REPORT
ON
THE COOPERATIVE MINERAL EXPLORATION
IN
SHEBENIK AREA, THE REPUBLIC OF ALBANIA

PHASE II

MARCH 1997

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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Preface

In response to a request by the Republic of Albania the Japanese Government decided to have a cooperative mineral exploration carried out in the Shebenik area of southeastern Albania for confirmation of possible mineral resource endowments and charged the Japan International Cooperation Agency (JICA) with that task. Since the surveys involved the specialized fields of geology and mineral resources, JICA decided to commission the Metal Mining Agency of Japan (MMAJ) to undertake them.

The surveys were started in 1995 and continued to 1996 as the second year, during which a geological and magnetic and drilling surveys were carried out.

For that second year of the surveys MMAJ formed a survey team consisting of 6-person, 2-geologists and 3-geophysicists and 1-drilling supervisor, and sent it to that country. With the cooperation of Albanian Ministry of Mineral Resources and Energy (MMRE) and the Albanian Geological Survey (Gjeoalba) the mission completed its task as scheduled.

The present report covers the findings of the geological, magnetic geophysical and drilling surveys carried out in that second year and will constitute a part of the final report on the whole project.

Finally, we would like to take this opportunity to express our heartfelt gratitude to those at the Albanian government agencies concerned, Japan's Ministry of Foreign Affairs and Ministry of International Trade and Industry and the Japanese Embassy in Austria who have cooperated in implementation of the surveys and to those others in Albania and Japan who have furnished direct and indirect assistance in the project.

February, 1997

Kimio FUJITA
President
Japan International Cooperation Agency

Shozaburo KIYOTAKI
President
Metal Mining Agency of Japan

Summary

The present survey corresponds to the second year (phase II) of the "Cooperative Mineral Exploration in the Shebenik area of the Republic of Albania," started on the basis of the "Scope of Works" exchanged between, the Japan International Cooperation Agency and the Metal Mining Agency of Japan, on the one hand, and the Ministry of Mineral Resources and Energy of the Republic of Albania and the Albanian Geological Survey (Gjeoalba), on the other hand.

The phase II survey comprises a geological, magnetic and drilling surveys. The geological survey was carried out in the Central Shebenik area (area: 22 km^2), located in the central part of the Shebenik ultrabasic massif. The magnetic survey covered the western half (10 km^2) of the geological survey area and involved 102 line-kilometers of survey as well as including a survey above the Katjel deposit for verification of the effectiveness of magnetic survey method. The drilling survey involved a total of 19 holes (total length of 2,333.41 m) in eight areas selected on the basis of the results of the phase I survey and existing material made available by the Albanian side: Bregu i Pishes, Fusha e Madhe, Gjorduke, Qarri i Zi, Shesh Bush No.1, Pishkash South, Murriq and Mbi Skroske. Simultaneously the results of previous surveys regarding chrome deposits in the Shebenik area were reviewed for new identification of areas that need to be surveyed in the future.

The results of those phase II surveys are summarized below:

The geology of the Central Shebenik area consists of ultrabasic rocks belonging to the Shebenik ultrabasic massif, Cretaceous limestone and Tertiary terrigenous sediments. The ultrabasic rocks, which have the widest distribution of the three, consist of harzburgite and dunite accompanied by podiform type chrome deposits. The chromitite constituting the chrome deposits has, without exception, a mode of occurrence with a dunite envelope. The chrome indications confirmed on the surface have a maximum thickness of 2 meters.

The ultrabasic rocks are divided into a Massive dunite-harzburgite suite (MDHS) and a Dunite-harzburgite suite with remarkable layering (DHSRL) in ascending order. It is in the Dunite-rich zone of the MDHS that most of the chrome deposits and indications are to be found, and that is where many dunite lenses are concentrated. Furthermore, it is in the Dunite-rich zone directly under the boundary with the DHSRL that there is particular concentration of massive chromitite. Those facts suggest that the chrome deposits in the study area are genetically controlled by stratigraphical horizon in terms of ophiolite sequence.

In the EPMA analysis for chromian spinel included in harzburgite, dunite and chromitite many anomalies were detected in samples from the Dunite-rich zone. There were five localities for which many EPMA anomalies were detected: Gobille, No. 115 (Qafa e Dinarit), Buzgare, Ahu i Vetem and Lugu i Batres. The EPMA anomalies were particularly frequent for Ahu i Vetem. In this zone Cr# values of around 0.6 were noted in the harzburgite, and there are massive chromitite with a thickness of up to 2 meters. On the basis of such survey results and after comparison with other regions of the world it is concluded that one can expect to find chrome deposits from several tens of thousands to several hundreds of thousands of tons in the study area.

The results of the magnetic survey revealed many magnetic anomalies in the vicinity of chrome deposits and indications, leading to the conclusion that a relationship exists between chrome deposits and magnetic anomalies. In the magnetic survey directly above a chrome outcrop accompanied by chromitite and its dunite envelope a weak, low magnetic anomaly was identified. In measurement of natural remanent magnetization it was found that dunite, with quite a high probability, and some harzburgite have natural remanent magnetization with a direction different from the present geomagnetic field or clearly inverse polarity. Moreover, the results of magnetic susceptibility measurements on outcrops show that there is no significant difference according to lithofacies. It is considered, therefore, that dunite or dunite accompanied by chromitite which has natural reverse magnetization can often be identified as low magnetic anomalies.

In the drilling survey of the 5 areas, i.e. Bregu i Pishes, Gjorduke, Qarri i Zi, Shesh Bush No.1 and Murriq for the purpose of exploring the lower extensions of known deposits and indications, massive to disseminated chromitite with Cr_2O_3 values of 21.60-49.70% was encountered in two drill holes each in the Bregu i Pishes and Qarri i Zi areas, for which EPMA anomalies were noted in the phase I survey. Chromitite ore was not encountered, however, in the other 3 areas, the reasons being major displacement of the ore body because of faulting in the case of the Gjorduke and Shesh Bush No. 1 areas and lack of significant ore deposit in the case of the Murriq area.

In the drilling survey in the 3 areas of Fusha e Madhe, Pishkash South and Mbi Skroske for the purpose of investigating zones of magnetic anomalies many dunite bodies were found, but no

concentrations of chromian spinel as chromitite were recognized in any of the drill holes. In the case of the Fusha e Madhe area the reason for magnetic anomaly is considered to be magnetite produced in faulted and fractured zones, but for the other two areas the reasons were not elucidated.

The rock in the drill cores is very similar in all of the drill holes and consists mainly of harzburgite accompanied by dunite with rare accompaniment of pyroxenite dikes. There are frequent occurrences of faulted, fractured and brecciated zones, and the chromitite has, without exception, a dunite envelope. Almost all of such ultrabasic rocks are serpentinized, except in the deeper part of the Gjorduke and Bregu i Pishes areas, where they are relatively fresh.

In platinum group element (PGE) analysis of the chromitite cores all of the samples showed the typical ophiolite pattern on the chondrite normalized diagram, and no conspicuous concentrations of PGE were noted.

In EPMA analysis of chromian spinel included in the core samples the most EPMA anomalies were detected in the Qarri i Zi area although some were also detected in the Bregu i Pishes, Pishkash South and Mbi Skroske areas. Cr#-V_2O_3 anomalies, the most important index for chrome exploration, were recognized in three areas ,i.e. Bregu i Pishes, Qarri i Zi and Pishkash South, and harzburgite with Cr# values under 0.6 was detected in three areas, i.e. Qarri i Zi, Pishkash South and Mbi Skroske, the values in the Bregu i Pishes area, too, being very near to 0.6.

Considering the above-mentioned survey results, it is proposed that the drilling survey in the third year of this project be carried out in the 5 areas mentioned below.

Rank	Name of area	Method	Reason for selection	Purpose of survey
1	Bregu i Pishes	Drilling	-Ore found in MJAS-1, 2 and EPMA anomalies	-Exploration for northern downward extension of ore encountered in of MJAS-1, 2. -Confirmation of scale of ore body.
2	Ahu i Vetem	Drilling	-Many chrome outcrops and EPMA anomalies	-Downward exploration of Ahu i Vetem, Qafa e Dinarit and Lugu i Batres (Gobille).
3	Hija e Zeze	Drilling	-Massive ore encountered in the galley survey	-Exploration for northern extension of the newly encountered ore.
4	Pishkash-5	Drilling	-In EPMA anomaly zone, -Ore lost to east of faults	-Detection of ore body migrated by faulting
5	Qarri i Zi	Drilling	-Many EPMA anomalies -Ore found by MJAS-8,9	- Exploration for northern extension of the dunite with chromitite and EPMA anomaly

Since ore was encountered in MJAS-1 and MJAS-2 in the Bregu i Pishes area, drilling to confirm the extent of the ore body and the northern extensions thereof is necessary.

The Ahu i Vetem area, which comprises many deposits and indications including Ahu i Vetem, Qafa e Dinarit, Lugu i Batres and Gobille, is geologically situated in the Dunite-rich zone directly below the boundary between the MDHS and the DHSRL, and massive chromitite with a thickness of 1.5 m has been confirmed there. It is the zone that attracts the most attention in view of the fact also that numerous EPMA anomalies have been noted.

The Hija e Zeze area is situated about 2 km south-southeast of the Bregu i Pishes area. There outcrops of massive chromitite with a thickness of 2 m have been discovered in the past, but the northern extension was unconfirmed. However, in the gallery implemented by Gjeoalba in 1996 the northern extension of the ore body displaced by faults was detected. The ore is disseminated to massive and has a Cr_2O_3 grade of 43.70%. Since it has only just been discovered, a drilling survey will be necessary in order to confirm its extent.

