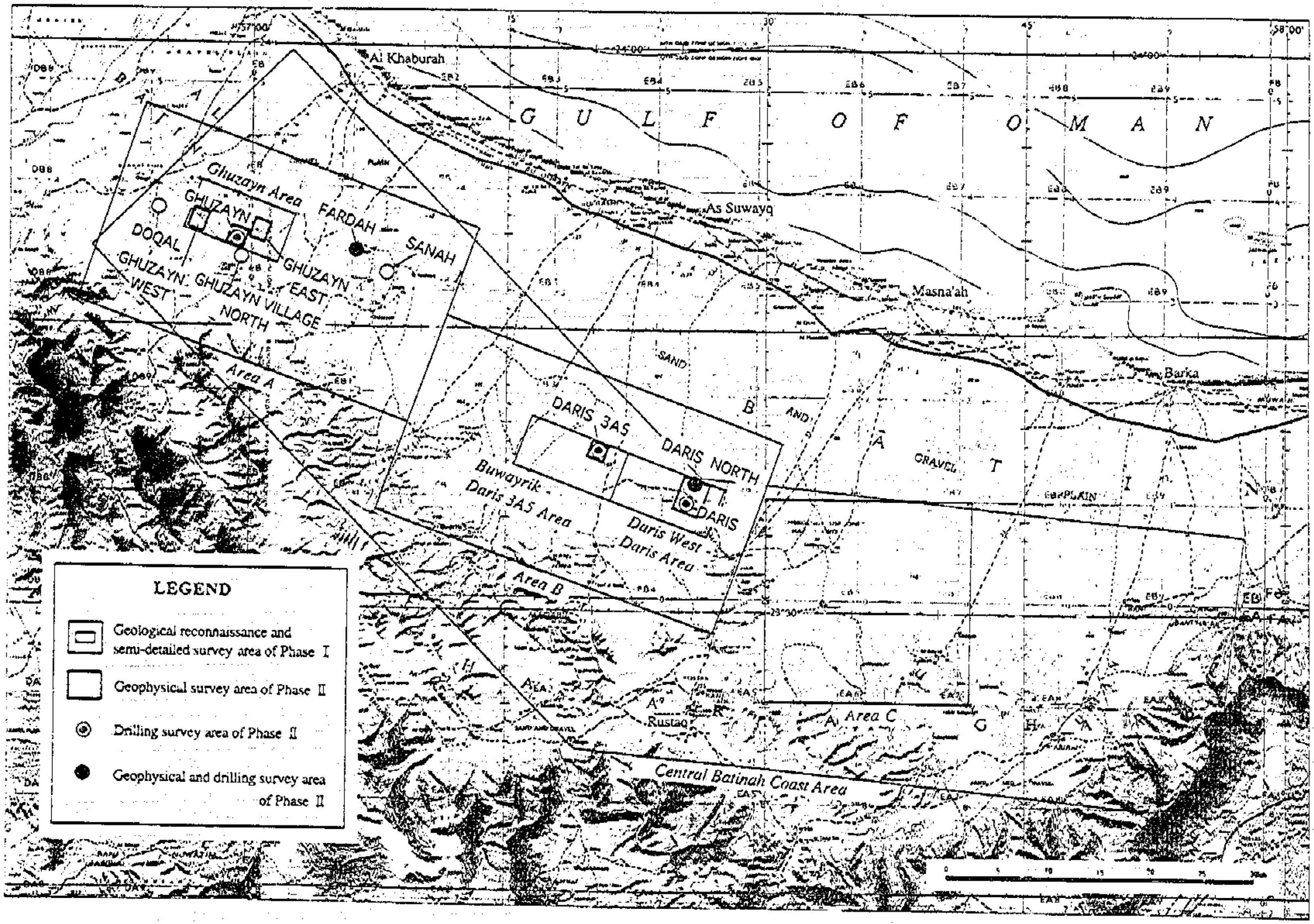

Fig.2 Location map of the survey areas

ABSTRACT

The Government of Sultanate of Oman and the Government of Japan agreed to conduct a mineral exploration project in the Central Batinah Coast area. The Scope of Work for this project was signed by both governments on 7th February,1995. The objective of this project is to explore and assess the mineral potential of the survey area. This consolidated report includes the survey results of the Phase I (1995) and Phase I I (1996).

In the area under study, several exploration works have been already carried out mostly near the known mineral occurrences, however, other parts of the area have been only partially explored because of wide coverage of Quaternary deposits.

In Phase I, reconnaissance and semi-detailed geological surveys and geophysical survey including TDIP and TEM methods were conducted in the area. These geophysical surveys were carried out in Ghuzayn, Daris 3A5 and Daris Areas selected by the semi-detailed geological survey.

Since the massive sulphide deposits occur along a contact between the Lower extrusive rocks 1 and 2 of the Lower volcanic rocks, the contact was traced throughout the areas. Areas A and B show the extensive distribution of the contact zone, however, in the area C, the sheeted dyke was overlain directly by the Middle volcanic rocks without the Lower extrusive rocks 1 and 2 and consequently, the Area C shows a low potencial for economic deposits.

In addition to the known gossan in Ghuzayn, Daris 3A5 and Daris, new gossans were found in Doqal, Fardah, Sanah, north of Ghuzayn village and Qulayyah. The samples in Doqal and Fardah show contents of gold and silver.

TDIP geophysical survey was carried out in the areas of Ghuzayn, Ghuzayn West, Ghuzayn East, Daris 3A5 and Daris. IP anomalies were detected in the north and west of Ghuzayn area, in and around the gossan in Daris. Moreover, a relatively high chargeability zone extending towards west from the gossan was detected in Daris 3A5 area.

TEM survey carried out to confirm the anomalies detected by TDIP survey, resulted in finding TEM anomalies in the north and west of Ghuzayn, and the north and northwest of the gossan in Daris area.

On the basis of the results of Phase I, drilling survey and geophysical survey including TDIP and TEM methods were conducted for Phase II project. The drilling survey was carried out in Ghuzayn, Daris, Daris 3A5, Daris north and Fardah areas; IP survey was carried out in Fardah, Sanah, Ghuzayn village north and Doqal areas, while TEM survey in Ghuzayn, Daris north, Fardah, Sanah and Doqal areas.

Drilling survey conducted in Ghuzayn area intersected massive sulphide ore bodies in two places, i.e., northern and western bodies. The northern body found to the north of gossan, showed a maximum core length of 7.95m with average assays of 4.66% Cu in MJOB-G3 hole. The western body found to the west of gossan,

indicated a maximum core length of 37.1m with average assays of 1.88% Cu in MJOB-G14 hole.

In Phase II, TEM survey in Ghuzayn area resulted in highlighting the extension of massive sulphide ore bodies which were intersected by drilling in two places. The TEM data also show that the western body has an extension of 150m wide in east-west and 300m long in north-south, while the northern body extends 150m wide in east-west and 100m long in north-south. In some other locations, TEM data also provided interesting anomalies considered to be of high potential for massive sulphide ore bodies.

In Doqal area, TEM survey was conducted in order to investigate the high metal factor zone detected during the TDIP survey. Since TEM anomalies were extracted in an area where overlaps the above mentioned high metal factor zone, it can be clearly seen that the area has a high potential for mineralization of massive sulphide.

The above results show that the Central Batinah Coast area has a high potential for bearing massive sulphide deposits. As a continuation of the exploration program for the project, drilling and geophysical surveys are required to confirm the existence of ore bodies and their extensions in Ghuzayn and Doqal areas. Moreover, it is necessary to evaluate the areas showing high metal factors in the central western part of Daris and the areas around Ghuzayn and Doqal.

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PART I GENERAL

PART II SURVEY RESULTS

PART III CONCLUSIONS AND RECOMMENDATIONS

PART I GENERAL

CHAPTER 1 INTRODUCTION

1-1 Background and Objectives

This survey was carried out as a cooperative mineral exploration program in the Central Batinah Coast area of Oman in two years from 1995 to 1996, based on the Scope of Works agreed on 7th February, 1995 between the Government of Japan and the Government of the Sultanate of Oman.

The survey aimed at discovering new mineral deposits in the Central Batinah Coast area by clarifying the geological setting and characteristics of mineral deposits.

Several exploration works were carried out in this area in and around the known mineralization occurrences. However, these works were limited only to the vicinity of mineralization showings and in view of the whole area, very limited portions were merely explored. This is caused by the fact that the area is widely covered by Quaternary sediments. Therefore, it is important for mineral exploration in this area to systematically investigate the underlying part of the sediments.

1-2 Coverage and Outline of Works

The Central Batinah Coast area, the objective area of this survey, is located in the west of Muscat, the capital of the country, and lies between the Oman Mountains and the Gulf of Oman. The survey area is shown in Figs. 1 and 2. The survey procedure of conducted works in the project is summarized in Fig.I-1-1.

In Phase I, reconnaissance and semi-detailed geological surveys and geophysical survey by TDIP and TEM methods were conducted in the area. Geophysical surveys were carried out in Ghuzayn, Daris 3A5 and Daris Areas selected by the semi-detailed geological survey.

In Phase II, geophysical survey by TDIP and TEM methods and drilling survey were conducted on the basis of the results of Phase I. IP survey was carried out in Fardah, Sanah, Ghuzayn village north and Doqal areas; TEM survey in Ghuzayn, Daris north, Fardah, Sanah and Doqal areas, while the drilling survey was carried out in Ghuzayn, Daris, Daris 3A5, Daris north and Fardah areas,.

Survey amounts of the project, as well as the number of the laboratory samples are shown in Table I-1-1.

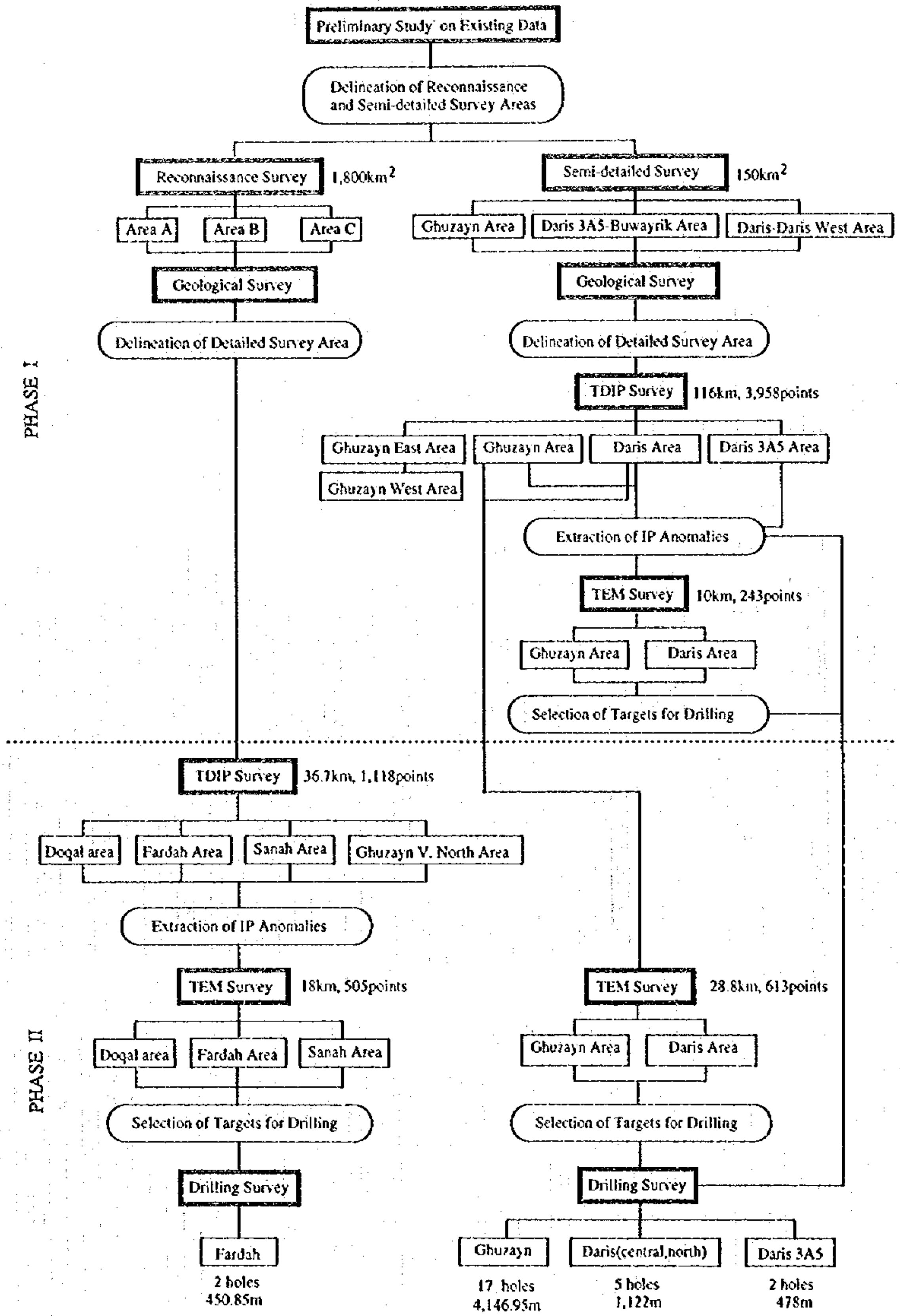


Fig. I-1-1 Flow of the project

Table I-1-1 Amounts of works

	Pase I		Phase II	
Reconnaissance Geological Survey	Area coverage Survey route	1,800 km2 50 km		
Semi-detailed Geological Survey	Area coverage Survey route	150 km2 81 km		
(Laboratory Work)	Thin section Polished section X-ray diffraction Chemical analysis of ore	21 samples 20 samples 22 samples 56 samples		
TDIP Survey	Survey area Line length Measurements Laboratory work	Ghuzayn, Ghuzayn East Ghuzayn West, Daris Daris 3A5 116 km 3,958 poins 21 samples	Survey area Line length Measurements Laboratory work	Doqal, Fardah, Sanah Ghuzayn village north 36.7 km 1,118 points 20 samples
TEM Survey	Survey area Line length Measurements	Ghuzayn Daris(central) 10 km 243 points	Survey area Line length Measurements	Ghuzayn, Fardah Sanah, Doqal Daris(north) 46.8 km 1,018 points
Drilling Survey			Ghuzayn area Daris area (central, north) Daris 3A5 area Fardah area (Total amount)	17 holes, 4,146.95 m 5 holes, 1,122.00 m 2 holes, 478.00 m 2 holes, 450.85 m (26 holes, 6,197.80 m)
(Laboratory Work)			Thin section Polished section X-ray diffraction Chemical analysis of ore	30 samples 12 samples 20 samples 325 samples

1-3 Members of the Project

(1) Project planning and negotiation

Japanese Counterpart

Atsuhiko Minowa	Metal Mining Agency of Japan
Nobuyasu Nishikawa	Metal Mining Agency of Japan
Kazuko Matsumoto	Japan International Cooperation Agency

Omani Counterpart

Mohammed bin Hussain Kassim	Ministry of Petroleum and Minerals
Hilal Mohamed SAultan Al-Azri	Ministry of Petroleum and Minerals
Said Salim Al Fori	Ministry of Petroleum and Minerals
Salim Omer Abdullah Ibrahim	Ministry of Petroleum and Minerals

(2) Inspection of field work

Kenji Nakamura	Metal Mining Agency of Japan
Katsuhisa Ono	Metal Mining Agency of Japan

(3) Field work

Japanese Counterpart

Yoshiaki Shibata	Team leader	Bishimetal Exploration Co., Ltd.
Mikio Kajima	Drilling survey	Bishimetal Exploration Co., Ltd.
Motomu Goto	Geological survey	Bishimetal Exploration Co., Ltd.
Toshimasa Tajima	Geophysical survey	Bishimetal Exploration Co., Ltd.
Escobar David	Geophysical survey	Bishimetal Exploration Co., Ltd.
Junichi Sasaki	Geophysical survey	Bishimetal Exploration Co., Ltd.
Tosio Kasagi	Geophysical survey	Bishimetal Exploration Co., Ltd.
Takeharu Takahashi	Geophysical survey	Bishimetal Exploration Co., Ltd.
Susumu Endo	Geophysical survey	Bishimetal Exploration Co., Ltd.

Omani Counterpart

Salim Omer Abdullah Ibrahim	Director	Ministry of Petroleum and Minerals
Mohammed Salem Al-Battashi	Geologist	Ministry of Petroleum and Minerals
Hussain Abubaker Al-Zubaidy	Geophysicist	Ministry of Petroleum and Minerals
Durair Ismail A'Shaikh	Geologist	Ministry of Petroleum and Minerals
Mohammed Salieh Hammed Al-Araimi	Geologist	Ministry of Petroleum and Minerals

1-4 Survey Period

The field work and compilation activities were conducted in Oman during the period shown below.

Phase I

Geological survey:	October 10, 1995	to	January 9, 1996
Geophysical survey:	October 10, 1995	to	January 9, 1996

Phase II

Drilling survey:	July 9, 1996	to	December 26, 1996
Geophysical survey:	September 17, 1996	to	December 7, 1996

CHAPTER 2 GEOGRAPHY OF THE SURVEY AREA

2-1 Location and Access

The sultanate of Oman is situated in the southeast corner of the Arabian Peninsula and having an area of about 300,000 km^2. The population is approximately two millions and the capital city is Muscat (Fig. 1).

The survey area is located in the west of the capital city of Muscat and has an extension of about 3,300 km^2 running parallel to the Oman Mountains and the Gulf of Oman. The center of the investigation area has approximately a latitude of 23°30'N and a longitude of 57°30'E. It takes about 1.5 hours by vehicle for 130 km driving along coast line from Muscat to As Suwayq, near the central part of the survey area.

2-2 Topography and Drainage System

The survey area consists of a hilly land between an altitude of about 100m and 1,000m, forming the foot of the Oman Mountains and a coastal plain along the Gulf of Oman (Batinah Coast Plain).
Dry rivers, so-called wadis, run almost N-S in the Batinah Coast Plain from hilly land in the south to the Golf of Oman. Major wadis are in order from east to west: Wadi Ajal, Wadi Bani Kharus, Wadi Ma'awil, Wadi al Abiad, wadi Far, Wadi al Hawoayn, Wadi Wadiyah, Wadi Mabrah, Wadi Halhal and Wadi al Hawasinah.

2-3 Climate and Vegetation

Climate of the Batinah Coast Plain is semi-dry type, though it presents high temperature and some humidity because it is separated from the desert region by the Oman Mountains. As the humidity coming from the sea is stopped by the Oman Mountains, usually rain falls in the mountain region in winter season. The infiltrated water from the rain is supplied to coastal plain, so that many kinds of vegetables are cultivated there in addition to the representative agricultural products of Oman such as lime, mango, tobacco, etc. However, excepting cultivated land, vegetation is very scarce and the vegetation of acacia, etc. is observed only in and around the wadis.

The temperature in summer season (April to October) averages 40°C and sometimes goes up to 50°C. Humidity is 40% during daytime but goes up to nearly 100% during night time. The average temperature in winter season (November to March) is approximately 25°C.

CHAPTER 3 GEOLOGY AND ECONOMIC GEOLOGY OF THE CENTRAL BATINAH COAST AREA

3-1 General Geology

Geology of the project area according to 1: 250,000 geological map published by Ministry of Petroleum and Minerals, as shown in Fig.I-3-1, consists of Pre-Late Permian Basement and Hajar unit of Autochthonous to Parautochthonous units, Hawasinah Nappe and Samail Nappe assumed to have thrust over the Autochthonous to Parautochthonous units, Post-Nappe units and Quaternary sediments, which are distributed in this order from south to north.

Pre-Late Permian Basement crops out in the western edge of the area and composed of basaltic and andesitic pillow lavas.

Hajar unit covers the eastern edge and south central part of the area and consists of the Late Permian Akhdar Formation comprising of limestone and dolomite, the Jurassic Sahtan Formation comprising of sandstone and limestone, the Jurassic to Cretaceous Kahmah Formation of limestone beds, the Cretaceous Wasia Formation of limestone beds and the Cretasious Muti Formation consisting of conglomerate, breccia, limestone, sandstone and chert.

Hawasinah Nappe is composed of the Late Permian to Jurassic Baid Formation and Hamrat Formation distributed in the western edge and south central of the area, and of the Triassic Umar Formation cropping out mainly in the northern part of the area. The Baid Formation consists of carbonate rocks, the Hamrat Formation consists of quartz sandstone, shale, chert, limestone, basalt, andesite and keratophyre, and the Umar Formation consists of chert, limestone and breccia.

Samail Nappe is mostly composed of Ophiolite(Samail Ophiolite) and extensively distributed in the area. Succession of the Samail Ophiolite, is described as follows:

(Bottom) (1) Tectonites
(2) Cumulate sequence
(3) High-level gabbro
(4) Sheeted-dyke complex
(Top) (5) Samail volcanic rocks;

Post-Nappe units consist of the Upper Cretaceous Aruma Formation and Tertiary Hadhramut Formation, and are cropping out along a line almost parallel to the coastal line.The Aruma Formation is composed of polymict conglomerate and marl and the Hadhramut Formation is composed of limestone, carbonate rocks and marl.

Quaternary sediments are comprised of fan deposits, terrace deposits and stream sediments, and are well exposed in the northern side of the area.

