NO.

REPORT ON THE MINERAL EXPLORATION IN THE MARRAKECH-TEKNA AREA, THE KINGDOM OF MOROCCO CONSOLIDATED REPORT

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JAPAN INTERNATIONAL COOPERATION AGENCY
JAPAN OIL, GAS AND METALS NATIONAL CORPORATION

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PREFACE

In response to the request of the government of the Kingdom of Morocco, the Japanese Government decided to enforce various Surveys on deposit exploration including geological and geophysical surveys to evaluate potential of mineral resources in the Marrakech-Tekna area located in the middle-west of Morocco and entrusted the Japan International Cooperation Agency (JICA) with the execution of such Survey. Since details of the Survey were concerned with specialized fields of geology and geological resources, JICA entrusted the Metal Mining Agency of Japan (the present, Japan Oil, Gas and Metals National Corporation: JOGMEC).

The survey was carried out in three phases from 2002 to 2005. The field survey program in the area has completed as scheduled in cooperation with the Bureau de Recherches et de Participations Minieres (BRPM) and the concerned governmental organizations of Morocco.

This report includes summary of the surveys in three phases.

Finally, we would like to express a deep appreciation for the cooperation of the concerned governmental organizations of Morocco and Japan.

February, 2005

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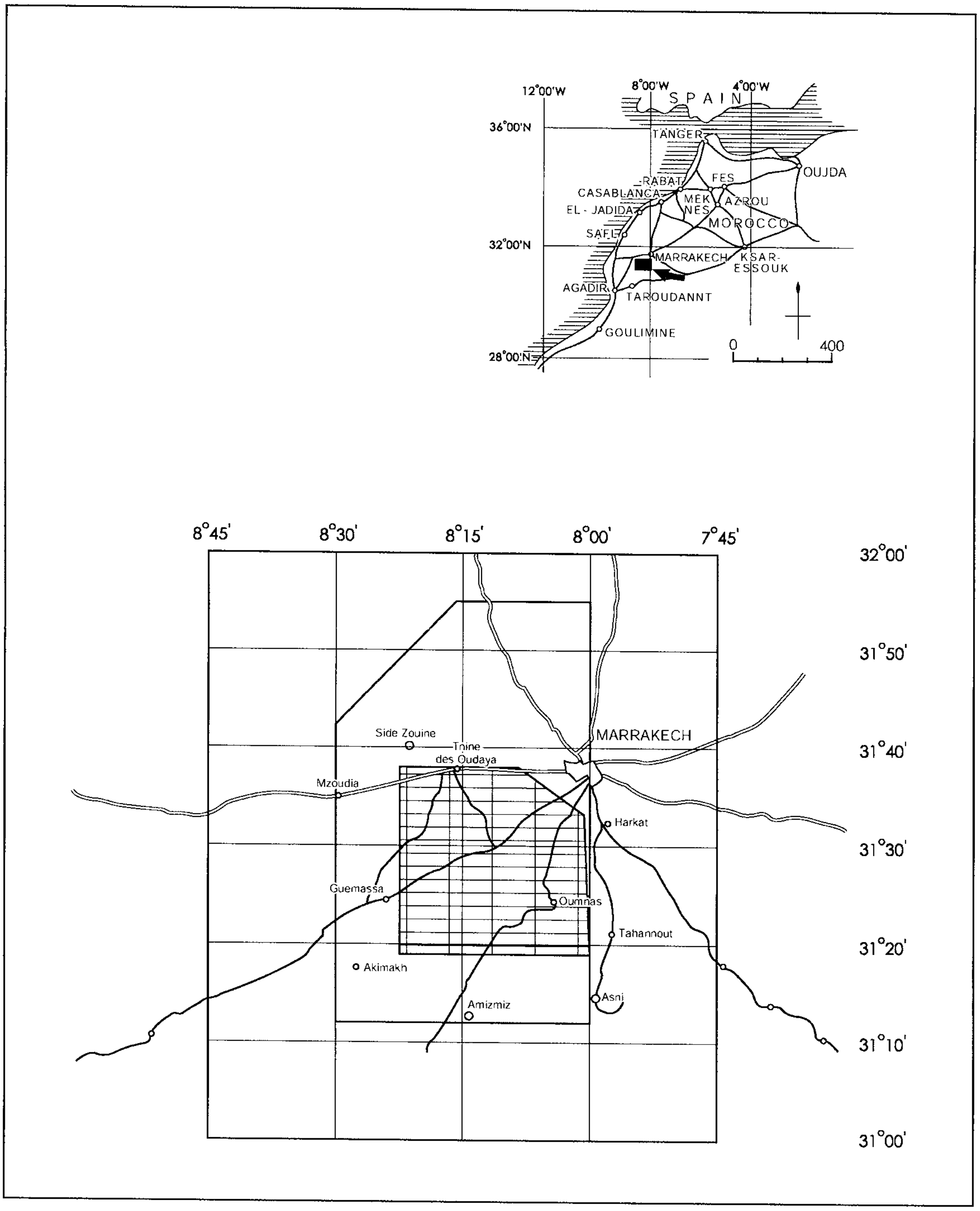

Fig.1 Location Map of the Survey Area

Summary

This survey was carried out in Marrakech-Tekna area, the Kingdom of Morocco. The purpose of this survey is to extract the prospective area of volcanic massive sulfide ore deposit of cupper-lead-zinc by geological and geophysical survey and mineralization analysis. The technology transfer to the counterpart organization is also the major purpose of this survey.

As the phase I survey, the geological survey, drilling core observation and airborne geophysical survey were carried out to analyze the mineralization characteristics of massive sulfide ore deposit and to obtain the findings to analyze/interpret the results of the above airborne geophysical survey. As the result of the Survey is as followings.

According to the result mentioned above, because it is possible that there are not only the ore deposit that has high magnetic anomaly but also that has medium to low magnetic anomaly in the Survey area, following anomalies were selected as survey areas.

1) Low resistivity zone + high to medium magnetic anomaly: possibility of the existence of high magnetic massive sulfide ore deposit.
2) High magnetic anomaly zone: Possibility of the existence of high magnetic massive sulfide ore deposit.
3) Low resistivity zone: possibility of the existence of medium to low magnetic massive sulfide ore deposit.

Phase II and Phase III's program has been conducted in areas showing magnetic or conductivity anomalies in the first year's program. The electrical IP method and electromagnetic TEM method have been applied in the program. It is also due to that Cenozoic sediments cover the most surface. And drilling survey was carried out in order to know geological structure and the situation of mineralization.

As the results sulfides (pyrrhotite, sphalerite and pyrite etc.) were often observed in pelitic – silty schist. Sulfur isotope ratio of sulfide from MJTK-6 in Azzouz area indicates some volcanic influence.

Therefore gravity survey, in western area of Azzouz, can be effective to get some indication of Volcanic rocks as the footwall of volcanic massive sulfide ore deposits.

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Part I

General Remark

Part I General Remark

Chapter 1 Outline of the Survey

1-1 Object of the Survey

Marrakech-Tekna in the Kingdom of Morocco as the target area of our survey has a high potential of the massive sulfide deposit existence containing multiple metal elements similar to those in KUROKO in Japan or Iberian pyrite belt distributed in Spain and Portugal, where BRPM and private mining companies (including those abroad) have energetically enforced their deposit explorations. This survey was carried out in order to find promising districts with the existence of massive sulfide deposits and to contrive technical transfer to the government officers of the country through field's work and analysis of the geological conditions and mineralization.

1-2 Survey Area

The Marrakech Tekna area is located in the central part of the Kingdom of Morocco (Fig.1).

1-3 Survey Method and Contents

(1) Phase I

Compilation of existing data, geological survey, existing drilling core logging to identify ore horizon and airborne geophysical survey are applied as for the Phase I Survey in order to find survey area of massive sulfide ore deposits.

Items	Quantity
Geological survey Drilling core survey Airborne geophysical survey	2,100km² (entire area), 3638.15 km (core length), 27 existing drilling cores 6,853.5km (flight length), 1,110km² (survey area)

(2) Phase 2

The eight districts have been investigated by the electric prospecting IP method, and the three districts have been tested by the electromagnetic TEM method. Table I-1-1 Survey contents and amount of works.

• Electric survey (IP method)

District	Line	Line kilometer	Points	Remarks
MJTK-IP-1	A	2.0	80	E-W direction
	B	2.0	80	E-W
	C	2.0	80	E-W
	D	2.0	80	E-W
	E(a-north)	2.0	80	E-W
	F(d-south)	1.6	60	E-W
MJTK-IP-2	A	2.0	80	E-W
	B	2.0	80	E-W
	C	2.0	80	E-W
MJTK-IP-3	A	1.2	40	N-S
	B	1.3	45	N-S
	C	1.2	40	E-W
	D	1.3	45	N-S
MJTK-IP-4	A	1.0	30	NE-SW
MJTK-IP-5	A	1.0	30	E-W
MJTK-IP-6	A	1.0	30	E-W
	B	1.0	30	E-W
	C	1.0	30	E-W
MJTK-IP-7	A	1.5	55	E-W
	B	1.5	55	E-W
	C	1.5	55	E-W
	A-200	1.6	20	E-W、Intervals:200m
MJTK-IP-8	A	1.0	30	E-W
Total		35.1	1,235	

• Electromagnetic survey (TEM method)

Area name	Number of stations	Length of survey lines	Spacing (m)
MJTK-IP1	104	N-S 9 lines 4050m E-W 1 line 2000m	50 100
MJTK-IP6	9	E-W 1 line 800m	100
MJTK-IP7	26	N-S 1 line 400m E-W 1 line 1800m	50 100
Total	139	9050m	

Drilling survey

Number	Inclination	Direction	Length	Coordinates		Altitude
MJTK-1	-90°	--	592.70m	N31 32 39.9	W08 04 25.9	577m
MJTK-2	-70°	90°	253.20m	N31 32 33.3	W08 04 49.2	571m
(Total)			845.90m			

(3) Phase 3

six survey districts were selected for the electric IP method, two of them have been surveyed by the electromagnetic TEM method.

