THE REPUBLIC OF TURKEY

MINERAL RESEARCH AND EXPLORATION INSTITUTE

REPORT ON GEOLOGICAL SURVEY

OF

TUNCELİ AND KOPDAĞ AREA, EASTERN TURKEY

PHASE II

KOPDAĞ AREA

FEBRUARY 1979

METAL MINING AGENCY OF JAPAN

JAPAN INTERNATIONAL COOPERATION AGENCY

GOVERNMENT OF JAPAN

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PREFACE

The Government of Japan, in response to the request of the Government of the Republic of Turkey, decided to conduct cooperative mineral exploration project in Kopdağ area in eastern Turkey and entrusted its execution to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The project started in 1977 under close collaboration with Maden Tetkik ve Arama Enstitüsü (MTA) of the Republic of Turkey. The intention of the project is to study potentiality of chrome deposit in the area.

Between 23 June, 1978 and 31 January, 1979, the Metal Mining Agency of Japan dispatched a survey team headed by Mr. Hajime TAKAHASHI to conduct geological survey of the Phase II of the project.

This report is a compilation of the basic survey findings of the Phase II. At the completion of the project, consolidated report will be submitted to be Government of the Republic of Turkey.

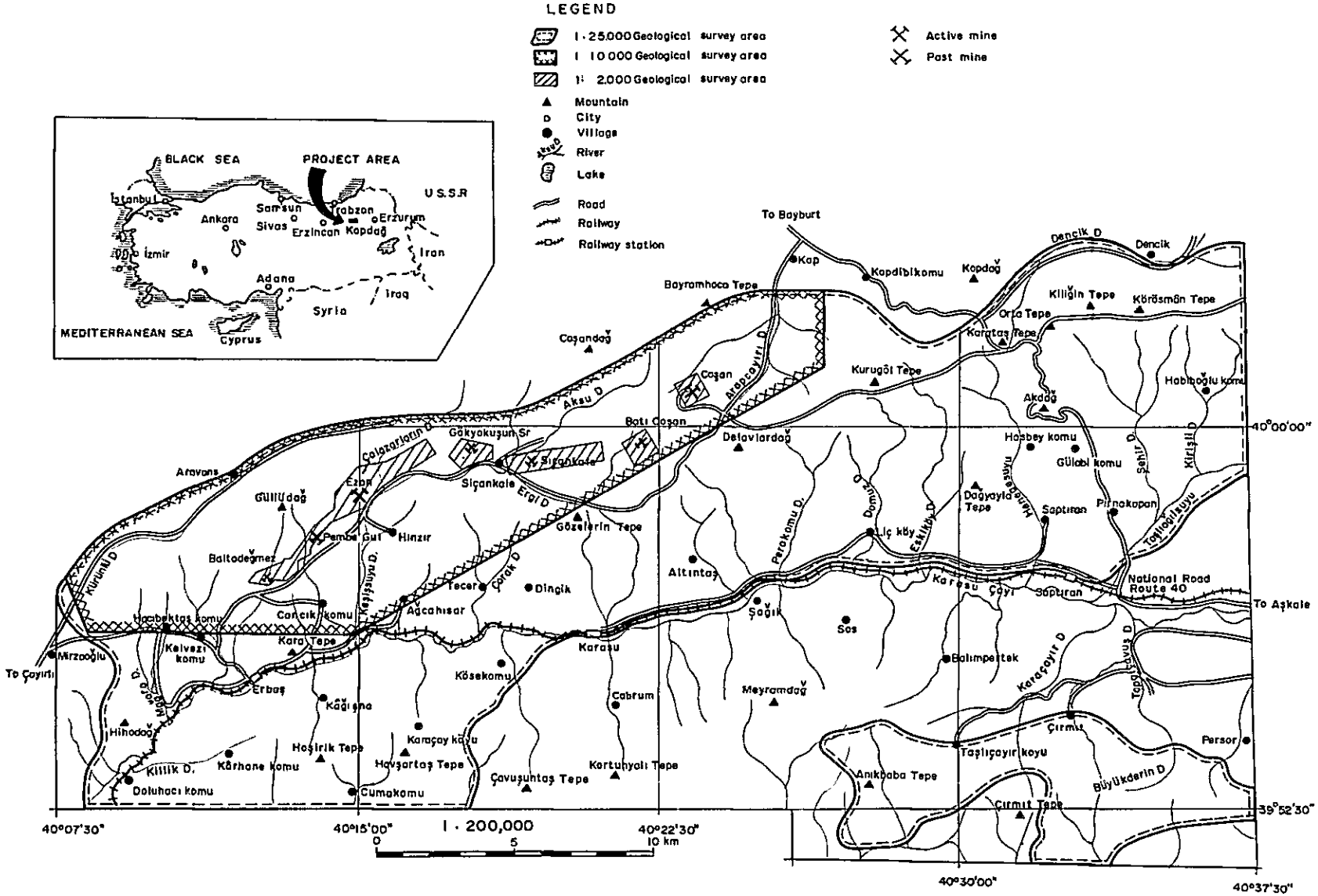
We wish to express our appreciation to all of the organizations and members who bore the responsibility for the project; the Government of the Republic of Turkey, Maden Tetkik ve Arama Enstitüsü, and other authorities and the Embassy of Japan in Turkey.

February 1979

Shinsaku Hogen
President
Japan International Cooperation Agency

Masayuki Nishiie
President
Metal Mining Agency of Japan

KEY MAP AND LOCATION MAP



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Abstract

The contents of this report are summarized as follows :

1) The aim of the project was to find economic mineral deposits in the area. Chromite deposits in ultrabasic rocks were the first target for exploration.

2) Based on the results of the previous work and of the photogeological survey in 1977, geological survey was carried out this year (1978).

Amount of work in 1978 can be enumerated as follows :

reconnaissance geological survey	(map scale 1: 25,000)	320 km^2
semi-detailed geological survey	(map scale 1: 10,000)	120 km^2
detailed geological survey	(map scale 1: 2,000)	10 km^2
sketch of trenches	(map scale 1: 100, 1: 500, etc.)	202 places
sketch of galleries	(map scale 1: 500)	950 m

3) Field survey was done from 19, July, 1978 to 7, October, 1978. Four Turkish and four Japanese geologists participated in the survey.

4) Administratively, project area belongs to Aşkale and Tercan district of Erzurum province, Çayırlı district of Erzincan province, and Bayburt district of Gümüşhane province.

It is located between 39°51'21"N and 40°03'39"N latitudinally and between 40°07'30"E and 40°37'30"E longitudinally. Topographic maps used, are Erzincan i-44, a2, b1.2.3, Trabzon h-44, c3.4, Tortum h-45, d4 and Erzurum i-45, a1.4.

5) Two mountain ranges, one in the northern part of the area (tentatively called Kop mountain range) and another in the southern part of the area (tentatively called Meyram mountain range), run from east to west. Between them, Karasu, the uppermost stream of the Fırat (Euphrates) flows from east to west. Most of the

drainage system in the area belongs to that of Karasu. Drainage system in the north-east part of the area beyond Kop mountain range, belongs to that of Çoruh.

Topography of the area is generally gentle. However, strongly serpentinized ultrabasic rocks, igneous intrusive rocks, limestone, talus and terrace deposit occasionally form cliffs and steep slopes.

6) Due to the high latitude and altitude, climatic conditions are severe. It snows from October until May. Even from June to September, if it can be called summer, it is cold at night.

The area is covered by grassland, no forest is present.

7) Transportation in the area is not very convenient. It takes 3.5 hours by car from Erzurum to the center of the area via Aşkale, and 7 ~ 8 hours by car from Trabzon via Gümüşhane and Bayburt.

Telecommunications are available only at local cities, such as Bayburt and Aşkale, outside of the area.

Small villages are scattered in the area. Population of the area is small ; it is estimated to be 10 ~ 15 people/km.

Main industries in the area are stock farming, agriculture, and mining.

Owing to the circumstances mentioned above, all the material for survey and daily living must be brought in from outside of the area.

8) The largest part of the area is composed of ultrabasic rocks. They intrude into limestone of the uppermost Jurassic ~ lower Cretaceous (tentatively named Meyramdağ limestone). They are covered by Eocene ~ Pliocene sediments (tentatively named Kopdağ limestone and Aşkale sandstone) and post-Pleistocene talus, terrace and alluvial deposits.

Many kinds of igneous intrusive rocks, gabbro, diorite, diorite porphyrite, quartz porphyry and volcanic rocks, intrude into ultrabasic rocks.

9) Dunite in ultrabasic rocks is divided into two groups according to its distribution. One is located in the northern part of the ultrabasic rocks with ENE direction (named northern dunite zone). It is approximately 18 km long and 1,000 m wide, and occupies the upper horizon in ultrabasic rocks.

The other (named dunite lens) occurs as small zones and dykes in harzburgite, everywhere in the area.

Dunite is mostly serpentinized.

10) Harzburgite makes up approximately 80 % of the ultrabasic rocks. It is situated mainly in the middle ~ lower horizon of the ultrabasic rocks, and partly in the uppermost horizon. It extends to ENE. It is 40 km long and more than 3,000 m wide.

Pyroxenite, both orthopyroxenite and clinopyroxenite, forms small zones and dykes everywhere in the ultrabasic rocks.

Wehrlite is not common in the area.

11) Serpentinite occurs commonly in the ultrabasic rocks. Dunite is apt to be serpentinized, especially at the northern dunite zone. Lateritization and silicification are locally observed. Carbonate rocks occur as lenticular bodies in the ultrabasic rocks.

12) Plutonic intrusive rocks, gabbro and diorite, are distributed mainly along the northernmost and southernmost boundary of the ultrabasic rocks. They commonly form bosses or stocks and occasionally dykes. They are genetically related to the ultrabasic rocks.

Hypabyssal intrusive rocks, diorite porphyrite and quartz porphyry are distributed as dykes in the ultrabasic rocks, especially in their southern half. They are hypabyssal facies of diorite etc.

Rhyolite (or andesite) dykes which seem to be a volcanic facies of quartz porphyry, occur locally. Basalt lava is found partly along the boundary between Kopdağ limestone and ultrabasic rocks in the northern part of the area.

13) Ultrabasic and related igneous rocks are deposited from south toward north. Their sequence, harzburgite - dunite - gabbro - diorite - basalt, suggests the tectonite - cumulite sequence. However, occurrence of harzburgite at the uppermost horizon leaves a problem if the above interpretation is adopted.

14) Lithostratigraphic units of the area, are also in general deposited from south toward north. Meyramdağ limestone, ultrabasic rocks, and Kopdağ limestone have ENE strike with N dip.

Two fault systems, N system and E system, are present in the ultrabasic rocks. The N fault system is younger than E fault system.

15) Many chromite deposits occur in the ultrabasic rocks, mostly in dunite. They are found in every horizon of the ultrabasic rocks and concentrated into 3 ore zones.

One ore zone is located at the upper horizon of the ultrabasic rocks. It is found in northern dunite zone from Çamlı Tepe area to Baltadeğmez and tentatively called the northern chrome zone. Another ore zone is located in the middle horizon of the ultrabasic rocks. It extends from Kârhanekomu area to Tecer and is tentatively called the southern chrome zone.

The third ore zone occurs in the middle ~ slightly lower horizon of the ultrabasic

rocks. It is found around Gülabikomu and Pırnakapan, eastern part of the area and is called the eastern Kop chrome zone.

16) Among the three chrome zones, the northern chrome zone is the biggest. It extends 18 km in ENE direction. Two mines, Coşan and Ezan, are operated by private companies. 127 trenches and 11 galleries (excluding closed galleries) are present.

17) In the southern chrome zone and the eastern Kop chrome zone, scale of the orebody is small and continuity of the deposit cannot be expected. 22 trenches in the southern chrome zone and 53 trenches in the eastern Kop chrome zone are defined. Most of them are for exploration.

18) Direction of unit orebody and chromite banding are occasionally different from each other. Examples are given for Coşan deposit, Tepebaşı deposit, and Sıçankale deposit.

19) Chromite orebody is commonly lenticular, and occasionally layered or network shaped. Often, it has a clear contact with the host rock at the hangingwall side, while it gradually disappears into the host rock at the footwall side.

In talus deposits near chromite mines, gravels of chromite occur in some cases. At Sıçankale, Coşan and Pembe Gül, the above phenomenon is observed.

20) The chromite ore is massive ~ disseminated. It becomes powdery due to the weathering of serpentinite on the land surface. Around the orebody, chromite banding is developed.

21) Minor faults are commonly observed around the orebody. But they do not dislocate the orebody very much. A minor folding is found only in the orebody at Tepebaşı mine.

22) Generally speaking, unit orebody of chromite in this area is small.

Extension to strikeside does not exceed 100 m except for Ezan mine and it is in general less than 20 m. Width of the unit orebody is 20 m at maximum, and less than 2 m in general.

Reserve anticipated from the unit orebody is mostly less than 1,000 ton except for Coşan and Ezan mines. Even the largest reserve in Ezan mine is estimated to be less than 100,000 ton. All of the large-scaled orebodies occur in the northern chrome zone.

Grade of ore varies according to the mine and the place. It is high in the northern chrome zone and low in the eastern Kop chrome zone. In many cases, it is better at the hangingwall side of orebody than at the footwall side.

23) It is remarkable that the serpentinized zone is mostly in accord with chrome zone. This phenomenon is especially emphasized in the northern chrome zone.

24) Ore minerals are mostly chromite and a small amount of uvarovite. At Ezan and Pembe Gül mine, kaemmererite occurs.

Gangue minerals are mostly serpentine, accompanied commonly by stichtite, carbonate minerals (mainly magnesite), brucite, asbestos, talc, magnetite, and occasionally artinite, silica minerals and iron-oxides.

25) Cr·Fe ratio falls generally between 1.8 and 2.8, with 2.2 medium value. Cr·Al ratio is mostly between 4.0 and 5.8. Anomalous ratios are found in specimens from the southern chrome zone, the eastern Kop chrome zone, and Dikyokuş mine.

26) Carbonate minerals, as alteration product of the ultrabasic rocks, especially of dunite, are found commonly in lenticular bodies.

Big deposits occur near Aravans at the northwestern end of the ultrabasic rocks

and near Hasbeykomu in the eastern Kop chrome zone. The former is under exploration by M.T.A.

27) Each unit orebody was studies in detail and volume of each trench and amount of ore taken out from the trench was estimated, even though it was difficult or uncertain in many cases.

Based on these data, evaluation from 1st (A) order to 7th (G) order of each chromite deposit was attempted. Ezan mine ranked as A order, Coşan mine as B, and Pembe Gül and Civelek mines as C.

28) Methods for future prospect are discussed. Trenching and drilling exploration are the leading methods needed to clarify the development of orebody at strikeside and dipside extension. Detailed geological survey may be necessary if trenching and drilling produce promising results. Due to the severe serpentinization of the host rock careful consideration is necessary before underground prospecting and this method cannot be recommended at the present time.

29) Areas and amount of work for future prospect are discussed and listed in Fig. 4. Amount of work which have the first (A) and second (B) priorities total 500 m^3 for trenching, 1,660 m for drilling exploration, and 1.69 km^2 for follow-up detailed geological survey.

30) For exploration in 1979, following projects are proposed: 12 drill holes with 1,150 m of total length at Ezan mine, 500 m^3 of trenching at Ezan mine etc. and 2 km^2 of follow-up geological detailed survey at Ezan and Coşan mine.

Field work is limited, at most, to the period from middle of June to early October.

1. INTRODUCTION

1.1 Work objective

The aim of the project was to find economic mineral deposits in the area. Chromite was the first target for exploration. However, basic data of general geology and economic geology were not sufficient for exploration, and the work had to be begun by a reconnaissance survey.

The survey was started in 1977. However, the survey in 1977 was limited only to analysis of aerial photographs without field check, due to the delays and severe climatic conditions. Some information on general geology, geologic structure, alterations and indications of mineral occurrence were obtained.

Based on the above results and considering the results of previous work, objectives of work in 1978 were as follows :

1) to check the results of 1977 photogeological analysis in the field.

2) to clarify the lithology and geologic structure related to mineral occurrences.

3) to study the details on mineral deposits.

4) to evaluate the economic importance and the potential of future prospect of the mineral deposits.

5) to recommend promising areas and methods for future prospecting.

To meet these objectives, following projects were proposed :

a reconnaissance geological survey in an area of 300 km^2 in the eastern half and southwestern part of the area on a map scale of 1: 25,000 ; a semi-detailed geological survey in an area of 100 km^2 in the northwestern part of the area where

chromite deposits are already known, on a map scale of 1: 10,000; a detailed geological survey in an area of 10 km^2 with promising zone of chromite deposits on a map scale of 1: 2,000; 100 m^3 trench exploration for chromite deposits and sketch of galleries already known, 1,000 m in length on a map scale of 1: 500.

1.2 Work procedure

This year's survey began in the middle of May. Turkish team hired guide workers and prepared camping facilities, field vehicles, and other equipment for necessary field work. However, due to abundant snowfall, lingering snow, and collapse of roads, two months were needed to complete the camp-building.

Japanese team arrived in Ankara on June, 24. After completing necessary procedures in Ankara, they made an inspection tour of Guleman mine, the biggest chromite mine in Turkey under the guidance of leaders of Mineral Exploration Department, Mineral Research and Exploration Institute (Maden Tetkik ve Arama Enstitüsü, hereunder abbreviated as M. T. A.).

The Japanese team arrived in Kopdağ on 16th of July via Araklı where Eastern Black Sea Branch of M. T. A. is situated. Field survey began on July 19 and ended on October 7. without any trouble. From August 6, to September 3, was the Moslem month of fastening.

From October 8 to November 30, office work was carried out at Eastern Black Sea Branch of M. T. A.

From October 17, the survey team again visited the field to discuss the results with Dr. Tandoğan ENGİN, Assistant Director (at that time) of Mineral Exploration Department, M. T. A., Dr. Ünal ARTAN, Chrome Section Chief, Mineral Exploration Department and Dr. Hideo HIRANO, Japanese expert in M. T. A.

On November 1, Japanese Mission of Metal Mining Agency, visited Araklı and Kopdağ. However, as the road was closed due to snow, they could not reach most parts of the field.

From December until the end of January, discussions of the field results and future prospect were made at M. T.A., Ankara.

From December 14 to December 18, second Japanese Mission of Japan International Cooperation Agency and Metal Mining Agency visited M.T.A. Ankara, to discuss the work in 1979.

Fossil identification was made by Paleontological Division, M. T.A. and chemical analysis of ore was carried out by Laboratory Department, M.T.A. Polished sections and thin sections were made at Eastern Blak Sea Branch, M.T.A. and studied by the survey team. X-ray diffractive analyses were done in Japan.

From February 1 to March 2, two members of technical staff of M. T.A., Ruhi ÇALGIN, Cevdet EMİN, were invited to Japan as guests of this project.

1.3 Participating personnel in the survey

Personnels who participated in the survey in 1978 are shown hereunder :

Turkish Team	Japanese Team
Supervisors	
Yılmaz ALTUN	Hisamitsu MORIWAKI
	Kazuhiro CHIMURA
	Hiroshi OKANO
Geologists	
Sadık AÇAN	Hajime TAKAHASHI
İbrahim KOÇ	Kazuyasu SUGAWARA

Nejdet YURDUSEV	Shigehisa FUJIWARA
Mahir İZMİR	Kazuyoshi MASUBUSHI

1.4 Amount of work

Amount of work which has been done in 1978 is as follows :

Reconnaissance geological survey	(map scale 1: 25,000)	320 km^2
Semi-detailed geological survey	(map scale 1: 10,000)	120 km^2
Detailed geological survey	(map scale 1: 2,000)	10 km^2
Sketch of trenches	(map scale 1: 100, 1: 200, 1: 500 etc.)	202 places
Sketch of galleries	(map scale 1: 500)	950 m

In the detailed geological survey, sketch of trenches and galleries, compass and measure were used to make a topographic map. For some parts (Ezan and Coşan mine), plain table was used.

Amount of laboratory tests is as follows :

Thin sections	54 samples
Polished sections	23 samples
X-ray diffractive analyses	30 samples
Fossil identification	3 samples
Chemical analyses of ore for Cr_2O_3, Al_2O_3, FeO, MgO and SiO_2	18 samples

1.5 Location of the survey area

Location of the survey area is shown on Location map and enclosed within points listed below.

A	40°03'39"N	40°37'30"E
B	39°51'21"N	40°37'30"E
C	39°51'32"N	40°25'50"E

D	39°52'36"N	40°25'50"E
E	39°52'30"N	40°07'30"E
F	39°52'51"N	40°07'30"E

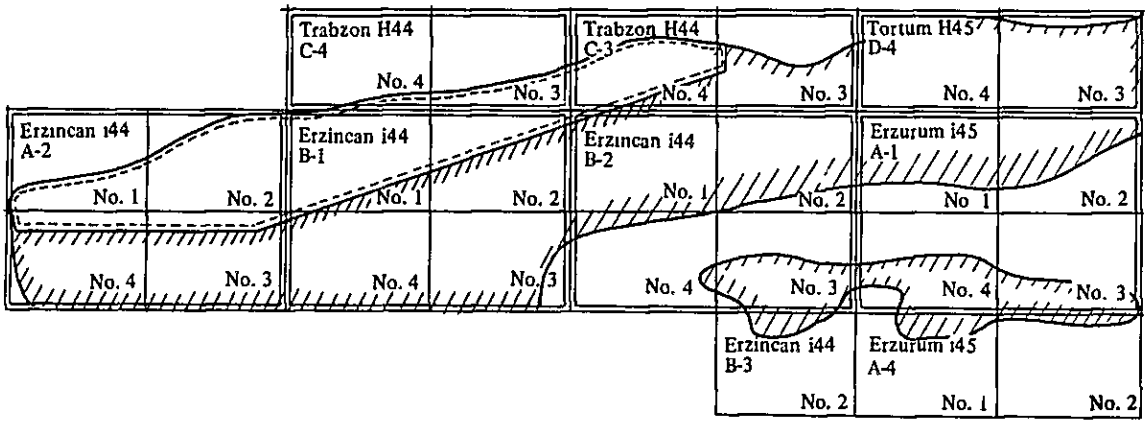
The area belongs to administrative provinces shown below :

northwestern part of the area; northwestward from Kalvezikomu and along the drainage of Kürünlüdere	Çayırlı district, Erzincan province
northern part of the area; such as drainage of Arapçayırıdere (except the drainage of Dencikdere)	Bayburt district, Gümüşhane province
southwestern part of the area; westward from Karasu station at the south bank of Karasu Çayı	Tercan district, Erzurum province
other parts of the area;	Aşkale district, Erzurum province

1.6 Topographic maps

Topographic maps used for the survey are shown hereunder. Results of the geological survey (except detailed geological survey) are shown, however, on drainage maps.

Topographic maps for detailed geological survey (map scale 1: 2,000) were made mostly by the survey team and partly (Ezan and Coşan mine) by the surveyor of M.T.A. Resutls of the survey are given on the topographic maps.



survey area (map scale 1:25,000)

survey area (map scale 1:10,000)

1.7 Acknowledgements

We wish to express deep gratiture to Professor Dr. Nizihi CANITEZ, General Director of M.T.A. for his support of this project.

Thanks are due to Dr. Tandoğan ENGİN, Director of Mineral Exploration Department, M.T.A. and Dr. Ünal ARTAN, Chief of Chrome Section of the above-mentioned Department for providing us with much help and valuable guidance.

Also we take pleasure in recognizing the help and support of the staff of Eastern Black Sea Branch of M.T.A., headed by Mr. Temel Y. NEBİOĞLU.

