REPORT
ON
THE MINERAL EXPLORATION
IN
THE KICHI-SANDYK AREA
THE KYRGHYZ REPUBLIC

(PHASE I)

MARCH 1998

JAPAN INTERNATIONAL COOPERATION AGENCY

METAL MINING AGENCY OF JAPAN

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PREFACE

In response to the request of the Government of the Kyrghyz Republic, the Japanese Government decided to conduct a Mineral Exploration in the Kichi-Sandyk area of western Kyrghyz and entrusted to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The JICA and the MMAJ sent to the Kyrghyz Republic a survey team headed by Mr. Mikio Takahashi from September 7 to October 18, 1997.

The team exchanged views with the State Concern "KYRGHYZALTYN" of the Government of the Kyrghyz Republic and conducted a field survey in the Kichi-Sandyk area. After the team returned to Japan, further studies were made and the present report has been prepared.

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

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

March, 1998

Kimio Fujita
President
Japan International Cooperation Agency

Hiroaki Hiyama
President
Metal Mining Agency of Japan

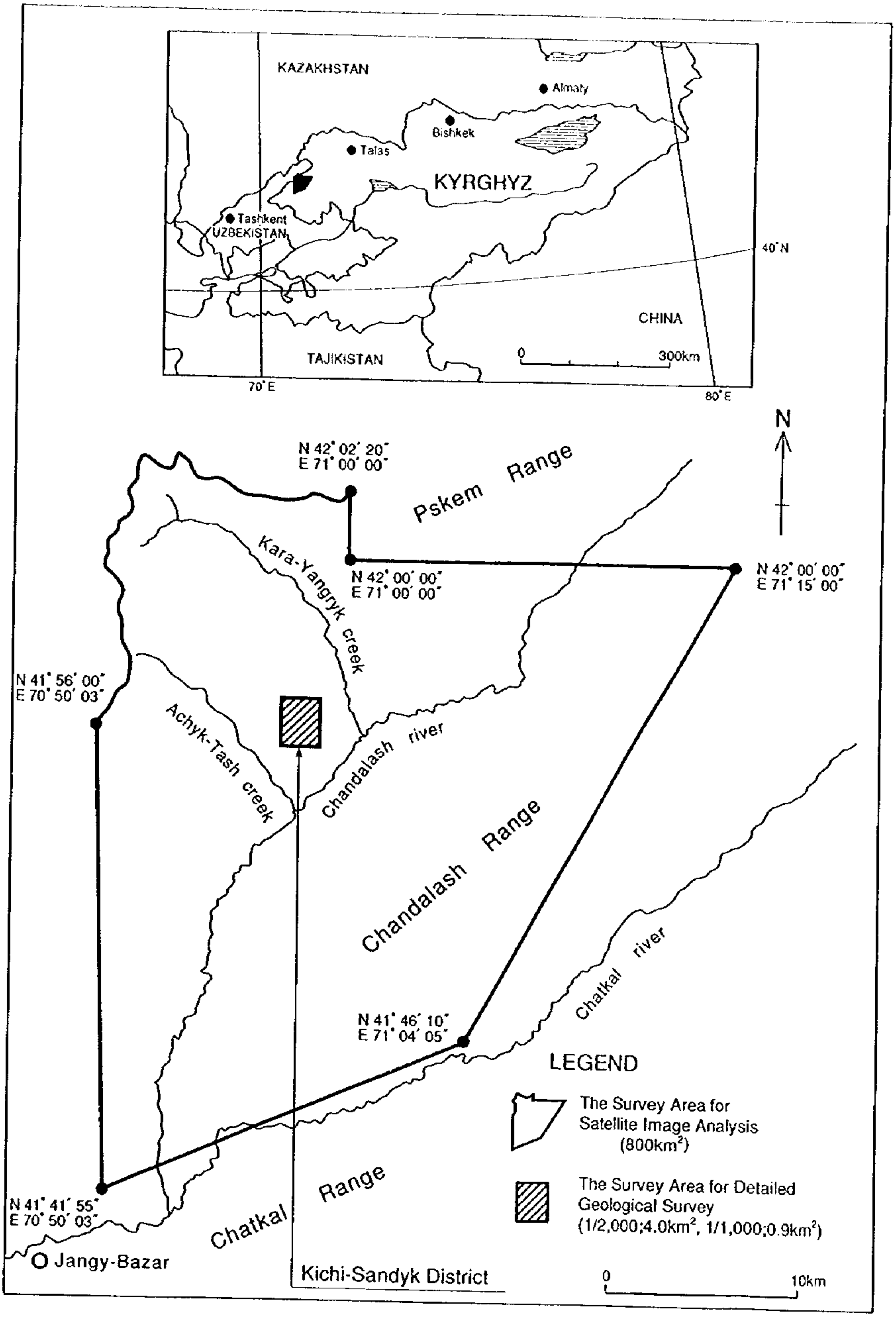

Fig. I - 1 Location Map of the Survey Area

РЕЗЮМЕ

Настоящий отчет является сводом результатов фундаментального исследования по программе сотрудничества в освоении недровых ресурсов на первый год, которое было проведено в Кичи-Сандыкском регионе Республики Кыргызстан. Цель исследования заключалась в выяснении геологической обстановки и расположения рудных месторождений, а также в нахождении новых месторождений в названном регионе. Работы по разведке на месте были проведены с сентября по октябрь 1997 г.

В рамках исследования на первый год в Кичи-Сандыкском регионе площадью 800 км² (по всему региону) была проведена расшифровка изображений, снятых с борта искусственного спутника, для получения данных по геологической структуре и литостратиграфического подразделения в широких пределах названного региона. Сверх того, по данному региону были собраны и проанализированы существующие данные с целью определения общих направлений исследовательской работы на следующий год и далее. В двух местах, а именно в Кичи-Сандыкском районе (4 км²) и на Кичи-Сандыкском месторождении (0,9 км²), которые включаются в названный выше регион, была проведена точная геологическая разведка с траншейной разведкой для определения отношения между геологией, геологической структурой и процессом минерализации. Такая работа дала нам следующие результаты:

В результате расшифровки снятых с борта искусственного спутника изображений всего Кичи-Сандыкского региона выяснено то, что центральная часть зоны исследования является перспективной зоной для разведки, где сосредоточенным образом располагаются участки с линейной структурой и спектральными аномалиями и к которой относится Кичи-Сандыкское месторождение. Турпак-Туштыский участок с признаками руды, который считается вторым после Кичи-Сандыкского перспективным месторождением, также располагается на южном конце этой перспективной зоны и, к тому же, на линии, протянутой от линейной структуры ССЗ-ЮЮВ, которая ограничивает минерализацию на Кичи-Сандыкском месторождении. При этом следует отметить, что, вокруг этого потенциального месторождения найдены участки спектральных аномалий. В дополнение к этому найденные на поверхности грунта многочисленные участки с признаками руды дают нам обоснование считать Кичи-Сандыкский регион весьма перспективной зоной для разведки.

