No. 6

REPORT
ON
THE MINERAL EXPLORATION
IN
THE ZHAMAN-AIBAT AND SAMARSKY AREA
REPUBLIC OF KAZAKHSTAN

(PHASE III)

MARCH 1997

JICA LIBRARY
J 1138091 [2]

JAPAN INTERNATIONAL COOPERATION AGENCY

METAL MINING AGENCY OF JAPAN

MPN
CR (2)
97-075

REPORT
ON
THE MINERAL EXPLORATION
IN
THE ZHAMAN-AIBAT AND SAMARSKY AREA
REPUBLIC OF KAZAKHSTAN

(PHASE III)

MARCH 1997

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

1138091 (2)

PREFACE

In response to the request from the Government of the Republic of Kazakhstan, the Japanese Government decided to conduct a Mineral Exploration Project in the Zhaman-Aibat and Samarsky Areas and entrusted the survey to the Japan International Cooperation Agency (JICA) and Metal Mining Agency of Japan (MMAJ).

JICA and MMAJ sent to Kazakhstan a survey team headed by Mr.Akeo Onishi from 11 July, 1996 to 30 August, 1996.

The team exchanged views with officials of the Government of the Republic of Kazakhstan and conducted a field survey in the Zhaman-Aibat. After the team returned to Japan, further studies were made and the final report has been prepared.

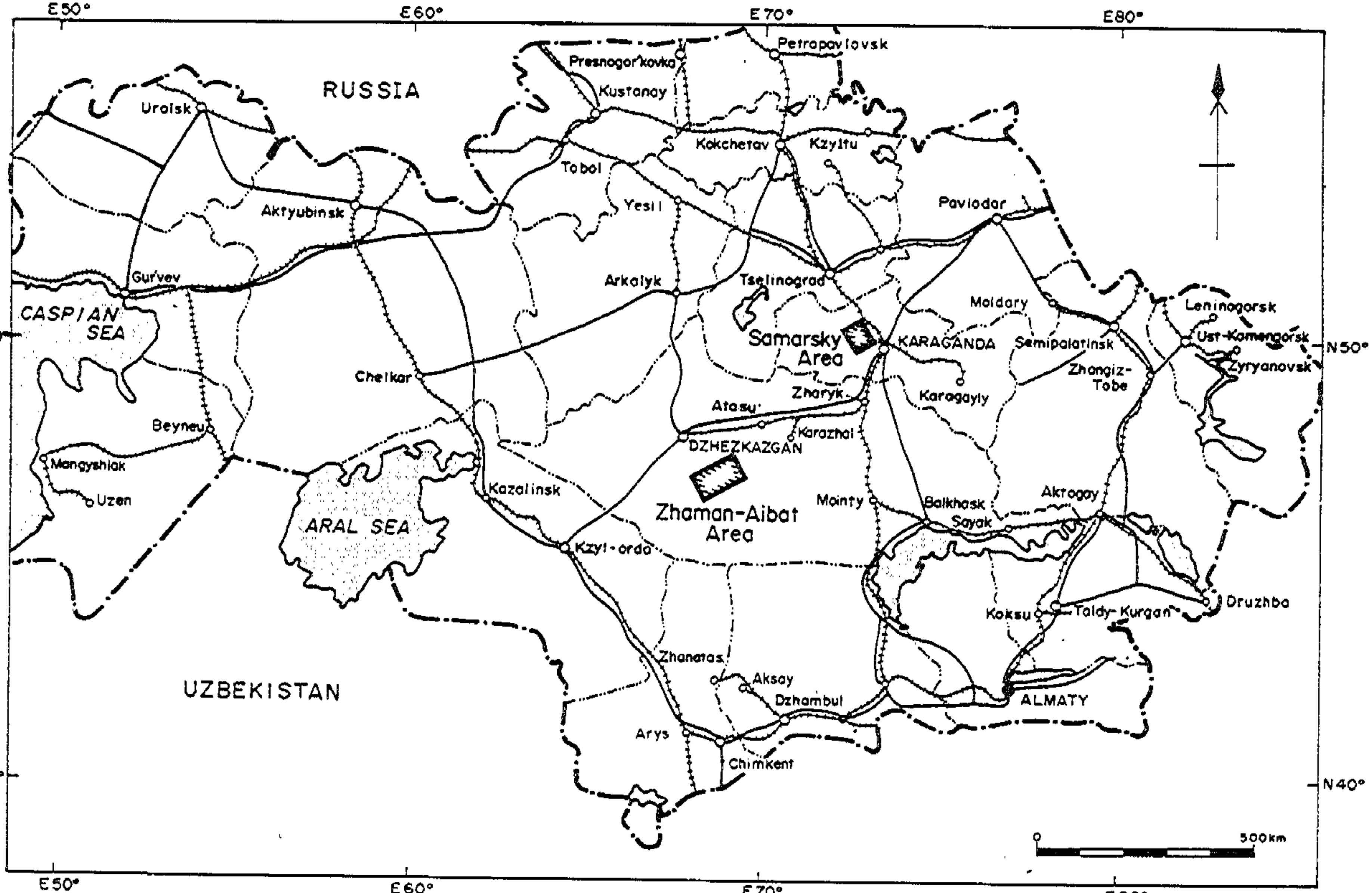
We hope that this report will serve for the development of the Project and will contribute to the promotion of friendly relations between our two countries.

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

March, 1997

Kimio Fujita
President
Japan International Cooperation Agency

Shozaburo Kiyotaki
President
Metal Mining Agency of Japan



Location Map of the Project Areas

Резюме

Резюме

Базовое изучение по проекту сотрудничества в разработке природных ресурсов районов Жаман-Айбат и Самарский Республики Казахстан проводится с целью поисков и разведки минеральных ископаемых и оценки запасов в рамках 3-летнего проекта, начавшегося в 1994 г. Этот год является заключительным, третьим годом проекта.

Район Жаман-Айбат

Месторождение Жаман-Айбат является стратиформным медным месторождением, находящимся в сером песчанике внутри аллювиально-дельтных отложений красноцветного песчаника, сформировавшегося со среднего-позднего каменноугольного периода по пермский период. До настоящего времени выявлено 3 рудных тела – восточное, центральное и северное – на участке протяженностью 12,5 км с востока на запад и 5 км с севера на юг. Глубина залегания месторождения 460-650 м от земной поверхности. Основные минералы: халькоцит, дигенит, борнит. Основные типы руд: медь, полиметаллические руды (Cu + Pb + Zn), свинцово-цинковые руды. По результатам подсчетов японской группы изучения рудные запасы (геологические запасы) составляют 193 млн. тонн (1,4%Cu, 0,3%Pb, 16 г/тонн Ag, мощность рудного пласта 5,4 м).

Было проведено два вертикальных бурения: скважина MJK-1 (глубина 650,50 м) в восточном рудном теле и скважина MJK-2 (глубина 700,00 м) в центральном рудном теле. MJK-1 выявила медную руду (3,87%Cu) мощностью 7,8 м в нижнем слое Джезказганского пласта. MJK-2 выявила полиметаллическую руду (3,88%Cu, 3,04%Pb) мощностью 8,0 м и медную руду (1,89%Cu) мощностью 7,8 м в нижнем слое Джезказганского пласта. Кроме этого, были выявлены 2 зоны слабой минерализации меди (0,67-0,30%Cu) мощностью 3,6-5,7 м в верхней части Таскдукской формации.

Было проведено пробное обогащение медной руды восточного рудного тела и полиметаллической руды центрального рудного тела. Содержание металлов в медной руде было следующим: 1,69%Cu, 0,51%Pb, 0,03%Zn, 12 г/тонну Ag. В результате коллективно-селективной флотации коэффициент извлечения меди медного концентрата 39%Cu, 1%Pb составил 86%, а коэффициент извлечения свинца свинцового концентрата 48%Pb, 11%Cu составил 67%. Содержание металлов в полиметаллической руде было следующим: 1,70%Cu, 1,11%Pb, 0,03%Zn, 5 г/тонну Ag. В результате коллективно-селективной флотации коэффициент извлечения меди медного концентрата 32%Cu, 5,59%Pb составил 92%, а коэффициент извлечения свинца свинцового концентрата 66%Pb, 15,0%Cu составил 78%.

Разрабатываемое в настоящее время Джезказганское месторождение геологически во многом схоже с месторождением Жаман-Айбат, поэтому техника добычи Джезказганского месторождения может быть применена в Жаман-Айбате. Было проведено изучение на месте в отношении способов разработки на Джезказганском руднике. Для подземной разработки используются три метода: камерно-столбовая разработка, разработка с закладкой и слоевая выемка. Коэффициент извлечения снижается из-за увеличения диаметра камер (м) и ширины междукамерных целиков (м) вместе с увеличением глубины (м). На месторождении Жаман-Айбат мощность рудного тела наиболее сильного горизонта 4-I составляет 6 м, а глубина залегания 500-750 м. При подсчете по формуле Джезказганского месторождения коэффициент извлечения на глубинах 600 м и 700 м составит 75,3% и 73,7% соответственно.

При составлении общего проекта разработки месторождения Жаман-Айбат вначале были подсчитаны извлекаемые запасы. Извлекаемые запасы были определены в 119 млн. тонн при содержании 0,4%Cu, минимальной высоте выработки 3 м, коэффициенте извлечения (камерно-столбовой разработкой) 75% и коэффициенте разубоживания 5%. Рудник Жаман-Айбат был спроектирован следующим образом. Это рудник средних масштабов с подземной выработкой. От города Джезказган будет проложена железная и автомобильная дорога, электричество будет закупаться. Возле рудника будет построена рудообогатительная фабрика, занимающая только извлечением медного концентрата. Он будет перевозиться на завод по рафинированию меди Джезказганского рудника. Медь и серебро из медного концентрата будут идти на продажу. В случае, если ежегодный объем добычи составит 5,6 млн. тонн, то мощность участка добычи будет 19200 тонн в день, содержание меди в концентрате 35%, коэффициент извлечения при обогащении 90%, объем обогащения 596 тонн в день. Период действия рудника предполагается 22 года.

По подсчетам, затраты на эксплуатацию рудника Жаман-Айбат составят 15,92 долларов США на тонну руды, 67 центов на фунт меди. В том числе, 35% приходится на добычу, 13% на эксплуатацию объектов на руднике, 27% на обогащение, 6% на общие административные расходы, 2% на транспортировку концентрата и 17% на управление участком. Затраты пускового периода составят 492 млн. долларов США, из них 471 млн. долларов потребуется на строительство и 21 млн. долларов на оборотные средства. Из 492 млн. долларов 347 млн. долларов уйдет на начальные капиталовложения и 150.000.000 долларов на дополнительные. С учетом стоимости капитала и налогов внутренняя ставка дохода (Internal Rate of Return – IRR, или коэффициент окупаемости капиталовложений) составит 5,40%. При налоговой ставке в 30% обеспечивается IRR 3%. Для сведения налогов к нулю требуется IRR в 12,3%. Был проведен анализ эластичности IRR по таким показателям, оказывающим наибольшее влияние на прибыльность, как цена на медь, торкрет-бетон и железобетон, затраты пускового периода и затраты на эксплуатацию. В результате было получено, что сокращение затрат на эксплуатацию на 30% повышает IRR до 7,77%, а сокращение на 30% затрат пускового периода повышает IRR до 4,99%. При этом IRR будет изменяться также вследствие колебаний цен на медь.

Исходя из таких вопросов экономичности, в настоящее время необходимо отложить разработку месторождения Жаман-Айбат, однако в дальнейшем есть основания надеятся, что новый рудник будет здесь открыт. В перспективе необходимо активно прорабатывать вопросы несения государством расходов на строительство железных и автомобильных дорог и прокладке линий электропередач, а также введения системы льготной амортизации в отношении деятельности по добыче. Учитывая возможность повышения цен на медь и снижения себестоимости в результате развития технологий добычи, в дальнейшем необходим периодический пересчет рентабельности рудника.

Район Самарский

В районе Самарский выявлено месторождение двух типов: медно-молибденовое месторождение порфирного типа, и месторождение серебра полиметаллического типа. Медно-молибденовое месторождение порфирного типа состоит из пород замещения внутрипустотной породы вулканических трубок кварцевого диорита и гранодиорита (Карамендинского комплекса) девонского периода, а также интрузивных тел и вкраплений вокруг него. Обнаружена окисленная зона на глубине 30-50 м от поверхности, а на глубине – зона первичных сульфидов. Зона вторичного обогащения не выявлена. Места с высоким содержанием представляют собой замещение медного колчедана и кварца внутрипустотной породы вулканических трубок, поэтому их форма отражает форму вулканических трубок. Они расположены на глубине от 300 м от поверхности земли и ниже. Частичное бурение подтвердило их простирание до глубины более 750 м. Серебряное полиметаллическое месторождение распределяется по зоне дробления, выходящей на верхнюю поверхность многочисленных надвигов, идущих почти по северо-южному направлению в северо-западной и западной части района Самарский. До настоящего времени были выявлены основная дайка и 3 побочные дайки. Средняя ширина дайки 5,6 м, среднее содержание золота 3,82 грамм на тонну. Предполагается среднее содержание серебра 20 г на тонну. Минерализация выявлена 800 м по простиранию и 1000 м по уклону на глубине до 350 м.

Был проведен подсчет геологических запасов в районе центрального рудного тела медно-молибденового месторождения порфирного типа. При подсчете применялся используемый в "Карагандагеология" метод послойной разрезки, содержание меди принималось 0,5%Cu. Были получены следующие результаты: геологические запасы 114 395 015 тонн, запасы меди 1 458 777 тонн, среднее содержание меди 1,28%Cu. По всем этим показателям результаты оценки японской стороны были несколько выше.

Известное сейчас медно-молибденовое месторождение находится на глубине более 300 м, что весьма осложняет его разработку. Необходимы дальнейшие поиски интрузивных пород и зоны вулканических трубок на меньшей глубине. Говоря конкретно, кандидатами здесь могут быть участок кварцевого диорита на северо-востоке и востоке существующего месторождения, вулканические трубки и участок возле них в 1 км на юго-восток от существующего месторождения и участок между существующим месторождением и Тулкулинским сбросом. Необходимо также проверить минерализацию в протяженной части на юге от существующего серебряного полиметаллического месторождения и на глубине.

SUMMARY

The three year mineral exploration program in the Zhaman-Aibat and Samarsky Areas of Central Kazakhstan was launched in 1995 with the aim of exploring and evaluating mineral resources in these areas. The primary aim of the program this year (phase III) is to evaluate the Zhaman-Aibat Deposit and to produce a conceptual development design. The secondary aim is to summarize the exploration data of the Zhaman-Aibat and Samarsky Areas.

