PART I

GENERALITIES

Chapter 1 Introduction

1-1 Antecedents of the Survey

The subject survey of mineral resources in the Kokpetinskaya Area of the Republic of Kazakhstan is executed by the Japanese Government to comply with the request of the Kazakh Government, in conformity to the Scope of Work agreed to between the two governments on June 6, 2000.

The survey is intended to investigate geology and ilmenite placer deposits located in the Kokpetinskaya area (Fig. I-1), thereby assisting development of the mineral industry of the host nation. It is also aimed to promote technology transfer to the host country's organizations concerned, through the collaborative surveys.

The Republic of Kazakhstan is known for her rich underground resources and ranks among the world's top nations in terms of some metallic mineral reserves. The Kazakh metal industry has made remarkable growth in recent years in the production of gold, titanium sponge, zinc and copper, activated by the investment from overseas accompanied by technology transfer and renovated management systems. The growth rate of the Kazak nonferrous metal industry reached 12 % in 1997. The country ranks fourth in the production of titanium and sixth in magnesium metal as by-product. Further growth of the industry is expected inasmuch as a number of promising ore deposits are known to exist within the country.

The potential ore reserves of titanium in the survey area have been considered promising. It is expected that, in case economically minable ore reserves are confirmed, the commercialization is relatively easy because a large metallurgical kombinat for titanium has been established in the area. Kazakhstan has been striving for development of the industry that contributes to the acquisition of foreign currencies. The subject survey has been requested for, under these circumstances.

1-2 Outline of the Phase I Survey

1-2-1 Survey area

The Kokpetinskaya area is located in the Kokpetinskiy District of the East Kazakhstan Region, some 750 km northeast of Almaty, the ex-capital city of the Republic, and some 150km south of Ust-Kamenogorsk, the regional capital. (Fig. I-1)

The topography of the survey area is mostly flatlands with little inclination at an approximate altitude of 500 m, where farmlands mainly of wheat and sunflowers spread out. The flatlands are traversed by paved roads and partially by unpaved roads.

1-2-2 Contents of the survey

During Phase I, study and analysis of existing data and geological survey of the subject area that covers 2,700 km^2 were carried out, as well as drilling survey at 17 boreholes totaling 655.0m at two -- the southern flank of Bektemir Placer No.1 and No. 3 -- within the survey area.

1) Analysis of existing data

(1) Purpose

It was intended to make a comprehensive analysis of existing data, referring to geologic maps, tectonic maps and geologic report elaborated by the host nation's organizations through geological and other surveys, with a view to outlining the ore deposits, ore manifestations and their occurrence in the Kokpetinskaya area, for systematic apprehension of data and information necessary for providing guidelines for the succeeding years' survey.

(2) Place of data analysis

The analytical work was conducted in Japan.

2) Geological survey

(1) Purpose

General geological survey was carried out in order to grasp the geology and geologic structure of the survey area and, especially, to ascertain occurrence of Tertiary formations in which ore deposits are embedded and also to make inference of old buried valleys and their hinterlands.

Drilling survey was also conducted to clarify the relationship of the geology and geologic structure with occurrence of ore deposits in the Kokpetinskaya area. It was intended to apprehend occurrence o f ilmenite deposits mainly at the Bektemir district, where occurrence of ore deposits is highly probable in the light of existing data. Based upon the survey findings, sizes and economic viability of ore deposits in the subject area are outlined.

(2) General geological survey

General geological survey was implemented over the whole area of the Kokpetinskaya area (2,700 km^2) in the quantities indicated below.

Table I-1-1 Outline of the Survey (1)

Items	Quantity
Geological survey	General geological survey (whole area) Area ; 2,700 km^2 Length of route ; 72 km Drilling core survey (Table I-1-1(2)) Length of core ; 655 m (17 holes)

For field survey, 1:50,000-scale route maps were prepared by enlarging 1:100,000-scale topographic maps. The survey findings are consolidated in the geologic maps at a scale of 1:100,000. The results of drilling core survey are shown in the geologic columns while the drilling results are in the geologic cross sections by survey line.

Simultaneously with the general geological survey and the drilling core survey, laboratory tests were carried out in the quantities indicated in Appendix 2-1, the results of which were utilized for the analysis.

3) Drilling survey

(1) Purpose

Drilling survey was implemented at the Bektemir district with the aim of seizing ore bodies and grasping their occurrence in the southern flanks of the already known Bektemir Placer No1 and No.3.

(2) Drilling locations and quantities

The drilling was implemented at the locations indicated in Fig. II-3-1. Quantities of the drilling are shown below.

Table Ⅰ-1-1 Outline of the Survey (2)

District	Hole No.	Direction	Dip	Length
Southern flank of Bektemir Placer No.1 (500 m x 200 m grid)	MJBK-1	–	-90°	32.0 m
	MJBK-2	–	-90°	44.0 m
	MJBK-3	–	-90°	41.0 m
	MJBK-4	–	-90°	36.0 m
	MJBK-5	–	-90°	37.0 m
	MJBK-6	–	-90°	30.0 m
	MJBK-7	–	-90°	43.0 m
	MJBK-8	–	-90°	43.0 m
	MJBK-9	–	-90°	42.0 m
	MJBK-10	–	-90°	36.0 m
	MJBK-16	–	-90°	41.0 m
	MJBK-17	–	-90°	46.0 m
Sub-total	12 holes			471.0 m
Southern flank of Bektemir Placer No.3 (200 m interval)	MJBK-11	–	-90°	37.0 m
	MJBK-12	–	-90°	41.5 m
	MJBK-13	–	-90°	39.0 m
	MJBK-14	–	-90°	32.0 m
	MJBK-15	–	-90°	34.5 m
Sub-total	5 holes			184.0 m
Total	17 holes			655.0 m

(3) Drilling work

The drilling work was undertaken by "Geoincenter", a local drilling contractor. After core identification and photographing, various types of sampling in the quantities indicated in Appendix 2-1 were done for laboratory testing. The results of core identification are incorporated in 1:200-scale geologic columns.

1-2-3 Organization of survey team

The participants in the planning, negotiation and field survey were as follows.

1) Planning and negotiation

Japan		Kazakhstan	
Name	Entity	Name	Entity
Toshio Sakasegawa (Leader)	MMAJ	M. Saiduakasv	C.G.U.R.P
Masayuki Chiba (Supervision)	JICA	A. M.Zhylkaidarov	C.G.U.R.P
Keita Kouda (Geology)	MMAJ	S. B. Berikbolov	C.G.U.R.P
Kouji Yasuda (Mining Environment)	MMAJ		

2) Survey team

Japan		Kazakhstan	
Name	Entity	Name	Entity
Katsuji Fukumoto (Leader)	MINDECO	M. Saiduakasv (Coordinator)	C.G.U.R.P.
Yoshiaki Ishizuka (Drilling engineer)	MINDECO	A. M. Zhylkaidarov(Coordinator)	C.G.U.R.P.
Nobuhiko Yamamoto (Drilling engineer)	MINDECO	S. B. Berikbolov (Coordinator)	C.G.U.R.P.
		A. A.Malygin (Coordinator)	VOSTKAZNEDRA
		E. M. Selifonov Coordinator)	GEOINCENTER
		I. E. Selifonov (Coordinator)	GEOINCENTER
		E. G. Maksimov (Geology)	GEOINCENTER
		V. Y. Pashov (Geology)	GEOINCENTER

3) Supervision of local work

Hiroyoshi Okishima	MMAJ	August 31st, 2000 to September 2nd, 2000 September 24th, 2000 to September 27th, 2000
Tadashi Ito	MMAJ	September 21st, 2000 to September 30th, 2000
Kazuo Masuda	MMAJ	September 21st, 2000 to October 7th, 2000
Hiroyuki Katayama	MMAJ	September 21st, 2000 to October 7th, 2000

C.G.U.R.P.; Committee of Geology and Underground Resources Protection,
The Ministry of Energy and Mineral Resources (the former Ministry of

Natural Resources and Environmental Protection) of the Republic of Kazakhstan

VOSTKAZNEDRA; East Kazakhstan Territorial Department of Protection and Using Natural Resources

JICA; Japan International Cooperation Agency

MMAJ; Metal Mining Agency of Japan

MINDECO; Mitsui Mineral Development Engineering Co., LTD.