The Pishkash-5 area is located in a zone where the harzburgite has Cr# under 0.6 and massive to disseminated high-grade ore occurs. It includes the Pishkash-5 deposit exploited in the past. The western part of the ore body has migrated as a result of the movement of a N-S fault, and discovery of the lost ore body is an urgent task. Pishkash-4, Guri Pishkash and other chrome deposits are located nearby.

Although chromitite was encountered in the Qarri i Zi area in MJAS-8 and MJAS-9, this year's surveys have made it clear that it probably does not extend further southward. Nevertheless, in view of the fact that a high frequency of EPMA anomalies has been noted and that there are many indications in the vicinity, further drilling should be carried out in the northern part of the area.

It should be added that in the drilling survey of the Ahu i Vetem area a considerable length of existing roads will have to be repaired and construction of new roads to the drilling sites will be necessary. Besides that, in view of the fact that the Ahu i Vetem area is located at elevations of over 1,500 m, it will be necessary to consider the need to complete the field works before late September, when snow begins to fall.

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Chapter 1 Introduction

Chapter 1 Introduction

1-1 Project Summary

1-1-1 Background and Purpose

The present survey of the phase II has been carried out in the Shebenik area on the basis of the "Scope of Works" signed on July 5, 1995, between the Japanese International Cooperation Agency (JICA) and Metal Mining Agency of Japan (MMAJ) and, on the one hand, the Ministry of Mineral Resources and Energy of the Republic of Albania (MMRE) and Albanian Geological Survey (Gjeoalba), on the other hand.

In this, the second, year of semi-detailed geological and geophysical magnetic surveys of the Central Shebenik area and a drilling survey of the Southern Shebenik and the Northern Pogradec areas, selected by the results of the phase I survey in 1995, were carried out.

The purposes of the semi-detailed survey of the Central Shebenik area have been (1) elucidation of the relationship between geology, geological structure and chrome mineralization on the basis of the data obtained by the geological and magnetic surveys along with laboratory tests and (2) extraction of promising areas for future drilling surveys in the area, and the purposes of the drilling survey in the Southern Shebenik area and the Northern Pogradec area have been detection of the extensions of known deposits and investigation of magnetic anomalies and EPMA anomalies detected by the phase I surveys.

1-1-2 Conclusions and Recommendation of the Phase I Survey in 1995

(1) Conclusions

The conclusions on the basis of the results of the phase I survey can be summarized as follows:

a) The Shebenik-Pogradec ultrabasic massif is endowed with many chromitite deposits of the Alpine podiform type.

b) Almost all of the large-scale chrome deposits so far discovered are located in the area from the southern part of the Shebenik massif to the Pogradec massif, in which the lower horizons of the Shebenik-Pogradec ultrabasic massif are distributed. The geochemical study by EPMA analysis of the chromian spinel also yielded indices favorable to concentration of chromitite in those areas.

c) Favorable indices were not obtained in EPMA analysis of samples from the northern part of the Shebenik massif.

For the above reasons the southern part of the Shebenik massif and the Pogradec massif are in the focus of attention as promising areas that will have to be further exploration. In future continuation of exploration of those areas it will be necessary to take into consideration the following circumstances made clear by the explorations that have been carried out in the past:

a) Since the Pogradec massif has already undergone systematic exploration, there is little possibility of discovering new deposits by surface surveys.

b) The southern part of the Shebenik massif has not been thoroughly explored because of the topographically difficult terrain, and therefore there is still room for further surface exploration.

(2) Recommendation

The following surveys were recommended for the phase II survey in 1996 on the basis of the above conclusions concerning the results of the phase I survey:

a) Semi-detailed geological survey and geophysical magnetic survey

- Central Shebenik area on north side of Bushtrice river

The Central Shebenik area represents the northern extension of the area in which the main chrome deposits of the Shebenik-Pogradec ultrabasic massif are distributed. In spite of the fact that there are distributed many chromitite indications in it, the area has not yet been thoroughly surveyed because of the topographical difficulty.

b) Drilling Survey

- Northern part of Pogradec massif (Murriq, Fusha e Madhe, Gjorduke, Bregu i Pishes and Shesh Bush No.1)

Although many explorations have been carried out in these areas in the past, there is still room for further surveys. In particular, favorable EPMA indices have been obtained for the Bregu i Pishes area concerning the possibility of dense concentrations of chromitite.

- Southern part of Shebenik massif (Qarri i Zi, Mbi Skroske and Pishkash No. 5)

Although the Qarri i Zi deposit has been exploited at shallow depths, lower parts of it have not yet been explored. Furthermore, the EPMA analysis has given favorable indices concerning the possibility of existence of dense concentrations of chromitite. In Mbi Skroske and Pishkash No.5 there are chrome indications at which magnetic anomalies have been noted.

1-1-3 Content of the Survey

The phase II survey comprises a geological survey, a magnetic survey and a drilling survey. Fig. 1-1-1 gives the scopes of each, and Table 1-1-1 the quantities of work of each of them.

1-1-4 Survey Periods

The work periods of each survey were be as follows:

. Local part of the study (geological survey):	June 17 - July 27, 1996
. Local part of the study (magnetic survey):	July 15 - August 24, 1996
. Local part of the study (drilling survey):	June 17 - December 21, 1996
. Laboratory tests and preparation of report:	July 28, 1996 - February 23, 1997

1-1-5 Personnel

Table 1-1-2 gives the survey team that undertook the project negotiations and the personnel who took part in the field works.

1-2 Survey Areas

1-2-1 Location

The Shebenik area is a mountainous area in the southeast part of the Republic of Albania. To the east it borders on Macedonia and Lake Ohrit. In it the Shebenik Mountain Range, with Mt. Shebenik (elevation: 2,262 m) as a representative peak, runs in the NNW-SSE direction. The Shebenik mountain region comprises the Shebenik massif to the north and the Pogradec massif to the south. The towns of Librazhd on the northwest edge of the area and Pogradec on the southern edge are the region's transportation hubs and centers of industry.

The Central Shebenik area (Fig.1-2-1), covered by the semi-detailed surveys, is a area with an scope of 22 square kilometers on the north bank of the Bushtrice River near the middle of the Shebenik ultrabasic massif. It is about 25 km north-northwest of Pogradec and about 11 km east of Librazhd.

The Southern Shebenik area, where the drilling survey was carried out, is located immediately south of the Central Shebenik area. It comprises the three drilling target areas of Qarri i Zi, Mbi Skroske and Pishkash south in the order west to east. Also covered by the drilling survey was the Northern Pogradec area, which is located in the northern part of the Pogradec ultrabasic massif on