We would like to thank the staff of Laboratory Department for chemical analysis of ore, the staff of Paleonotology Division for fossil identification and to surveyors for the preparation of topographic maps.

Dr. Hideo HIRANO, Japanese expert of M.T.A. guided us kindly in microscopic observations.

2. ENVIRONMENT AROUND THE PROJECT AREA

2.1 Topography

The area is situated in the northern part of inner arc of the Eastern Taurus Mountains. Two mountain ranges, Kop mountain range (tentative name) in the northern part and Meyram mountain range (tentative name) in the southern part extend almost parallel from east to west. Kop mountains have generally an altitude of 2,300 ~ 2,700 m. The highest is Coşandağ* (2,975m), outside of the survey area. Güllüdağ (2,603 m), Kopdağ (2,918 m), and Bayramhoca Tepe** (2,557 m) are the main mountains in and near the area. Meyram mountains have an altitude of 1,800 ~ 2,500 m. The highest is Meyramdağ (2,669 m), outside of the survey area. Havşartaş Tepe (1,940 m) and Kortunyalı Tepe (2,316 m) are the main mountains in and the near the area.

In the center of the area, between Kop mountains and Meyram mountains, Karasu Çayı***, the uppermost part of Fırat (Euphrates) river flows from east to west. Almost all of the survey area belongs to the Karasu drainage. Beyond Kop mountains to the north, the eastern half of the area belongs to the drainage of Çoruh Nehir**** which flows to the east through USSR into the Black Sea, while the western half belongs to the Kürünlüdere drainage, a branch of Karasu.

The altitude of the area ranges from 1,400 m to 2,650 m. Mountains are gentle-shaped in general. Their slope mostly does not exceed 25°. However, strongly serpentinized ultrabasic rocks, limestone, dykes of igneous rocks, talus and terrace deposits occasionally form cliffs and steep slopes. Rivers of E-W drainage system are generally big and gentle sloping with U-shaped valleys. On the contrary, rivers of

* dağ : mountain
** Tepe : summit
*** Çayı : river
**** Nehir : large river

N-S drainage system are small and steep sloping with V-shaped valleys.

Karasu makes Aşkale plain at the eastern end of the area. Deluvial plain or elevated old river terrace is developed along the rivers of E-W drainage system. Talus deposits are common in the ultrabasic rock area.

Water supply is available throughout the year, as many springs are present everywhere.

2.2 Climate

Due to the high latitude and altitude of the area, the climate is severe. Depending on year, altitude, and place, but generally from the middle of October until May, it snows. Northern flank of Kop mountains is covered with snow more than 2 m thick, while on southern side of Karasu, it is less than 0.5 m thick. Even in June and September, it snows occasionally. Lowest temperature in winter reaches a maximum of -30° and average -15°.

The summer season, if it can be called summer, is from June to September. It rarely rains and it is seldom even cloudy. Temperature varies very much in a day, 30° during daytime and less than 10° at night.

Annual precipitation is approximately 500 mm and is concentrated in winter season. It is windy throughout all seasons, especially in mountain areas. At the beginning of the winter, heavy thunderstorms take place occasionally.

2.3 Vegetation

Due to the high altitude and scarcity of precipitation, no forest has developed. Trees, mainly pine, cypross and natural pier are observed along rivers and around springs. They are neither tall nor big. Almost all areas are covered by grasses and bushes. They start to grow out in June and after blooming, they wither by

September.

Near villages and along the Karasu, there are fields of wheat, barn millet and vegetables.

Thickness of soil in this area is in general less than 1 m and humus soil is rarely present. But in serpentinized areas in ultrabasic rocks and in the areas of river terraces and talus deposits, its thickness reaches more than 2 m.

2.4 Transportation

Transportation from Ankara to the field is not very convenient. Once a day regular air service from Ankara to Erzurum and to Trabzon is available by Turkish Air Line. The flight takes approximately 1 hour.

There is a long distance bus service between Ankara and main cities. From Ankara to Erzurum and Trabzon bus service is available, approximately 10 times a day and each takes about 13 hours. There is bus service from Ankara to Bayburt, Gümüşhane and Aşkale, too. Railroad from Anakra to Kars via Erzurum passes through the field along Karasu. Three or four times a day, train connects the field to Ankara directly, including one express (blue train) a day, but it takes 18 hours from the field to Ankara.

Road conditions are not very good around the area. National route, Route 2 which connects Erzurum and Sivas via Erzincan, Route 40 which connects Aşkale and Gümüşhane via Bayburt and Route 65 which runs between Gümüşhane and Trabzon are asphalt, all-weather roads.

Some roads, for example, from Karataş to Erbaş station via Sıçankale Y.*, from Aravans to Çayırlı along Kürünlüdere are stabilized, but they are closed during winter.

* Y. (Yayla) : summer dwelling

Many roads connecting villages are present. But most of them are in very bad condition, so that only jeep can go through. Some examples are, road from Bayburt to Delavlardağ via Kopkomu*, from Erbaş station to Çayırlı via Kelvezikomu and Hacıbektaşkomu, from Aşkale to Karasu station along Karasu and from Kopdağ to Dencik.

As there is no bridge for cars across Karasu, southern side of Karasu area is hard to reach. In the dry season, Karasu can be crossed by jeep at a few points but generally, to reach them, one must start from Aşkale to Tercan by Route 2 and then take the road which connects the villages.

From Erzurum to the Sıçankale Y. via Karataş which is located at the center of the area and where field camp was established, it takes 3.5 hours by car. From Trabzon to Bayburt by Route 65 and 40, and then via Kopkomu and Delavlardağ to Sıçankale Y., it takes 7-8 hours. From Sıçankale Y. to the chrome mine under operation (Coşan and Ezan) it takes 30 minutes by car.

However, since many roads are under construction or are being repaired, transportation will be improved near future.

2.5 Telecommunications

Telecommunications can be said to be very bad. No telephone, telegram and even mail service, except for some parts near the national route and railroad, is available. The nearest place where telephone and telegram is available, is Bayburt. It takes 2-3 hours to Ankara or Trabzon by express telephone and one day by telegram. Airmail service between Bayburt and Japan is good. It takes only one week, except for packages. Mail from Ankara to Bayburt takes 2-6 days according to the type of mail.

* komu : village

2.6 Population

Because of the nature of the area, population is very small and its density is estimated to be 10-15 people/km^2 approximately. Along the Karasu, and other big rivers, there are scattered villages. Population of each village ranges from one to several hundreds.

Cities near the area such as Bayburt and Aşkale have a population of 10,000. Erzurum and Trabzon, provincial capitals, have a population of 100,000. As the population of the area is small, workers for this project are very difficult to find in the villages. This year, workers from Aşkale and from Black Sea region were employed.

2.7 Industries and education

Main industries in the area are stock farming, agriculture, and mining. Stock farming of sheep, goats, and cows is developed in every village. Dairy products, fur, and meat are the main sources of income of the villagers. Number of cattle reaches more than ten times that of the human population. Agriculture is developed of level land such as river terraces and alluvial plains. Wheat, pasture, barn millet and vegetables are the main products.

Two chrome mines, Coşan mine and Ezan mine are under operation. Both of them belong to private companies. Both Ezan mine, managed by Kop Chrome Co. and Coşan mine, managed by Kop Mining Co. produce approximately 700-1,000 tons of crude ore a year. However, period of operation is limited to the summer season, due to climatic conditions. Crude ore is taken mainly from trenches and partly from adits. After handpicking, crude ore is transferred to storage at Karataş and then transported to Trabzon for sale. Workers in mines total 300-400 are mostly villagers

living near the mines.

Outside of the area, a magnesite mine is under operation, maganed by Ülsoy Mining Co. Near Aşkale, along the national route, there is a limestone quarry (out of operation) and a cement factory.

Most of the villages have a primary school and some have a junior high school. But for further education, one must go to Aşkale or Bayburt. Universities near the area are Black Sea Technical University at Trabzon and Atatürk University at Erzurum.

Because of the circumstances mentioned above, all the goods necessary for work and living, must be brought from outside of the area. Daily necessities, gasoline and most foods can be obtained in Bayburt and Aşkale.

Industrial material, equipment for work, field vehicles and other necessary goods were supplied by Eastern Black Sea Branch, M.T.A. and Black Sea region. Some types of meat, vegetables and dairy products are available within the area.

3. GEOLOGY

3.1 Preface

Geology of the area consists of limestone of the uppermost Jurassic ~ lower Cretaceous, ultrabasic and basic ~ intermediate igneous intrusive rocks from the Cretaceous to Paleogene, calcareous sedimentary rocks deposited during Eocene and Pliocene, terrace and talus deposit of Plio-Pleistocene age and alluvial deposits. A small amount of schist occurs in the gabbro as xenoliths. Eighty percent of the area is occupied by ultrabasic rocks. These rocks extend from WSW to ENE, generally gently dipping to the north. Thus the order of deposition becomes younger toward north. For convenience sake, Mesozoic limestone is tentatively named Mayramdağ limestone, calcareous sedimentary rocks of Tertiary are called Kopdağ limestone (mainly distributed in the northern part of the area) and Aşkale sandstone (distributed in the southeastern part).

3.2 Schist

This rock occurs only in gabbroic and granitic intrusive bodies, so the distribution is mainly in the northern part of the area where ultrabasic rocks and Kopdağ limestone are in contact. It can be observed around Güllüdağ and near Karataş.

It occurs as irregularly-shaped, small blocks (approximately 100 m). Its thickness is uncertain but is estimated to be less than several tens of meters. Its contact with gabbro is quite obscure, as if it changed gradually in gabbro. Therefore in the field it is called foliated gabbro. It is black and has good schistosity.

Microscopically, it is defined as epidote actinolite schist and amphibolite. The former has schistose texture and is composed of actinolite, epidote-clinozoisite, albite, leucoxene, and chlorite. The latter is schistose, coarse grained, and composed

of brownish green hornblende and plagioclase with a small amount of clinozoisite and leucoxene. Judging from the mode of occurrence, they are xenoliths in gabbro or granitic rock.

It is correlated to pre-Mesozoic actinolite epidote schist described by KAADEN, G. (1962).

3.3 Meyramdağ limestone

Distribution of this rock can be divided into two. One is from Çavuşuntaş Tepe to the east of Saptıran through Meyramdağ. Most of the Meyram mountain range is composed of this rock. Another is from Akdağ to Habiboğlukomu. It extends from west to east and generally dips to the north with 20° - 30°. Occasionally, it is disturbed at the contact with ultrabasic rocks. Its thickness exceeds 1,000 m at Meyramdağ but it is 200 - 300 m at Akdağ.

It is in contact with ultrabasic rocks and near Meyramdağ it is covered unconformably by Aşkale sandstone. At the right bank of Karasu, it is overlie harzburburgite and occurs as blocks in harzburgite. At Akdağ it seems to over lie harzburgite, but at the contact, many minor faults, folds and thrusts are present in the limestone. So this limestone is judged to be older than ultrabasic rocks.

At Akdağ, an ammonite was found in this limestone and was identified to be uppermost Jurassic or lower Cretaceous. Between Aktaş and Pırnakapan, small massif of limestone overlies harzburgite and Molluscs in this limestone indicate Miocene ~ Pliocene age. Such small massifs are present everywhere in ultrabasic rock areas, where it occupies the summit of mountains and overlies the ultrabasic rocks. They are judged as Kopdağ limestone, discussed later, but the division between the Meyramdağ and Kopdağ limestone, is sometimes difficult because their occurrence

is similar and their outcrops are sometimes very close.

Meyramdağ limestone is composed of creamy white, fine grained, and well stratified limestone. A small amount of calcareous mudstone, siltstone and gypsum are intercalated in it. Except when it occasionally becomes saccharoidal at the contact with ultrabasic rocks, no remarkable alteration is observed.

Microscopically, limestone is oolitic and composed of equigranular, very fine grained calcite. A small amount of argillaceous material is included.

This limestone is correlated to Jurassic ~ lower Cretaceous limestone by KAADEN, G. (1962).

3.4 Kopdağ limestone

This limestone is distributed widely in the northernmost zone of the area. It extends along the drainage of Kürünlüdere, Coşandağ, Kopdağ, and Dencikdere from west to east.

Small massifs of approximately 200 - 300 m in diameter are present in the ultrabasic rocks. They occur mostly at the summits of mountains. They are found along Kop mountain range and along and south of Karasu.

This limestone covers ultrabasic rocks and shows very gentle trend, dipping to the north, except at the contact with ultrabasic rocks. It is more than 500 m thick at the northernmost zone but less than 100 m in the small massifs.

Molluscs found between Aktaş and Pırnakapan in a small massif show age between Miocene and Pliocene. A fossil fish was found near Güllüdağ.

Kopdağ limestone is mainly composed of limestone which cannot be distinguished from the limestone of Meyramdağ. Calcareous sandstone, fine conglomerate, siltstone and mudstone are commonly intercalated in it. Tuffaceous layer including

breccia is present locally near the contact with ultrabasic rocks. Tuffaceous layer occurs near the basaltic lava which overlies ultrabasic rocks. So this part is presumed to be related to the basalt. Frequency of intercalations of sandstone, conglomerate, silstone and mudstone is far higher than that of Meyramdağ limestone.

Fine, round gravel less than 3 cm size, composed of chert, sandstone, limestone, and marl with calcareous matrix makes thin layer of interformational fine conglomerate. Calcareous mudstone, siltstone, and sandstone have the same mode of occurrence as the limestone. They are creamy white – pale green and well stratified. Volcanic rock of the tuffaceous layer has basic - intermediate composition. It is pale green and massive. Tuffaceous breccia, which is small is size and amount, is composed of volcanic rock, sandstone, and chert.

Microscopically, the limestone is mostly composed of calcite. Fragments of feldspar and argillaceous material are also present. The sandstone is composed of angular - subangular grains of quartz, plagioclase, and fragments of chert. A small amount of ferruginous material, apatite and chlorite is present. The cement is mainly composed of carbonate minerals. Some specimens contain microfossils, volcanic breccia, and magnetized chromite. (refer to Appendix 3-26)

At the contact with ultrabasic rocks in the northern part of the area, mineral springs are present here and there. They have a high content of hydrogen sulfide gas and reprecipitate calcareous sinter. Examples are seen at Deveçukları Sr.* and Dencik. (refer to Appendix 1)

This limestone was correlated to thin-layered limestone of upper Jurassic ~ lower Cretaceous by KAADEN, G. (1962).

* Sr (Sırt) : ridge

3.5 Aşkale sandstone

The Aşkale sandstone occurs in the southeasternmost part of the area, south of Çırmıt Tepe. This covers unconformably the Meyramdağ limestone and ultrabasic rocks. It extends from E to W dipping 20° - 40° to the south. Its thickness is uncertain but exceeds 400 m.

It is calcareous and composed of sandstone, mudstone, siltstone, and conglomerate. Sandstone and conglomerate are dominant. Conglomerate is composed of fine, round gravel of sandstone, mudstone, and siltstone with calcareous matrix. It is not a basal but rather interformational conglomerate.

Compared with the Kopdağ and Meyramdağ limestones, it is characterized by deep brownish red color originating from ferruginous minerals, by weakness of consolidation, and by different constituent rocks.

Nummulites etc. which are found in this limestone, indicate Eocene. Therefore, this limestone is older than the Kopdağ limestone. But the relation between these limestones is not certain.

This is difficult to correlate with previous data but this may be correlated with unclassified Neogene terrestrial or lacustrine sediment described by GATTINGER, T.E. (1962).

3.6 Talus deposits

These deposits are distributed everywhere in the area of ultrabasic rocks. It is especially developed along the mountain sides and steep brooks of Kop mountain range.

The shape of a deposits is quite irregular and its dimensions do not in general exceed 200 m. Its thickness is less than several tens of meters. Judging from the mode

of occurrence, this deposit is a talus deposit. It covers unconformably ultrabasic rocks, Kopdağ limestone, etc. It is brownish khaki colored, ill-sorted, and generally not well-stratified.

It is composed of huge angular - subangular block of rocks such as ultrabasic rocks, gabbro, diorite, limestone. Size of blocks reaches 50 cm. Large amount of blocks in comparison with matrix is characteristic. Near chrome deposits, blocks of chromite are common. Cementing materials are mostly fine grained carbonate minerals. They are completely consolidated but the age of formation is estimated to be young.

This is correlated with some part of Pleistocene conglomerate by KAADEN, G. (1962).

3.7 Terrace deposits

They are developed at the southern side of Kop mountain range, especially along Karasu. Examples are shown, from Ağcahisar to Liç, around Hihodağ and Dağyayla Tepe. Their extent varies from several tens of meters to several kilometers, and its thickness from 10 m to more than 300 m. From Erbaş station to Hihodağ and from Dağyayla Tepe to Saptıran, they show maximum development. They unconformably cover ultrabasic rocks. Direction of extent is quite irregular and and has several dip angles.

These deposits are mostly consolidated and composed mainly of conglomerate with intercalated layers of mudstone, siltstone, and sandstone. Conglomerate consists of cobbles and boulders some more than 30 cm in diameter. Several kinds of rocks such as ultrabasic rocks, limestone, gabbro, diorite, etc. are included and most of them are autochtonous. These cobbles range from round to subangular. Carbonate and silica minerals are the dominant cementing materials.

In contrast with the talus deposits, these deposits are well-stratified and consist of cobbles of several kinds and shapes. Location and dimension where it occurs are different too. However, when they occur on a mountain side, they are difficult to distinguish from each other.

3.8 Alluvial deposits

Alluvial deposits occur along Karasu and form a wide plain around the town of Aşkale. Small-scale deposits can be seen along the drainage of E-W system such as Kürünlüdere, Keşişsuyudere, Dencikdere, Taşlıoğılsuyu. Their dimension and thickness varies from place to place. It is composed of unconsolidated soil, clay, silt, and gravel.

3.9 Ultrabasic rocks

Ultrabasic rocks occupy 80 % of the area and are situated at its center. They extend WSW-ENE and generally dip to the north. They are divided into dunite, harzburgite, wehrlite ortho-and clino-pyroxenite. Harzburgite makes up 80 %, then dunite and pyroxenite follow in importance. Wehrlite is uncommon in the area.

3.9.1 Dunite

Dunite is observed in two areas. One is from Baltadeğmez mine to Coşan mine from WSW to ENE at the southern side of Kopdağ. (hereafter this is called northern dunite zone). It occupies the upper horizon in ultrabasic rocks. Its extent reaches 18 km and its thickness is approximately 1,000 m. It dips 20° - 40° to the north. It is in contact with gabbro, harzburgite, Kopdağ limestone etc, in the north, and with harzburgite in the south.

Another dunite occurs as lenticular body in harzburgite. In some cases it

forms dunite zones and in other cases dunite dykes (hereafter called dunite lens). It is frequent in the northern half of harzburgite. Their size ranges from several hundreds to several tens of meters. Direction of strike and dip varies, but NE strike with NW dip is dominant. When it forms zones, it changes gradually to harzburgite at the contact.

In northern dunite zone, dunite is dark gray to gray, fine grained and strongly serpentinized, especially in the western half. All the known large-scale chromite deposits occur and bandings of chromite are concentrated in this zone. On the contrary, in dunite lens, dunite is olive green to olive gray and coarse grained. It is more or less serpentinized but grade of serpentinization is far weaker than that of the northern zone. Many small chromite deposits occur in this lens.

Microscopically, dunite is composed of olivine, chromite, and magnetite. In almost all cases, olivine is more or less altered to serpentine, brucite, and carbonate minerals, asbestos and talc, but pseudomorphs are present. Chromite is abundant and hexagonal or octahedral in form. Magnetite is commonly observed around olivine and chromite crystals and along fractures.

3.9.2 Harzburgite

This rock occupies middle-lower horizon of ultrabasic rocks. It extends from west to east; along Kürünlüdere, Hacıbektaşkomu, Gözelerin Tepe, and Gülabikomu. It intrudes into the Meyramdağ limestone and is covered by the Kopdağ limestone, Aşkale sandstone and other young sediments. Many dykes and bosses of basic-intermediate igneous rocks, dunite, and pyroxenite occur in it.

It extends more than 40 km with ENE strike and N dip of 20° ~ 40°. Its thickness varies from 3,000 m to more than 4,000 m. Besides the main body mentioned

above, narrow zone of harzburgite is present at the uppermost horizon of ultrabasic rocks around Ezan and Coşan mines. It extends approximately 10 km with NE strike and 40° NW dip and its thickness is 300 - 500 m.

Macroscopically, harzburgite is dark green and has coarse pyroxene crystals. Facies change from dunitic to pyroxenitic is present. It is replaced partly by serpentinite of greenish-white color. Pyroxene-olivine banding is present but not common.

Microscopically, it is composed of olivine and orthopyroxene (enstatite). Most olivine is altered to serpentine. Enstatite is commonly altered to bustite. Magnetite and chromite are accessory minerals. Clinopyroxene, if present, occurs in small amounts. Brucite, serpentine, carbonate minerals and saponite are common as alteration products. One specimen is judged to be lherzolite (refer to Appendix 3-32).

3.9.3 Wehrlite

This rock occurs in the northern dunite zone as a lenticular body. Its maximum extent is several tens of meters and its thickness is less than several meters. A few examples can be seen at Coşan and Batı Coşan mines.

It is deep green on fresh and brown on weathered surface. It is usually serpentinized.

Microscopically, it is composed of olivine and clinopyroxene (diopside). Olivine is completely altered to brucite and serpentine. Diopside has partly changed to clay minerals and serpentine. Small amount of carbonate minerals is present.

3.9.4 Clinopyroxenite

This rock occurs in the northern dunite zone as dykes and zones. Its extent is

small, generally less than 1 km in length and 10 - 20 m in thickness.

It is brown to greenish black and more or less serpentinized.

Microscopically, it is composed of equidimensional diopside with small amount of olivine and chromite. Diopside is partly altered to clay minerals, chlorite and carbonate minerals along the cleavage. Olivine is completely serpentinized.

3.9.5 Orthopyroxenite

This rock commonly occurs in harzburgite as dykes and zones. It is developed near the southern boundary of northern dunite zone. Scale varies from several hundred meters to 1 m in extent and from several tens of meters to several tens of centimeters in thickness.

It is deep green and partly altered.

3.9.6 Serpentinite.

Ultrabasic rocks in the area are more or less serpentinized. Dunite is the most serpentinized rock type. Serpentinization of dunite and harzburgite or other rocks differs not only by its grade but also by the color; serpentinite from dunite is creamy white while that from other rocks is bluish white.

Northern dunite zone is more strongly serpentinized than other areas. Serpentinization is strongest especially in the western half of the zone. Here, dunite becomes fragile and forms powdery sediments on the land surface. Many fine networks composed of asbestos, talc, and magnesite are observed.

Serpentinized zone is approximately in accord with the chromite occurrences. Serpentinite which is the host rock of the chromite deposits, was examined by X-ray diffractive analysis. Besides serpentine, chromite, brucite, magnesite and stichtite

are commonly present and artinite (Coşan) or aragonite (Sıçankale) are partly included (refer to Appendix 6).

Microscopically, serpentinite is composed of serpentine, both antigorite and crysotile. However, pseudomorphs of olivine and pyroxene can be recognized in most cases. Besides serpentine, carbonate minerals (mostly magnesite), brucite, saponite, chromite, and magnetite are commonly included.

3.9.7 Carbonate rocks in ultrabasic rocks

Due to the alteration of ultrabasic rocks, carbonate minerals are condensed to make the lenticular body. They are composed of magnesite and dolomite. Big deposits occur at Aravans and Hasbeykomu. Extent is several hundred meters and the thickness varies from 100 m to 10 m. At Aravans, it occurs on so large a scale as to be under commercial exploration. The direction of strike is not in accord with that of ultrabasic rocks. It fills cracks in the original rock.