1-2-4 Period of the survey

Item	2000						2001		
	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Period
Planning and Preparation		17 — 22							Aug.17th ~ Aug.22th
Field Survey		23 —	—	— 16					Aug.23th ~ Oct.16th
Test and Analysis			26 —	—	—	—	— 18		Sept.26th ~ Jan.18th
Compilation of Report				17 —	—	—	— 31		Oct.17th ~ Jan.31st

Chapter 2 Geography of the Survey Area

2-1 Location and Access

The Kokpetinskaya area, which covers an area of 2,700 km^2, is situated in the Kokpetinskiy District of the East Kazakhstan Region (Fig. I-1, 2).

Table I -2-1 Geographic Coordinates of the Kokpetinskaya Area

Angular points of Area's contour	Coordinates	
	Northern latitude	Eastern longitude
1	48°46'51"	82°21'33"
2	49°07'22"	82°33'15"
3	48°54'37"	83°26'21"
4	48°34'07"	83°14'48"

Major population centers in the area are the Kokpekty village in the southwest and the Samarskaya village in the northeast. In the vicinity of the known ore deposits, there are villages such as Beloe and Koitas.

The Kokpekty village, the seat of the local administration center, is situated near the southwest boundary of the survey area and connected with the Ust-Kamenogorsk, the regional capital, by the Kokpekty - Samarskaya - Ust-Kamenogorsk highway and the Kokpekty - Georgievka - Ust-Kamenogorsk highway. These highways are passable all the year round except temporary closures in wintertime due to snowstorms and snowslides in the mountains. Many small villages in the area are connected by roadway networks.

Between May and October, steamer service is available from the pier of the Bukhtarma (Zaisan) reservoir, 6 km from Kaznakovka, up to the Bukhtarma station, Ust-Kamenogorsk.

The nearest railway station is Ognevka, about 100km north of the Bektemir deposit area.

2-2 Topography and Drainage System

1) Topography

Topographically, the survey area can be divided into three zones -- the southern piedmont zone of the Kalbinskiy Range, the small hill zone transitive from the range to the basin, and the northwestern peripheries of the Zaisanskaya Basin.

The southern piedmont zone of the Kalbinskiy Range lies in a mountainous area in the north of the survey area, where rocks are exposed on the ridges. The altitude of the ridges is 1,200 m to 1,400 m and 750 m to 800 m at the valley bottoms.

The transitive small-hill zone in between the Range and the Basin lies along the mid-stream of the rivers such as the Mal. Bukon, the Bol. Bukon and the Kuludzhun. The altitude is 960 m to 970 m on the ridges while 550 m to 600 m in the vicinity of the Podgornoye, Beloe and Marinogorka villages.

The northwestern peripheries of the Zaisanskaya Basin are flatlands south of the Podgornoye, Beloe, Marinogorka and Moskovka villages, where the Preobrazhenskiy and Karaotkelskiy intrusive rock bodies are exposed in the Quaternary, as well as the Carboniferous weathering monadnocks subjected to contact metamorphism. The altitude is 650 m on the northwestern hills while 450 m to 480 m in the southern flatlands, which include the drilling sites in the southern flank of Bektemir Placer No.1 and No.3.

2) Drainage system

The drainage system in the area is situated at the left bank side of the Irtysh river, the present Zaisan reservoir. In the survey area, the rivers rising from the Kalbinskiy range, such as the Mal. Bukon, the Bol. Bukon and the Khuldzhun, flow southward and change the direction eastward at the swampy zone in the lower reaches of the Tentek-Bol. Bukon rivers.

The rivers in the mountain and piedmont zones are swollen between April and June. In the lower reaches, the flooding season falls on April to May. From June onward, the surface water is exhausted. The rivers are frozen between the end of November and the end of December, and thaw in April.

2-3 Climate, Fauna and Flora

1) Climate

The area's climate is a mixture of the Mongolian-type continental climate, the Central Asian steppe to semi-desert climate and the West Siberian-type continental climate, characterized by the drastic fluctuations of atmospheric temperature in a day and a year and between seasons, and also by the low humidity. Main climatic data are given in Table I-2-2.

In wintertime, weather is mostly fine. January is the coldest month, when the minimum temperature falls to –36℃ to –45℃. Snowfall begins around October 20th and intensifies in November. The surface soil is frozen up to 1.5 m deep and covered with snow of 0.9 m to 1.1 m thick. Snow stays for 150 to 160 days in a year. In winter, the northerly and easterly winds at the velocity of 4 to 7 m/sec are frequent. Snowstorms rise as frequently as 3 to 15 times a month (10 days a month on average). Snow begins to thaw from the end of March to the beginning of April.

The weather in summertime is mostly fine. The atmospheric temperature sharply fluctuates in a day. Temperature in June, the hottest month, is from 35℃ to 42℃. Precipitation during summer accounts for 30% to 40% of the annual total. Rainfalls are mostly heavy and accompanied by thunder, although flood disasters are rare. The dry season from spring to summer lasts for a month or two. An adequate time for field work is April to mid-October.

2) Fauna and flora

(1) Flora

The area has varieties of flora. Besides the natural vegetation, there are cultivated lands, afforested lands, grasslands and meadows.

On the mountainside and in the gorges of the Kablinskiy range, shrubs such as dog roses, honeysuckles and hawthorns form thickets. Bushes of willows, bird cherry trees, dog roses, snow-ball tree and currant grow in the riverside zones. Along rivers and streams in the small hill zones, thickets of hops and blackberries flourish, where floodplains are utilized as farmlands.

Along the rivers at the northwestern end of the Zaisanskaya basin, there are many bushes of sedge and rush, swampy lands and farmlands.

(2) Fauna

The mountain and hill zones are inhabited by black grouses, hazel grouses, partridges, wild pigeons, foxes, wolves and snakes. At the Kalbinskiy ridge in the north of the area, kabarga-antelopes, wild pigs, steppe bustards, jerboas and other indigenous animals are protected.

Table I -2-2 Climatic Features of the Kokpetinskaya Area

Month	1	2	3	4	5	6	7	8	9	10	11	12	Total	Average
Temperature (℃)	-17,9	-15,4	+9,9	+4,9	+13,4	+19	+21,4	+19,8	+19,1	+4,9	-7,2	-15,6		+3,04
Precipitation (mm)	27	20	30	33	45	47	42	46	19	12	15	23	359	-
Evaporation from the surface (mm)	-	-	-	60	98	99	96	90	70	51	-	-	564	-
Average number of days with unfavorable conditions; Strong wind (≧15 m/sec)	-	-	-	0,8	1,5	1,3	1,0	1,4	1,0	-	-	-	7.0	-
Ditto; Dust storms	-	-	-	0,5	2,1	2,7	3,3	3,2	2,3	-	-	-	14.1	-

Chapter 3 Existing Geological Data on the Survey Area

3-1 Outline of Past Surveys

1) Geological survey

In 1952, G.I. Sokratov conducted geological survey at a scale of 1:200,000 based on the topographic maps M-44-X X IX, publishing the geologic maps in 1964 and the explanatory notes in 1965 (Fig.II-1-1).

From 1956 to 1958, B. F. Baranov, N. I. Bykova and M. A. Murakhovskiy carried out geological survey at a scale of 1:200,000 based on the maps M-44-XXX, and published the geologic maps in 1963.

In 1961, N. N. Popova and E. Popov elaborated a 1:200,000 geologic maps M-44-X X IX and the explanatory notes.

From 1964 to 1968, the Altai Geological and Geophysical Survey Party carried out magnetic and electrical surveys at a scale of 1:50 000, but failed to extract a promising ore deposit

2) Exploration of ore deposits

Since the 1960's to date, exploration of gold and coal deposits and titanium placers have been carried out intermittently.

(1) Gold

From 1973 to 1975, K. S. Akhmetov of the Altayzoloto was engaged in preliminary evaluation of the Kalby gold deposit in an area that includes the Kokpetinskaya area. Many of the quartz veins accompanied by gold and sulfide minerals, exploited from the second half of the 19th Century to the first half of the 20th Century, were judged to have certain potentials.

Recently, the Altai branch of the Institute of Geological Sciences recommended for implementation of geological exploration works.

(2) Coal

In 1951, V. G. Sagunov explored coal deposits in the Kokpetinskaya area, to seize small coal reserves of the $B+C_1+C_2$ categories amounting to 88,000 t.

Between 1965 and 1967, the Party of Non-Ore Raw Materials implemented coal drilling, ascertaining coal strata in the Upper Formation of the Kokpetinskaya Formation, although no promising potentialities were acquired.

So far, concentration of coal strata in the Upper Kokpetinskaya Formation has been unknown.