Principal geologic structure of the area is the piled-up structure formed in the time when the Samail Nappe was detached from the ocean floor and obducted over the Arabian platform during the Late Cretaceous Alpine orogenic cycle. The Samail Nappe in the area consists of two blocks which are the Haylayn block in the west and the Rustaq block in the east, and is divided by faults trending northeastly. Many thrust faults are found in the area and constitute boundaries of structural and tectonic units of the Samail nappe, such as Tectonite - Cumulate Sequence - Sheeted dyke Complex - Volcanic rocks.

3-2 Mineralization and Mining Activities

3-2-1 Mineralization

Occurrences of copper deposits, being the main target of the project are schematicaly shown in Fig.I-3-2.

The massive sulphide deposits in the Oman Mountains are situated in the lower part of the Samail Volcanic Rocks and are classified into the Cyprus-type copper deposits. In general, the Cyprus-type copper deposits are understood to be formed on sea-floor and accompanied with basic volcanics in footwall.

Major Cyprus-type copper deposits in Oman Mountain consist of Lasail and Baida deposits in the Sohar area, Rakah and Hayl as Sahil deposits in the Rakah area. The Lasail deposit is of large scale, and its general features are as follows:

(1) The Lasail deposit occurs along the contact between the Lower extrusive 1 and 2, near a major fault (Lasail Fault) and extends in a NNW-SSE direction, parallel to the fault.

(2) The massive ore zone shows an elongated saucer shape, with a maximum thickness of about 50m at its proximal part, with maximum lengths of 600m and 300m along N-S and E-W directions, respectively.

(3) The deposit is dominated by an abundance of pyrite and chalcopyrite with minor sphalerite, magnetite, hematite, quartz and gypsum.

(4) These minerals mentioned above, represent a distinct zonal arrangement, where chalcopyrite and pyrite are dominant in the proximal zone , while sphalerite, magnetite and hematite are predominant in the distal zone.

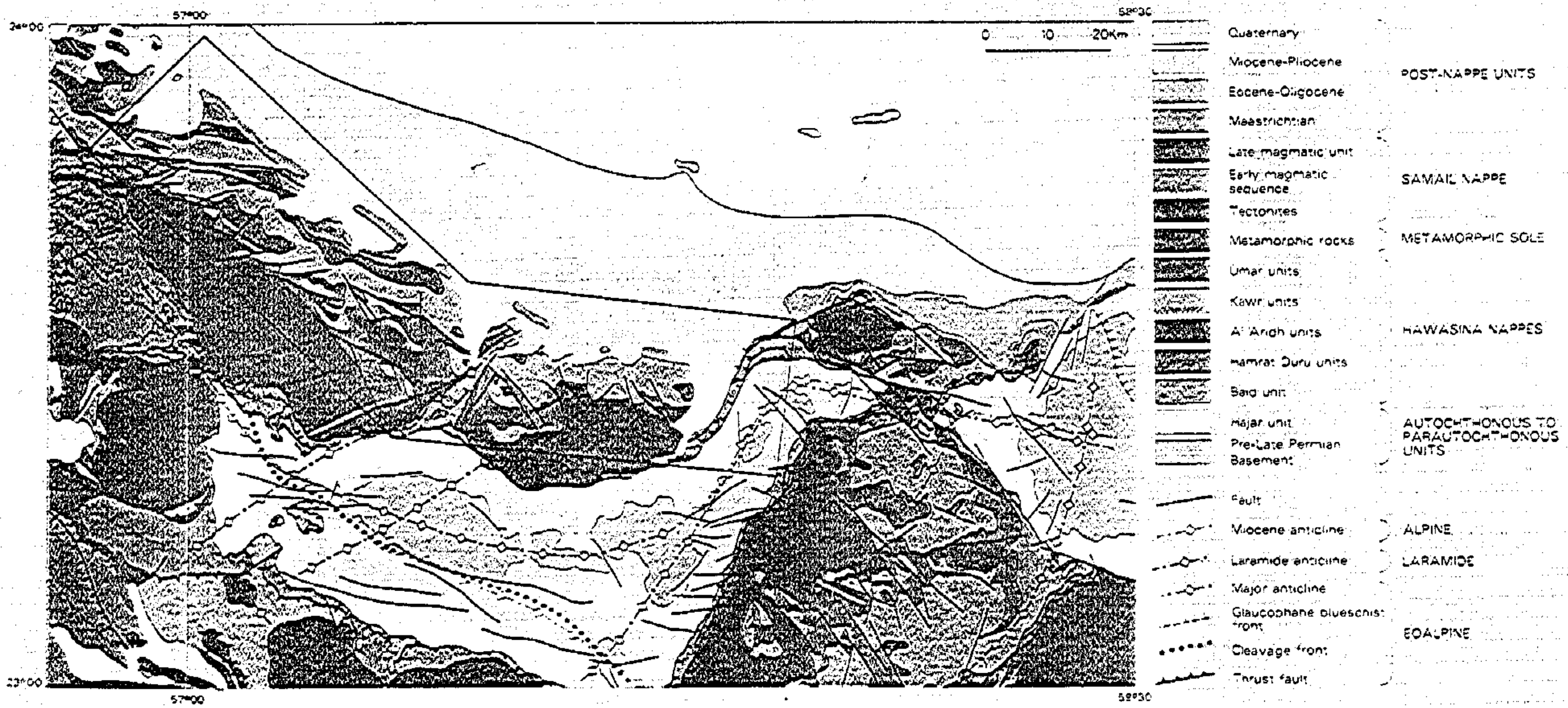
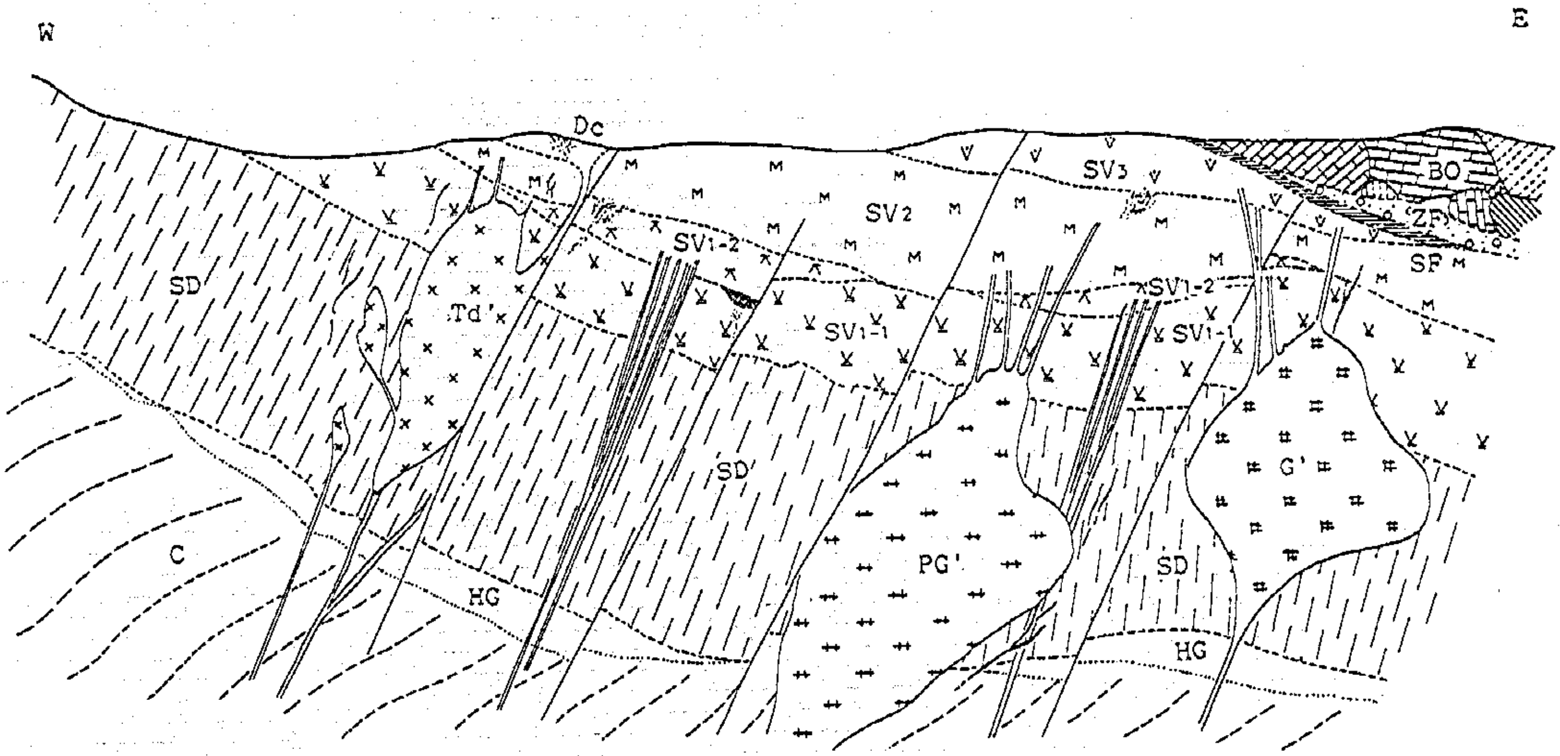


Fig.I-3-1 Geologic map of the Central Batinah Coast area



C : Cumulate sequence
HG: High-level gabbro
SD: Sheeted-dyke complex
SV1-1 : Lower extrusives 1
SV1-2 : Lower extrusives 2
SV2 : Middle volcanic rocks

Dc : Dacite
SV3: Upper volcanic rocks
SF : Suhaylah formation
ZF : Zabyat formation
BO : Batinah olistostrome
G' : Gabbro

PG': Peridotite and gabbro complex
Td': Trondhjemite
(symbol) : Massive type mineralization
(symbol) : Vein type mineralization
(symbol) : Stockwork/dissemination type mineralization

Fig.I-3-2 Schematic distribution of Samail Volcanic Rocks and mineralization in Sohar area

3-2-2 Brief history of mining

The Oman Mountains region in the northern part of Oman is known as a major producer of copper during the era of Mesopotamia. It is been said that the exploitation and smelting of copper in the ancient times continued up to around 940 A.D. of the early era of Islam. The copper deposits operated in that period are presumed to be the same as the current exploitation level of the Lasail mine and Rakah deposit and a great volume of slag and ancient smelter sites can be observed in this area even at the present days.

The modern exploration activity, mainly aimed to copper deposits in the Oman Mountains, commenced by Prospection Ltd. of Canada in the decade of 1960. Presently known deposits of Lasail, Bayda, Aarja in Sohar area and Hayl as Sahil and Rakah deposits in Rakah area were explored at that period up to diamond drillings, confirming the existence of those deposits.

In the decade of 1970, the Government of Oman purchased the title of property owned by Prospection Ltd. and started the mine development in Sohar area. Consequently in 1983, the operations of Lasail and Bayda mines and Sohar copper smelter were commenced by OMCO(Oman Mining Company) which was established and fully owned by the Government of Oman. The capacity of this smelter has a copper metal production of 24,000 tons per year.

For the purpose of keeping a stable supply of raw material to the Sohar smelter, the Government of Oman awarded in 1984, through international tender, to Bishimetal Exploration Co., Ltd. a contract for a copper exploration program in an area of 8,000 km^2 surrounding the Sohar smelter. Investigations were carried out for a period of 4 years up to 1987 and some ore reserves were newly obtained in and around the known deposits, and at the same time, many mineralized zones were confirmed.

On the other hand, BGRM of France was awarded in 1983, a project of geological mapping in the northern Oman Mountains region by the Government of Oman and carried out such works until 1985.

During the course of their mapping program, a zone of large scaled gossan was discovered together with the confirmation of several mineralized zones near the village of Hayl as Safil, located at the foothills of the Oman Mountains.

The Government of Oman awarded in 1985 to BRGM a contract until 1986 for the exploration of 13 major copper mineralized zones discovered in the course of mapping. As a result, the existence of a massive sulphide deposit was confirmed in the gossan zone near the village of Hayl as Safil. The objective areas of the present cooperative mineral exploration program, such as Ghuzayn, Buwayrick, Daris West, Daris 3A5, Daris and Al Ajal were included in the above mentioned 13 mineralization zones.

In 1988, the Government of Oman requested to the Government of Japan to investigate the possibility of developing the Hayl as Safil and the Rakah deposits. In response to such request, the Government of Japan carried out a Cooperative Mineral Exploration Program and a Regional Development Plan through Japan International Cooperation Agency (JICA) and Metal Mining Agency of Japan (MMAJ) in order to study the possibility of mining development in this area.

On the other hand, in 1988 OMCO commenced the mine development of Arja deposit in Sohar area by supplying raw material to the Sohar smelter due to the exhaustion of ore reserves at Lasail and Bayda mines. However, the Arja deposit was mined out in 1993 and as such, the smelter operates by the purchased ore from abroad. The total production and grade of closed mines are as follows:

Lasail Mine	9,183,677	tonnes	1.42% Cu
Aarja Mine	2,561,887	tonnes	0.97% Cu
Bayda Mine	790,891	tonnes	1.60% Cu
Lasail West Mine	434,478	tonnes	1.02% Cu

From the above mentioned background, the Government of Oman and OMCO are aggressively continuing exploration activities for the development of the domestic mines. Especially, in Hayl as Safil deposit, intensive exploration works has been carried out and three satellite ore bodies which are Al Jadeed, Al Asgher and Al Bishara have been confirmed in the periphery of the main deposits. The ore reserves and grade obtained by these exploration activities are about 11 millions tonnes with 1.44% Cu and 0.73g/t Au including Hayl as Safil deposit, its satellite ore bodies and Rakah deposits.

In 1994, Rakah gold mine started the operation utilizing gold rich gossan near surface and has been produced about 500kg gold annually.

Furthermore, to reconsider the results of the exploration works already carried out, the Government of Oman conducted an airborne magnetic survey in the northeastern side of the Oman Mountains from 1990 to 1992, and as a result, magnetic anomalous zones related to mineralization were delineated.

On this basis and since 1995, the present cooperative project commenced by conducting mainly investigations of geophysical and drilling surveys.

CHAPTER 4 SURVEY RESULTS

4-1 Geological Survey Results

Previous studies on massive sulphide deposits in Oman corresponding to Lasail and Bayd deposits in Sohar provide the ideas as a survey hypothesis, in which the geological survey was carried out on the following two important hypothesis:

(1) The deposit shows a stratigraphic control and occurs along a contact between the Lower extrusive rocks 1 and 2 of the clasification by Bishimetal (1987).

(2) The central part of large deposits shows relatively low magnetic value caused by the demagnetization related to alteration. It is expected that the magnetic values will provide more information to define interesting areas.

About the magnetic features of (2), significant magnetic contact zones probably related to alteration were extracted in the area by the airborne geophysical survey carried out by Ministry of Petroleum and Minerals from 1990 to 1992, as shown in Fig.I-4-1 and I-4-2. Therefore, the areas in and around these magnetic contact zones were considered to be the most potencial areas and as a result, the areas area-A, area-B and area-C were selected for the survey area in Phase I. Within these areas, moreover, the areas around known copper occurences were chosen as a semi-detailed survey area.

4-1-1 Reconnaissance survey

A reconnaissance geological survey was conducted in the Areas-A, -B and C to clarify and confirm the mineralization in the areas. The discussion on the relationship between mineralization and significant magnetic contact zones was also made during the survey.

Since the massive sulphide deposits occur along a contact between the Lower extrusive rocks 1 and 2 of the Lower volcanic rocks, the contact was traced throughout the areas and its distribution was clarified. Area A and B show the extensive distribution of the contact zone, however, in the Area C, the sheeted dyke was overlain directly by the Middle volcanic rocks without the Lower extrusive rocks 1 and 2 and consequently, the Area C can be excluded for further mineral exploration work.

In addition to the known gassan in Ghuzayn, Daris 3A5 and Daris, new gossans were found in the Doqal, Fardah, Sanah, north of Ghuzayn village and Qulayyah.

Magnetic contact zones were extracted from all the areas where gossans were formed and they gave a useful information for exploration purposes. Other zones, however, were also extracted in the area where no

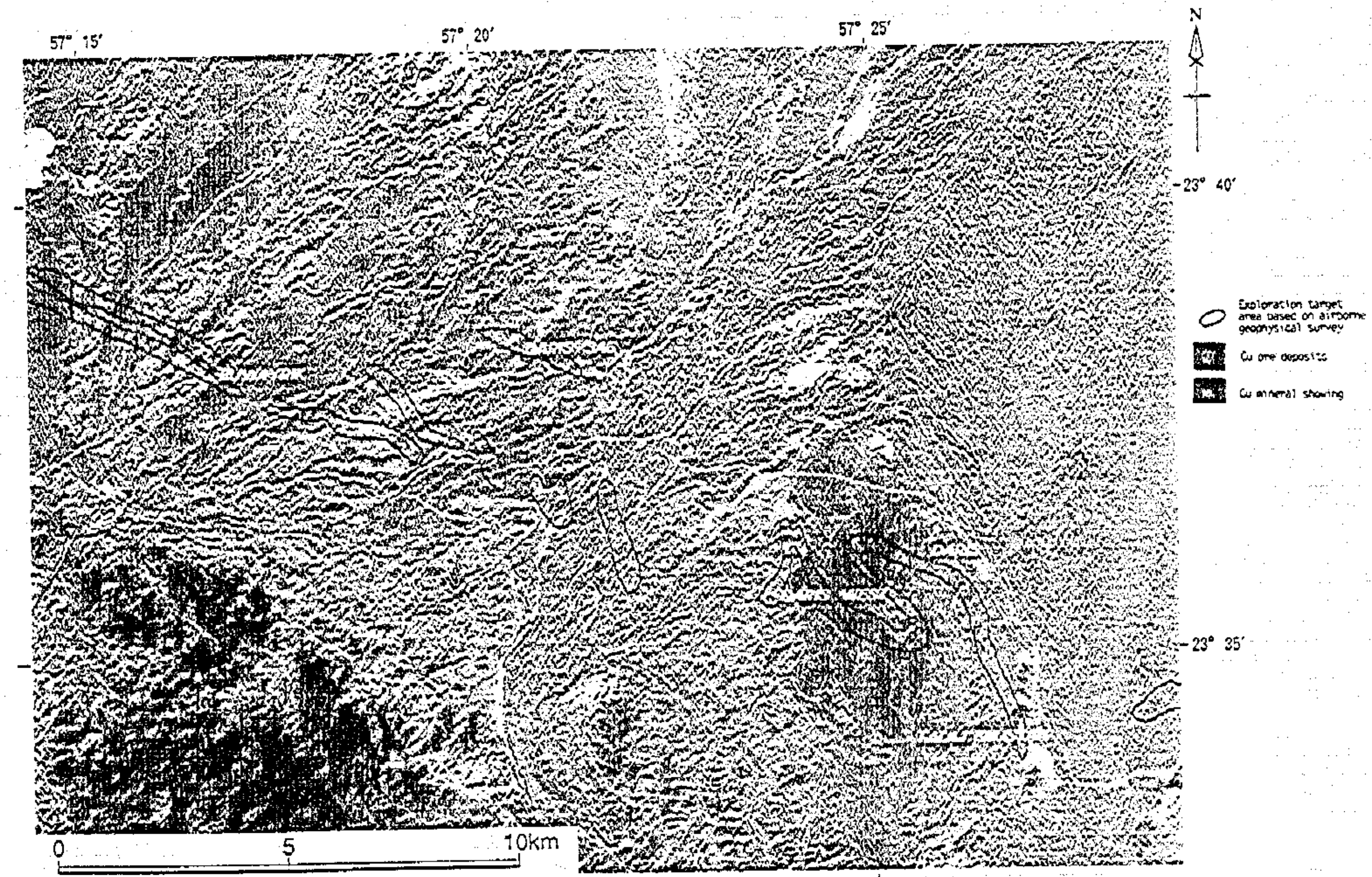


Fig.I-4-1 Significant magnetic contact zone on Landsat image in the central survey area

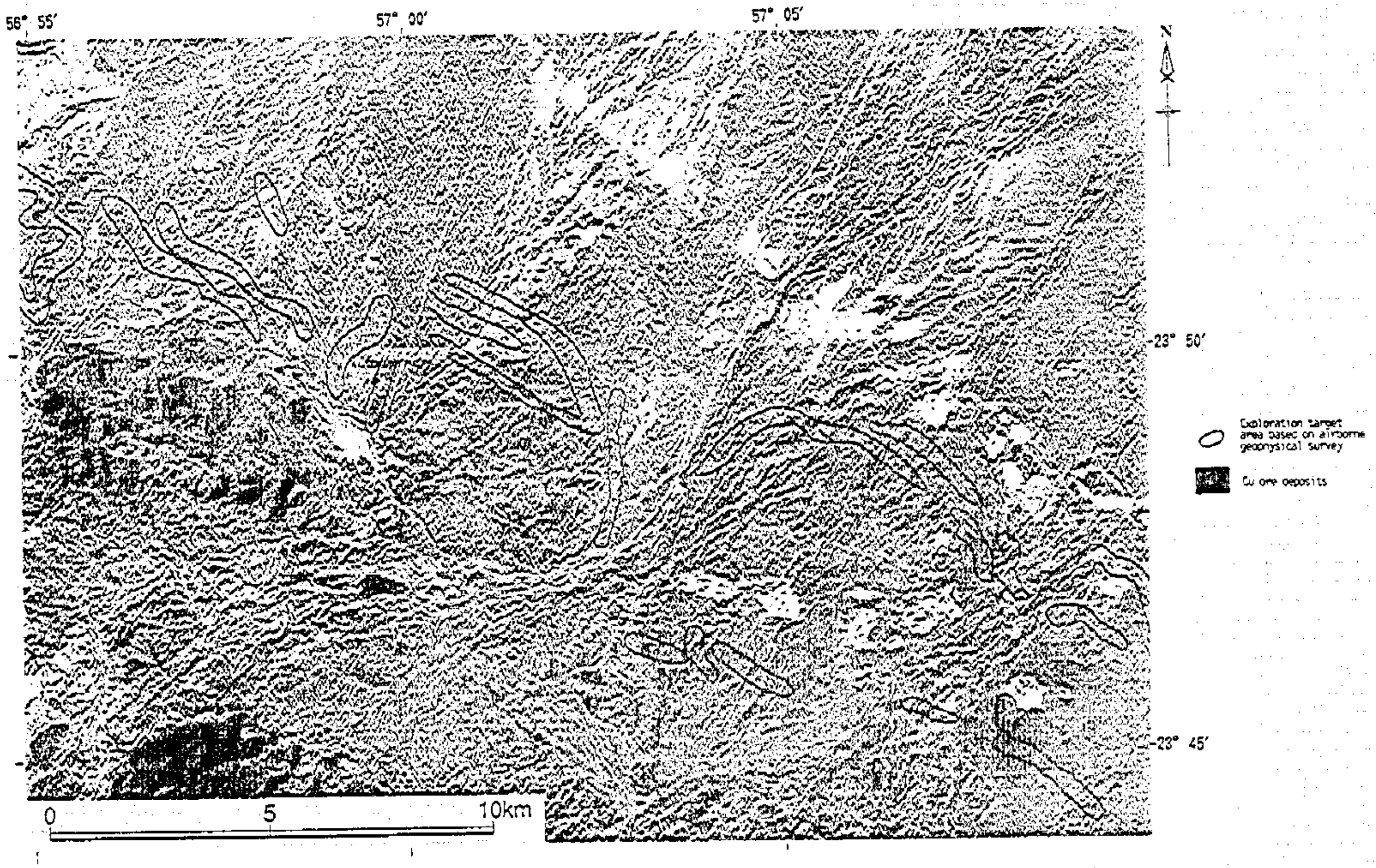


Fig.I-4-2 Significant magnetic contact zone on Landsat image in the western survey area

favorable geologic features for copper mineralization can be observed. Some of these zones were only useful to clarify the flow boundaries of volcanic rocks.