It is white, compact and very fine. Microscopically, it is composed of fine, equidimensional grains of magnesite and dolomite. Occasionally, it includes feldspar grains and chlorite aggregates.

It occurs also as lenticular or layered bodies around Hihodağ, Cancıkkomu, and in the area extending from Ağcahisar through Tecer to Dingik, resting on harzburgite and overlain by terrace deposits. It extends approximately 50 m and is 10 m wide. It is white and granular. Microscopically, it is composed of fine, oval-shaped magnesite and dolomite with a small amount of feldspar and chlorite.

In strongly serpentinized dunite in the northern dunite zone, fine networks of magnesite are developed.

At Cancıkkomu, chromite ore coexists with dolomite.

3.9.8 Altered ultrabasic rocks (except serpentinite)

In the ultrabasic rocks, an altered (except serpentinization) zone is occasionally observed. It is developed in harzburgite in the southern half of the area. It has dyke-like occurrence at the field. It was found along the south bank of Karasu, around Tecer and south of Hihodağ. It is developed south of Hihodağ, where it extends 4 km with 200 m thickness. In other areas, scale varies ; from 10 to 1,000 m in extent and 5 - 20 m in width. There are several directions of extent and it is not in accord with the structure of ultrabasic rocks.

The altered rock is browish red, porous, hard, and ferruginous. Sometimes it is brecciated and the breccia is identified to be dunite or harzburgite. It is lateritized, silicified, and carbonatized.

Microscopically, a specimen has oolitic texture in lateritic crust. Constituent minerals are mainly goethite and gibbsite? In another case, large amount of quartz and chalcedony is present due to silicification. Another specimen is composed of aggregates of carbonate minerals with plagioclase, magnetite and epidote - clinozoisite. (It should be called carbonate rock.) The other has so much hematite and silica (chalcedony) as to be called hematite bearing chert.

These rocks are probably the products of serpentinization, lateritization, silicification (or carbonatization) and carbonatization (or silicification), respectively.

3.10 Plutonic and hypabyssal igneous rocks

Genetically, these rocks are divided into two. One is gabbro - diorite - granitic rock sequence and another is diorite porphyrite - quartz porphyry sequence. The former is related to the ultrabasic series and the latter is the hypabyssal facies of diorite and granitic rock. Their distribution is different; the former is concent-

rated at the northern and southern limit of ultrabasic rocks. The latter is common from middle to lower horizon of ultrabasic rocks. Their mode of occurrence is also different. The former sequence occurs as stocks, bosses and dykes of comparatively large scale. The latter forms only thin dykes.

3.10.1 Gabbro

This rock occurs as stocks and bosses in the northernmost and southernmost part of the ultrabasic rocks. It intrudes into dunite and harzburgite and is covered by Kopdağ limestone. Examples are given around Güllüdağ, Karataş Tepe and Anık-baba Tepe.

Their size reaches approximately 4 -5 km in diameter. Zone of distribution is mostly parallel to the extension of ultrabasic rocks. Besides these, small bosses are found in the middle horizon of harzburgite around Dingik etc.

Generally its facies change from gabbro to microgabbro and diorite gradually. No clear boundary can be drawn between them but judging from field observation, basic part intruded earlier. It is holocrystalline and deep green in color.

Microscopically, it is divided into gabbro, quartz bearing gabbro, and alkali gabbro.

The former two are almost the same in character except for the presence of quartz. They have subhedral poikilitic texture. Main constituent minerals are greenish-brown anhedral hornblende which includes augite and plagioclase (andesine - labrado-rite) with subhedral - euhedral shape. Quartz, if present, is anhedral and fills inter-stices between plagioclase grains.

Gabbro from a dyke near Hacıbektaşkomu is exceptionally alkaline gabbroic pegmatite. (refer to Appendix 3-22) It has pegmatitic texture and constituent minerals

are oxyhornblende - kaersutite, aegirine augite, plagioclase, sphene, apatite, and potash feldspar.

Alteration is generally of very low grade.

3.10.2 Diorite

Occurrence of diorite is mostly the same as that of gabbro. Especially it occurs near Güllüdağ as stocks in gabbro. However, compared with the gabbro, diorite is smaller in size. It occurs as small dykes in ultrabasic rocks too.

Rock facies vary extensively from basic to acidic. It is subdivided into diorite, quartz diorite, microdiorite but no clear boundary can be drawn between them. It is holocrystalline and fine to coarse grained. Its color varies from deep green to pale green according to the amount of mafic minerals.

Microscopically it is identified as diorite or quartz diorite by the presence of quartz. Both of them, however, have the same features under microscope.

Main constituent mineral is greenish brown, anhedral hornblende. Euhedral plagioclase (andesine-oligoclase), augite, and saussurite, prehnite, and clinozoisite are included. Quartz, if present, fills interstices between plagioclase and small amount of potash feldspar fills the interstices between plagioclase and other minerals.

3.10.3 Granitic rock

The name is not correct because, as revealed by microscopic study, this rock is actually quartz diorite. However, in the field, white acidic rock can be identified. This rock changes gradually to diorite and no clear boundary can be seen. Thus it may be called acidic diorite or leucocratic diorite.

Distribution and mode of occurrence are similar to that of diorite. It is almost

the same as diorite. Amount of potash feldspar is too small to qualify it as granite or granodiorite.

3.10.4 Diorite porphyrite, quartz diorite porphyrite and quartz porphyry

This rock occurs as dykes everywhere in ultrabasic rocks, especially in their middle to lower horizon. Judging from the occurrence, some of these rocks seem to change facies to diorite, and they cannot be divided from each other.

The size of outcrops is at maximum 2 -3 km in length and 10 - 50 m in width. There are several directions of intrusion, N, NE, and WNW. These rocks intrude into ultrabasic rocks and other igneous rocks. A few example is observed in the Meyramdağ limestone. Period of intrusion is the latest among igneous rocks excluding volcanic rocks.

Diorite porphyrite and quartz diorite porphyrite are pale green and porphyritic. Microscopically, phenocrysts of plagioclase are euhedral albite - oligoclase. Phenocrysts of hornblende are completely altered to Fe-chlorite and epidote. Quartz, if present, occurs as microphenocrysts. Groundmass is composed of albite and silica minerals, occasionally with a small amount of potash feldspar.

Quartz porphyry is white and porphyritic with coarse prismatic plagioclase and acicular hornblende phenocrysts.

Microscopically, plagioclase, hornblende and quartz are present as phenocrysts. Hornblende is greenish brown, long prismatic, and euhedral. Plagioclase is prismatic, euhedral, and altered to albite, kaoline minerals and epidote. Quartz is euhedral and corroded. Euhedral apatite is present as microphenocrysts. Groundmass is composed of aggregates of very fine grained anhedral quartz and albite with a small amount of potash feldspar.

Aegirine-bearing diorite porphyrite was identified in a specimen (refer to Appendix 3-3).

3.11 Volcanic rocks

3.11.1 Basalt

Basalt is distributed only at the boundary between Kopdağ limestone and ultrabasic rocks in the northern part of the area. By its occurrence it is judged to be lava. It is surrounded by a tuffaceous part. Structurally it occupies the uppermost horizon of the ultrabasic rocks. It covers gabbro and harzburgite. Dimensions of the outcrop are not large, it is less than 100 m long and less than 20 m thick.

It is dark gray, very fine grained and porous, contaminated with iron-oxides. Microscopically, original rock name could not be defined due to severe alteration. Pilotaxitic texture is present. Phenocrysts of mafic minerals are completely altered to chlorite and epidote and that of plagioclase to carbonate minerals. Groundmass is composed of feldspar, opaque minerals, sphene, and epidote. Many irregular druses are present in it.

3.11.2 Rhyolite (or andesite)

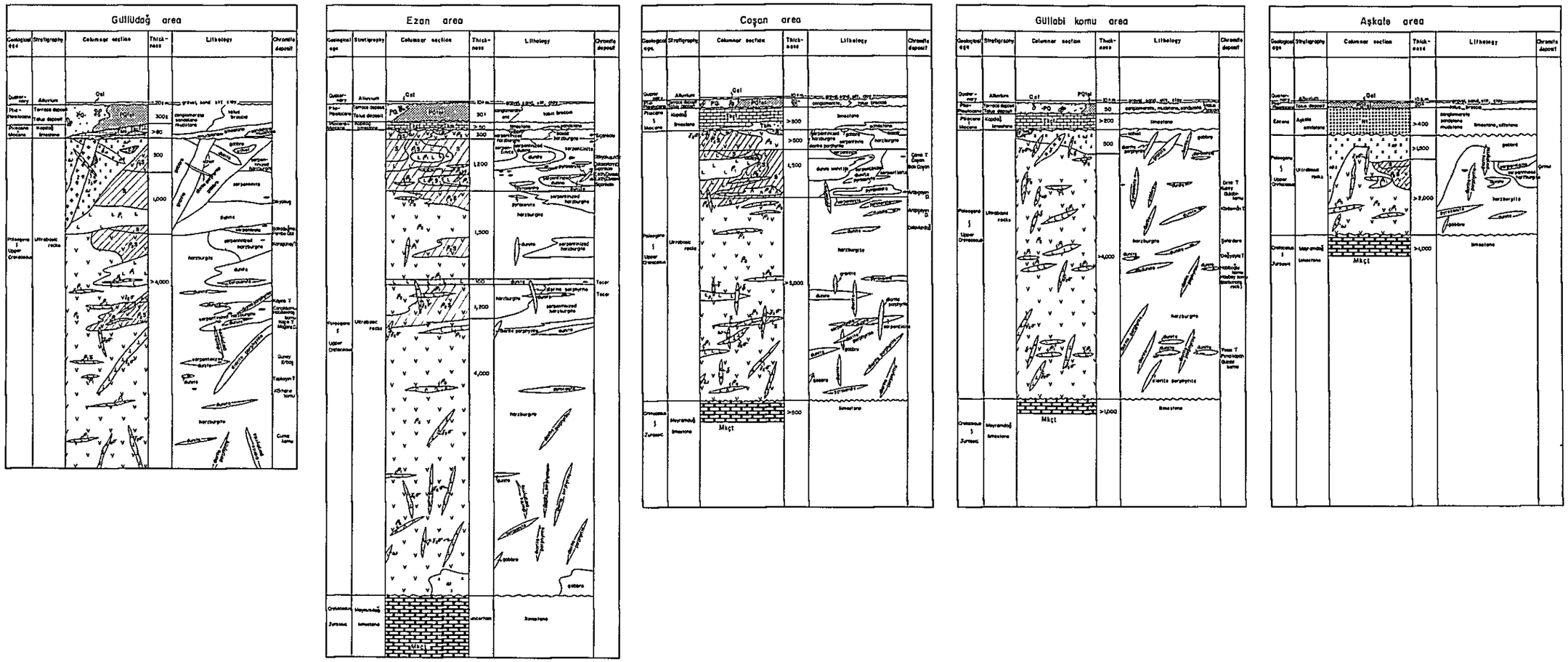
Some dykes of quartz porphyry show volcanic facies. Examples are observed at Kürünlüdere. Its outcrop is small and mode of occurrence is the same as that of quartz porphyry. It is pale bluish-white, fine, and porphyritic. Microscopically, it is porphyritic and hypocrystalline. Euhedral plagioclase and hornblende are observed as phenocrysts. Silica mineral was not identified. Due to the severe alteration, large amounts of chlorite, carbonate minerals, and saussurite are present.

3.12 Natrolite rock

In the ultrabasic rocks at Kürünlüdere, Henegesuyu, and Atölendere, a white, thin dyke is observed. It is several meters long and 1 - 2 m wide. It looks like a monomineralic rock and seems to be albitite.

However, microscopically, most of this rock is composed of euhedral-anhedral, coarse natrolite. Aegirine augite of pleochroic green color is next in abundance. Fe-chlorite, leucoxene, sphene, apatite, and a carbonate mineral are present though only in small amounts. This rock is thought to have been formed secondarily, and the original rock name is quite unknown.

Fig 1. Schematic columnar section



4. STRUCTURAL GEOLOGY

4.1 Preface

As the survey area is thought to be situated at the center of Alpine orogenic belt, several tectonic lines due to severe structural movement are anticipated. In fact, intrusion of several types of igneous rocks, and severe alteration are evidences of orogenesis. However, after deposition of the several igneous rocks, this area is not distrubed so much.

In the area, sedimentary and igneous rocks are superposed from south to north. Direction of general structure of the area is WSW-ENE.

Remarkable unconformity is observed between Meyramdağ limestone and ultrabasic rocks, ultrabasic rocks and Aşkale sandstone, and between pre-Pliocene rocks and post-Pliocene sediments.

Faults in the area have two directions, N system and E system.

No remarkable folding is present in the area.

4.2 Structure of sedimentary rocks

Generally speaking, sedimentary rocks, Meyramdağ limestone, Kopdağ limestone, Aşkale sandstone, talus and terrace deposits have simple and gentle structure. Meyramdağ limestone dips 20° - 30° N with E strike. It is disturbed only at the contact with ultrabasic rocks. Minor faults, folds and thrusts are commonly present and blocks of limestone occur in ultrabasic rock with fault contact.

Kopdağ limestone generally dips 20° N with E strike. The limestone which is distributed in northernmost part in the area is disturbed only at the boundary with ultrabasic rocks. The reason is uncertain: due to the presence of fault between them

or difference of their competency at the time of oscillatory movement after deposition.

4.3 Structure of ultrabasic rocks

To learn the structure of the ultrabasic rocks, direction of the chromite bandings, olivine-pryoxene bandings and pyroxenite dykes were measured and the results are shown in Fig. 2. However, except for northern dunite zone, such bandings or dykes are not enough to define the structure in detail.

Generally speaking, structure of the ultrabasic rocks defined by bandings is not in accord with their extension. It has NE strike and 40°NW dip. No difference between chromite bandings and olivine-pryoxene bandings was found. In the western part of the area (westward from Ezan), bandings of E strike with 30°N dip are dominant. When the directions of bandings are studied in detail, they shows complicated features. This phenomenon suggests that ultrabasic rocks may have intruded simultaneously in a broad sense but that local variations in time and direction of intrusion took place. Alternately at the time of or after the intrusion, dislocation of ultrabasic body by fault movements and formation of secondary bandings may have occurred.

Direction of bandings and pyroxenite dykes is different. This suggests transition of structural movement at the time of ultrabasic intrusion.

Two fault systems, N system and E system are present. They are described in full later. Ultrabasic rocks have not been structurally disturbed by intrusions of other igneous rocks.

As mentioned before, ultrabasic rocks and related igneous rocks are deposited from south toward north. Except for gabbro stocks at the southernmost part, the sequence of deposition is as follows :

harzburgite and orthopyroxenite - dunite and clinopyroxenite - gabbro - dio-

rite-basalt.

This sequence suggests tectonite - cumulite sequence in ophiolite even though it is imperfect. However, in the northernmost part of the ultrabasic rocks, harzburgite zone, which seems to occupy higher horizon than dunite is present. Genetical interpretation was not made yet for this harzburgite.

4.4 Structure of igneous rocks except ultrabasic rocks

Shape and direction of intrusion of igneous rocks except ultrabasic rocks are different according to the rock type.

Gabbro and diorite usually form stocks and bosses. Granitic rocks form dykes in some cases, but usually occur associated with gabbro and diorite. Their distribution is characteristically concentrated at the northern and southern limit of ultrabasic rocks and mostly parallel to them.

On the contrary, hypabyssal intrusive rocks, diorite porphyrite and quartz porphyry, usually form dykes everywhere in the ultrabasic rocks especially at their middle-lower horizon. They have several directions of intrusion, as shown in Fig. 2-5. Three systems, NE, ENE, WNW are dominant. The intrusion of the three systems seems to be of same period and their relation to each other is uncertain. They are not directly related to the structure of the ultrabasic rocks.

4.5 Faults and folds

Faults and folds in the area seem to have occurred at the time of or after the formation of igneous rocks. Except for minor faults and folds in the limestone at the boundary with the ultrabasic rocks, faults and folds are divided into two systems, N and E.

The former system has several directions: NE, N and NW, with 300 m maximum horizontal dislocation. It is observed everywhere in ultrabasic rocks.

As examples of this fault, a fault near Armutlu mine, and Tecer and given. Near Pembe Gül mine, a gabbroic intrusive body shows blocky dislocation to the south by this fault.

The latter system, (E system) is not defined in the area. Its age of formation may be older than that of the N system. Its direction is ENE, which means almost parallel to the extent of ultrabasic rocks. Distribution of gabbro-diorite intrusions and serpentinized zone follows this direction. Therefore, this fault may be related to the principal direction of tectonic movement at the time of Alpine orogenesis. However, no evidence is present. This fault is observed in the northern part of the ultrabasic rocks. As an example, fault from Coşan mine to Ezan mine can be cited. Amount of dislocation is uncertain.

Minor faults around the chromite deposits are summarized in Fig. 2-4. As shown in the figure, faults of NNE ~ E strike with gentle N dip are remakable. This direction is the direction of fault between hangingwall of chromite deposit and host rock.

4.6 Tectonic movements and igneous activity

History of the lithological sequences, tectonic movements and igneous activity are briefly enumerated as follows :

1) During the end of the Jurassic and early Cretaceous, flysh sediments which were mostly calcareous, formed a thick pile in the area. Strong subsidence might have been present throughout this period.

2) Due to the Alpine orogenic movement, intrusion of ultrabasic rocks

took place from Cretaceous period, and might have continued to Paleogene.

The order of intrusion was harzburgite - dunite. Without intermission, several kinds of igneous rocks intruded. The order of intrusion was gabbro - diorite - diorite porphyrite - quartz porphyry - volcanic rocks.

Minor faults and folds in Meyramdağ limestone and E system faults in ultrabasic rocks may be related to the above igneous intrusions.

3) Not much later, sedimentation of a large amount of calcareous material started, accompanied in the beginning by local basaltic volcanic activity. It continued from Paleogene to Pliocene.

4) After the Pliocene epoch, tectonic movement in the area changed to lift. Talus and terrace deposit might have been deposited after Pleistocene. Not earlier than Plio-Pleistocene, N system fault occurred due to the lift and subsidence of the area.

5) The area is still unstable as it belongs to the active northeastern Anatolia fault zone.

Fig 2-1 Stereographic projection of chromite bandings (in 1 : 10.000 mapping area)

Fig 2-1-1 Coşan (Trabzon H-44,C3,No4 map area)

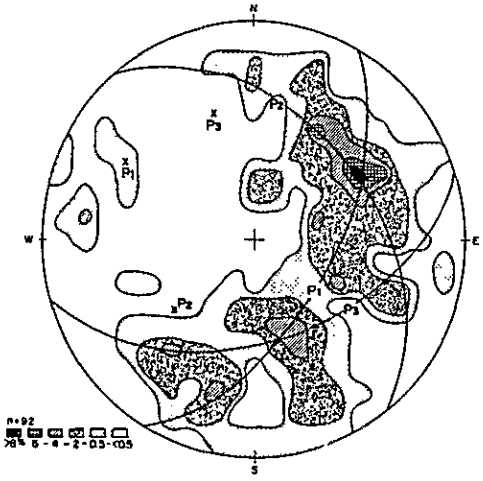


Fig 2-1-2 Batı Coşan (Erzincan I-44,b1,No2 map area)
Sıçankale

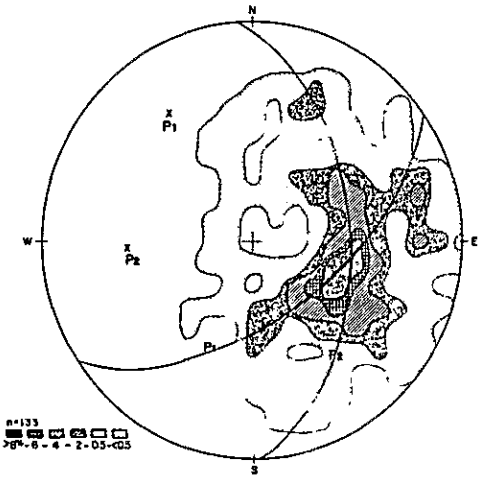


Fig 2-1-3 Gökyokuşun Sr.(Erzincan I-44, b1, No1 map area)
Ezan

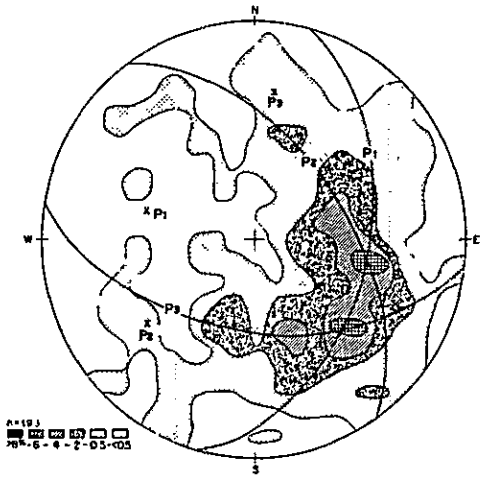


Fig 2-1-4 Civelek (Erzincan I-44,a-2,No1,No2 map area)
Hacıbektaşkomu

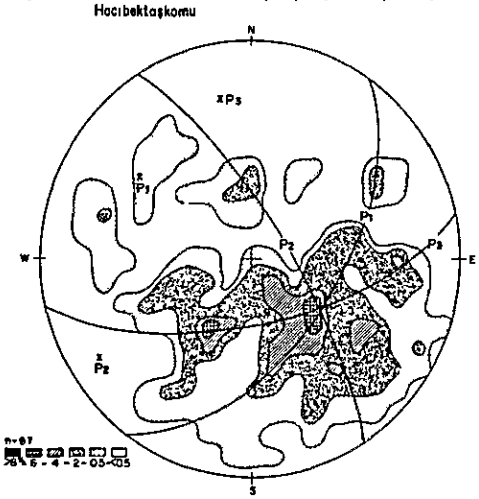


Fig 2-1-5 Whole area

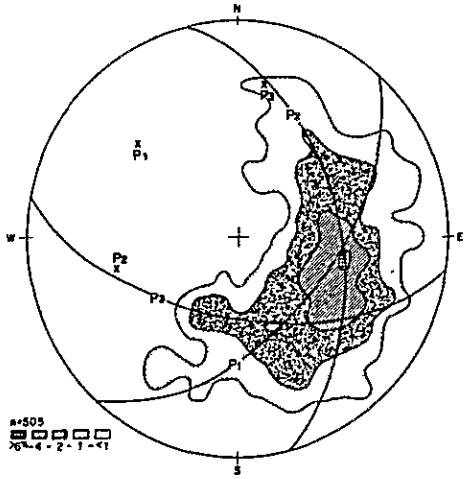


Fig 2-2 Stereographic projection of olivine-pyroxene bandings (in the project area)

Fig 2-2-1 Eastern area (Eastward from 40°22'30"E)

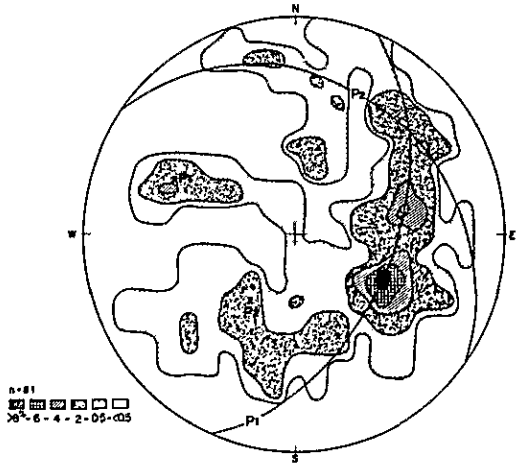


Fig 2-2-2 Central area (40°15'00"E - 40°22'30"E)