・ Electric survey (IP method)

District	District Code	Method	Length (line)	Number of Point
Azzouz	MJTK-IP04-1	Dipole-Dipole	39.9km（*）	1635
Hbibi	MJTK-IP04-2	Dipole-Dipole	1.5km(=1.5km×1 line)	55
Harch	MJTK-IP04-3	Dipole-Dipole	2.0km(=2.0km×1 line)	80
Maouch	MJTK-IP04-4	Dipole-Dipole	1.6km(=1.6km×1 line)	60
Khefawna-N	MJTK-IP04-5	Dipole-Dipole	6.0km(=2.0km×3 lines)	240
Talzelt-N	MJTK-IP04-6	Dipole-Dipole	6.0km(=2.0km×3 lines)	240
Total			57.0km	2310

*(=3.0km×3 lines+2.8km×1 line+2.7km×1 line+2.5km×1 line+2.3km×1 line+2.2km×2 lines+2.0km×6 line ＋1.5km×2 lines+1.2km×1 line)

・ Electromagnetic survey（TEM method）

Area name	Tx-Rx configuration	Number of stations	Length of survey lines
Azzouz	In loop	146	
	Fixed loop		300m*3lines*2loop
Khefawna	In loop	19	
Total		165	1,800m

And the drilling survey of following 4 holes was carried out.

No.	Inclination	Declination	Length	Coordinates		Altitude
MJTK-3	-70°	325°	701.0m	N31 28 30.5	W08 11 49.8	588m
MJTK-4	-55°	325°	601.2m	N31 28 40.1	W08 11 34.9	570m
MJTK-5	-70°	270°	502.1m	N31 24 59.1	W08 12 22.7	682m
MJTK-6	-70°	325°	301.9m	N31 28 10.2	W08 12 11.0	589m
		Total	2106.2m			

1-4 Survey Terms and Members

Survey terms of each phase are as follows.

(1) Phase I

Description of survey	Period
Preliminary survey Geological survey Airborne geophysical survey	July 14 to 24, 2002 September 10 to October 13, 2002 January 4 to March 7, 2003

(2) Phase 2

Geophysical survey	(Field survey)	From August 31,2003 to September 1, 2003
Drilling survey	Local stay period	From December 16, 2003 to February 13, 2004
	Drilling period	From December 24, 2003 to January 28, 2004
	Observation of rock core	From December 29, 2003 to February 12, 2004

(3) Phase 3

Geophysical survey	(Field survey)	From August 31,2004 to October 22, 2004
Drilling survey	Local stay period	From November 20,2004 to February 15, 2005
	Drilling period	From November 28,2004 to February 9, 2005
	Observation of rock core	From November 29,2004 to February 10, 2005

Survey members of each phase are as follows.

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1-5 Outline of the Survey Area

1-5-1 Locations and Access

There are paved roads in most sections from Rabat to the area. It takes approximately 1.2 hour to get to Setat from Rabat via highway. And, It takes approximately 2.5 hours to go to Marrakech from Setat via main road. In addition, direct flights to Paris and to London are available at the international airports in Rabat, Casablanca and Marrakech.

1-5-2 Geography, Climate, and Vegetation in the Survey Area

It is approximately 330km to the south of Rabat (capital city), north of the Haut Atlas Mountains, and also southwest of Marrakech. The survey area extends from 31° 19' to 31° 38' north latitude and from 8° 01' to 8° 24' in west longitude.

The climate of the area is dry as daily and annual fluctuations of temperatures are significant. It goes more than 40℃ in summer, and approximately 0℃ in winter.

The survey area generally consists of gentle hills with altitude of 400-800m above sea level. The Jebilet Mountains extend along the north district of the area. The Haouz plane is distributed in the central part. And the Guemassa Mountains are distributed in the southern part.

The climate of the area is of arid-inland, temperature widely varies day and night, and season to season, over 40 degrees in Celsius in summer and near zero degree in winter. The vegetation in the area is generally poor, however, some plants adequate for arid area like olives, grapes, wheat, etc. are cultivated. Sheep pasturage is also common. The rainy season ranges April and May, and October and November, and the annual precipitation is about 300 millimeters.

Occasional heavy rainfalls in the rainy season give some rigorous damage.

1-5-3 Outline of the Geology

The modeled geological column is shown in Fig I-1-5-1. Geological map is shown in Fig I-1-5-2. The central Jubilet in the north of the Survey area consists of the basement rocks that were deposited with the strike of the direction approximate NS or NNE – SSW and the dip to the east. On the other hand, the geological structure of Guemassa in the south of the Survey area consists of the sediments with the strike of the direction NNW – SSE or NE – SW and the dip to the east. The basement rocks are mainly composed of pelite rocks of Devonian - Carboniferous - Permian that are interbedded with limestone, tuff and psammytic rock layers. Besides them, the basement rocks are interbedded with many acid or basic sills.

The geology of Visean, Upper Carboniferous, in the central Jubilet and Guemassa, is composed of pelite rocks, acid volcanic rocks, basic volcanic rocks, rhythmic alternation, phyllite of the Sarhlef Formation, and carbonate rocks and pelite rocks of the Tequsim Formation that is the upper of the Sarhlef Formation