(3) Titanium

From 1965 to 1967, the Party of Non-Ore Raw Materials implemented drilling aimed at coal, which resulted in the discovery of the Karaotkel deposit of ilmenite and zircon.

In 1972, the initial prospecting was carried out by the party.

Between 1983 and 1989, revaluation of ore reserves including feldspar and quartz was effected by the State Institute of Rare Metals (GIREMET). In 1990, the revaluated ore reserves were approved by the State Committee of Reserves.

However, development of the Karaotkel deposit had to be suspended owing to the insufficient demand for feldspar, shortage of funds for complicated treatment processes of the placer, and insufficient interest on the part of the Titanium-Magnesium Kombinat (TMK).

From 1988 to 1992, the Altai Geological Expedition conducted geochemical and geophysical prospecting at a scale of 1:50,000 in the Karaotkel deposit area and discovered the Bektemir ilmenite deposit in 1989. From 1990 to 1995, the same Party conducted exploration and evaluation in the Preobrazhenskiy intrusive, complex rock body area. As the result of these surveys, three ilmenite deposits -- the Placer Nos.1, 2 and 3-- were confirmed around the Preobrazhenskiy intrusive, complex rock body.

From 1997 to 1998, the Geoincenter, a consulting company, conducted technical and economic evaluation of the Placer No.1, with the funds provided by the TMK. The State Committee of Reserves approved the ore reserves of the C_2 category of 9,269,000 m^3 and the ilmenite reserves of 1,634,000 t averaging 176.3 kg/m^3.

From 1998 to 1999, the Geoincenter executed, with the TMK's funds, detailed exploration of the Placer No.1. The ore reserves of the category B, C_1 and C_2 of 11,958,000 kg/m^3 and the ilmentite reserves of 1,815,000 t averaging 151.78 kg/m^3 were approved by the State Committee of Reserves.

Also in 1999, the UNIDO implemented a feasibility study on Ilmenite Concentrate Plant Project for the Bektemir placer.

3-2 General Geology and Geologic Structure

The survey area is underlain by the following geologic units. (PL.II-2-1 and Figs.I-3-1 and -2)

1) Paleozoic Basement rocks

(1) Lower Carboniferous Arkalyk Formation:

The Formation is composed of sedimentary rocks, pyroclastic rocks and limestones.

(2) Lower Carboniferous Kokpekti Formation:

The Formation is composed of sedimentary rocks, pyroclastic rocks and limestones.

(3) Middle Carboniferous Bukon Formation

The lower part of the Formation is composed of conglomerates, sandstones and shale, whereas the upper part comprises shale, coaly shale and, rarely, sandstones and tuffaceous sandstones.

(4) Middle to Upper Carboniferous Maityab Formation

The Formation is composed of effusive rocks such as andesitic porphyrite and andesite which intercalate thin beds of tuff and tuffaceous sandstone, and rarely basaltic and diabasic porphyrite.

2) Upper Cretaceous weathering crusts

The Cretaceous weathering crusts develop over the Upper Carboniferous sedimentary, volcanic rocks and intrusive, complex rock bodies and are intensively argillized (kaolinite, montmorillonite and illite).

3) Cenozoic

The Cenozoic System consists of the Neogene and Quaternary rocks.

(1) Neogene Aral Formation:

The Formation is composed of clay, sandy clay, sand and loam, rarely including pebbles. The Formation is the horizon in which ilmenite placers occur.

(2) Quaternary

The Quaternary System consists of sand-gravel-pebble in the lower part and loam, clay, aeolian sand in the middle to upper part and recent stream sediments on the top.

4) Igneous rocks

The Preobrazhenskiy and the Karaotkelskiy intrusive, complex rock bodies and dikes are present.

(1) Preobrazhenskiy and Karaotkelskiy rock bodies

These intrusive, complex rock bodies can be classified by the intrusion time and rock facies, as follows:

a. Maksutskiy intrusive, complex rock body (Upper Permian to Lower Triassic): gabbro, diorite and monzonite
b. Saikanskiy intrusive, complex rock body (Middle to Upper Triassic): syenite, diorite and granosyenite
c. Delbegeteyskiy intrusive, complex rock body (Lower to Middle Jurassic) : granite and granosyenite

(2) Dikes: Granite porphyry, syenite porphyry, granodiorite, quartz porphyry and aplite intrude into the Paleozoic rocks.

5) Geologic structure

The Kokpetinskaya area is situated in the zone of the Kazakhstani continent colliding with the old Gorny Altai continent. The collision took place at the last stage of the Hercynian movement along the Gornostayevsko-Charsko-Zimunayskaya fracture zone, which stretches in the N-W direction over 800 km in extension and 10-15 km to 70 km in width. The Baladzhalskiy fault in the WNW-ESE direction, traversing the north of the survey area, constitutes an integral part of the mentioned fracture zone (Fig. I-4-1, 2).

The Hercynian fracture zone has complex structure, where mélange consisting of formations of different times, overlapped by folds, faults and thrust faults, crop out in belt, lens and block forms. The mélange is composed of Silurian to Visean (Lower Carboniferous) limestone, aplite, diabase, andesite, quartzite, mudstone, etc.

After folding and erosion of the Upper Visean, molasse was formed, to which corresponding are the Middle to Upper Carboniferous, marine and continental Kokpekti Formation, the continental Bukon Formation and Maityab Formation. The thickness of the molasse reaches 8 km.

The Baladzhalskiy fault is considered to be a passage of molten magma. The intrusions of the Preobrazhenskiy and Karaotkelskiy rock bodies are considered to be related with the fracture zone.

The Bèktemirskiy and Espinskiy faults in the NE-SW direction are interpreted to be either lateral faults or faults with little dislocations.

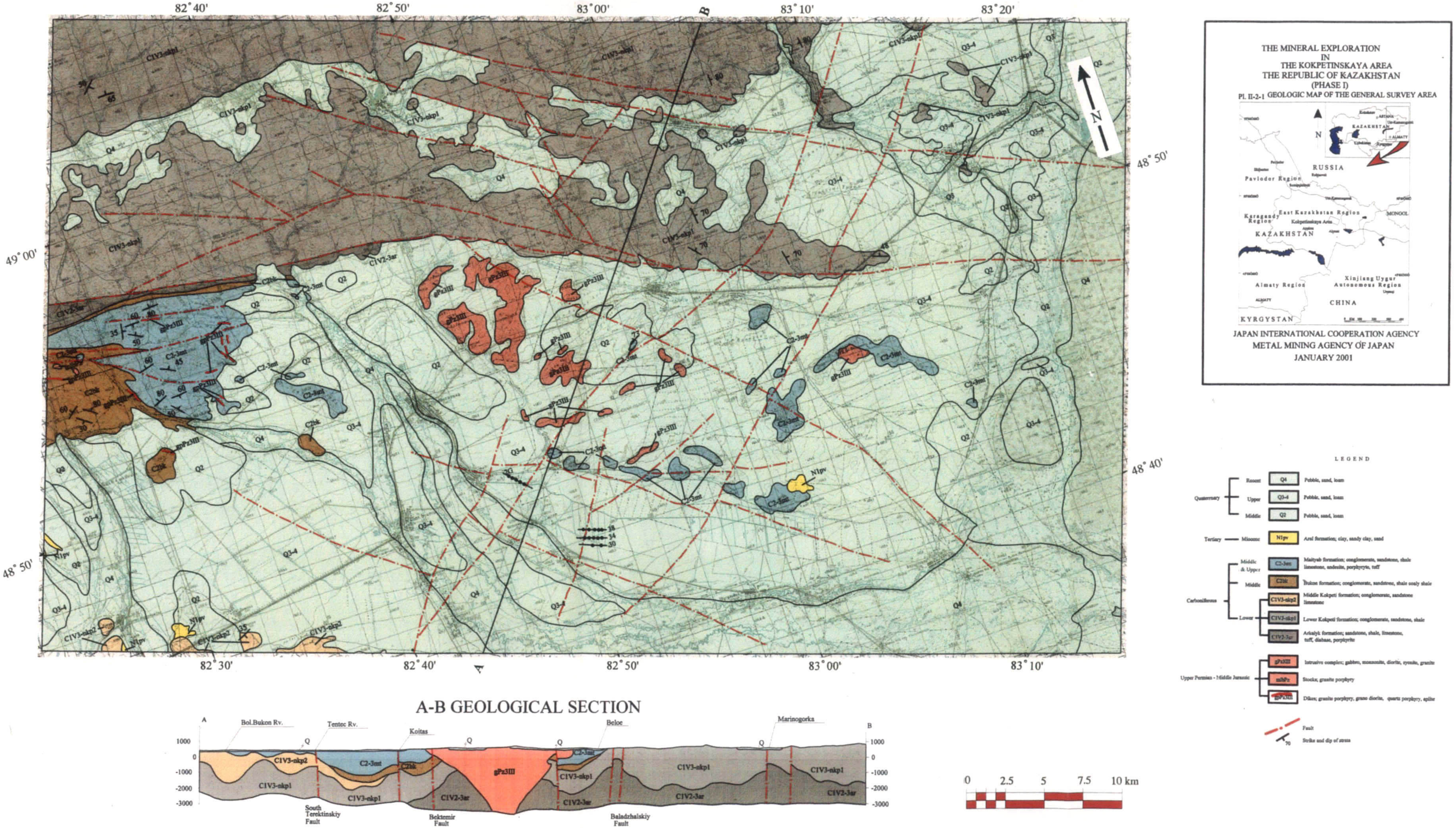
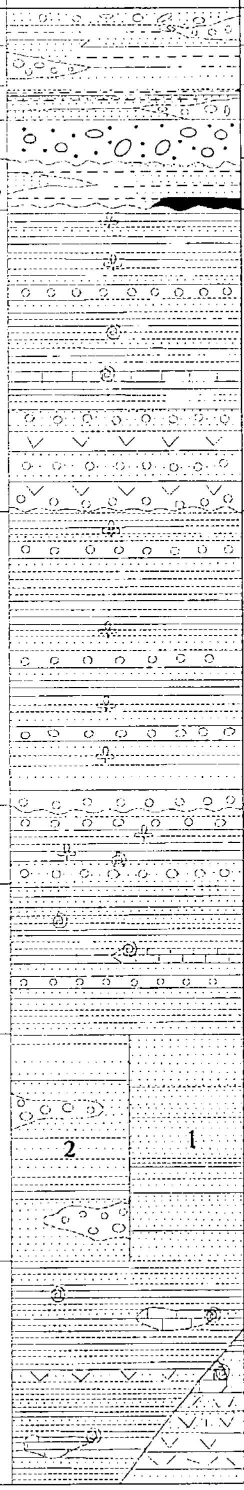