Zhaman-Aibat Area

The stratiform copper mineralization occurs exclusively in the grey-colored alluvial-deltaic sandstone faces within " Red Sandstone Formation" of the Carboniferous. More than 900 drill holes confirm that there are three main orebodies, namely, the Central, Northern and Eastern Orebodies. These orebodies are distributed in an area with dimensions :12.5km in the east-west direction and approximately 5 km in the north-south direction. The depth of the ore horizon is approximately 460m~480m in the eastern area and the depth increases towards the west. At the western edge of the Central Orebody it reaches 650m in depth. The mineral assemblage of the ore is comparatively simple. The main minerals are chalcocite, digenite and bornite. Galena, sphalerite, chalcopyrite and pyrite are in small amounts. Major ore types are confined to the Copper Ore (Cu), Complex Ore (Cu+Pb+Zn) and Lead-Zinc Ore (Pb+Zn). The ore reserves (geological resources) and average ore grade with the cutoff grade of 0.4% Cu were calculated by the japanese survey team. The results indicates that the ore reserves were 193 million tons, the average metal contents 1.4%Cu, rerespectively.

For the purpose of confirming ore stratigraphy and occurrence, and of providing samples for the ore dressing tests, two holes, MJK-1 and MJK-2 were drilled. MJK-1 was drilled in the Eastern Orebody in 1995 and the copper mineralization (Ore Horizon 4- I) could be observed between the depths of 598.0m and 605.8m. MJK-2 was drilled in the Central Orebody in 1996. In this drill hole, the copper and lead mineralization (Ore Horizon 4- I) could be observed between the depths of 605.4m and 619.7m, and weak copper mineralization (Ore Horizons 3-VI and 3- II) between the depths of 630.0m and 635.7m and between 688.9m and 692.5m respectively.

Ore dressing tests of the Copper Ore and of the Complex Ore were carried out. From the series of test results, it is considered that bulk differential flotation is adaptable to both the Copper Ore and to the Complex Ore. By the bulk differential flotation process of the Copper Ore, a copper concentrate of 39%Cu with copper recovery of 86% and a lead concentrate of 48%Pb with lead recovery of 67% were obtained. For the Complex Ore, a copper concentrate of 32%Cu with copper recovery of 92% and a lead concentrate of 66%Pb with lead recovery of 78% were obtained.

For the conceptual design and the cost calculation of the Zhaman-Aibat Mine development, the mine development and mining method were adopted based on verbal reports on the Zhezkazgan Mine whose deposit has analogies to the Zhaman-Aibat Deposit. The panel and pillar mining method applied at the Zhezkazgan Mine was selected. The mining ore recovery and dilution of ore were determined as 75% and 5%, respectively. The minable ore reserves, metal amount, average ore

grade and average ore thickness with the cutoff grade of 0.4% Cu and with the minimum mining height of 3.0m were calculated. The results indicates that the minable ore reserves were 118,742 kilo tons and total metal amounts were estimated to be as 1,375 kilo tons Cu, 195 kilo tons Pb, 35 kilo tons Zn, 1,019 tons Ag, respectively. Thus, the average metal contents are 1.16%Cu, 0.16%Pb, 0.03%Zn, 8.59g/tAg, respectively.

The configuration of the Zhaman-Aibat Mine by this conceptual design was drawn from the following; The mine will be of medium size incorporating the underground mining method supported by several vertical shafts. A railroad and paved road will be constructed between Zhezkazgan City and the Mine site. Electricity will be supplied from a transformer station by a 220kV power line. An ore dressing plant will be constructed at the mine site and the produced copper concentrates will be transported to the processing plant in Zhezkazgan City. Copper and silver contained in the copper concentrates will be sold to the Zhezkazgan smelting plant. The annual production of the Zhaman-Aibat Deposit is estimated as 5.6 million tons (mine life:22 years), that is set for the base case. From the results of the milling tests, the copper concentrate recovered is expected to be 35% Cu grade with a recovery of approximately 90%. The amount of copper concentrate is 596 tons / day. It is estimated that the total number of mine workers including management staff, will be 930. In detail, there will be 450 underground workers, 350 surface workers, 130 engineers and general/administration staff.

It is estimated that the operation cost will be 15.92 $US /ton ore, 67 cent/ lb of Cu in the base case. In detail, mining will be 35%, mine facilities 13%, ore dressing 27%, administration 6%, concentrate transport 2% and camp management 17%. The capital cost was estimated as 492 million $US in the base cae within which 471 million $US are for construction cost and 21 million $US are for working capital. Of the estimated 492 million $US, 347 million $US will be needed for primary investment and 150 million $US for additional investment. The discount cash flow / internal rate of return (hereinafter DCF / IRR) was estimated as 5.40% in the base case, under the conditions of ore dressing recovery of 90% and 98%, respectively, treatment charge / refining charge (hereinafter TC / RC) is 20 cent/ lb Cu, and metal prices 2,500$US / ton for Cu and 4.0 $US /TR OZ for Ag. It should be noted that financing costs and taxes are not taken into account in this DCR / IRR. Considering a tax rate of 30%, and assuming an IRR of 3%, an IRR (before paying tax and interest) of at least 12% will be necessary.

Although present development of the Zhaman-Aibat Deposit is considered economically marginal, the deposit satisfies essential criteria for successful future mining and it has a clear potential for exploitation. It is expected that an increase of sales revenue resulting from rising copper prices in the international market and decreasing mining costs associated with the introduction of more efficient mining technologies will impact beneficially on the economics of the project. Continuous review and re-assessment of the economics of the Zhaman-Aibat Deposit is therefore strongly recommended. In order to realize the profitable development of the Zhaman-Aibat Mine, the government sholud actively support infrastructure construction such as railroads, roads, electricity and water supplies. Further support from the government should include exemptions from taxes, sales duties and import duties.

Samarsky Area

It is confirmed that there are two types of ore deposit, porphyry type copper-molybdenum deposit and gold-bearing polymetallic deposit. The porphyry type copper-molybdenum mineralization occurs in breccia pipes which were formed within the intrusive bodies of quartzdiorite at an early stage and in the granodiorite porphyry at a later stage. The oxidized zone is confirmed to the depth of 30m - 50m and the primary sulfide zone starts from this depth and continues to greater depths. Secondary enrichment zones have not been reported. The high grade zone of greater than 1.0%Cu is exclusively found within the breccia pipes mentioned above. Thus, the shape of the high grade copper orebody is represented by that of the breccia pipes. The actual shape of the orebody shows an increasing diameter towards greater depth. Gold-bearing polymetallic deposits are distributed in the sheared zone of the hanging wall side of thrusts running in the north-south direction in the north-western to western part of the survey area. The previous survey confirmed that there is one main vein and three branch veins. These veins strike in the north-south direction and dip 35° - 50° to the west. The average thickness and ore grade is estimated to be respectively 5.6m and 3.82 g/t Au and 20g/tAg. It is confirmed that the ore zone continues approximately 800m along the strike direction and 1,000m along the dip direction, which means that mineralization is confirmed to a depth of 350m below the surface.

In the Samarsky copper-molybdenum deposit, it is confirmed that the high grade copper mineralized zone is located deep beneath the surface. Considering the reality of the actual mining operation, some difficulties associated with the depth of mining are expected. Thus, the future exploration should focus on surveys for finding new copper-molybdenum mineralization at shallower depths. It is recommended that the following works be carried out in future campaigns:

- the eastern marginal area of the quartz diorite intrusive body
- in the areas surrounding the breccia pipe located, about 1km southeast of the known orebody
- in the area between the known orebody and the Tulkulin Fault.
- the southern extension and the deeper mineralization of the known gold-bearing polymetallic deposit

CONTENTS

Part III DETAILED REPORT ON THE SAMARSKY AREA

Part IV CONCLUSION AND RECOMMENDATION

FIGURES AND TABLES

APPENDICES

PLATES

PART I GENERAL

Part I General

Chapter 1 Introduction

1-1 Background

The main objective of this survey is to explore and evaluate mineral deposits of the survey area, as mentioned in the Scope of Work for the Mineral Exploration in the Zhaman-Aibat Area. The Scope of Work was agreed on December 29,1994 between the Government of Kazakhstan through the Ministry for Geology and Conservation of National Resources (MFG), and the Japan International Cooperation Agency (JICA), and the Metal Mining Agency of Japan (MMAJ). The present survey is a three-year project which commenced in the fiscal year of 1994, and this year is the 3rd year (Phase III) of the project.

The programme of the first year included data analysis and evaluation of previous survey data of the Zhaman-Aibat Area and the Samarsky Area, and confirmed the geological setting and mode of occurrence of the ore deposits and re-evaluated previously surveyed deposits. In the Zhaman-Aibat Area satellite image analysis revealed lineaments and geological structure and extracted alteration zones within the deposit.

In the 2nd year of the project, the survey concentrated on the Zhaman-Aibat Area. That is, the previous survey data were analyzed and a part of the ore reserves of the Zhaman-Aibat Deposit were evaluated. In order to gather data on the copper ore deposit, such as stratigraphy of the lithofaces and to confirm its mode of occurrence, a drilling survey was conducted. The recovered mineralized drill cores were used for ore dressing tests and an appropriate ore dressing process was examined.

In the 3rd year of the project, the survey has also concentrated on the Zhaman-Aibat Area and more detailed surveys were conducted. That is, the previous survey data obtained during the 1st and 2nd years and the 3rd year, were analyzed and entire ore reserves of the Zhaman-Aibat Deposit were evaluated. For the ore reserves estimation, construction of the Zhaman-Aibat Deposit data base was been started in the 2nd year, and was completed in the 3rd year. In order to gather data on the Complex Ore, such as stratigraphy of the lithofaces and to confirm its mode of occurrence, a drilling survey was conducted. The recovered mineralized drill cores were used for ore dressing tests and an appropriate ore dressing process was examined. Finally, mine operating costs, capital costs and profitability were evaluated based on the results of minable ore reserve estimation and a conceptual design of the Zhaman-Aibat Mine.

1-2 Objective

The main objective of the project is to assess the mineral potential of the Zhaman-Aibat Area. The project's final goal is to contribute to the development of the mineral deposit and to transfer technology to the staff of the Kazakhstan Government and of Kazakhstan private companies.