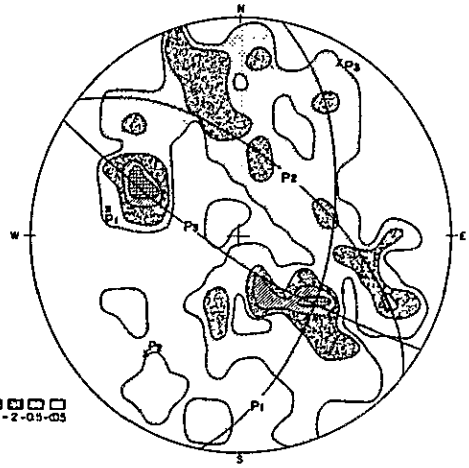


Fig 2-2-3 Western area (Westward from 40°15'00"E)

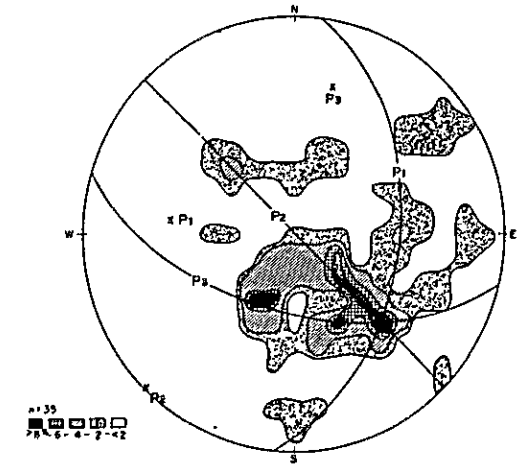


Fig 2-2-4 Whole area

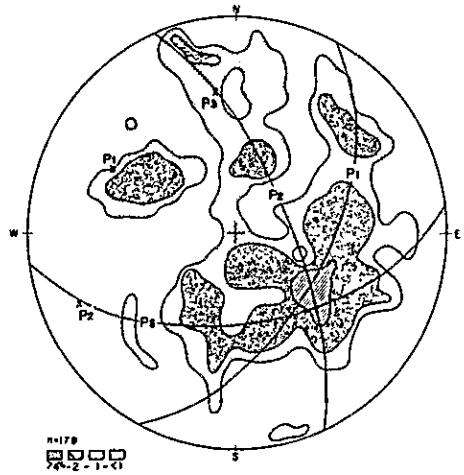


Fig 2-3 Stereographic projection of pyroxenite dykes (in the project area)

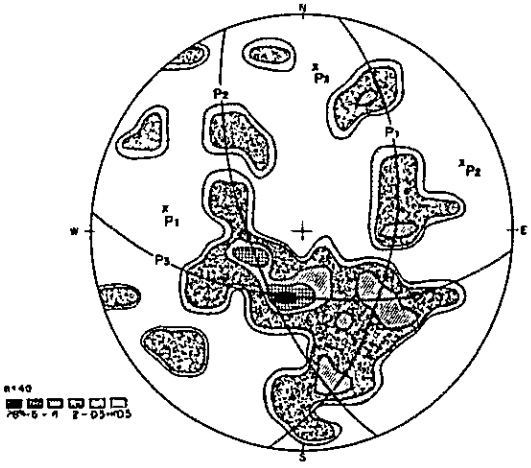


Fig 2-4 Stereographic projection of faults around chromite deposits (in the project area)

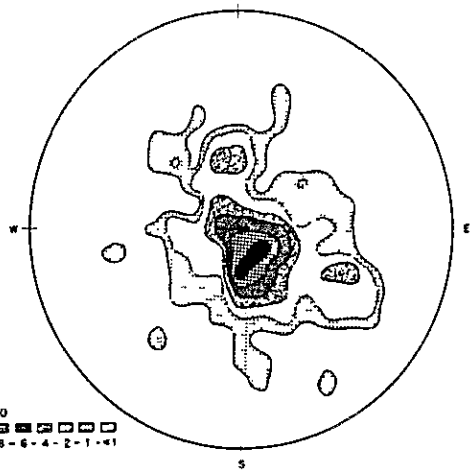
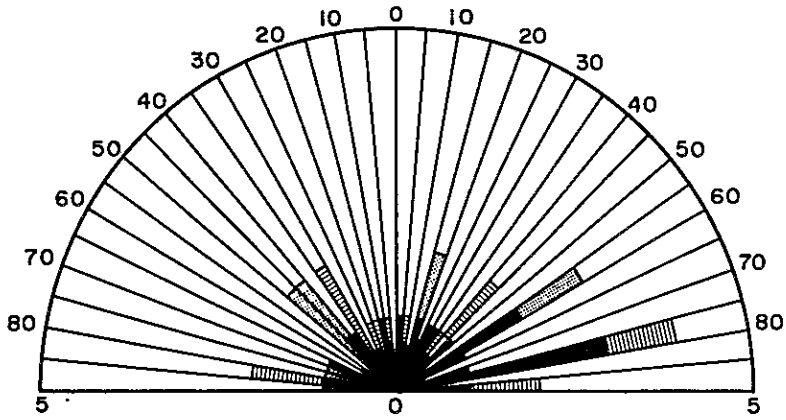


Fig. 2-5 Diagram of igneous intrusives

Plutonic rocks



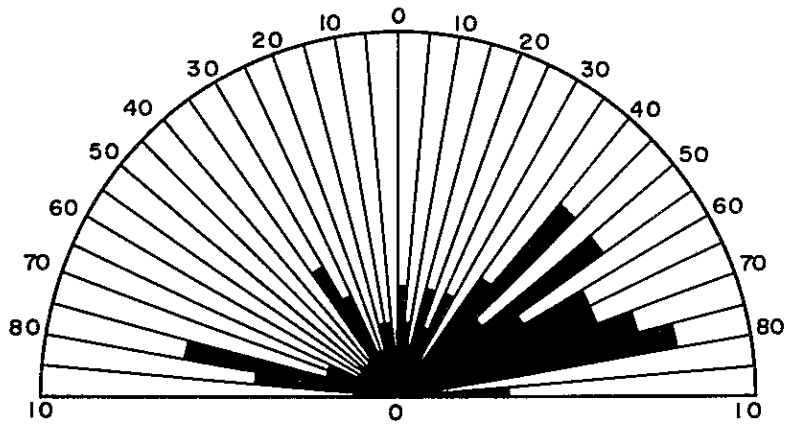
n: 38

gabbro

diorite and quartz diorite

granitic rocks

Porphyritic rocks



n: 99

diorite porphyrite ~ quartz porphyry

5. ECONOMIC GEOLOGY

5.1 Preface

Economic mineral deposits in the area consist of many occurrences of chromite in the ultrabasic rocks. Carbonate deposits and limestone quarry in the area are not very important economically.

Chromite deposits are located in three zones: one is located between Çamlı Tepe and Baltadeğmez mine in the northern dunite zone (hereafter called northern chrome zone), another is scattered from Kârhanekomu to Cancıkkomu and Tecer along the both banks of Karasu (hereafter called southern chrome zone). These two zones are called the western Kop chrome deposit. The other is distributed around Güllabikomu and Pırnakapan, and called the eastern Kop chrome deposit.

The northern chrome zone is the biggest. Two mines under operation, Coşan and Ezan, belong to this zone. As for the other two zones, even though some old mines are present, scale of the deposit is inferior from the economic point of view.

During this year's survey, geology of the northern chrome zone was studied in detail, mostly with the accurracy of 1: 2,000 map scale. For other zones, reconnaissance geological survey was carried out on a map scale of 1: 25,000.

However, all trenches and galleries visible were sketched on 1: 100 - 1: 2,000 scale. Volume of trenches and amount of ore taken out from trenches were estimated for each, although some estimates were not accurate due to cover of debris and soils. Results of the study of trenches and galleries are shown in Appendix 7 and Plate 7, 8 and they are compiled in Fig. 3.

Carbonate deposits in and out of the area are under exploration by M. T. A. now. Therefore, they were not studies in detail this time.

Study of limestone as industrial material was outside the scope of this year's survey.

5.2 Individual mineral deposits

5.2.1 Coşan mine (northern chrome zone)

Coşan mine is located on the right bank of Iskınlığındere, 7km from Sıçankale Y. in NE 65° direction. Its altitude ranges from 2450 m - 2670 m. It belongs to Kop, Bayburt, Gümüşhane, administratively. Truck is available from Bayburt or from Sıçankale Y. via Delavlardağ and it takes 2.5 hours from Bayburt and 0.5 hours from Sıçankale Y. This mine is under operation. Details are given in chapter 2 article 7. Due to its altitude, this mine has the severest weather conditions. Generally snow remains until June and starts falling from the middle of September.

This mine has 13 trenches and 1 exploration gallery. Most of them reach the orebody and under working. However, exploration gallery has not reached the orebody yet.

The mine is situated in the eastern part of northern chrome zone. There is only one orebody and it extends NNE with 800 m of strikeside extension and 90 m of dipside extension. It is dislocated by faults striking NE. There are 7 unit orebodies. Their size is 10 - 90 m strikeside and 5 - 30 m in width.

Country rock is dunite in which small clinopyroxenite dykes occur commonly. Dunite is more or less serpentinized but the grade of alteration is not very strong. Hangingwall of the orebody has massive ore and sharp fault contact with dunite, while at footwall side ore changes from massive type to disseminated type gradually. Direction of unit orebody and direction of chromite bandings are different; exactly speaking,

near the hangingwall side, difference is not so remarkable but towards footwall side, it is apparent. The unit orebody has NNE strike with 60°W dip and the chromite bandings have NW strike with 40° ~ 60° SW dip.

Grade of ore increases towards hangingwall to reach 35 - 40 % Cr_2O_3 and decreases to 20 - 25 % Cr_2O_3 towards footwall. Average grade of ore is 35 % Cr_2O_3.

Orebody has layered - lenticular shape and ore is massive - disseminated.

Ore mineral is chromite and gangue mineral is mostly serpentine with small amount of magnetite, brucite, carbonate minerals, and artinite.

Northern end of the orebody is very close to Kopdağ limestone. But this end is presumed to change its direction to NE and continue to Çamlı Tepe. Towards the south, orebody decreases its grade and size and disappears, although ore zone extends to Büyüksivri Tepe.

Total volume of trenches was estimated to be 64,000 m^3 and amount of ore taken out from the trenches was estimated to total 52,000 tons. Stock of ore varies according to the season.

This mine is the second largest in the area. It is classified as 2nd (B) order.

5.2.2 Çamlı Tepe area and Arapçayırıdere area (northern chrome zone)

Approximately 3 km NE, from Coşan mine one trench (TD-39) is observed in serpentinite. Orebody in the trench is small (maximum width 1 m), it has ENE strike and 80°N dip and grade of ore is approximately 35 % Cr_2O_3. Many chromite bandings are observed.

Ore minerals and gangue minerals are the same as those of Coşan mine.

Volume of the trench is 20 m^3 and amount of ore taken out from it is less than 10 tons.

This area is presumed to belong to the same ore zone as Coşan. However, no evidence was found as no outcrop is present between Coşan and this area.

Three kilometers southeast of Coşan mine there are 4 trenches in serpentinite and dunite (Arapçayırıdere). Ore deposit in this area is situated in a lower horizon than Coşan mine. It occurs in the lowermost horizon of northern dunite zone (a part occurs in the uppermost horizon of harzburgite). Details of this deposit are the same as those of Coşan.

Çamlı Tepe is evaluated as 4th (D) class and Arapçayırıdere as 7th (G) class.

5.2.3 Büyüksivri Tepe area (northern chrome zone)

One kilometer to the southwest from Coşan mine at an altitude of 2,590 – 2,720 m, 3 trenches are present. In these trenches, massive, lenticular chromite occurs in dunite. Its length is approximately 30 m and its width is 1 - 3 m. It has N strike with E dip and E strike with uncertain dip. Grade of ore is 35 % Cr_2O_3. Ore and gangue minerals are the same as in Coşan.

Volume of trenches is approximately 3,000 m^3 and the largest amount of ore taken out from the trenches is 320 tons. Stock of ore is approximately 10 tons. Location of the trench and mode of occurrence of ore body suggest that this deposit belongs to the Coşan ore zone, even though critical evidence is absent.

This area is evaluated as 5th (E) class.

5.2.4 Batı Coşan mine (northern chrome zone)

This mine is situated at Bendindere, upper reach of Ergidere at an altitude of 2,400 m. It is 5 km N 80° E from Sıçankale Y. and belongs to Sıçankale Y., Aşkale Erzurum. From Sıçankale Y. only jeep is available and it takes 25 minutes.

In this mine, 9 trenches are present in an ore zone which continues from ENE to WSW in dunite. Grade of alteration of dunite is not extensive. This deposit was exploited in the past.

Direction of both unit orebody and chromite banding is not parallel to that of ore zone, striking NE and dipping 40° NW. Unit orebody has 10 - 40 m strikeside length, 2 - 4 m dipside length and 30 % Cr_2O_3 grade.

Massive ore is common at the center of ore zone and at hangingwall side where orebody has sharp contact to the host rock. Both at the end of ore zone and at the footwall side, disseminated ore and chromite bandings are dominant. Ore minerals and gangue minerals are the same as in Coşan mine.

Total volume of trenches is estimated to be 1,900 m^3 and total amount of ore taken out from trenches to be 900 tons. Amount of stock of crude ore is about 10 tons.

As the class of evaluation, this is ranked to be 4th (D) order.

5.2.5 Sıçankale mine (northern chrome zone)

This mine is spread widely along Külekçinin Sr. near Sıçankale Y., from 2,100 to 2,500 m in altitude. It belongs to Sıçankale Y., Aşkale, Erzurum. Roads for cars to the mine are mostly destroyed, but 10 - 40 minutes on foot are enough to reach it from Sıçankale Y.

Twenty-nine trenches remain in the mine and they are divided into 4 groups; TD-15, 16; TX-1 ~ 7 and 11; TD-1 ~ 10, 37 and TX-8 ~ 10; and TD-11 ~ 14, 36 from upper to lower horizon.

Among them, TD-1 ~ 10, 37 and TX-8 ~ 10 (footwall orebody) is the main ore body and it develops especially around TD-1 ~ 10. Ore zones have N 60° - 70° E direction and length of 130 - 450 m. They are in dunite which is well serpentinized,

especially at the hangingwall ore zone. Orebody of the uppermost horizon (TD-15, 16) occurs in harzburgite. Unit orebody is lenticular - layered and has NE-ENE, NW strike and 20° - 50° NW~ N, NE dip. It is 2 - 40 m in length, 0.2 - 6 m in width and 30 - 45 % Cr_2O_3 grade.

Type of ore is massive and disseminated. The two types occur randomly in the ore body. Chromite bandings are common around the ore body. It is remarkable that their direction is N, NE, NW and is not in accord with that of the ore zone and unit orebody.

Ore minerals are mostly chromite with a small amount of uvarovite. Gangue minerals are mostly serpentine, followed by brucite, talc, carbonate mineral (magnesite), magnetite, and aragonite.

As the unit orebody is small, orebody suddenly disappears or changes to chromite banding.

Total volume of 29 trenches is estimated to be 14,700 m^3 and total amount of ore taken out from trenches to be 6,200 tons. Among the trenches, TX-10 is the biggest; 10,500 m^3 and 4,000 tons respectively. Stock of crude ore is mostly carried away and rest of it is small.

Although ore zone in this mine is wide and many trenches are present, unit orebody is small and density of chromite occurrence is low. Therefore class of evaluation is 4th (D) order.

Chromite deposit was noted near Mollabekir Tepe at the southern end of this area by KAADEN, G. (1962). This deposit occurs in talus deposit and is judged to be a placer. This type of deposit will be described in the article on Pembe Gül mine.

5.2.6 Gökyokuşun Sr. area (northern chrome zone)

This area is located near the Gökyokuşun Sr., 1 km west of Sıçankale Y. at an altitude of 2,200 - 2,280 m. It belongs to Sıçankale Y., Aşkale, Erzurum. No road for cars is present and it takes 20 minutes on foot from the road between Sıçankale Y. and Erbaş station.

Thirteen trenches are present and they can be separated into two groups. Seven trenches (TC-16~22) are situated near Camlitepenin Sr. and 6 trenches (TC-23 ~28) in Gökyokuşun Sr. Both groups of trenches are for exploration. They are excavated in powdery serpentinite. Structural relation between the two groups is uncertain. Trenches near Camlitepenin Sr. are 250 m long in NE 30° direction. Unit orebody extends in N direction with 50° ~ 60° W dip. It is 0.4 - 7 m long and 0.5 - 3 m wide. Different from the direction of the orebody, chromite banding has NE strike and 50° - 60° NW dip. Orebody at Gökyokuşun Sr. is 300 m long in NW direction. Unit orebody extends in NE direction with 42° NW dip, while chromite banding has NE strike and 75° NW dip. The unit orebody is 0.6 - 8 m long and 0.3 - 0.5 m wide.

Grade of ore for both groups is uncertain. Shape of the orebody, type of ore and kinds of ore minerals and gangue minerals are the same as in Sıçankale mine.

Total volume of trenches is small, 100 m^3, and total amount of ore taken out from the trenches is less than 100 tons. Stock of crude ore is approximately 10 tons.

The scale of orebody is too small to be highly ranked. The class is estimated to be 5th (E) order.

5.2.7 Çalazarlarındere area (northern chrome zone)

This area is located along Çalazarlarındere, a branch of Keşişsuyudere, approximately 4 km west from Sıçankale Y. at an altitude of 2,000 - 2,170 m. As no

road for cars is present in the area, it takes 30 - 60 minutes from the road between Sıçankale Y. and Erbaş station. It belongs to Sıçankale Y., Aşkale, Erzurum. Four trenches for exploration are present. Besides trenches, there is an outcrop of ore at a large cliff (SZ-1). Trenches and the outcrop seem to belong to the same ore zone, which extends 750 m and has N 15° E direction. Host rock is serpentinite.

Unit orebody has N 30° E strike, 60° NW dip, more than 0.5 m strikeside length and 0.3 - 1.5 m width. It is lenticular in shape of massive and disseminated type. Average grade of ore is 30 - 40 % Cr_2O_3. Chromite banding occurs commonly and shows several directions. Ore minerals and gangue minerals are the same as in Sıçankale mine.

Total volume of trenches is estimated to be less than 10 m^3 and total amount of ore taken out from the trenches to be less than 10 tons. Stock of ore remaining is not clear.

The rank of evaluation is 5th (E) order.

5.2.8 Ezan mine --- Sulu, C kafa, B kafa, Doğu Ezan, Orta Ezan, Batı Ezan, Armutlu, Tepebaşı, Civelek --- (northern chrome zone)

This mine is located on the mountainside of İsliyayla Tepe at an altitude of 1,930 - 2,100 m. It is 5 km W from Sıçankale Y. Truck is available and it takes 30 minutes from Sıçankale Y. Administratively it belongs to Sıçankale Y., Aşkale, Erzurum.

This mine is the biggest in the area and is under operation as mentioned in chapter 2 article 7.

Area of the mine is subdivided, from east to west: Sulu, C kafa, B kafa, Doğu Ezan, Orta Ezan, Batı Ezan, Armutlu, Tepebaşı and Civelek.

Number of trenches and galleries observed are as follows;

Area	Trenches			Total volume of trenches (m^3)	Ore taken out from trenches (ton)	Galleries	
	for exploration	for exploitation	(under operation in 1978)			total	(closed)
Sulu	2	9	(2)	33,800	17,900	4	(1)
C kafa	1	3	(1)	34,200	18,900	4	(2)
B kafa	-	1	(1)	116,000	118,100	2	(-)
Doğu Ezan	2	1	(-)	22,300	3,900	4	(2)
Orta Ezan	-	2	(1)	78,500	36,700	1	(-)
Batı Ezan	-	2	(2)	69,300	54,600	1	(1)
Armutlu	1	1	(1)	15,900	15,800	-	(-)
Tepebaşı	6	1	(1)	5,700	4,700	1	(1)
Civelek	2	3	(-)	2,400	600	-	(-)
Total	14	23	(9)	378,100	270,700	17	(7)

Amount of stock is large and varies all the time.

Although trenches and galleries are many, there are two main ore zones (except for a part of Tepebaşı). Hangingwall ore zone (northern zone) runs from east to to west, connecting the trenches TC-13 ~ 10, TM-1 (Sulu), TZ-3 (B kafa) TZ-1 (Batı Ezan) TC-1 (Armutlu), and TA-18, TB-1, 2 (Civelek). Footwall ore zone (southern zone) occurs connecting the trenches, TC-14, 31, TM-2, 1 (Sulu), TZ-4 ~ 7 (C kafa), TZ-3 (B kafa), TZ-2, TC-9 (Doğu Ezan) TC-8 (Orta Ezan), TC-6, 5, 2, 33 (Tepebaşı) and TA-17 (Civelek).

Both ore zones occur in dunite. Around this mine, dunite is strongly serpentinized and becomes fragile. On the surface, it weathers into powdery thick piles (1 - 2 m in average).

Two ore zones extend generally in NE - ENE direction in parallel and their length reaches approximately 1.5 km.

Between Batı Ezan and Armutlu, a fault with NNW strike dislocates the orebody for about 300 m horizontally. Besides this, minor faults have only several meters - 10 meters of horizontal dislocation.

Unit orebody has various strikes and dips but generally, it has NNE, NE, ENE strike and 30° - 80°N dip. It is large except for Tepebaşı and Civelek. It reaches 10 - 220 m strikeside, 30 m dipside, and 15 - 20 m in width. Its shape is lenticular and type of ore is mainly massive accompanied by disseminated ore. Generally, hangingwall of orebody is of high grade and has a sharp contact with serpentinite, while at footwall side, orebody decreases its grade and becomes disseminated ore. Generally, hangingwall of orebody is of high grade and becomes disseminated type. Grade of ore varies from 25 % Cr_2O_3 up to more than 45 %, and is 35 % on the average.

At Tepebaşı and Civelek, unit orebody decreases in size and grade. It has 10 - 30 m long strikeside, 1 - 10 m long dipside, and 0.1 - 5 m in width. Grade of ore is 25 - 35 % Cr_2O_3 for Tepebaşı and 30 - 40 % Cr_2O_3 for Civelek. The amount of disseminated ore exceeds massive ore at Tepebaşı.

At a part of Tepebaşı, a third ore zone is observed. It is situated in the lowest ore horizon. It extends in S direction for 200 m. Unit orebody is very small: 1 - 30 m long along the strike, 1 m in width, and grade of ore is 25 - 30 % Cr_2O_3. So it is of no economical importance, but as it has minor folds with axis in NW 30° direction, it is interesting genetically. Chromite banding is not so common around this area due to severe serpentinization. It shows several directions and is or is not in accord with the direction of unit orebody and ore zone. East of Sulu, many chromite bandings are present. Both ore zones are presumed to continue to this banding zone. But no relation was found between Çalazarlarındere area and Ezan mine. West of

Civelek, both ore zones continue to Pembe Gül mine (see next article), decreasing in size. However, due to the intrusion of gabbro and diorite, and the fault, continuity is not confirmed.

Ore minerals in Ezan mine are mostly chromite. Small amount of uvarovite occurs commonly and kaemmererite occurs in B kafa, Orta Ezan and Doğu Ezan. Gangue minerals are mostly serpentine with talc, brucite, stichtite, zeolite, carbonate minerals, magnetite etc.

This mine is the only one ranked as 1st (A) order.