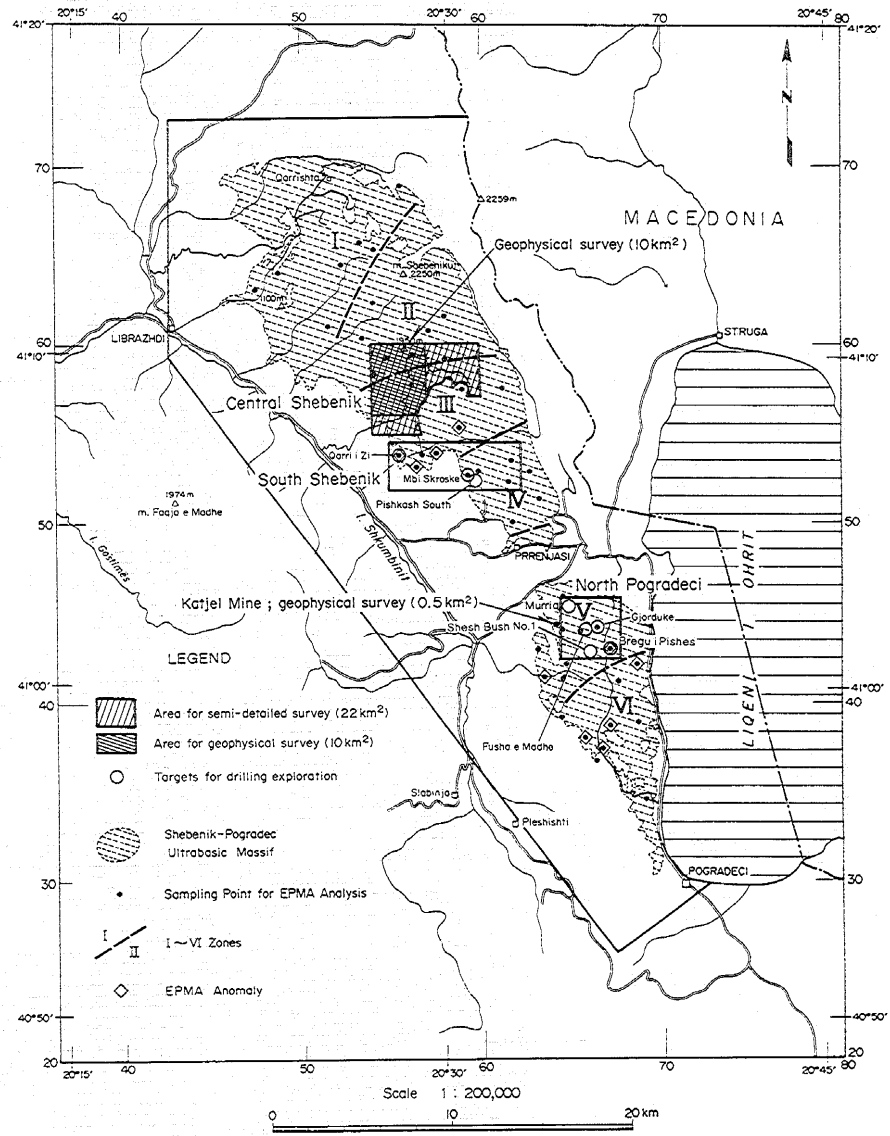


Fig. 1-1-1 Location map of the survey areas in 1996

Table 1-1-1 Survey Works in 1996 Fiscal Year

(1) Field works

Type of Survey	Quantity of field works			
-Geological Survey	Scope of survey	Length of survey		Number of sample
Central Shebenik Area	22 km²	72.6 km		72 pcs.
-Magnetic Survey	Scope of survey	Length of survey line		Number of measurement
Central Shebenik Area	10 km²	102.32 km, 41 lines		5,155 points
Katjel Area	0.52 km²	7.21 km, 18 lines		378 points
-Drilling Survey				
Zone	No.of hole	Depth(m)	Inclination	Direction
Bregu i Pishes	MJAS- 1	80.00	-43°	S60°W
	MJAS- 2	80.00	-45°	S60°W
	MJAS- 3	130.86	-40°	S60°W
Fusha e Madhe	MJAS- 4	191.50	-45°	N50°W
Gjorduke	MJAS- 6	170.10	-60°	S70°W
	MJAS- 7	167.30	-49°	S70°W
Qarri i Zi	MJAS- 8	87.50	-40°	S60°E
	MJAS- 9	101.55	-51°	S60°E
	MJAS-10	101.13	-46°	S60°E
Shesh Bush No.1	MJAS-12	100.60	-40°	S60°W
	MJAS-13	100.00	-43°	S60°W
	MJAS-14	100.80	-40°	S60°W
Pishkash South	MJAS-15	209.50	-45°	E
	MJAS-16	211.80	-60°	E
Murriq	MJAS-18	100.00	-30°	N
	MJAS-19	100.00	-30°	N
Mbi Skroske	MJAS-20	100.17	-55°	N54°E
	MJAS-21	100.60	-55°	S30°E
	MJAS-22	100.00	-63°	S10°W

(2) Laboratory tests and Measurements

Item	Number	Remarks
-Laboratory Test for Geological Survey		
-Thin Section of Rocks	28 pcs.	
-Polished-thin Section of Ores	20 pcs.	
-Quantitative Analysis by EPMA	44 pcs.	TiO_2, Al_2O_3, Cr_2O_3, Fe_2O_3, V_2O_3, FeO, MnO, MgO
-Chemical Analysis of Rocks	37 pcs.	Al,Ba,Be,Bi,Cd,Ca,Cr,Co,Cu,Fe,Pb,Mg,Mn,Mo,Ni, P,K,Ag,Na,Sr,Ti,W,V and Zn
-Chemical Analysis of Ores	30 pcs.	Cr_2O_3
-Chemical analysis of PGE	12 pcs.	Os, Ir, Ru, Rh, Pt, Pd, Au and Re
-Laboratory Test for Geophysical Survey		
-Natural Magnetic Remnant	20 pcs.	(Central Shebenik area)
-Magnetic Susceptibility	149 points	(Central Shebenik area: 123, Katjel area: 26)
-Laboratory Test for Drilling Survey		
-Thin Section of Rocks	21 pcs.	
-Polished-thin Section of Ores	31 pcs.	
-Quantitative Analysis by EPMA	31 pcs.	TiO_2, Al_2O_3, Cr_2O_3, Fe_2O_3, V_2O_3, FeO, MnO, MgO
-Chemical Analysis of Rocks	20 pcs.	Al,Ba,Be,Bi,Cd,Ca,Cr,Co,Cu,Fe,Pb,Mg,Mn,Mo,Ni, P,K,Ag,Na,Sr,Ti,W,V and Zn
-Chemical Analysis of Ores	20 pcs.	Cr_2O_3
-Chemical Analysis of PGE	20 pcs.	Os, Ir, Ru, Rh, Pt, Pd, Au and Re

Table 1-1-2 Personnel

Japanese Counterpart		Albanian Counterpart
Field supervisor		
Mr. Yoshiaki IGARASHI, MMAJ		Mr. Vasil GRILLO, Gjeoalba Mr. Vaxhid TAHSINI, Gjeoalba
Field survey team		
Leader	Mr. Hiroshi Miyajima, SMC	Mr. Kristaq DHIMA, Geological Institute, Gjeoalba
Geologist	Mr. Norihiro NAGANO, SMC	Mr. Besnik POJANI, Korce Enterprise, Gjeoalba
Geologist	Mr. Ichiro MATSUMOTO,SMC	Mr. Fatmir BLACELI, Pogradec Enterprise, Gjeoalba
Geophysicist	Mr. Hiroyuki II, SMC	Mr. Aleksander KOSPIRI, Geophysical Center, Gjeoalba
Geophysicist	Mr. Mitsuru KATSUDA,SMC	Mr. Gani SHEHU, Geophysical Center, Gjeoalba
Geophysicist	Mr. Daijiro UEHARA, SMC	Mr. Apollon DILO, Geophysical Center, Gjeoalba
Geophysicist		Mr. Albi KOSPIRI, Geophysical Center, Gjeoalba
Geophysicist		Mr. Agron FESHTI, Geophysical Center, Gjeoalba

Remarks; MMAJ: Metal Mining Agency of Japan, Gjeoalba: Albanian Geological Survey,
SMC: Sumiko Consultants Co., Ltd.

the western shore of Lake Ohrit. It consists of the five areas, Murriq, Fusha e Madhe, Gjorduke, Bregu i Pishes and Shesh Bush No.1 from north to south. Their locations are given inFig.1-2-2.

Pogradec is a small town with a population of about 10,000 located on the south shore of Lake Ohrit at an elevation of 700 m. It is visited by large numbers of tourists in the summer as a resort and bathing center. Although international telephone calls can be made and fax messages can be sent from its post, telephone and telegraph office (PTT), those services are frequently interrupted because of technical trouble. In the way of accommodation, there is a former state-run hotel and a rest home operated by the military and well as many private accommodation facilities. Librazhd, located on the northwest fringe of the Shebenik area, has a population of only a few thousand. It, too, has a former state-run, now private, hotel and a post, telephone and telegraph office.

1-2-2 Accessibility

A paved national highway runs from the capital, Tirana, to the town of Pogradec, located some 80 km to the southeast. That highway passes through Elbasan, one of the country's main industrial cities, Librazhd and Prrenjas on its way to Pogradec and goes on to the borders with Macedonia and Greece. It takes 3 to 4 hours from Tirana to Pogradec.

The Central Shebenik area is a mountainous area with elevations ranging between 1,000 m and 2,000 m. In order to get to the semi-detailed survey area one can take an unpaved forestry road that takes off from the highway between Librazhd and Pogradec. A point with an elevation of 1,700 m on the north side of Mt. Kryqi i Vakut that is situated approximately in the middle of the survey area can be reached by that road by 4-WD vehicle, but the road is in very poor condition and is no longer negotiable when it rains. The distance from the turnoff from the highway, Xhyra (Bushit), to the reservoir on the southwest edge of the survey area is about 9 km and takes about 1 hour by car. The distance from the reservoir to the 1,700 m point is about another 5 km and takes roughly another 1 hour to cover. Xhyra (Bushit) is at a road distance of about 12 km from Librazhd and can be reached from there in about 20 minutes.

To reach the Bregu i Pishes, Gjorduke, Fusha e Madhe and Shesh Bush No. 1 areas of the Northern Pogradec area, where a drilling survey was carried out, one first took the unpaved road