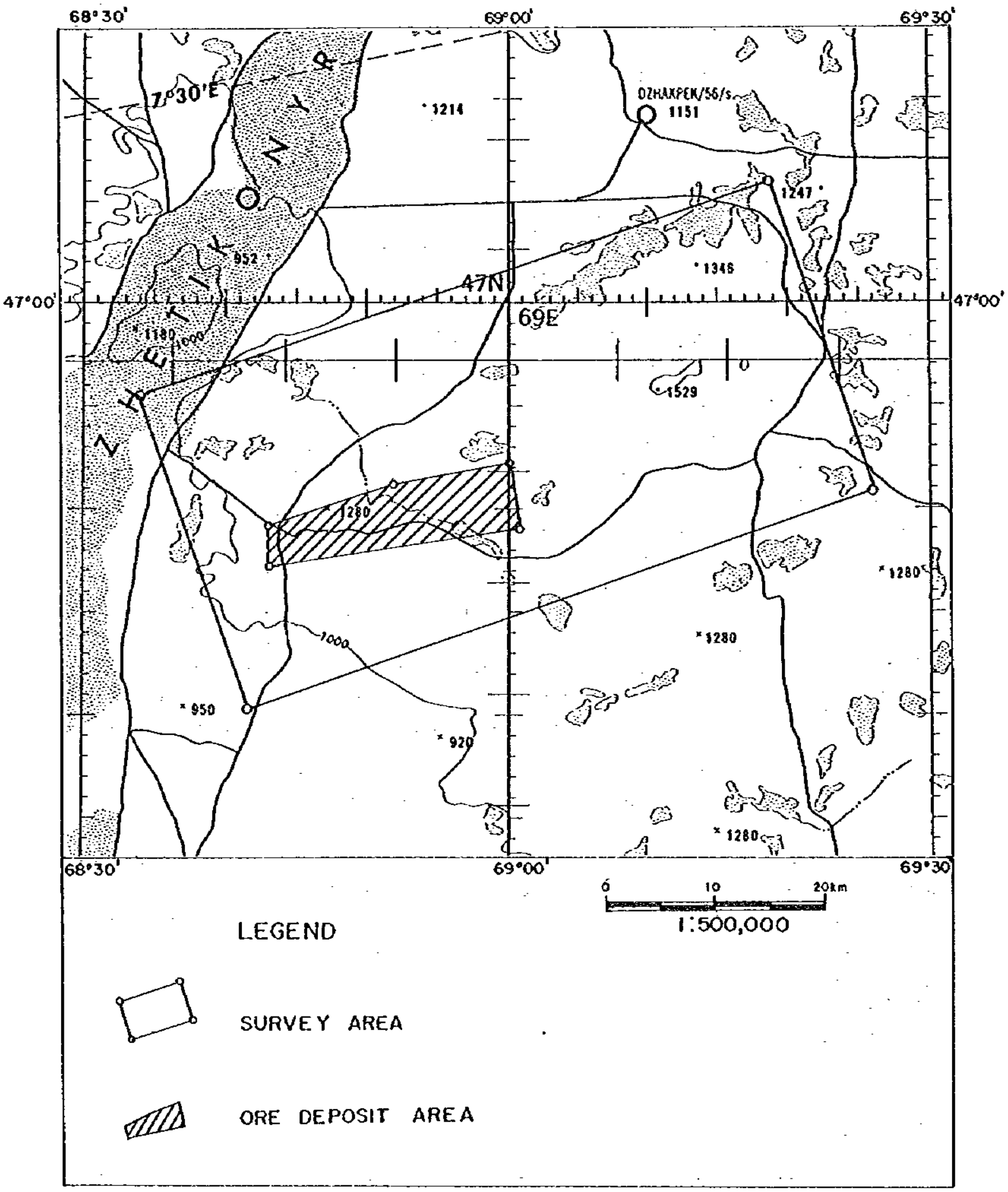


Fig. 1-1-1 Location Map of the Zhaman-Aibat Area

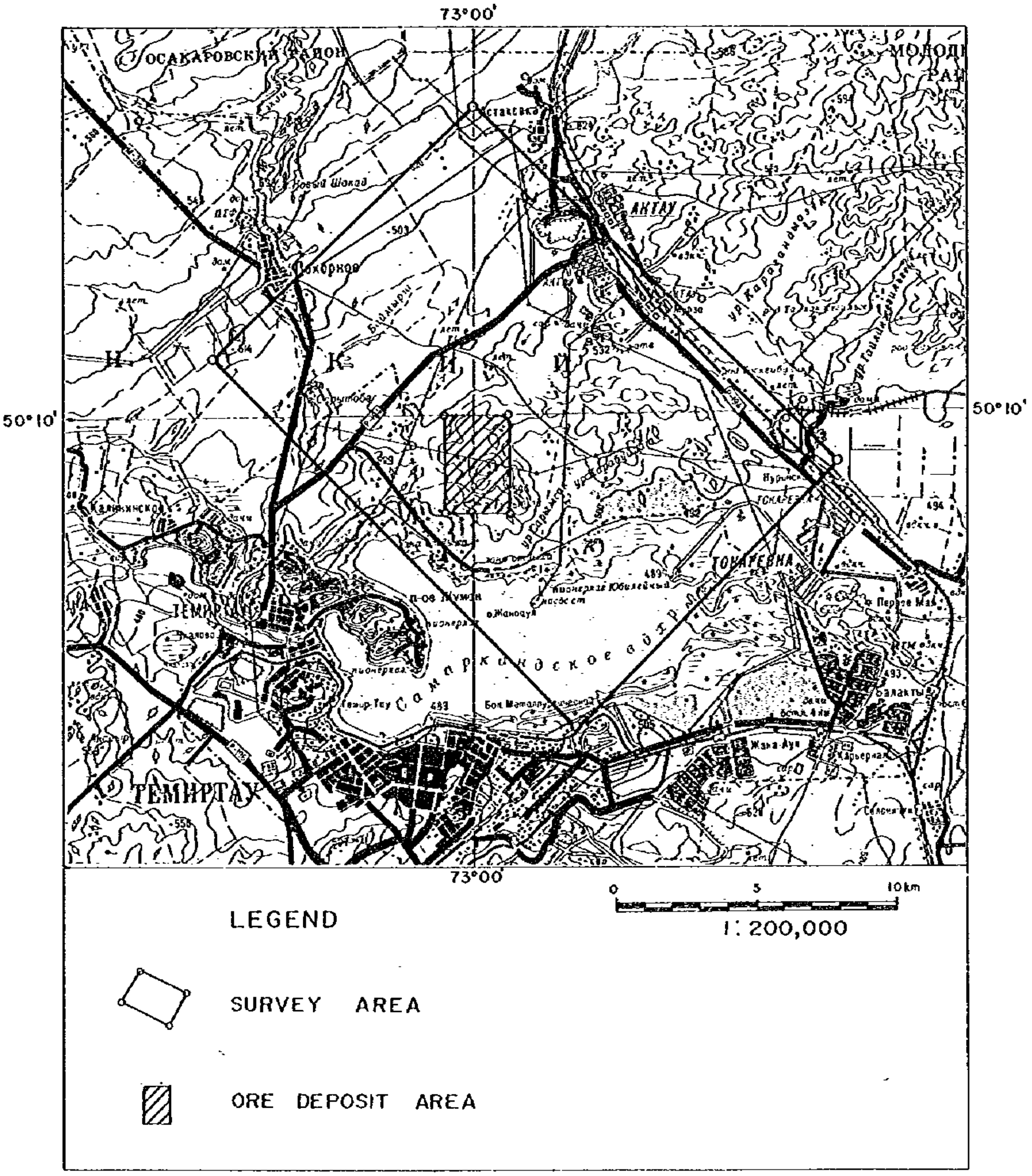


Fig. 1-1-2 Location Map of the Samarsky Area

1-3 Survey Area

The Zhaman-Aibat copper deposit area is located in the Zhana-Arkin district of the Zhezkazgan region, 180km to the southeast of Zhezkazgan in Central Kazakhstan. The topography of the area is characterized by hummock relief with relative elevations up to approximately 30m. The altitude of the Zhaman-Aibat copper deposit area is approximately 320~380m above sea level (Fig.1-1-1).

The Samarsky copper deposit area is located in the Telmansky district of the Karaganda region 35 km to the north of Karaganda and 10km to the north of Temirtau. The topography of the area is characterized by hummock relief, and the altitude is approximately 490~590m above sea level (Fig.1-1-2). Access to the Samarsky copper deposit from Karaganda is by highway : Karaganda-Temirtau-Polornoye-Tselinograd route (No.36).

1-4 Outline of the Survey

The outline of the survey carried out within the period of three years commencing from 1994 is sown in Table 1-1-1, and the details are shown in Table 1-1-2, Table 1-1-3 and Table 1-1-4. The scope of the work from 1994 to 1996 is as follows;

First Year's Survey (1994)

1) Data collection and compilation
   Target area : Zhanan-Aibat area and Samarsky area
   Collected data : mainly concerned with geology, geochemistry and geophysics
   Place of data collection : Ministry for Geology and Conservation of Mineral Resources (here-in-after referred to as MFG), A.O. Zhezkazgangeologya and A.O. Karagandageologya

2) Geological Resources Estimation
   Target area : Block A in the Zhaman-Aibat Deposit and the Central Deopsit in the Samarsky area
   Calculation method : polygon method for Block A, and panel method for the Central Deposit

3) Satellite Image analysis
   Target area : Zhaman-Aibat area, 1,800km^2
   Satellite data : Landsat TM5

Second Year's Survey (1995)

1) Data collection and compilation
   Target area : Zhaman-Aibat area
   Collected data : mainly concerned with drill core assays, mining technology, ore dressing tests and geology,
   Place of data collection : A.O. Zhezkazgangeologya and A.O. Zhezkazgantsuvetmet

2) Geological Resources Estimation
   Target area : Eastern Orebody and a part of Central Orebody in the Zhaman-Aibat Deposit
   Calculation method : Polygon method

3) Drilling Survey

Target area: Eastern Orebody in the Zhaman-Aibat Deposit

Name of drill hole : MJK-1

Total drill length : 650.50m

Inclination : vertical

Mineralization : copper ore mainly composed of chalcocite

4) Ore Dressing Test

Test samples : mineralized cores (copper ore) recovered from MJK-1

Weight of the test samples : 23kg

Preliminary tests : grindability, bulk rougher flotation, flotation speed, straight differential flotation and size analysis of flotation tailings

Bulk differential flotation tests : investigation of the particle size and collectors in copper-lead separation

Third Year's Survey (1996)

1) Data collection and compilation

Target area : Zhaman-Aibat area

Collected data : mainly concerned with drill core assays, mining technology, mining cost, infrastructure, ore dressing tests and geology,

Place of data collection : A.O. Zhezkazgangeologya and A.O. Zhezkazgantsuvetmet

2) Geological Resources Estimation

Target area : Eastern Orebody, Central Orebody and Northern Orebody in the Zhaman-Aibat Deposit

Calculation method : Polygon method, geostatistics

3) Drilling Survey

Target area: Central Orebody in the Zhaman-Aibat Deposit

Name of drill hole : MJK-2

Total drill length : 700.00m

Inclination : vertical

Mineralization : Complex Ore mainly composed of chalcocite and galena

4) Ore Dressing Test

Test samples : mineralized cores (copper ore) recovered from MJK-2

Weight of the test samples : 80kg

Preliminary tests : grindability, bulk rougher flotation, bulk rougher flotation in different grinding sizes, selection of collector, straight differential flotation, semi-bulk flotation and size analysis of flotation tailings

Substantial flotation tests : regrinding of bulk concentrate, lead-copper /zinc differential flotation and cleaning flotation, separation of copper, lead and zinc, cleaning of rougher copper and lead concentrates, confirmation test

Table 1-1-1 Outline of the Project Works Carried Out in 1994, 1995 and 1996

Fiscal Year	Field Works Duration	Area	Items	Remarks
1994	Dec. 8th, 1994 - Feb. 1st, 1995	Zhaman-Aibat	Data collection, compilation and evaluation	Previous works
			Geological resources estimation	Block A of the Eastern Orebody
			Satellite image analysis	Data: Landsat TM5
			Geological survey	Site survey for the satellite image analysis
			Laboratory tests	Details are shown in Table 1-1-2
		Samarsky	Data collection, compilation and evaluation	Previous works
			Geological resources estimation	Central Cu-Mo Deposit
			Laboratory tests	Details are shown in Table 1-1-2
1995	Jul. 25th, 1995 - Sep. 29th, 1995	Zhaman-Aibat	Data collection, compilation and evaluation	Previous works,mining technology and data base construction
			Geological resources estimation	Eastern and Central Orebody
			Drilling survey	MJK-1 (depth=650m) in the Eastern Orebody
			Laboratory tests	Details are shown in Table 1-1-2
			Ore dressing test	Copper Ore, details are shown in Table 1-1-3
1996	Jul. 11th, 1996 - Aug. 30th, 1995	Zhaman-Aibat	Data collection, compilation and evaluation	Previous works,mining technology and data base construction
			Geological resources and ore reserve estimation	Eastern, Central and Northern Orebody
			Development plan of the Zhaman-Aibat Mine	Conceptual design, cost estimation etc.
			Drilling survey	MJK-2 (depth=700m) in the Central Orebody
			Laboratory tests	Details are shown in Table 1-1-2
			Ore dressing test	Complex Ore, details are shown in Table 1-1-4

Table 1-1-2 List of Labolatory Tests

Fiscal Year	Items		Number
	Observation of thin sections	:	10
1994	Observation of polished sections	:	10
	Whole rock analysis	:	10
	SiO_2, TiO_2, Al_2O_3, Fe_2O_3, FeO, CaO, MnO, Na_2O, MgO, K_2O, P_2O_5, LOI		
	Assays of mineralized samples	:	50
	Au, Ag, Cu, Pb, Zn		
	Observation of thin sections	:	5
1995	Observation of polished sections	:	8
	Whole rock analysis	:	5
	SiO_2, TiO_2, Al_2O_3, Fe_2O_3, FeO, CaO, MnO, Na_2O, MgO, K_2O, P_2O_5, LOI		
	Assays of mineralized samples	:	72
	Au, Ag, Cu, Pb, Zn, Fe(total), Re, S(sulfide), S(sulfate)		
	Assays of mineralized samples	:	8
	Au, Ag, Cu, Pb, Zn, Fe(total), Re, S(sulfide), S(sulfate),S(elemental), $Fe(2+)$		
	Electron microprobe analisis of ore minerals	:	3
	Cu, Pb, Ag, Fe, S		
	Color image mapping by electron microprobe analisis	:	3
	Cu, Fe, Ag, S		
	Check assays of mineralized samples	:	36
	Ag, Cu, Pb, Zn		
	Observation of thin sections	:	10
1996	Observation of polished sections	:	15
	X-ray diffractive tests (bulk)	:	5
	Whole rock analysis	:	5
	SiO_2, TiO_2, Al_2O_3, Fe_2O_3, FeO, CaO, MnO, Na_2O, MgO, K_2O, P_2O_5, LOI		
	Assays of mineralized samples	:	97
	Au, Ag, Cu, Pb, Zn, Fe(total), Re, S(sulfide)		
	Assays of mineralized samples	:	6
	Au, Ag, Cu, Pb, Zn, Fe(total), Re, S(sulfide), S(sulfate), $Fe(2+)$		
	Assays of mineralized samples	:	30
	Ag, Cu, Pb, Zn		
	Electron microprobe analisis of ore minerals	:	13
	Cu, Pb, Zn, Ag, Fe, S		
	Color image mapping by electron microprobe analisis	:	3
	Cu, Pb, Fe,S		

Table 1 - 1 - 3 Ore Dressing Tests : Copper Ore

Item	Tests and analyses	Times	Number of samples	Total number of analyses
Phisical analyses				
	① Mesurement of work index	1	1	1
	② Microscopic observatioon of polished ore	---		3
	③ Chemical analyses of ore (19 elements;Cu,Pb,Zn,Fe, S,Sb,As,Bi,Cd,Hg,Au,Ag, Re,SiO_2,Al_2O_3,MgO,CaO, K_2O,Na_2O)	---		1
	④ Powder X-ray diffractometer analyses of ore	---		1
Preliminary metallurgical tests				
Grinding test	① Chemical analyses (3 elements; Cu, Pb, S)	3	5 (5 size ranges)	15
Rougher flotation test (Bulk flotation)	① Chemical analyses (2 elements; Cu, Pb)	3	4	12
Kinetic flotation test	① Chemical analyses (3 elements; Cu, Pb, S)	2	5	10
	② Chemical analyses (Bulk conc. :5 elements; Cu, Pb, Zn, Fe, S)	---	---	1
Straight-differential flotation test (Comparing test)	① Chemical analyses (2 elements; Cu, Pb)	3	4	12
Particle size analyses of flotation tailings	① Chemical analyses (2 elements; Cu, Pb)	3	5 (5 size ranges)	15
Differential flotation tests				
Cleaning flotation test (flotation size)	① Chemical analyses (2 elements; Cu, Pb)	3	4	12
Cleaning flotation test (reagents)	① Chemical analyses (2 elements; Cu, Pb)	4	4	16
Confirmation test (Flotation conditions)	① Chemical analyses (2 elements; Cu, Pb)	4	5	20
	② Microscopic observation of polished ore (Cu conc., Tailing)	---	---	3
	③ Chemical analyses of conc. (Cu conc., Pb conc. 21 elements : Cu,Pb,Zn,Fe, S,Sb,As,Bi,Cd,Hg,Au,Ag, Cl,F,Re,SiO_2,Al_2O_3,MgO, CaO,K_2O,Na_2O)	---	---	2

Table 1 - 1 - 4 Ore Dressing Tests : Complex Ore

Item	Tests and analyses	Times	Number of samples	Total number of analyses
Phisical analyses				
	① Mesurement of work index	1	1	1
	② Microscopic observatioon of polished ore	---		1
	③ Chemical analyses of ore (23 elements;Cu,Pb,Zn,Fe, S,Sb,As,Bi,Cd,Hg,Au,Ag,Te, Mo,Re,SiO_2,Al_2O_3,MgO,CaO, K_2O,Na_2O,Cl,F)	---		1
	④ Powder X-ray diffractometer analyses of ore	---		1
Preliminary metallurgical tests				
Grinding test	① Chemical analyses (5 elements; Cu, Pb, Zn, Fe S)	3	4	12
Rougher flotation test (Bulk flotation)	① Chemical analyses (5 elements; Cu, Pb, Zn, Fe S)	1	1	1
Particle size rougher flotation	① Chemical analyses (3 elements; Cu, Pb, Zn)	4	4	16
Collector test	① Chemical analyses (3 elements; Cu, Pb, Zn)	4	4	16
Straight-differential flotation test (Comparing test)	① Chemical analyses (3 elements; Cu, Pb, Zn)	3	7	21
Semi-comprehensive flotation	① Chemical analyses (3 elements; Cu, Pb, Zn)	2	3	6
Particle size analyses of flotation tailings	① Chemical analyses (3 elements; Cu, Pb, Zn)	8	4	32
Differential flotation tests				
Regriding test (Comprehensive flotation)	① Chemical analyses (5 elements; Cu, Pb, Zn, Fe S)	3	3	9
Pb-Cu,Zn separation flotation test	① Chemical analyses (3 elements; Cu, Pb, Zn)	3	6	18
Cu-Zn separating flotation test	① Chemical analyses (3 elements; Cu, Pb, Zn)	3	6	18
Cleaning flotation test	① Chemical analyses (3 elements; Cu, Pb, Zn)	9	4	36
Confirmation test (Flotation conditions)	① Chemical analyses (3 elements; Cu, Pb, Zn)	3	5	15
	② Microscopic observation of polished ore (bulk, conc.)	---	---	2
	③ Microscopic observation of polished ore (Cu conc., Pb conc., Zn conc.)	---	---	3
	④ Chemical analyses of conc. (Cu conc., Pb conc., Zn conc.) 20 elements : Fe,S,Sb,As,Bi, Cd,Hg,Au,Ag,Te,Mo,Re,SiO_2, Al_2O_3, MgO,CaO,K_2O,Na_2O. Cl,F,	---	---	3

1-5 Survey Duration

First year's survey (1994)	Site Survey	: from December 11th, 1994 to February 1st, 1995
	Data analysis	: from February 2nd, 1995 to February 28th, 1995
Second year's survey (1995)	Site Survey	: from July 25th, 1995 to September 29, 1995
	Data analysis	: from September 30, 1995 to February 29th, 1996
Third year's survey (1996)	Site Survey	: from July 11th, 1996 to August 30th, 1996
	Interim reporting	: from November 24th, 1996 to December 7th, 1996
	Data analysis	: from August 31th, 1996 to February 28th, 1996

1-6 Organization

Members of the preliminary mission are listed in Table 1-1-5 together with members from the Kazakhstan side. The member list of the survey team is shown in Table 1-1-6.