4-1-2 Semi-detailed survey

Semi-detailed geological survey was conducted in Ghuzayn area in Area-A and Buwayrik- Daris 3A5 area and Daris-Daris west area in Area-B in order to clarify the mineralization in the area and evaluate the potencial of copper deposits.

The following items were clarified during the survey.

(1) The main gossan in Ghuzayn has the scale of 200m in east-west direction and 400m in north-south direction and emplaced in the Lower extrusive rocks 2 (V1-2) close to the boundary with the Lower extrusive rocks 1 (V1-1).

(2) In the Ghuzayn area, several copper bearing quartz veins with some length were found in the east and a gossanized basalt lava of the Lower extrusive rocks 1 (V1-1) was observed in the west.

(3) The gossan of Daris 3A5 prospect is emplaced in the Middle volcanic rocks (V2).

(4) The Buwayrik prospect shows only slight silicification and no favorable geologic features for copper mineralization can be observed.

(5) The gossan of Daris prospect is emplaced in the Lower volcanic rocks (V1-2) with the size of 10m x 30m on the surface.

(6) Only pyritization in some dykes of the Sheeted dyke unit was observed in the Daris West prospect and no favorable geologic features for copper mineralization can be seen.

4-2 Geophysical Survey Results

The geoelectrical structure reflected by massive sulphide deposits is characterized by high chargeability and low resistivity. In this regards, the geophysical methods TDIP and TEM are quite effective for prospecting sulphide deposits.

The TDIP method has the advantage of measuring at the same time the two parameters of chargeability and resistivity, and as such, it is an effective method to delineate mineralized zones by covering a wide area through the spreading the survey lines on the area. However,one of the weak points of the IP method is its ability to measure the IP parameters only along lines, therefore,if deeper exploration depth is wanted due to a deep target, the resolving power decreases more and becomes in this way, more difficult to determine the place of the source of the anomaly. On the other hand, since the TEM method is sensitivity to the electrical response from the underground structure below the observed station, this method may assist in defining more clearly the conductive zones such as massive sulfide deposits.

For these reasons, we used TDIP method as a reconnaissance survey to extract any existing sulphide mineralization, and TEM method as a detailed survey to delineate the most promising locations for drilling survey.

4-2-1 TDIP Survey

The TDIP geophysical survey method was carried out in order to detect chargeable zones which could arise from sulphide and associated mineralization in Ghuzayn, Ghuzayn East, Ghuzayn West, Ghuzayn village north, Doqal, Daris and Daris 3A5, whose areas were selected due to the results of the geological survey.

In Ghuzayn,a high chargeability zone was detected in the cental part of the area surrounding the main gossan, in which several high metal factor zones associated with low resistivities were delineated as promising locations.

In Daris area, a distinctive high chargeability zone was widely detected to the north of the gossan,and several high metal factor locations were delineated at the margin of a high chargeability zone. A high metal factor zone trending along a NW-SE direction was also detected in the northern part of the area. The TDIP results in Daris area are shown in Fig.I-4-4.

In Doqal area,a high chargeability anomaly of large extension is delineated in the central part of the area, which is accompanied by a low resistivity anomalous zone. Metal factors calculated from chargeability and resistivity data show high values in the central part which appears to extend in a north-south direction. The results are shown in Fig.II-4-3.

In both, Fardah and Sanah areas, a remarkable low resistivity anomalous zone was extracted at the north of an argillized gossan trending east to west. Chargeabilities, however, show only low values in the area covered by extrusive rocks and consequently, only oxidized ore body can be expected in these areas.

In Daris 3A5, even though some difficulties appeared during the survey due to the extremely low resistivities, relatively high chargeability zones were delineated trending to the west from the gossan.

For the area of Ghuzayn West, Ghuzayn East and Ghuzayn village north, no significant IP anomalies are found in the area covered by extrusive rocks, therefore, no further investigation is envisaged in this area.

4-2-2 TEM Survey

TEM survey was carried out in Ghuzayn, Daris and Doqal areas where high metal factor anomalies of wide distribution were delineated by TDIP survey. TEM survey was also conducted in Fardah and Sanah areas, where low resistivity zones were extracted by TDIP survey in order to clarify the resistivity structure and delineate the target locations for drilling survey.

TEM data acquired from Ghuzayn area highlighted the extension of massive sulphide ore bodies which were discovered in two places by drilling conducted in Phase II, showing that the western body has an extension of 150m wide in east-west and 100m long in north-south direction and that the northern body extends 150m wide in east-west and 100m long in north-south. In addition, TEM data reveal also three

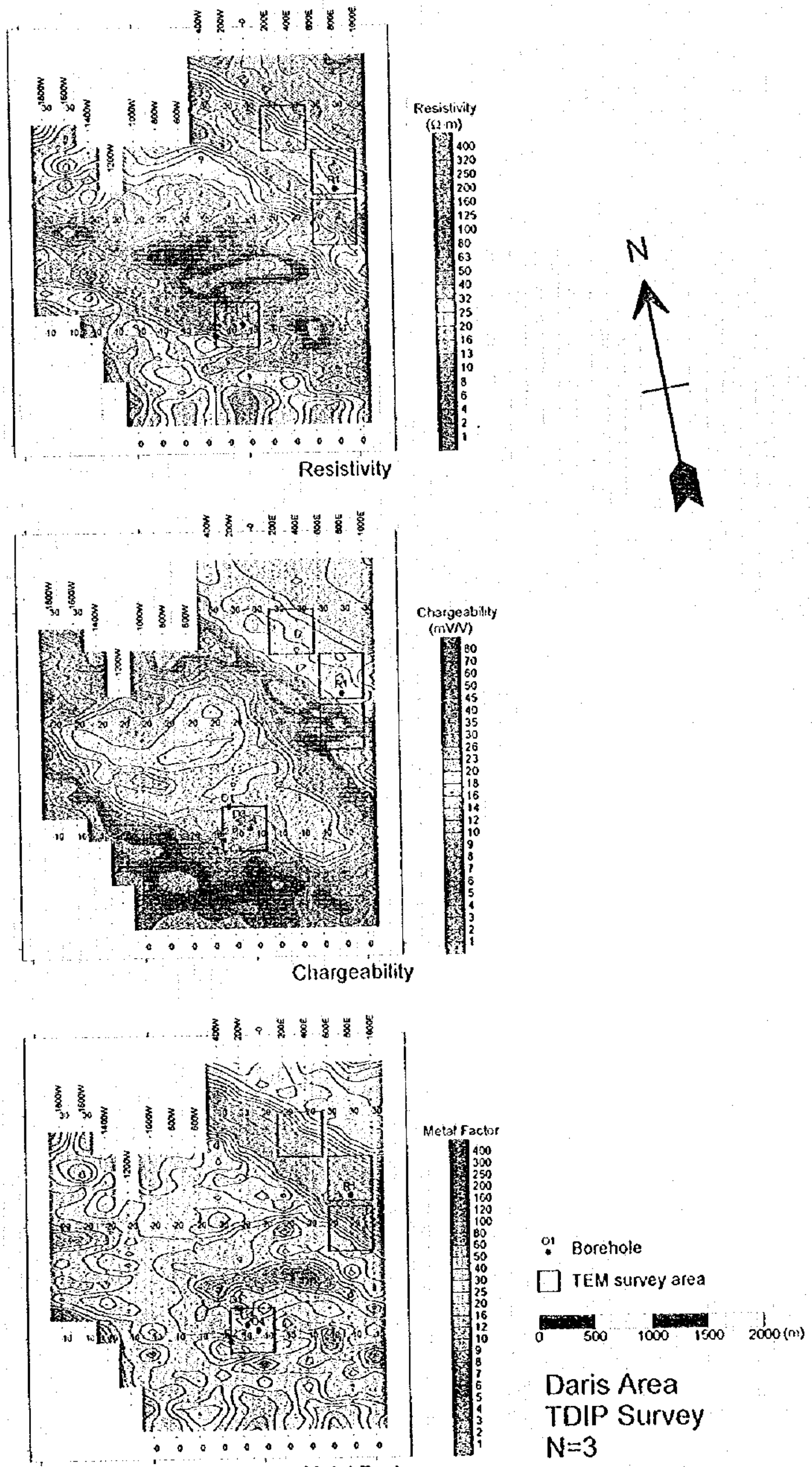


Fig.I-4-3 IP plane map in Daris area

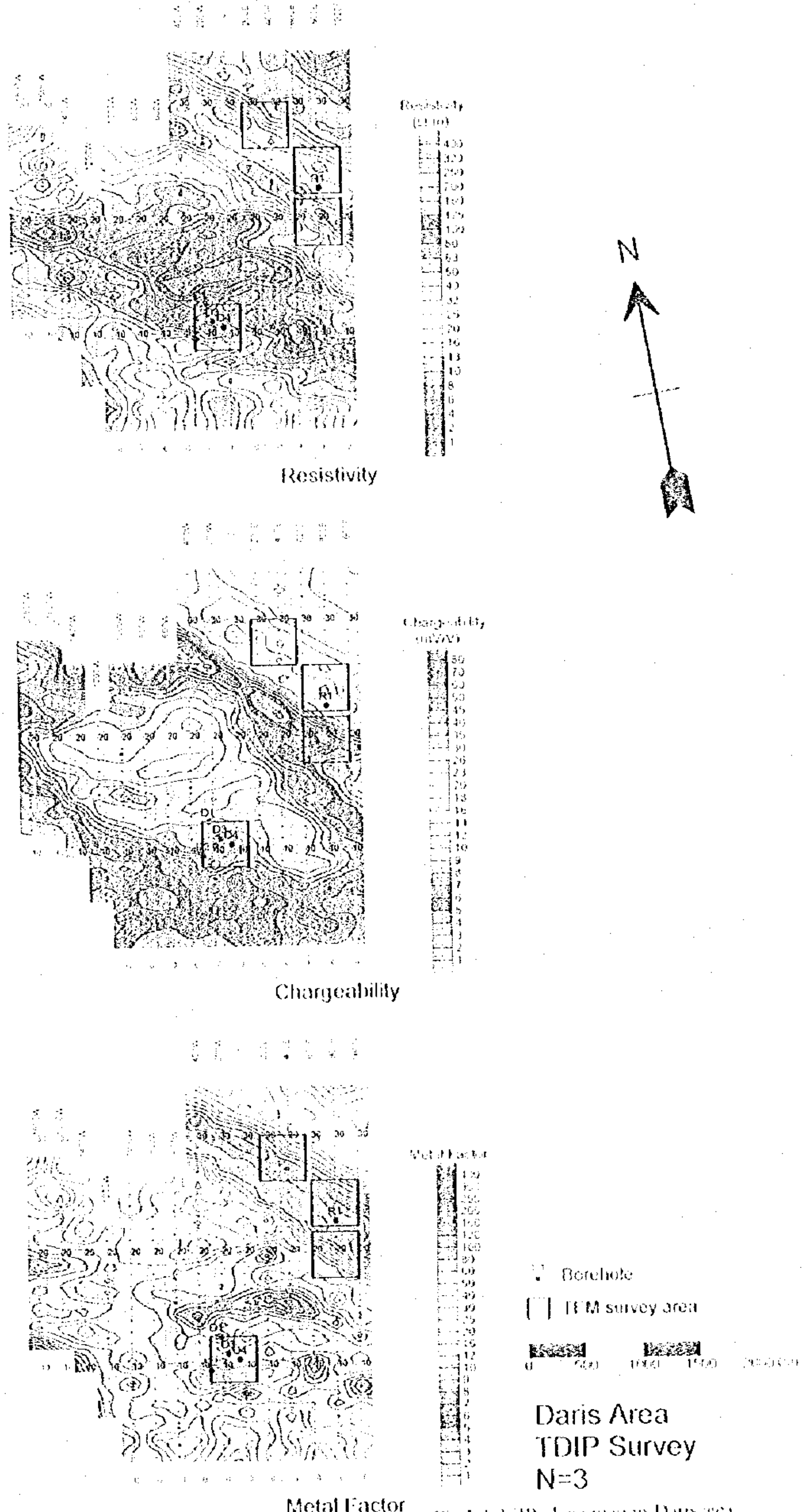


Fig.I-4-3 IP plane map in Daris area

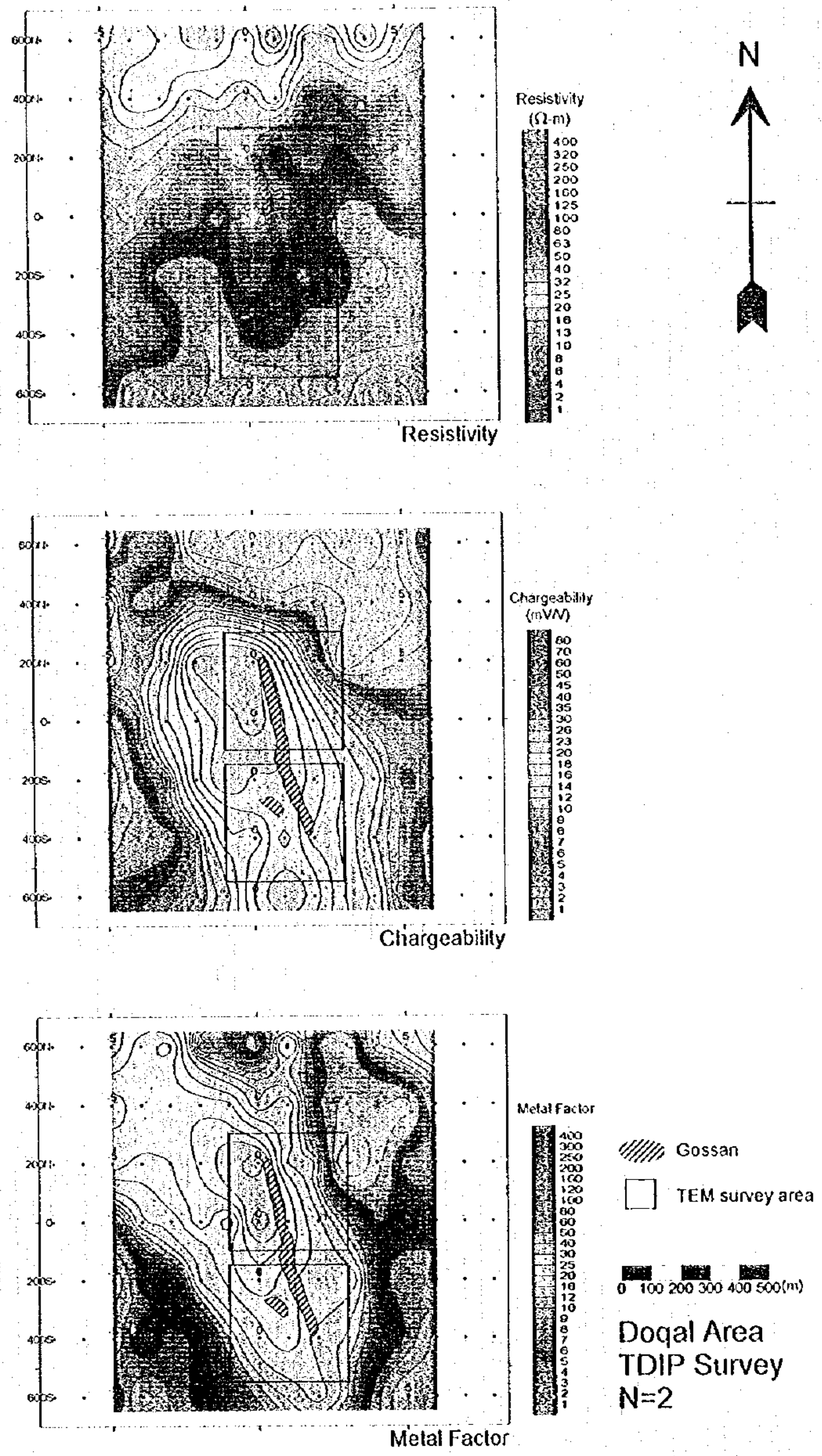
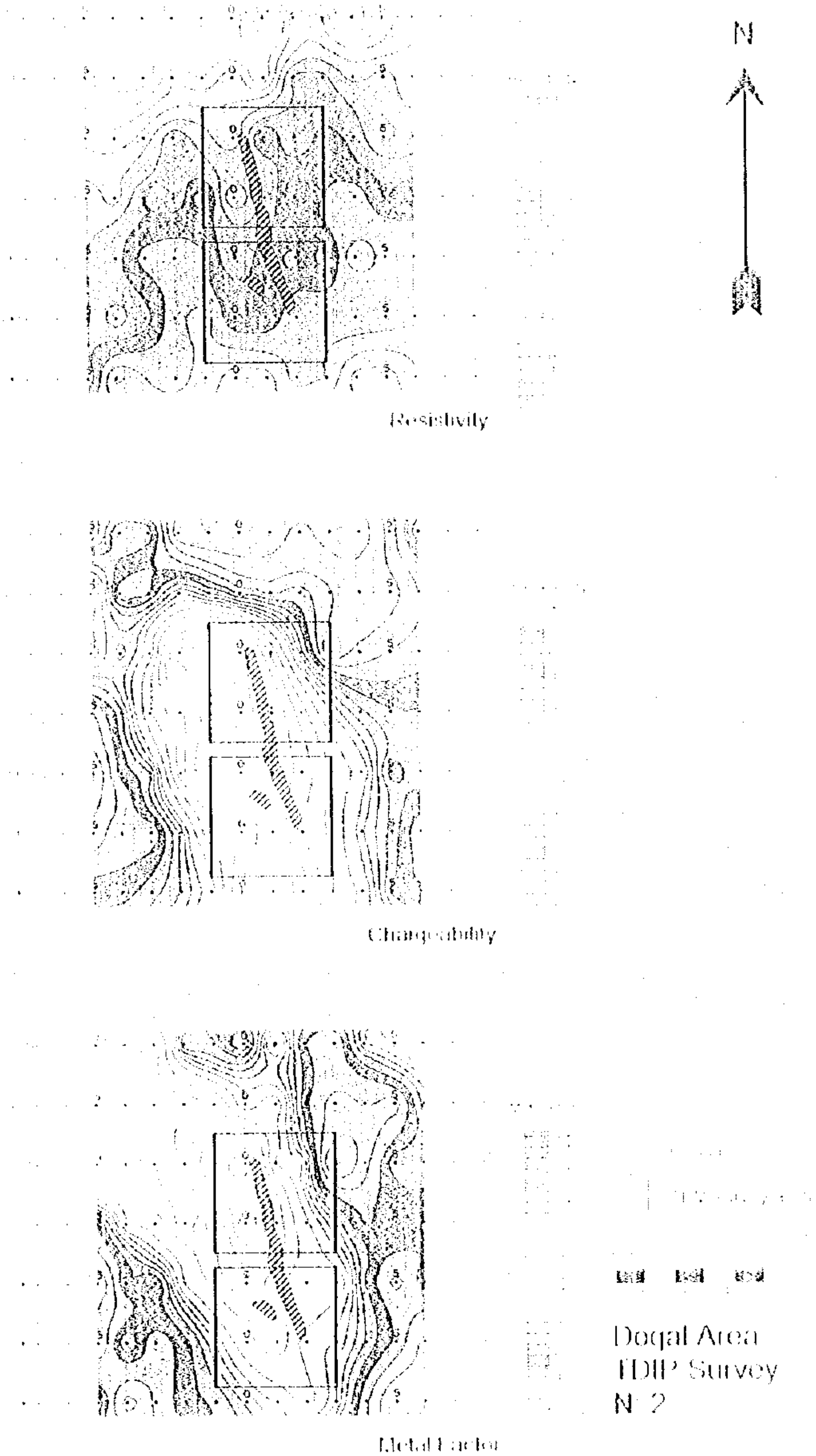