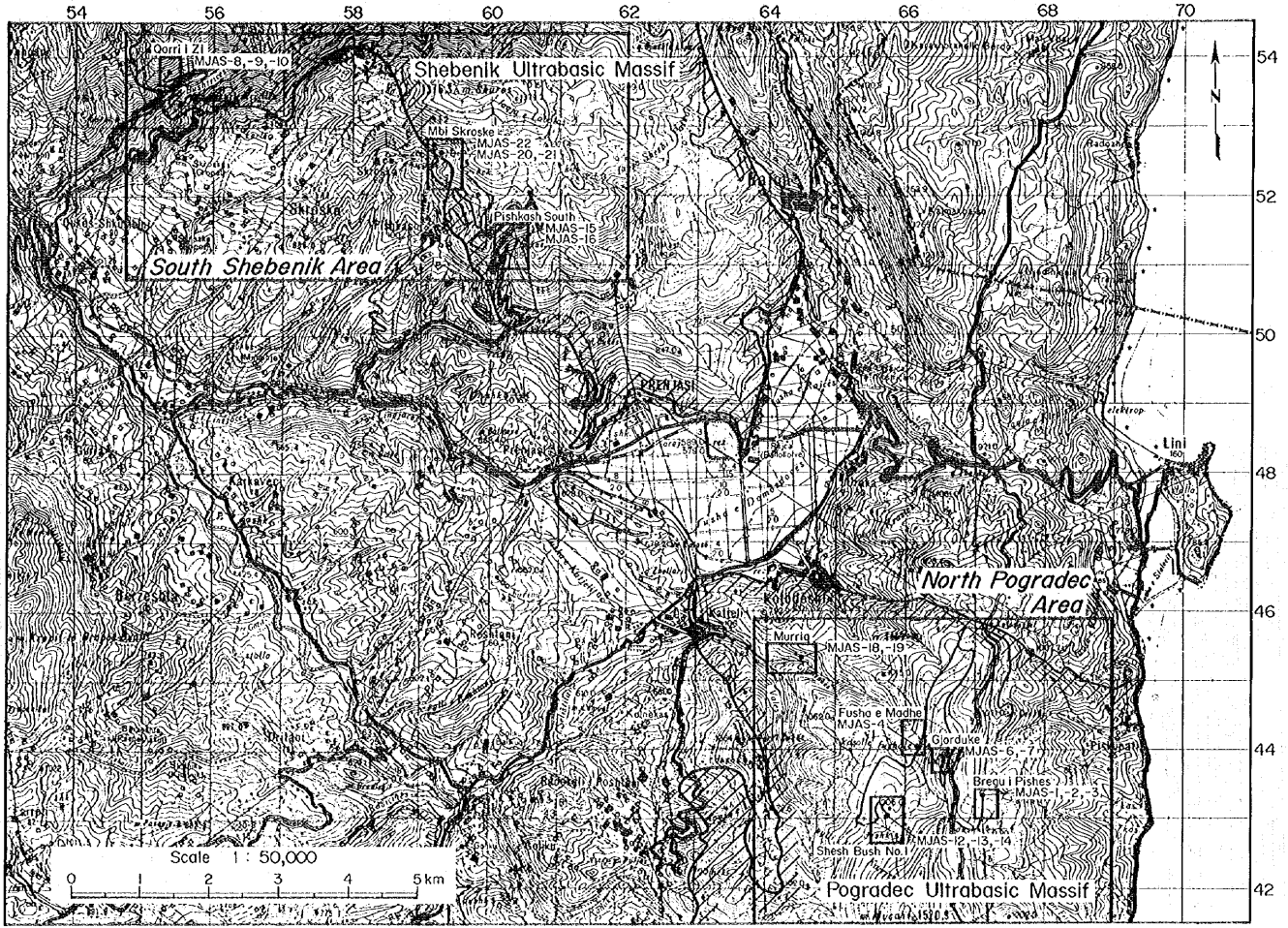


Fig. 1-2-2 Location map of the drilling survey areas

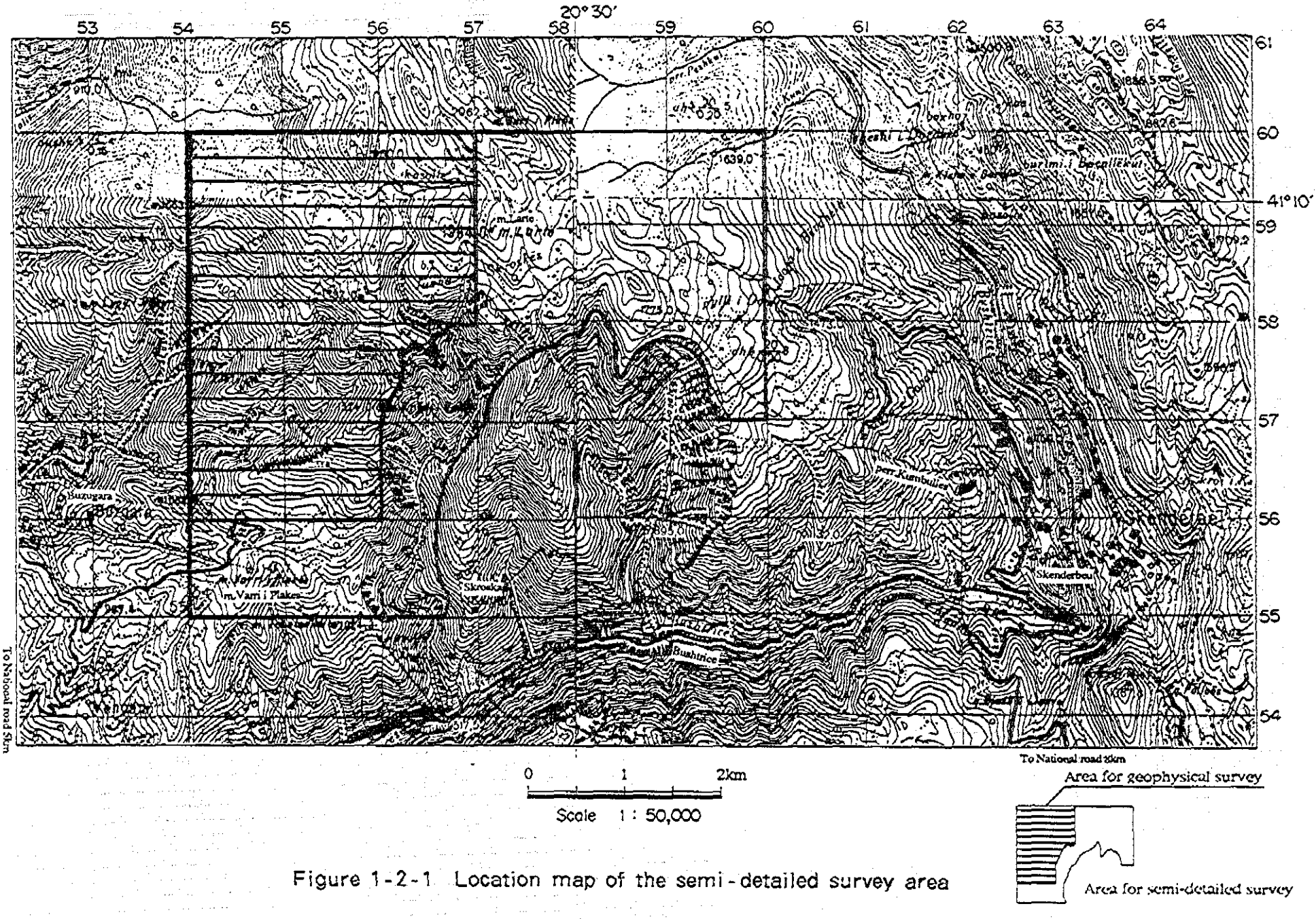


Figure 1-2-1 Location map of the semi-detailed survey area

between Qaf Thane and Pogradec via Çervenak and then existing roads that were repaired and partly newly constructed for that purpose. The Murriq area was reached by first taking an existing unpaved road from Prrenjas to the Katjel mine and from there a new access road with a length of about 800 m.

As for the southern part of the Shebenik area, the Pishkash South area was reached by the existing mine road of the Guri Pishkash Fe-Ni mine after repairing it since that area is located very near to it. The Qarri i Zi area was reached first by the existing unpaved road along the Bushtrice river and then a another unpaved road, a former prospecting road, to near the site after it was repaired and lastly a short newly constructed road section to the site. In order to reach the Mbi Skroske area it was necessary to construct about 1.5 km of new access road from the existing road to the Pishkash-4 chrome mine.

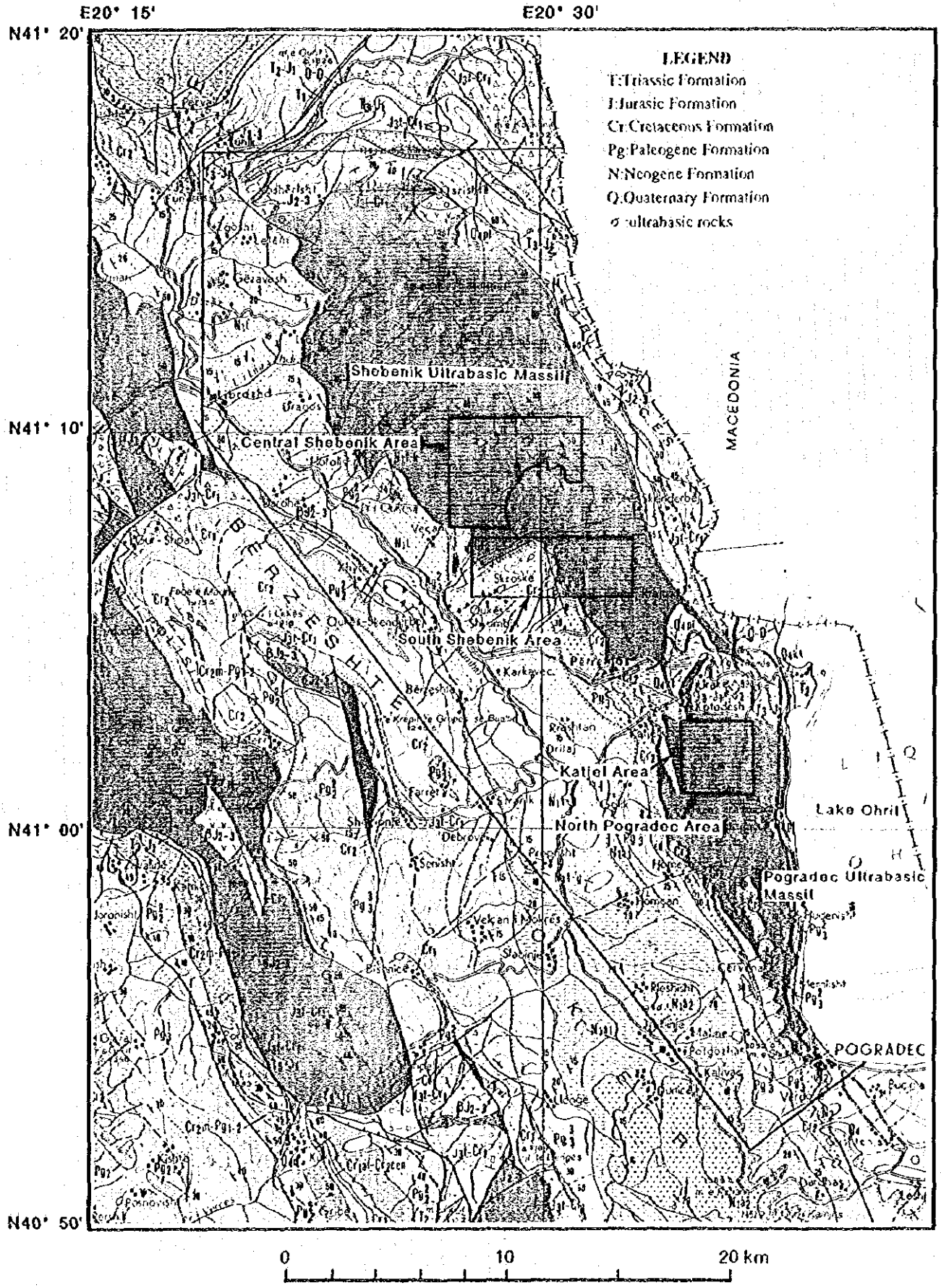


Fig. 1-2-3 Geologic map of the Shebenik Area

Chapter 2 Results of Work

Chapter 2 Results of Work

2-1 Geological Survey

2-1-1 Geology

The geology of the semi-detailed survey area consists of ultrabasic rocks belonging to the Shebenik ultrabasic massif, the Cretaceous limestone and the Neogene terrigenous sediments. The ultrabasic rocks composed mainly of harzburgite with small amounts of dunite and harzburgite are distributed throughout most of the area. The Cretaceous limestone and the Neogene sediments are unconformably underlain by the ultrabasic rocks and occupy the southwestern corner of the survey area (Fig. 2-1-1 and Table 2-1-1).