Table 1-1-5 Preliminary Mission and Kazakhstan Personnel Attended the Meeting

JAPAN	Republic of Kazakhstan
Mr. Masamo Kando (Mining Division, MITI*1)	Mr. Bitimbaev Zh. M. (Deputy Minister, MFG*2)
Mr. Fumihiro Ono (Mining Division, MITI)	Mr. Tjugai M. O. (Head of Mineral Resources Dpt., MFG)
Mr. Kenichi Takahashi (JICA*3)	Mr. Mokohov V. A. (Deputy Head of Solid Minerals Dpt., MFG)
Mr. Jiro Osako (Overseas Activities Department, MMAJ*4)	Mr. Schelchkov E. M. (Deputy Head of Geological Information Dpt., MFG)
Mr. Takahisa Yamamoto (Overseas Activities Department, MMAJ)	Mr. Sadchikov B. Y. (Deputy General Director of the Dpt. of the Mining and Smelting Compex, Min. of Trade and Industry)
Mr. Yoshihiro Kubota (Overseas Activities Department, MMAJ)	

*1: Ministry of International Trade and Industry
*2: Ministry for Geology and Conservation of Mineral Resources of the Republic of Kazakhstan
*3: Japan International Cooperation Agency
*4: Metal Mining Agency of Japan

Table 1-1-6 Member List of the Survey Team

Fiscal Year	Japanese Survey Team	Kazakhstan Survey Team
1994		***Zhezkazgangeologiya***
	Mr. Akeo Onishi (Leader, Sumiko Consultants Co., Ltd.)	Mr. Khuseinov Zh.I. (President)
	Mr. Kazuo Sano (Sumiko Consultants Co., Ltd.)	Mr. Ospanov U. O. (Chief Deputy)
	Mr. Yoshio Takeda (Sumiko Consultants Co., Ltd.)	Mr. Kasimovski P. A. (Chief Engineer)
	Mr. Ryo Kubota (Sumiko Consultants Co., Ltd.)	Mr. Kazimir V. T. (Chief Geophysicist)
		Mr. Suleimenov K. (Chief Geologist)
		Mr. Uzhva V. I. (Chief Geologist of Zhaman-Aibat Party)
		Mr. Ospanov K S. (Production Manager)
		Karagandageologiya
		Mr. Userov Z. S. (President)
		Mr. Brown V. V. (Vice-President)
		Mr. Gabay M. L. (Cheif Geologist)
		Mr. Gusev N. M. (Chief of Samarsky Party)
		Mr. Medvedev V. K. (Chief Geologist)
		Mr. Kovalev A. V. (Chief Geologist)
		Mr. Esshenko A. V. (Chief Engineer)
1995		***Zhezkazgangeologiya***
	Mr. Akeo Onishi (Leader, Sumiko Consultants Co., Ltd.)	Mr. Khuseinov Zh I. (President)
	Mr. Yoshio Takeda (Sumiko Consultants Co., Ltd.)	Mr. Ospanov U. O. (Vice-President)
	Mr. Sumio Kudo (Sumiko Consultaats Co., Ltd.)	Mr. Kasimovski P. A. (Vice-President)
	Mr. Akihiko Murase (Sumiko Consultants Co., Ltd.)	Mr. Kazimir V. T. (Chief Geophysicist)
	Mr. Takaaki Nagao (Sumiko Consultants Co., Ltd.)	Mr. Ospanov K.S. (Production Manager)
		Mr. Uzhva V. I. (Chief Geologist of Zhaman-Aibat Party)
		Mr. Cheglakov A.I. (Chief Engineer)
		Mr. Baimaeldinov E.B. (Head of Zhaman-Aibat Party)
		Mr. Shingisov A.U. (Chief Engineer of Zhaman-Aibat Party)
		Mr. Nisambaev A.O. (Drilling Master)
		Zhezkagantsvetmet
		Head Office
		Mr. Ibraeva G. N. (Manager of planning)
		Mr. Gennadi P. (Manager of development)
		Mr. Tanenov T. I. (Chief geologist)
		East Mine
		Mr. Uruymov B. A. (Mine Manager)
		Mr. Sopoviev C. H. (Production manager)
		South Mine
		Mr. Biljanov A. (Technical manager)
		North Mine
		Mr. Kozhubayev M. K. (Chief engineer)
		Mr. Irzhanov A. (Assistant production manager)
		Mr. Ikonnikov G. (Chief geologist)
		Reserch Center
		Mr. Kunashbaev S. (Vice president)
		No.1 Mill & No.2 Mill
		Mr. Tokbulatov T. (Chief engineer)
		Mr. Volyada V. (Production manager)

Table 1-1-6 Member List of the Survey Team (*continued*)

Fiscal Year	Japanese Survey Team	Kazakhstan Survey Team
1996	**Survey team**	***Zhezkazgangeologiya***
	Mr. Akeo Onishi (Leader, Sumiko Consultants Co., Ltd.)	Mr. Khuseinov Zh.I. (President)
	Mr. Mitsuru Suzuki (Sumiko Consultants Co., Ltd.)	Mr. Kazimir V. T. (Vice-President)
	Mr. Takaaki Nagao (Sumiko Consultants Co., Ltd.)	Mr. Aristanbaev A. A. (Vice-President)
	Mr. Masashi Hayakawa (Sumiko Consultants Co., Ltd.)	Mr. Uzhva V. I. (Chief Geologist of Zhaman-Aibat Party)
	Mr. Makoto Umedera (Sumiko Consultants Co., Ltd.)	Ms. Orlova V. N. (Geologist of Zhaman-Aibat Party)
		Ms. Soklina L. R. (Geologist of Zhaman-Aibat Party)
	Interim reporting mission	Mr. Cheglacov A I. (Chief Engineer)
	Mr.Yoshitaka Hosoi	Mr. Dayletbaev M. (Head of Zhaman-Aibat Party)
	(Overseas Activities Department,MMAJ)	Mr. Arqatyk S. V.(Drilling Master)
	Mr.Toshio Chiba (Account Department,MMAJ)	
	Mr. Akeo Onishi (Leader, Sumiko Consultants Co., Ltd.)	***Zhezkagantsvetmet***
		Head Office
		Mr. Lavetskij (Technical Manager)
		Mr. Tanenov T. I. (Chief geologist)
		Mr. Chuikov (Deputy manager, transport)
		Ms. Etkina (Deputy manager, construction)
		Mr. Labodsky (Deputy manager, equipment)
		Mr.Malakhov (Deputy manager, materials)
		Mining Department
		Mr. Shechepkin (Deputy exective, blasting)
		Mr. Isayev (Chief mining engineer)
		Mr. Zhabaspaev (Account manager)
		Mr. Dhmyga (Deputy chief geologist)
		Mr. Eshcheuko (Deputy manager, geomechanics)
		Mr. Vakhzushev (Deputy manager, mining Dept.)
		Reserch & Design Institute
		Mr. Shayakhmetov (Chief engineer)

Chapter 2 Geography of the Survey Area

2-1 Location and Access

The Zhaman-Aibat Area is located in the south-western part of Central Kazakhstan, approximately 180km southeast of Zhezkazgan. The geographic coordinates of the four corners of the Zhaman-Aibat survey area are (in clockwise direction) Point 1; 46° 40' 10"N / 68° 41' 30"E, Point 2; 46° 55' 30"N / 68° 34' 00"E, Point 3; 47° 06' 00"N/69° 18' 40"E, Point 4; 46° 50 '40"N /69° 26'00"E (Fig.1-1-1).

The area is accessible by driving 90km from Zhezkazgan on an all-weather road (the Kzyl-Orda road) to the junction of the Sarysu River bridge and then driving eastward for about 90km on a gravel road to reach Zhaman-Aibat Area via the village of Jetykonur.

The Samarsky survey area is located in the Telmansky district of the Karaganda region 35km to the north of Karaganda, and 10km to the north of Termitau. Geographic coordinates of the corners of the Samarsky survey are are (in clockwise direction) Point 1; 50° 11'25"N/72° 52'45"E, Point 2; 50° 16'45"N/73° 00'00"E, Point 3; 50° 09'38"N/73° 10'50"E, Point 4; 50° 04'18"N/ 732'47"E (Fig.1-1-2).

The area is accessesible from Karaganda by: the Karaganda-Temirtau-Tselinograd all-weather road (Route 36) for approximately 30km; route 194 toward the town of Akutau from the junction 5km north of Temirtau for approximately 5km; a paved road heading to the southeast to the Samarsky Sanatorium on the north shore of a water reservoir (approx. 5km); a gravel road from the Sanatorium heading to the north (approx. 5km).

2-2 Topography

The Zhaman-Aibat Area is located on the eastern flank of the Zhezkazgan-Sarysu depression formed during the Carboniferous age. The area may physiographycally be divided into two units reflecting underlying geology. The first unit has relatively moderate relief, low hills with relative heights 10-30m and absolute heights ranging from 300 to 320m altitude. The second unit is of high relief in the center of the area, where the Zhaman-Aibat horst anticline is formed. The relative height difference between the 2 units is approximately 60-80m. The drainage in the area is partly integrated due to the dry continental climatic condition.

The topography of the Samarsky survey area belongs to "stage of old age" classification and it is characterized by low hills. Hill and valley form of relief prevails in the area. The altitude varies from 500m to 600m. The relief is complicated by shallow seasonal river beds of small nameless rivers, run-off dells and small artificial water storage areas and open pits (quarries). The highest elevation in the area of the deposit is 594.2m and the lowest point is 489.3m.

2-3 Climate and Vegetation

Climate of both survey areas is sharp continental and is classified as a zone of dry feather-grass steppe. Those areas are arid in all seasons with very small amounts of rain in summer and several tens of centimeters of snow in winter. The vegetation in these areas is very thin. With a sharp continental climate, the surface of the ground is rarely covered by xerophytic vegetation in the summer season. The major vegetation in both survey areas is feathergrass, sagebrush and other groups of grasses. Therefore, it is very suitable for exploration by remote-sensing methods.

In the Zhaman-Aibat Area the average annual temperature is +5.5° C with the average monthly summer temperature up to +33° C. In winter the temperatures fall to -33° C. The average precipitation in the area is 140-150mm per annum (Table 1-2-1).

In the Samarsky area the average annual temperature is +3.1° C with an average monthly summertime temperature up to +23° C. In winter temperatures are as low as -18° C. The average annual precipitation does not exceed 250 mm, but 1992 and 1993 were extraordinarily wet years (Table 1-2-2).

Table 1-2-1 Climatological Data of the Zhezkazgan Area

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave./Total
Maximum Temperature (℃)	-15	-10	-5	15	30	35	35	25	20	15	5	-10	-
Minimum Temperature (℃)	-30	-25	-10	10	20	25	25	20	15	5	-3	-20	-
Average Temperature (℃)	-16.0	-14.6	7.2	6.2	15.5	21.6	24.0	21.4	14.4	4.8	-5.1	-12.8	5.5
Precipitation (mm)	13	12	14	14	11	17	16	11	8	12	10	12	150

Minimum Temperature -50.0 ℃
Maximum Temperature 43.0 ℃

(Zhaman-Aibat Exploration Camp)
Total snow covered days 120 - 150 days
Rainy season : June - August

Table 1-2-2 Climatological Data of the Samarsky Area

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Average Temperature (℃)													
1991	-12.5	-15.4	-9.0	5.9	14.2	21.6	21.3	16.5	14.1	8.4	-1.7	-10.4	4.4
1992	-8.7	-11.4	-9.2	5.1	11.9	15.7	19.9	16.3	7.7	3.8	-3.2	-9.7	3.2
1993	-11.4	-13.5	-7.0	3.2	10.8	18.1	18.9	18.1	8.3	4.0	-13.7	-13.8	1.8
1991 - 1993	-10.9	-13.4	-8.4	4.7	12.3	18.5	20.0	17.0	10.0	5.4	-6.2	-11.3	3.1
Precipitation (mm)													
1991	44	4	14	7	42	3	26	19	18	14	22	35	248
1992	30	10	11	38	43	39	16	64	35	19	3	36	344
1993	29	33	48	46	32	47	77	19	10	9	16	10	376
1991 - 1993	34.3	15.7	24.3	30.3	39.0	29.7	39.7	34.0	21.0	14.0	13.7	27.0	322.7

Chapter 3 Summary of the Survey Results

3-1 Survey Results of the Zhaman-Aibat Area

3-1-1 Previous Geological Works

Systematic geological works in the Zhaman-Aibat Area started in the 1920's. From 1959 to 1964, the Zhezkazgan Exploration Expedition Party drilled in the Zhaman-Aibat Area and confirmed copper mineralization at the depth of 400 - 700m beneath the surface. Its thickness was estimated as 0. 4 - 1.0m with copper grade of 1.16 - 1.30%. During the period from 1981 to 1984, the exploration by the Zhezkazgan Exploration Expedition Party resulted in the detection of commercial grade copper and copper-lead mineralization at the depth of 615m - 700m. According to the drilling statistics, since 1981, a total of 1,006 holes have been drilled with a total drilling length of 638,587m. Of the 1,006 holes, a total of 835 were for exploration purposes and 171 holes were drilled with large diameter and short length for sampling.

3-1-2 Geology and Mineralization

(1) The Zhaman-Aibat Area is located at the zone of intersection of the Chu-Ili anticlinorium with the eastern edge of the Zhezkazgan Sarysu depression (Fig.1-3-1, Fig.1-3-2). The geologic formations of the area range mainly from the Carboniferous to the Cretaceous in age. The absence of igneous and intrusive activities and significant thickness of sediments are characteristics of the geology in the area. The tectonic structure of the ore deposit area is related to the axial zone of the Zhaman-Aibat horst anticline, stretching in sub-latitudinal direction with steep northern and gentle southern limbs (Fig.1-3-3).