Fig. I-3-1 Geological Map of the Kokpetinskaya Area



System	Series	Stage	Mark	Geologic column	Thickness	Characteristics of rock
Quaternary	Recent		Q_4		0-5	Pebble, sand, sandy loam, loam and clay with rock fragments
	Upper		Q_{3-4}		0-15	Pebble, sand, sandy loam, loam and clay with rock fragments
	Middle		Q_2		0-10	Pebble, sand, clay, loam and sandy loam
	Lower		Q_1		0-10	Sand, pebble and gravel
Neogene	Miocene		$N_1^{2-3}pv$		0-20	Aral formation; clay, sandy clay and sand with ilmenite placer
Carboniferous	Middle and Upper		$C_{2-3}mt$		1500-2000	Maityab formation; Conglomerate, sandstone, siltstone, shale, limestone, andesite, porphyrite and tuff, with flora and fauna
	Middle		C_2bk		1500-2000	Bukon formation; Conglomerate, arkose sandstone, sandstone, siltstone, shale, coaly shale and coal with flora
	Lower	Visean and Namur	C_1V_3-nkp_3		300-500	Upper Kokpekti formation; Conglomerate, greywacke sandstone, siltstone, shale and coal with flora and fauna
			C_1V_3-nkp_2		1000	Middle Kokpekti formation; Tuffaceous conglomerate, sandstone, siltstone, shale and limestone with fauna
			C_1V_3-nkp_1		1500	Lower Kokpekti formation; 1. North east zone-Tuffaceous sandstone, siltstone and shale 2. South west zone- Conglomerate, tuffaceous sandstone, siltstone, and shale with flora and fauna
		Visean	$C_1V_{2-3}ar$		1500 1000	Arkalyk formation; 1. North east zone- Sandstone, siltstone, shale, limestone, tuff, diabase, porphyrite, felsite 2. South west zone- Shale, siltstone, sandstone, tuff, limestone with fauna

Fig. I-3-2 Schematic Geologic Column of the Kokpetinskaya Area

Chapter 4 Overall Review of the Survey Findings

4-1 Relationship of Geology and Geologic Structure with Mineralization

The placer deposit area lies to the northwest of the Zaisan basin and is situated in the East Zharminskiy synclinorium zone. The zone, bounded in the north by the WNW-ESE Baladzhalskiy fault, adjoins the West Kalbinskiy synclinorium zone (Fig. I-4-1). The Baladzhalskiy fault constitutes an integral part of the Gornostayevsko – Charsko - Zimunayskaya fracture zone which extends over 800 km in extension and 10-15 km to 70 km in width. The initial fracture occurred at the time of tectonic movements that started in Later Carboniferous to Permian time and presumably continued during the Paleogene time, as well.

In the survey area, the Maytuibinskaya graben-syncline, the Terektinskaya graben-syncline and the intermediate Bektemirskaya horst-anticline, in the WNW-ESE direction, were formed. (Fig.I-4-1)

The Baladzhalskiy fault is inferred to be a passage of molten magma, and the Preobrazhenskiy and Karaotkelskiy intrusive, complex rock bodies presumably intruded along the Bektemirskaya horst-anticline. The Bektemirskaya horst-anticline was completed with the intrusion of these intrusive, complex rock bodies and came to be the source of detritus that flowed into surrounding recesses -- the Maytubinskaya and Terektinskaya graben-synclines -- since then till the Quaternary time.

Presumably, the structure formed by the displacement of the faults with the WNW-ESE trend, such as the Baladzhalskiy fault and the South Terektinskaya fault, determined the place of denudation and sedimentation, thus play ing the important role in forming the placers.

The Bektemirskiy and Espinskiy faults, both in the NE-SW direction, are considered to be either lateral faults or faults with little dislocations, where valleys were formed by denudation along the fracture zones of the faults in and after the Paleocene time. It is inferred that, in the Cenozoic time, these old valleys were submerged as the old Lake Zaisan expanded, where the Aral Formation including ilmenite-zircon ore sand deposited.

4-2 Characteristics of Mineralization

4-2-1 Bektemir Placer

The Bektemir and Karaotkel placer deposits are known to exist in the Survey area. So far, the three placers -- the Placer Nos.1 to 3 -- exist at the Bektemir deposit. (Fig.I-4-2 and Table I-4-1)

1) No.1 ore body

(1) Location

The placer is located to the south of the Preobrazhenskiy intrusive, complex rock body.

(2) Form

The Placer No.1 is a placer depositing in the old valleys, consisting of the main stream in the NE-SW direction and a branch on the right bank side.

Extension of the already explored ore body is 5,250 m, while its maximum width is 650 m in the south and 150 m to 250 m in the north. The ore bodies are 1.1 m to 11 m thick.

The riverbed inclination is 10-12 m/km upstream, and 3-4 m/km downstream. The riverbed is composed of clay of weathering crusts or weathered Paleozoic rocks. The riverbed is gently undulated; at intersections of valleys with faults, elongated depressions are frequently observed. The both slopes of old valleys are gently inclined toward the center line.

(3) Rock facies

The ore body is embedded in sand and blueish sandy clay of the Aral Formation. Type of soil of the Aral Formation, characterized by the high clay contents, can be classified as follows.

Types of sediment	Clay contents
a. argillized sand	65% or less
b. argillaceous sand	65% to 75%
c. sandy clay	75% to 95%
d. clay	95% or more

The sediments indicate clear grading, as the grain size of sand generally increases downward while the clay content decreases. The base of the grading is composed of fine-grained sand and poorly sorted sand; and, in the lower part, a clay layer that served as old riverbed is existent.

(4) Mineralization

In the sandy beds of the ore body, there are ilmenite sand beds in thin layers or in lens forms. Repetition up to four grades is confirmed in the ore body; the number decreases toward the both slopes of the old buried valleys.

The Phase I analysis of the grain size distribution of ilmenite revealed that 92% to 98% falls within the range between -0.315 mm and +0.040 mm.

Chemical analysis of the ilmenite and the international trade standards are shown below.