The geological map at the scale of 1:10,000 (Plate 2-1-1) was prepared by synthesizing the results of the semi-detailed survey and the 1:10,000 geological map prepared by BLACERI (1990) which covers the southern part of the Shebenik ultrabasic massif including the survey area.

(1) Shebenik-Pogradec Ultrabasic Massif

The ultrabasic rocks in this area consist mainly of harzburgite and dunite sometimes accompanied by chromitite deposits and small dikes of pyroxenite and gabbro with a thickness of several centimeters to a hundred centimeters in some places. All the chromitite deposits occur in dunite and are surrounded by dunite envelopes.

The ultrabasic rocks in the area are generally serpentinized. The degree of serpentinization, however, is not so strong that it is easy to identify the original rock by the presence or absence of pyroxene. Dunite is dark gray to dark green and its weathered surface is very smooth and light brown in color. Dunite consists of olivine and chromian spinel as primary minerals. Secondary minerals in dunite are mainly serpentine, magnetite and rarely chlorite. Harzburgite is also dark gray to dark green in color and includes coarse-grained orthopyroxene with a maximum length of 1 cm. Weathered harzburgite has a rough surface due to the presence of orthopyroxene. Harzburgite consists mainly of olivine and orthopyroxene with small amounts of clinopyroxene and chromian spinel as primary minerals. Secondary minerals are mainly serpentine and rarely talc.

The ultrabasic rocks are divided into two major suites, in ascending order, the Massive dunite-harzburgite suite (MDHS) and the Dunite-harzburgite suite with remarkable layering (DHSRL) based upon content ratio of dunite and manner of contact with dunite and harzburgite in the field. The Massive dunite-harzburgite suite consists of massive harzburgite accompanied with dunite lenses. This suite is subdivided into the Harzburgite 1 (Hz 1) and the Dunite rich zones (H-D). The former is mainly of massive harzburgite rarely with dunite lenses and the latter is dominant with dunite lenses including relatively large ones. The Dunite-harzburgite suite with remarkable layering consists of harzburgite intercalating with thin dunite layers. This suite is also subdivided into the Harzburgite 2 (Hz 2) and the Layered dunite and harzburgite (Du). The former is mainly of harzburgite rarely with thin dunite layers and the latter is of layered dunite and harzburgite.

Massive dunite-harzburgite suite (MDHS)

-Harzburgite 1 (Hz 1)

The Harzburgite 1 consists mainly of harzburgite and rarely accompanied by small dunite lenses with a thickness of several tens to several hundreds of centimeters. The Harzburgite 1 is widely distributed in the central to southwestern part of the area. Dunite lenses varies considerably in its strike and dip.

Table 2-1-1 Schematic geological column of the Central Shebenik area

GEOLOGICAL AGE		COLUMNAR SECTION	SYMBOL	THICKNESS (m)	ROCKFACIES	MINERALIZATION	STRATIGRAPHY OF TRANSITION ZONE IN OPHIOLITE
CENOZOIC	QUARTERNARY		Q	10-30	gravel, sand, silt , clay		modified by Nicolas and Prinzhofer (1983)
CENOZOIC	TERTIARY NEOGENE		Tmi	>250	red conglomerate and sandstone		
MESOZOIC	CRETACEOUS		K	>100	limestone		gabbroic formation
MESOZOIC	JURASSIC	Hz, Du, Chromitite, H-D, Pyroxenite	Shebenik-Pogradec Ultrabasic Massif: Hz2/Du	>2500	dunite-harzburgite suite with remarkable layering Hz2:Harzburgite 2 harzburgite with small dunite layer Du: Dunite and harzburgite layer layered dunite and harzburgite	podiform chromitite ? disseminated chromitite in dunite	dunite with foliation chromitite clinopyroxenite and websterite
MESOZOIC	JURASSIC	Chromitite, H-D, Pyroxenite, Hz	Shebenik-Pogradec Ultrabasic Massif: Hz1/H-D	>4000	massive dunite-harzburgite suite Hz1:Harzburgite 1 massive harzburgite with dunite lense H-D: Dunite rich zone harzburgite rich in various sized dunite lense	massive chromitite ~ disseminated chromitite in dunite ?	harzburgite with foliation

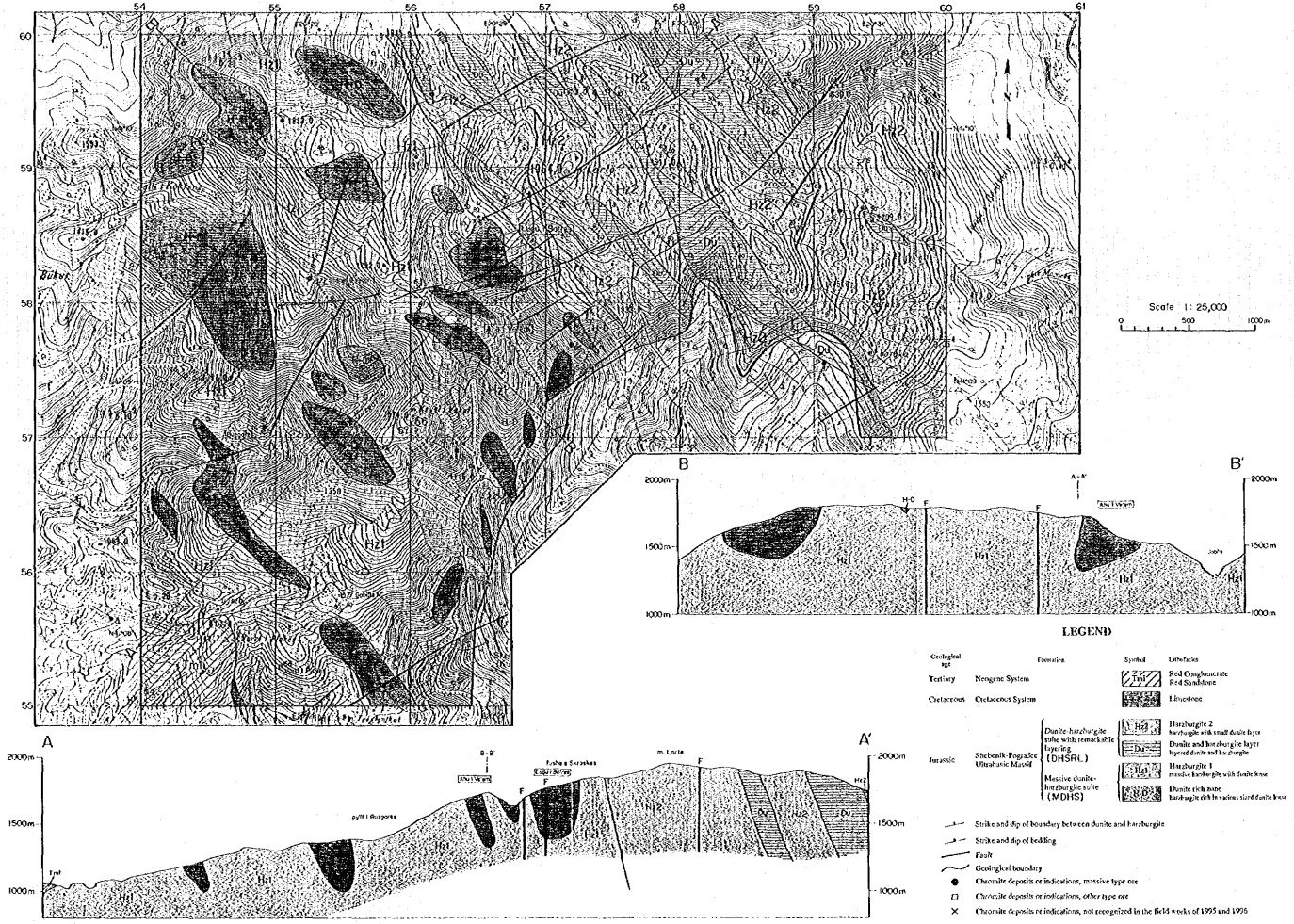


Figure 2-1-1 Geologic map of the Central Shebenik area

-Dunite rich zone (H-D)

The Dunite rich zone is distributed in the central to western part of the area. This zone consists of massive harzburgite frequently accompanied by dunite lenses in various size. Each dunite lens has a thickness of several hundreds of centimeters to several tens of meters and show variable strike and dip. Dunite lenses sometimes yield massive to disseminated chromitites and the scale of each chromitite is relatively large. Each of the Dunite rich zones occupies an area with width and length of several hundreds of meters to about one kilometer. Most of the zones are distributed in the vicinity of the boundary between the MDHS and the DHSRL.

In the Dunite rich zone, the lithological change from harzburgite to dunite is gradual and the boundary between them is irregular and obscure as shown in Fig. 2-1-2. The mode of orthopyroxene in harzburgite and dunite is variable throughout. For example, dunite with orthopyroxene and harzburgite relatively poor in orthopyroxene are both found. This fact shows the existence of a transitional lithology between harzburgite and dunite. This transitional lithology is especially dominant around chromite deposits.