5.2.9 Pembe Gül mine (northern chrome zone)

This mine is located on the northern side of Keşan Tepe at an altitude of 2,115 - 2,200 m. It is 7 km SW 70° from Sıçankale Y. and belongs to Cancıkkomu, Aşkale, Erzurum.

As the road for cars is broken, one must walk from Sıçankale Y. - Erbaş station road. It takes about 60 minutes from Sıçankale Y. by car and on foot.

A large trench for exploitation, 8 small trenches for exploration and a gallery (closed) are present. The trench for exploitation is mostly covered with debris.

Two zones, one on the hangingwall side and the other on the footwall side, are present in this mine. However, as the two zones are close to each other and displaced by fault, relation between two zones is still uncertain. The two ore zones extend approximately 100 m in NNE direction. Toward east, they seem to continue to Civelek mine and toward west Baltadeğmez mine.

The ore zones occur in dunite which is strongly serpentinized like in Ezan mine. Unit orebody has NE or NNE strike dipping to 40° - 60° NW, while chromite bandings around this mine have NW strike and 20° - 30° NE dip. Size of the unit orebody varies

from 20 - 30 m along strike and 0.2 - 2 m in width. The ore body is lenticular or layered. Type of ore is massive and disseminated. Due to weathering of dunite, powdery ore is commonly observed. Grade of ore is high, reaching 40 - 45 % Cr_2O_3. Ore minerals and gangue minerals are the same as in Ezan. Pembe Gül is famous for the occurrence of kaemmererite.

Along the road down from the Pembe Gül mine, chromite gravel is commonly included in talus deposit. This phenomenon can be seen at Coşan mine, Sıçankale mine and Mağaradere area. The size and shape are quite irregular and grade of ore is less than 25 % Cr_2O_3. This type of deposit is of no economic importance, but it is important for exploration as an indication of chromite deposit.

Total volume of trenches is estimated to be 3,300 m^3 and total amount of ore taken out from the trenches to be 1,000 tons. Stock of ore is more than 100 tons.

As scale of orebody is small compared with Ezan and Coşan mine, this mine is ranked as 3rd (C) order.

5.2.10 Baltadeğmez mine and Dikyokuş mine (northern chrome zone)

These mines are stituated around Baltadeğmez Sr., 9 km S 65° W from Sıçankale Y. at an altitude of 1,960 m (Baltadeğmez) and 2,000 - 2,100 m (Dikyokuş). They belong to Cancıkkomu, Aşkale, Erzurum. Baltadeğmez mine is located near the road between Sıçankale Y. and Erbaş station, so 45 minutes by car are enough to reach it from Sıçankale Y. Only footpath is available to Dikyokuş and it takes 15 minutes from Baltadeğmez mine.

Baltadeğmez mine belongs to footwall ore zone and Dikyokuş to hangingwall ore zone. These zones continue from Pembe Gül, though intermittently. These two mines are the westernmost of the northern chrome zone. Both zones are in dunite

which is strongly serpentinized like in Ezan mine. Both ore zones extend in E direction for 160 m (Baltadeğmez) and 400 m (Dikyokuş).

Five trenches (Baltadeğmez) and three trenches (Dikyokuş) were found.

Unit orebody and chromite bandings have E strike with 30° - 50° N dip. Unit orebody is small, 8 - 25 m long and 0.8 - 1.5 m wide for Baltadeğmez and 1 - 9 m long and 0.2 - 0.8 m wide for Dikyokuş. Grade of ore is 30 - 40 % Cr_2O_3 (Baltadeğmez) and 20 % Cr_2O_3 (Dikyokuş). Orebody is layered or lenticular, of massive and disseminated type. Powdery chromite is common due to the weathering of serpentinized dunite. Ore minerals and gangue minerals are the same as in Ezan mine except for the absence of kaemmererite in this area.

Total volume of trenches is estimated to be 500 m^3 for Baltadeğmez and 50 m^3 for Dikyokuş. Total amount of ore taken out from trenches is 500 tons for Baltadeğmez and 50 tons for Dikyokuş.

As the scale of orebody is small, these mines are ranked as 4th (D) order (Baltadeğmez) and 6th (F) order (Dikyokuş).

5.2.11 Karagüney Tepe area

This is situated at the summit of Karagüney Tepe (1,925 m), north of Kelvezikomu, 10 km S 70° W from Sıçankale Y. It belongs to Kelvezikomu, Çayırlı, Erzincan. To Kelvezikomu, car is available by the road from Sıçankale Y. to Çayırlı via Hacıbektaşkomu. It takes approximately 1 hour from Sıçankale Y. to Kelvezikomu. From Kelvezikomu to the mine, it takes 20 minutes on foot.

There are 3 trenches for exploration in the serpentinite altered from harzburgite. This deposit differs by its geological situation from deposits in the northern dunite zone.

Ore body has N 65° W strike, 34° N dip. It is 2 m long and 0.2 m wide. It is layered, massive accompanied by disseminated ore around it. Grade of ore is high, to 40 - 45 % Cr_2O_3. Ore minerals are mostly chromite with small amount of uvarovite. Gangue minerals are mostly serpentine with stichtite, carbonate minerals, and magnetite.

Total volume of trenches is estimated to be 3 m^3 and total amount of ore taken out from trenches to be less than 1 ton, all of which is left as stock near trenches.

As the size of the orebody is very small, this area is ranked as 7th (G) order.

5.2.12 Hacıbektaşkomu mine

This mine is situated 1 km N-NW of Hacıbektaşkomu and 14 km S 65° W from Sıçankale Y. It occupies the southern mountain side of Burakanyurdu Tepe at an altitude of 1,865 - 1,790 m. It belongs to Hacıbektaşkomu, Çayırlı, Erzincan. It takes 1.5 hours from Sıçankale Y. to Hacıbektaşkomu by car and then 15 minutes on foot to the mine.

There are 12 trenches, 4 of them were exploited in the past. These trenches are in harzburgite and in a dunite lens in harzburgite. Dunite is strongly serpentinized. There is one main ore zone; it has NW direction. Unit orebodies, however, have NNW-WNW strike and W - N dip. Chromite bandings have the same direction as the unit orebody.

The unit orebody is small; 2 - 11 m in length and 0.2 - 2 m in width. It is lenticular - layered in shape and of massive - disseminated type. On the surface, ore becomes powdery due to the serpentinization of dunite (refer to Appendix 1). Grade of ore is 30 % Cr_2O_3 on the average. Ore minerals and gangue minerals are the same as in Karagüney Tepe area.

Total volume of trenches is estimated to be 330 m^3 and total amount of ore taken out from trenches to be 400 tons. Stock of ore is small.

As the orebody is small, this mine is ranked as 5th (E) order.

5.2.13 Kayınlı Tepe area

The area is situated at the summit of Kayınlı Tepe (1,820 m) near Kürünlüdere, 15 km W from Sıçankale Y. It is the westernmost chromite occurrence in the survey area and belongs to Mirzaoğlu, Çayırlı, Erzincan. It takes about 2 hours by car from Sıçankale Y. to Mirzaoğlu, and then 30 minutes on foot to the mine.

There are 3 exploration trenches in a strongly serpentinized dunite lens. Ore zone and unit orebody both extend in NW direction and chromite banding has NW, ENE strike and SW, S dip. The unit orebody is small; 3-4 m in length and 0.3 m in width. Orebody is lenticular and of massive - disseminated type. Ore minerals and gangue minerals are the same as in Karagüney Tepe area.

Total volume of trenches is estimated to be 40 m^3 and total ore taken out from the trenches to be less than 10 tons.

As the orebody is small and development of orebody cannot be expected, this area is ranked as 7th (G) order.

5.2.14 Mağaradere area (southern chrome zone)

The area is situated 3 km SW of Erbaş station at an altitude of 1,570 m. It belongs to Karaali komu, Çayırlı, Erzincan. Jeep to the mine is available by the road between Erbaş station and Hacıbektaşkomu, and it takes about 30 minutes from Erbaş station.

This area belongs to the southern chrome zone. Compared with the northern

chrome zone, the southern zone is not clearly defined and is not situated in the same horizon in ultrabasic rocks. So the relation between chromite occurrences in the southern zone is difficult to determine.

There are 6 exploration trenches in dunite. However, ultrabasic rocks in the area are strongly altered by silicification, lateritization, and carbonatization, and the original rock name is not certain.

Direction of the ore zone and unit orebody is ENE with 60° N - 90° N dip. The unit orebody is 6 - 7 m long and 0.25 - 0.6 m wide. Orebody is layered, lenticular, or network shaped and of massive - disseminated type. Grade of ore is 20 - 35 % Cr_2O_3. Ore minerals are chromite and gangue minerals are serpentine, magnetite, silica minerals, goethite, and carbonate minerals.

Total volume of trenches is estimated to be 240 m^3 and total amount of ore taken out from the trenches to be 200 tons. Stock of ore remaining is approximately 20 tons.

The area is ranked as 6th (F) order due to its small size.

5.2.15 Kârhanekomu area (southern chrome zone)

This is situated 1 km NW from Kârhanekomu on the south bank of Karasu and 35 km S 35° W from Erbaş station. It has 1,650 m altitude and belongs to Kârhanekomu, Tercan, Erzurum. It is near the vehicle road between Kârhanekomu and Doluhacı-komu and takes 20 minutes by car and on foot to reach the mine from Kârhanekomu. However, from Erbaş station, one can arrive there only on foot and it takes 2.5 hours.

There is a trench (TA-33) in strongly serpentinized harzburgite. Orebody has N 30° E strike and 30° NW dip. It is 10 - 14 m long and 0.3 - 1 m wide. It is lenticular - network shaped, and of massive - disseminated type. Powdery ore due to the weathering

of serpentinite is present. Grade of ore is approximately 25 - 40 % Cr_2O_3. Ore minerals and gangue minerals are the same as in Karagüney Tepe area.

Volume of the trench is estimated to be 180 m^3 and the largest amount of ore taken out from the trench to be 300 tons.

The area is ranked as 6th (F) order.

5.2.16 Cancıkkomu mine and Kara Tepe area (southern chrome zone)

The area is located near Cancıkkomu, 9 km S 50° W from Sıçankale Y. Cancıkkomu mine is 0.5 km south from Cancıkkomu, at an altitude of 1,690 m. Kara Tepe area is 1.2 km SSW from Cancıkkomu on the northern side of Kara Tepe (1,565 m). Jeep is available near these areas and it takes 50 - 60 minutes from Sıçankale Y. They belong to Cancıkkomu, Aşkale, Erzurum.

Chromite deposits of the two areas occur in a more or less serpentinized dunite lens (Kara Tepe) or harzburgite (Cancıkkomu) but structural relation between them is uncertain. There are two trenches in Cancıkkomu mine and one trench in Kara Tepe area.

At Cancıkkomu, direction of the orebody is uncertain and at Kara Tepe, it has NE strike with uncertain dip.

The unit orebody is 2 - 10 m and 0.3 - 1 m wide at Cancıkkomu, and 3 m and 0.2 m respectively at Kara Tepe. Orebody is lenticular or network shaped and of massive - disseminated type. Grade of ore is generally high, 20 - 40 % Cr_2O_3 at Cancıkkomu and 40 - 45 % Cr_2O_3 at Kara Tepe.

Ore minerals are mostly chromite with small amounts of uvarovite. Gangue minerals are serpentine, brucite, dolomite, magnetite, and goethite.

It is remarkable that chromite ore coexists with dolomite at Cancıkkomu.

Chromite forms networks and veinlets in dolomite.

Total volume of trenches is estimated to be 90 m^3 at Cancıkkomu and 10 m^3 at Kara Tepe. Amount of ore taken out from the trenches is 100 tons and less than 10 tons respectively. Amount of stock of ore is 20 tons at Cancıkkomu and very small at Kara Tape.

The areas are ranked as lower than 6th (F) order.

5.2.17 Güney Erbaş area (southern chromite zone)

This mine is located on the south bank of Karasu, 1 km SSE of Erbaş station. It has an altitude of 1,600 - 1,685 m and belongs to Kâğışna, Tercan, Erzurum. Due to the absence of bridge for cars, one must cross Karasu on foot during dry season and it takes 20 minutes from Erbaş station to the mine. Jeep is available from Tercan to Kâğışna and it takes 2.5 hours from Tercan to the mine by this route.

There are 7 trenches. They belong to the same ore zone included in a serpentinized dunite lens. Direction of ore zone, and unit orebody is NE, WNW. The unit orebody is 1 - 12 m long and 0.3 - 1 m wide. Ore body is lenticular and of massive - disseminated type. Grade of ore varies from 30 % to 40 % Cr_2O_3. Ore minerals and gangue minerals are the same as in Karagüney Tepe.

Total volume of trenches is estimated to be 40 m^3 and amount of ore taken out from the trenches to be 170 tons. Amount of stock of ore is approximately 30 tons. The area is estimated as 7th (G) order.

5.2.18 Topkayın Tepe area (southern chrome zone)

The area is situated at the southern side of Topkayın Tepe, 2 km to S 60° E from Erbaş station. Its altitude is 1,690 m and it belongs to Kâğışna, Tercan,

Erzurum. It takes approximately 35 minutes on foot from Erbaş station across the Karasu.

An exploration trench (TB-13) is present in a serpentinized dunite lens. Judging from the location, this trench is at the footwall of Güney Erbaş ore zone. Due to soil cover, however, no ore is observed in the trench.

Volume of trench is estimated to be less than 1 m^3.

It is ranked as 7th (G) order.

5.2.19 Tecer area (southern chrome zone)

This area is located 9 km N 70° E from Erbaş station, north of Tecer and Ağcahisar. It has an altitude of 1,830 - 1,910 m and belongs to Tecer or Ağcahisar, Aşkale, Erzurum. It takes approximately 1 hour by car and on foot from Erbaş station to this area.

Chromite deposit in this area is the easternmost deposit in the southern chrome zone. Ore zone extends intermittently about 2.5 km from Çorakdere to Ağcahisar.

There are four exploration trenches in a dunite lens. Direction of ore zone is E, and trench of unit orebody has NE strike with 60° NW dip. Direction of chromite bandings is in accord with that of the ore zone. Massive ore is included in the chromite bandings around the deposit.

Orebody is lenticular in shape and of massive - disseminated type. Grade of ore is approximately 40 % Cr_2O_3. Ore minerals and gangue minerals are the same as in the southern chrome zone.

Total volume of trenches is estimated to be 10 m^3 and total amount of ore taken out from the trenches to be approximately 10 tons. Stock of ore is uncertain.

This area is evaluated as 7th (G) rank.

5.2.20 Cumakomu area

This mine is situated near Cumakomu, 5 km S 40° E from Erbaş station. It has 1,750 m altitude and belongs to Cumakomu, Tercan, Erzurum.

Car is available from Tercan to Cumakomu and then it takes 20 minutes on foot from Cumakomu to the mine.

This chromite deposit is one of the few deposits which occur at the lower horizon of ultrabasic rocks.

Two trenches, one big and one small, are present and it seems to have been worked a few years ago. However, compared with the size of the trenches, the orebody remaining is very small. Orebody occurs in a strongly serpentinized dunite lens and has WNW strike. It is 4 - 25 m long and 1 - 2 m wide. It is lenticular and of massive-disseminated type. Its grade is 20 % Cr_2O_3 on the average. No difference in minerals is observed in comparison with those of the other chrome deposits in the southern chrome zone.

Total volume of trenches is estimated to be 2,520 m^3 and amount of ore taken out from the trenches is 1,800 tons, even though these estimates are highly uncertain. Amount of stock of ore is approximately 15 tons.

The area is ranked as 6th (F) order.

5.2.21 Delavlardağ area

It is located at the peak of Delavlardağ, near the intersection of roads, Karataş - Sıçankale Y., Coşan - Sıçankale Y., and Kop - Sıçankale Y. It has 2,470 m altitude and belongs to Sıçankale Y., Aşkale, Erzurum. It takes about 40 minutes by car and on foot from Sıçankale Y. to the mine.

A small exploration trench is found in harzburgite which is situated at the footwall

of northern dunite zone. Orebody has NNE strike and SE, NW dip. It is 10 m long and 0.4 m wide. It is layered - lenticular in shape and mostly of disseminated type. Grade of ore is less than 35 % Cr_2O_3. Ore mineral is chromite and gangue minerals are serpentine, olivine, enstatite, carbonate minerals, and magnetite.

Volume of the trench is estimated to be 20 m^3 and amount of ore taken out from the trench to be 10 tons, most of which remains around the trench.

The area is evaluated as 7th (G) order.

5.2.22 Orta Tepe area, Körösmân Tepe area, Şehirdere area and Habiboğlukomu area (eastern Kop chrome zone)

These areas are situated east of National Route 40 along the Kop mountain range. Orta Tepe and Körösmân Tepe are located near the summit of Kop mountain range and belong to Dencik, Aşkale, Erzurum. Şehirdere and Habiboğlukomu area located on the southern side of the mountain range and belong to Şehirderekomu or Habiboğlukomu, Aşkale, Erzurum. These areas can be easily reached by the road for cars which runs along the summits of the mountain range. It takes 35 - 70 minutes from Pırnakapan.

These chrome occurrences do not form any ore horizon; they occur independently. It may be said that, Orta Tepe and Körösmân Tepe area situated on the hangingwall side and the others on the footwall side. Trenches observed are summarized as follows :

Area	Number of trenches	Total volume of trenches (m^3)	Amount of ore taken out from trenches (ton)	Stock of ore (ton)
Orta Tepe	5	25	30	30
Körösmân Tepe	1	2,290	220	150
Şehirdere	1	140	30	3
Habiboğlukomu	3	70	20	1

All orebodies are included in dunite lenses or in harzburgite. The host rocks around the orebody are more or less serpentinized.

Scale and direction of ore deposit are summarized as follows :

Area	Direction of unit orebody	length of strike side (m)	Width (m)	Average grade of ore (Cr_2O_3)
Orta Tepe	N 70°E 60°NW	0.4 - 8	0.2 - 0.8	15 - 30 %
Körösmân Tepe	uncertain	17 - 25	0.8	30 - 40 %
Şehirdere	uncertain	8	0.8	30 %
Habiboğlukomu	N 0° - 35°E 50° - 80°W	2 - 5	0.3 - 0.6	35 - 40 %

Small amount of chromite banding occur and it has several directions. Orebody is lenticular, layered, and network shaped and of generally disseminated and partly massive type.

Ore minerals are mostly chromite and gangue minerals are serpentinite, magnetite, olivine, pyroxene, carbonate minerals, brucite, etc. At Orta Tepe, nodule chromite with 1 cm in diameter is remarkable.

These chromite occurrences are so small in size and low in grade that further development cannot be expected. They are ranked as 7th (G) order.

5.2.23 Gülabikomu mine and Dağyayla Tepe area (eastern Kop chrome zone)

Gülabikomu mine is situated west of National Route 40, 1.5 - 2 km N 50°W from Pırnakapan. Dağyayla Tepe area is 3 km west from Gülabikomu mine. It has

1,870 m altitude in Gülabikomu and 2,045 m in Dağyayla Tepe area. Both areas belong to Gülabikomu or Hasbeykomu, Aşkale, Erzurum. From Pırnakapan to Gülabikomu, car is available and it takes 10 minutes. From Gülabikomu to the mine, it takes 10 - 15 minutes on foot and to Dağyayla Tepe area, 40 minutes on foot.

Both mines probably belong to the same ore zone, although evidence is uncertain. Their mode of occurrence is identical.

Chromite deposits occur in serpentinized dunite lenses and in harzburgite. Harzburgite is more or less rich in olivine.

There are 32 trenches in Gülabikomu and one trench in Dağyayla Tepe but most of them have volumes less than 100 m^3. Some of them were exploited but most of them were for exploration.

Ore zone and unit orebody have several directions. The orebody is 2 - 25 m long and 0.3 - 5 m wide. Orebody is lenticular, network-shaped and layered. Type of ore is mostly disseminated and partly massive.

Grade of ore varies from 25 to 35 % Cr_2O_3 but generally, it is low. Ore minerals are mostly chromite and a small amount of uvarovite. Gangue minerals are serpentine, carbonate minerals, brucite, magnetite, olivine, pyroxene, etc.

Total volume of trenches (including Dağyayla Tepe) is estimated to be 3,510 m^3 and amount of ore taken out from the trenches to be 3,700 tons. Amount of stock of ore is small.

Although many chromite deposits occur in the area, they are small and low grade. They are ranked as 6th (F) order.

A trench (TY-1) is observed 2 km NW from Gülabikomu. Details of this trench are uncertain.

5.2.24 Pırnakapan mine and Yassı Tepe area (eastern Kop chrome zone)

These mines are located 1.5 - 2 km from Pırnakapan. They are situated along the summit of Yassı Tepe at an altitude of 1,850 m. They belong to Pırnakapan, Aşkale, Erzurum. It takes 10 minutes by car and 10 minutes on foot to Pırnakapan mine and 10 minutes by car and 20 minutes on foot to Yassı Tepe area from Pırnakapan.

They are situated at the eastern extension of Gülabikomu mine across the National Route 40 and are thought to belong to the same ore zone. There are 3 to 6 trenches in each mine and some of them have been exploited in the past. Host rock of the ore deposit is dunite lenses and harzburgite, which is rich in olivine. It is more or less serpentinized.

Ore zone extends in E direction but unit orebody has several directions. The unit orebody is 3 - 30 m long and 0.2 - 1 m wide.

Orebody is network shape or lenticular and mostly of disseminated and partly of massive type. Grade of ore is 30 % Cr_2O_3 on the average. Ore minerals and gangue minerals are the same as in Gülabikomu.

Total volume of trenches is estimated to be 1,000 m^3 for Pırnakapan mine and 300 m^3 for Yassı Tepe area. Amount of ore taken out from the trenches is 680 tons and 30 tons, respectively. Stock of ore is small.

These mines are ranked as 6 - 7th (F - G) order.

5.2.25 Çırmıt area

Beyond the Karasu to the south in the southeastern part of the survey area, small outcrop of ultrabasic rocks is observed.

Ultrabasic rocks in this area seem to be the lower horizon and gabbro is dominant. Only one occurrence of chromite is confirmed near Çırmıt, 8 km S 20° W from

Pırnakapan. It is situated at an altitude of approximately 2,000 m and belongs to Çırmıt, Aşkale, Erzurum. To Çırmıt, it takes 20 minutes on foot to the mine.

There are two exploration trenches in harzburgite, which is more or less serpentinized. Direction of ore zone and unit orebody is NNE. Unit orebody is 10 m long and 1 m wide. The orebody is lenticular-layered and of massive - disseminated type. Grade of ore is 35 - 40 % Cr_2O_3. Ore minerals and gangue minerals are the same as in Gülabikomu mine.

Total volume of trenches is estimated to be 50 m^3 and amount of ore taken out from trenches to be 60 tons. Stock of ore is estimated to be 6 tons.

As the size and grade of ore is small, this area is ranked as 6th (F) order.

5.2.26 Carbonate occurrences

Carbonate rocks, which are alteration products of ultrabasic rocks, especially dunite, occur in several places as lenticular bodies. Two massive bodies are under exploitation. One is near Aravans, along the Kürünlüdere and the other is outside the project area to the east. As both of them are under exploration by M. T.A., details concerning these mines are omitted from this report.

Besides these, a group of old exploration trenches is situated near Hasbeykomu, 4 km N 55° W from Pırnakapan. It is at 1,920 - 1,950 m altitude and belongs to Hasbeykomu, Aşkale, Erzurum. It takes 30 minutes by jeep from Pırnakapan to Hasbeykomu and then 10 minutes on foot to the trenches.