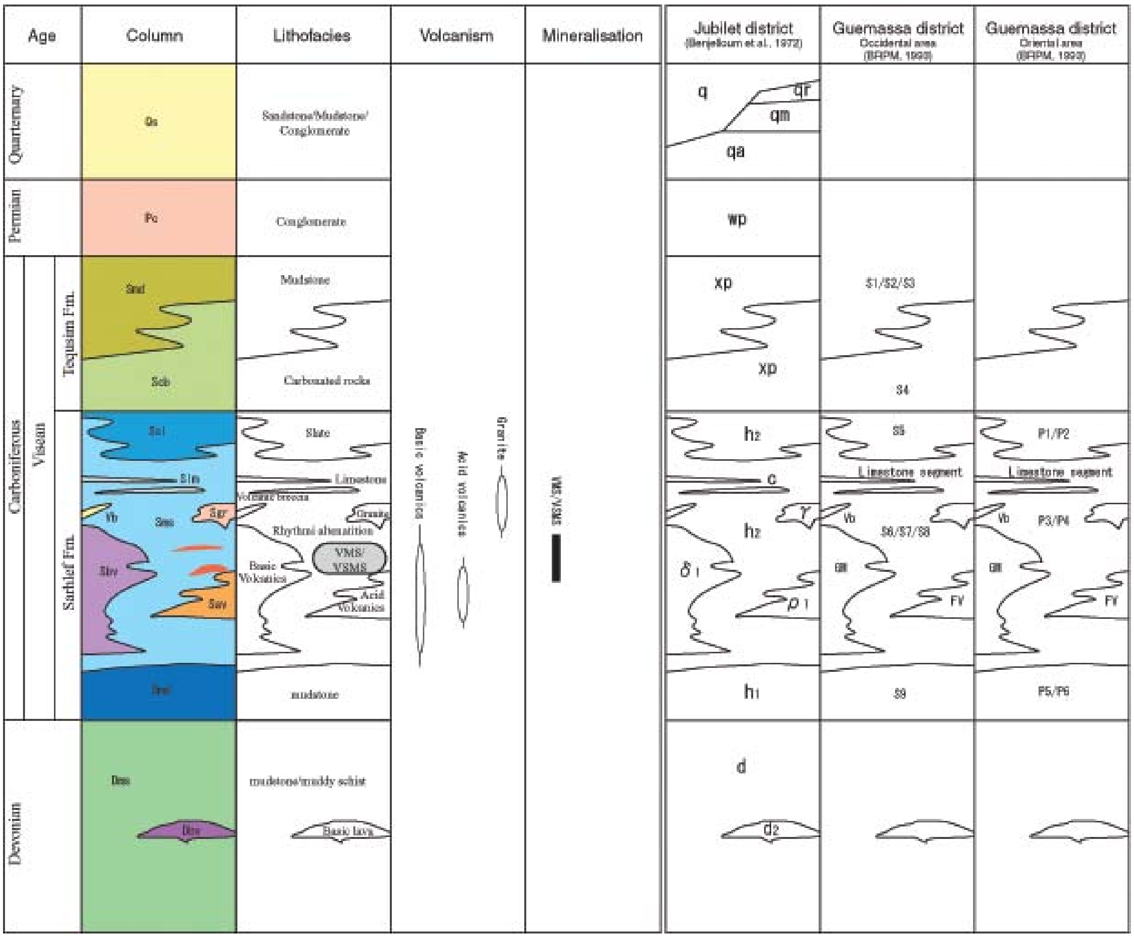

Fig I-1-5-1 Geological Column at Marrakech-Tekna Area

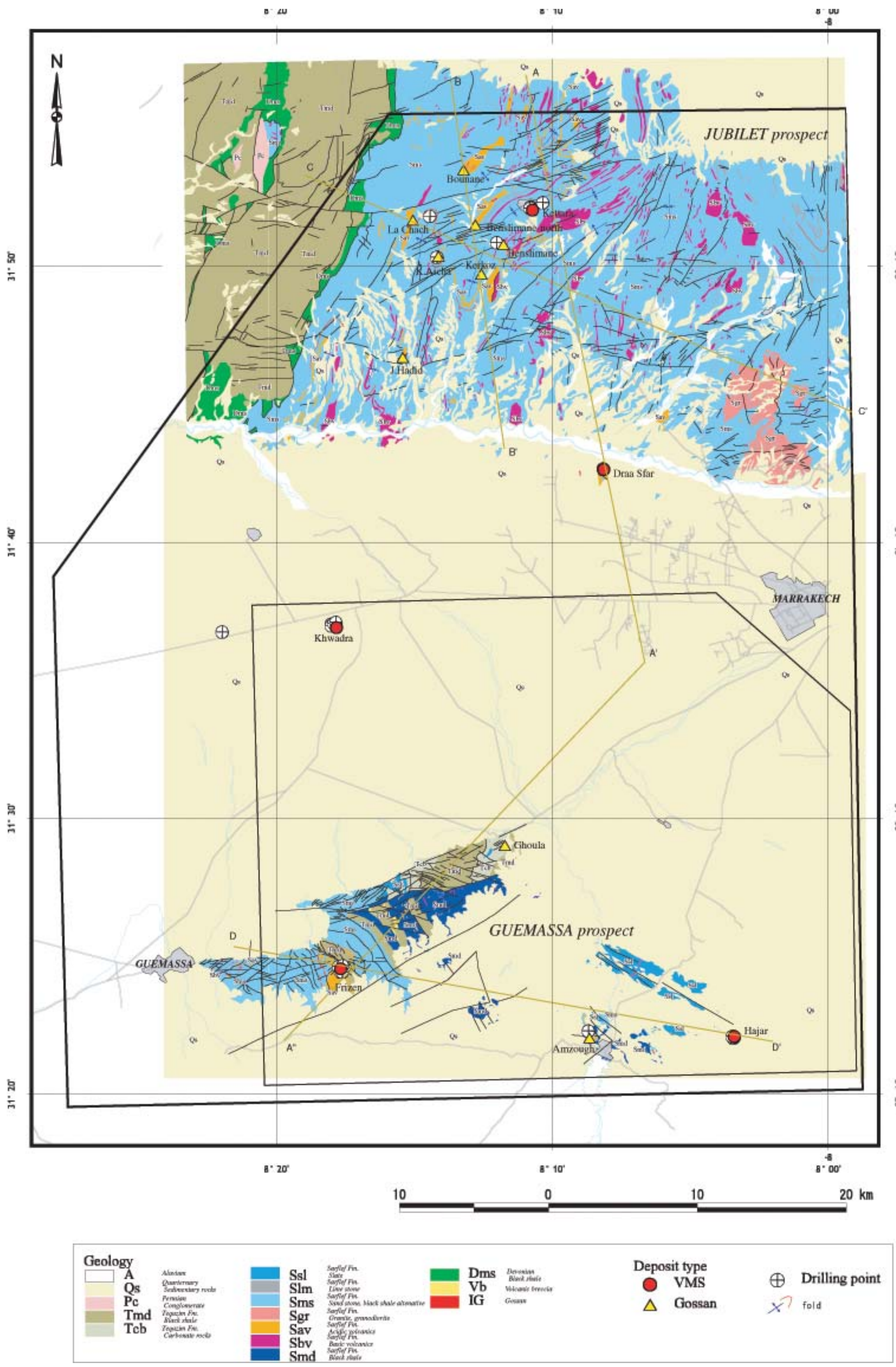

Fig I-1-5-2 Geological Map of Marrakech-Tekna Area

1-5-4 Mines and Mining activity

The mining product is the greatest foreign currency income source for Morocco at present, and occupies about 30 percent of the total export value, about six percent of GDP. The most important mineral product of Morocco is phosphorite mainly consisting of apatite, and Morocco is the third largest exporting country in the world, following U.S and China.

Other than phosphorite, Morocco also exports silicon, lead, copper, zinc, silver, and manganese. Ore deposits of gold, cobalt, nickel, iron, uranium, and fluorite are also known in this country (Fig.I-1-5-4-1 Ore Deposits in Morocco).

The massive sulfide ore deposits exist in the surrounding area of the survey area. The Draa Sfar Mine to the north of the survey area and the Hajar Mine to the east are in operation at present. The Kettara Mine to the north of the survey area was in operation in the past. The Kettara Mine situating to the north of the survey area was discovered in 1937, and been operated until 1982 for pyrrhotite ore. The pyrrhotite was utilized as reducing agent for phosphate ore produced in Morocco. It is said that the mine has about 1,000 tons of reserve at present.

The Draa Sfar Mine situating to the northeast of the survey area started their iron ore production in 1953. The ore is in the oxide zone near surface. BRPM performed a magnetic survey and drilling program in 1962, and succeeded to discover a thin lenticular body of copper-bearing pyrrhotite ore. BRPM mined out about 4,000,000 tons of ore from a zone down to 150 meters during a period from 1968 to 1982. During a period from 1986 to 1996, BRPM performed drilling programs, then sold the mine to a private company, Compagnie Miniere des Guemassa (CMG) in 1997. The Draa Sfar Deposit is hosted in a rhyolite body and overlying rhyolitic tuff in vertical. The ore body extends more than 800 meters to both sides, and is overlain by silty rock.

The Hajar Mine is situated 35 kilometers south of the Marrakech. BRPM discovered the ore by their drilling program for a magnetic anomaly zone in 1984, and continued their exploration activity until 1988. ONA and BRPM founded a new company, Compagnie Miniere des Guemassa (CMG), and CMG bought the mine. CMG started operation in 1992, and is producing about 100,000 tons of zinc, 40,000 tons of lead, and 30,000 tons of copper in every year.

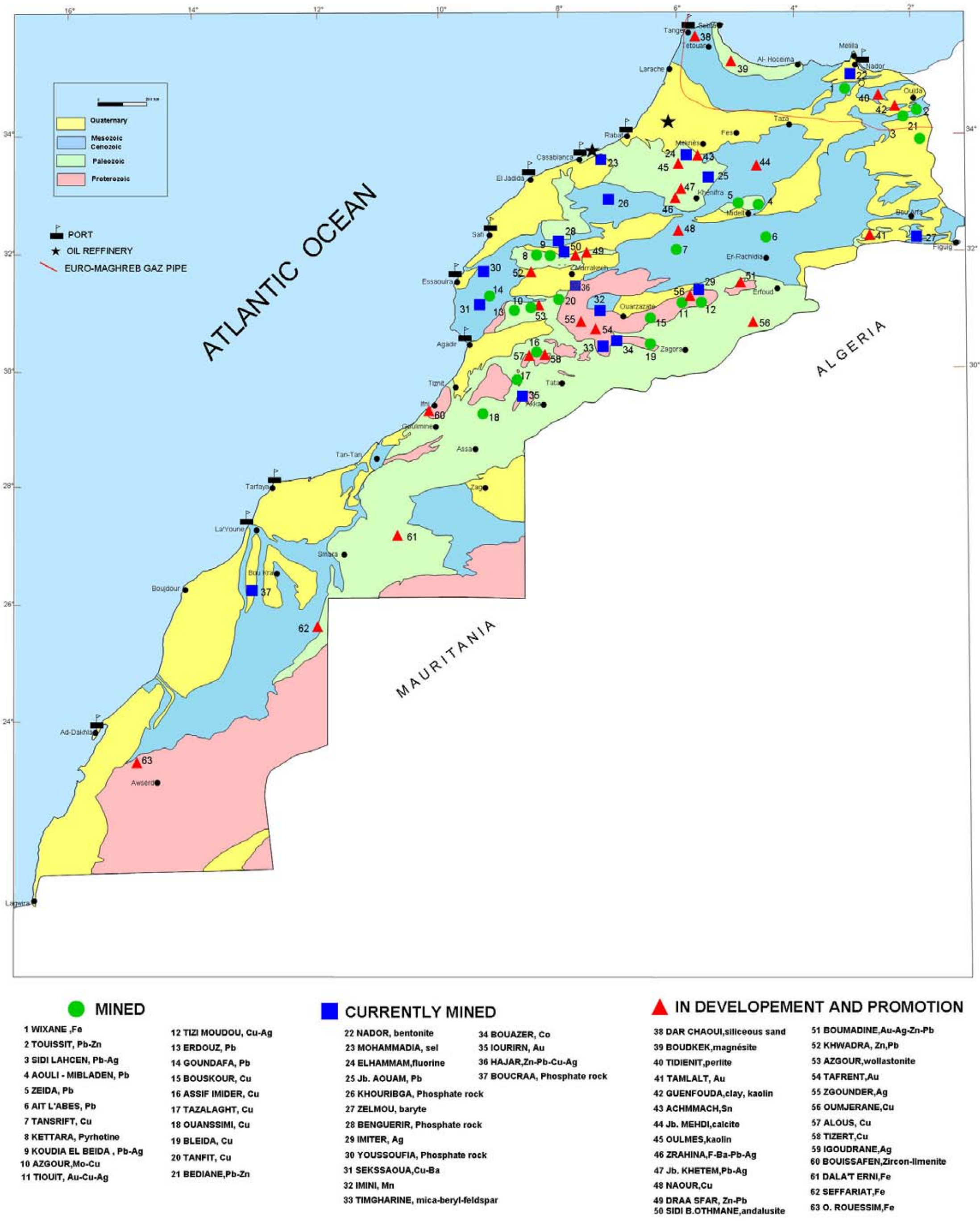

Fig.I-1-5-4-1 Ore Deposits in Morocco

Chapter 2 Conclusion and Recommendation

2-1 Conclusion

Mineralization of calcite and sulfide was mainly found at MJTK-1,3,4,5 and 6. Sulfide is usually along schistosity (foliation).

Pelitic and silty schist is friable with graphite even though the schist is with calcareous and sandy schist.

However, the lithofacies do not change so much, and sometimes alternate with several mm unit. Therefore it is difficult to simply divide the lithofacies by the repetition of same lithofacies.

The schistosity (foliation) sometimes has a different direction from bedding. the schistosity was formed by structural movement metamorphism, and schistosity usually has similar direction to axis of a fold. Therefore bedding is often different to schistosity near anticline or syncline.

Pyrrhotite was metamorphosed from pyrite, however it is often along foliation. Metamorphism was not at a time.

Pyrite was formed more than twice, and the latter mineralization was much weaker.

In other words, most pyrite were brought by early mineralization. The earlier mineralization is with sphalerite, and a considerable part of pyrite changed to pyrrhotite through metamorphism.

The resistivity inversely correlates with the chargeability in general. And the chargeability slightly correlates with the magnetic susceptibility. Therefore the chargeability is due to pyrrhotite more than graphite.

Pyrrhotite concentrate at 360m depth in MJTK-5 and this mineralization zone probably form the magnetic anomaly. The chargeability may be due to pyrrhotite even around other drilling holes. It is likely that there are a wide pyrrhotite zone around MJTK-3,4 and 6. Pyrrhotite is dominant with sphalerite, galena, chalcopyrite and pyrite in microscope. It can be regarded not only as vein-like and network-like but also as thin layered type. The ratio of sulfur isotope is similar to Hajar mine. Probably, MJTK-6 is near a volcanic hydrothermal ore deposit, and MJTK-3 is affected by biological isotope circulation.

2-2 Recommendation for future

It is difficult to distinguish the main ore deposit and surrounding sulfide concentration only by magnetic anomalies. The existence of the volcanic rocks as the footwall may indicate main ore body, therefore it is necessary to know the underground structure by gravity survey. And the method of sulfide isotope is effective to consider the drilling survey method of the part under the

Cenozoic sediments.