Fig.I-4-4 IP plane map in Doqal area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Resistivity
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Metal Factor
Doqal Area
TDIP Survey
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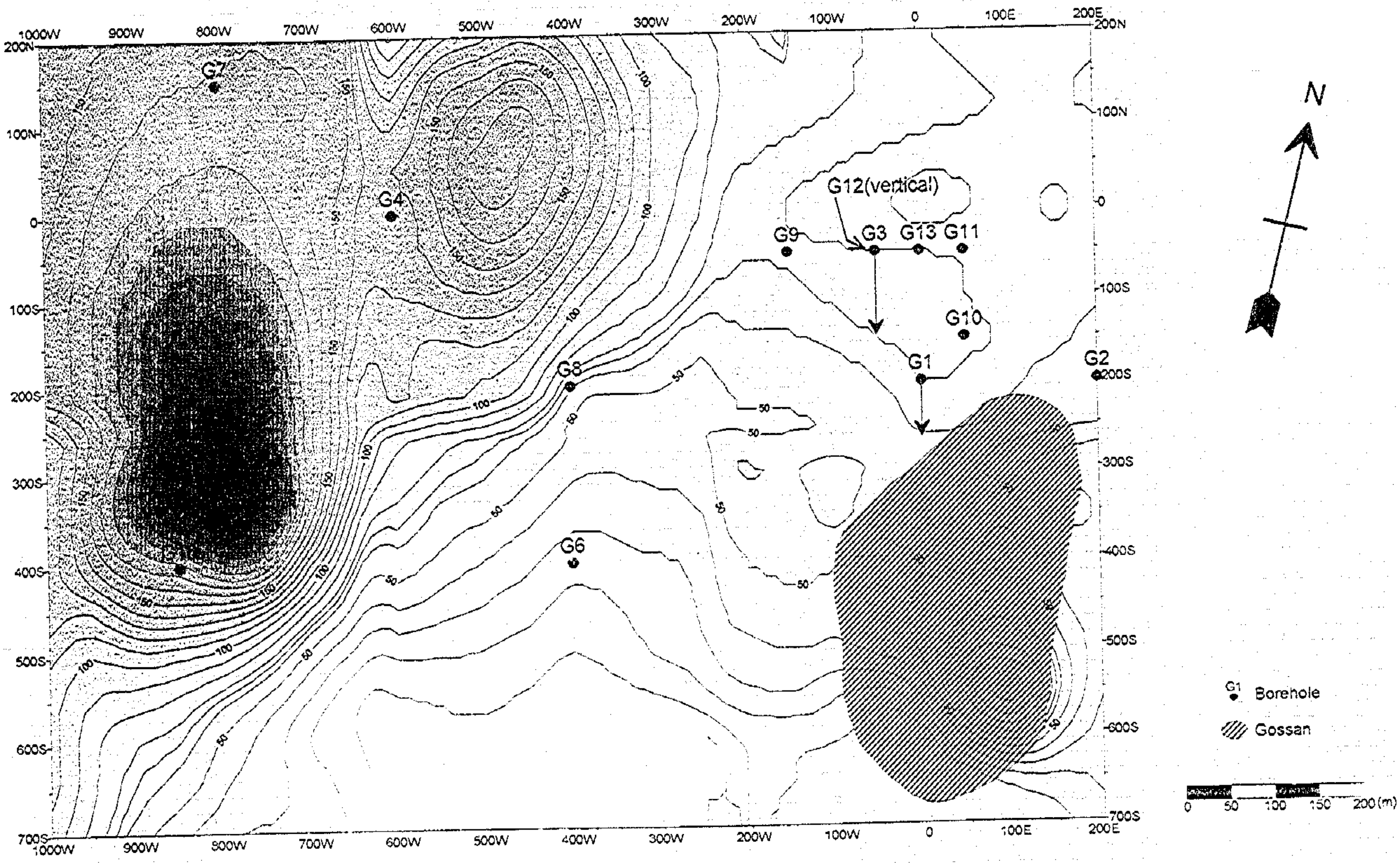
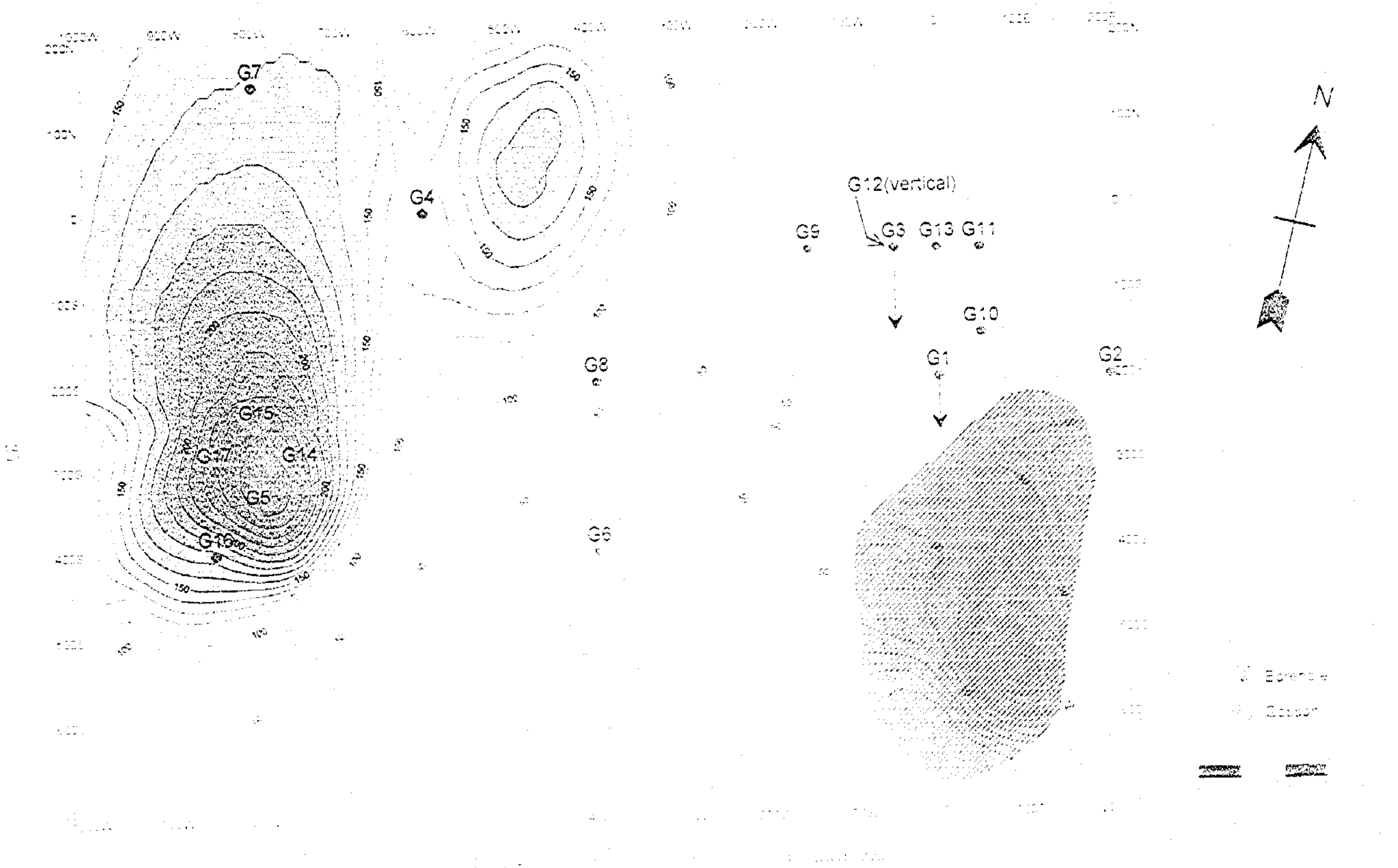


Fig.I-4-5 TEM response compiled map in Ghuzayn area



N
G12(vertical)
G1
G2
G3
G4
G5
G6
G7
G8
G9
G10
G11
G13
G14
G15
G16
G17
150
200

interesting locations (see Fig.I-4-5) which may give indications of a high potential for massive sulphide mineralization.

In the cental part of Daris area, TEM anomaly was detected at shallow depth in the east, at middle depth in the south and at depth in the central part of TEM loop. In the northern part of Daris, a TEM wide anomaly zone was also delineated overlapping with a low resistivity zone extracted by TDIP survey.

In Doqal area,the TEM survey carried out in order to investigates the high metal factor zone detected by TDIP, delineated a TEM anomaly in the area which overlaps with the high metal factor zone.

In Fardah and Sanah areas, a TEM anomaly was delineated near the center of a low TDIP resistivity zone trending northwest-southeast,respectively.

4-3 Drilling survey

On the basis of the results of the geophysical survey conducted in Phases I and II, drilling survey was carried out in four areas, i.e., Ghuzayn, Daris, Daris 3A5 and Fardah areas with 26 boreholes and 6,197.8m drilling length in total.

Drilling survey conducted in Ghuzayn area discovered massive sulphide bodies in two places, i.e., in the northern and western part. The northern body located to the north of gossan was intersected by the boreholes MJOB-G3 and G13 with a maximum core length of 7.95m with average assays of 4.66% Cu in MJOB-G3. The western body located to the west of gossan was intersected by the boreholes MJOB-G5, G14, G15, G16 and G17. The maximum core length of 37.1m with average assays of 1.88% Cu was found in the borehole MJOB-G14. The other boreholes indicated the following results: Borehole G5: 33.7m with1.47% Cu, G15: 29.9m with 1.55% Cu, G16: 2.5m with 1.63% Cu, and G17: 6.9m with 1.17% Cu. The depth of the ore bodies ranges from 130m to 154m in northern body, and from 134m to 220m in the western body. In addition to the massive ore body, stockwork ore zones consisting of dissemination and networks were found below the massive ore bodies in MJOB-G3 and G14 holes, with core lengths and assays of 36.6m with 0.47% Cu and 65.75m with 0.61% Cu, respectively. A summary of the type of ore, detection depth, thickness and assays are shown in Table I-4-1, while the location of the boreholes is shown in Fig. I-4-6.

Drilling survey in Ghuzayn area also revealed that in the area, the volcanic rocks and massive sulphide ore bodies show a tendency to strike along northeast-southwest and dipping northwest by 20°to 30°.

On the other hand, the drilling surveys in Daris, Daris north, Daris 3A5 and Fardah areas did not find any massive sulphide ore body.

Table I-4-1 Summary of results on drilling survey in Ghuzayn Area

Ore Body Name	Bore Hole NO.	Type of Ore	Depth (m)		Thickness (m)	Average Grade	
			from	to		Cu%	Zn(%)
Ghuzayn Northern Body	MJOB-G3	stockwork(upper)	115.15	133.00	17.85	0.22	0.01
		massive sulphide	133.45	138.60	5.15	4.85	0.04
		massive sulphide	140.00	142.80	2.80	3.77	0.06
		stockwork(lower)	142.80	166.65	23.85	0.40	0.11
		stockwork(lower)	167.15	179.90	12.75	0.59	0.03
		stockwork(lower)	185.35	233.50	48.15	0.27	0.02
		stockwork(lower)	246.10	247.25	1.15	0.30	0.17
		stockwork(lower)	279.50	288.20	8.70	0.15	2.66
	MJOB-G13	massive sulphide	152.80	154.40	1.60	0.17	0.04
Ghuzayn Western Body	MJOB-G5	stockwork	134.00	136.90	2.90	0.33	0.01
		massive sulphide	136.90	170.60	33.70	1.47	0.04
	MJOB-G14	massive sulphide	119.80	164.75	37.10	1.88	0.04
		stockwork	164.75	171.50	6.75	2.74	0.44
		stockwork	171.50	230.50	59.00	0.37	0.32
	MJOB-G15	(metaliferous sediment)	178.85	179.20	0.35	2.10	0.01
		massive sulphide	179.20	212.30	29.90	1.55	0.05
	MJOB-G16	stockwork	186.30	186.90	0.60	0.14	0.04
		massive sulphide	186.90	189.40	2.50	1.63	0.05
	MJOB-G17	massive sulphide	215.90	222.80	6.90	1.17	0.05

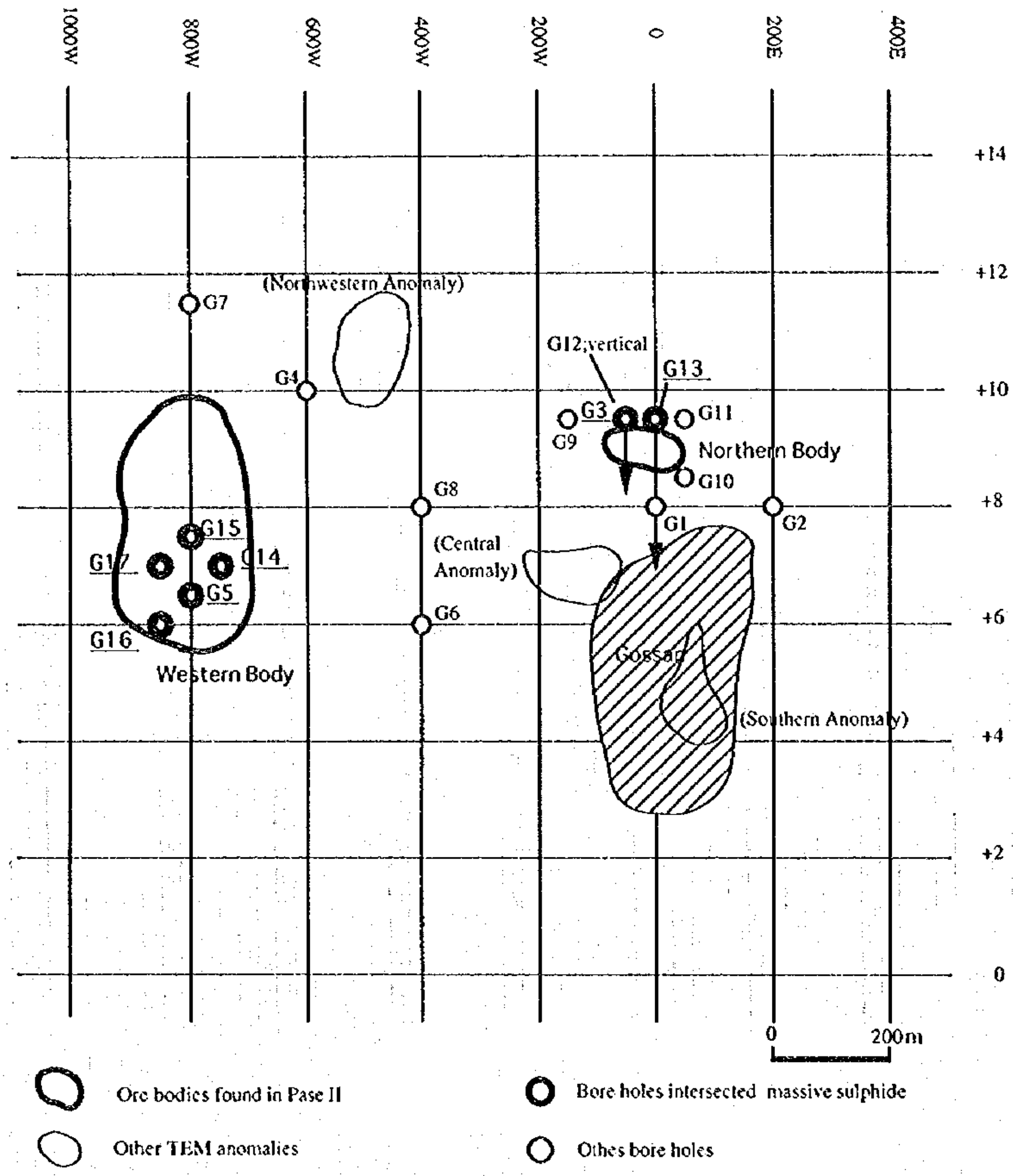


Fig.I-4-6 Lacation map of Ore bodies, TEM anomalies and bore hples in Ghuzayn area

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5-1 Conclusions

The survey results of two years from 1995 to 1996 can be summarized as follows:

(1) Drilling survey conducted in Ghuzayn area discovered massive sulphide bodies in two places, i.e., in the northern and western part. The Northern body located to the north of gossan, shows a maximum core length of 7.95m with average assays of 4.66% Cu in MJOB-G3 hole. The Western body located to the west of gossan, shows a maximum core length of 37.1m with average assays of 1.88% Cu in MJOB-G14 hole.

(2) TEM survey in Ghuzayn area highlighted the extension of massive sulphide ore bodies which were discovered in two places by drilling conducted in Phase II. The TEM data show also that the Western body has an extension of 150m wide in east-west direction and 300m long in north-south direction and that the Northern body extends 150m wide in east-west and 100m long in north-south. In addition, TEM data reveal also three interesting anomalies which may give indications of high potential for massive sulphide mineralization.

(3) In Doqal area, TEM survey was conducted in order to investigate the high metal factor zone detected by TDIP. Since the TEM anomalies extracted in the area correspond well to a high metal factor zone, it became clear that this area may have a high potential for mineralization of massive sulphide.

(4) In Daris area, drilling survey conducted in the central and northern part of the area, could not intersect any significant sulphide mineralization. However, a distinctive high chargeability zone was widely distributed to the north of the gossan and several high metal factor locations were delineated at the margin of a high chargeability zone. Accordingly, there is a possibility for the existence of massive sulphide deposits.

(5) Because of the thick coverage of Quaternary sediments, a ground geophysical survey seems to be the most important and effective tool for the exploration of copper deposits in Oman. According to the survey of two years in Central Batinah Coast for the exploration of Cyprus-type massive sulphide deposits, it is safe to say that the utilization of the TDIP method as a first step, is very effective to delineate a promissing sulphide mineralized zone while covering a wide area, and as a second step, the implementation of a TEM method is a powerful technique to delineate the most promissing

locations for drilling. TEM surveys by means of small loop(50m x 50m) along with the drilling survey can delineate in more detail the extension of ore bodies and allocate better the drilling targets.

5-2 Recommendations

Results of two years surveys show that the Central Batinah Coast area has a high potential for bearing massive sulphide deposits. As a continuation to the exploration program for the project, drilling and geophysical surveys are required in the areas of Ghuzayn, Doqal and Daris area as follows:

(1) Ghuzayn Area

1) Drilling survey is recommended to clarify the details of Northern and Western ore bodies found in this Phase II, along with TEM survey by using small loops(50m x 50m) to delineate in more detail the extension of bodies and to allocate drilling targets.

2) Drilling and TEM small loop surveys are recommended to investigate other anomalies detected by the TEM large loop survey carried out in Phase II.

3) TDIP survey is recommended around the area where TDIP was carried out in Phase I, in order to evaluate the total potential for mineralization in Ghuzayn area.

(2) Doqal Area

1) Drilling survey is recommended to be carried out to investigate the possible mineralization reflected by the anomalies detected by TDIP and TEM surveys in Phase II.

2) Since TEM anomalies still continue towards north beyond the area covered by the TEM survey of Phase II, it is neccessary to conduct a TEM survey in northern part in order to trace the detected anomaly zone. In addition, TEM survey is recommended to be carried out in the western part where IP anomaly was detected.

3) TDIP survey is recommended around the area where TDIP was carried out in Phase I, in order to evaluate the total potential for mineralization in Doqal area.

(3) Daris Area

Since the high metal factor zone detected in Phase I during the TDIP survey needs of further clarification, it is recommended to continue TEM survey in selected locations defined by the high metal factors detected in the central-western part of this area.

PART II SURVEY RESULTS

CHAPTER 1 GEOLOGICAL SURVEY

1-1 Stratigraphy of the Survey Area

The geology of the Central Batinah Coast area is composed of Samail ophiolite and supra-ophiolite sediments of allochthonous Samail Nappe and Tertiary and Quaternary formations of post-nappe autochthonous Unit. The stratigraphy of the survey area is shown in Fig.II-1-1.

1-1-1 Samail Ophiolite

The Samail Ophiolite includes tectonites, a cumulate sequence, a high-level gabbro, a sheeted-dyke complex, Samail volcanic rocks and intrusive rocks from lower part of ophiolite. Within these, the Samail volcanic rocks is impregnated by the massive sulphide deposits.

(1) Tectonites (TH)

Most of the outcrops of the tectonite consist of brown-weathering harzburgite. It also includes small dunite bodies and subordinate lherzolite.