A carbonate deposit is included in a serpentinized dunite lens. Its extends in N 15° E direction, 140 m strikeside and 120 m in width. It has lenticular shape and is of massive type. Ore minerals are magnesite and dolomite. Gangue minerals hardly occur. About 10 exploration trenches are present. Their total volumes is

estimated to be 500 m^3 and amount of ore taken out from trenches to be 1,200 tons.

Besides the above deposit, carbonate rocks are found near Cancıkkomu, Ağcahisar, Tecer, etc. But the size is so small and the grade is so low, that they are not worth describing.

5.3 Characteristic features of the chromite deposits

5.3.1 Host rock

It is remarkable that the chromite deposits in the area are included in dunite. Northern chromite zone which extends from Coşan to Baltadeğmez mine quite coincides with northern dunite zone. Most of the chromite deposits in the southern chrome zone and the eastern Kop chrome zone are included in dunite lenses in harzburgite. Even when chromite exceptionally occurs in harzburgite, this harzburgite is rich in olivine.

5.3.2 Distribution of the chrome deposits

Distribution of chrome zone follows ENE direction, the main direction of ultrabasic rocks. Chromite occurs in almost all horizons of the ultrabasic rocks, but all the large-scale orebodies are concentrated in the upper horizon of the ultrabasic rocks.

5.3.3 Direction of ore zone, unit orebody, and chromite bandings

Very interesting and important thing is, that the directions of ore zone, unit orebody, and chromite bandings commonly differ from each other.

Direction of unit orebody is divided into N system and E system. Directional relation between ore zone, unit orebody and, chromite bandings was studied as follows :

A) Relation between ore zone and unit orebody

(a) N system of unit orebody

1) directions of ore zone and unit orebody are in accord or approximately in accord :

Coşan, Sıçankale (partly) Gökyokuşun Sr. (partly) Pembe Gül, Hacıbektaşkomu, Gülabikomu, Çırmıt, Tepebaşı

2) directions of ore zone and unit orebody are not in accord :

Batı Coşan, Gökyokuşun Sr.

(b) E system of unit orebody

1) direction of ore zone and unit orebody are in accord or approximately in accord :

Sıçankale, Sulu, Ezan, Civelek, Baltadeğmez, Dikyokuş, Mağaradere, Güney Erbaş

2) directions of ore zone and unit orebody are not in accord :

Hacıbektaşkomu (partly) Tecer (partly)

B) Relation between unit orebody and chromite bandings

(a) N system of unit orebody

1) directions of unit orebody and chromite bandings are in accord or approximately in accord :

Batı Coşan, Gökyokuşun Sr. Tepebaşı, Delavlardağ

2) directions of unit orebody and chromite bandings are not in accord :

Coşan, Sıçankale (partly) Tepebaşı (partly)

(b) E system of unit orebody

1) directions of unit orebody and chromite bandings are in accord or approximately in accord :

Çamlı Tepe, Sulu, Civelek, Baltadeğmez, Dikyokuş, Güney Erbaş, Orta Tepe

2) directions of unit orebody and chromite bandings are not in accord : Sıçankale

At Ezan mine, several of the above relations exist.

In the case where directions of unit orebody and chromite bandings are not in accord, angle of intersection becomes larger towards footwall side. Whether this phenomenon is due to the secondary formation of chromite bandings or due to the dislocation of chromite bearing solution at the time of its precipitation by minor fault, is unknown as no evidence was found.

The reason of directional difference between ore zone and unit orebody may be that, direction of ore zone is controlled by the comparatively large structural system of ultrabasic rocks, while unit orebody is affected by the minor structural system; or perhaps, that unit orebody, especially a small orebody, is dislocated by minor faults at the time of or after deposition.

The reason of directional difference between unit orebody and chromite bandings may be due to the dislocation of unit orebody at the time of deposition by a minor inclination of the rockbody or by a minor fault, due to the formation of secondary banding, or due to the repetition of deposition of the orebody.

However, no evidence supporting the above explanations was found.

5.3.4 Shape and type of the orebody

Shape of the orebody is usually lenticular. It looks partly layered. In the case where the orebody is small in width, it has network shape. The ore is either massive or disseminated. At Coşan and Sıçankale deposit, hangingwall side of orebody has a sharp contact with the host rock. It looks like a fault contact in some cases.

On the contrary, footwall side gradually changes into the host rock. Massive ore is apt to concentrate to hangingwall side, while disseminated ore and chromite banding are common in footwall side.

5.3.5 Faults and folds

No tectonic line which is related directly to chromite deposits is confirmed. E fault system is possibly related to the genesis of chromite deposits, because the area of distribution and its direction agree with those of chromite deposits. However, no conclusive evidence was obtained. A tectonic line directly related to the formation of the chromite deposits may have been present, but it has disappeared due to later stage tectonic movements.

Orebodies are dislocated by faults of the N system. Amount of horizontal dislocation is less than 300 m. There are many minor faults in the orebodies, but they dislocate them only very little.

At a part of Tepebaşı mine, minor folds are present in the orebody. This phenomenon is exceptional and may suggest the presence of local structural movement after or at the time of chromite deposition.

5.3.6 Alteration

It is remarkable that serpentinized zone is almost in agreement with the chromite zone. Especially, in the northern dunite zone which is strongly serpentinized, all the large chromite deposits occur. Serpentinization itself is not directly related to the chromite mineralization. But actually, serpentinization is one of the indication useful in exploration.

The reason may be that dunite in which chromite deposits occur, is apt to be serpentinized. Other reason may be that a tectonic line was present along the northern

dunite zone, and that it caused serpentinization after the deposition of the orebodies. However, no confirming evidence was found.

5.3.7 Scale and grade of ore

As for the scale of orebody, no large unit orebody is present in this area. Strikeside extension does not exceed 100 m except 200 m at Ezan mine and in general is less than 20 m. Width of the orebody is 20 m maximum and less than 2 m generally. Therefore anticipated reserve of the unit orebody is less than 1,000 tons, except for that of Ezan mine and Coşan mine. Even for the biggest orebody in Ezan mine the reserve does not exceed 100,000 tons.

Grade of ore is variable according to the area and place. Grade of ore in the northern chrome zone is generally high and becomes higher towards west. As for the southern chrome zone, grade of ore varies according to the mine, but generally it has high grade. Grade of the eastern Kop chrome zone is mostly low. In an orebody, grade of ore is higher towards hangingwall. However, it must be noted that these tendencies have many exceptions.

5.3.8 Ore minerals and gangue minerals

Without exception, ore minerals are mostly chromite. A small amount of uvarovite is in general present along the cracks and fissures in orebody. Kaemmererite occurs in Doğu Ezan, Orta Ezan, B kafa and Pembe Gül, where it fills the cracks and fissures of the orebody. Uvarovite and kaemmererite are secondary alteration products of chromite.

As for metallic minerals, a small amount of magnetite which is altered from chromite is commonly present in chromite. It has anhedral form, fine grain and occurs along the cracks of chromite or dots irregularly in chromite. Magnetite and

pyrite are included usually in ultrabasic rock as accessory minerals.

Gangue minerals are mostly serpentine which is altered from olivine and pyroxene. Carbonate minerals (mostly magnesite), stichtite, talc, brucite, asbestos, and artinite are present.

5.3.9 Chemical composition of ore

To study the relation between Cr, Fe and Al, list of chemical analyses is given in Appendix 5.

As for Cr/Fe ratio, in most cases it ranges from 1.8 - 2.8 with 2.2 medium. High Cr and low Fe samples (Cr/Fe $>$ 3.4) are found in the southern chrome zone, such as Kara Tepe and Tecer. Low Cr and high Fe sample (Cr/Fe $<$ 1.5) was found in Dikyokuş.

As for Cr/Al ratio, two groups were observed: one is from 4.0 to 4.4 and the other from 5.0 to 5.8. Low Cr and high Al samples were observed at Dikyokuş and Körösmân Tepe in the eastern Kop chrome zone.

Anomalous ratio of a sample from Dikyokuş may have been caused by the abundance of host rock in the sample.

Positive correlation between Cr/Fe and Cr/Al is present.

Magnesium and silica ratios to chrome show the same tendency as Cr/Fe and Al/Fe ratios. Anomalous ratio is found in samples from Tecer and Dikyokuş. Whether the ore in the northern chrome zone is different from that of the southern chrome zone and eastern Kop chrome zone, is not certain due to scarcity of data.

Fig. 3 List of chromite deposits (1)

Number	Map number *1	Name	Number of trenches and galleries *2	Directions *3: Ore zone	Unit ore body: Strike	Unit ore body: Dip	Chromite banding: Strike	Chromite banding: Dip	Size and grade of the unit orebody: Extension to strike side m	Width m	Grade *4 % Cr_2O_3	A. Extension of the ore zone m	B. Total length of the unit orebody m	B/A	Volume of trenches m^3	Estimated ore taken out from trenches ton	Remarks	Evaluation of the deposit *5
1	TBZ, h-44 c3, No.4	Çamlı Tepe	TD-39	*	N50°E	60°NW	N80°E	80°N	10	1	35	*	10	*	20	< 10		D
2	"	Arapçayırıdere	TC-41	*	N40°E	60°NW	-	-	*	0.5	*	*	*	*	< 10	< 10		G
			TY-38,39,40	N40°E*	*	*	-	-	10*	1*	*	*	24	*	230*	*		F
3	"	Coşan	TD-38	N*	N35°W	40°NE	N10°E	40°SE	9	0.8	40	*	9	*	30	20	TD-42-45, GD-1 are excluded	D
			TD-29-35, TC-30	N15°W	N15°E	60°W	N30°-50°W	40°-60°SW	90	5-30	35	800	233	0.29	63,950	51,910		B
			TD-42-45,	-N45°E	N30°W	40°-60°SW												
4	EZN, 1-44 b2, No.1	Büyükelvri Tepe	TD-26	*	N10°W	30°E	N14°E	28°W	30	1	35	*	30	*	320	180		E
	TBZ, h-44 a2, No.4		TD-27,28	*	N80°E*	*	-	-	7	3	35	*	13	*	2,770	140		F
5	EZN, 1-44 b1, No.2	Batı Coşan	TD-17-25,46	N70°E	N12°-40°E	40°NW	N4°-30°E	30°-50°NW	10-40	2-4	30	370	116	0.31	1,920	900		D
6	EZN, 1-44 b1, No.2	Sıçankale	TX-3,11	N70°E	*	*	*	*	5*	1.5-3*	40-45	200	10	0.05	640	150	upper horizon	G
	(TBZ, h-44 c4, No.3 .... TX-3)		TX-1,2,4-7	*	*	*	N55°E	29°NW	2-3*	1-2*	30*	*	*	*	110	10*		
			TD-37	N60°W	N20°E	52°NW	*	*	5	1	40*	30	10	0.33	30	20	middle horizon	G
					N35°W	50°NE												
			TX-8-10	N60°E	N50°-80°E	40°SE	N0°-30°E	50°-58°W	40	6	30-40	400	40	0.10	10,500	4,300		D
			TD-1-10	N70°E	N60°E	20°NW	N5°-40°E	60°W	5-15	2-4	30-40	450	47	0.15	1,390	1,380		D
					N30°W	50°SW	N0°-30°W	40°-75°W										
			TD-11,13	N60°E	N60°E	55°SE	N25°E	60°NW	7	0.2-0.7	30-40	130	10	0.08	1,020	160		E
			TD-13,14	N60°E	N80°E	50°N	N10°E	40°W	4-7	0.4-1.5	35	150	18	0.12	650	150	lower horizon	C
					N50°W	35°NE												
			TD-36	*	*	*	N30°E	40°NW	*	*	35*	*	*	*	< 10	*		G
			TD-15,16	E	N5°E	50°W	N50°E	40°NW	5*	0.5	35 40	180	10*	0.05	210	50	uppermost horizon	G
		(summarized)		N60°W-E	N5°-20°E	50°W	N0°-55°E	29°-60°NW	2-40	0.2-6	30-45	1,540	165	0.10	14,660	6,240	TD-37 is excluded	D
					N50°-80°E	20°-50°N, 85°SE	N0°-30°W	40°-75°W										
					N35°-50°W	35°-50°NE, 50°SW												
7	EZN, 1-44 b1, No.1	Gökyokuşun Sr.	TC-16-22	N30°E	N8°W-N15°E	52°-68°W	N15°-45°E	45°-68°NW	0.4-7	0.5-3	*	250	12	0.04	60	40	upper horizon	E
			TC-23-28	N30°W	N30°E	42°NW	N35°E	75°NW	0.6-8	0.3-0.5	*	300	15	0.05	30	30	lower horizon	F
8	EZN, 1-44 b1, No.1	Çalazarlarındere	TC-36-39	N15°E	N30°E	60°NW	N30°-50°E	48°-58°NW	0.5	0.3-1.5	30-40	750	15	0.02	< 10	< 10	outcrop (SZ-1) is included	E
			SZ-1				N10°E-N25°W	30°-70°W										
							N55°-80°W	40°-55°SW										
9	"	Sulu (Ezan mine)	TC-10-13, GC-2-6, (TM-1)	N60°E	N65°E-N65°W	23°-65°N	N45°-65°E	45°-68°NW	5-60	1-7	*	400	80	0.20	9,800	4,900	upper horizon	A
							N35°W	55°NE										
			TC-14,31, TM-1,2 GC-1, GX-1	N85°E	N50°E-N50E	30°-80°NW	N69°-87°W	41°S, 35°N	8-60	1.5-10	30-45	450	110	0.24	23,890	12,720	lower horizon	A
					N60°-90°W	30°-35°N	N25°-40°E	35°-46°NW										
			TC-15	*	N15°E	30°W	-	-	7	1	*	*	7	*	320	290	east of Sulu	F
		(summarized)		N60°-85°E	N50°E-N60°W	23°-80°N	N25°-65°E	35°-66°NW	5-60	1-10	30-48	850	190	0.22	33,510	17,910		A
					N15°E	30°W	N69°-87°W	41°S, 35°N										
10	EZN, 1-44 b1, No.1	C Kafa, B Kafa Doğu Ezan Orta Ezan Batı Ezan (Ezan mine)	TC-7, TZ-1,3, GC-7	N70°E	N10°-85°E	40°-72°NW	*	*	60-220	5-20	35-40	700	340	0.49	127,300	141,200	upper horizon	A
			TZ-8, GB-2	*	N85°E	48°N	N50°W	33°NE	20	2 5	*	*	20	*	460	300	middle horizon	F
			TC-8,9, TZ-2-7 GA-1,2, GB-1, GM-1 GC-3,4,8,9, GD-2,3	N50°E	N40°W N10°-90°E	75°SE 25°-90° N-NW	N60°E N20°-48°W N	72°S 80°NE, 80°SW 10°W	10-85	1.5-15	35-45	750	385	0.51	192,330	90,640	lower horizon	A
			TC-34	*	*	*	N78°E	55°N	*	*	*	*	*	*	120	*	lowermost horizon	F
		(summarized)		N50°-70°E	N10°-90°E N40°W	25°-90° N-NW 75°SE	N20°-50°W N60°-78°E	33°-80°NE, 80°SW 55°N, 72°S	10-220	1.5-20	35-45	1,450	725	0 50	320,210	232,140		A
11	"	Armutlu (Ezan mine)	TC-1	*	N40°E	47°NW	-	-	50	15-20	35-45	*	50	*	15,900	15,750	upper horizon	A
			TC-32	*	*	*	N85°E	55°S	< 1	<1	*	*	< 1	*	< 10	<10	lower horizon	G
12	"	Tepebaşı (Ezan mine)	TC-2,5,6,33,42, GC-5,	N35°E	N0°-48°E	55°-80°NW	N10°E	80°E	0.5-30	0.2-5	30-35	530	40	0.07	3,500	3,620	lower horizon	D
							N52°W	32°NE										
			TC-3,4,35	N10°W	N34°-40°E	36°-60°NW	N35°E	60°NW	1-30	0.5-3	25-30	200	40	0.20	2,200	550	lowermost horizon	E
							N10°W	60°W										
13	EZN, 1-44 a2, No.2	Civelek (Ezan mine)	TB-1,2, TA-18	N65°E	N70°-90°E	50°-80°SE	-	-	10-20	0.8-2.5	25-40	200	45	0.22	2,390	595	upper horizon	C
			TA-17, TB-23	*	N25°-70°E	28°-72°NW	N60°E	57°NW	0.1-8	0.1-2	30-35	*	6	*	30	20	lower horizon	D
9-13		Ezan mine (summarized)		N35°-85°E N10°W	N0°-90°E N40°-60°W	50°-90°SE 25°-90°N, NW 23°-80°N, 75°SE	N10°-85°E N N10°-87°W	35°-66°NW, 55°-72°S 10°W 32°-80°NE, 41°-80°SW	0.1-220	0.1-20	30-45	3,230	1,040	0.32	378,050	270,595		A
14	"	Pembe Gül	TA-11-16	N10°-20°E	N5°E	40°W	-	-	1.3-2	0.3	40-45	71	8	0.11	< 10	< 10	lower horizon	E
					N48°E	38°NW												
			TM-3,4, TB-3, GB-3	*	N15°-40°E N2°-60°W	58°SE, 65°NW 32°-64°SW	N57°W N28°W N10°E-N8°W	30°NE 20°NE 52°-80°E	2-30	0.2-2	25-35	*	40	*	3,300	1,000		C

Fig. 3 List of chromite deposits (2)

Number	Map number *1	Name	Number of trenches and galleries *2	Directions *3					Size and grade of the unit orebody						Estimated ore taken out from trenches	Remarks	Evaluation of the deposit *5
				Ore zone	Unit ore body		Chromite banding		Extension to strike side	Width	Grade *4	A: Extension of the ore zone	B: Total length of the unit orebody	B/A	Volume of trenches			
					Strike	Dip	Strike	Dip	m	m	% Cr_2O_3	m	m		m^3	ton		
15	EZN, i-44 a-2, No 2	Baltadegmez	TA-5 - 9	N74°-80°E	N76°E N16°E	44°N 10°W	E	28°N	6 - 25	0.8 - 1.5	30 - 40	150	61	0.26	490	470		D
16	"	Dikyolay	TA-10, TB-4,5	N85°W	N85°E	32°N	N70°-85°W	47°N, 20°S	1 - 9	0.2 - 0.8	30	400	12	0.03	50	50		F
17	"	Karagüney Tepe	TA-3 - 4	N80°E	N85°W	34°N	-	-	2.4	0.2	45°	90	2	0.03	< 10	< 10		G
18	EZN, i-44 a2, No.1	Hacibektaş-komu	TA-19,20,22,25	N30°W	N15°-70°W	65°W	N10°W	70°E	8 - 11	1.5 - 2	35 - 40	95	38	0.32	270	330	main deposit	E
			TA-21	"	"	65°E	N35°-45°E	60°-90°NW										
			TA-23,24	N40°W	N10°W	75°W*	N30°W N80°E	50°E 60°S	4 3.5	1 0.2	10 - 35 15	" 10	4 3.5	" 0.35	10 20	30 < 10		G G
			TA-26 - 28 *	N55°W	N40°E N75°E	55°-70°NW 40°N	N40°E N65°W	55°NW 60°N	4	0.6	very low	26	4	0.15	< 10	10	eastern part	G
			TB-6	"	"	"	N70°E	55°N	3	0.3	35	"	3	"	< 10	< 10	"	G
			TB-7 (*)	"	"	"	"	"	2.4	0.2	"	"	2.4	"	< 10	< 10	western part	G
		(summarized)		N35°-65°W	N10°-70°W N40°-75°E	65°-75°W, 65°E 60°-70°NW	N70°-85°E N65°W N10°-30°W N35°-45°E	55°N, 60°S 60°N 30°-70°E 55°-90°NW	2.4 - 11	0.2 - 2	25 - 35	151	38	0.25	350	490		E
19	EZN, i-44 a2, No.1	Kayinli Tepe	TB-8 - 10	N60°W	N65°W*	"	N60°W N80°E	35°SW 33°S	3.3 - 4.5	0.3	30 - 35	40	12	0.30	40	< 10		G
20	EZN, i-44 a2, No.4	Mağara dere	TA-29 - 32, (A)	N75°E	N75°E	85°-90°N	-	-	6.5 - 7	0.25 - 0.6	20 - 35	420	33	0.08	240	230		F
21	"	Kirbasekomu	TA-33 *	"	N30°E*	30°W*	-	-	10 - 14	0.5 - 1	25 - 40	"	14	"	180	300		F'
22	EZN, i-44 a2, No.2	Cascikkomu	TA-34,35 *	N25°W	"	"	-	-	2 - 10	0.5 - 1	20 - 40	95	12	0.13	90	100		F'
23	EZN, i-44 a2, No.3	Kara Tepe	TB-11	"	N60°E	"	-	-	3.5*	0.2*	40 - 45	"	3.5*	"	10	< 10		G
24	"	Güney Erbaş	TA-36 - 41, TB-12 (*)	N60°E	N75°W - 85°E	"	N75°W	42°N	1 - 12	0.3 - 1	30 - 40	800	30	0.04	40	170		G
25	"	Tepkayın Tepe	TB-13	"	N40°E	"	-	-	3*	0.1*	"	"	3*	"	< 10	< 10		G
26	EZN, i-44 b1, No.1	Tecer	TC-29,40 TZ-9,10	N75°W N60°E	N40°E "	60°NW "	- N85°W	- 45°N	1 - 1.5 "	0.5 - 1 "	40 "	800 100	2.3 "	0.00 "	11 "	10 "		G G
27	EZN, i-44 a2, No 3	Cuma komu	TY-36,37	N80°W	N80°W*	"	-	"	4 - 25	1 - 2	20	75	29	0.37	2,520	1,790		F'
28	EZN, i-44 b2, No.1	Delaviardağ	TB-22 (*)	"	N20°-35°E	86°SE 75°NW	N20°E	86°SE	10	0.4	30 - 35	"	10	"	20	10		G
29	TOR, h-45 d4, No.4	Orta Tepe	TA-42 - 46	N32°E	N62°-72°E N30°W	16°-86°NW 62°SW	N62°-72°E	16°-66°NW	0.4 - 6	0.2 - 0.8	25 - 30	44	32	0.50	25	30		G
30	TOR, h-45 d4, No.3	Koroxnala Tepe	TB-20 (*)	"	"	"	N85°W	70°N	17 - 25	0.8	30 - 40	"	25	"	2,290	220		F'
31	"	Şehirdere	TB-21	"	N25°E*	"	N0°-27°E	33°-50°SE	8	0.8	30	"	8	"	140	30		G
32	"	Habibağa komu	TB-17 - 19 (*)	N20°E	N0°-35°E	80°-90°W	-	-	1.7 - 4.5	0.3 - 0.6	35 - 40	150	10	0.06	70	20		G
33	EZR, i-45 a1, No 1	Gülaki komu	TY-1 *	"	N25°E	"	-	-	10	<1	"	"	10	"	40	40	Hanegraindere	G
			TY-2 - 4 *	N50°E or N40°W	N50°-72°E	25 - 85°NW 72°SE	N60°E	25°NW	4 - 9	0.2 - 0.8	20 - 25	41	12	0.29	20	30		G
			TY-5 - 13	N30°W or N70°E	N10°E, 60°E N20°-80°W	"	N0°-80°W N60°-85°E	36°-70°NE 20°-45°NW	2 - 18	0.4 - 3.3	30	200*	61	0.31	930	530		F
			TY-14 - 17	N70°E	N0°-45°E	"	-	-	2 - 20	0.3 - 3	"	240	25	0.10	1,500	2,000		F
			TY-18 - 25 *	N10°-35°E	N25°-85°W	75°SW	N48°E	22°SE	3 - 25	0.3 - 1	20 - 35	350	70	0.20	590	340	TY-20 is a gallery.	F
			TY-26 - 28	"	N10°-45°E N10°W	" "	N60°E	37°NW	3 - 13	1 - 3	"	"	16	"	280	620		G
			TY-29 - 33	N25°E	N35°-65°E	"	N N75°W	55°W 46°NE	5	1 - 2	"	220	>10	>0.04	60	70		G
		(summarized)		N10°-35°E N70°-80°E N30°-40°W	N0°-45°E N50°-72°E N10°-85°W	" 25°-65°NW 72°E, 72°W	N48°-85°E N N0°-80°W	N	2 - 25	0.3 - 2	20 - 35	1,051	178	0.16	3,420	3,630		F
34	EZR, i-45 a1, No.1	Dagyayla Tepe	TY-34	"	N70°W	"	"	"	12*	2*	"	"	12*	"	90	80		G
35	"	Pırnakapan	TA-47 - 49 TA-50, (A), (B)	N70°W "	N70°W* N75°E	" 32°N	N70°E N75°E	38°SE 32°N	17 - 30 3.2	1 - 1.2 0.3	40* 20 - 35	150 "	47 3.2	0.31 "	960 30	670 10		F F'
36	EZR, i-45 a1, No 2	Yassi Tepe	TB-14 - 16 (*)	"	N20°W or N70°E	"	N0°-85°E N27°-60°W	28°-80°, N-W 57°-62°NW, 61°SW	3 - 6.3	0.2 - 0.5	"	"	15	"	300	30		G
37	EZR, i-45 a1, No.4	Çırnıl	TB-40,41 *	N30°E	N12°-30°E	80°-85°W	-	-	10 - 12	1	35 - 40	200*	22	0.11	80	20		F
38	"	"	TY-35	"	N45°E	"	N10°E	44°SE	7	0.6	25 - 30	"	7	"	30	< 10	location is uncertain	G

Remarks: *1 TBZ: Trabzon
EZN: Erzincan
EZR: Erzurum
TOR: Tortum

*2 * : kind of the host rock is harzburgite
(*) : kind of the host rock is harzburgite in part.
no mark: kind of the host rock is dunite, serpentinite or uncertain

*3 * : uncertain
~ : none

*4 grade of ore is macroscopically estimated.