Результаты траншейной разведки, проведенной в этом году в полосе минерализации в центральной части Кичи-Сандыкского месторождения, по-

зволили нам найти жилообразные скарны с многочисленными участками минерализации золота и серебра, показывающими южный склон в системе СЗ. Результаты анализа трещин, которые ограничивают эти жилообразные скарны, показали конструкцию с направлением смещения "Север 45° ~ 47° Запад" и склоном 56° ~ 74° СЗ. С учетом пределов, где был наблюден процесс минерализации в ходе траншейной разведки, мы считаем, что участки минерализации, которые наблюдаются на поверхности грунта, могут продолжаться примерно 200 м вдоль трещин по направлению их смещения и, по крайней мере, 100 м вниз. В дальнейшем основная задача для оценки потенциала будет заключаться в постижении положения с минерализацией и продолжительности (структуры и масштаба) полосы минерализации вниз и по направлению смещения трещин.

В результате точной геологической разведки (1/2000) в Кичи-Сандыкском районе выяснено, что слоистые скарны в северной полосе минерализации продолжаются примерно 2 км, хотя прерывистым образом, в сторону ЮЗ вдоль границы гранодиоритовой и известняковой пород. К тому же, эти скарны, имея частичные признаки высокого содержания золота и серебра, показывают склон к северу.

С учетом изложенных выше результатов исследования рекомендуется выполнить следующие работы в рамках исследования на второй год:

1) Уточнение продолжительность полосы минерализации в центральной части Кичи-Сандыкского месторождения вниз и по направлению смещения трещин, а также проведение разведки с разбуриванием для непосредственного выяснения положения с минерализацией в той же полосе минерализации.

2) Проведение разведки с разбуриванием на границе между гранодиоритовой и известняковой породами с целью выяснения распределения и структуры слоистых скарнов, таких как наблюдаемые в северной полосе минерализации, и положения с минерализацией. Одновременное проведение точной геологической разведки (1/100 - 1/500), в т.ч. траншейной разведки, на границе между гранодиоритовой и известняковой породами в слоистых скарнах.

3) Проведение геологической разведки Турпак-Туштыского участка, который относится к южной части Кичи-Сандыкского региона, сочтенного

нами перспективным для разведки в результате расшифровки снятых с борта искусственного спутника изображений, а также разведка перспективных участков в Кичи-Сандыкского района и прилегающих к нему местах.

SUMMARY

This report summarizes the results of the first year survey implemented in the Kichi-Sandyk area, Kyrghyz Republic. The survey was intended to clarify geological conditions and distribution of ore deposits in this area, and to discover new ore deposits. Field survey was carried out from September 1997 to October 1997.

In the first year survey, satellite images were analyzed in order to grasp regional geological structure and to make classification of geological units of the entire 800 km^2 area of Kichi-Sandyk. Existing data were also gathered and analyzed to obtain useful information on which exploration for the following years could be planned. In addition, detailed surveys, including trenching survey for geological structure and its relation with mineralization, were conducted for the inner Kichi-Sandyk district (4km^2) and Kichi-Sandyk deposit area (0.9km^2). Here are the findings.

Satellite image analysis for the entire Kichi-Sandyk area has revealed that there is a promising area for mineral exploration in the central part of the survey area, with a heavy concentration of lineaments and spectral anomaly areas, and that the Kichi-Sandyk deposit lies within this promising area. Furthermore, given the fact that it lies in the south end of the above area in the extension of the NNW-SSE lineaments and that spectral anomaly was detected around it, coupled with the surface patterns of mineralization, mineral showing areas in Turpak-Tushty too are promising.

From the results of this year's trenching survey in the mineralization area of Kichi-Sandyk deposit, numerous developments of vein skarn with gold and copper mineralization with NW trends and southward inclination have been discovered. Based on a fracture analysis on the pattern of fractures it was estimated that these vein skarns had the structure with the strike of N45° ~47° W and the dip of 56° ~ 75° SW. Therefore, given the area in which mineralization was confirmed by trenching survey, it is probable that the mineralization zone extends 200m in the strike direction and at least 100m deep. Further analysis of the extension (both structure and size) of this mineralization zone in both the strike and vertical directions is needed in order to make an evaluation of its potential.

A detailed geological survey (1/2,000) of the Kichi-Sandyk district has revealed that the bedded skarn of the northern mineralization zone extends, though not continuously, as far as 2km in the SW direction along the boundary between granodiorite porphyry and limestone. This skarn is estimated to have northward inclination with mineralization of partially high grade copper and gold.

On the bases of the above findings, we propose the following for the phase 2 survey.

1) A drilling survey to find out directly the continuity of the central mineralization zone (in both strike and downward directions) in Kichi-Sandyk deposit and its conditions of mineralization.

2) Drilling survey of the boundary area between granodiorite porphyry and limestone to find out the distribution and the structure of bedded skarn typical in the northern mineralization zone, as well as detailed geological survey (1/100～1/500), including trenching, of the outcrop of bedded skarn and the boundary area between granodiorite porphyry and limestone.

3) Geological survey on the area with mineral showings in Turpak-Tushty in the southern part of Kichi-Sandyk area which the satellite image analysis has identified as meeting most criteria for promising mineral exploration.

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PART Ⅰ GENERAL REMARKS

CHAPTER 1 INTRODUCTION

1-1 Background and Purposes of Survey

In April, 1996 Kyrghyzaltyn, the State Concern of the Kyrghyz Republic contacted the government of Japan, through the State Commission of the Kyrghyz Republic on Foreign Investment and Economic Assistance, and made a request for cooperation. In June, 1996 the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ) sent a survey and negotiating team to the Kyrghyz Republic, and a Scope of Work concerning Kichi-Sandyk district was exchanged in the same year.