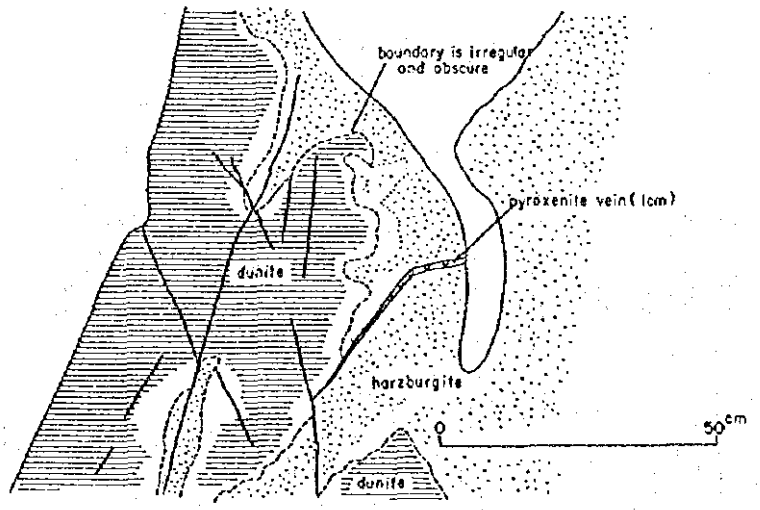


Fig.2-1-2 Sketch showing irregular shaped and obscure boundary between dunite and harzburgite dominant in the Dunite rich zone (H-D) of the Massive dunite-harzburgite suite.

Dunite-harzburgite suite with remarkable layering (DHSRL)

-Harzburgite 2 (Hz 2)

The Harzburgite 2 (Hz 2) is widely distributed in the northeastern part of the area. It consists mainly of harzburgite rarely intercalating with thin dunite layers with thickness of several to several tens of centimeters. The boundary between harzburgite and intercalated dunite is very sharp. Dunite layers have a constant strike ranging from N20°W to N40°W and is dipping constantly northeastwards with 60 to 80 degrees.

-Dunite and harzburgite layer (Du)

The Dunite and harzburgite layer consists of layered harzburgite frequently intercalated with many thin dunite layers with a thickness of several to several hundreds of centimeters and is distributed in the northeastern part of the area. These dunite intercalations show constant strikes with a direction of N20°W to N40°W and are dipping northeastward with 60 to 80 degrees. Even layered dunite with a thickness of only several centimeters has good continuity laterally in the

direction of its strikes as shown in Fig. 2-1-3. The boundary between harzburgite and intercalated dunite is very sharp. The strike and dip of layered dunite are concordant with the general geological structure of the Shebenik-Pogradec ultrabasic massif.

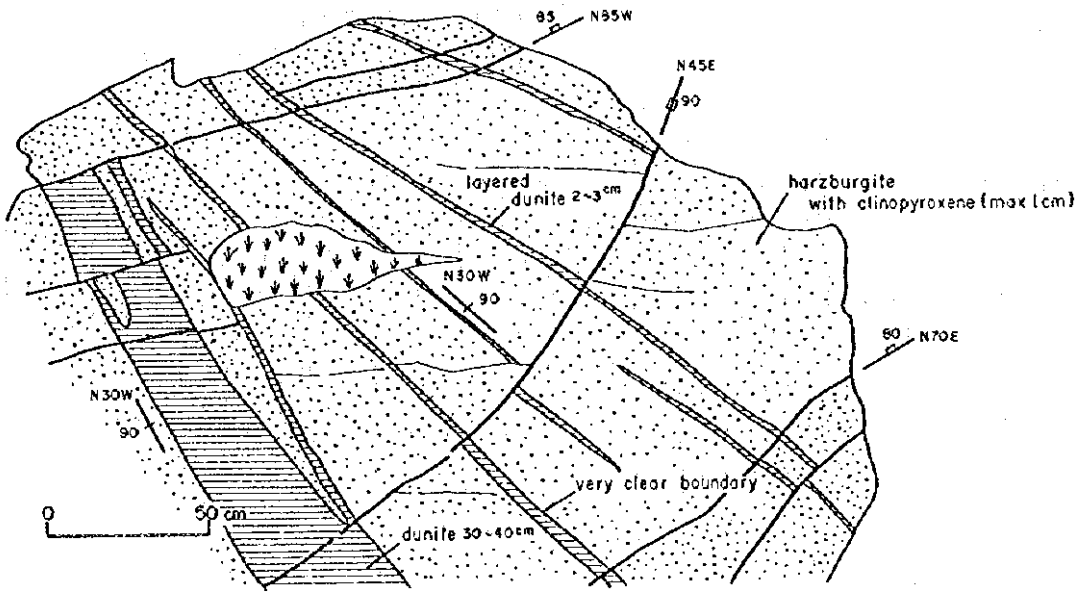


Fig. 2-1-3 Sketch showing typical lithofacies of the Dunite and harzburgite layer (Du)

(2) Cretaceous System

The Cretaceous System of this area consists of limestone and occupies a small area in the southwestern part of the area. The limestone is unconformably underlain by the Shebenik ultrabasic massif.

(3) Neogene System

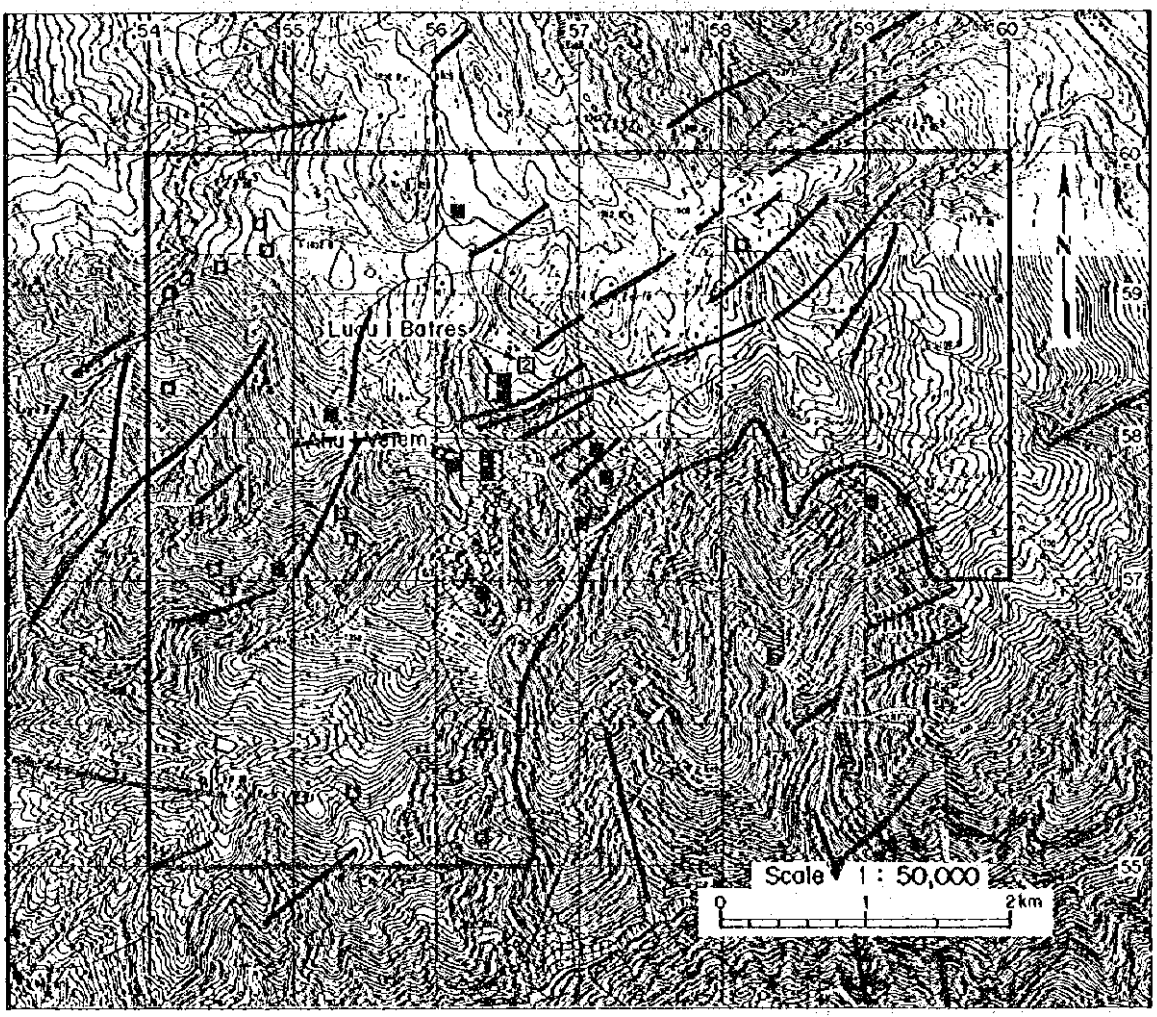
The Neogene system consists of alternations of sandstone, shale and conglomerate. This system is distributed in the southwestern corner of the area and is unconformably underlain by the Shebenik ultrabasic massif and the Cretaceous System. The Neogene System strikes from WNW-ESE to NW-SE dipping gently southwards with an angle of 10 to 20 degrees.

Conglomerate is poorly sorted and includes pebble to cobble sized ultrabasic rocks and limestones. The conglomerate covering directly the Cretaceous limestone includes abundant limestone gravels.

Unconformity between the Neogene System and the Shebenik ultrabasic massif is observed at an outcrop along the logging road to the south of the reservoir. An alternation of red sandstone and siltstone is overlaying horizontally on the ultrabasic rocks with red alteration zones developed on their surface.