*5 order of the evaluation A (first order) - G (seventh order)

6. COMPARISON WITH PREVIOUS WORK

Previous works which have been carried out by M.T.A. and others are shown in the 1977 report. Among them, the work done by KAADEN, G. (1962) is the most important. The results of this work are compared with the results in this year's survey.

In addition to the above, photogeological survey of this project in 1977 will be compared with the results of field survey in 1978.

6.1 Comparison with the results of work by KAADEN, G. (1962)

The work by KAADEN, G. was done in the area from Coşan to the west. It extends farther to the northwest than the 1978 survey area. This work is compiled into geological map on 1: 25,000 scale.

As no ultrabasic rocks are present in his map at the northwestern part beyond Kürünlüdere, comparison is limited to the area from Coşan to Kürünlüdere and to the south of the Karasu.

Important results of comparison are summarized as follows :

1) Kopdağ limestone, at least near the boundary with the ultrabasic rocks, is of Miocene - Pliocene age according the 1978 survey, but it is lower Cretaceous - upper Jurassic according to KAADEN, G.

2) "Serpentinzed ultrabasic rocks" used by KAADEN, G., were identified mostly as harzburgite by the 1978 survey. "Serpentinized ultrabasic rocks rich in veinlets of magnesite" used by KAADEN, G., was identified as dunite of the northern dunite zone.

3) Distribution of gabbro is small in the area according to KAADEN, G. The survey of this year demonstrated wide distribution of basic - intermediate igneous

rocks.

4) Location of chromite occurrence is almost the same in both surveys. However, with the lapse of time, new chrome occurrences were found in the area.

6.2 Comparison with the results of photogeological survey

The area of photogeological survey is bigger than the area of the survey in 1978. So the area of comparison is limited to the survey area in 1978. Important results of comparison are listed as follows :

1) Gabbroic - dioritic intrusions in the ultrabasic rocks were not discovered by photogeology.

2) Distribution of ultrabasic rocks as shown by photogeology is mostly is agreement with the results of field survey in 1978. However, boundary between ultrabasic rocks and limestones, especially Meyramdağ limestone, is different. It is found many times along the rivers and brooks but it is not shown on photogeological map.

3) Kopdağ limestone overlays the ultrabasic rocks, while it is shown as intruded by the ultrabasic rocks on photogeological map.

4) Many faults on the photogeological map could not be found by the field survey.

5) Serpentinized zone is in good accord with the results of the field survey.

6) Trenches on photogeological map were most useful for field survey. They agreed with the chromite occurrences in the field, although with the lapse of time, new trenches were found in the field. Some of the trenches on photogeological map, K-18, 19 etc., are the buildingstone quarries.

7. FUTURE PROSPECT

7.1 Evaluation of chromite deposits

In this year's survey, size and grade of each orebody were studied and volume of trenches and amount of ore taken out from the trenches were estimated. Based on these data, evaluation of the deposit was attempted. However, due to the conditions of the trenches, correct data could not be obtained in many cases. Moreover, evaluation of the known ore deposit does not always mean the evaluation of potentiality of ore deposit. However, as an indicator for future prospect, evaluations of chromite deposits are listed below.

This evaluation must be reexamined according to the results of exploration in future.

A order	Ezan (including Armutlu, Ezan, B kafa C kafa, Sulu)
B "	Coşan
C "	Pembe Gül, Civelek
D "	Batı Coşan, Sıçankale, Baltadeğmez, Tepebaşı, Çamlı Tepe
E "	Gökyokuşun Sr., Çalazarlarındere, Hacıbektaşkomu, Büyüksivri Tepe
F "	Dikyokuş, Mağaradere, Cumakomu, Kârhanekomu, Körösmân Tepe, Pırnakapan, Gülabikomu, Arapçayırıdere, Cancıkkomu, Çırmıt
G "	Topkayın Tepe, Delavlardağ, Orta Tepe, Şehirdere, Kayınlı Tepe, Karagüney Tepe, Habiboğlukomu, Yassı Tepe, Dağyayla Tepe, Kara Tepe, Güney Erbaş, Tecer

Among these, F and G order are at this moment judged not to be worth furture

prospect.

7.2 Prospecting method

The 1978 survey studied features of the orebody in all trenches and galleries which can be observed. Therefore, detailed surveys for promising areas are suggested for future prospect.

In the survey area covered by 1: 25,000 and 1: 10,000 geological mapping, detailed geological survey is necessary to clarify the relation between geology and chromite deposit and to learn the details of orebody, in the case that a promising area is found.

In the survey area covered by 1: 2,000 geological mapping, exploration by trenching and drilling is suggested. As all the outcrops were checked by geological survey in 1978, trenching will become one of the leading methods of furure exploration. Cost of trenching is rather lower than that of drilling and this method will be effective for all orebodies. Trenching is aimed to clarify the development of orebody in strikeside extent and to learn the details of scale and grade of ore. For this method, a buldozer is absolutely necessary due to the absence of workers in the area.

For economically important chromite deposits, drilling exploration is suitable. It is aimed to clarify the development of orebody in both strikeside extent and dipside extent. As the scale of unit orebody is small, intervals of drilling must be decided carefully. The largest interval of drilling should not exceed 100 m and a 30 - 50 m interval is recomended. At the first stage of this exploration, shorthole drilling is the best method.

As for underground prospecting, it is at present not recommended for this area except for Coşan mine, because due to severe serpentinization, host rock is very fragile. All walls of the gallery must be supported and, even if supported, few years are enough to destroy it. High cost and adequate technique are necessary to open a gallery. Therefore, this method should be considered only when no other method is suitable for exploration or when it is used not only for exploration but also for exploitation.

7.3 Area and amount of work in the future

According to the results of the survey in 1978, area and amount of work in the future are discussed and listed in Fig. 4.

Order of the area for future exploration applies the evaluation of chromite deposit mentioned before. Priority of exploration is again ranked by the importance of the area and by the priority of the method.

Let's suppose that a deposit is evaluated as E order and 10 trenches and 2 drillings are necessary to clarify all the details of the orebody. But, at the first stage of exploration, such amount of exploration will not be requested. For example, 2 trenches must be excavated at first and then if they reach the ore, rest of trenches will be necessary. If the results of trenching get good results, 2 drillings will be requested. In this case, 2 trenches are ranked as E priority and they never exceed the the rank of the deposit. Then, 8 trenches are ranked as F priority and drillings as G priority.

Thus, amount of work is summarized in following table. Among them, exploration of A, B and C priority is worth a prospect at the present time.

priority of the prospect	detailed geological survey * 1: 1,000 - 1: 2,000		trench exploration *		drilling exploration *		remarks
	number of places	area (km^2)	places	volume (m^3)	number of holes	length (m)	
A	1	1.29	4	125	10	1,060	only Ezan mine
B	1	0.40	9	375	6	600	Ezan mine
C	1	0.21	10	375	9	890	Coşan mine
D	2	0.60	20	775	9	555	
E	-	-	28	1,400	6	510	
F	4	4.10	32	1,575	5	290	
G	-	-	10	575	2	140	
Total	9	6.60	113	5,200	47	4,045	

* Area for trench and drilling exploration must be followed up by a detailed geological survey.

Geological survey of A, B and C priority means this follow-up survey.

7.4 Exploration program in 1979

After the discussion of area and method for future prospect, exploration program in 1979 are recommended.

Details are listed in Fig. 4, however, according to the conditions in the field and the progress of exploration, this program will be changed. Program is summarized as follows :

1) At Ezan area (including Ezan, Armutlu, B Kafa, C Kafa and Sulu), twelve drillings must be carried out to find the size and grade of orebody at the dipside extent. Almost all of the big unit orebodies are the target of this exploration; one drilling for one unit orebody. Total length of drilling is estimated to be 1,150 m

2) Trenching must be carried out in Ezan area (including Ezan, Armutlu, B Kafa, C Kafa, Sulu, Tepebaşı, Civelek). If time allows, area must be extended to Coşan mine and Pembe Gül mine. Total amount planned is 500 m^3.

3) As the above-mentioned exploration which is carried out at Ezan and Coşan mine progress, detailed geological survey is necessary to follow-up the results of the above exploration.

Map scale for this survey is 1: 1,000 in general but if occasion demands, more detailed map scale will be needed. Topographic map will have to be newly made for this survey. Total area of the survey is estimated to be 2 km^2.

4) At present, geological check survey in the area, covered by 1: 10,000 and 1: 25,000 map in 1978, is not planned, but may become advisable in light of the results of exploration in 1979 or new information on chromite occurrence.

5) Period of field survey or exploration is strictly limited to a period from middle of June to early October, due to weather conditions. Also, few workers are in the area and all the material necessary for work and everyday living must be transported from outside of the area.

Fig. 4 List for future prospects (1)

Number	Name	Map number *1	Extension of known orebody m *8	Evaluation of the mine *2	Trenches and galleries related with prospecting	Purpose *3	Number of prospecting	Area or coordinates *4	Trenching					Drilling					Geological survey		Remarks	Priority *2	Candidates for 1979 *7
									Number pcs	Amount *5 m^3	Direction	Interval m	Extension of prospecting zone m	Number pcs	Amount m	Direction	Estimated length to cut the orebody m	Depth of the orebody from outcrop ML *6	Amount km^2	Map scale			
1	Çamlı Tepe	TBZ, H-44 c3, No.4	*	D	TD-39	Str-ext.	a-1	around TD-39	1	25	N40°E S50°W	-	-	-	-	-	-	-	-	-	-	D	-
2	Arapçayırı-dere	TBZ, H-44 c3, No.4	*	F	TY-38,39	Str-ext.	c-15	between TY-38,39	1	50	N40°W	-	25	-	-	-	-	-	-	-	-	F	-
					TY-38	E-Str-ext.	c-16	eastward from TY-38	1	50	N40°W	-	30	-	-	-	-	-	-	-	-	F	-
					TY-39	W-Str-ext.	c-17	westward from TY-39	1	50	N40°W	-	30	-	-	-	-	-	-	-	-	F	-
3	Coşan	TBZ, H-44 c3, No.4	29	B	TD-35,38,39	E-Str-ext.	b-2,4,6,8	between TD-35,	4	100	E	100	800	-	-	-	-	-	-	-	No outcrop is observed on the land surface	D	-
							b-1,3,5,7	TD-39	4	100												E	-
					TD-35 TC-30	Str-ext.	c-2,4,6 c-1,3,5	between TD-35, TC-30	3 3	75 75	N60°E	30	210	-	-	-	-	-	-	-	This trenching can substitute to start from both trenches	B C	O -
					TD-33, GD-1	Dip-ext.	c-7	30.32N, 18.74E	-	-	-	-	-	1	100	-90°	80	-100	-	-	-	B	-
					TD-32	Dip-ext.	c-8	30.20N, 18.72E	-	-	-	-	-	1	150	E, -60°	105	-100	-	-	-	B	-
					TC-30	Dip-ext. Dis-f.	c-9	30.68N, 18.92E	-	-	-	-	-	1	120	E, -60°	90	- 75	-	-	-	C	-
					TD-31,32	Str-ext. Dis-f.	c-10	between TD-31,32	1	*50	N70°W	-	20	-	-	-	-	-	-	-	*extension width depth 20m 2.5m 1m	B	O
					TD-31,32	Dip-ext. Dis-f.	c-11	30.15N, 18.67E	-	-	-	-	-	1	150	E, -60°	105	-100	-	-	-	B	-
					TD-29,31	Str-ext.	c-12	between TD-29,31	1	50	N60°W	-	25	-	-	-	-	-	-	-	-	C	-
					TD-31	Dip-ext.	c-13	30.06N, 18.65E	-	-	-	-	-	1	120	-90°	100	-100	-	-	-	C	-
					TD-29 - 35 TC-30	follow-up survey	c-14	surrounded by the 4 points (W,X,Y,Z) W: 30.09N, 18.81E X: 30.79N, 19.19E Y: 29.83N, 18.90E Z: 29.94N, 18.52E	-	-	-	-	-	-	-	-	-	-	0.4	1/500 | 1/1,000	Development by mining operations must be taken into account extension N20°E : 1 km N70°W : 0.4 km	B	O
	(total)								18	450				5	640				0.4				
4	Büyüksivri Tepe	EZN, I-44 b2, No.1	*	E	TD-26	Str-ext.	d-1,2	around TD-26	2	50	N10°W S10°E	30	60	-	-	-	-	-	-	-	-	E	-
5	Batı Coşan	EZN, I-44 b1, No.2	31	D	TD-25	E-Str-ext.	e-4,8,12	eastward from TD-25	3	150												D	-
							e-2,6,10		3	150	N30°W	30	360	-	-	-	-	-	-	-	-	E	-
							e-1,3,5,7,9		6	300												F	-
					TD-17	W-Str-ext.	e-13,15	westward from TD-17	2	100	N50°W	30	120	-	-	-	-	-	-	-	-	E	-
							e-14,16		2	100												F	-
					TD-21	Dip-ext.	e-17	28.17N, 18.58E	-	-	-	-	-	1	70	S60°E, -50°	40	- 15	-	-	-	E	-
					TD-18	Dip-ext.	e-18	28.07N, 16.49E	-	-	-	-	-	1	30	S60°E, -70°	25	- 50	-	-	-	E	-
					—	Dip-ext. of chromite banding zone	e-19	27.98N, 17.16E	-	-	-	-	-	1	90	N30°W, -50°	70	- 50	-	-	ore-shoot is expected	E	-
							e-20	27.99N, 17.16E						1	70	N40°E, -60°	60	- 50	-	-		E	-
					TD-17 - 25	follow-up survey	e-21	surrounded by 4 points (W,X,Y,Z) W: 27.98N, 16.33E X: 27.82E, 16.45E Y: 28.48N, 17.21E Z: 28.63N, 17.08E	-	-	-	-	-	-	-	-	-	-	0.2	1/500 | 1/1,000	extension N50°E : 1 km N40°W : 0.2 km	D	-
	(total)								16	800				4	260				0.2				
6	Sıçankale	EZN, I-44 b1, No.2	5 - 15	D	TD-11 - 14	Str-ext.	f-2,4,6		3	*300	N	50	300	-	-	-	-	-	-	-	*extension 20 m	E	-
							f-1,3,5		3	*300											width 2.5 m	F	-
						Str-ext.	f-8,10		2	*200											depth 2 m	F	-
							f-7,9,11		3	*300	N20°W	200	1,000	-	-	-	-	-	-	-	volume 100 m^3	G	-
					TD-2 - 10	Dip-ext.	f-12	27.31N, 12.66E						1	40	-90°	30	- 30			drilling interval	D	-
							f-13	27.25N, 12.47E	-	-	-	-	-	1	40	-90°	25	- 25	-	-	is 200 m for each	D	-
							f-14	27.26N, 12.29E						1	30	-90°	15	- 15				D	-
					TX-10	Dip-ext.	f-15	28.05N, 13.61E						1	70							F	-
						NE-Dip-ext.	f-16	28.09N, 13.64E	-	-	-	-	-	1	70	S50°E, -60°	55	- 60	-	-	trenching precedes	G	-
						SW-Dip-ext.	f-17	28.02N, 13.57E						1	70							G	-
						NE-Str-ext.	f-18	from TX-10	1	50	N40°E	-	-	-	-	-	-	-	-	trenching starts from	E	-
						SW-Str-ext.	f-19		1	50	S40°W	-	-								TX-10	D	-

Fig. 4 List for future prospects (2)

Number	Name	Map number *1	Extension of known orebody m *8	Evaluation of the mine *2	Trenches and galleries related with prospecting	Purpose *3	Number of prospecting	Area or coordinates *4	Trenching: Number pcs	Trenching: Amount *5 m3	Trenching: Direction	Trenching: Interval m	Trenching: Extension of prospecting zone m	Drilling: Number pcs	Drilling: Amount m	Drilling: Direction	Drilling: Estimated length to cut the orebody m	Drilling: Depth of the orebody from outcrop ML. *6	Geological survey: Amount km2	Geological survey: Map scale	Remarks	Priority *2	Candidates for 1979 *7
					TX-1,4,5,6,7	Str-ext.	f-20 – 23	between TX-1,4,5,6,7	4	200	N	50	250	-	-	-	-	-	-	-	-	G	-
					around TX-10	to get informations of chromite deposit and follow-up survey	f-24	surrounded by 4 points (W,X,Y,Z) W: 27.95N, 13.26E X: 27.68N, 13.55E Y: 28.64N, 13.95E Z: 28.39N, 14.23E	-	-	-	-	-	-	-	-	-	-	0.4	1/500 | 1/1,000	extension N45°E : 1 km N45°W : 0.4 km This area is not included in 1/2,000 mapping area in 1978	D	-
	(total)								17	1,400				6	320				0.4				
7	Gökyokuşun Sr.	EZN, I-44 b1, No.1	4 - 5	E	TC-25 – 27	Str-ext.	g-1 – 3	between TC-25 – 27	3	75	N65°W	25	100	-	-	-	-	-	-	-	-	F	-
					TC-23	W-Str-ext.	g-4 – 6	westward from TC-23	3	150	N	25	75	-	-	-	-	-	-	-	-	F	-
					TC-22	NE-Str-ext.	g-8, 10	northeastward from	2	50				-	-	-	-	-	-	-	-	E	-
							g-7,9,11	TC-22	3	75	N35°W	25	125									F	-
					TC-17 – 20	Str-ext.	g-13,15	between TC-17 and	2	50				-	-	-	-	-	-	-	-	F	-
							g-12,14,16	TC-20	3	75	N70°W	25	150									G	-
	(total)								16	475				-	-				-				
8	Çalazarlarındere	EZN, I-44 b1, No.1	2	E	SZ-1, TC-39	Str-ext.	h-1	northward from SZ-1	1	100	N60°W	50	50	-	-	-	-	-	-	-	-	E	-
							h-2, 3	between SZ-1, TC-39	2	150	W	50	150									E	-
9	Sulu (Ezan mine)	EZN, I-44 b1, No.1	20 - 24	A	TM-1, 2	Dip-ext.	i-1	27.12N, 07.62E						1	40	-90°	30	-30				B	◎
					TC-10, GC-2		i-2	27.12N, 07.63E						1	50	-90°	45	-45			drilling interval is	B	◎
					TC-10,11,12,31	Dip-ext.	i-3	27.22N, 07.65E	-	-	-	-	-	1	60	-90°	60	-60	-	-	50 m for each.	C	-
					"		i-4	27.25N, 07.69E						1	80	-90°	70	-60				A	◎
					"		i-5	27.27N, 07.74E						1	110	-90°	85	-60				C	-
					TC-13		i-6	27.28N, 07.79E						1	130	-90°	110	-60				C	-
					TC-14,31	Str-ext.	i-7 – 9	between TC-14,31	3	75	S45°W	40	160	-	-	-	-	-	-	-		A	○
						E-Str-ext.	i-10	eastward from TC-14	1	50												A	○
							i-11	"	1	50	N10°E	30	60	-	-	-	-	-	-	-	-	B	○
					TC-14,31	E-Dip-ext.	i-12	27.12N, 07.87E						1	120	-90°	100	-60			drilling interval: 50m	C	-
					"	expecting massive	i-13	27.08N, 07.91E						1	110	-90°	90	-60			trenching (i-10,11)	B	-
					TC-14	orebody	i-14	27.10N, 08.00E	-	-	-	-	-	1	110	-90°	90	-60	-	-	precedes	D	-
					"		i-15	27.17N, 08.06E						1	100	-90°	80	-60			drilling interval: 100m	C	-
					"		i-16	27.26N, 08.10E						1	120	-90°	100	-60				E	-
	(total)								5	175				11	1,040			-					
10	C Kafa				TM-1, TZ-7	Str-ext.	j-1	between TM-1, TZ-1	1	25	N40°W	30	90	-	-	-	-	-	-	-	-	C	-
	B Kafa						j-2		1	25	N											C	-
	Doğu Ezan	EZN, I-44 b1, No.1	49 - 51	A	TZ-3, 7	Str-ext. (hanging wall horizon)	j-3,4	between TZ-3, 7	2	100	N20°W	50	150	-	-	-	-	-	-	-	-	B	○
	Orta Ezan																						
	Batı Ezan				TZ-3, TC-7	Str-ext. (hanging wall horizon)	j-5	between TZ-3, and	1	50	N	50	200	-	-	-	-	-	-	-	-	B	○
	(Ezan mine)						j-6	TC-7	1	50	N40°W											B	○
					TZ-1	Dip-ext. (hanging wall horizon)	j-7	26.95N, 06.80E						1	105	-90°	85					A	◎
					TC-7		j-8	26.88N, 06.95E						1	80	S, -80°	60					A	◎
					TZ-3		j-9	27.01N, 07.07E						1	130	-90°	110					A	◎
					TC-8		j-10	26.60N, 07.00E	-	-	-	-	-	1	95	S, -80°	75	- 50	-	-	-	A	◎
					TC-9, TZ-8	Dip-ext. (footwall horizon)	j-11	26.73N, 07.10E						1	110	-90°	90					A	◎
					TZ-3, TZ-8		j-12	26.80N, 07.11E						1	120	-90°	100					A	◎
					TZ-4, 6		j-13	26.95N, 07.28E						1	110	-90°	90					A	◎
					TC-7 – 15,31,34 TM-1,2 TZ-1 – 8 GA-1,2 GB-1,2 GC-1 – 9 GD-2,3 GM-1, GX-1	follow-up survey (including Sulu)	j-14	surrounded by 4 points (W,X,Y,Z) W: 27.44N, 08.10E X: 26.92N, 06.70E Y: 26.41N, 06.86E Z: 26.99N, 08.59E	-	-	-	-	-	-	-	-	-	0.75	1/500 | 1/1,000	extension N70°E 1.5 km N20°W: 0.5 km Development by mining operation must be taken into account	A	○
	(total)								6	250				7	750				0.75				