Isotope ratio indicates some past hydrothermal activity by volcanism in Azzouz area. Some magnetic anomalies distribute even in west area from the Azzouz area, therefore the gravity survey in the expanded area may indicate volcanic rocks as the footwall of volcanic massive sulfide deposit.

The magnetic anomaly in Khefawna area is not large and the pyrrhotite concentration in MJTK-5 can be regarded as the cause of the anomaly. Therefore Khefawna area can hardly have any more promising part.

Part II

Details of the Survey

Part II Details of the Survey

Chapter 1 Collection and Analysis of the Existing Data

Exploration of the periphery of this area has been conducted by BRPM and its joint explorers on Jebilet, Guemassa and Haouz plain. The activities can be divided into three periods of time as follows.

Around 1930s: Surface survey was performed on gossan in the area of outcrops (Kettara deposit in Jebilet),

1960s onward: gyophysical survey was performed on the ground concealed deposits andsurface prospects and the underground extension of gossan (Draa Sfar deposit in the south of Jebilet),

The latter half of 1980s onward: airborne geophysical survey and the ground survey on concealed deposits (discovery of Hajar deposit in the east of Guemassa mountain mass and Khwadra deposit in Haouz plain - both of them are concealed deposits).

As a result, we confirmed high-magnetism anomaly in the airborne magnetic survey and known deposits, especially gossan ranging from Lachach in Jebilet, Kt. Aicha, Kechnet to Jbel Hedit and gossan ranging from Bensliman to Kerkoz and gossan distributed in the south and north of Kettara showed extremely good correspondence with each other. Basic volcanic rocks such as microgabbros, structural elements such as faults and contact metamorphic rocks such as granites and quarzites distributed in the eastern and western edges of the survey area are found to have caused the high-magnetism anomaly.

On the other hand, with respect to the anomaly of airborne electro-magnetism (resistivity), since most of gossan (deposits and mineral occurrences) show middle to low resistivities (~ several hundred Ω/m), and basic volcanic rocks show high resistivities (3000Ω/m ~), we found that the resistivity is effective to identify the two matters similarly showing high anomalies in airborne magnetism.

As a result of the above examination of the existing data, it can be considered that deposit potential is high in the parts with high magnetism anomaly and low resistivity.

Chapter 2 Geological Survey

2-1 Geology and Geological Structure

The center of the Jubilet area in the north of the area consists of the basement rocks that were deposited with the strike of the direction approximate NS or NNE – SSW and the dip to the east. On the other hand, the geological structure of Guemassa district in the south of the area consists of the sediments with the strike of the direction NNW – SSE or NE – SW and the dip to the east. The basement rocks are mainly composed of pelite rocks of Devonian - Carboniferous - Permian that are interbedded with limestone, tuff and psammytic rock layers. Besides them, the basement rocks are interbedded with many acid or basic sill-like rock bodies.

The geology of Visean, upper Carboniferous, in the central Jubilet area and Guemassa district, is composed of pelite rocks, acid volcanic rocks, basic volcanic rocks, rhythmic alternation, phyllite of the Sarhlef Formation, and carbonate rocks and pelite rocks of the Tequsim Formation that is the upper of the Sarhlef Formation.

Sedimentary rocks consist of shale, slate and schist and include much sericite, chlorite etc. by microscopic observation and X-ray diffraction. They are highly affected by regional metamorphism and alteration of ore mineralization. Variation of alkaline alteration strength at hanging wall and footwall of massive sulfide ore deposit was studied by boring core and the result showed some high alteration strength at hanging wall side. This indicates the possibility that hydrothermal activity continued for some time after formation of the ore deposit or was overlapped by another hydrothermal activities. As for major elements, positive correlation with Al_2O_3 and TiO_2 which are said to inflect the origin of broken chips, and V, K_2O and P_2O_3 and negative correlation with SiO_2, CaO and Fe_2O_3 exist and the trends of general sea floor sediments are recognized. The dispersion of SiO_2 in Hajar, Draa Sfar, and Kettara deposits is due to the supply of detritus origin material by acid volcanic activity. The content of CaO has a tendency to be higher than others in Khwardra deposit because the supply of biogenic origin material is higher than others. As for rare earths pattern, LREE is rich and Eu anomaly is observed. This is due to island arc volcanic detritus origin material. The tendency that total rare earths (TREE) increases at the hanging wall side of the ore deposit is considered to be due to the move of rare earths from the hanging side to the floor side by hydrothermal solution. Sulfur isotope of sulfide in pelite varies from about -35 % to +25 % and has tendency to be lighter at hanging wall side than floor wall side. This tendency seems to indicate that the environment of sedimentation changes from Anoxic environment to oxidic environment according to Kajiwara (1989), Kajiwara and Kaiho (1992), Komuro (1999).

Chemical composition and radioactive dating were studied on the volcanic rocks distributing in the neighborhood of each ore deposit in this area. The result of the chemical composition analysis showed the rare earths pattern of acid volcanic rocks (rhyolite) in Hajar, Khwardra, and Draa Sfar deposits has light rare earths abundantly and flat pattern having Eu anomaly. As for major components, similar tendency indicating negative correlation with SiO_2, K_2O, Rb, Ba and Cs is seen so that these acid volcanic rocks are considered to have similar geochemical properties. However, the neighboring Safsafa deposit has different properties or the acid volcanic rocks (tonalitic mylonite) of. Also when comparing the basic volcanic rocks (dolerite) of this area with besalt, LIL element and HFS element of other area, it was found that the basic volcanic rocks of this area has features of island arc dolerite having much LIL element and differs from N-MORB which has poor LIL and HFS.

From the results of the measurement of K-Ar radioactive dating aiming at grasping mineralizing dating and igneous activity dating, volcanic rocks are classified to plutonic igneous activity, acid volcanic activity, mineralizing alteration (Guemassa) and mineralizing alteration (Jebilet). The datings of plutonic igneous activity and acid volcanic activity are 290 to 360 Ma, the dating of mineralizing alteration (Guemassa) is 260 to 320 Ma and are equivalent to the late stage of the activities of abyssal rock and volcanic rock, and the dating of mineralizing alteration (Jebilet) is equivalent to after the activities of plutonic rocks and volcanic rocks.

2-2 Mineralization and alteration

The distribution of deposits is shown in Fig.II-2-2-1. The ore deposits distributed in Jubilet and Guemassa area are Cu – Pb – Zn – Fe massive sulfide ore deposits that occurred within the alternating beds of pelites and sandstones, the alternating beds of pelites and acid volcanic rocks.

Kettara deposit in the center of the Jubilet area, Draa Sfar and Khwadra deposits in the southern end of the Jubilet area forming the boundary area of the basement and Tertiary layer, Hajar deposit in the western end of the Guemassa area, and Frizen deposit in the east are the main massive sulfide ore deposits in this area.

The shapes of these ore deposits are layered, massive, lenticular, and banded. The major combination of minerals is pyrrhtite, pyrite, galena, and chalcopyrite. Acid and/or basic volcanic rocks are distributed in the vicinity of the ore deposit. The volcanic rocks relates to the mineralization.

Khwadra, Draa Sfar, Kettara, Hajar, and Frizen deposits are classified as the massive sulfide ore deposits by the deposit shape, the combination of minerals and related igneous rocks. It becomes obvious that these ore deposits were formed by repetition of mineralization in the early stage and the late stage, considering the mode of occurrence of these ore deposit, ore minerals and alteration of the host rocks.

The mineralization of the early stage and the late stage are represented by pyrrhotite and pyrite respectively from the viewpoint of Fe–S minerals. The early stage mineralization is divided into the early I sub-stage and the early II sub-stage in Khwadra and Hajar deposits. The former is represented by hexagonal pyrrhotite and the latter is represented by monoclinic pyrrhotite. The hexagonal pyrrhotite crystallized in the early I sub-stage was generally changed to monoclinic pyrrhotite by the late stage mineralization. On the other hand, the monoclinic pyrrhotite crystallized in the early II sub-stage was changed to marcasite. Therefore, pyrrhotites crystallized in different minaralization stages was changed in their compositions by the repetition of later mineralization in the massive sulfide ore deposit in this area. The mineralization temperature of the early I sub-stage was 270 - 280 ℃, that of the early II sub-stage was 200 - 230℃, and that of the late stage was 200 - 250 ℃ by the homoginazed temperature of the liquid inclusion within quartz that coexist pyrrhotite.

The marked variation of the sulfur isotopic ratio within one ore deposit or within one ore-bearing area is in sharp contrast to the uniform sulfur ratio of the black-ore deposit in Japan. The following reasons are considered as the different sulfur isotopic ratios; the difference of the physical and the chemical conditions of mineralization environment of the ore deposit, mixing of organic origin sulfur, the restriction of supply of seawater origin sulfur. That is, the effect of the mixing of organic origin sulfur was relatively marked in Khwadra deposit, and the effect of the contribution of magma origin sulfur was relatively marked to the mineralization in Hajar deposit and Frizen deposit.

The high geomagnetic anomalies are detected in Khwadra deposit and Hajar deposit where monoclinic pyrrhotite is characteristically occurred. On the other hand, the high and the low geomagnetic anomalies are distributed neighboring in Draa Sfar deposit where hexagonal pyrrhotite and monoclinic pyrrhotite coexist. Only the low geomagnetic anomalies are detected in Kettara deposit and Frizen deposit where hexagonal hyrrhotite and pyrite coexist. Therefore, the following possibilities are pointed out that there is a massive sulfide ore deposit composed of hexagonal pyrrhotite and pyrite in the medium to low geomagnetic anomaly areas like Kettara and Frizen deposits, and that there is a massive Pb – Zn sulfide ore deposit composed of hexagonal pyrrhotite and monoclinic pyrrhotite in the area where a high geomagnetic anomaly area is adjacent to a low anomaly area.