(2) Cumulate sequence (C)

The cumulate sequence consists of cumulate dunite, cumulate peridotite, cumulate peridotite and dunite,cumulate layered gabbro and cumulate planar-laminated gabbro. The cumulate dunite comprises mainly chrome-spinel dunite, clinopyroxene dunite, troctolite andwehrlite. The cumulate peridotite is made up of alternating layers of dunite, wehrlite, troctolite, clinopyroxenite and in some places, lherzolite. The cumulate peridotite and dunite consist of gabbro alternating with wehrlite, troctolite, clinopyroxenite and dunite. The cumulate layered gabbro comprises mainly gabbro with layers of troctolite, wehrlite and clinopyroxenite. The cumulate planar-laminated gabbro occupies the top of the cumulate sequence with the gabbro displaying a marked planar orientation in the minerals.

(3) High level gabbro (HG)

The high level gabbro appears at the top of the cumulate sequence, separating it from the sheeted-dyke complex. It consists of a equigranular hornblende gabbro with a variable grain size.

(4) Sheeted-dyke complex (SD)

In outcrops, the sheeted-dyke complex appears as a set of sub-parallel dykes of 0.5 to 3 m thick and in general with 5 to 10 cm wide chilled margins, whose composition ranges from microgabbroic to doleritic. The sheeted-dyke complex appears gradually at the bottom of the Lower volcanic rocks.

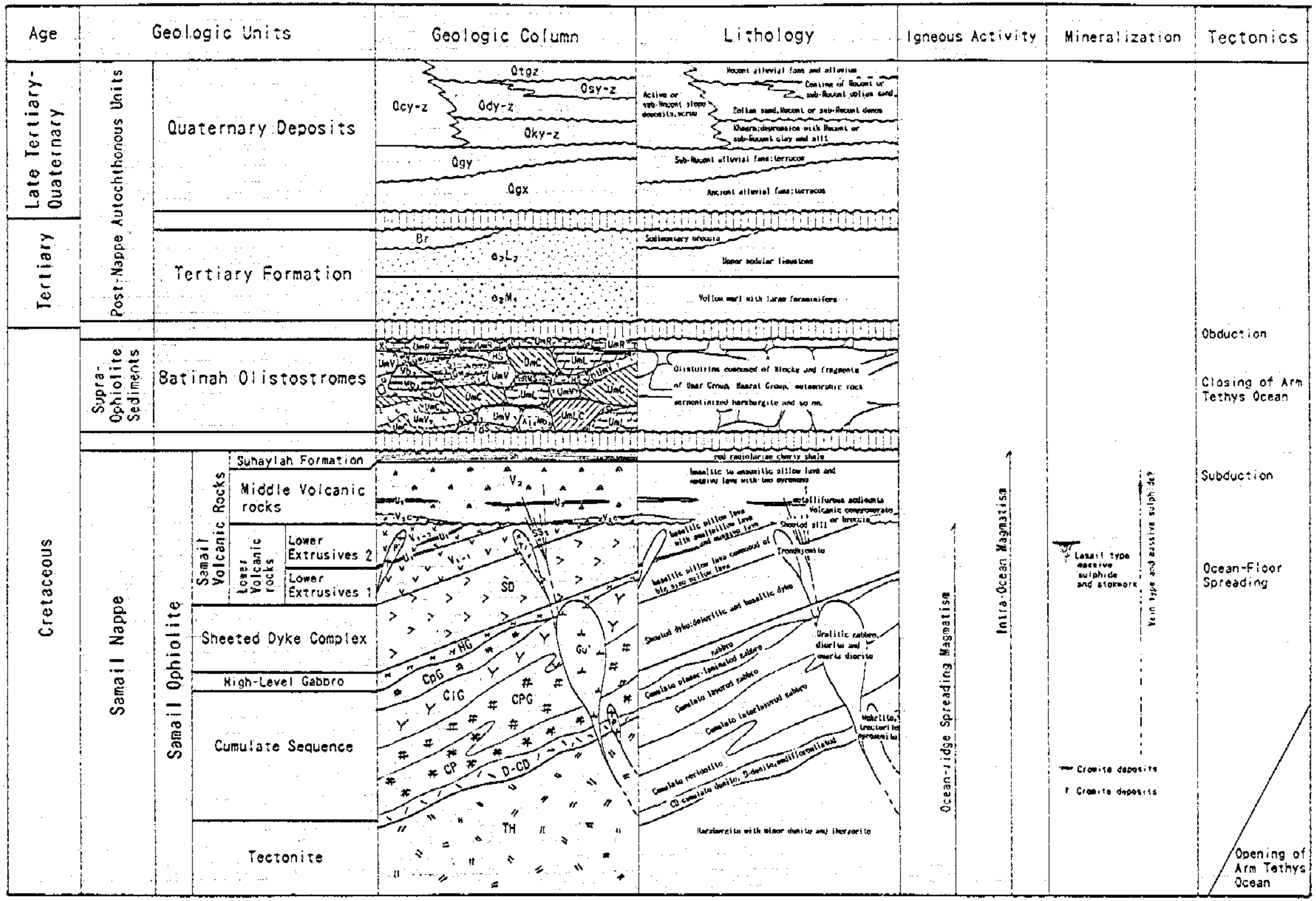


Fig.II-1-1 Stratigraphic columnar section of survey area

(5) Samail volcanic rocks (SV)

The Samail volcanic rocks were emplaced during three episodes represented by Lower volcanic rocks (SV1), Middle volcanic rocks (SV2) and Upper volcanic rocks. The Upper volcanic rocks do not appear in the areas.

(a) Lower volcanic rocks (SV1)

The Lower volcanic rocks unit consist of Lower extrusives 1 (V1-1), Lower extrusives 2 (V1-2) and metalliferous sediments (U1). The Lower extrusives 1 and the sheeted-dyke complex bear a gradual relationship. The Lower extrusives 2 conformably overlies the Lower extrusives 1. The metalliferous sediments are observed at the top of the Lower extrusives 1 and/or intercalated in the Lower extrusives 2.

The Lower extrusives 1 (V1-1) consist of basaltic lavas, and composed mainly by a reddish brown colored big pillow lava of 1.5 m to 2 m size in diameter. The Lower extrusives 1 also consist of reddish brown to grey colored massive lava including sheet flow unit, hyaloclastite and pillow breccia. The pillow lava is aphyric or aphanitic and accompanied with thick interpillow of 10cm to 40cm in thickness. The massive lava shows grey to brownish grey color with a thickness of several 10 cm to several meters. Columnar joints are developed in the thick massive lava.

The Lower extrusives 2 (V1-2) consist of basalt to andesite and composed mainly of pillow lava acompanied with massive lava. The pillow lava shows light grey to purpulish grey in color with pillow sizes mainly of 10 cm to 1 m in size and maximum of 1.5 m. It is characteristicaly accompanied in many places with small sized pillow lavas of 10 cm to 30 cm in size. This pillow lave, in addition, is phyric and porpyritic and shows a variole-like texture. In contrary to Lower extrusives 1, it is accompanied with thin interpillow of 5cm to 10cm in thickness. The massive lavas show grey to brownish grey color with thickness of several meters. Columnar joints are developed in the thick massive lavas. The upper part of the Lower extrusives 2 includes pillow lavas with radial joints.

Massive sulphide deposits are situated in the contact between V1-1 and V1-2, and seem to be formed on the early time of volcanism of V1-2. This stratigraphic control for ore bodies plays an important role for the exploration activities in the project area and accordingly, it is certainly needed to discriminate between V1-1 and V1-2. Table II-1-1 shows a comparison between pillow lavas of V1-1 and V1-2.

The metalliferous sediments (U1) is the so-called umber which includes many radiolarias. This unit shows dark brown color.

(b) Middle volcanic rocks (SV1)

The Middle volcanic rocks unit (V2) consists of volcanic conglomerate and breccia (V2c), sheeted sills (SS2), Middle extrusives (V2) and metalliferous sediments (U2). The rocks unconformably overlies the sheeted-dyke complex and the Lower volcanic rocks.

The volcanic conglomerate and breccia (V2c) consist of angular to rounded matrices of sand to gravels

Table II-1-1 Comparison of pillow lavas in Samail Ophiolite

Pillow Lavas	Rock Type	Color	Size and Shape	Petrographic Features	Field Observation Features
Pillow lava(V2) of Middle Volcanic rocks	Basalt to andesite	Light green	Size: 0.6m to 2.5m in across. (large sized pillow) Irregular shape.	Sub-ophytic and partially porphyritic textures. Phenocryst: Clinopyroxene and coarse groundmass.	Dominant metalliferous sediment layer. Rugged surface. Amigdaloidal texture.
Pillow lava(V1-2) of Lower extrusive 2, Lower Volcanic rocks	Basalt	Light greenish gray	Size: 0.3m to 0.5m in across. (small sized pillow) Closely packed.	Porphyritic texture. Phenocryst: Clinopyroxene and orthopyroxene	Dominant metalliferous sediment layer. Variole-like texture. Thin interpillows(1cm to 5cm in thickness).
Pillow lava(V1-1) of Lower extrusive 1, Lower Volcanic rocks	Basalt to andesite	Dark brown and greenish brown	Size: 0.6m to 1.2m in across. (medium sized pillow) Round to oval shape, elongated tube with radial cooling joint.	Aphyric and aphanitic texture. Phenocryst: Clinopyroxene	Thick interpillows(5cm to 40cm in thickness).

and of fragments and blocks of sheeted dykes and Lower volcanic rocks.

The sheeted sills (SS2) consist of dykes, sheets and sills of grey-colored andesite to dacite.

The middle extrusives (V2) consist mainly of pillow lavas and massive lavas of andesite containing clinopyroxene and orthopyroxene. Most of the lavas are massive. The weathered surface show various colors, suchas grey, brownish grey, green, blueish grey, orange color. In general the massive lava shows a doleritic texture. The pillow lavas show purple, green and greenish grey colors. Most of the pillow lavas present irregular pillow shape with a diameter of about 0.5 to 1.0 m.

The metalliferous sediments (U2) are the so-called umber and contains many radiolarias. This unit shows brownish black color.

(c) Suhaylah Formation (Sh)

This formation occupies the top of the Samail volcanic rocks and consists of reddish brown cherty shale containing many radiolarias.

(6) Intrusive rocks

The intrusive rocks unit includes peridotite, uralitic gabbro, Trondhjemite and late dolerite dykes.

1-1-2 Supra-ophiolite Sediments (Batinah Olistostrome)

The sediments, so-called Batinah Olistostrome, consist of the olistoliths of Tethys Sea sedimentary rocks formed at the same time when Tethys Sea was formed. The olistoliths came as a result of the obduction process at the same time when Tethys Sea closed. The olistoliths are composed of mega-fragments of Hamurat Duru Group and Umar Group, metamorphic rocks and serpentinized peridotite.

1-1-3 Tertiary and Quaternary sedimentary rocks

These units consist of Tertiary and Quaternary deposits. The Tertiary deposits consist of yellow marl with large foraminifera and upper nodular limestone of late Paleocene to early Eocene and sedimentary breccia. The Quaternary deposits consist of ancient alluvial fans, sub-Recent alluvial fans, active or sub-Recent slope deposits (Qcy-z), Khagra of depression with Recent or sub-Recent clay and silt, eolian sand of Recent or sub-Recent dunes, coating of sub-Recent dunes and Recent alluvial fans and alluvium.

1-2 Geological Structure of the Area

Main structure of the central Batinah coast area is considered as the pile-up structure formed when allochthonous Samail ophiolite and supra-ophiolite sediments have been thrust over the Arabian shield at the late Cretaceous age. The Tertiary and Quaternary deposits of the post-nappe autochthonous units unconformably overlies the allochthonous units in the central Batinah coast. The Samail Nappe which formed the pile-up structure consists of two blocks: Haylayn block (west part of the area) and Rustaq block (east part). The blocks are bounded by NE-SW faults and lineaments located at 10km west of Barka in the Batinah coast. Many thrust faults are developed in the area which formed contacts of piled-up blocks formed before Tertiary and sliced the autochthonous and allochthonous blocks. High-angle faults developed in the area cut each of the above blocks and displaced the geologic boundaries. These faults were formed before the Tertiary.

1-3 Massive Sulphide Deposits in the Area

Massive sulphide deposits distributed in the project area are considered to be formed by hydrothermal convection processes in the spreading ridge of the Paleo-Tethys sea during Middle to Late Cretaceous age.

On the basis of the results of the exploration projects in the northern Oman mountains, Bishimetal (1987) proposed the idea of the formation processes of massive sulphide deposits as follows(Fig.II-1-2):

1) During spreading after the eruption of Lower extrusives1(V1-1), intensive intrusion of dykes occurred around the marginal part of the magma chamber along major normal faults and/or fractures. This intrusion initiated the eruption of Lower extrusives2(V1-2).
2) The intrusion of dykes may have caused local hydrothermal convection around the cluster of dykes, overlaping the pre-existing major convection.
3) This local convection may have provided voluminous hydrothermal fluids containing ore-forming metals which were exhaled to the superficial parts of Lower extrusives 1 and discharged on the seafloor along numerous fractures parallel to the major faults.
4) Ore-forming fluids exhaled on the seafloor precipitated ore minerals and formed a massive sulphide deposits in a relatively large depression formed on an undulating surface of Lower extrusives 1.
5) Then volcanic activities became intense again and above massive sulphide deposits was covered by Lower extrusives 2.

In the project area, massive sulphide deposits of small scale are already found in Ghuzayn, Daris and Daris 3A5 deposits by previous investigations conducted by Prospection Ltd. and BRGM as mentioned in detail later.

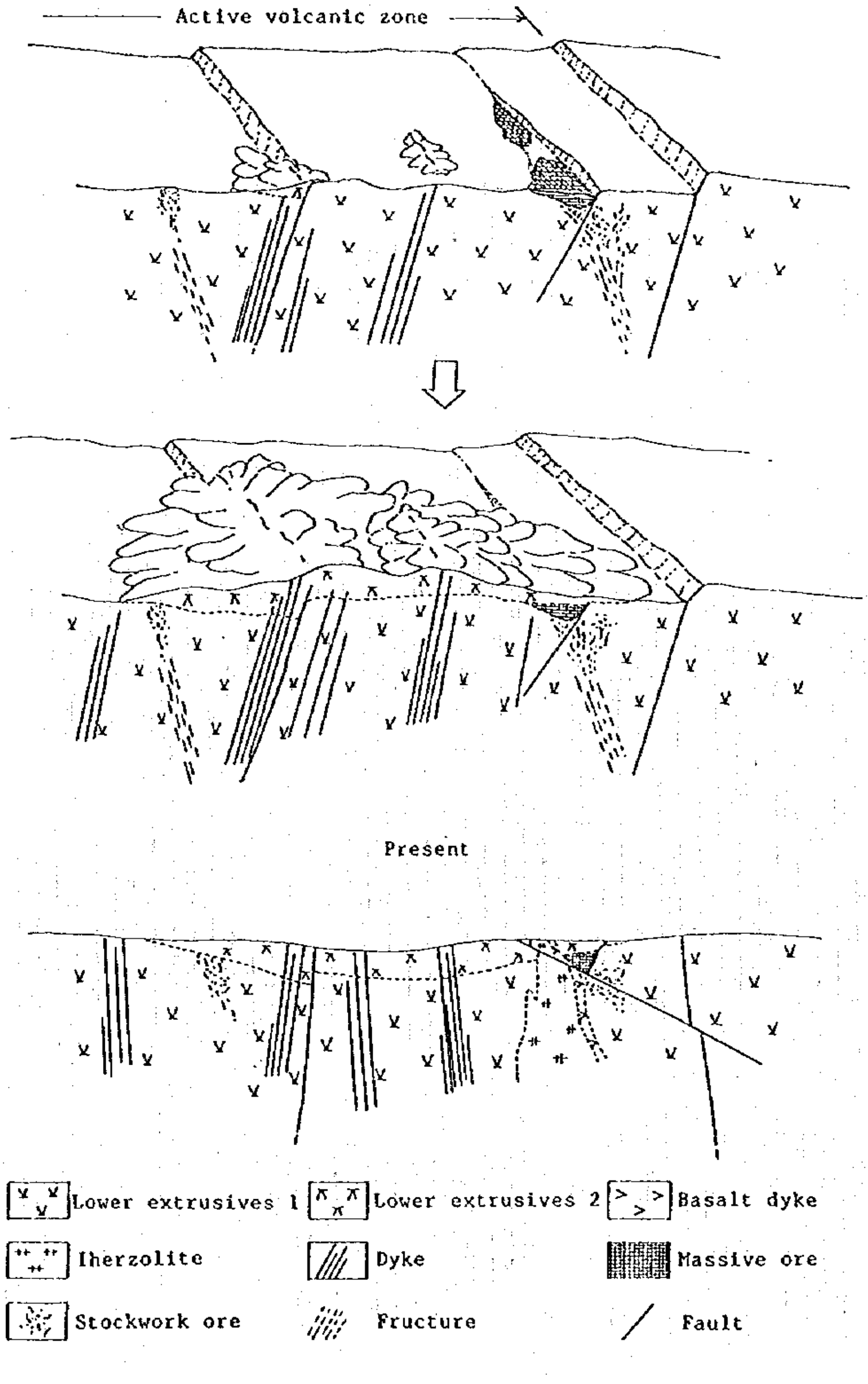


Fig.II-1-2 Schematic formation processes of massive sulphide deposits in Sohar

1-4 Results of the Reconnaissance Geological Survey

A reconnaissance geological survey was conducted in the Areas-A, -B and C to clarify and confirm the mineralization in the area. Discussions on the relationship between mineralization and significant magnetic contact zones were also carried out during the survey.

Since the massive sulphide deposits occur along a contact between the Lower extrusive rocks 1 and 2 of the Lower volcanic rocks, the contact was traced throughout the areas and the distribution was clarified. Area A and B show the extensive distribution of the contact zone, however, in the Area C, the sheeted dyke was overlain directly by the Middle volcanic rocks without the Lower extrusive rocks 1 and 2 and for this reason, the Area C does not seem to present favorable conditions for the finding of these kind of deposits.

In addition to the known gossan in Ghuzayn, Daris 3A5 and Daris, new gossans were found in the Doqal, Fardah, Sanah, north of Ghuzayn village and Qulayyah.

Magnetic contact zones, extracted from all the areas where gossans were formed, presented in general useful information for exploration purposes. Some of them, presented no favorable geologic features for copper mineralization but were useful to clarify the flow boundaries of volcanic rocks.

1-5 Results of the Semi-detailed Geological Survey

Semi-detailed geological survey was conducted in Ghuzayn Area in Area-A, and Buwayrik- Daris 3A5 Area and Daris-Daris west Area in Area-B in order to clarify the mineralization in the area and evaluate the potencial of copper deposits.

The following characteristics were clarified during the survey:

(1) The main gossan in Ghuzayn has the scale of 200m in east-west direction and 400m in north-south direction and was emplaced in the Lower extrusive rocks 2 (V1-2) close to the boundary with the Lower extrusive rocks 1 (V1-1).

(2) In the Ghuzayn area, several copper bearing quartz veins with some length were found in the east and a gossanized basalt lava of the Lower extrusive rocks 1 (V1-1) was observed in the west.

(3) The gossan of Daris 3A5 prospect is emplaced in the Middle volcanic rocks (V2).

(4) The Buwayrik prospect shows only slight silicification and no favorable geologic features for copper mineralization can be observed.

(5) The gossan of Daris prospect is emplaced in the Lower volcanic rocks (V1-2) with the size of 10m x 30m on the surface.

(6) Only pyritization in some dykes of the Sheeted dyke unit was observed in the Daris West prospect and no favorable geologic features for copper mineralization can be expected.

1-6 Delineation of TDIP Survey Areas

On the basis of the results on reconnaissance and semi-detailed geological survey, the following nine areas were selected for TDIP survey:

(1) Ghuzayn-Doqal area

a. Ghuzayn area

b. Ghuzayn East area

c. Ghuzayn West area

d. Ghuzayn villadge North area

e. Doqal area

(2) Fardah-Sanah area

a. Fardah area

b. Sanah area

(3) Daris -Daris 3A5 area

a. Daris area

b. Daris 3A5 area

CHAPTER 2 DETAILED SURVEY IN GHUZAYN-DOQAL AREA

2-1 Geology and Mineralization

2-1-1 Geology

The area is covering the west of project area. The Geology of the area consists of Sheeted dyke and Samail volcanic rocks of Samail Ophiolite, Supra-Ophiolite sediments (Batinah Olistostromes), Tertiary sedimentary rocks of autochthonous and Quaternary formations (Fig. II-2-1). The Lower volcanic rocks of Samail volcanic rocks with impregnated massive sulphide deposits, are widely distributed in the area.

2-1-2 Mineralization

Ghuzayn deposit is already known by previous investigations. Besides this, copper mineral showings accompanied with gossan weare found by this survey in Doqal, Ghuzayn East, Ghuzayn West and Ghuzayn village North.

Ghuzayn deposit is located about 20km south of Al Khaburah in the western edge of the project area. The large siliceous gossan probably corresponds to a completely oxidized stockwork zone emplaced near the contact between Lower extrusives 1 and Lower extrusives 2. Previous drilling survey conducted by Prospection Ltd. in the vicinity of the gossan during 1975 to1977 found a massive sulphide ore body at the depth of about 70m with maximum core length of 19.72m and average grade of 0.2% Cu (Fig.II-2-2 and II-2-3). Stockwork zone composed of pyrite and magnetite stringers were also intersected by these drillings. An estimate reserve of 559,000t at an uneconomic 0.33% Cu was given by this drilling survey(HaddadinM.A.et al, 1983).