Element	TiO_2 (%)	FeO (%)	SiO_2 (%)	P_2O_5 (%)	Cr_2O_3 (%)	V_2O_5 (%)
Assay result	53.4～58.7	15.1～26.7	1.7～3.5	0.01～0.03	0.02～0.03	0.14～0.21
International Trading Standard	≧54	28～32	≦1.5	≦0.05	≦0.05	≦0.1

As seen in the Table, some of the assay values do not satisfy the world's trade standard specifications; therefore, it would be difficult for the ilmenite to be internationally traded, but it meets the first class standards of Kazakhstan (TU-48-4-236-72) and seems to fit for production of titanium sponge and titanium white.

In the already explored area in the north of the Placer, the thickness of the ore body is 1.1 m to 11.0 m, averaging 5.4 m, while that of the overburden is 7.5 m to 31.0 m, averaging 18.7 m. The ilmenite contents at the ore body portions intersected by drilling are 94.6 to 279.55 kg/m^3, averaging 151.78 kg/m^3. (Table I-4-1)

In the Phase I survey area in the south of the Placer, the ore body is 2.1 m to 8.9 m thick, averaging 5.51m, while the overburden is 24.0 m to 36.0 m thick, averaging 29.6 m. The ilmenite contents at the ore body portions intersected by drillin g are 105.41-201.10 kg/m^3, averaging 123.95 kg/m^3. Zircon contents are as low as 0.5-3.4 kg/m^3. Very small quantities of rutile and leucoxene have also been confirmed.

There is a tendency that the ore body increases in width and volume southward, whereas the grade of ore sand declines and the overburden volume increases.

As the result of ore reserves estimation, the ore reserves of the C_2 category additionally acquired by the Phase I exploration are as follows:

Cutoff criteria: 70 kg/m^3 or more on the hanging wall side and 100 kg/m^3 or more on the footwall side; or,
2.0m x 100 kg/m^3 or more, whichever be greater.

Ore reserves: 5 million kg/m^3

Ilmenite content: 620,000 t

Ilmenite average grade: 124 kg/m^3

Stripping ratio: 5.38 m^3/m^3

In view of the above ilmenite contents and the stripping ratio, the ore body is economically exploitable by open-pit mining, under the Kazakh standards (ex-C.C.C.P. standard).

Table I -4-2 Ilmenite Content and Maximum Economical Stripping Ratio

Average content of ilmenite (kg/m^3)	Maximum economical stripping ratio (m^3/m^3)
100	2.58
110	3.90
120	5.21
124	**5.75**
130	6.56
140	7.87
150	9.21

2) Placer No.2

(1) Location

The ore body is located to the northeast of the Preobrazhenskiy intrusive, complex rock body.

(2) Form

The Placer No.2, a placer depositing in the old valleys, consists of the two branches of a old buried valley which join at around the Beloe village.

The first branch is in the SW-NE direction, about 3 km long, 200 m wide upstream and 400 m wide downstream. The riverbed inclination is 20 m/km upstream and 4 to 7 m/km downstream.

The second one is in the NW-SE about 4 km long and 200 m to 400 m wide. The riverbed inclination is 20 m or more /km upstream and 4-5 m/km downstream.

The ore body is 2 m to 34 m thick, averaging 7.7 m.

(3) Mineralization

The ore body is composed of light grey to greenish grey-colored sandy clay in the Aral Formation depositing in old valleys and poorly sorted argillaceous arkose sand, accompanied by irregularly disseminated ilmenite.

According to the existing data, the grain size distribution of ilmenite falls within the range between -0,25 mm and +0.1 mm, in most cases.

Chemical composition of ilmenite taken from the existing data is shown below.

Element	TiO_2 (%)	P_2O_5 (%)	Cr_2O_3 (%)	V_2O_5 (%)
Assay result	53.8～54.8	0.015～0.02	0.015～0.022	0.19～0.23

Ilmenite contents vary from 1 kg/m^3 to 150 kg/m^3, averaging 80.2 kg/m^3, while zircon contents are as low as 0.5 to 1.5 kg/m^3.

3) Placer No.3

(1) Location

The Placer lies from the center to the west of the Preobrazhenskiy intrusive, complex rock body.

(2) Form

The Placer, a placer depositing in old valleys, is in the direction of WNW-ESE and continues over 12.5 km from east to west, whose extreme west has been unconfirmed.

Besides the main stream, there are many branches in the N-S and E-W directions, which flow in from the right bank side in relation to the main stream.

The main placer is 100 m to 200 m wide upstream and 600 m to 800 m wide downstream, while the branches are 50-200 m to 300-400 m wide.

The riverbed inclination varies from 50 m/km in the branches to 11.5 m/km upstream in the main stream and 2 to 3 m/km in the main placer portion.

(3) Mineralization

The ore body is emplaced in arkose sand and sandy clay.

The thickness of the ore body based on a calculation by ore block is 7.6 m to 14.5m. The average ilmenite content is 64.8 kg/m^3.

4-2-2 Karaotkel placer

At the Karaotkel ore deposit, occurrence of a placer has so far been known. (Fig. I-4-2 and Table I-4-1)

(1) Location

The placer, located 15 km ESE of the Bektemir Placer No.1, extends from the center to the southeast of the Karaotkelskiy intrusive, complex rock body.

(2) Form

The ore deposit is a placer depositing in old valleys, consisting of a main stream in the NW-SE direction and many branches.

The size of the explored placer is 12,000 m long, max. 300 m to 600 m wide in the northwest branches and 1,000 m to 1,600 m wide in the southeast main stream, and 7.3m thick on average.

(3) Mineralization

The ore body is embedded in argillaceous sand in the Aral Formation depositing in old valleys; besides, weak mineralization is observed in Mesozoic weathering crusts.

The Aral Formation in the ore body is composed of clay (62% to 64%) and sand (36% to 38%). The weathering crusts that develop over syenite and syenite diorite of the Karaotkelskiy intrusive, complex rock body is composed of clay (55%) and sand (45%).

Regarding grain size distribution of the ilmenite, 86% falls within the range from -0.315 mm to +0.04 mm, according to the existing data.

Chemical composition of the ilmenite taken from the existing data is shown below.

Element	TiO_2 (%)	FeO (%)	SiO_2 (%)	P_2O_5 (%)	Cr_2O_3 (%)
Assay result	53.8	11.2	1.84	0.08	0.01

Ilmenite contents of the ore body in the Aral Formation are 18-20 kg/m^3 to 200 kg/m3, and zircon contents are 3 to 30 kg/m^3, while those in the weathering crusts are 18 to 83 kg/m^3 and 1.5 to 6 kg/m^3, respectively.

The average thickness of the ore body is 7.3 m, and that of the overburden is 7.6 m. The average ilmenite contents are 23.3 kg/m^3. (Table I-4-1)

4-3 Oringins of Ilmenite and Zircon

The ilmenite-zircon placers lie around the outcrops of the Preobrazhenskiy and Karaotkelskiy intrusive, complex rock body. The placers are presumed to have deposited in covered old valleys under the Quaternary. (Fig. II-2-2) From the occurrence of these placers, it is interpreted that the ilmenite and zircon were derived from the Preobrazhenskiy and Karaotkelskiy intrusive, complex rock bodies.

Among the intrusive rocks, gabbro and monzonite have the highest TiO_2 contents. Granite and syenite tend to be of lower TiO_2 contents but of higher zircon contents. TiO_2 contents of the respective rocks based on the existing data are shown below.

No.	Rock	Intrusive Rock Body	TiO_2 (%)
1	Gabbro	Karaotkelskiy	1.75 to 8
2	Monzonite	Karaotkelskiy	1.54-1.65 ~4-5
3	Granodiorite	Karaotkelskiy	1.17
4	Syenite	Karaotkelskiy	1.17-3
5	Alkaline granite	Karaotkelskiy	0.07-1.07 ~1.8
6	Gabbro	Preobrazhenskiy	max.12

Following are the results of chemical analysis made in Phase I with the JOEL element analyzer.

No.	No. of sample	Intrusive Rock Body	Rock	TiO_2	ZrO_2
1	9-16-9	Karaotkelskiy	Aegirine granite	0.18	0.11
2	9-20-4	Maityab formation	Andesite tuff	0.64	0.02
3	9-28-2	Preobrazhenskiy	Granite	0.37	0.03
4	9-28-3	Preobrazhenskiy	Granite	0.09	0.03
5	9-28-4	Preobrazhenskiy	Monzonite	1.10	0.02
6	9-28-10	Preobrazhenskiy	Granite	0.18	0.02

Based on these observations, it is interpreted that the high ilmenite contents in gabbros and monzonite caused ilmenite concentration in weathering residuals and subsequent formation of placers.