The purpose of this study is to explore the metal deposits in the above mentioned area, by means of satellite image analysis, analysis of existing data, geological survey and drilling survey.

1-2 The Scope, Purpose and Outline of the Task for the First Year

According to the Scope of Work confirmed by Kyrghyzaltyn and JICA and MMAJ, the survey is to cover the $800km^2$ area. Satellite image analysis, analysis of existing data and geological survey were conducted this year.

The purposes of this year's surveys are:

1) To find out regional geological structure of the survey area by photogeological interpretation of satellite images, and to locate alteration zone by spectral analysis.
2) To grasp a general view of the mineralization and mineral showing as well as mineral resources in the survey area by collecting, organizing and analyzing existing data.
3) To grasp the size, quality and characteristics of mineralization and to estimate mineralization potential.

1-3 Survey Team

An initial survey and negotiating team was sent to the Kyrghyz Republic from July 26 to August 6, 1997. Here are the names of the members for the Japanese survey and negotiating team and the negotiating team of the counterpart.

Japan:

Akira SATO (Head/General)	MMAJ*1
Toru NAWATA (Planning and Coordination)	JICA*2
Satoshi YAMAGUCHI (geologist)	MMAJ

Kyrghyz Republic:

Almas T. CHUKIN	SPFKR*3
Sheysheraly M. MURZAGAZIEVB	SAGMR*4
Almazbek S. JAKYPOV	Kyrghyzaltyn*5
Alexander V. YARKOV	Kyrghyzaltyn
Gennady A. SAVCHENKO	Kyrghyzaltyn
Erick I. KHAFIZOF	Kyrghyzaltyn

*1 : The Metal Mining Agency of Japan

*2 : The Japan International Cooperation Agency

*3 : The State Property Fund of the Kyrghyz Republic

*4 : The State Agency on Geology and Mineral Resources of the Government of the Kyrghyz Republic

*5 : Kyrghyz State Concern "Kyrghyzaltyn"

A field survey team was sent from September 7 to October 18, 1997. Here are the names of the members of the Japanese field survey team and their counterpart in Kyrghyz.

Japan:

Mikio TAKAHASHI (Head/General)	MINDECO*6
Naoto AIZAWA(Geologist)	MINDECO
Tatsuo YAMAZAKI (Geologist)	MINDECO

Kyrghyz Republic:

Alexander V. YARKOV (Chief coordinator)	Kyrghzaltyn
Gennady A. SAVCHENKO (Chief geologist)	Kyrghzaltyn
Ryskul DZHUMAGULOV (Field coordinator)	Kyrghzaltyn
Ignor A. APOG (Geologist)	Kyrghzaltyn
Anatoly NIKITEN (Geologist)	Kyrghzaltyn
Asunov BOBOSHCO (Geologist)	Kyrghzaltyn

*6 : Mitsui Mineral Development Engineering Co., Ltd.

Satellite images were analyzed by the following researchers in Japan.

Kazuhiro ADACHI (Image processing)	MINDECO
Hidehisa WATANABE (Image processing)	MINDECO

1-4 Period and Quantities of Survey

The quantities of survey are shown in Table I -1.

Table I -1 Period of Survey

Items	1997					1998	
	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Planning	14 29						
Satellite Image Anal.	14 29			1		30	
Field Survey		7	18				
Laboratory Works			20			30	
Making Report			20				27

The phase 1 survey is summarized as follows.

A. Satellite Image Analysis :	Kichi-Sandyk Area	800km^2
B. Geological Survey :	Kichi-Sandyk District	Scale 1:2,000
	survey area	4.0km^2
	route length	15.0km
	Kichi-Sandyk Deposit	Scale 1:1,000
	survey area	0.9km^2
	route length	15.0km
	trenching survey	909.0m
	road repair and construction	47.5km
	bulldozer cutting and opening	909.0m

CHAPTER 2 GEOGRAPHY OF THE SURVEY AREA

2-1 Location and Transportation

The area surveyed, which is about 800km², is located in the middle of the Central Tien-Shan mountains by the boarder with the Republic of Uzbekistan. Administratively it belongs to Chatkal district in Alabuka region in the state of Dzhalal-Abad. It extends about 27km in the East-West direction, 30km in the North -South direction, and has a total area of 800 square kilometers, and is surrounded by the following points:

42° 02′ 20″ north latitude,	71° 00′ 00″ east longitude
42° 00′ 00″ north latitude,	71° 00′ 00″ east longitude
42° 00′ 00″ north latitude,	71° 15′ 00″ east longitude
41° 46′ 10″ north latitude,	71° 04′ 05″ east longitude
41° 41′ 55″ north latitude,	70° 50′ 03″ east longitude
41° 56′ 00″ north latitude,	70° 50′ 03″ east longitude

The nearest village, Jany-Bazar, is about 200 km northwest of Dzhalal-Abad, and there is an old exploration road (47km) going from the village to the survey area. There are two routes from Bishkek, the capital city, to Dzhalal-Abad: one goes through Toktogul, Tash-Kumyr, Alabuka and Chapchama mountain pass (2,814m), and the other goes through Talas, Kirovskoye and Kara-Buura mountain pass (3,305m). The distance from Bishkek is 800km for the first route, and 520km for the second route. Although the former route is considerably longer than the latter, it is kept open throughout the year. On the other hand, a large part of the second route is mountainous going through mountain passes higher than 3,000m like Kara-Buura pass with fairly bad road conditions, and is closed during the winter season.

2-2 Topography and Drainage System

The Tien-Shan Mountains are divided into three parts : Northern, Central and Southern. Our survey area is located in the southern part of the Central Tien-Shan Mountains. In the north of our survey area are Pskem Mountains, which are the border with Uzbekistan and the watershed of the area, running from southwest to northeast.

The surveyed area is on the southern side of Pskem Mountains with the altitude between 2,600m and 3,000m. Mineral showings are distributed at the altitude between 2,800m and 2,950m. General topography of the area is a near flat plateau with slight ups and downs and sharply eroded valleys. The largest river in the area is Chatkal river, which originates in the Chandalash and Chatkal Mountains and runs from north-east-east to south-west-west.