Doqal showing is located 10km west of Ghuzayn deposit and to the south of Doqal village. The gossan was found in the Middle volcanic rocks in a narrow zone as shown in Fig.II-2-4. It is a 10m in width and over 600m in length. The 2.0g/t Au and 44.2g/t Ag in maximum were obtained after the analysis of gossan samples in Phase I.

Ghuzayn East showing is located about 2km northeast of Ghuzayn deposit. Chalcopyrite bearing quartz veins and quartz stockworks are observed in the Lower extrusives 1 and 2 in this showing.

Ghuzayn West showing is located about 4km west of Ghuzayn deposit. Slightly gossanized Lower extrusives 1 accompanied by local chalcopyrite bearing quartz stockworks are observed in this showing.

Ghuzayn village north showing is situated 2km northeast of Ghuzayn gossan. This showing, located near the contact between Lower extrusives 1 and 2, is accompanied by a gossan with oxidized copper and a metalliferous sediment with magnetite. Silicification and argillization can also be observed in the showing.

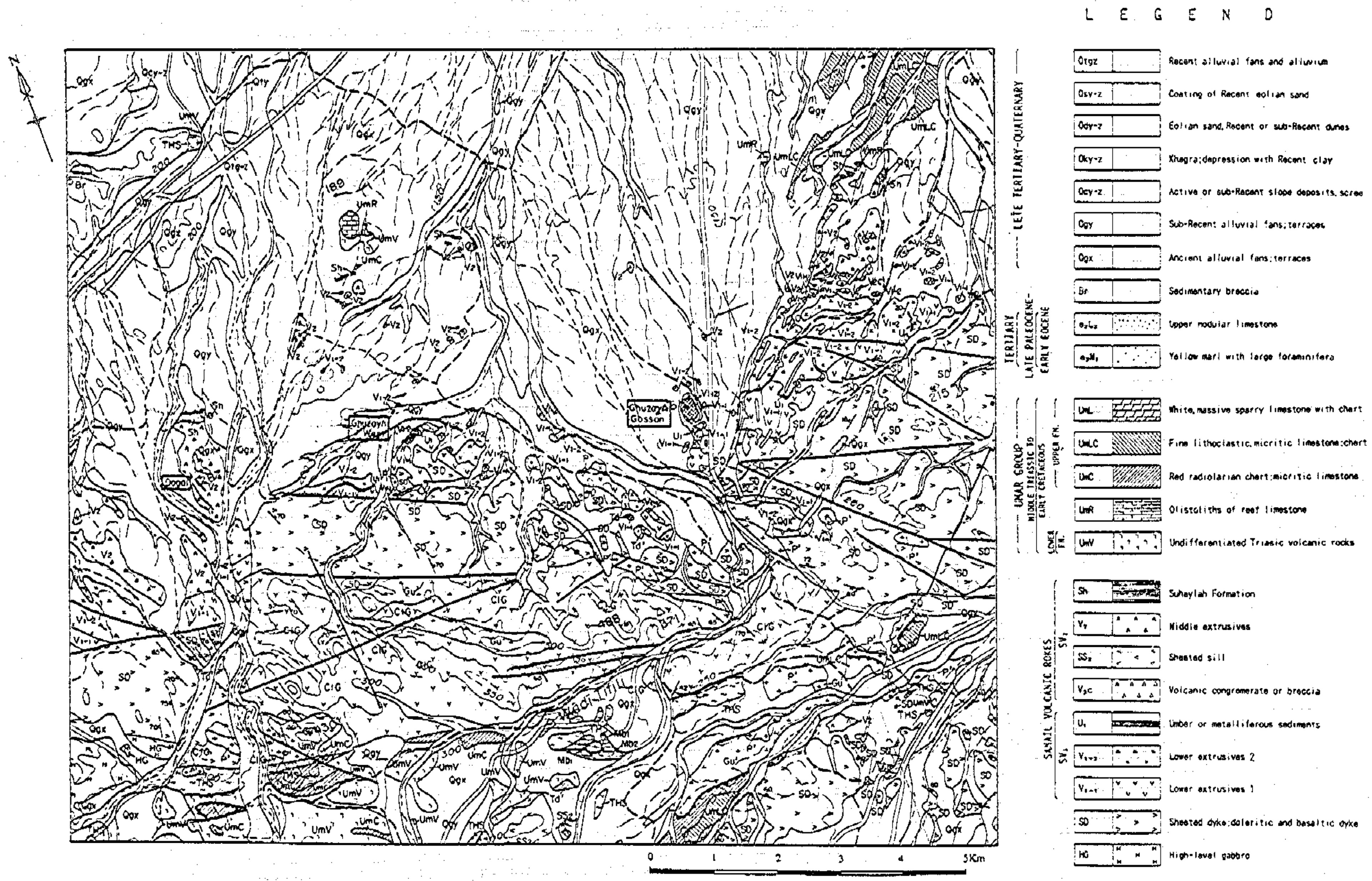


Fig.II-2-1 Geologic map of Ghuzayn–Doqal area

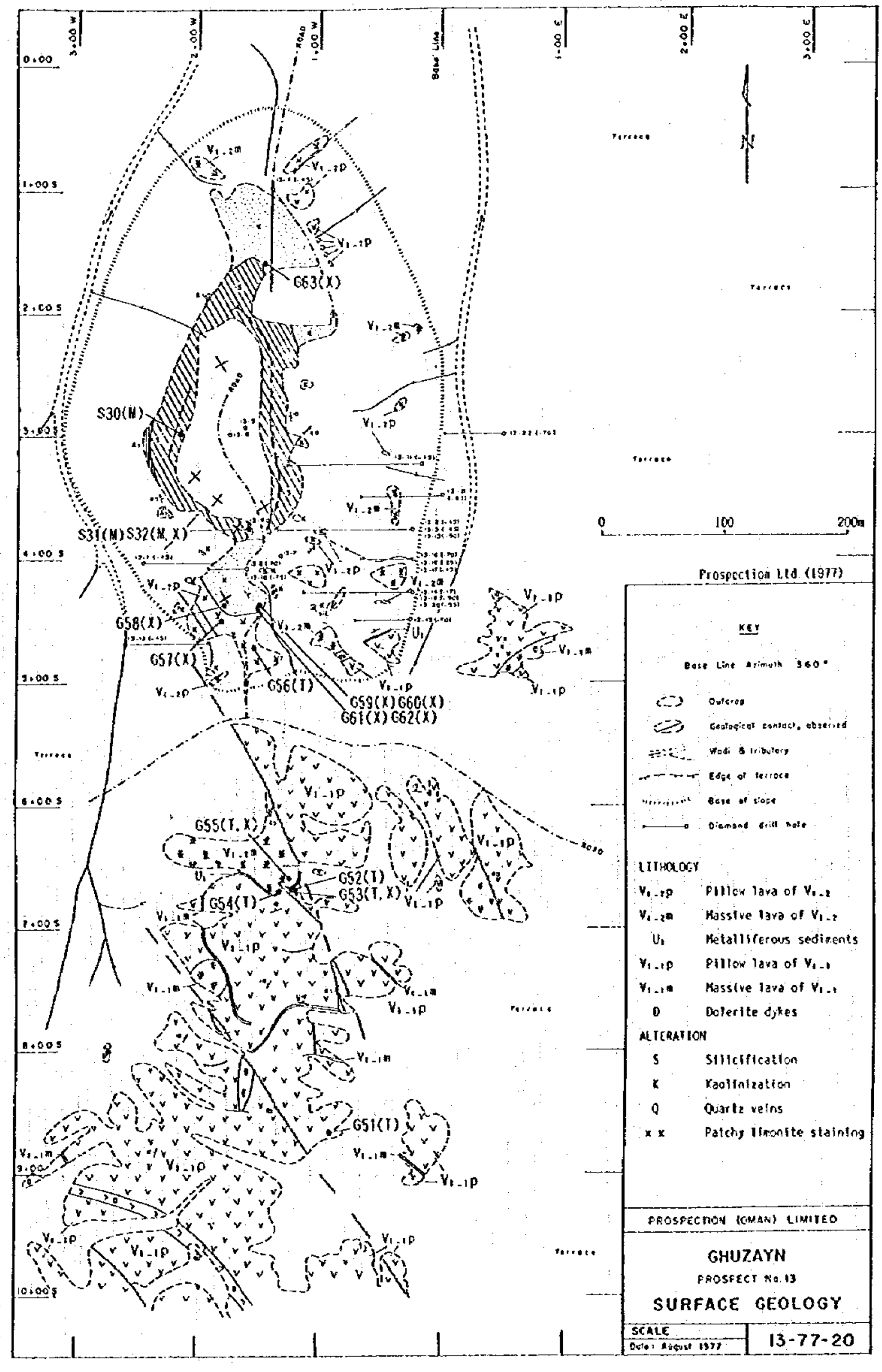


Fig.II-2-2 Geologic map and mineral showing of Ghuzayn Gossan

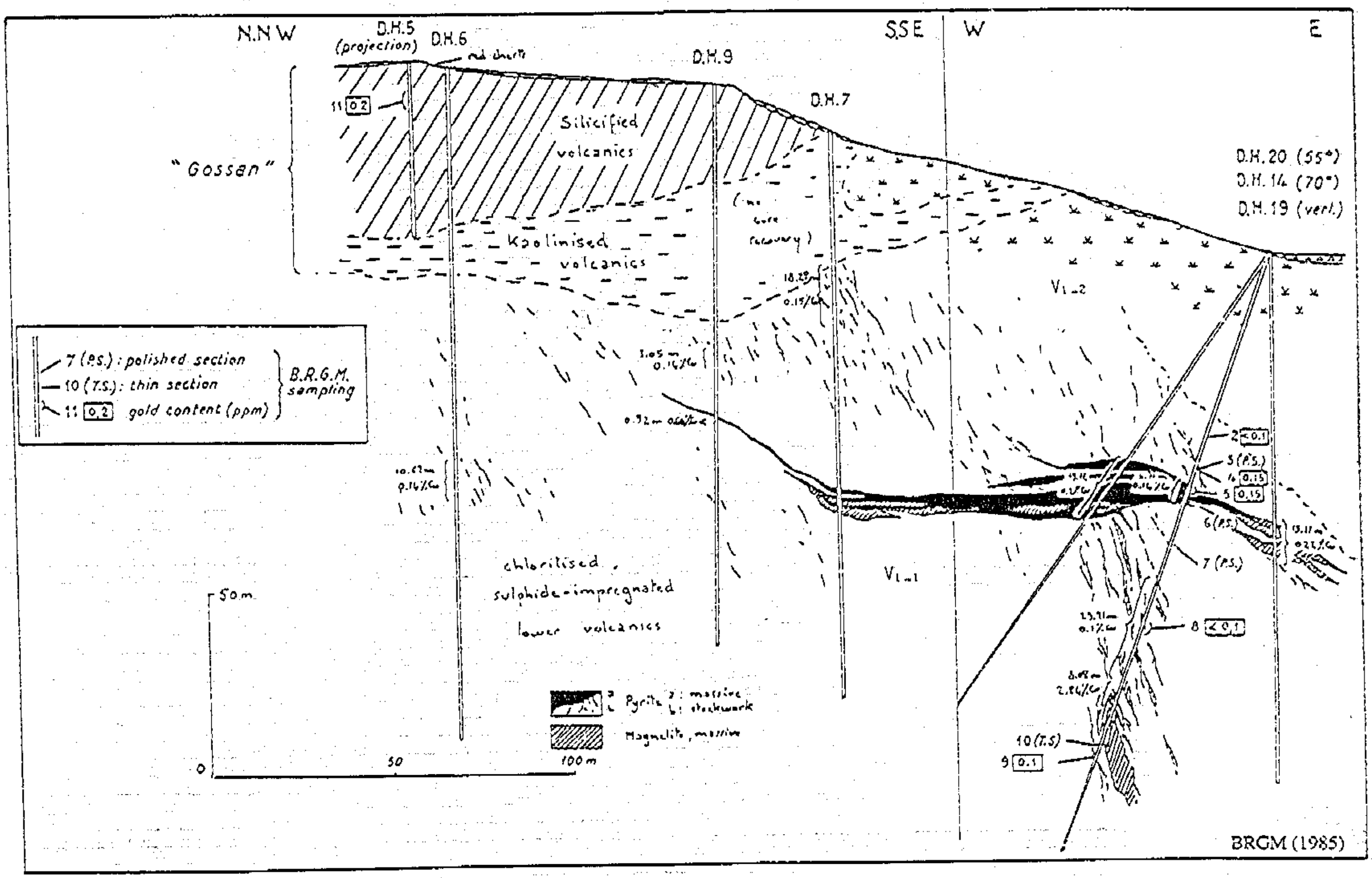


Fig.II-2-3 Geologic profile of Ghuzayn Gossan

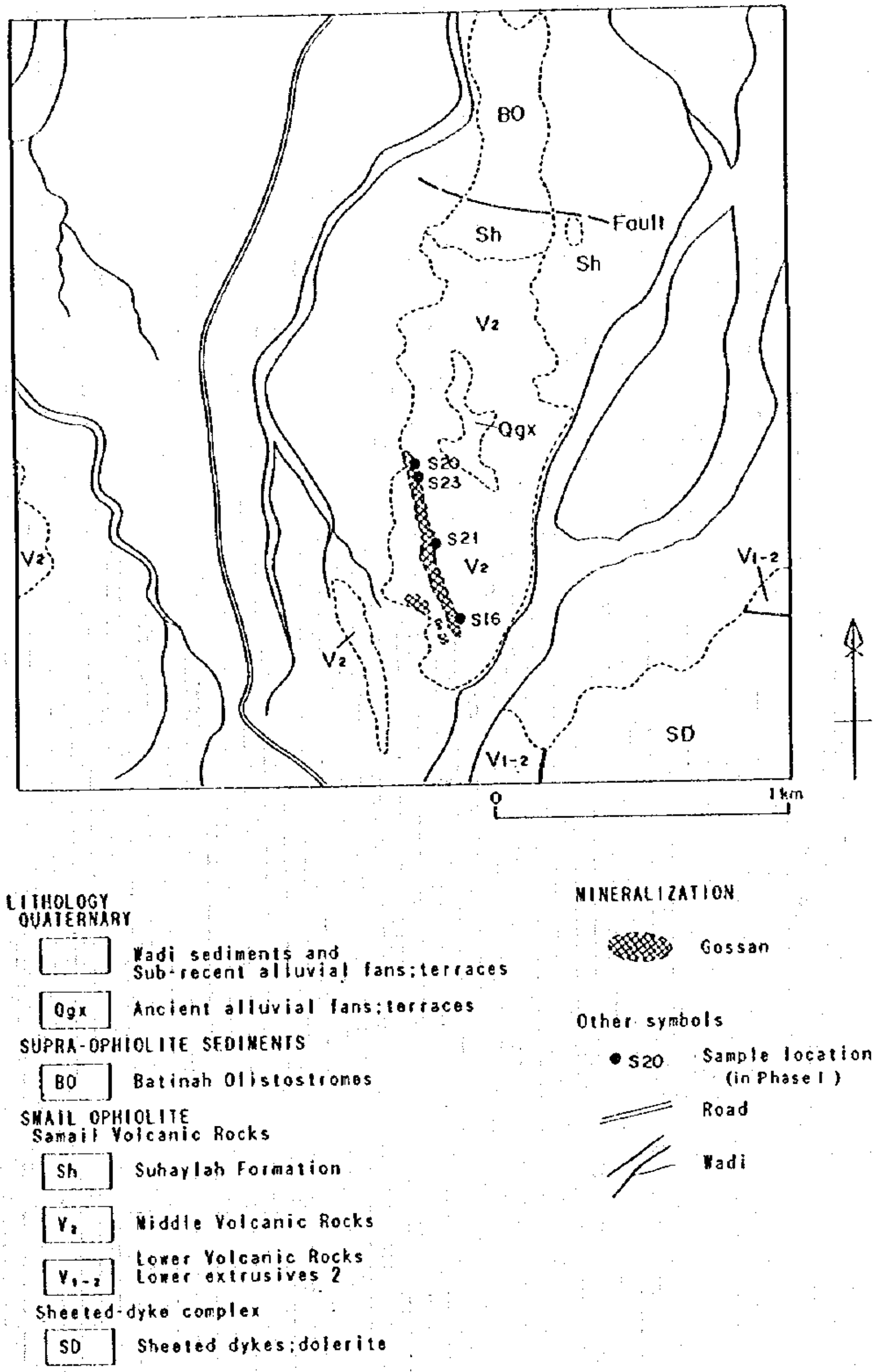


Fig.II-2-4 Mineral showing of Doqal area

2-2 Survey Results in Ghuzayn Area

2-2-1 Geophysical Survey

(1) Outline of Survey

TDIP and TEM survey were conducted in this survey area, as illustrated in Fig.II-2-5.

As for TDIP survey, a total of 21.5km line-length with eleven survey lines were set in the direction of N14°W. Interval between each line was 200m. Measurements were taken every 100m interval along the survey lines by adopting a dipole-dipole configuration at N factors (electrode separation) set from 1 to 4.

In relation to TEM survey, six loops were set and the data were collected at every 50m inteval within a 400 m x 400 m grid for each loop. The loop adopted was a fixed type square loop of 600 m x 600 m with a total observed stations of 370 points.

(2) Survey results

(a) TDIP survey

The results are shown in Fig.II-2-6(1), II-2-6(2).

The resistivity distribution is generally high in the south side and low in the north side of the area. A high resistivity zone above 100 Ωm is distributed in the area surrounding the main gossan, particularly it is evidently seen in the above mentioned figures at the level n=1. Low resistivity zones below 50 ohm-m are recognized in the north side of the area and in the vicinity of the main gossan at the level n=1, and additionally, other low resistivity zones are seen at the north and west side of the main gossan at the level n=3. The above low resistivity zone at n=1 in the north side of the area is elongated in the NE-SW direction and nearly correponds to the aeromagnetic anomaly location.

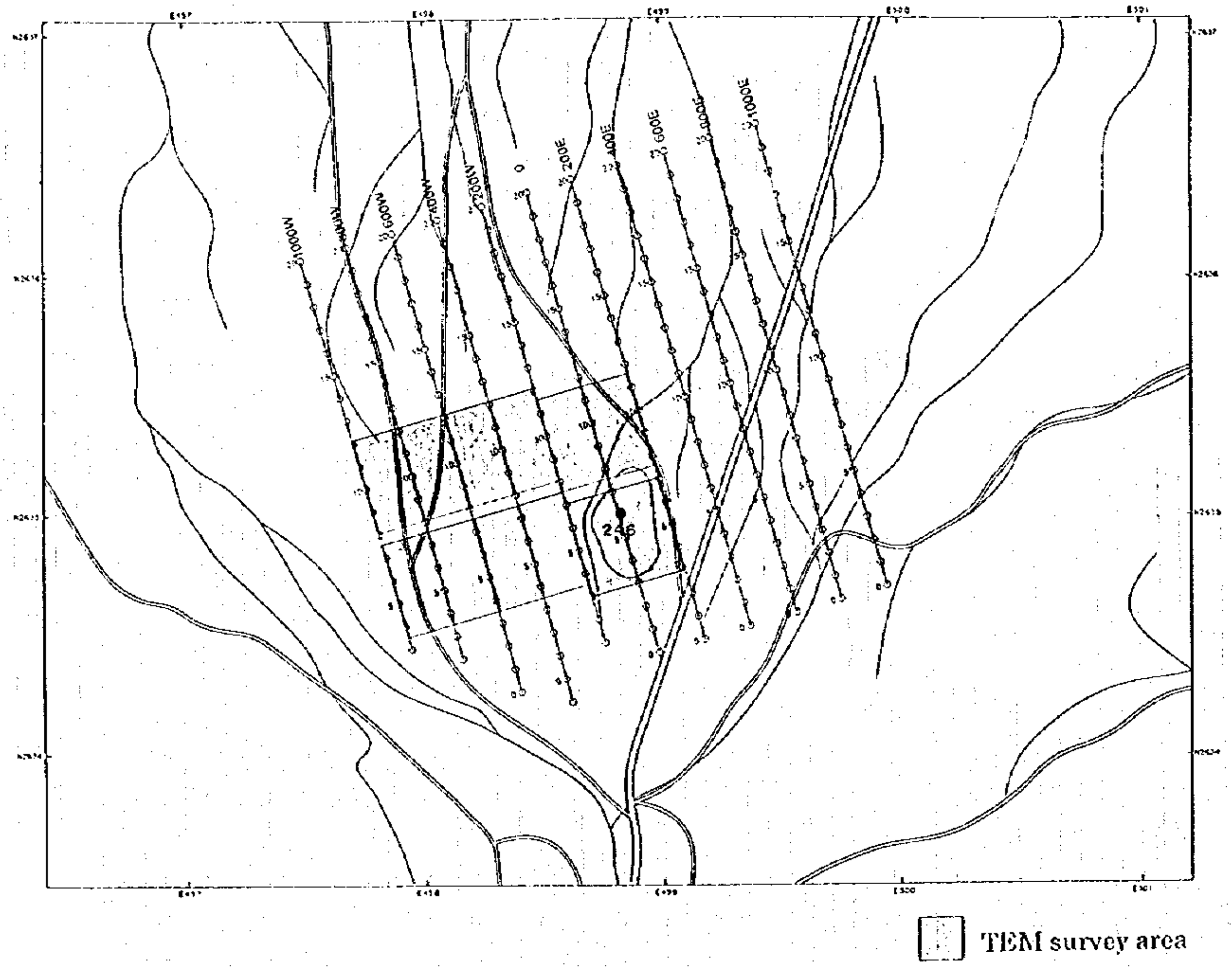
The chargeabilty distribution is generally high in the south side and low in the north side of the area at both levels n=1 and n=3. High chargeability zones above 10mV/V are widely distributed in the west and north of the main gossan. The chargeability overlapping the low resistivity zone in the north side of the area is less than 5mV/V.