(2) The stratiform copper mineralization occurs exclusively in the grey-colored alluvial-deltaic sandstone faces within " Red Sandstone Formation" of the Carboniferous (Fig.1-3-4).

(3) More than 900 drill holes on a 200m × 200m grid spacing confirm that there are three main orebodies, namely, the Central, Northern and Eastern Orebodies. These orebodies are distributed in an area with dimensions : 12.5km in the east-west direction and approximately 5 km in the north-south direction (Table 1-3-1, Fig.1-3-3).

(4) The depth of the ore horizon is approximately 460m～480m in the eastern area and the depth increases towards the west. At the western edge of the Central Orebody it reaches 650m in depth.

(5) The Taskuduk Formation contains five ore horizons, the Zhezkazgan Formation six horizons and the Zhidelisai Formation one horizon. Major commercial mineralization is confined to the Ore Horizon 4-I. Copper grade, thickness and area extent of the Ore Horizon 4-I are overwhelmingly greater than those of any other ore horizon (Table 1-3-2).

(6) The mineral assemblage of the ore is comparatively simple. The main minerals are

chalcocite, digenite and bornite. Galena, chalcopyrite and pyrite are in small amounts. Accessory minerals are sphalerite, covellite, tennantite, electrum, native silver and native copper.

(7) Major ore types are confined to the Copper Ore (Cu), Complex Ore (Cu+Pb+Zn) and Lead-Zinc Ore (Pb+Zn). Based on the result of ore reserve (geological resources) estimation by the Japanese survey team, the Copper Ore accounts for 87% and Complex Ore accounts for 11% of total ore reserves.

Table 1-3-1 List of Mineral Showings in the Zhaman-Aibat Area

	Zhaman-Aibat	Taskura
Type of Deposit	Stratiform Copper Deposit	Stratiform Copper Deposit
Ore Type	Cu, Pb, (Zn), Ag	Cu
Dimension	14km(EW) x 4km(NS)	0.3km(EW) x 0.3km(NS)
Depth	470 - 710m	0 - 30m
Ore Grade	1.4% Cu, 0.3% Pb, 16g/t Ag	1.0 - 1.3% Cu
Ore Reserve	190 million tons	7 - 9 million tons
Ore Minerals	Chalcocite, Digenite, Djurleite Bornite, Chalcopyrite, Galena	Chalcocite, Bornite, Chalcopyrite Malachite

Table 1-3-2 Characteristics of Each Orebody in the Zhaman-Aibat Ore Deposit

Orebody		Eastern Orebody	Central Orebody		Northern Orebody
Ore Horizon	Main	4-I	4-I		4-I
	Minor	3-V ~ VI, 4-II ~ III	3-V ~ VI, 4-II ~ III		3-V ~ VI
Ore Type		mainly Copper Ore	Complex Ore and Copper Ore		mainly Copper Ore
Ore Reserve*		116 million tons	38 million tons		39 million tons
Thickness (average)*		5.5m	4.6m		6.6m
			Complex Ore	Copper Ore	
Ore Grade* (average)	Cu	1.3%	1.5%	1.9%	1.3%
	Pb	-	1.8%	0.3%	0.1%
	Zn	-	0.3%	0.1%	-
	Ag	11g/t	11g/t	11g/t	37g/t

*: after the results of geological resources estimation (see Part II Chapter3)

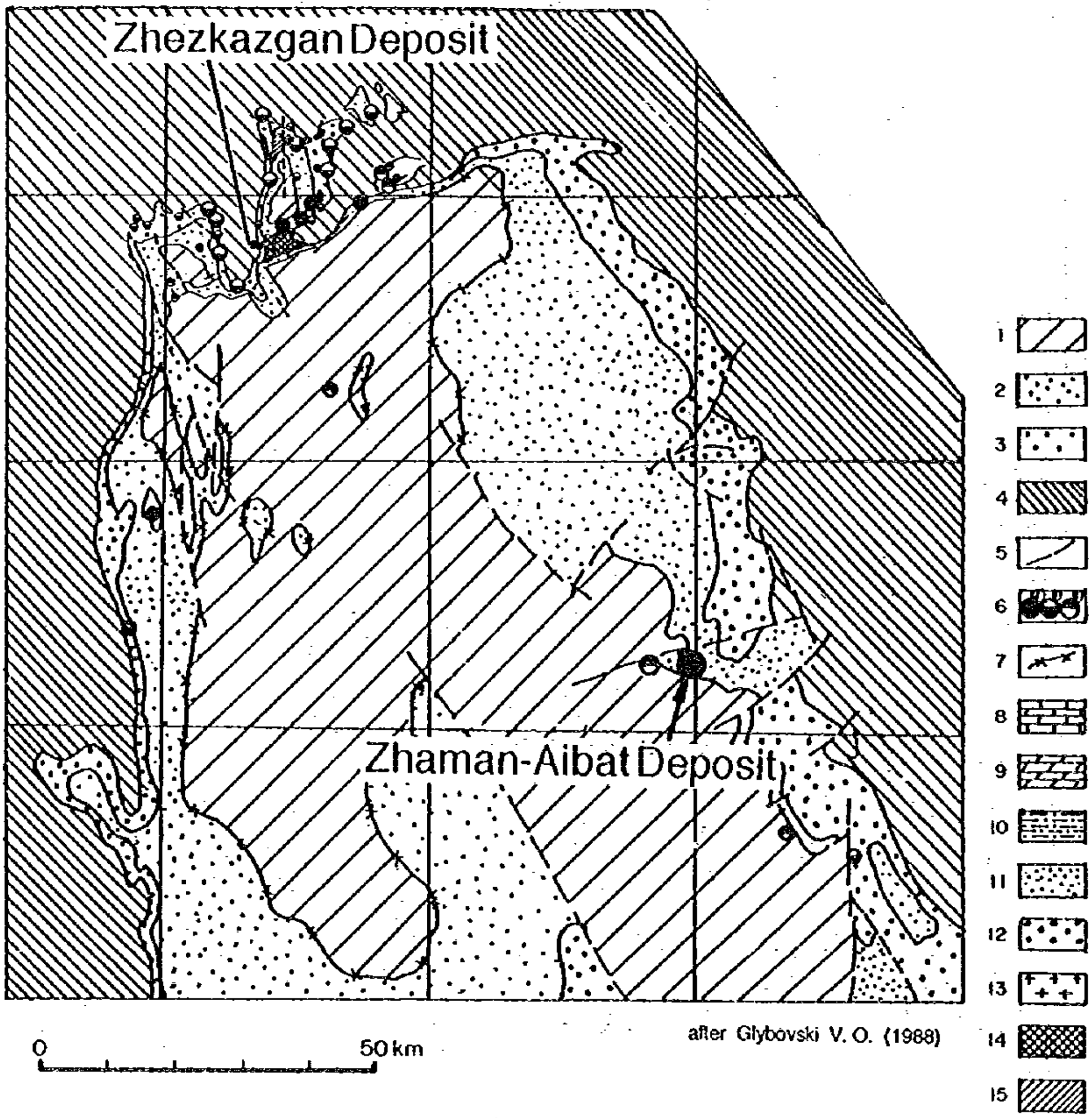
Ministry of Geology (1982)

0 15 30 45 60 75 km

LEGEND

Q_{I-IV}	Quaternary		Boundary of formation
$N_1^1 2$	Neogene		Boundary of contemporaneous meteropic facies
$P_1^1 3$	Paleogene		Boundary of tectonic zone
K	Cretaceous		Thrust fault
$P_1^1 2$	Permian		Equi-contour line of base of blanket layer
C_3	Upper Carboniferous		Tectonic zone
C_2	Middle Carboniferous	$\gamma\beta$	Gabbro
$C_1 V\text{-}3$	Lower Carboniferous; Serpukhov Stage	δ	Serpentinite, dunite
D	Devonian	β	Diabase, diabase-porphyry
S	Silurian		Acidic efusive rocks
O	Ordovician		Intermediate efusive rocks
Є	Cambrian		Zhaman-Aibat Area

Fig.1-3-1 Regional Geological Map of the Zhaman-Aibat Area



1 Grey marl deposition of Permian
2 Red rhodusite-gypsum-salt-bearing formation of evaporite type of lower Permian
3 Cuprous red formation of middle and upper Carboniferous
4 Grey terrigenous-Carboniferous depositions of lower Carboniferous
5 Tectonic dislocation
6 Type of mineralization of cuprous sandstone (a-Zhezkazgan type, b-Zhilandin type, c-Mansfeld type)
7 Cuprous stratum of Mansfeld type
8 Limestone including flints
9 Marl
10 Aleurolite and argillite
11 Sandstone
12 Conglomerate
13 Gypsum and salt
14 Zhezkazgan type deposit (actual mining or exploration completed)
15 Zhilandin type deposit (exploration completed)

Fig.1-3-2 Regional Distribution of Stratiform Copper Deposits in the Zhezkazgan-Sarysu Depression

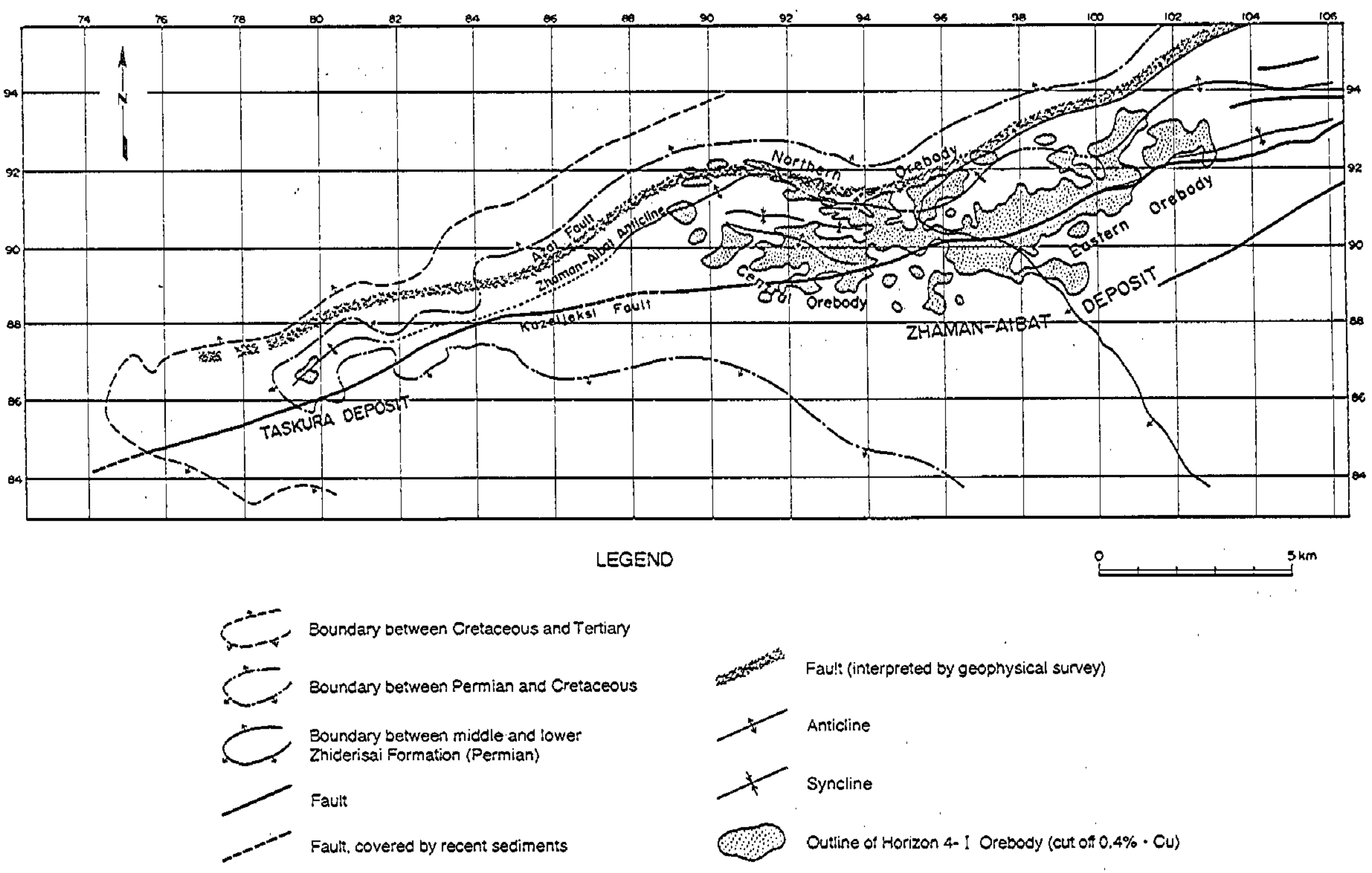
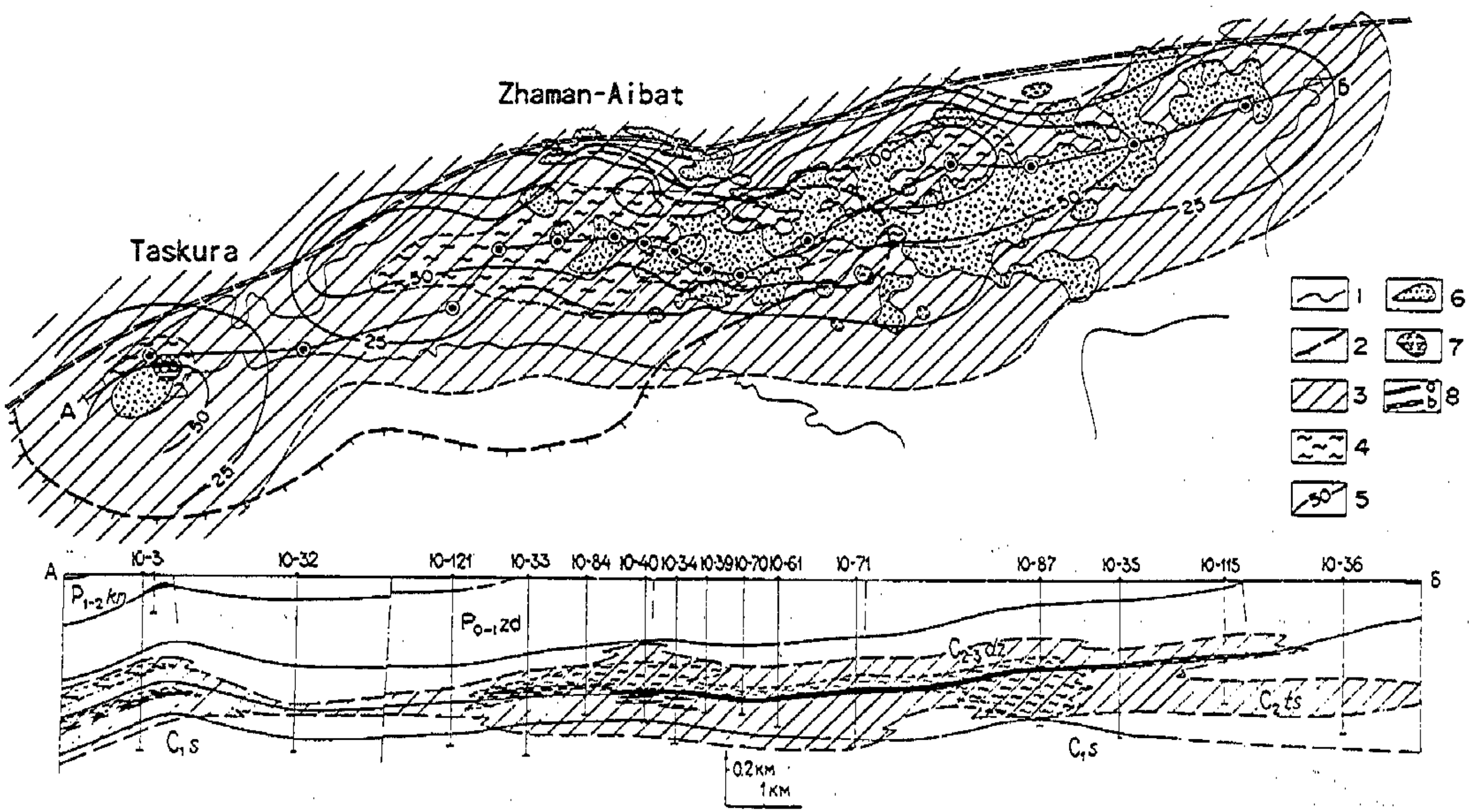