2-1-2 Geologic Structure

The geologic structure of the Shebenik ultrabasic massif in the area shows a homoclinal structure with a strike of NNW-SSE dipping northeastward. The Cretaceous System and the Neogene System unconformably underlain by the ultrabasic massif have a geologic structure dipping gently westward. Several parallel faults in the direction ENE-WSW are observed in the



LEGEND

Lineament detected on LANDSAT image

Chromitite deposit and showing
verified by the field survey of 1995 and 1996

■ Massive type ore

□ Other type ore

Figure 2-1-4 Lineament map of the Central Shebenik area

northeastern part of the area.

The Dunite and harzburgite layer located in the northeastern part of the area is intercalated with thin dunite with a thickness of several to several hundreds of centimeters. Thin layered dunite has a constant strike in the direction of N20° W to N40° W and is dipping constantly 60 to 80 degrees to the northeast. These structures are concordant with the direction of extension of the Shebenik ultrabasic massif and are considered as primary structure formed by igneous activity accompanying the formation of the ultramafic rocks.

The Cretaceous System and the Neogene System of the southwestern part of the area are situated at the eastern limb of a synclinal structure with an axis parallel to the Shkumbin River in N-S direction. These systems are dipping gently to the west.

Many lineaments are detected as indicated in Fig. 2-1-4 on the LANDSAT TM image enlarged at a scale of 1 to 50,000 from the original one used for the phase I survey in 1995. Several parallel lineaments in the direction of ENE-WSW are detected in the region from the northeastern part of the area to the Mt. Larte. Some of them show left lateral displacements on the image.

2-1-3 Chromitite Deposits

(1) Distribution and Relationship with Lithofacies

Thirty-six chromitites deposits were confirmed in the Central Shebenik area during the field geological survey in 1995 (see Fig. 2-1-5 and PL. 2-1-2). Most of those deposits are distributed in the MDHS below the DHSRL, however, it is very rare in the DHSRL except for four small ones.

Chromitite is always enclosed in dunite and dunite lenses are frequently recognized around the dunite enclosing chromitite. Thickness of dunite by which chromitite is enclosed has a wide range from several centimeter to several tens of meters. Figs. 2-1-6(1) to (5) give geological sketches of typical modes of occurrence of chromitite in the area.

(2) Dimensions of Chromitite

Chromitite in the area is variable in size, for example, smaller ones have lateral dimensions of several to several tens of centimeters and relatively large ones are one to two meters wide and have lengths of more than fifteen meters. Ahu i Vetem (PL. 2-1-3) and Lugu i Batres (PL. 2-1-4), two of the larger chromitite bodies in the area, are found in the Massive dunite-harzburgite suite near the boundary of both suites. Distribution of relatively large chromitite deposits with length or thickness of more than one meter is shown in Fig. 2-1-5.

(3) Mode of Occurrence of Chromitite

Mode of occurrence of chromitites is classified into five ore-types based on the degree and mode of concentration of chromian spinel in the field; massive, nodular, antinodular, disseminated and banded chromitites. Four classes of ore-type are indicated in the location map of chromitite deposits (see Fig. 2-1-5) as follows because of nodular and anti-nodular chromitite are shown as one group.

1. Massive chromitite
2. Nodular and anti-nodular chromitite
3. Disseminated chromitite
4. Banded chromitite

This classification is an artificial one so some of chromitite show a neutral feature between each type. More than two types of chromitites are recognized together in the same outcrop in some places. Each ore type indicated in Fig. 2-1-5 represents the dominant ore type at each location. Massive chromitite ore-type is dominant in the upper part of the Massive dunite-harzburgite suite

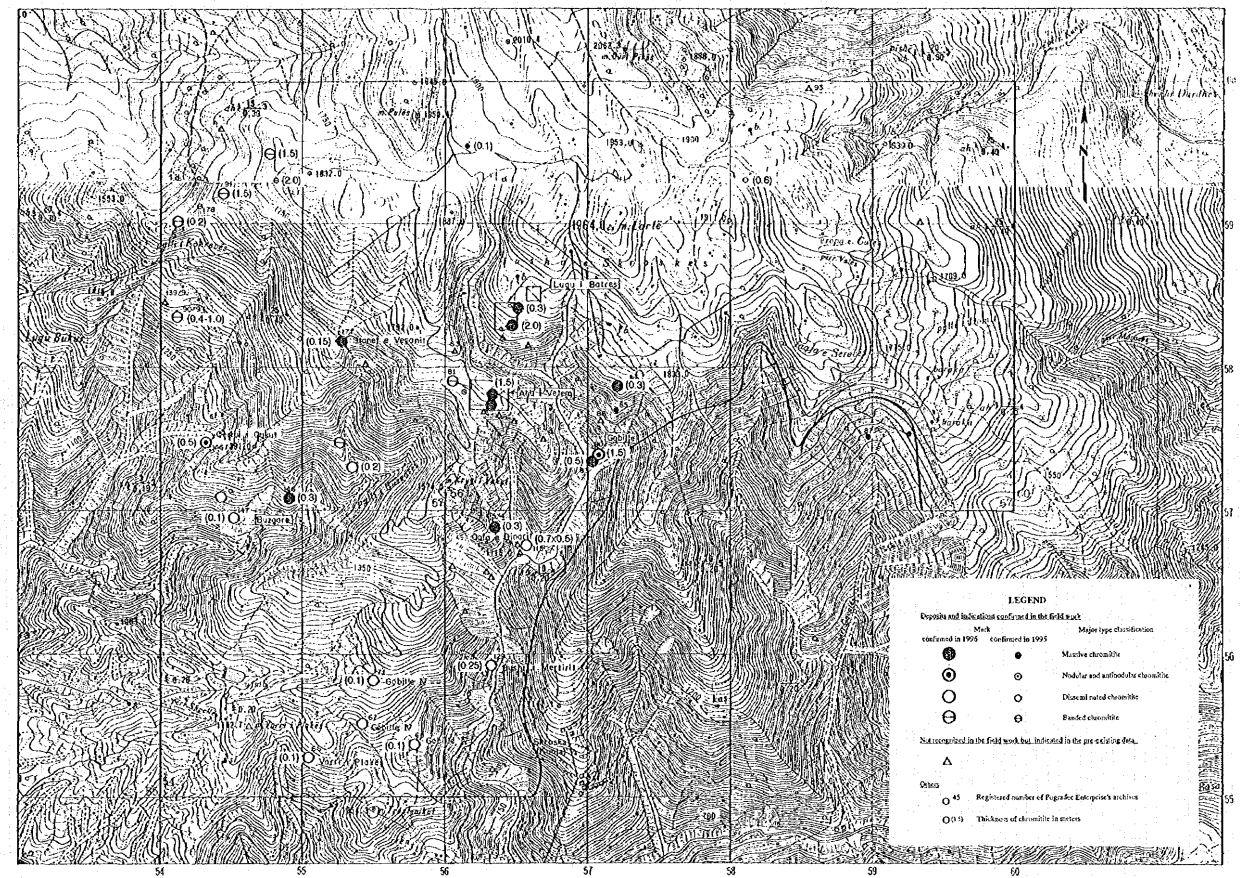


Figure 2-1-5 Location of chromitite deposits and showings in the Central Shebenik area

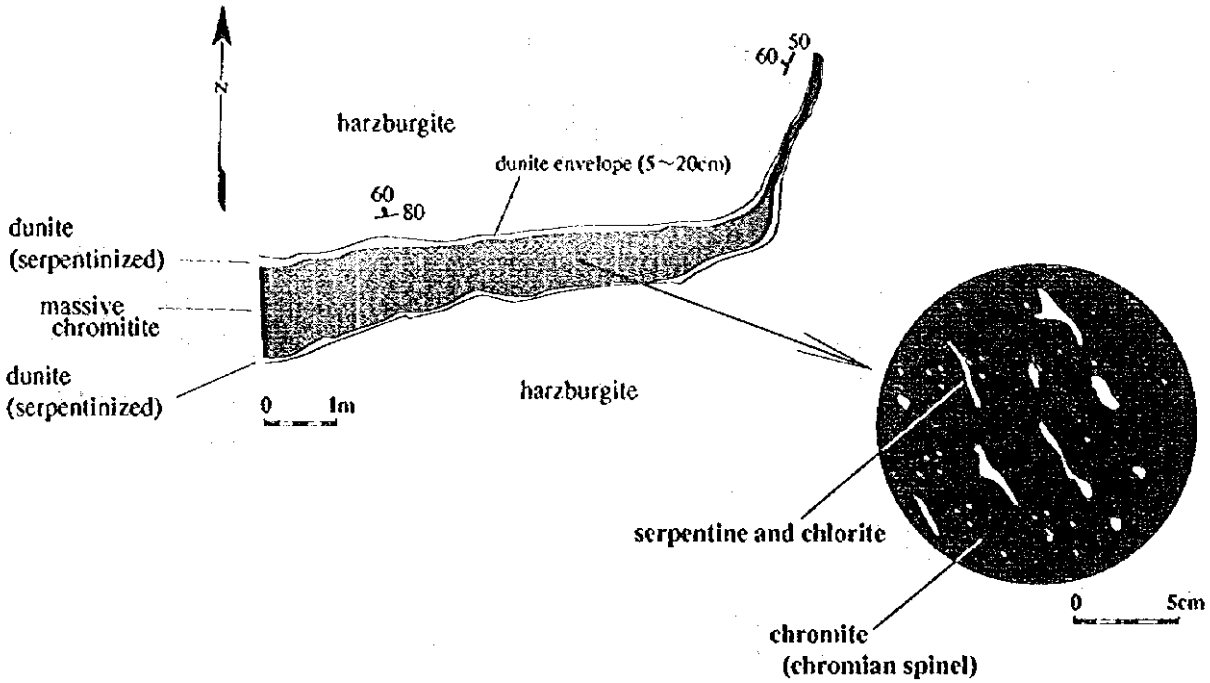


Figure 2-1-6(1) Sketch of massive type chromitite deposit
sample location; IM013 (Lugu i Batres)