2-3 Climate and Vegetation

Most part of the survey area lies between 2,000m and 3,000m in altitude, and its climate is of high mountain. The coldest month of the year is January with the temperature as low as -40 degrees Celsius, and the warmest month is August with the temperature higher than 28 degrees. Daily fluctuation of the temperature is great, which is typical for the inland area. The winter is cold with heavy snow falls. The first snow of the season falls in the beginning to the middle of October, and the annual precipitation amounts to 740mm-1200mm. The average monthly temperature of the survey area (3,000m in altitude) is shown in Table I -2. The areas with mineral showing, which are about 2,800m in altitude, have poor development of soils with little vegetation - just some grasses and Alpine plants. Development of foliage, mainly bushes with some broadleaf trees such as white birch and poplars and conifers similar to pines, is seen only along the rivers at the altitude lower than 2,000m.

Table I -2 Temperature & Humidity in the Kichi-Sandyk Distrit

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ave. Temp (℃)	-19.5	-15.7	-8.0	-0.8	3.8	6.6	9.1	8.4	4.1	-2.1	-11.0	-17.8
Humidity	60%	-	-	-	-	-	22%	-	-	-	-	-

* : relative humidity(%)

CHAPTER 3 EXISTING GEOLOGICAL INFORMATION ABOUT THE SURVEY AREA

3-1 Outline of Previous Surveys

Geological surveys into the valleys of Chatkal and Chandalash rivers began in the late 19th century, and a deposit of placer gold along the Chandalash was investigated in 1898.

The 1:500,000 geological surveys from 1931 to 1936 revealed a series of mineralization sites including pyrite along upper streams of the Achyktash river, including a gold deposit along the Chandalash river. This gold deposit, as well as tungsten/molybdenum deposit of Toyalmysh in the upper valley of the Chandalash was mined during the second world war (1941-1945).

Systematic investigations of the area were began in 1948, and the 1:200,000 survey was conducted between 1952 and 1954.

The 1:50,000 geological survey was conducted in the main part of this area from 1965 to 1968, and Kichi-Sandyk deposit was discovered. That called for more detailed surveys.

From 1973 to 1976 geological survey, sampling of heavy minerals and geochemical survey, electric prospecting (IP), magnetic prospecting, gravitational prospecting were carried out in the mineralization areas of Chandalash-Chatkal. A series of geological maps including an integrated geological map, a 1:10,000 geological map, and location map of samples were produced. Trenches, bulldozer opening (27,000m^3) , drilling of pits (612m), and digging of a short tunnel (22m) were applied to the Kichi-Sandyk deposit. Major mineralization zones were investigated down to 10 to 15m from the surface by means of pits with drift and short tunnels. Many samples were collected by channel sampling method, and as many as 3,296 pieces were analyzed.

The results suggested high probabilities of gold deposit in the Kichi-Sandyk area, but no further survey or searching was conducted after 1976.

3-2 General Geology of the Survey Area

The survey area is situated in the western Kirghyz, or west of the dividing Talas-Fergansky fault, within the Middle Tien-Shan folding zone of the Hercynian folding system which extends from the central Kyrghyz to the western Kyrghyz. It lies on the southern slopes of Pskem mountains, the border with the Republic of Uzbekistan, between the two creeks flowing into the Chatkal river (Fig. I-1).

The Middle Tien-Shan folding zone lies between Northern Tien-Shan folding zone of the Caledonian folding system and Southern Tien-Shan folding zone of the Hercynian folding zone. By middle Proterozoic (Ripheian) it is believed that the geosyncline had been formed to produce land at least partially. In this area, the Middle Proterozoic groups consisting mainly of glacial sediments, volcanic rocks and carbonaceous sediments and the Paleozoic groups consisting of flysch, terrigenic and volcanic sediments are underlain as the basement rocks, and the Cenozoic of lake sedimennts and molasse lies on top of them.

Various types of igneous activities in Kylghyz, such as the ones caused by subduction of the plate and alkaline magma of the inner continent, are known to have existed from Proterozoic era to the late Paleozoic era. In the survey area, granite of late Paleozoic (Carboniferous and Permian) is distributed among the basement rocks. Major geological stratigraphy in the Kichi-Sandyk area is shown below. A regional tectonic map is shown in Fig. I -3-1 and a schematic geological column is shown in Fig. I-3-2, respectively.

3-2-1 Sedimentary Rocks

1) Proterozoic groups

(1) Uzunbulak formation (Middle Proterozoic : Riphean system)

These strata consist mainly of molasse and are divided into two parts; the lower part and the upper part. The thickness of this formation is 100m～600m. Lower molasse which is distributed in the Chandalash mountains is characterized by conglomeratic slate rich in coarse pebbles. Mineralization in this formation is specialized for gold and copper. There is a possibility of discovering placer deposits in fine-grained sandstone, siltstone and silty shale.

(2) Mursash formation (Upper Proterozoic : Vendian system)

This formation consists of carbonaceous congromerately shale, trachybasalt, trachyandesite and terrigenous deposit. Total thickness of the Mursash reaches 150m ～ 200m, and it is distributed near the watershed of Pskem mountain range. The upper part of this formation is composed of sandstone - mudstone beds (100m in thickness), rarely intercalated with thin carbonate beds. Characteristics of mineralization in this formation are not clear, but deposits of porphyry copper - molybdenum ore may be expected in trachybasalt - trachyandesite formation.

(3) Shorashuy formation (Upper Proterozoic : Vendian system)