Fig.1-3-3 Geological Structure of the Zhaman-Aibat Area



1 Boundary of outcrop of cuprous red coloured formation
2 Epicentre of con-sedimentation
3 Distributed area of epigenetic grey coloured rocks
4 Distributed area of syngenetic grey coloured rocks
5 Isopac line of grey sandstone
6 General outline of assumed-commercial mineralization of the Zhezkazgan type
7 The outline of assumed-commercial mineralization of the Mansf eld type
8 Ore body (a: high grade, b: low grade)

Glybovski V. O. (1988)

Fig.1-3-4 Geological Setting of the Zhaman-Aibat Ore Deposit

3-1-3 Geological Resources Estimation

(1) For the geological resources estimation, construction of the Zhaman-Aibat Deposit data base was started in 1995, and completed in 1996. Input parameters to this data base are ; locality (E-W coordination, N-S coordination), elevation, inclination (inclination, azimuth), depth of samples, assay data (Cu, Pb, Zn, Ag, Re, S) and ore horizon.

(2) The Eastern Orebody and the main part of the Central Orebody were selected for the geological resources estimation in the first and second year's studies. For the third year's study, the overall geological resources of the Zhaman-Aibat Deposit were estimated.

(3) The polygon method was utilized for the estimation. The ore blocks were constructed by the polygon method. The ore reserves and metal amount were calculated for each polygon block. The average specific gravity was assumed as 2.600 which is the same value used by the Zhezkazgangeologiya.

(4) The mineralized layers were calculated and categorized into three types of ore according to their major chemical characterisics. They are Copper Ore, Complex Ores and Lead-Zinc Ores. The cut-off grade for each ore type was determined, according to the resolution of the Zhezkazgangeologya. The cut-off grades were set at 0.4% Cu for the Copper Ores, 0.8%Pb+Zn and 0.3%Cu for the Complex Ores, 1.1%Pb+Zn for the Lead-Zinc Ores.

(5) The calculated ore reserves of each polygonal block were categorized into three groups on the basis of exploration stage, and were correlated to three ore reserve categories: a) Category I; drill pattern is denser than 200m x 200m grid, and continuity (of ore blocks) is confirmed, b) Category II; drill pattern is not denser than 200m x 200m grid, and continuity is confirmed, c) Category III; drill pattern is not denser than 200m x 200m grid, and no spatial continuity is confirmed.

(6) In this report, the geological resources are defined as the total amount of the ore reserves of Category I and Category II.

(7) The geological resources were calculated as ;

Eastern Orebody:	116million tons	(mainly Cu Ore: 1.3%Cu, 11g/tAg, 5.5m thick),
Central Orebody:	38million tons	(Cu Ore: 1.9%Cu, 11g/tAg, 3.9m thick,
		Complex Ore: 1.5%Cu, 1.8%Pb,0.3%Zn, 11g/tAg, 5.6m thick),
Northern Orebody:	39million tons	(mainly Cu Ore: 1.3%, 37g/t Ag, 6.6m thick),
Total:	193million tons	(1.4%Cu, 0.3%Pb, 16g/tAg, 5.4m thick)

(8) 87.4% of the whole geological resources are Copper Ore, and 10.9% are Complex Ore. Lead-Zinc Ore account for only 1.7% of the geological resources. The zinc grade was calculated as 0.3% in the Complex Ore of the Central Orebody. It can be seen that zinc is not an important factor for the evaluation of the Zhaman-Aibat Deposit. The Copper Ore is widely distributed in the Zhaman-Aibat Deposit, but the Complex Ore and the Lead-Zinc Ore show uneven distributions. 85% of the Complex Ore and 65% of the Lead-Zinc Ore are in the Central Orebody.

(9) In recent years, the Zhezkazgangeologiya calculated the total amount of Copper Ore and Complex Ore in the Zhaman-Aibat Deposit. They estimated that the total ore reserves were 190 - 200 million tons (1.6%±Cu, 0.25%±Pb, 18g/t±Ag). Compared with the results of the Japanese survey team, it can be seen that the copper grade is a little higher. But there is no serious problem in this stage of geological resources estimation.

3-1-4 Remote-Sensing Data Analysis

Photogeological Interpretation of Satellite Images

(1) By the photogeological analysis, the Zhaman-Aibat Area was classified into three topographic categories of desert, low plane and low hills (with three sub-categories).

(2) Geological classification (corresponding to stratigraphy) of the target area was distinguished as 10 geologic units and subunits. Referring to published geologic maps, these geologic units correspond to Permian, Cretaceous and Quaternary systems. The Carboniferous system described in the maps was not however distinguished in the satellite images.

(3) The major geologic structure in the area is the asymmetric anticlinal structure located in the central part. Its axis has a direction of east-north-east and plunges to the west-south-west. Faults cut the anticline and two other incomplete circular structures were also extracted in the image.

Satellite Image Data Processing

(1) Satellite data from Landsat TM5 scenes (Path 155, Row 027 and Path 155, Row 028) were used for the satellite image analysis in the Zhaman-Aibat Area. The processing method involved generation of color composite images and color density slice maps in order to distinguish alteration zones.

(2) Three processed color areas are associated with the Zhaman-Aibat horst anticline; a blue area spreads as a triangle-shape to the west of the horst, a reddish purple area surrounds the horst in a semicircle, and the rest of the area is yellowish green.

(3) The blue area identifies iron oxide and iron hydroxide that coincides with the "red sandstone". The reddish purple area corresponds to Quaternary sediments surrounding the Zhaman-Aibat horst anticline. The yellowish green area corresponds to weathered layers of Quaternary and Cretaceous age.

3-1-5 Drilling Survey

For the purpose of confirming ore stratigraphy and occurrence, and of providing samples for the ore dressing tests, two holes, MJK-1 and MJK-2 were drilled.

MJK-1

MJK-1 (final depth: 650.5m, vertical) was drilled in the Eastern Orebody in 1995 and the copper mineralization (Ore Horizon 4- I) could be observed between the depths of 598.0m and 605.8m.

Depth	: 598.00m - 605.78m
Thickness of mineralization	: 7.78m
Metal content	: 3.78%Cu, 1.17%Pb, 0.03%Zn, 22.7g/tAg, 11.2g/tRe
Ore minerals	: chalcocite>>bornite>galena, chalcopyrite
Mineral occurrence	: light grey - greenish grey, fine - medium grained sandstone, interlayers of grey siltstone and interformational conglomerate consisting of pebble - granule, limestone, shale, dacite.
Alteration	: silicification, chloritization.

MJK-2

MJK-2 (final depth: 700.0m, vertical) was drilled in the Central Orebody in 1996. In this drill hole, the copper and lead mineralization (Ore Horizon 4- I) could be observed between the depths of 605.4m and 619.7m, and weak copper mineralization (Ore Horizons 3-VI and 3-II) between the depths of 630.0m and 635.7m and between 688.9m and 692.5m respectively.

Upper part of Ore Horizon 4-I

Depth	: 605.40m - 613.40m
Thickness of mineralization	: 8.00m
Metal content	: 3.88%Cu, 3.04%Pb, 0.06%Zn, 9.09g/tAg, 18.3g/tRe
Ore minerals	: chalcocite>> bornite, galena>> chalcopyrite, pyrite, covellite, electrum, stromeyerite
Ore structure	: disseminated, patches, laminated
Country rock	: grey - dark grey, fine - coarse grained sandstone (with carbonate cement) and siltstone, with thin interlayers of granule conglomerate (Raimundo Conglomerate)

Lower part of Ore Horizon 4-I

Depth	: 613.40m - 619.65m
Thickness of mineralization	: 6.25m
Metal content	: 1.89%Cu, 0.00%Pb, 0.01%Zn, 3.68g/tAg, 1.7g/tRe
Ore minerals	: chalcocite>> bornite
Ore structure	: disseminated, patches
Country rock	: light grey, medium - coarse grained sandstone with carbonate cement and minor siltstone, with interlayers (20 - 100cm in thickness) of granule - pebble conglomerate (Raimundo Conglomerate)

Ore Horizon 3-VI

Depth	: 630.0m - 635.70m
Thickness of mineralization	: 5.70m
Metal content	: 0.67%Cu, 0.01%Pb, 0.01%Zn, 1.87g/tAg, 0.0g/tRe
Ore minerals	: chalcocite>> bornite> pyrite
Ore structure	: disseminated, lamonated
Country rock	: Greenish grey, midium - coarse grained sandstone with carbonate cement

Ore Horizon 3-II

Depth	: 688.85m - 692.45m
Thickness of mineralization	: 3.60m
Metal content	: 0.30%Cu, 0.14%Pb, 0.01%Zn, 1.45g/tAg, 4.6g/tRe
Ore minerals	: chalcocite>> bornite> galena, chalcopyrite, pyrite
Ore structure	: disseminated
Country rock	: Greenish grey, fine grained sandstone with carbonate cement and siltstone

3-1-6 Ore Dressing Test

Copper Ore

(1) The amount of the composite samples used for the metallurgical tests was about 23kg. It consisted of MJK-1 core mixed with some rock from the hanging wall and foot wall (0.01~0.16%Cu). The grade of the test samples after adjustment was 1.69%Cu, 0.51%Pb, 0.03%Zn, 1.80%Fe, 1.01%S, <0.1g/tAu, 12g/tAg.

(2) The main constituent ore mineral was chalcocite with small amounts of bornite, galena, and pyrite. Minor amounts of chalcopyrite, sphalerite and rutile were also present. The size of mineral particles was generally fine, 1~500 μ m.

(3) The estimated value of the work index was 15.4kwh/t. Generally speaking, this smple ore was rather hard.

(4) The optimized rougher flotation size was minus 200 mesh 65%, and the flotation time was 10 minutes.

(5) For differential flotation, the suitable reagents were sodium isopropyl xanthate as collector and potassium ferrocyanide as depressant.

(6) With greater re-grinding, the lead recovery increased but excessive re-grinding decreased the lead recovery.

(7) By the bulk differential flotation process, a copper concentrate of 39%Cu and 1%Pb with copper recovery of 86% and a lead concentrate of 48%Pb and 11%Cu with lead recovery of 67% were obtained.

(8) By the straight differential flotation process, the copper concentrate of 30%Cu and 3%Pb with copper recovery 85% and the lead concentrate of 59%Pb and 10%Cu with lead recovery 67% were obtained.

(9) Considering the lead concentrate, straight differential flotation is better, but considering the copper concentrate, bulk differential flotation is better. Bulk differential flotation is therefore considered economically superior.

<u>Complex Ore</u>

(1) About 80kg of ore was used to prepare composite samples for metallurgical tests. This material was composed of MJK-2 core (8.00m length, Ore Horizon 4-I) and ore samples which had been obtained by the Kazakhstan team. The composite samples after preparation were 1.70%Cu, 1.11%Pb, 0.03%Zn, 2.21%Fe, 1.00%S, <0.1g/tAu, and 5g/tAg.

(2) The main constituent ore minerals were chalcocite, galena and bornite with small amounts of pyrite, chalcopyrite and sphalerite. The size of mineral particles was generally fine, 1~500 μ m.

(3) The value of the work index was 13.2kwh/t, which is an ordinary value for copper ore.

(4) For differential flotation, the suitable reagents were sodium isopropyl xanthate as collector and potassium ferrocyanide as depressant.

(5) By the bulk differential flotation process, a copper concentrate of 32.3%Cu with copper recovery 92.3% and a lead concentrate of 66.1%Pb with lead recovery 77.6% were obtained. However, a zinc concentrate was not recovered due to low grade of sample ore, zinc is contained in the lead concentrate in this flowsheet.

(9) From the series of test results, it is considered that bulk differential flotation is adaptable to this Complex Ore.

3-1-7 Mining Technology and Mining Cost in the Zhezkazgan Copper Mine

(1) The Zhezkazgantsvetmet joint stock company is holding four mining companies, and is involved in operations from mining, ore-dressing, smelting to refining. The company has been recently established as part of the market economy system after the break up of a "combine" which was the biggest under the former USSR.

(2) At present, under the Zhezkazgantsvetmet, 31,000 people are working in 14 companies, such as mine, ore dressing, smelting, refining etc.

(3) In the summer of 1995 , the Samsung Corporation obtained the management right of the Zhezkazgantsvetmet providing the working capital and guaranteeing surety obligations. Previous financial difficulties in production are being solved and the sales amount of the Zhezkazgantsvetmet is being slowly increased.

(4) The Zhezkazgan copper deposit is being mined by four mining joint stock companies, namely the East Mine, West Mine, North Mine and South Mine. Among these mines, three are being operated by the underground mining method. The North Mine is being operated by an open pit mining method.

(5) The output of the mine in 1995 was 16,840 thousand tons with grade of 0.96%Cu including 5,160 thousand tons with grade of 0.64%Cu by open pit mining and 11,680 thousand tons, which represents 69% of the total mine production with grade of 1.10%Cu by underground mining.

(6) The orebody of the Zhezkazgan copper deposit is being mined by three kinds of the underground mining method, namely panel and pillar, room and pillar, and slicing methods. These mining methods were chosen according to the morphology and properties of the ore deposits, such as thickness(m), ore grade(%Cu), inclination (degree) and the character of the country rock and ore. In case of ore horizons less than 18m thick and less than 2.5%Cu in grade, the panel and pillar mining method is used. This mining method is being operated without filling and produces 75% of total mine production in the Zhezkazgan copper mine. The room and pillar mining method is adopted in the mining of ore grade higher than 2.5%Cu. After initial mining by the room and pillar method, filling work is performed and after leaving for six months, second stage mining starts and fills the rest.