The ore deposits are classified into following three types by mineralization:

a) Early I sub-stage dominant type

Medium geomagnetic anomaly [Draa Sfar deposit]

b) Repeated type of the early I sub-stage + the late stage

Medium + low magnetic anomaly [Frizen deposit, Kettara deposit]

c) Repeated type of the early II sub-stage + the late stage

High + low geomagnetic anomaly [Khwadra deposit, Hajar deposit]

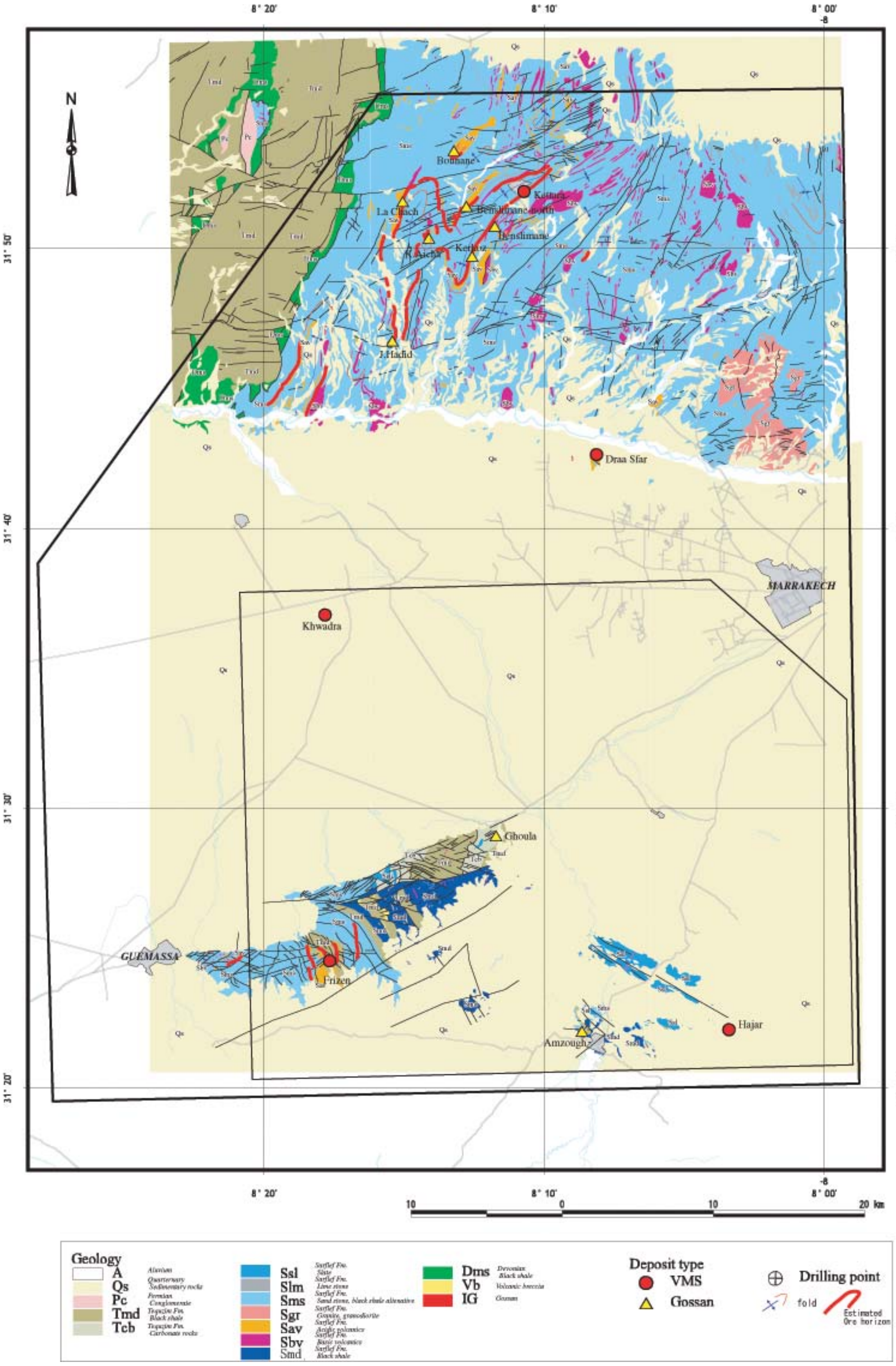

Fig.II-2-2-1 Distribution of deposits at Marrakech-Tekna area

(conclusion)

As results, the following prospecting policy is obtained by the total analysis of geological survey, analysis of drilling cores and laboratory tests.

1) The prospective area of the existence of the rhythmic alternation of the Sarhlef Formation in deep part
2) The prospective area of the existence of acid volcanic rocks of the Sarhlef Formation in deep part
3) The prospective area of the existence of concealed sulfide ore deposit that is harmonized by the combination of the various geomagnetic anomalies by the classification of ore deposit type

Chapter 3　Airborne Geophysical Survey

3-1 Outline of the Survey

Interpreting the geology of the survey area by combining airborne magnetic survey data with airborne electromagnetic survey data shows that magnetic and resistivity structure is different in north and south of the boundary of resistivity at the center of the survey area (NE-SW system) in this area.

In the south distribution area of basement rock is a part extracted as a low magnetic zone by RMI and low resistivity zone by the decay constant. It is thought that the resistivity is high with a shallow outcrop of basement rock and middle with a deep one. All from igneous rocks through volcanic clastic rocks occur at 3 points: southeast (Hajar deposit), west (Frizen deposit) and north. In addition, magnetic indications suggestive of the occurrence of the said rocks in other area can be observed. Given as promising sites are those where there is concurrence of local low resistivity and high magnetic anomaly or where these two are adjacent.

In the north resistivity structure make it possible to extract the following 3 areas:

(a) Area at the west end: low resistivity from shallow through deep part

(b) Central area extending from east to west: middle/high resistivity at shallow part - low resistivity at deep part

(a) Northern area extending from east to west: low resistivity at shallow part-middle resistivity at deep part

If in the areas (b) and (c) there is a basement rock with concealed outcrop, the location containing igneous rock to volcanic clastic rock shows a high magnetic anomaly with a diameter of 2 to 4 km as verified by RMI. Given as promising sites are the zones of overlapping local low resistivity and high magnetic anomaly locally or where these two are adjacent. Such a zone are obtained in the northwest area and around high magnetic anomalies that is considered granite stock in the northeast area.

3-2 Potential of existing massive sulfide deposits

Areas where following airborne geophysical anomalies had been observed were selected as survey areas considering the probability of the existence of mineral deposit due to low resistivity and magnetic anomaly, and medium to low magnetic anomaly obtained by airborne geophysical survey.

(1) Low resistivity zone + high to medium magnetic anomaly

(a) The area where low resistivity zone overlaps medium magnetic anomaly which exist numerously from Khwadra deposit at northwest part of the airborne geophysical survey area to Ghoula district in Guemassa though marked high magnetic anomaly was not obtained by the survey at this time.

(b) Low resistivity area existing in relatively large-scale high magnetic anomaly in the northeast part, western part of Menala airport (Marrakech airport).

(2) High magnetic anomaly part

(a) Small scale medium to high magnetic anomaly zone dotted in relatively large scale high magnetic anomaly in the north east part, western part of Marrakech airport.

(b) Small scale medium to high magnetic anomaly zone dotted in relatively large scale high magnetic anomaly at south west part of Khwadra ore deposit, Nasfar.

(3) Low resistivity part

(a) Low resistivity zone near Tamasloht, eastern direction of Ghoula. Magnetic anomaly is not seen

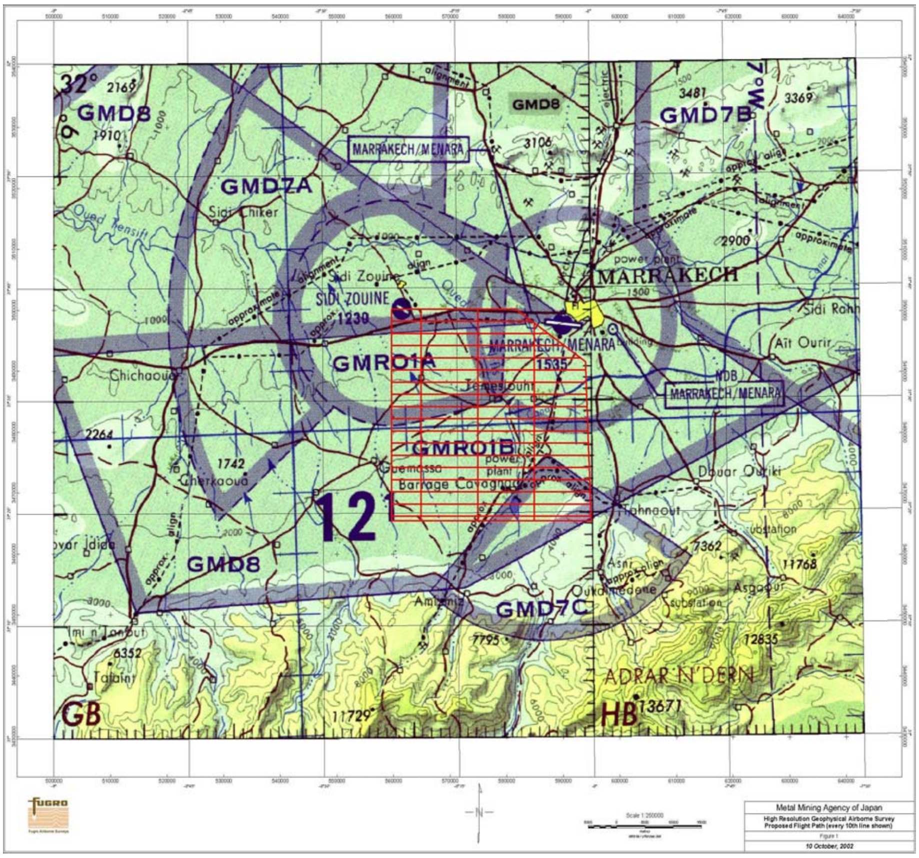

Fig.II-3-1-1 Location Map of Airborne geophysical survey area

Table II-3-1-1 Location of Airborne survey area

	WGS84測地系、UTM座標 Zone 29N		ランベルト正方位座標 モロッコ Zone1		10進緯経度		緯経度	
#	x	y	E	N	Lon	Lat	dd mm ss.ss	dd mm ss.ss
1	218377.6	119540.9	560000	3500000	-8.367288	31.633619	8° 22'2.24"	31° 38'1.03"
2	240373.3	118788.9	582000	3500000	-8.135313	31.632258	8° 08'7.13"	31° 37'56.13"
3	252098.0	110381.3	594000	3492000	-8.009553	31.559170	8° 0'34.39"	31° 33'33.01"
4	251213.2	84384.8	594000	3466000	-8.012017	31.324618	8° 0'43.26"	31° 19'28.62"
5	217214.4	85544.2	560000	3466000	-8.369349	31.326871	8° 22'9.66"	31° 36'36.73"