These strata consist mainly of mudstone and carbonate rocks, and are divided

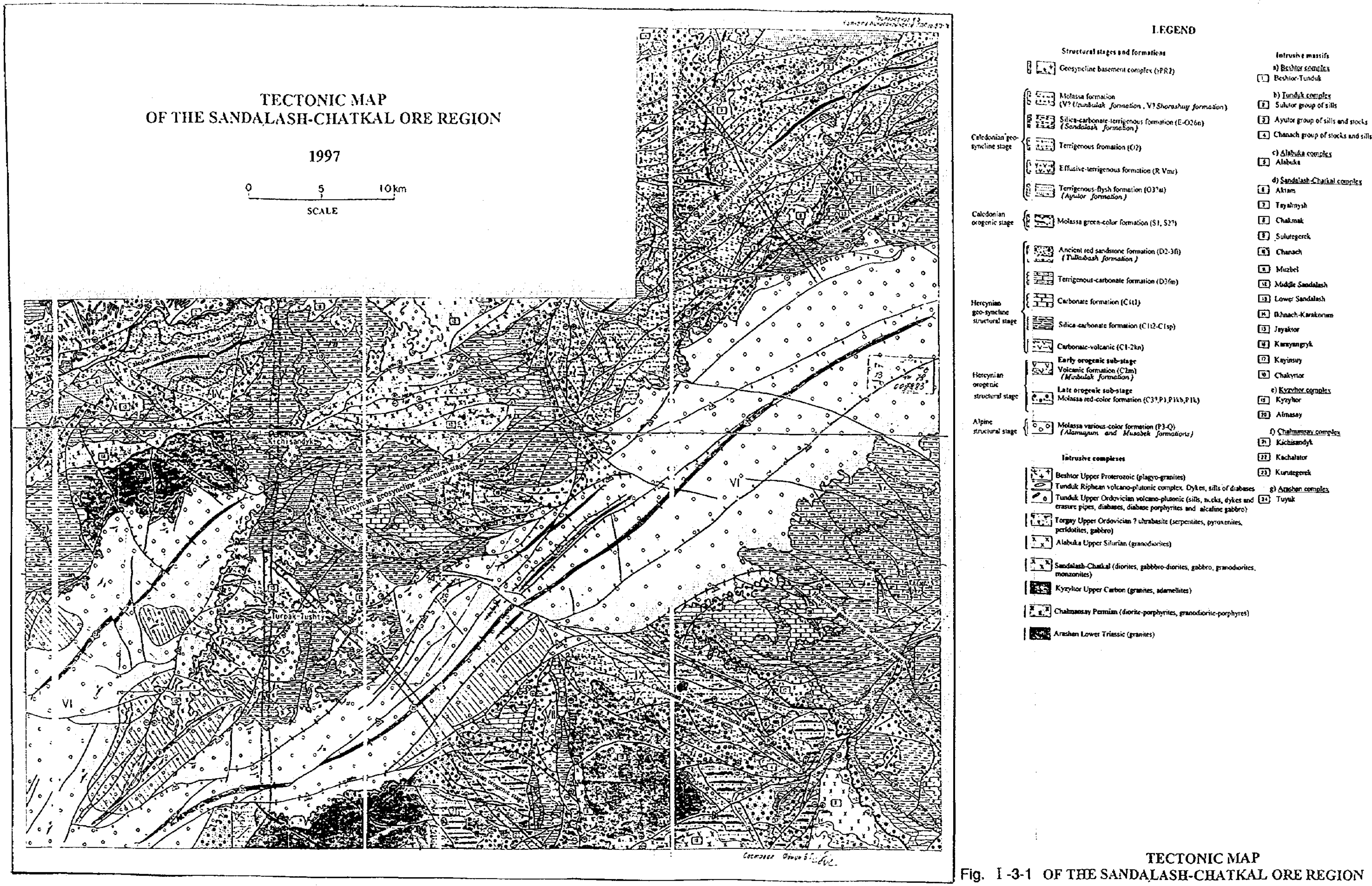


Fig. I -3-1 TECTONIC MAP OF THE SANDALASH-CHATKAL ORE REGION

Age			Formation	Lithology
Cenozoic	Quaternary	Pleistocene		alluvium
		Holocene		terrigenic sediments
	Tertiary	Neogene	Alamuyum/Musabek	terrigenic sediments
Paleozoic	Permian			
	Carboniferous	upper		
		middle	Minbulak	andesite, trachyandesite, tuff
		lower/middle		molasse, limestone
		lower		limestone, silt
				limestone, silt, dolomite, slate
				silt, limestone, dolomite
	Devonian	upper		limestone, marl
		lower/middle	Tulkubash	conglomrlate, sandstone
	Ordovician	upper/middle	Ayutor	sandstone, shale
		middle	Chandalash	shale, limestone, dolomite
	Cambrian	lower	Chandalash	shale, limestone, dolomite
Proterozoic	Vendian	upper	Shorashuy	mudstone, carbonate rock
			Mursash	tuff, shale, trachybasalt, trachyandesite, sandstone
	Ripheian	middle	Uzunbulak	sandstone, silt, shale

Fig. I-3-2 Schematic Geologic Column of the Survey Area into the upper and the lower parts. The thickness of this formation is estimated to be 450m～800m. In the Pskem mountain range this formation overlies the Mursash, and in the Chandalash mountain range it overlies the Uzunbulak. This formation is intruded by middle Carboniferous diorite - granodiorite which tends to be associated with mineralization of gold, tungsten, molybdenum, copper, polymetals, silver, antimony and others. Therefore, close attentions are paid to this formation and the upper Chandalash formation as embedding placer deposits of precious and rare metals.

2) Paleozoic groups

(1) Chandalash formation (Lower Cambrian Series～Middle Oldovician Series)

These strata consist mainly of terrigenous deposit (tillite and siliceous shale), limestone and dolomite, and are distributed widely in Chandalash mountain range and Pskem mountain range. This formation, which is distributed in Chandalash mountain range, is composed of dark gray-black argillaceous, carbonaceous silty shale, limestone and argillaceous shale. Its thickness is estimated 1,000m～1,500m. On the southern slope of Pskem mountain range, lower beds of this formation (tillitic conglomerate) lie on the upper Shorashuy, and as it goes higher it becomes interbedded silt and argillaceous shale or dolomitic limestone with intercalated sandstone layer.

(2) Ayutor formation (Middle～Upper Oldovician Series)

This formation consists of flysch which is composed mainly of interbedded sandstone and shale, and is distributed in Chandalash and Pskem mountain ranges. It is graywacke at the bottom and changes into rhythmically interbedded graywacke (1-15m) and siliceous sandstone (2-3m). The thickness of this formation reaches a maximum of 440m.

(3) Tulkubash formation (Lower～Middle Devonian Series)

This formation consists mainly of terrigenous carbonate sediments, and is distributed in Pskem and Chandalash mountain ranges. According to the existing data, this formation is divided into the lower part and the upper part. The lower part consists of conglomerate, graywacke and sandstone. Its thickness ranges from several meters to 630 meters. The upper part consists of arkose sandstone and slate being accompanied with thin and lens shaped medium-grained conglomerate. Argillaceous shale and marl lie at the top. Their thickness reaches 350m～700m.

The upper part of this formation has high potential for placer deposit, and copper and barite-copper deposits. High probabilities of gold deposits are also suggested.