With the exception of the north side of the area, the metal factor shows a similar tendency as the chargeability distribution. Several metal factor anomalies are located at the west and north side of the gossan at the level n=3, where the massive sulphide deposits were discovered by drillings at two locations.

(2) TEM survey

TEM survey was conducted to investigate in detail the high chargeability and metal factor zones widely detected in the north and west of the gossan.

The results are shown in Fig.II-2-7(1) and II-2-7(2). Five TEM anomalies were delineated, as shown in



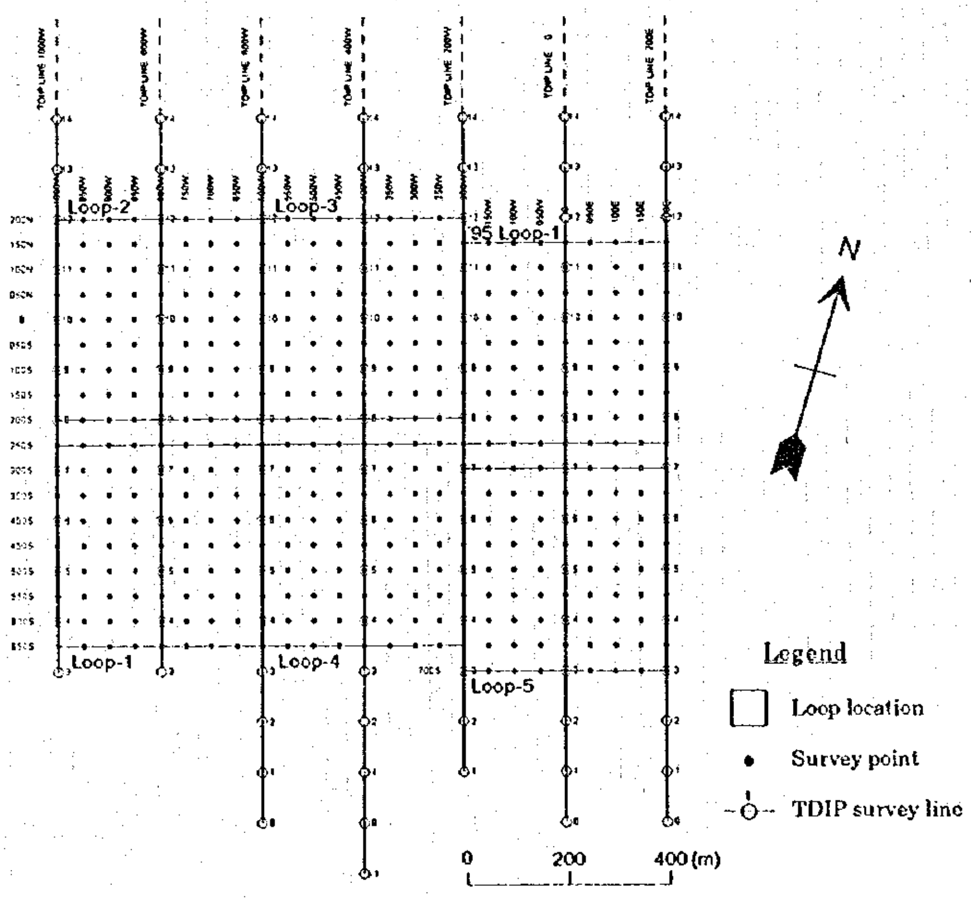


Fig.II-2-5 Geophysical survey locations in Ghuzayn area

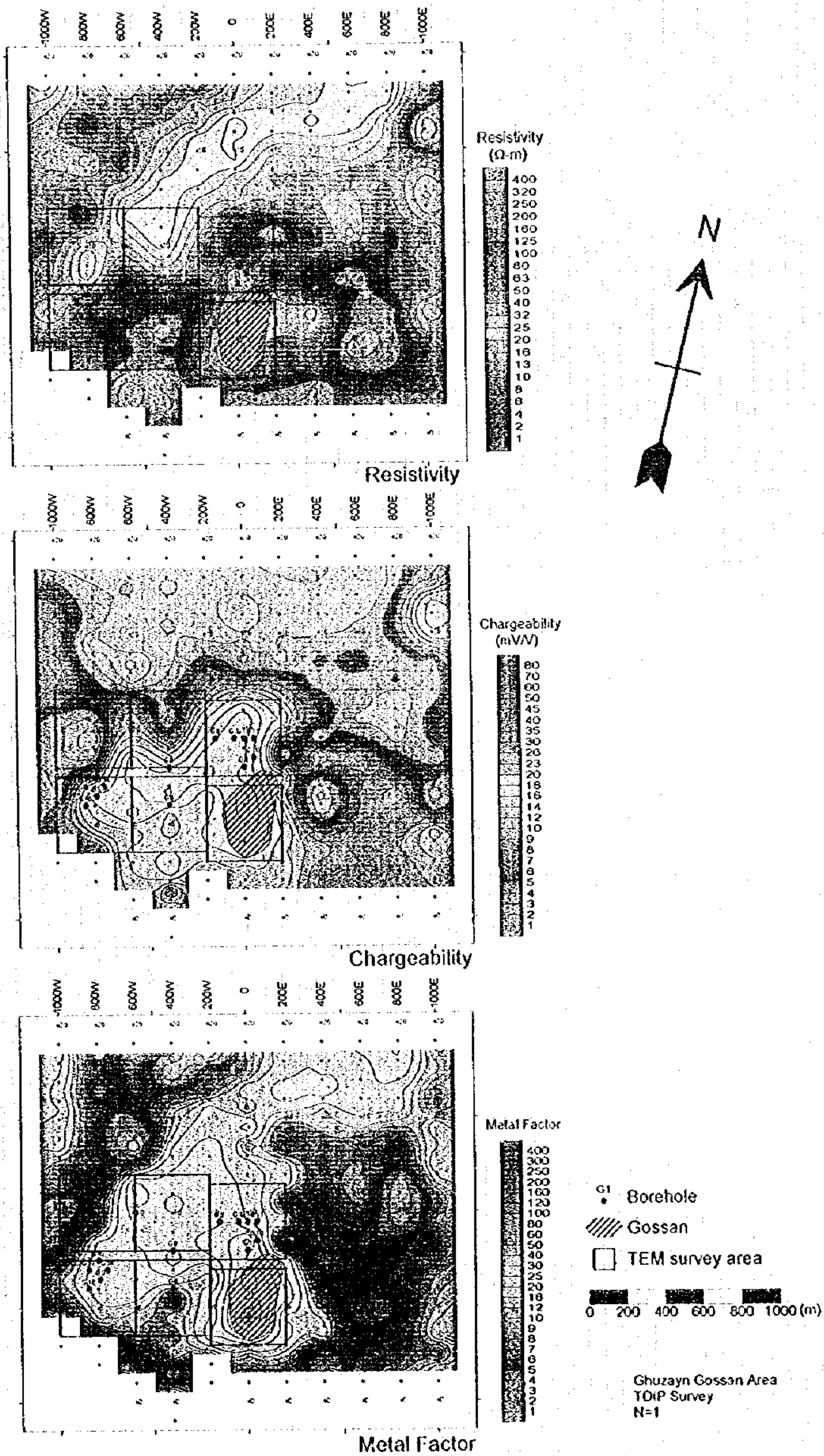
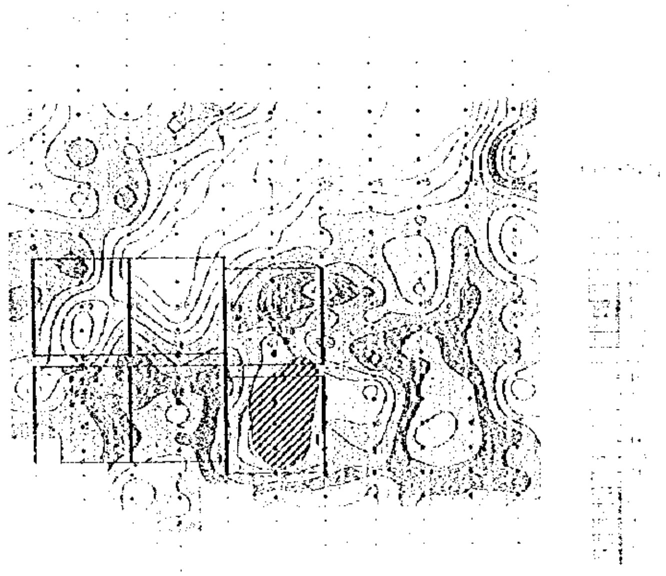
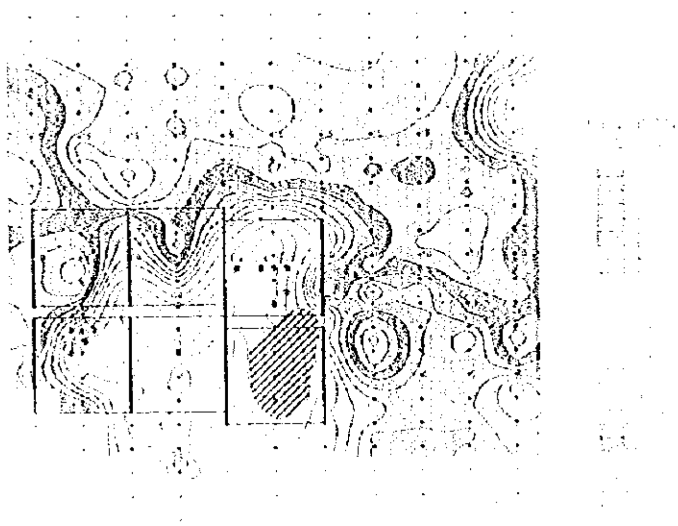


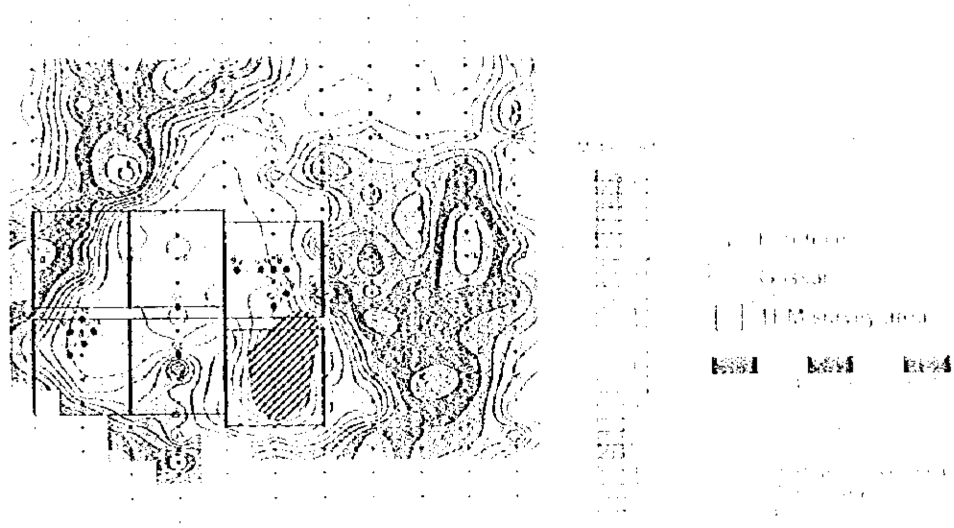
Fig.II-2-6(1) IP plane map at n=1 in Ghuzayn area



Resistivity



Chargeability



Metal Factor

Fig. II ... IP plane map of the ...

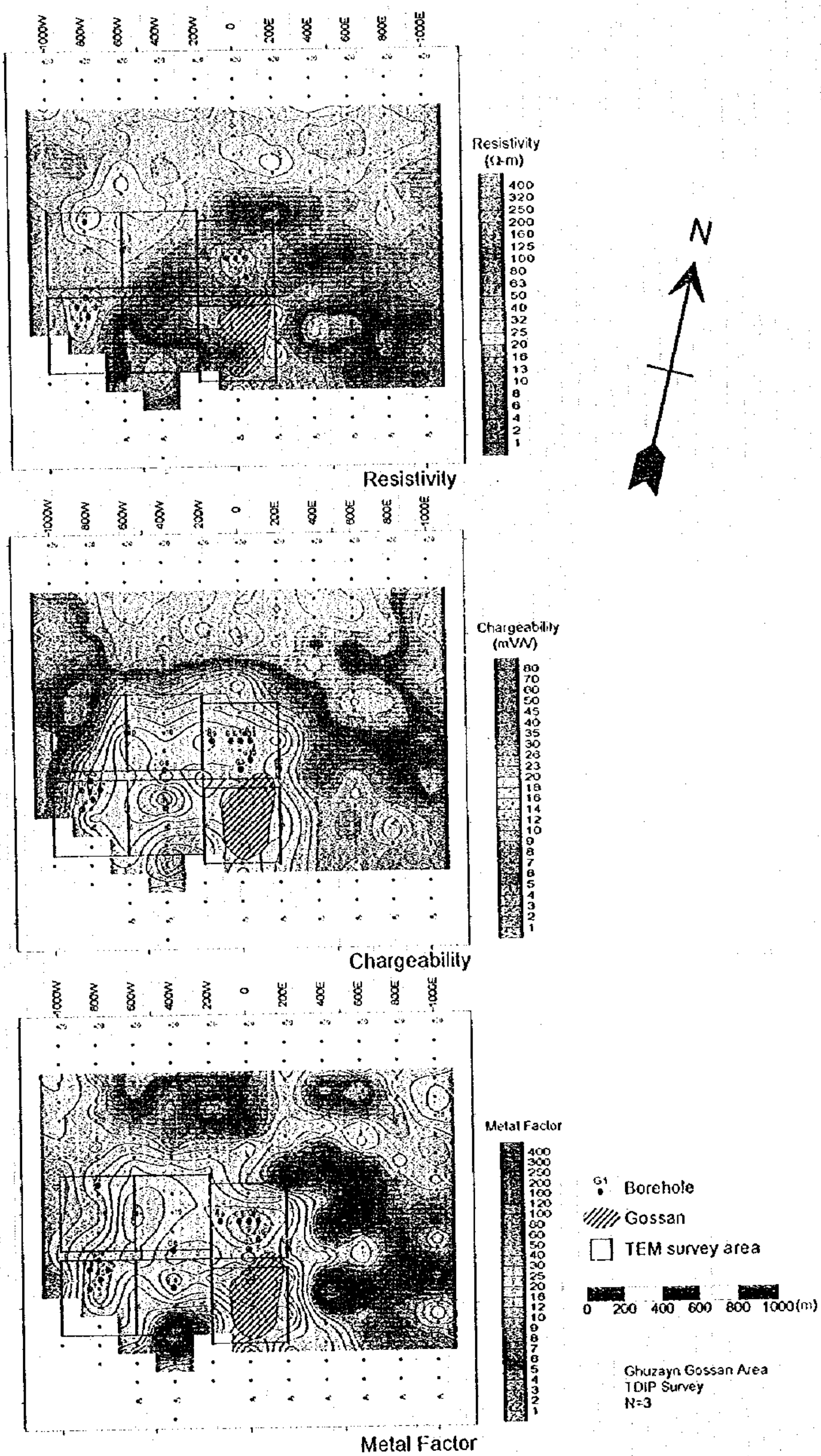
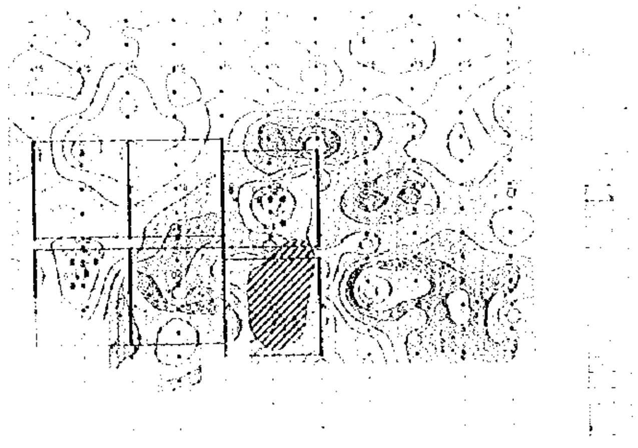
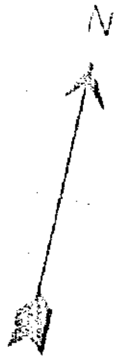
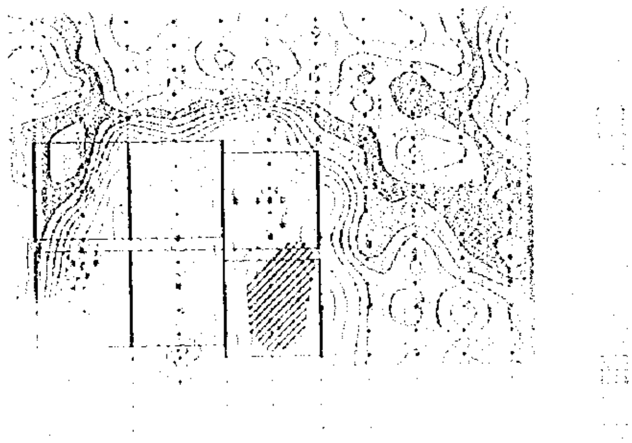