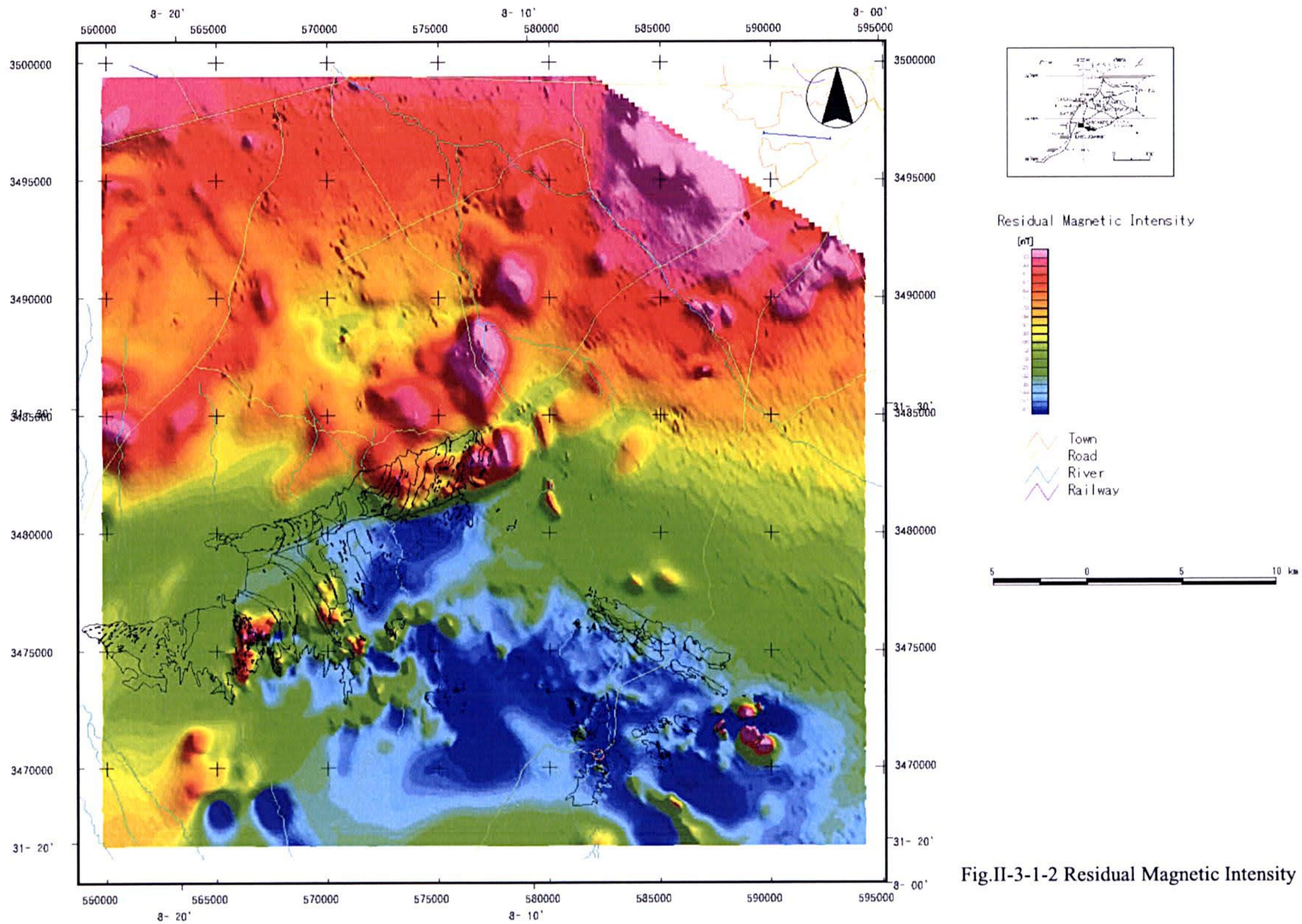

Fig.II-3-1-2 Residual Magnetic Intensity

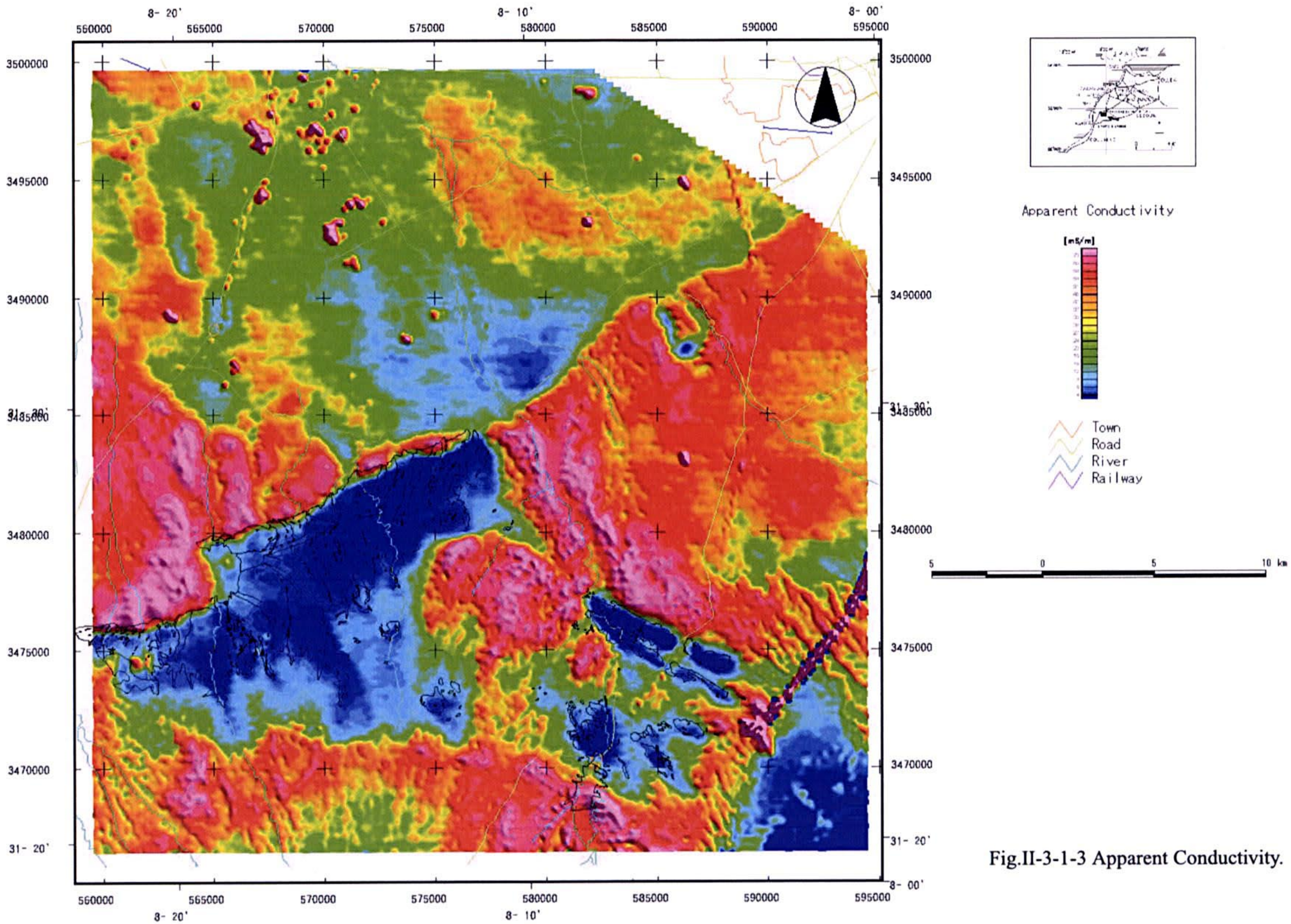

Fig.II-3-1-3 Apparent Conductivity.