(7) The mining recovery is quite sensitive to parameters, such as diameter of room pillars, width of rib pillars and depth from the surface. By using formulae developed by the Giprotsvetmet Institute in Moscow, if the thickness of ore is 6m, the mining recovery is calculated as 87.3%, 86.3%, 84.4%, 83.3% with increasing depth of 200m, 300m, 400m and 500m respectively. The Zhaman-Aibat ore deposit is located at greater depth than the Zhezkazgan deposit and mining recovery of 6m of ore thickness is estimated to be as low as 75.3% and 73.7% at the depths of 600m and 700m respectively.

(8) The information and data obtained on the mining costs are not sufficient for a detailed study. The estimated underground mining cost for the period from January to July in 1995, was 413 Tenge / ton-ore or 6.7 $US / ton-ore (at 60 Tenge / $US). These costs include the exploration and transportation costs to the hopper of vertical shafts. On the other hand, the estimated open-pit mining cost is approximately 260 Tenge / ton-ore or 4.3 $US / ton-ore.

3-1-8 Conceptual Design of the Zhaman-Aibat Mine

For the conceptual design and the cost calculation of the Zhaman-Aibat Mine development, definition standards in several countries, such as Australia and USA were used. And the mine development and mining method were adopted based on verbal reports on the Zhezkazgan Mine whose deposit has analogies to the Zhaman-Aibat Deposit.

(1) The assay data (Cu, Pb, Zn, Ag) stored in the Zhaman-Aibat Database were also used in the minable ore reserve estimation.

(2) The available drill holes for minable ore reserve estimation numbered 800. Among these drill holes, 371 contributed to the minable ore reserve estimation.

(3) To assess the continuity of grade and thickness of ore, and determine the grade distance to be used for interpolating block grades, a geostatistical analysis was conducted. 2D variograms were developed for Cu (%), Pb (%), Zn (%), Ag (g/t) and thickness of Ore Horizon 4-I.

(4) The minable ore reserve estimation was based on ore blocks 100m × 100m × thickness

determined by the range of the variograms. For the interpolation of grade and thickness of ore, the geostatistical technique of kriging utilizing the variogram models was used to estimate the block parameters. The search distance(m) for the kringing interpolation was determined by the variogram range.

(5) The panel and pillar mining method applied at the Zhezkazgan Mine was selected. The mining ore recovery and dilution of ore were determined as 75% and 5%, respectively. The minable ore reserves, metal amount, average ore grade and average ore thickness with the cutoff grade of 0.4% Cu and with the minimum mining height of 3.0m were calculated. The results indicates that the minable ore reserves were 118,742 kilo tons and total metal amounts were estimated to be 1,375 kilo tons Cu, 195 kilo tons Pb, 35 kilo tons Zn, 1,019 tons Ag, respectively. Thus, the average metal contents are 1.16%Cu, 0.16%Pb, 0.03%Zn, 8.59g/tAg, respectively.

(6) For the calculation of the mine development cost, "the Bureau of Mines Cost Estimating System Handbook (1987)" published by US Bureau of Mines, Department of Interior was used in this conceptual design. It is estimated that the error of estimation of design parameters is ±30~35%.

(7) The configuration of the Zhaman-Aibat Mine by this conceptual design was drawn from the following; The mine will be of medium size incorporating the underground mining method supported by several vertical shafts. A railroad and paved road will be constructed between Zhezkazgan City and the Mine site. Electricity will be supplied from a transformer station located between Zhezkazgan and Karaganda by a 220kV power line. An ore dressing plant will be constructed at the mine site and the produced copper concentrates will be transported to the processing plant in Zhezkazgan City. Copper and silver contained in the copper concentrates will be sold to the Zhezkazgan smelting plant.

(8) The annual production of the Zhaman-Aibat Deposit is estimated as 5.6 million tons, that is set for the base case. In this Study, the profitability in the case of production of ±20% of the annual production (4.5 million tons and 7.6 million tons) is also discussed.

(9) The rate of plant utilization is expected to be approximately 80%, therefore, the amount of milling ore per day is 19,200 tons/day. From the results of the milling tests, the copper concentrate recovered is expected to be 35% Cu grade with a recovery of approximately 90%. The amount of copper concentrate is 596 tons / day.

(10) In order to increase productivity and to reduce costs, it is assumed that mining will be done intensively in distinct areas established every 5 years, and that no secondary mining by filling would be performed.

(11) It is estimated that the total number of mine workers including management staff, will be 930. In detail, there will be 450 underground workers, 350 surface workers, 130 engineers and general / administration staff.

(12) It is estimated that the operation cost will be 15.92 $US/ton ore, 67 cent/ lb of Cu in the base case. In detail, mining will be 35%, mine facilities 13%, ore dressing 27%, administration 6%, concentrate transport 2% and camp management 17%.

(13) The capital cost was estimated as 492 million $US in the base cac within which 471 million

$US are for construction cost and 21 million $US are for working capital. Of the estimated 492 million $US, 347 million $US will be needed for primary investment and 150 million $US for additional investment.

(14) The discount cash flow / internal rate of return (hereinafter DCF / IRR) was estimated as 5.40% in the base case, under the conditions of ore dressing recovery of 90% and 98%, respectively, treatment charge /refining charge (hereinafter TC /RC) is 20 cent/ lb Cu, and metal prices 2,500$US / ton for Cu and 4.0 $US / TR OZ for Ag. It should be noted that capital costs and taxes are not taken into account in this DCR /IRR. Considering a tax rate of 30%, and assuming an IRR of 3%, an IRR (before paying tax and interest) of at least 12% will be necessary. IRRs of the other cases of annual production (ie. 4.5 million tons /year and 6.7 million tons / year) are estimated as 3.04% and 6.80%, respectively.

(15) A sensitivity analysi for the rate of return was performed by varying the parameters of copper price, TC / RC, capital costs and investiment costs from the standard model (annual production :5.6 million tons, copper price :2,500$US / ton Cu, TC / RC :20 cent/ lb Cu). In the case of 30% reduction of the operating cost, the IRR will increase to 7.77%, on the other hand a saving in capital cost of 30% will improve the IRR to 4.99%.

3-1-9 Recommendation

(1) Although present development of the Zhaman-Aibat Deposit is considered economically marginal, the deposit satisfies essential criteria for successful future mining and it has a clear potential for exploitation. It is expected that an increase of sales revenue resulting from rising copper prices in the international market and decreasing mining costs associated with the introduction of more efficient mining technologies will impact beneficially on the economics of the project. Continuous review and re-assessment of the economics of the Zhaman-Aibat Deposit is therefore strongly recommended.

(2) In order to realize the profitable development of the Zhaman-Aibat Mine, the government sholud actively support infrastructure construction such as railroads, roads, electricity and water supplies. Further support from the government should include exemptions from taxes, sales duties and import duties.

(3) By the results of this year's geostatistical assessment, the accuracy of the ore reserve estimation is adequate for pre-F/S stage. Additional drilling to confirm the grade distribution of high Cu and Ag in each orebody and the detailed distribution of Pb and Zn grades in the Central Orebody should be undertaken.

(4) The construction of a highly reliable data base and management of the data base are essential for the ore reserve evaluation and economic study. The introduction of a computer system, computer data base and an appropriate ore reserve evaluation methods which meet the requirement of a market economy system are urgently required.

3-2 Survey Results of the Samarsky Area

3-2-1 Previous Geological Works

(1) The first recorded prospecting in the "Sarymsak" area dates to 1935, when the prospecting for tourmalized secondary quartzite of Sarymsak mountain was carried out. The main target of this work was raw boron minerals. Gold mineralization was first detected in 1953 and was named "Nurin deposit". At the same time some small elongated zones with malachite and azurite were revealed among light colored (secondary quartzite) rocks. Copper dispersion haloes (0.1-0.4% in epicentres) and molybdenum haloes (0.02%) associated with secondary quartzite were found in the vicinity of the Sarymsak hill.

(2) As the Sarymsak secondary quartzite massive was considered to be very prospective from the standpoint of copper-porphyric type deposits, a geological survey has carried out in 1962 together with geophysical surveys at the scale of 1:10,000, covering the area of 15.75km^2. To explore the revealed anomalous zones and geochemical haloes, shallow drilling and exploratory workings were carried out. The results have confirmed, that the area is prospective for gold and copper-porphyric mineralization. Certain recommendations on conducting further exploratory work were made.

(3) After summarizing all past data by the Karagandageologiya (Karaganda Expedition), in 1989, the area was again targetted for intensive exploration drilling. To complete the geologic map of the central Samarsky copper deposit and surrounding area, mapping drillings (shallow drillings penetrating sediment cover to the bed rock) were carried out. Since 1990 exploration drilling has delineated the ore body of the Central Samarsky Copper Deposit and the Western Samarsky Gold-Polymetallic Deposit. A total of 76 exploration holes have been drilled.

Table 1-3-3 List of Mineral Showings in the Samarsky Area

	Samarsky Central	Samarsky North	Samarsky West
Type of Deposit	Porphyry Copper	Porphyry Copper	Au polymetallic
Ore Type	Cu, Mo	Cu, Mo	Au, Pb, Zn
Dimension	500m(NE) x 400m(NW) 2,000m x 1,500m (Max.)	400m x 250m	700m(NS) x 250m(EW) 8.6m in average thickness
Depth	50 - 600m	0 - 600m	0 - 350m
Ore Grade	1.28% Cu	not estimated	3.8 g/t Au, 20.0 g/t Ag
Ore Reserve	200 million tons (Cut-off 0.4% Cu)	not estimated	5.6 million tons
Ore Minerals	Chalcopyritecite,Chalcocite Molybdenite, Malachite	Chalcopyritecite,Chalcocite Molybdenite, Malachite	Galena, Sphalerite Native Gold

3-2-2 Geology and Mineralization

(1) The Samarsky Area is located at the margin of the Devonian volcanic belt at the junction of large caledonide structures, Erementay-Nyazsky anticlinorium, Semizbugin and Shokshan synclinoria (Fig.1-3-5). The structural position of the area results in wide development of volcanic, intrusive and volcanogenic-sedimentary formations of Devonian age (Fig.1-3-6).

(2) Devonian system is widely spread through the territory of the area. They compose basically the wings of a Tulkulin ring volcanic-plutonic structure and are divided into Early-Devonian Zharsor Formation and Middle-Devonian Konyr Formation.

(3) Intrusive rocks in the Samarsky area are strongly variable depending on the time of their intrusion, petrochemical properties and structural position. They are closely connected with Devonian volcanism, which resulted in the formation of ore containing Tulkulin volcanic-plutonic structure.

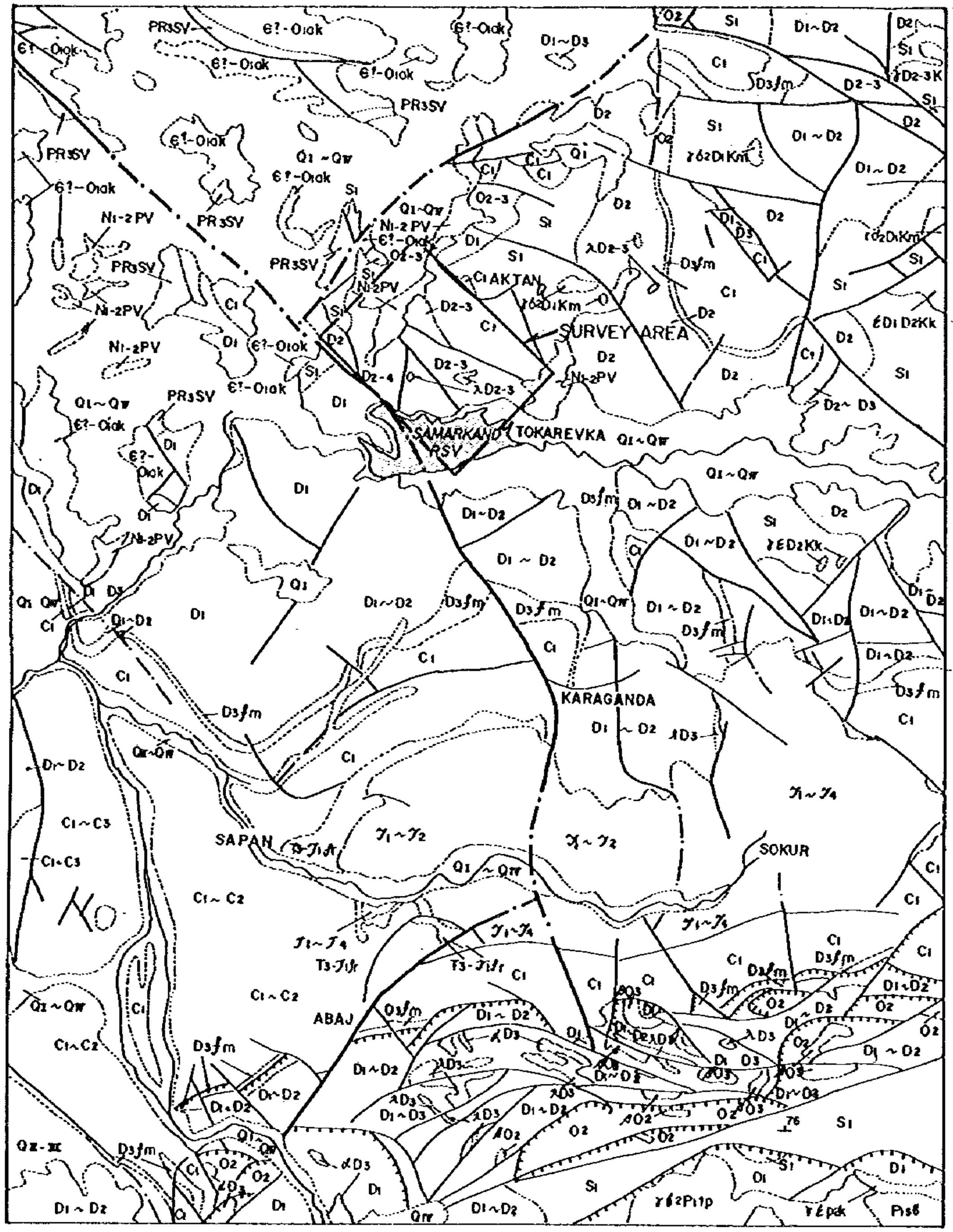
(4) It is confirmed that there are two types of ore deposit, porphyry type copper-molybdenum deposit and gold-bearing polymetallic deposit. These deposits show zonal distributions centered on copper-molybdenum zones.