It seems attributable to the source rocks in the backlands that ilmenite contents are high in the Bektemir placer which has the Preobrazhenskiy rock body rich in gabbros and monzonite as the backland, whereas the Karaotkel placer, which has the Karaotkelskiy rock body abundant with granite and syenite as the backland, has low ilmenite contents but relatively high zircon contents.

4-4 Potentials for Occurrence of Ore Deposits

On the basis of analysis of the existing data and Phase I survey findings, the potentialities for ore deposits in the survey area may be summarized as follows.

1) Bektemir district

(1) Placer No.1

The phase I drilling results indicate that the No.1 ore body tends to increase in the width and volume southward although its ilmenite contents slight ly decline and thickness of the overburden increases. Further drilling survey is required to confirm the southern limit and the widths of the No.1 ore body. The drilling should be conducted while considering the depths of economically minable ore, as the thickness of overburden increases southward.

To the south of the No.1 ore body, presence of the South Terektinskiy fault in the WNW-ESE direction is presumable. As the fault constitutes the southern limit of the Terektinskiy graben-syncline that is considered to have provided the place for deposition of ilmenite deriving from the Bektemirskaya horst anticline, the ilmenite mineralization is likely to degenerate on the southern side of the fault.

(2) Placer No.2

Of the Placer No.2, ample drilling surveys have been conducted by the Kazakh side, which have seized ore reserves of the categories C_2 and P_1 of 36,048,000 m^3 grading 80.24 kg/m^3 of ilmenite. A substantial addition to the ore reserves and the ilmenite contents is not anticipated even though further exploration of the ore body is attempted.

(3) Placer No.3

The Placer No.3 has also been explored by ample drilling on the part of Kazakhstan, whereby ore reserves of the categories C_2 and P_1 of 59,447,000 m^3 grading 64.81 kg/m^3 of ilmenite have been acquired. If further exploration is conducted, no substantial increase in the ore reserves and ilmenite contents of this ore body is expected.

Concerning the sedimentary environment of the ilmenite ore body intersected by the Phase I drilling at the southern flank of the Placer No.1, two hypotheses are conceivable. The first one holds that the ore body represents a placer depositing over the riverbeds of old valleys in the NE-SW direction controlled by the fracture zone of fault, whereas the second one holds that it is a placer depositing over the sub-lacustrine flattened surface. In this case, the drilling that intersected the ore body is considered to have seized the northeastern end of the ore body in the NW-SE direction, which extends continuously from the west side of the Placer No.3 to the southern flank of the Placer No.1.

Since potentialities for the ilmenite placer deposits in the survey area substantially vary depending on directions of the placers, it will be essential to confirm by drilling or geophysical prospecting the continuity of the ore body seized in Phase I.

2) Karaotkel district

The existing data indicate that the Karaotkel placer has large ore reserves ($B+C_1 = 147{,}579{,}000\ m^3$) but its ilmenite contents are low ($23.3/m^3$). As drilling surveys on the Kazakh part have been executed so amply also in this district that no substantial addition to the ore reserves and ilmenite contents is expectable if further drilling exploration is attempted. However, partially exploitable portions with high ilmenite contents may be extracted by revaluation of the district based on the existing data.

Although no detailed surveys intended for ilmenite have been done between the west side of the Karaotkel placer and the Bektemir placer, there is a possibility that ore deposits are found by future exploration, in view of the presence of a fault forming old valleys which provided places for deposition of ilmenite placer.

3) North Bektemir district

From the analysis of the existing data, it has been learned that no drilling nor other surveys focused on ilmenite have been undertaken in this district but presence of the old buried valleys rising from the Preobrazhenskiy intrusive rock body and the sublacustrine flattened surface are anticipated, therefore, there is a possibility of occurrence of new placers.

Table I -4-1　List of the Placer Ore Bodies in the Kokpetinskaya Area

Name of the Ore Bodies	Size of Ore Body		Ore Reserves		Ilmenite Grade (kg/m^3)	Zircon Grade (kg/m^3)	Thickness of the Ore Body (m)	Thickness of the Overburden (m)	Source Rock of Ilmenite
	Length (m)	Width (m)	Category	Ore Reserves ($th.m^3$)					
Bektemir No.1 Ore Body	5,250	150-250 ～650	$B+C_1+C_2$	11,958	151.78	—	5.4	18.7	Preobrazhenskiy intrusive body
South of Bektemir No.1 Ore Body (MMAJ, 2000)	1,000	650	C_2	5,009	123.95	0.5-3.4	5.5	29.6	Preobrazhenskiy intrusive body
Bektemir No.2 Ore Body	4,000	200 ～400	C_2+P_1	36,048	80.24	0.5-1.5	7.7	—	Preobrazhenskiy intrusive body
Bektemir No.3 Ore Body	12,500	100-200 ～800	C_2+P_1	59,447	64.81	—	7.6-14.5	—	Preobrazhenskiy intrusive body
Karaotkel Ore Body	12,000	300-600 ～1,600	$B+C_1$	147,579	23.3	1.7-5.9	7.3	7.6	Karaotkelskiy intrusive body