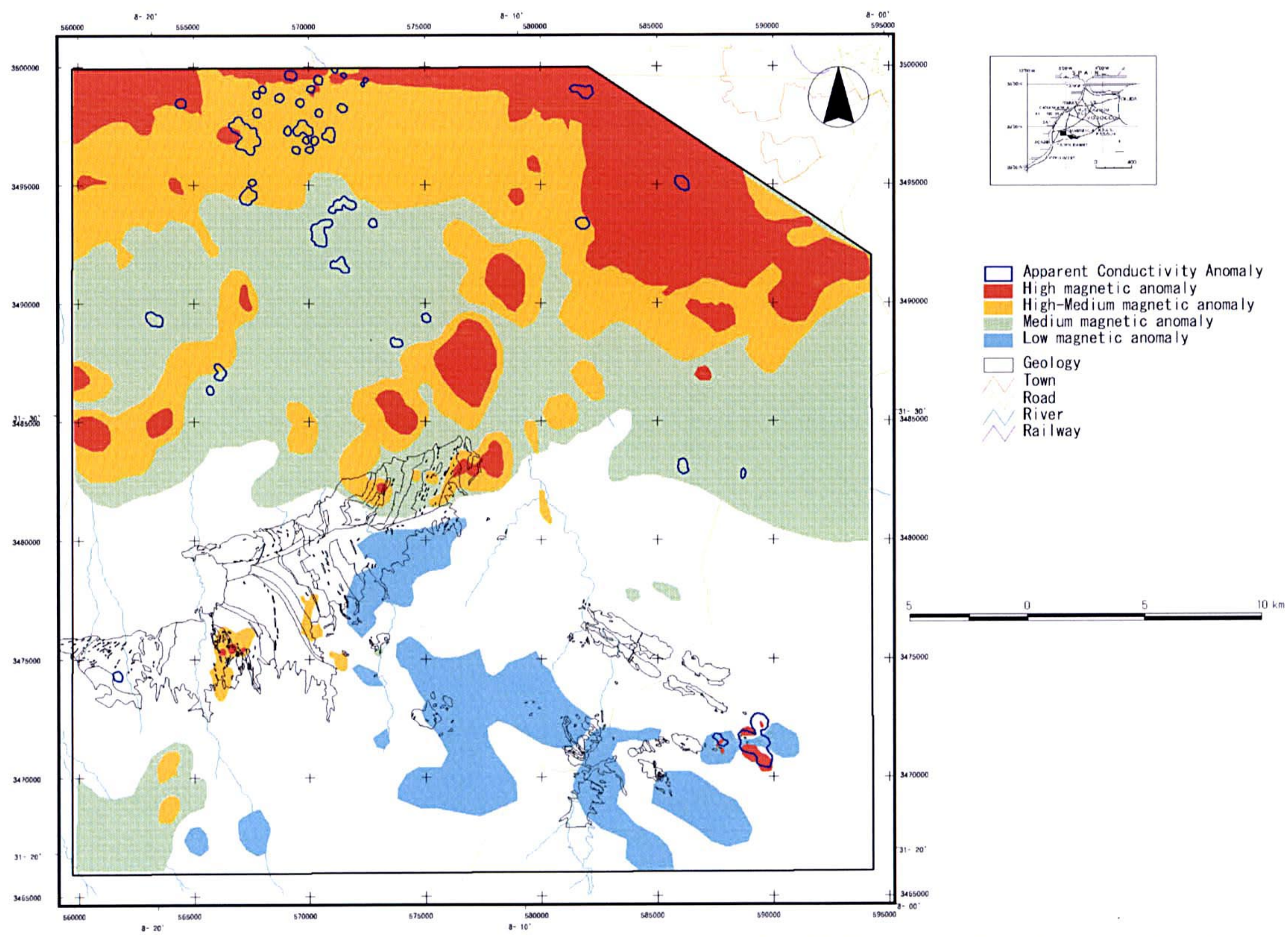

Fig.II-3-1-4 Interpretaion Map of Airborne geophysical survey

Chapter 4　Surface Geophysical survey

4-1 Geophysical survey (Phase II)

The survey has been performed, in 8 districts shown in Fig.II-4-1-1 and Fig.II-4-1-2, to extract high potential areas for the volcanogenic massive sulfide ore deposits being principally composed of copper, lead, and zinc minerals, through surveys and interpretation of geological environment and distribution of ore deposits. In addition to this, another object of the program is to transfer the concerned technology to the counterpart organizations. The year's program, as the second year program, has been conducted in areas showing magnetic or conductivity anomalies in the first year's program. The electrical IP method and electromagnetic TEM method have been applied in the program. The electric IP method has been applied for eight areas near Marrakech City. Much time has needed for the measuring due to the broad area underlain by the younger sediments and noise obstruction caused by artificial material such as well pumps. The problem has been solved by high power current output, and useful data have been obtained. The survey result has revealed that some IP anomalies exist in the MJTK-IP-1 district. It is thought that the thick young sediments underlie the MJTK-IP-6 and MJTK-IP-7 districts. In the other districts, no data indicating some mineralized zone has been obtained (Fig. II-4-1-3～20).

The electric prospecting TEM method has been performed with emphasis on the MJTK-IP-1 district (Fig,II-2-1-21～23), following the electric prospecting IP survey result. The result of this survey (Fig,II-2-1-24～31) has revealed that the thick young sediments exist about 150 meters thick in MJTK-IP-1, over 200 meters thick in MJTK-IP-6, and 250 meters thick in MJTK-IP-7. In the MJTK-IP-6 and MJTK-IP-7 districts, the banded resistivity structure is corresponded with the stratification of the young sediments. In the MJTK-IP-1 district, it is thought that the young sediments gently dip to the northeast. The analytical resistivity structure of the Paleozoic rocks is not actually correlated with the resistivity of rocks in situ due to some affection from the IP effect, showing some virtual resistivity zone. The intense IP effect seen in the electromagnetic prospecting TEM method corresponds the chargeability anomaly zone in the electric prospecting IP method.

BRPM has conducted ground magnetic and gravity surveys following the TEM survey in the MJTK-IP-1 zone. The survey program has revealed that a clear high-gravity zone is in the central MJTK-IP-1 zone, and a positive magnetic anomaly exists on the south side and a negative magnetic anomaly on the north side, suggesting some potential for compact and magnetic material.

Based on the above-mentioned result, following two potential zones can be introduced.

1) An igneous body, probably rhyolite disseminated by pyrrhotite, exists near the No.8 point of the survey line C in the central MJTK-IP-1 district. The chargeability anomaly zone surrounds north side of the igneous body, and corresponds with some mineralized or disseminated zone. The paired positive and negative magnetic anomaly and high gravity part is correlated with some igneous body.

2) A steep dipping, massive to stratified, large-scale subsurface sulfide ore deposit exists in the central district. The chargeability anomaly zone surrounds the ore body. The paired positive and negative magnetic anomaly and high gravity par corresponds with some ore mainly composed by pyrrhotite.