(4) Carbonaceous limestone (Upper Devonian Series : Fammennian series)

This formation is distributed on the ridges of the Chandalash mountains, and is divided into the biogenic limestone (100m～200m in thickness) and the carbonaceous limestone (200m～250m). This formation is considered to be related with bedded copper-barite deposits. Occurrence of gold deposits is expected with high probabilities especially in the area where this formation overlies the Chandalash formation directly or lies near it.

(5) Carbonaceous, biogenic limestone - dolomite (Lower Carboniferous : Tournaisian series)

This formation consists mainly of carbonate rocks, and is divided into the lower members of limestone-dolomite and the upper members of limestone-calcareous breccia. The total thickness of this formation is 1,200m～1,300m. In the central Asia silver bearing polymetal deposits are embedded in carbonaceous-biogenic limestone and dolomite in the Lower Carboniferous. Similar mineralization may be expected in the carbonate rocks of the upper Devonian and the lower Carboniferous which are distributed widely in the ridge areas of the Pskem mountains.

(6) Silty limestone - carbonaceous sediments (Lower Carboniferous : Visean series)

Silty limestone contains light brown silt and shows platy～massive forms. Its thickness is 600m. It bears a number of fossils of brachiopods, crinoids and foraminifera. Therefore, geologic ages of this formation have been determined by those fossils. Carbonaceous sediments consist of slaty, carbonaceous, silty limestone, shale and slate, and are as thick as 2,000m.

(7) Carbonaceous limestone - pyroclastic, molasse (Lower～Middle Carboniferous: Visean ～Serpukhovian series)

The lower part of this formation is biogenic limestone being composed of the medium limestone and limestone with interbedded thin slate. The thickness of this formation is 700m～850m. In the middle part brecciated limestone and a thin layer of dolomitic limestone are found. The upper part consists of carbonaceous limestone and sediments of pyroclastic molasse which consist of rhythmicaly alternating beds of limestone, tuffaceous shale, slate and sandstone. The thickness of this formation is 310 meters. At the top of this formation lies andestic tuff which bears a large amount of volcanic glass (0.2mm in diameter) and andestic rock fragments.

(8) Minbulak formation (Middle Carboniferous : Bashkirian series)

This formation consists of andesite lava, trachyandesite and tuff, and is distributed in the bottom of Turpak-Tushty valley. At its bottom lies pyroclastic conglomerate.

3) Cenozoic groups

(1) Alamuyum and Musabek formation (Neogene : lower Miocene series)

This formation is divided into two parts based on lithofacies and structure. The lower part consists of terrigenous carbonate rocks, and the upper part consists of terrigenous deposits. It is characteristically interbedded with alluvium, deltaic deposits and lake deposits, and is 1,500m thick. It is suggested that formation of these sediments is related with the activities of uplifting continent.

(2) Terrigenous molasse (Quaternary : Pleistocene ~Holocene series)

This formation consists of unsolidificated terrigenous molasse, and is separated by four unconformities. There are great differences in their origin, structure and constituents. Placer deposits occur in the alluvium and deltaic sediments in each stage.

3-2-2 Intrusive Rocks

(1) Beshutor bodies (Early Proterozoic ?)

These bodies consist of tonalite, plagioclase granite and granodiorite. Most of them show light gray to pinkish color with porphyritic texture and are composed of sericite and two-mica granitic rocks. They intrude along the axis of the Chandalah anticline located northeast of the watershed of the Pskem Mountain range. It extends 3~7km in width and 35km in elongation. Granodiorite in above-mentioned granitic rocks has an average of 0.06 g/t and a maximum of 0.32 g/t gold content. These bodies are related with gold deposits accompanied with copper and hydrothermal gold deposits in this area.

(2) Tunduk bodies (Late Proterozoic)

These bodies consist of small bodies and/or dikes of gabbro, diabae and dolerite. They are distributed in the Pskem and Chandalash mountains, partly in the Chatkal mountain. They intrude Beshutor bodies, the Uzunbulak of middle Proterozoic and the Shorashuy of upper Proterozoic and are overlain by the Chandalsh of the lower Cambrian to the middle Oldovician. They are related with the mineralization of nickel, cobalt, platinum and titanium.

(3) Alabuka body (Late Silurian)

This body consists of granodioritic rock. It occurs at one place in the Chatkal mountain located at southeast of this area, which may belongs to Caledonian orogene of early Paleozoic. It intrudes the Chandalash of lower Cambrian～middle Oldovician.

(4) Chandalash-Chatokal complex (Late Carboniferous)

These bodies consist of diorite and granodiorite. They are widely distributed in the Chandalash and Pskem mountains, partly in the Chatokal mountains. The Middle Chandalash body which is adjacent to the southeastern part of the Kichi-Sandyk ore showing, Karayangryk body in the north of the Middle Chandalash, Lower Chandarash in the south of Kichi-Sandyk ore showing, Kayinsuy body, Ikhnach-Karakorum body in the west of Kichi-Sandyk ore showing, Jayaktor body, Tayalmysh small body and Muzbel body at upper stream of Chandalash river are known as main bodies.

This complex is horizontally long and slender, and distributed discordantly on the folding structure. It intrudes as far as the Minbulak of the middle Carboniferous (Bashikirian series), and is identified as the activity of the late Carboniferous (303-326 million years) by isotopic dating of radioactive minerals.

Most of deposits and ore showings in this area, in particular gold, tungsten, bismuth and copper bearing skarnization, are related with this complex.

(5) Kyzylsay bodies (Late Carboniferous)

These bodies consists of coarse-grained porphyritic granodiorite and granite. They are widely distributed in the Chandalash and Chatkal mountains. Relatively large two bodies – Almasay body in the west of Kichi-Sandyk ore showing and Kzyltor body in the southeast of the Chatkal mountain – are distributed.

Skarn with mineralization of polymetals is related with the intrusions of Kyzylsay bodies.

(6) Chalmansay complex (Early Permian)

This complex consists of coarse-grained porphyritic granodiorite and granite. They are similar to the first phase of Kyzylsay bodies. It often forms small stocks. Major bodies of this complex include Kichi-Sandyk body which forms main mineralization zone of Kichi-Sandyk ore showing, Kurutegerek small body at upper stream of Chandalash river, and Kachalator body in the south of the Chatkal mountains. Many skarn deposits with mineralization of polymetals are known to be related with many dikes and small stocks of the Chalmansay complex. Copper–gold mineralization zones occur in Kichi-Sandyk and Kurutegerek ore showings.