Fig.II-2-6(2) IP plane map at n=3 in Ghuzayn area

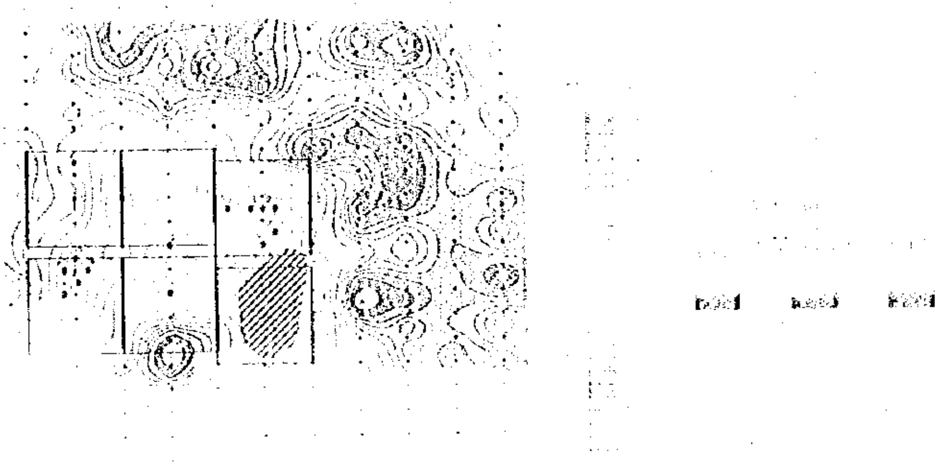




Resistivity



Chargeability



Metal Factor

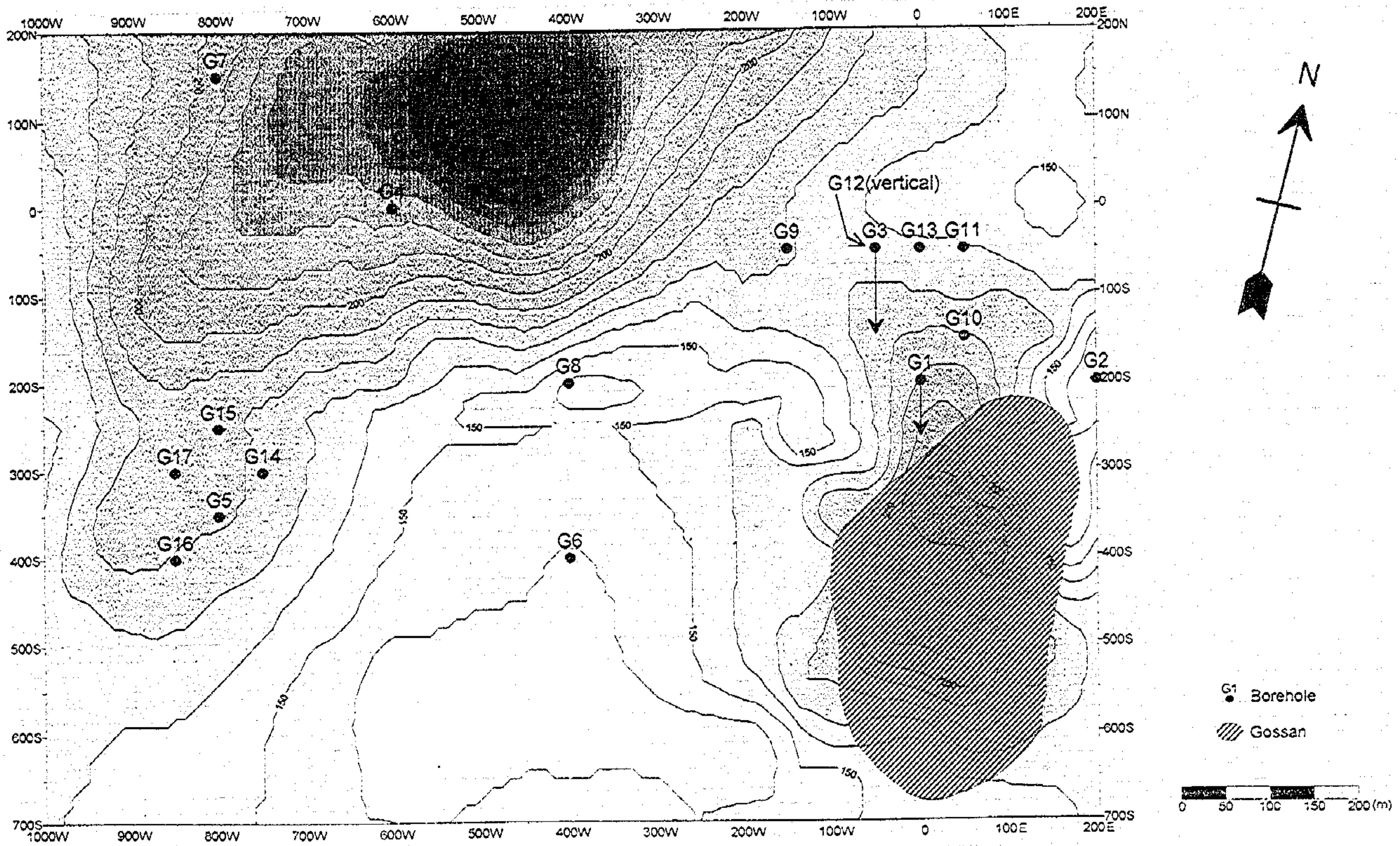
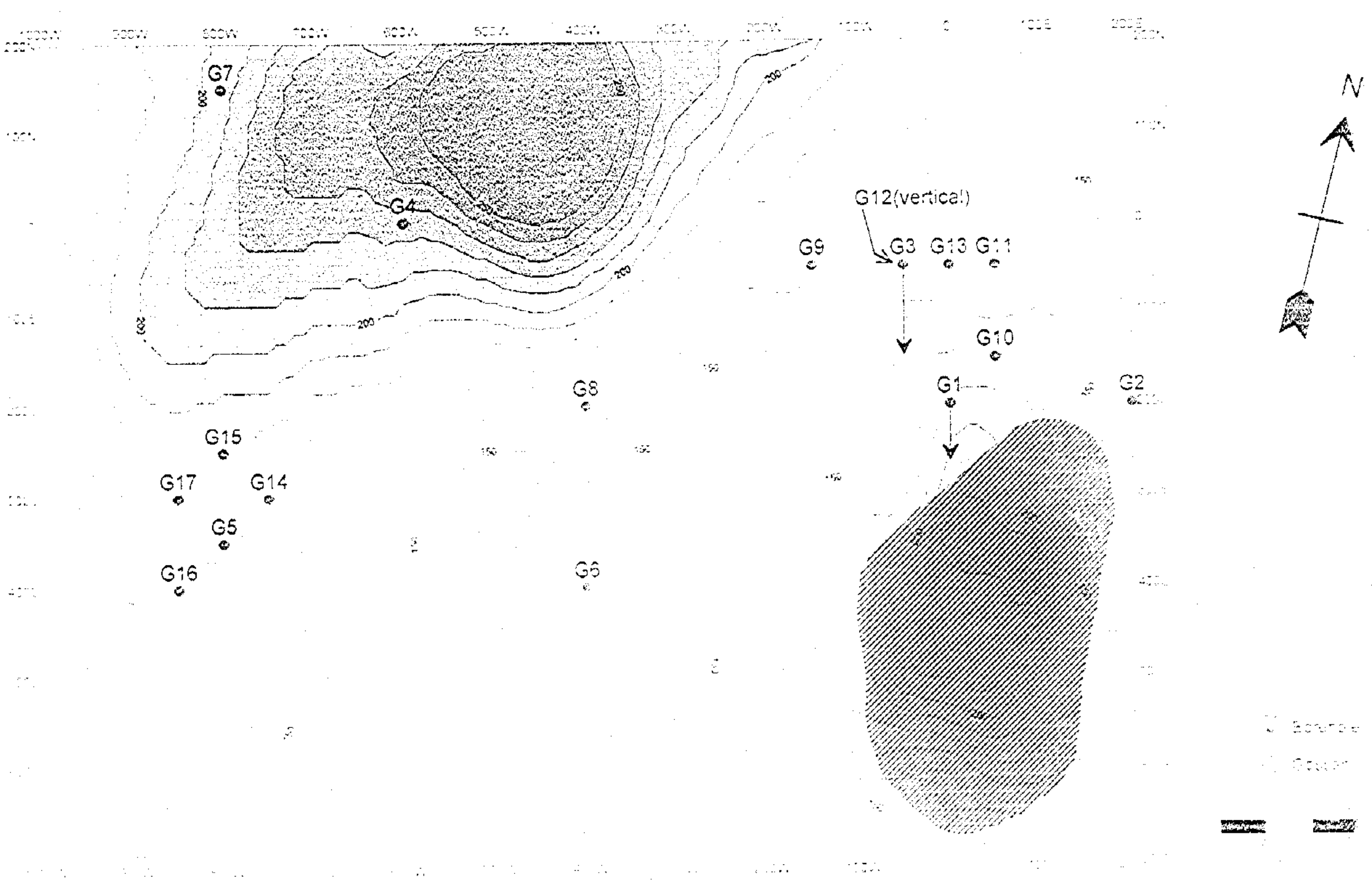


Fig.II-2-7(1) TEM compiled map around 100m depth in Ghuzayn area


N
G1
G2
G3
G4
G5
G6
G7
G8
G9
G10
G11
G12(vertical)
G13
G14
G15
G16
G17
200
250

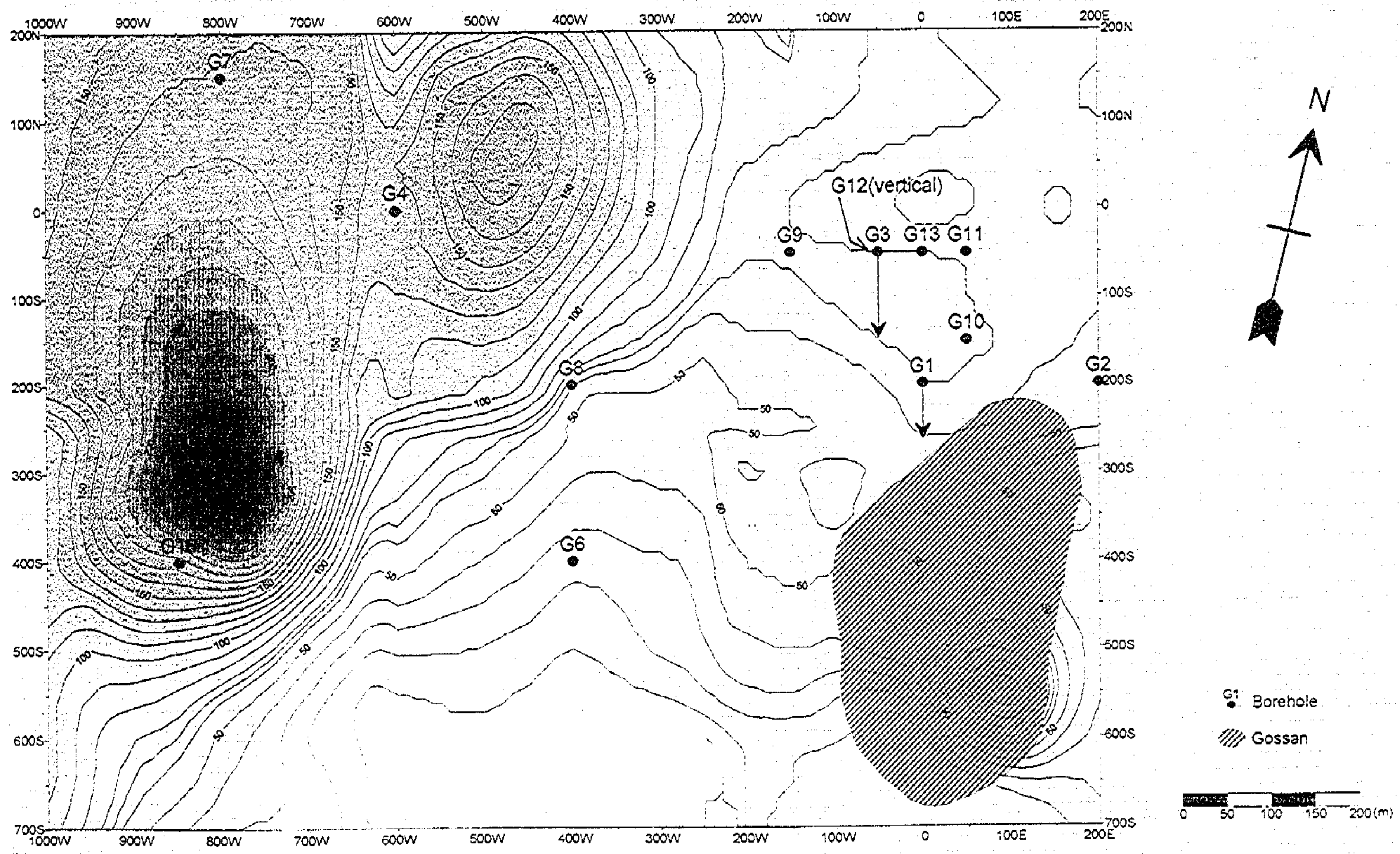


Fig.II-2-7(2) TEM compiled map around 200m depth in Ghuzayn area

N
G7
G4
G12(vertical)
G9
G3
G13
G11
G10
G1
G2
G8
G6
G15
G17
G14
G5
G16
150
200
100

Fig.II-2-7(2) and based on these anomalous distributions, massive sulphide deposits were discovered by the drilling survey in two locations; i.e., to the north side and west side of the gossan.

These two deposits are located on high metal factor zones and additionally, the TEM results shows more clearly the anomaly location due to the deposits. In particular, the TEM anomaly detected around MJOB-G5 is widely distributed to the north, which indicates that the deposit seems to extend to the north and with dimensions assumed to be around 150m in width(E-W) and 300m in length(N-S).

The scale of the northern deposit seems to be small compared with that of the western deposit, because the TEM anomaly distribution around borehole MJOB-G3 is not only not distinct, but also smaller than that of the distribution around MJOB-G5.

Three other TEM anomalies are detected at:

1) 150m east of borehole MJOB-G4,

2) eastern margin of the gossan

3) 200m southwest of MJOB-G1

Among of them,the distribution of anomaly detected at the east of MJOB-G4 is widely seen as shown in Fig.II-2-7(1) and Fig.II-2-7(2).

2-2-2 Drilling survey

(1) Outline of the survey

The high chargeability zone was detected in the central part of the area by TDIP survey conducted in Phase I. Within this zone, several low resistivity portions were delineated by TDIP and TEM survey data. Drilling survey was carried out to confirm mineralization on these low resistivity zones.

Amount of the survey carried out in Ghuzayn area consists of 17 boreholes and 4,146.95m in drilling length. The locations of the bore holes are shown in Fig. II-2-8.

(2) Results of the survey

Two massive sulphide ore bodies were discovered during this survey, i.e., the Northern body intersected by the boreholes of MJOB-G3 and G13 and the Western body intersected by the boreholes MJOB-G5, G14, G15, G16 and G17.

Description of the drilling logs of the principal boreholes that intersected massive sulphide ore bodies are briefly summarized as follow:

(a) MJOB-G3 borehole

Geology: Consisting of Quaternary sediments, Lower extrusives 2(V1-2) and Lower extrusives 1(V1- 1).

0.00m - 6.10m	Unconsolidated Quaternary sediments.
6.10m - 133.45m	Lower extrusives 2. It consists mainly of basaltic pillow lava and massive lava

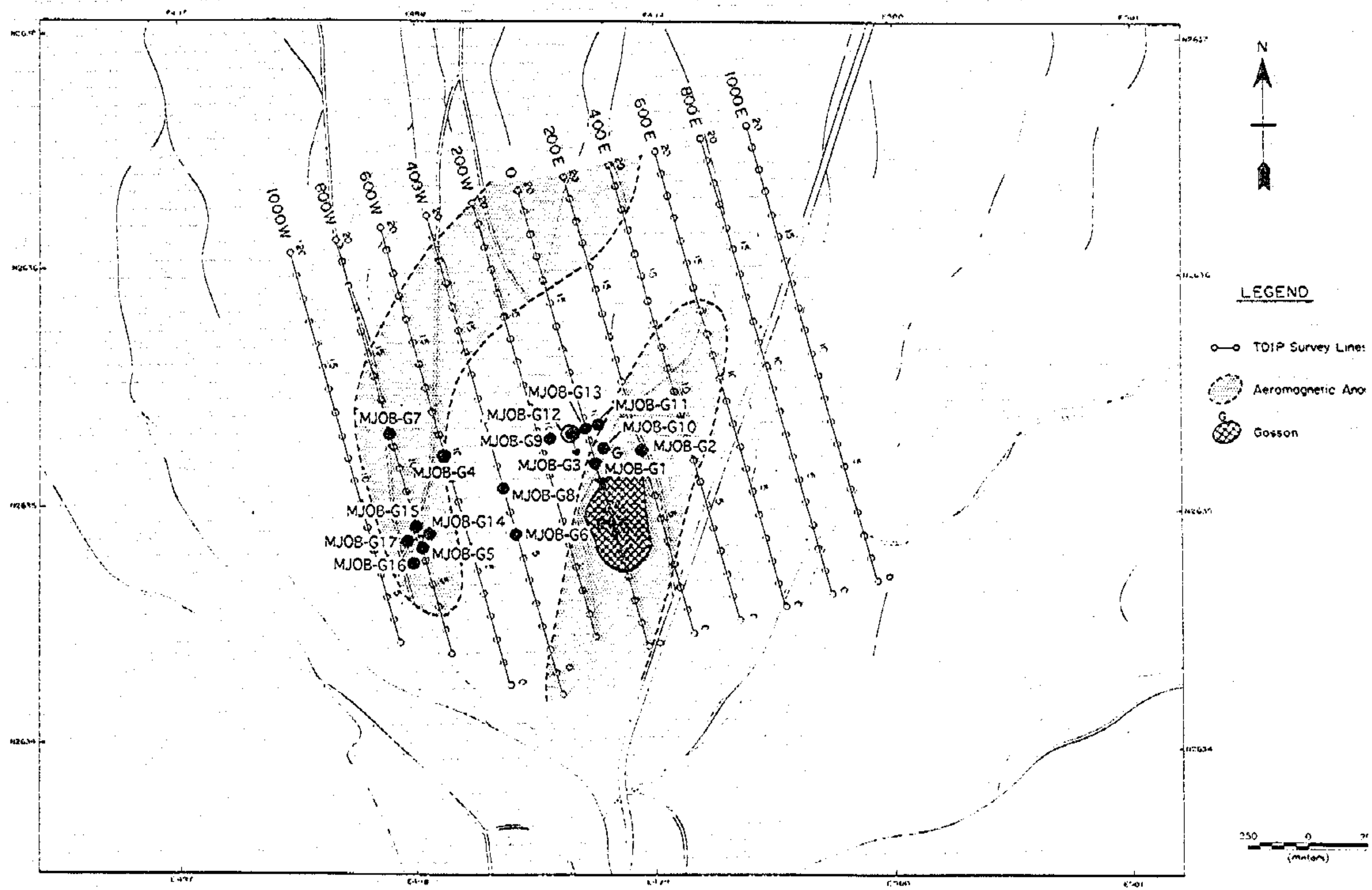


Fig.II-2-8 Location map of bore holes in Ghuzayn area intruded by many basalts and dolerite dikes.

133.45 - 142.80m Massive sulphide minerals (core length: 7.95m). basaltic dykes.

142.80 - 232.00m Stockworks with strong silicification and bleached lower extrusives 1.

232.00 - 300.40m(end of hole) Lower extrusive 1. It consists mainly of basaltic pillow lava with thick interpillows and accompanied in one portion by massive lava and hyaloclastite.

Mineralization: The above mentioned massive sulphide ore was confirmed in the core length of 7.95m, between the intervals of 133.45 and 142.80. Average grade of Cu is 4.66%, but Au was not detected. Pyrite disseminations are observed almost throughout. Above the detected massive sulphide, from 26.25 to 90.90m it is partially observed disseminated chalcopyrite and chalcopyrite-pyrite-quartz veins, from 115.15 to 121.30 it is observed strong chalcopyrite as well as pyrite dissemination. The average copper assay in the interval from 115.15 to 121.30m is 0.49%. Below massive sulphide, it is developed disseminations of pyrite and chalcopyrite as well as veinlets including stockwork zone. From 142.80 to 179.90 comparatively high copper grade is observed in places and the core length of 37.1m in this interval resulted with an average Cu grade of 0.46%. The stockwork zone continues down to 232.00m, but from 179.90 the average Cu grade decreases, so that the Cu grade in 1m interval exceeds in a little more than 0.5% in some places. Below 234.40m depth it is observed sphalerite disseminations and network veins. From 279.50 to 288.80 it is observed, in a 2m interval, an average grade for Zn of a bit more than 3% in some places.

Alteration: It is observed very strong silicification in the hanging wall and footwall of the massive body. In the hanging wall side, the strong silicification is observed from 132.00 to 133.00m, whereas in the footwall side it is observed down to 232.00m, where the texture of the host rock do not remain due to a strong silicification and additionally becoming white throughout the interval due to the bleaching process. At a depth of 18.20m it is already observed silicification but, in general, weak silicification is observed up to 132.0m. From the footwall side up to the depth of 232.00m, silicification is comparatively strong and continues all the way down the bottomhole. In limited places, it is observed partial epidotization in the hanging wall within the interpillow lava.

(b) MJOB-G5 borehole

Geology: Consisting of Quaternary sediments, Lower extrusives 2(V1-2) and Lower extrusives 1(V1- 1).

0.00 - 10.10m Unconsolidated Quaternary sediments.

10.10 - 23.10m Consolidated Quaternary sediments. (calcrete)

23.10 - 136.90m Lower extrusives 2. Mainly basaltic pillow lava as well as massive lava, accompanied by basalt and dolerite dikes.

136.90 - 170.6m Massive sulphide (core length 33.70m). The upper part is accompanied by magnetite layers of 2cm in thickness.

23.10 - 136.90(end of hole) Lower extrusives 1. Consisting of basaltic lavas with a little thick interpillows around 5 to 15cm of thickness.

Mineralization: As stated above, massive sulphide was intersected as indicated in the core length of 33.70m. Chemical analysis resulted in Cu 1.47%(average) and Au content of less than 0.1%. Pyrite dissemination is observed almost everywhere accompanied by chalcopyrite and pyrite bearing calcite or epidote-quartz sparse veinlets. Below the massive body, quartz veinlets of networks are seen developed, however, they are almost not accomapnied by ore minerals.

Alteration: From the depth of 63.70m to the bottom of the hole, weak silicification is observed. Epidote-calcite and epidote-quartz veins are often observed, though just above the massive sulphide ore from 133.05 to 136.90m it is strongly epidotized.

(c) MJOB-G14 borehole

Geology: Consisting of Quaternary sediments, Lower extrusives rocks 2(V1-2) of Lower volcanics, massive sulphide ore and Lower extrusive rocks 1 (V1-1).

0.00m - 3.50m	Unconsolidated Quaternary sediments.
3.50m - 18.60m	Consolidated Quaternary sediments (calcrete).
18.60m - 119.80m	Lower extrusive rocks 2. Consisting of basaltic pillow lava, massive lava and many intruded basaltic or doleritic dykes which cut accross the lavas. Metalliferous sediments are accompanied at the bottom of the interval between 119.50 and 119.80m.
119.80 - 164.75m	Massive sulphide ore (core length: 37.10m). Accompanied by basaltic dikes of 1 to 2m in width.
164.75 -305.40m(end of hole)	Lower extrusive rocks 1. Intensely silicified section from164.75m to 235.05m, show a stockwork of veinlets. From 235.05 to the bottom of the hole silicified pillow lava is observed.

Mineralization: Massive sulphide was intersected as indicated in the core of 37.10m in length. Average grade resulted in 1.88%Cu. A large part of the core shows a non-detected gold content. Although remarkable mineralization is not seen, weak pyrite dissemination is observed on the hanging wall side, on the footwall side and down to the depth of 230.50m, a stockwork is formed as in borehole G3. Pyrite dissemination, pyrite and sphalerite bearing quartz veins are developed in the depth of more than 230.50m. Among stockworks from 164.75m to 171.50m, which are rich in chalcopyrite, average grade resulted in 2.74%Cu, 0.44%Zn, , while for the section from 171.50m to 230.50m., average grade resulted in 0.37%Cu and 0.32% Zn.

Alteration: Only bleaching is observed on the hanging wall side. Remarkable silicification can not be recognized. Epidote networks are developed in the pillow lavas located just above the massive ores (between 104.80m and 119.50m). On the footwall side and down to 235.05m, intense silicification is observed. From 235.05 to the bottom of the hole, some silicification is observed.