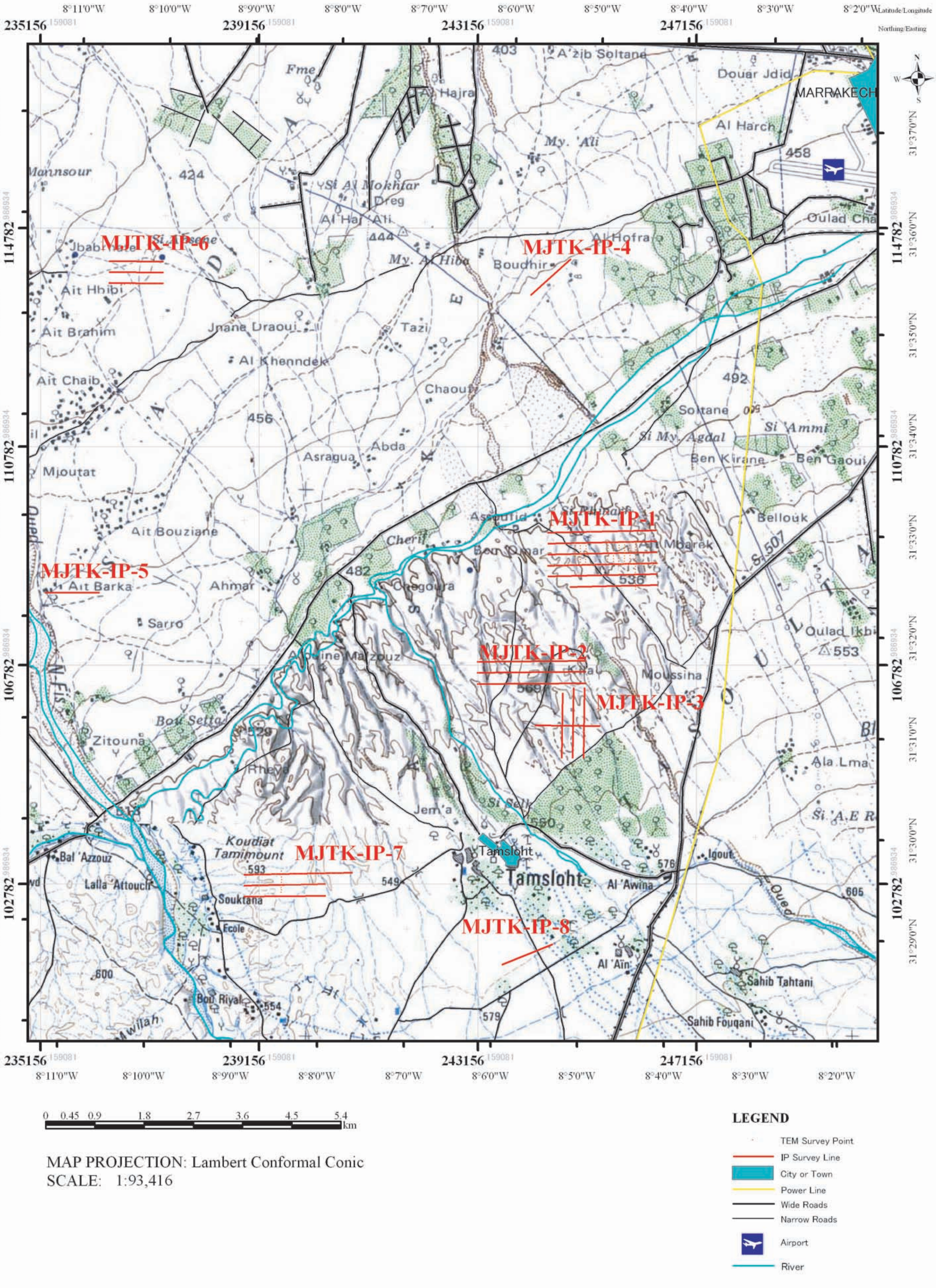

Fig.II-4-1-1 Survey location map of the Marrakech-Tekna area

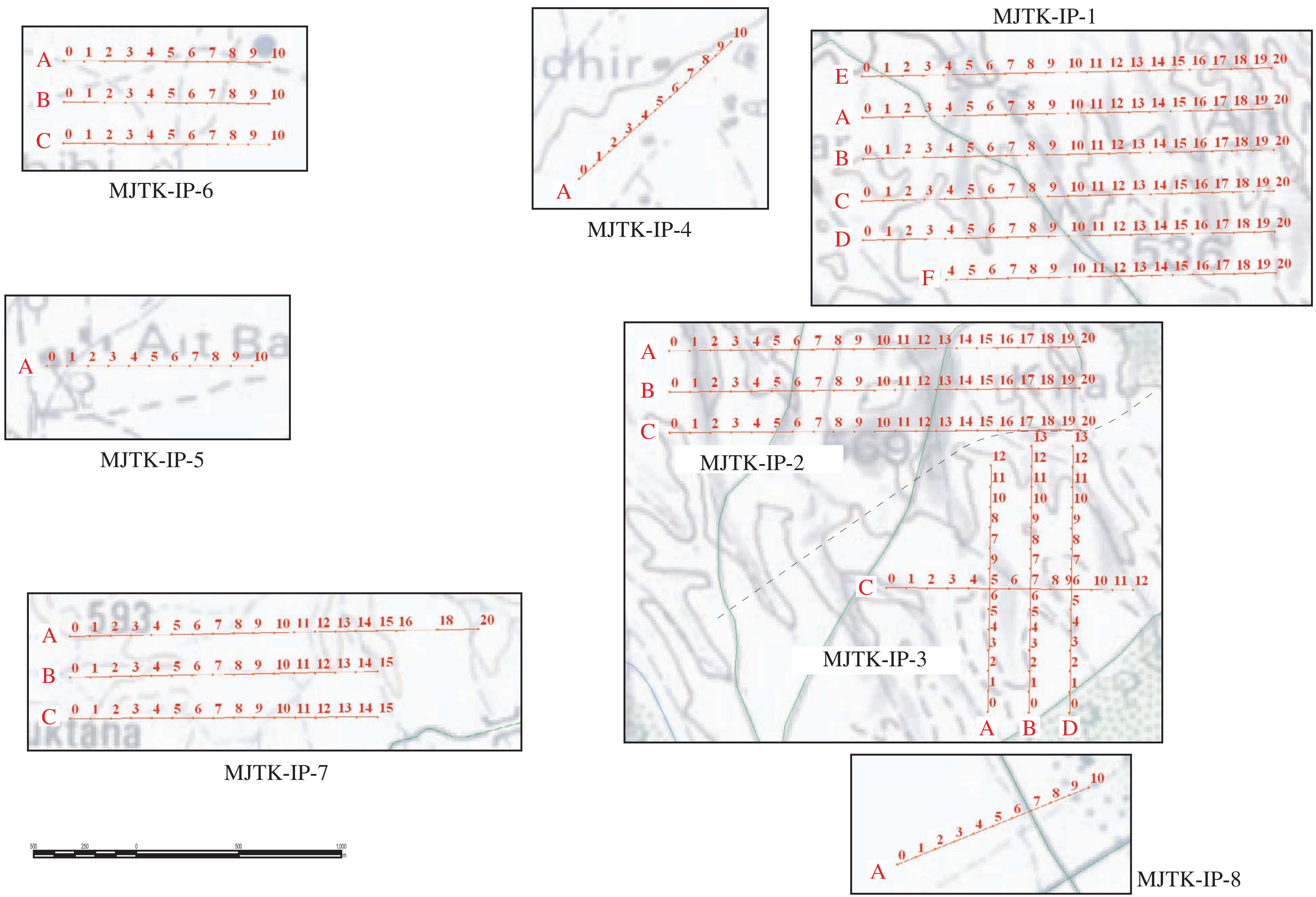

Fig.II-4-1-2 Outline map of Survey line

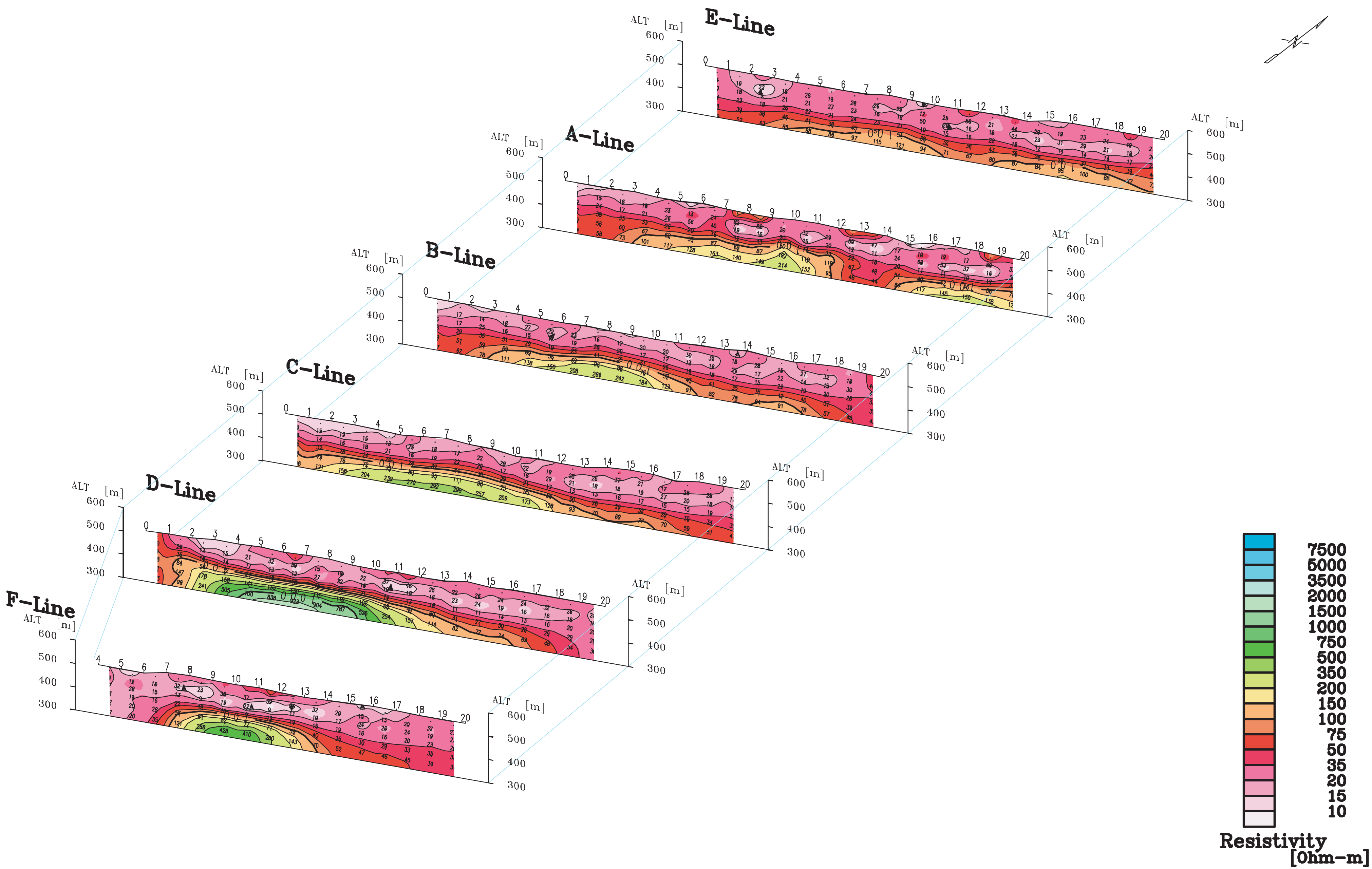

Fig.II-4-1-3 2D Analysis section of resistivity (MJTK-IP-1)

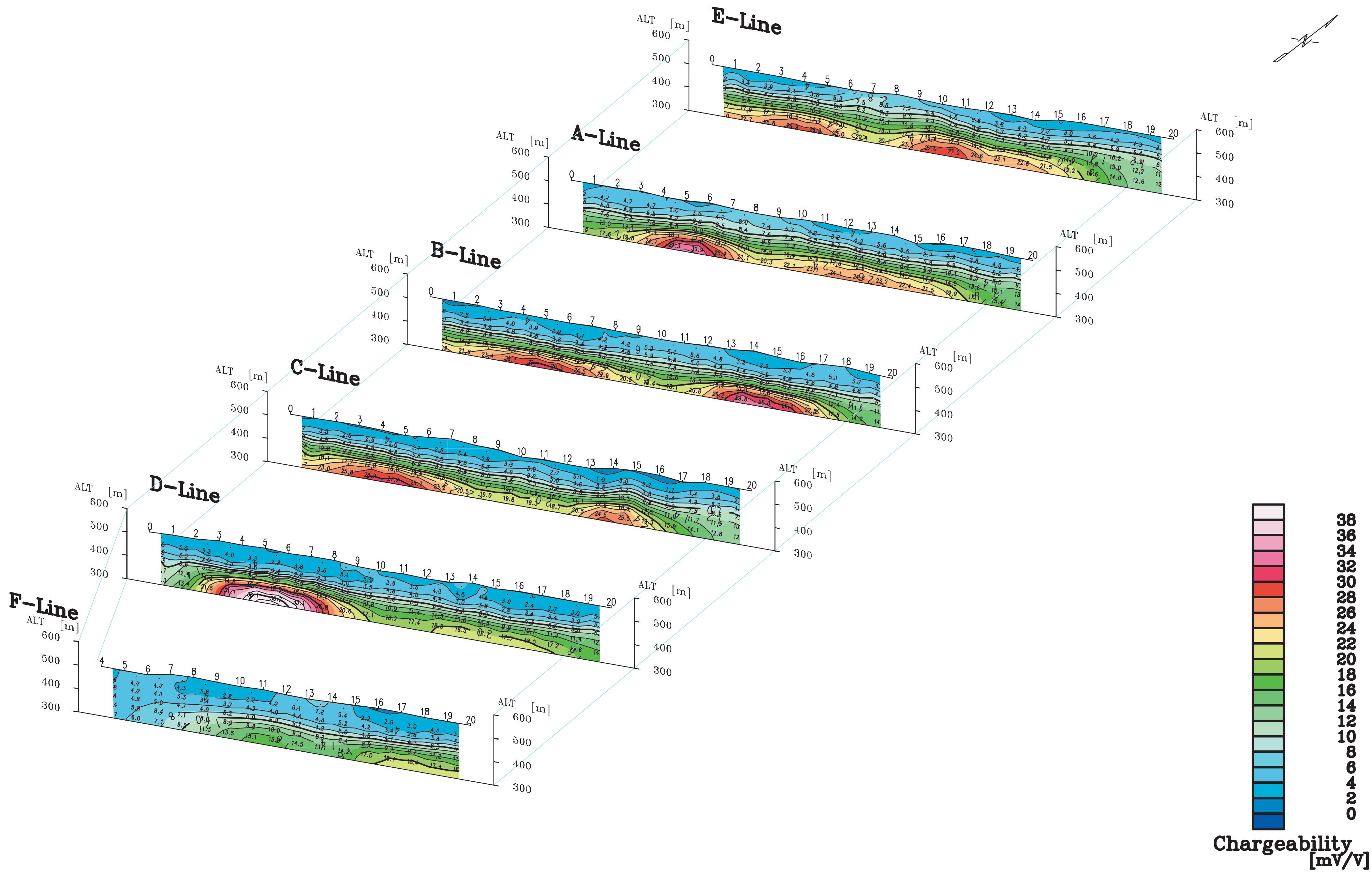

Fig.II-4-1-4 2D Analysis section of chargeability (MJTK-IP-1)