<u>Porphyry Type Copper-Molybdenum Deposit</u>

(1) The porphyry type copper-molybdenum mineralization occurs in breccia pipes which were formed within the intrusive bodies of quartzdiorite at an early stage and in the granodiorite porphyry at a later stage, which intruded the andesite - basalt lava, their pyroclastics and sedimentary rocks of the early Devonian in age. Among the ore minerals, the main primary copper ore mineral is chalcopyrite accompanied by rare occurrences of chalcocite and bornite. On the other hand, in the secondary copper minerals malachite is predominant and chrysocalla and azurite are rare.

(2) The oxidized zone is confirmed to the depth of 30m - 50m and the primary sulfide zone starts from this depth and continues to greater depths. Secondary enrichment zones have not been reported. The high grade zone of greater than 1.0%Cu is exclusively found within the breccia pipes mentioned above. Thus the shape of the high grade copper orebody is represented by that of the breccia pipes. The actual shape of the orebody shows an increasing diameter towards greater depth.

(3) The hydrothermal alteration shows that propylitic alteration forms a ring structure with a potassic alteration zone at its center. The argillic alteration zone is located in the outermost part of the hydrothermal alteration zone. Both the potassic and propylitic alteration zones are observed at depths greater than 500m - 600m. On the surface, propylitic and argillic alteration are widely distributed.



Ministry of Geology (1981)

0 10 20km
1:500,000

Q1~QIV	Upper~Lower Pleistocene
N1-2PV	Miocene - Pliocene, Pavlodar Formation
J1~J3	Middle~Lower division
T3~J1ʃr	Triassic system, upper division - Retsky stage - Jurassic system. Lower division - Saramskaya Formation.
P1cb	Lower Division. Chubaraygirskaya Formation
C1~C3	Upper~Lower division - Shakhamskaya Formation, Dolinskaya Formation, Karagamdinskaya Formation, Ashlyarikskaya Formation
D3fm	Non-articulated sediments
D1~D2	Middle~Upper~Lower division - Salkintauskaya Formation, Zhandarskaya Formation, Kurotozekskaya Formation, Byotarskaya Formation, Semizbuginskaya Formation, Zharsorskaya Formation
S1~S2	Non-articulated sediments - Yesemskaya Formation, Yermekskaya Formation
O2-3	Middle~Upper division - Baydayletskaya Formation
Є?-O1br	Cambrian system ?
PR1~PR3	Upper~Lower Proterozoic
γξ2P2k	Late Permian, Kokdombaksky Complex : granosienite
γ1P1tp	Early Permian, Toparsky Complex: granite of normal type and associated potassium feldspar-rich type
γδ2P1tp	Early Permian, Toparsky Complex: granodiorite
γD2-3k	Middle-Late Devonian, Korneevsky Complex: granite of normal type and associated potassium feldspar-rich type
λD3;λD2-3	Liparite
αD3	Andesite
βD3	Basalt and diabase
ξD1D2kk	Middle Devonian, Kokkuduktubibnsky Complex: quartzmonzonite,non-articulated
γξ1D2kk	Granosienite
αD2	Middle Devonian, Sub-volcanic bodies: andesite
γδ2Dkm	Early Devonian, Karametdimsky Complex: granodiorite
δ1D1km	Quartz diorite, tonalite
βO3	Late Ordovician, sub-volcanic bodies: basalt and diabase
(thick line)	Main faults (developed regionally)
(thin line)	Secondary faults (within folded structures)
(hatched line)	Overlap, upthrusts and faults (dashes indicate direction of dislocation)
(dashed line)	Fault in the basement covered by mantle

Fig.1-3-5 Regional Geological Map of the Samarsky Area

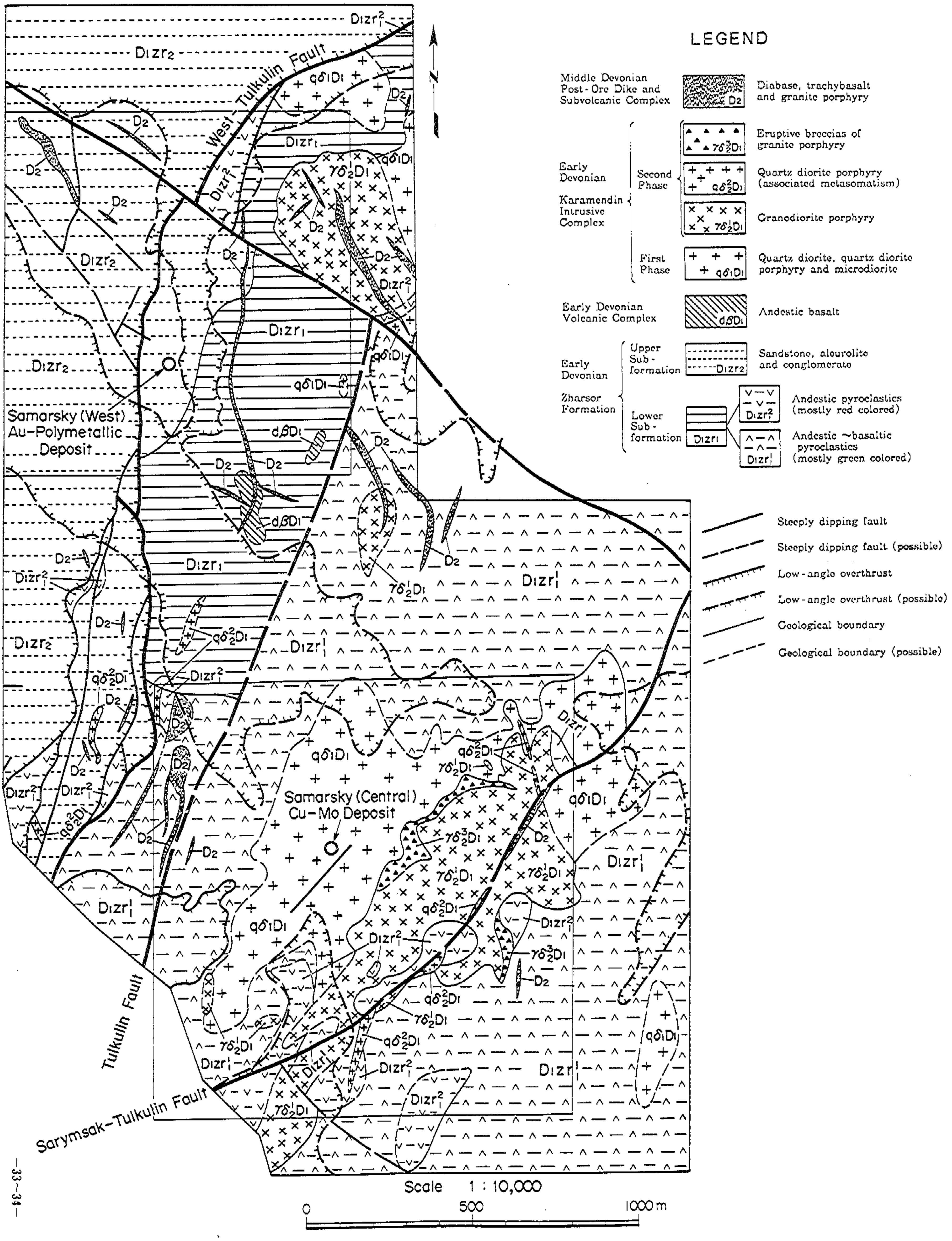


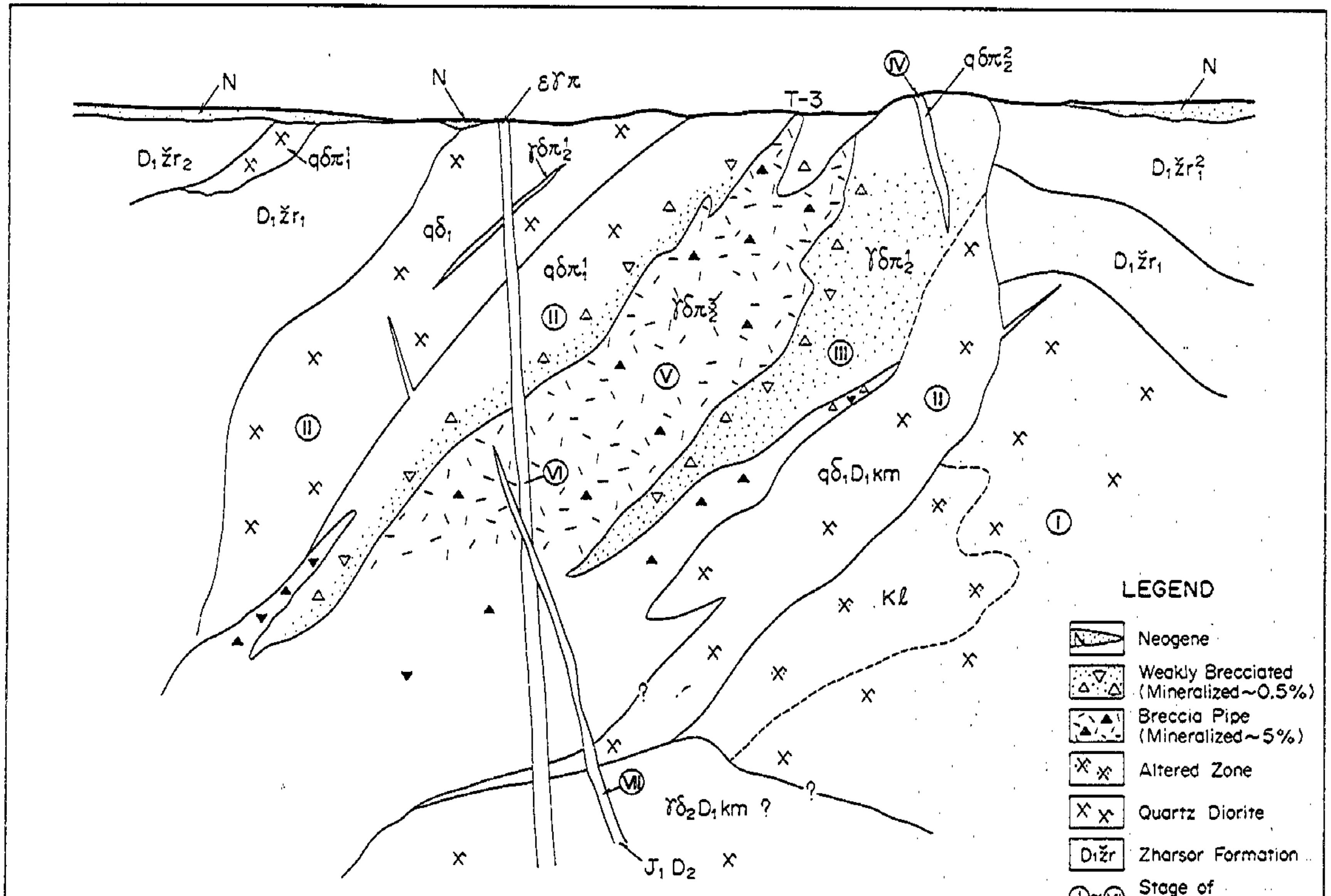
Fig. 1-3-6 Geological Map of the Samarsky Area

Gold-bearing Polymetallic Deposit

(1) Gold-bearing polymetallic deposits are located in the outer rim of the porphyry copper-molybdenum deposit, and are distributed in the sheared zone of the hanging wall side of thrusts running in the north-south direction in the north-western to western part of the survey area. The previous survey confirmed that there is one main ore vein and three branch veins.

(2) By the results of the drilling exploration, the vein of gold-bearing polymetallic deposits strikes in the north-south direction and dips 35° - 50° to the west. The average thickness and ore grade are estimated to be respectively 5.6m and 3.82 g/t Au and 20g/tAg. It is confirmed that the ore zone continues approximately 800m along the strike direction and 1,000m along the dip direction, which means that mineralization is confirmed to a depth of 350m below the surface.

(3) The veins consist of mainly quartz accompanied by galena, sphalerite, chalcopyrite. Gold occurs as native gold in quartz veins and some in galena, chalcopyrite and pyrite. Hydrothermal alteration is sericitization, carbonitization, argillization and silicification in character.



Originally Prepared by Joint Stock Company "Karagandageologiya"

Fig.1-3-7 Schematic Cross-Section of the Samarsky Ore Deposit

3-2-3 Geologcal Resources Estimation

(1) The copper-bearing part of the core sample was determined by semi-qualitative analysis of all cores. Only samples with high copper contents were separated and analyzed in the Karagandageologiya laboratory for copper, molybdenum, silver, gold and zinc. The analyzed sample units are basically two meters long core section. Because of time limitation, geological resources only inside the Central Samarsky Copper Deposit were calculated. Until now, twelve exploration drills have penetrated the copper ore in the deposit.

(2) The Japanese survey team checked the accuracy of the geological resources estimated by the Karagandageologiya. In this operation, the Japanese team adopted the same value of each analyzed sample, ore block delineation, cut-off grade and delineation condition used by Karagandageologiya. The panel area, block volume, density and average ore grade were calculated, and using these values, the weight and amount of metal in each block were determined. The subsequent summation of blocks gave the final geological ore reserve estimation. Except for the measurement and the calculation of ore block areas in panel sections, all other calculations were by personal computer using spread-sheet type software.

(3) The total area of Samarsky ore block panels calculated by the Japanese survey team is 378,838m^2 (99.0% of 382,663m^2 of Karagandageologiya). Then the volume of ore body is 41,447,469m^3 (101.8% of 40,729,933m^3). Multiplying the conventional value of density, 2.76 (same value) the total ore reserve is calculated as 114,395,015t (101.8% of 112,414,616t). The average copper content is 1.28%Cu (102.8% of 1.24%Cu) and the copper metal amount is 1,458,777t (104.4% of 1,397,806t) as calculated by the Japanese survey team.

3-2-4 Recommendation

(1) In the Samarsky copper-molybdenum deposit, it is confirmed that the high grade copper mineralized zone is located deep beneath the surface. Considering the reality of the actual mining operation, some difficulties of the deeper mining are expected. Thus, the future exploration should focus on the surveys for finding new copper-molybdenum mineralization at shallower depth. It is recommended that the following works be carried out in future campaign:

- the eastern marginal area of the quartz diorite intrusive body
- in the areas surrounding the breccia pipe located, about 1km southeast of the known orebody
- in the area between the known orebody and the Tulkulin fault.

(2) The exploration works for the southern extension and the deeper mineralization of the known gold-bearing polymetallic deposit are requied

(3) Following explorations are recommended for the future campaigns.

- Remote-sensing data analysis and ground truth checking of the Samarsky Area
- Electric survey (charged potential method) in the Cu-Mo deposit, in order to detect subsurface conductive bodies of copper-molybdenum deposits
- drilling surveys of the intrusives and the breccia pipes related to the copper-molybdenum deposits at shallower depth
- Seismic exploration (reflection wave method) to study geological structures at the vicinity of

gold-bearing polymetallic deposit

• drilling surveys of the southern extension and the deeper mineralization of the gold-bearing polymetallic deposit.