— : No data

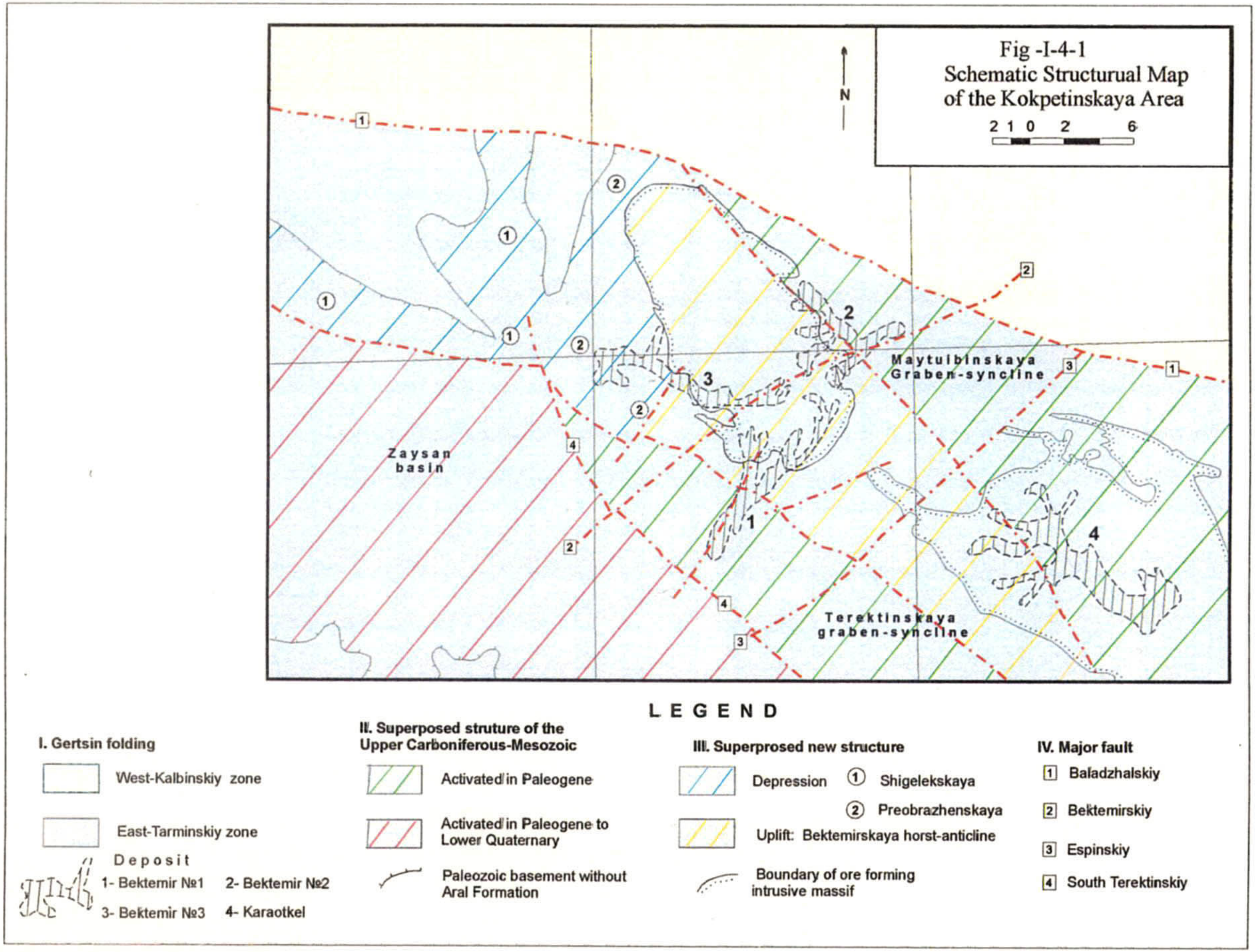
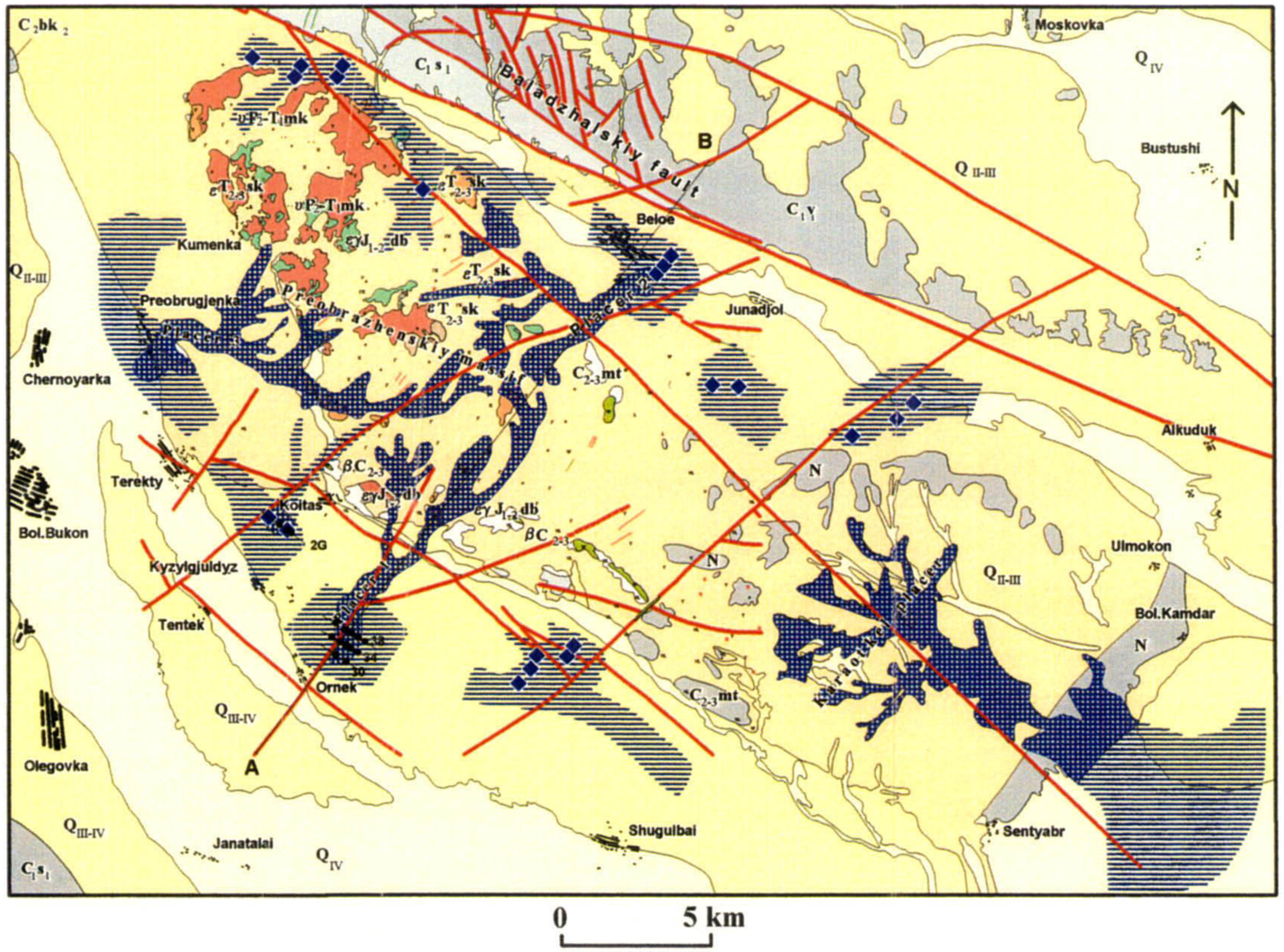


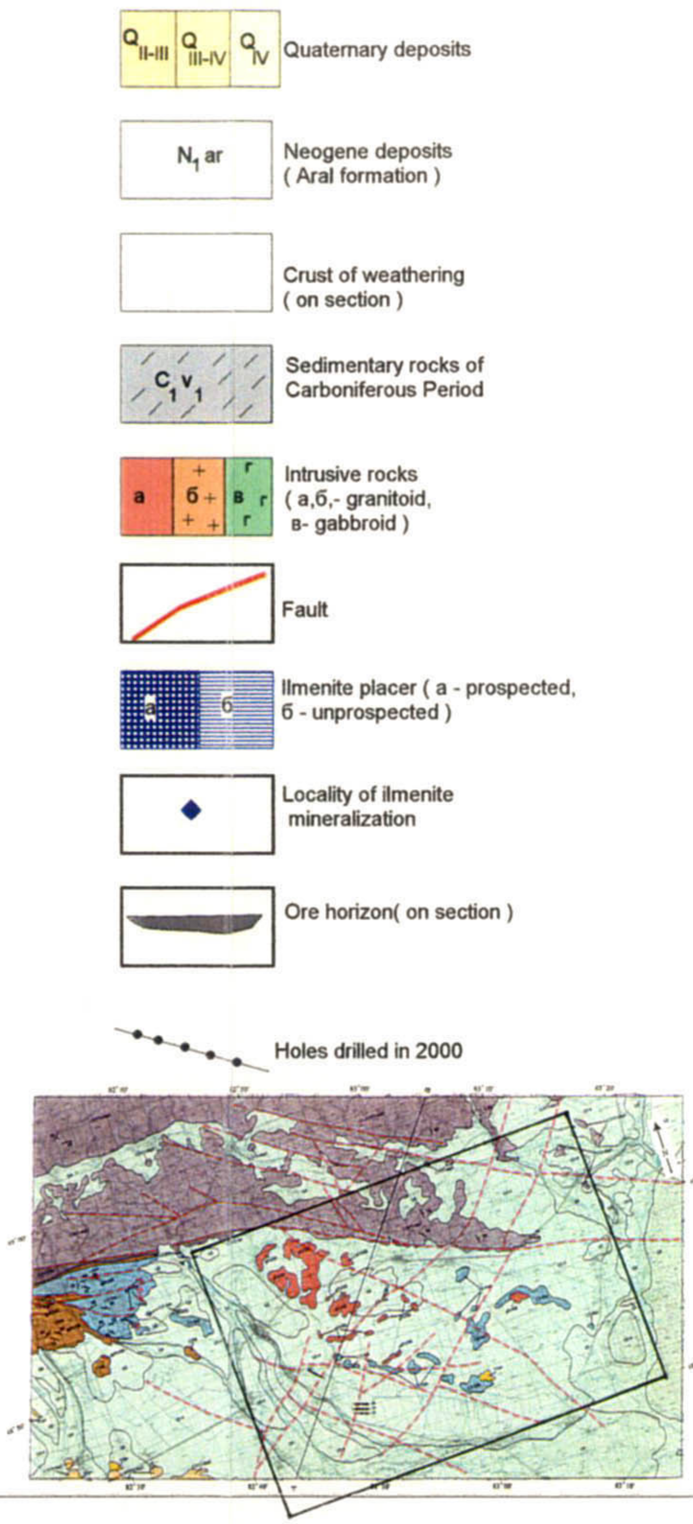
Fig -I-4-1
Schematic Structurual Map
of the Kokpetinskaya Area

Fig. I-4-2

Schematic Geological Map of the Satpaev Ore Field



Cross section A-B



Chapter 5 Conclusions and Recommendations for the Future Survey

5-1 Coclusions

5-1-1 Geological survey

1) Geology

The formations in the survey area consist of the Paleozoic basement rocks and the Neogene to Quaternary rocks of the Cenozoic age.

(1) Paleozoic basement rocks

The basement rocks are composed of the Carboniferous sedimentary rocks (shales, sandstones and conglomerates), pyroclastic rocks and lavas (andesite and porphyrites).