Fig. 4 List for future prospects (3)

Number	Name	Map number *1	Extension of known orebody m *8	Evaluation of the mine *2	Trenches and galleries related with prospecting	Purpose *3	Number of prospecting	Area or coordinates *4	Trenching					Drilling					Geological survey		Remarks	Priority *2	Candidates for 1979 *7
									Number pcs	Amount *5 m^3	Direction	Interval m	Extension of prospecting zone m	Number pcs	Amount m	Direction	Estimated length to cut the orebody m	Depth of the orebody from outcrop ML. *6	Amount km^2	Map scale			
11	Armutlu (Ezan mine)	EZN, I-44 b1, No.1 EZN, I-44 a2, No.2	*	A	TC-32	Dip-ext.	k-11	26.39N, 06.68E						1	70	-90°	60	- 50			Shaft is necessary for developments.	A	◎
						E-Dip-ext.	k-12	26.39N, 06.83E	-	-	-	-	-	1	150	-80°	100 130	- 50	-	-		A	◎
						W-Dip-ext.	k-13	26.30N, 05.98E						1	50	-90°	40	- 50				C	-
					TC-1-6, 32, 33, 35, 42, TA-17, 18, TB-1, 2, 23, GC-5	follow-up survey (including Tepebaşı, Civelek)	k-14	surrounded by 4 points (W,X,Y,Z) W: 26.12N, 07.12E X: 26.62N, 06.79E Y: 26.06N, 06.10E Z: 25.57N, 06.43E	-	-	-	-	-	-	-	-	-	-	-	0.54	1/500 I 1/1,000	extension N50°E : 0.9 km S40°E : 0.6 km Development by mining operations must be taken into account.	A	○
	(total)													3	270				0.54				
12	Tepebaşı (Ezan mine)	EZN, I-44 b1, No.1 EZN, I-44 a2, No.2	7-20	D	TC-2,42	Str-ext.	l-1,2	between TC-2,42	2	50	N40°W	50	150	-	-	-	-	-	-	-		D	-
					TC-2,33	"	l-3	between TC-2,33	1	25	S	50	100	-	-	-	-	-	-	-	-	D	-
					TC-33	"	l-4	westward from TC-33	1	25	S60°W	50	50	-	-	-	-	-	-	-		D	-
					TC-2	Dip-ext.	l-5	26.05N, 06.83E	-	-	-	-	-	1	90	S40°E, -80°	70	- 50	-	-	-	D	-
	(total)								4	100				1	90								
13	Civelek (Ezan mine)	EZN, I-44 a2, No.2	22	C	TB-2	E-Str-ext.	m-1,2	eastward from TB-1	2	100	N30°W	40	80	-	-	-	-	-	-	-	-	C	-
					TB-1	Dip-ext.	m-3	26.12N, 06.31E	-	-	-	-	-	1	80	N30°W, -80°	60	- 50	-	-	-	C	+
					TA-17	E-Str-ext.	m-4,6	between TA-17 and	2	100												D	-
							m-5,7	TC-33	2	100	N52°W	50	200	-	-	-	-	-	-	-	-	E	-
						W-Str-ext.	m-8	westward from TA-17	1	25	N72°E	70	70									F	-
							m-9		1	25	N74°W	130	130	-	-	-	-	-	-	-	-	F	-
					TB-23, TA-17	Str-ext.	m-10	NEward from TB-23	1	25	N60°W	50	50	-	-	-	-	-	-	-		F	-
	(total)								9	375				1	80				-				
9 - 13 total of Ezan mine									24	900				23	2,230				1.29		More drilling is necessary according to the works in 1979.		
14	Pembe Gül	EZN, I-44 a2, No.2	11	C	TA-16	Str-ext.	n-1	northward from TA-16	1	25	N60°W	25	25	-	-	-	-	-	-	-	-	E	-
					TA-13,14		n-2	between TA-13,14	1	25	N82°E	25	50									E	-
					TM-3, TA-11	Str-ext.	n-3	between TA-11, and	1	50	N18°W											D	-
							n-4	TM-3	1	50	N30°W	40	160	-	-	-	-	-	-	-	-	D	-
							n-5		1	50	N38°W											D	-
					TM-3	Str-ext.	n-6	westward from TM-3	1	50	N	50	50									C	-
					TM-4	Str-ext.	n-7	westward from TM-4	1	50	N62°W	50	50	-	-	-	-	-	-	-	-	C	-
					TB-3	S-Str-ext.	n-8	southward from TB-3	1	50	N80°W	50	50									D	-
					TM-3	Dip-ext.	n-9	24.05N, 05.02E	-	-	-	-	-	1	80	S35°E, -72°	65	- 25	-	-	-	D	+
					TM-4	Dip-ext.	n-10	24.39N, 04.95E	-	-	-	-	-	1	50	S35°E, -45°	35	- 35	-	-	-	D	+
					TM-3	Dip-ext.	n-11	24.28N, 05.02E	-	-	-	-	-	1	105	-90°	85	- 50	-	-	Shaft is necessary	E	-
					TM-4	Dip-ext.	n-12	24.38N, 04.95E	-	-	-	-	-	1	95	-90°	75	- 80	-	-	for development.	E	-
					TB-3, TM-3,4 TA-11 - 16, GB-3	follow-up survey	n-13	surrounded by 4 points (W,X,Y,Z) W: 24.67N, 05.20E X: 24.45N, 05.40E Y: 23.97N, 04.90E Z: 24.19N, 04.69E	-	-	-	-	-	-	-	-	-	-	-	0.21	1/500 I 1/1,000	extension N42°E : 0.7 km S48°E : 0.3 km	C	-
	(total)								8	350				4	330				0.21				
15	Baltadeğmez	EZN, I-44 a2, No.2	26	D	TA-8	Dip-ext.	o-1	23.24N, 04.16E	-	-	-	-	-	1	60	-90°	45	- 30	-	-	-	D	-
					TA-8	Dip-ext.	o-2	23.23N, 04.12E	-	-	-	-	-	1	55	-90°	40	- 30	-	-	-	D	-
					TA-5	E-Str-ext.	o-3	eastward from TA-5	1	50	S50°E	30	30									E	-
					TA-5,6	Str-ext.	o-4	between TA-5,6	1	50	S5°E	25	50	-	-	-	-	-	-	-	-	D	+
					TA-9	W-Str-ext.	o-5	westward from TA-9	1	50	S3°E	15	15									E	-
	(total)								3	150				2	115				-				

Fig. 4 List for future prospects (4)

Number	Name	Map number *1	Extension of known orebody m *3	Evaluation of the mine *2	Trenches and galleries related with prospecting c	Purpose *3	Number of prospecting	Area or coordinates *4	Trenching: Number pcs	Trenching: Amount *5 m3	Trenching: Direction	Trenching: Interval m	Trenching: Extension of prospecting zone m	Drilling: Number pcs	Drilling: Amount m	Drilling: Direction	Drilling: Estimated length to cut the orebody m	Drilling: Depth of the orebody from outcrop ML. *6	Geological survey: Amount km2	Geological survey: Map scale	Remarks	Priority *2	Candidates for 1979 *7
16	Dikyokuş	EZN, I-44 a2, No.2	3	F	TA-10	Str-ext.	o-6,7	around TA-10	2	100	S5°E	25	50	-	-	-	-	-	-	-	-	F	-
17	Karaguney Tepe	EZN, I-44 a2, No.2	3	G	not worth for prospecting																		
18	Hacıbektaş komu	EZN, I-44 a2, No.1	15 - 32	E	TA-22	N-Str-ext.	p-1	northward from TA-22	1	50	N88°E	-	30	-	-	-	-	-	-	-	-	E	-
					TA-19	S-Str-ext.	p-2	southward from TA-19	1	50	N58°E	-	30									E	-
					TA-19	Dip-ext.	p-3	21.59N, 99.10E						1	50	N58°E, -60°	35	- 30				F	-
					TA-20	Dip-ext.	p-4	21.58N, 99.10E						1	50	N58°E, -60°	35	- 30	-	-	-	F	-
					TA-22	Dip-ext.	p-5	21.66N, 99.09E						1	50	N78°W, -60°	35	- 30				F	-
	(total)								2	100				3	150				-				
19	Kayınlı Tepe	EZN, I-44 a2, No.1	30	G	not worth for prospecting																		
20	Mağara dere	EZN, I-44 a2, No.4	8	F	TA-29 - 32	to study the detail of the orebody	q-1	surrounded by 4 points (W,X,Y,Z) W: 19.65N, 00.07E X: 19.35N, 00.09E Y: 18.92N, 99.95E Z: 19.29N, 99.78E	-	-	-	-	-	-	-	-	-	-	-	0.4	1/2,000	extension N66°E : 1 km S24°E : 0.4 km	F	-
21	Kârhane komu	EZN, I-44 a2, No.4	*	F	not worth for prospecting																		
22	Cancıkkomu	EZN, I-44 a2, No.3	13	F	not worth for prospecting																		
23	Kara Tepe	EZN, I-44 a2, No.3	*	G	not worth for prospecting																		
24	Güney Erbaş		4	G																			
25	Topkayın Tepe		*	G																			
26	Tecer	EZN, I-44 b1, No.1	< 1	G	not worth for prospecting																		
27	Cuma komu	EZN, I-44 a2, No.3	37	F	not worth for prospecting																		
28	Delavlardağ	EZN, I-44 b2, No.1	*	G	not worth for prospecting																		
29	Orta Tepe	TOR, H-45 d4, No.4	50	G	not worth for prospecting																		
30	Körbesmân Tepe	TOR, H-45 d4, No.3	*	F	not worth for prospecting																		
31	Şehirdere		*	G																			
32	Habiboğlukomu		6	G																			
33	Gülabi komu	EZR, I-45 a1, No.1	10 - 31	F	TY-2 - 33	to study the chromite deposit in detail	t-1	surrounded by 4 points (W,X,Y,Z) W: 25.92N, 31.31E X: 27.37N, 31.31E Y: 26.52N, 33.00E Z: 28.00N, 33.00E	-	-	-	-	-	-	-	-	-	-	-	2.55	1/2,000	extension N70°E : 1.8 km N20°W : 1.5 km	F	-
34	Dağyayla Tepe	EZR, I-45 a1, No.1	*	G	not worth for prospecting																		

Fig. 4 List for future prospects (5)

Number	Name	Map number *1	Extension of known orebody m*8	Evaluation of the mine *2	Trenches and galleries related with prospecting	Purpose *3	Number of prospecting	Area or coordinates *4	Trenching: Number pcs	Trenching: Amount *5 m3	Trenching: Direction	Trenching: Interval m	Trenching: Extension of prospecting zone m	Drilling: Number pcs	Drilling: Amount m	Drilling: Direction	Drilling: Estimated length to cut the orebody m	Drilling: Depth of the orebody from outcrop ML.*6	Geological survey: Amount km2	Geological survey: Map scale	Remarks	Priority *2	Candidates for 1979 *7
35	Pırnakapan	EZR, I-45 a1, No.1	31	F	TA-47- 49	to study the chromite deposit in detail	u-1	surrounded by 4 points (W,X,Y,Z) W: 27.28N, 33.35E X: 28.00N, 33.35E Y: 28.75N, 34.50E Z: 28.00N, 34.50E	-	-	-	-	-	-	-	-	-	-	0.9	1/2,000	extension N60°E : 1.375 km N30°W : 0.75 km	F	-
36	Yassı Tepe	EZR, I-45 a1, No.2	*	G	TB-14 - 16																		
37	Çırmıt	EZR, I-45 a1, No.4	11	F	TD-40, 41	to study the chromite deposit in detail	v-1	surrounded by 4 points (W,X,Y,Z) W: 16.85N, 32.00E X: 17.65N, 32.51E Y: 17.50N, 32.75E Z: 16.70N, 32.20E	-	-	-	-	-	-	-	-	-	-	0.25	1/2,000	extension N30°E : 1 km N60°W : 0.25 km	F	-
	(grand total)								113	5,200				47	4,045				6.60				
								A priority	4	125				10	1,060				1.29		Amount of drilling in Ezan and Coşan mines increases according to the results of works in 1979		
								B "	9	375				6	600				0.40				
								C "	10	375				9	890				0.21				
								D "	20	775				9	555				0.60				
								E "	28	1,400				6	510				-				
								F "	32	1,575				5	290				4.10				
								G "	10	575				2	140				-				
								(in 1979)	(13	500)				(12	1,150)				*(1.69)		* approximately 2 km2		

Remarks:

*1 TBZ: Trabzon
EZN: Erzincan
EZR: Erzurum
TOR: Tortum

*2 A (1st order)
↓
G (7th order)

*3
ext.	extension
Str-ext.	extension to the strike-side
Dip-ext.	extension to the dip-side
N-ext.	extension toward north
Dis-f.	dislocation by fault must be considered

*4 Coordinates of drilling-site, and area for geological survey are shown.

*5 size of trenching (using buldozer)

extension × width × depth = volume

10 m × 2.5 m × 1 m or 2 m = 25 m^3 or 50 m^3

*6 Depth of the orebody in drill-hole from the outcrop or the trench is shown as - x meter level (ML)

*7 planned ◎
expected ○

8 Extension of known orebody = $\frac{\text{total length of the unit orebody}}{\text{extension of the ore zone}} \times 100$ (: uncertain)

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APPENDICES

Initial letters used for sample numbers trench, and gallery numbers are shown as follows :

T :	indicates the trench and pit	
G :	indicates the gallery	
S :	indicates the outcrop where sketch is made.	
A :	collected or surveyed by	Hajime TAKAHASHI
B :	"	Shigehisa FUJIWARA
C :	"	Kazuyoshi MASUBUCHI
D :	"	Kazuyasu SUGAWARA
M :	"	Mahir İZMİR
X :	"	İbrahim KOÇ
Y :	"	Nejdet YURDUSEV
Z :	"	Sadık AÇAN

APPENDIX 1

Photographs

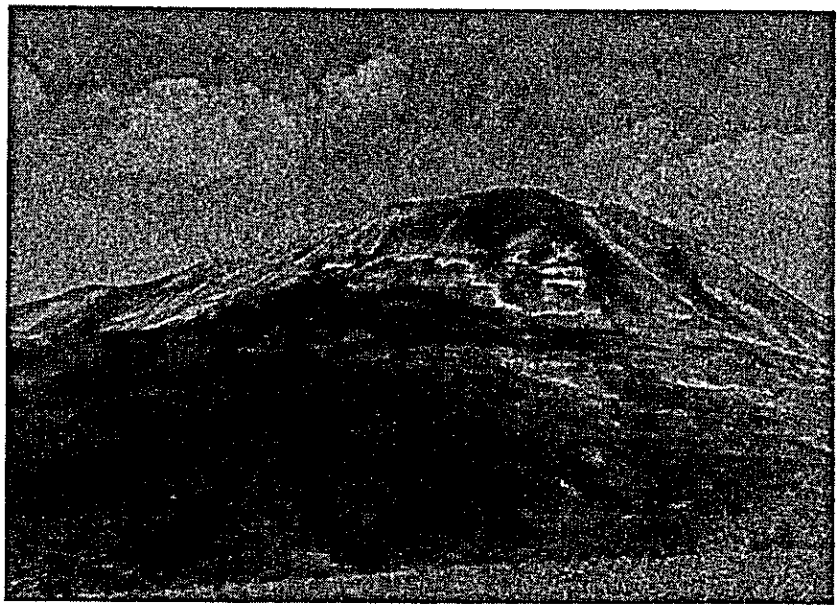

Photo No. :	1
Date :	24/8/1978
Map No. and location :	Tortum H-45, d4, No. 4., Kurugöl T., Aşkale, Erzurum
Explanation :	View of Kopdağ. It is 2,918 m high and composed of limestone of Tertiary (Tkçt).
Remarks :	Kopdağ itself is situated out of the survey area.

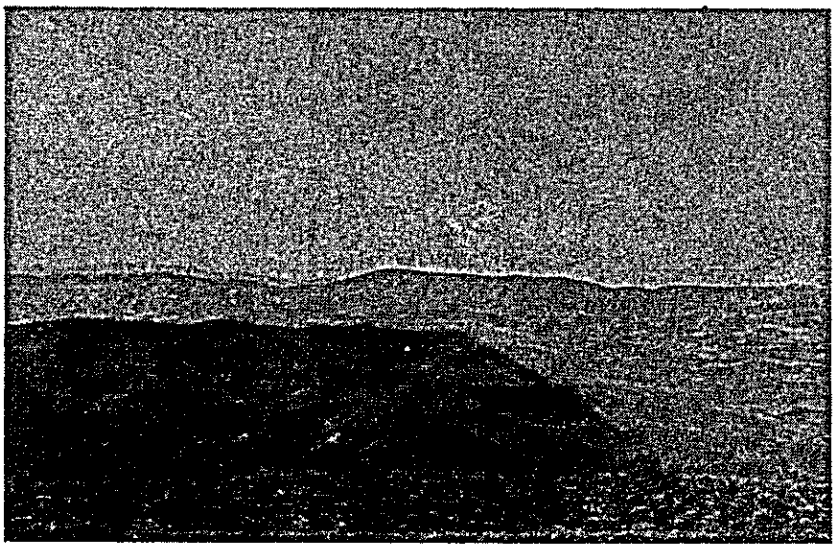

Photo No. :	2
Date :	9/8/1978
Map No. and location :	Erzincan, i-44, a2, No. 4, Karakuş T., Doluhacı komu, Tercan, Erzurum
Explanation :	View of Hihodağ. It is 1724 m high and composed of old terrace sediments (PQ), showing very gentle trend.

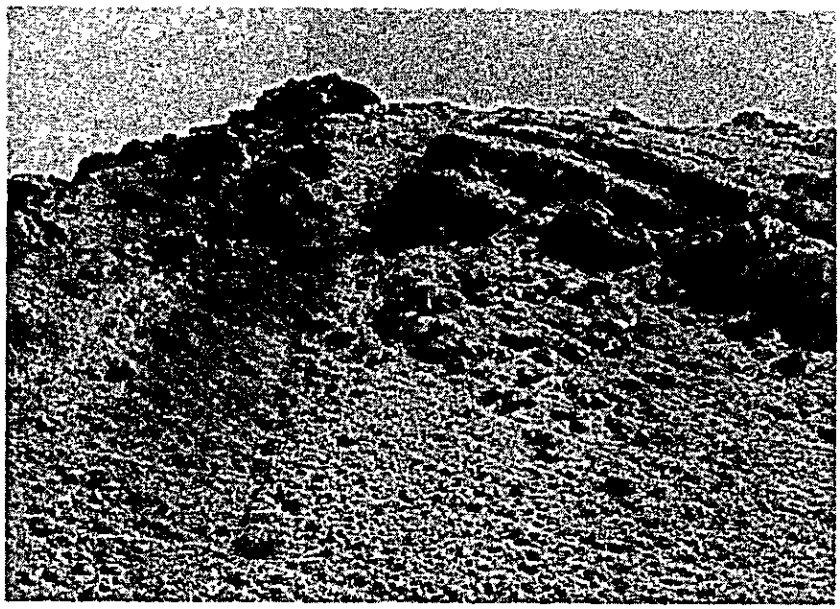

Photo No. : 3
Date : 9/8/1978
Map No. and location : Erzincan i-44, a2, No.4, Doluhacıkomu, Tercan, Erzurum
Explanation : Fault contact of harzburgite (left) with Kopdağ limestone (right). The latter covers the former unconformably.

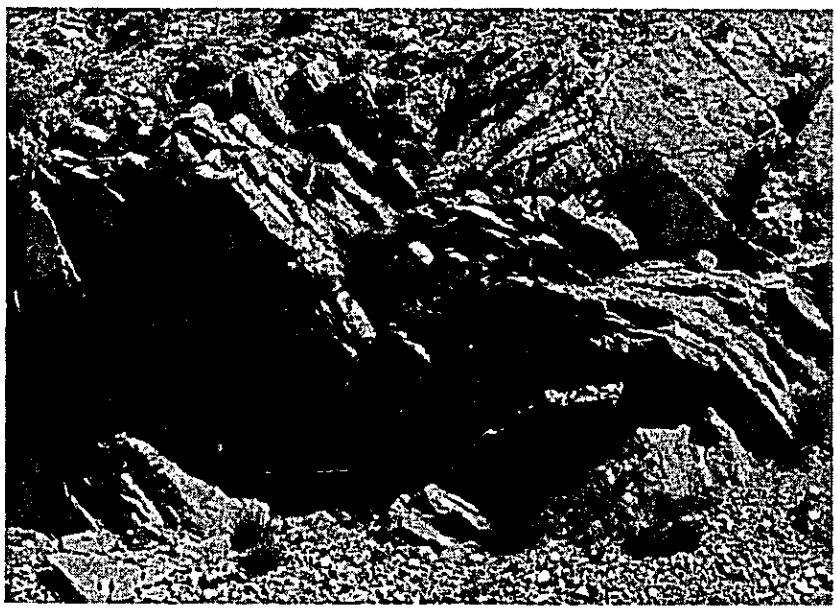

Photo No. : 4
Date : 24/8/1978
Map No. and Location : Tortum H-45, d4, No.4, Akdağ, Gülabikomu, Aşkale, Erzurum
Explanation : Meyramdağ limestone folds near the boundary with ultrabasic intrusive rocks.

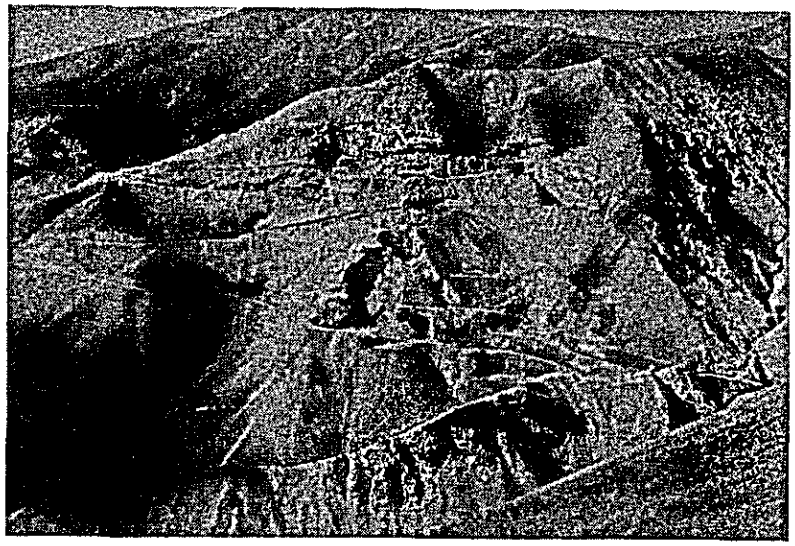

Photo No. : 5
Date : 18/7/1978
Map No. and location : Erzincan, i-44, b1, No.1, Ezan, Sıçankale Y., Aşkale, Erzurum
Explanation : B Kafa (upper) and C Kafa (lower) open cuts at Ezan mine.

Photo No. : 6
Date : 25/7/1978
Map No. and location : Trabzon, H-44, c3, No.4, Coşan, Kop, Bayburt, Gümüşhane
Explanation : Panoramic view of Coşan mine (from the north)
TC-30 open cut (upper) and wastes of GD-1 gallery (lower) are shown.