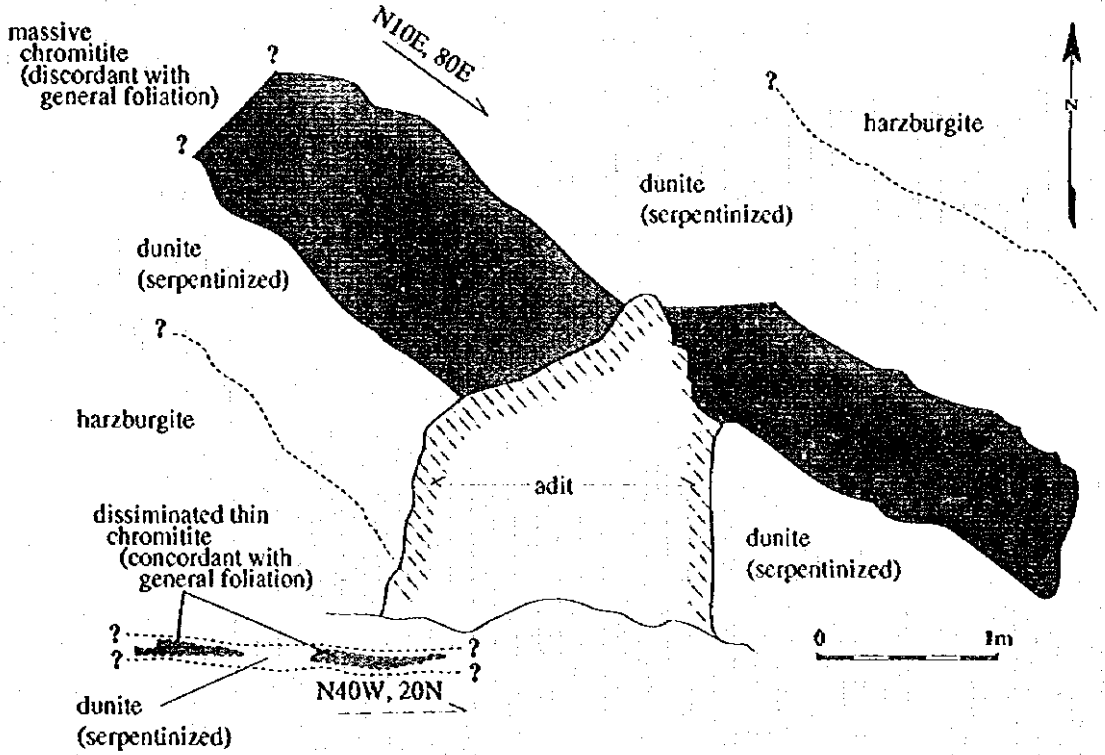


Figure 2-1-6(2) Sketch of massive type chromitite deposit
sample location; IM014 (Ahu i Vetem)

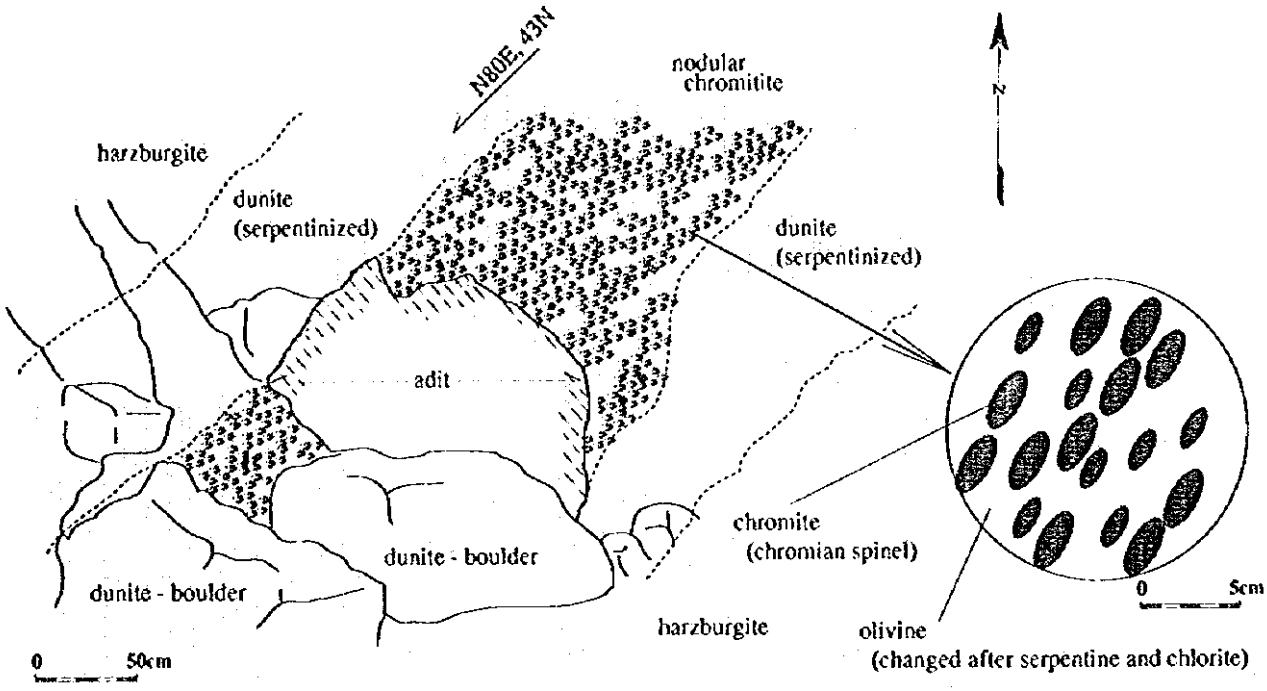


Figure 2-1-6(3) Sketch of nodular type chromitite deposit
sample location; IM002

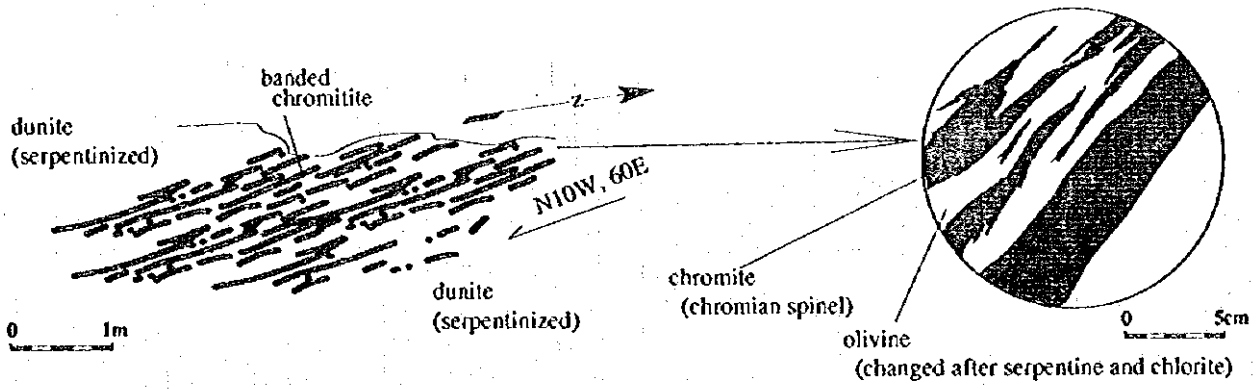


Figure 2-1-6(4) Sketch of banded type chromitite deposit
sample location; IM017

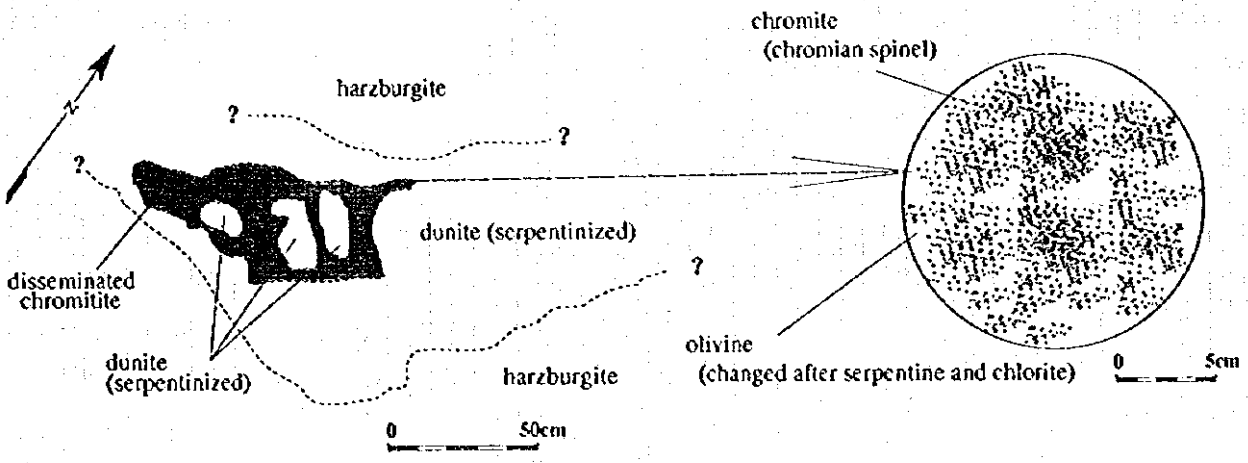


Figure 2-1-6(5) Sketch of disseminated type chromitite deposit
sample location; IM003