(2) Upper Cretaceous weathering crust

The weathering crusts are argillaceous weathering residuals developing over the Carboniferous sedimentary and volcanic rocks, and the intrusive rocks, and are overlain by the Neogene and Quaternary rocks. The thickness is generally 10 m to 20 m, reaching 50 m to 60 m in fracture zones.

The weathering crusts are intensively argillized (kaolinite, montmorillonite and illite).

(3) Neogene Aral Formation

The Formation unconformably overlies the basement rocks or their weathering crusts and underlies the Quaternary rocks. It is composed of clay, sandy clay and argillaceous sand, rarely intercalating pebbles. Ilmenite placers are embedded in sandy clay or argillaceous sand in the lower part of the Formation.

(4) Quaternary System

The System is composed of the Pleistocene gravel, loam, clay, aeolian sand and the Recent stream sediments.

(5) Igneous rocks

There lie Preobrazhenskiy intrusive, complex rock body and the Karaotkelskiy intrusive, complex rock body. The intrusive, complex rock bodies can be classified by intrusion time and rock facies, as follows:

- Upper Permian to the Lower Triassic: Gabbro, diorite and monzonite
- Middle to Upper Triassic: Syenite, diorite and granosyenite
- Lower to Middle Jurassic: Granite and granodiorite

Gabbro and monzonite have high contents of TiO_2, whereas granite and syenite are low in TiO_2 but high in ZrO_2. The Preobrazhenskiy rock body chiefly includes gabbroids and has high ilmenite contents.

2) Geologic structure

The ore field lies northwest of the Zaisan basin, located within the east

Zharminskiy synclinorium zone. The north side of the ore field is bounded by the Baladzhalskiy fault in the WNW-ESE direction, adjoing the west Kalbinskiy synclinorium zone.

The tectonic movement started in the Late Carboniferous to the Perminan time and presumably continued during the Paleogene time, to form the Maytuibinskaya and Terektinskaya graben-synclines in the WNW-ESE direction and, in between them, the Bektemirskaya horst-anticline. The Bektemirskaya horst-anticline is accompanied by intrusive, complex rock bodies and served as the source of detritus and ilmenite that flowed into the graben-synclines.

The faults in the NE-SW direction cut the intrusive complex rock bodies and the Carboniferous rocks to form valleys along the fracture zone of the faults, where the ilmenite placers were emplaced.

3) Ore deposit

The ore bodies are ilmenite placers emplaced in the Neogene Aral Formation, lying in the Bektemir district, Karaotkel district and the North Bektemir district.

The ilmenite placers are embedded in sandy clay and argillaceous sand of the Lower Formation of the Neogene Aral Formation. From the features, it is argillaceous but includes no gravels. The Aral Formation is inferred to be lacustrine sediments deposited in old valleys submerged as the old Lake Zaisan expanded.

Ilmenite of the Bektemir deposit is considered to derive from plutonic rocks of the Preobrazhenskiy intrusive rock body. The concentration of ilmenite in weathering residuals and the subsequent formation of the placers are ascribable especially to the high ilmenite contents in gabbro and monzonite.

5-1-2 Drilling survey

1) Southern flank of the Placer No.1

Over 1 km from the south side of the ore blocks with confirmed ore reserves of the C_2 category, the drilling survey was carried out 12 drillholes, totaling 471 m, in the 500m x 200m grid and on the three prospecting lines (Lines -38, 34 and 30).

The placer deposited on the riverbed of old valleys. The ore body intersected by the drilling is 2.1 m to 8.9 m thick, grading 105.41 to 201.10 kg/m^3 of ilmenite, while zircon contents are as low as 0.5 to 3.4 kg/m^3.

There is a tendency that the ore body increases in width and volume southward, whereas the grade of ore sand declines and the overburden volume increases.

The ore reserves of the C_2 category additionally acquired by the Phase I exploration are estimated as follows:

Cutoff criteria: 70 kg/m^3 or more on the hanging wall side and 100 kg/m^3 or more on the footwall side; or,

2.0m x 100 kg/m^3 or more, whichever be greater.

Ore reserves: 5 million kg/m^3

Ilmenite content: 621,000 t

Ilmenite average grade: 124 kg/m^3

Stripping ratio: 5.38 m^3/m^3

In view of the above ilmenite contents and the stripping ratio, the ore body is economically exploitable by open-pit mining, under the Kazakh standards (ex-C.C.C.P. standard).

2) Southern flank of the Placer No.3

On the Line-2G, five drillholes were carried out at intervals of 200 m, totaling 184 m. At two of the five drillholes (MJBK-12 and -15), ilmenite mineralization exceeding the cutoff criteria was ascertained. The drillhole MJBK-12 intersected the ore body of 1.9 m in thickness, averaging 110.72 kg/m^3 of ilmenite, while drillhole MJBK-15 intersected that of 4.4 m, averaging 121.11 kg/m^3. The depths of the ore body for drillholes MJBK-12 and MJBK-15 are 28.0 m and 24.5 m, respectively.

As regards to the sedimentary environment of the ilmenite ore body intersected by the drilling, two hypotheses are conceivable. The first one holds that the ore body is a placer depositing over the riverbed of old valleys controlled by the fracture zones. Based on this hypothesis, the seized mineralization is interpreted to have deposited in the two valleys controlled by the Bektemirskiy fault zone in the NE-SW direction.

The second one holds that it is a placer depositing over the sublacustrine flattened surface. According to the hypothesis, the drilling that intersected the ore body is considered to have seized the northeastern edge of the NW-SE ore body extending from the west side of the Placer No.3 to the south side of the Placer No.1.

It is therefore essential in drawing future prospecting lines to verify the directions of placer deposits in the area.

5-2 Recommendations for the Phase II Survey

From the Phase I survey findings, guiding principles for further exploration of the ore deposits have been drawn out, as discussed in the following paragraphs.

Concerning the genesis of ilmenite placer deposits in the survey area, it is interpreted that the source rocks such as gabbro and monzonite which have high TiO_2 content are present in the background, and two hypotheses of the sedimentary environment are possible as follows:

A. Placers depositing on the riverbeds of old buried valleys controlled by fracture zones; and,

B. Placers depositing on the sub-lacustrine flattened surface

Based on these hypotheses, drilling is an effective means for investigating extensions of the known ore deposits whilst, in totally unexplored areas, it is considered effective to grasp the underground structure such as the old buried valleys by methods such as geophysical prospecting.

The exploration plans for Phase II for the respective districts are summarized as follows:

1) Bektemir district

(1) Southern flank of the Placer No.1

It is necessary to implement additional drilling to confirm the southern limit and the widths of the Placer No.1, and to estimate ore reserves of the southern flank of the Bektemir Placer No.1. The drilling should be conducted while considering the depths of economically minable ore, as the thickness of overburden increases southward.

(2) Southern flank of the Placer No.3

Drilling is needed for determining the direction of the ore body ascertained in Phase I. Since it remains unknown whether hypothesis A or B is applicable to the mineralization seized in Phase I, it is necessary to implement drilling either on NE-SW prospecting lines passing through the MJBK-15 and -12 that intersected the ore body and traversing the Lines-2G at right angles, or on prospecting lines parallel on the northeast and southwest side of Line-2G. In case of continuity between the western portion of the Placer No.3 and the southern portion of the Placer No.1 is anticipated, drilling will have to be done between the two portions.

2) Karaotkel district

According to the existing data, the ilmenite contents of the Karaotkel placer deposit are low while zircon contents are rather high. Further work will be limited to revaluation based on the existing data, because of the low priority of the field survey such as drilling compared with the other districts.

3) Northern Bektemir district

Analysis of the existing data revealed that occurrence of placers depositing on the old buried valleys originating from the Preobrazhenskiy intrusive rock body and on the sub-lacustrine flattened surface are expected in this district, as well. It is necessary to implement geophysical prospecting to ascertain the old buried valleys and lacustrine topography, and drilling survey at portions where ilmenite is inferred to be deposited.

The possibility of occurrence of placer deposits depends largely on the occurrence of the Preobrazhenskiy intrusive, complex rocks and the Karaotkelskiy intrusive, complex rocks that are the source rocks of ilmenite and zircon, and also on geologic structure. Therefore, it seems possible to extract promising exploration targets of ilmenite if occurrence of these intrusive rocks is clarified by detailed geological survey in areas covering the North Bektemir, Bektemir and Karaotkel districts.

It is also conceivable to apply geophysical survey which are considered effective for extracting old buried valley topography, for grasping ilmenite-bearing geologic structure.