3-2-3 Geological Structure

The Kyrghyz Republic has undergone remarkable diastrophism four times (Baikal age, Caledonian age, Hercynian age and Alpine age) and consists of several blocks borderd by faults and lineaments accompanied with these tectonic movements. There was no large diastrophism until the late Mesozoic after the Hercynian age in Kyrghyz. The peneplain had been once formed. Present mountain topography has been formed by the movement and upheaval of the blocks

The survey area is situated within the Middle Tien-Shan folding zone of the Hercynian folding system, in the western Kyrghyz, or west of the dividing Talas-Fergansky fault. It is located in the right bank of the upper stream area of Chatkal river, adjacent to the border of the Republic of Uzbekistan.

Geological Structure of Kichi-Sandyk area are complicated by many folding structures. Chandalash large syncline, which include the whole survey area, continues 30～40km in width and more than 180km in length. Pskem anticline is located in the northwest of the survey area, in the center of which Beshtor granitic body of early Proterozoic intrudes. Molasse sediments are distributed on the eroded surface of Beshtor and Tunduk granitic bodies, changing upward to tillite, volcanic and terrigenous deposits of middle to the late Proterozoic. The tectonic belt of the Caledonian age which is 7km in length is formed by carbonate, silt and terrigenous deposits of the Cambrian to the middle Ordovician system and volcanic, terrigenous flysch sediments of middle to the upper Ordovician system, on which red sandstone beds of the middle to the upper Devonian are distributed unconformably.

The deposits of parageosyncline of the early Hercynian age change to terrigenous carbonate sediments of the upper Devonian system, carbonate rocks of the lower Carboniferous system and silt-carbonate rocks of lower～middle Carboneferous system toward the upper strata. The thickness of this formation reaches 4,500m.

These sediments are intruded by many stocks and dikes of Chandalash-Chatkal and Kyzylsay bodies of the late Carboniferous and Chalmansay complex. The sediments after the Hercynian orogeny show poor development. Middle Carboniferous andesite and reddish molasse of the upper Carboniferousto the lower Permian system are distributed in small area and the thickness of the formation is 500m.

3-3 Characteristics of gold mineralization in the Survey Area

In the survey area including Kichi-Sandyk deposit, Skarn has been often formed at the contact between the lower Caboniferous limestone and the Carboniferous and Permian intrusive rocks such as diorite, granodiorite, monzonite and granodiorite porphyry. Mineralization of copper-gold, antimony, tungsten and molybdenum are observed in the skarn. It is suggested that the skarn related with early Permian granodiorite porphyry (Chalmansay complex) contains gold with higher quality than that with the Chandalash-Chatkal complex.

Two ore showing areas of Kichi-Sandyk and Turpak-Tushty are identified as promising for copper-gold deposits in this area. Furthermore, several ore showings have been also entrapped. According to the results of the previous explorations by the Kyrghyz, 200 tons of gold (140t in Kichi-Sandyk district) and 350 thousand tons of copper have been assessed as the potentials for this area.

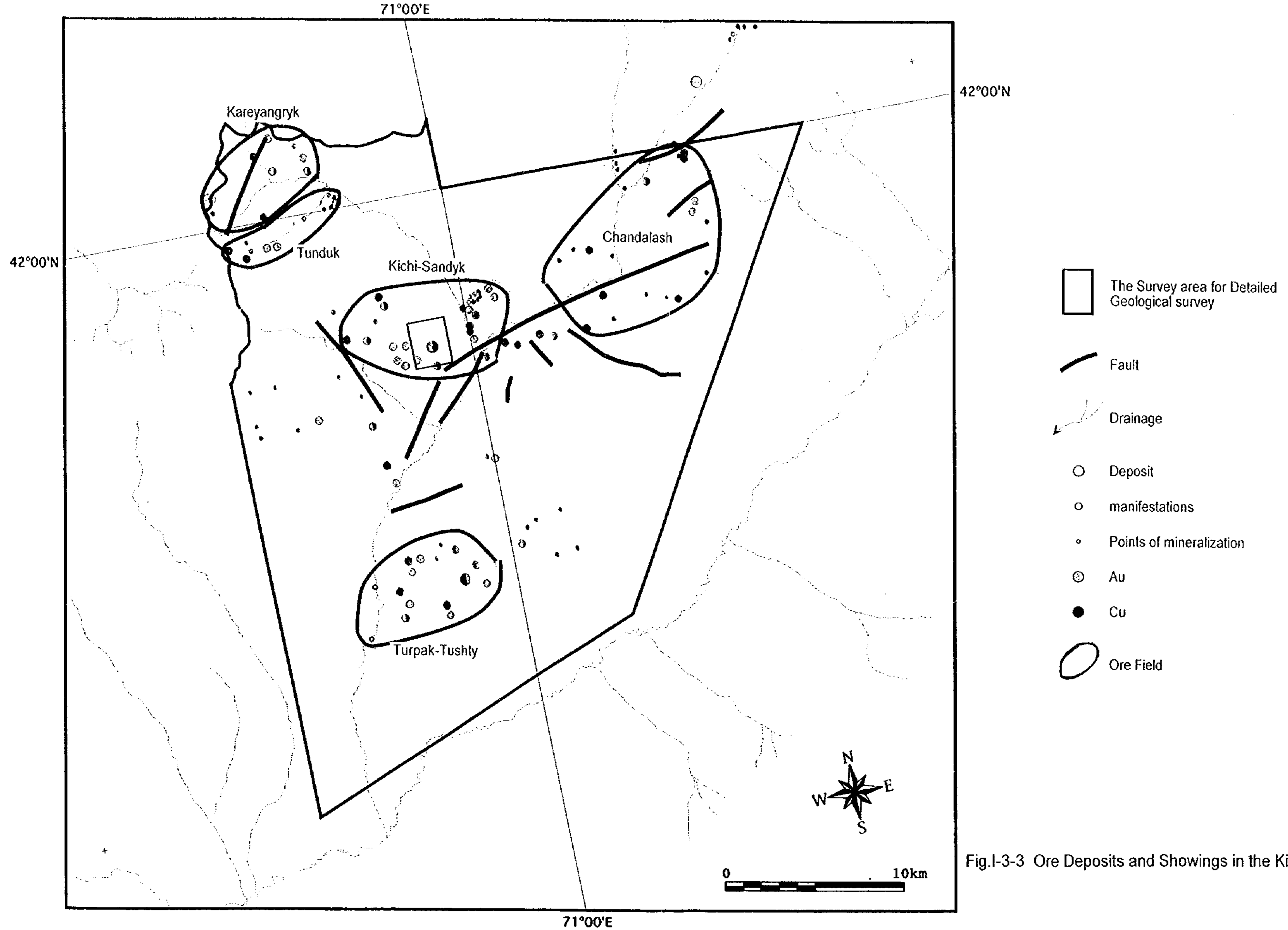


Fig.I-3-3 Ore Deposits and Showings in the Kichi-Sandyk Area

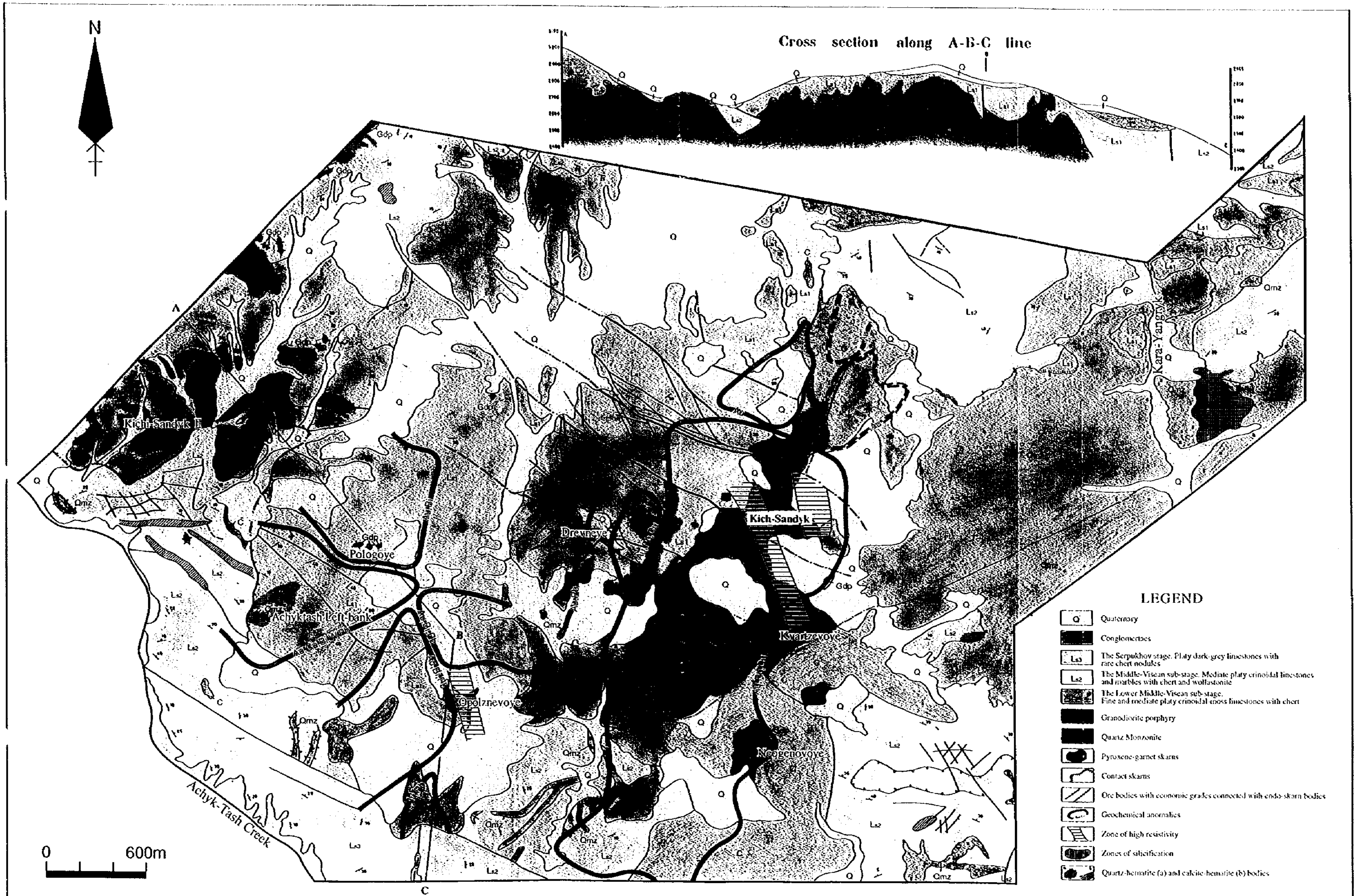


Fig. I-3-4 Summary of the Compilation

CHAPTER 4 COMPREHENSIVE ANALYSIS

4-1 Relationships between geology, geological structure and mineralization

The Kichi-Sandyk district is overlain by crystalline limestone of late Cambrian to early Carboniferous and intruding granodiorite porphyry of Permian. The former occurs in the north to the west of this area and has changed to crystalline limestone associated with wollastonite. The bedded skarn (exo-skarn) is formed at the contact between limestone and intrusive rocks. The skarn consists of garnet, wollastonite and epidote, in which copper bearing gold mineralization is exhibited. There is few outcrop in the survey area. This bedded skarn extends, not continuously, as far as 2km in the northeast to the southeast direction along the boundary of granodiorite porphyry in this survey area.

Granodiorite porphyry shows leucocratic lithofacies and is commonly suffered from hydrothermal alterations such as argillic alteration, carbonatization, chloritization and silicification. Numerous fissures and joints with the northeast to southeast strike are developed in the central mineralization zone situated in about the center of this survey area. Vein skarn (end-skarn) is formed along these fractures. It is smaller in size than the bedded skarn and exhibits vein shaped in 10 to 100 centimeter width. Skarnization zone in granodiorite porphyry extends in about 30m width. Skarn minerals consist mainly of garnet, subordinate with clinopyroxene and prehnite. Green copper minerals, bornite chalcopyrite and native gold occur as ore minerals.

Fault geography with the northwest to southeast strike and steep dip are developed in this survey area. It is suggested that these fault geography control the vein shaped mineralization zone associated with skarn in granodiorite porphyry.

4-2 Relationships between skarnization and mineralization

4-2-1 Bedded skarn

This skarn has been formed at the contact between crystallized calcareous sediments and intruding granodiorite and occurs extending to the northeast to southwest direction in this survey area. It consists mainly of garnet, wollastonite, epidote and calcite, forming a massive shape and extends, not continuously, as far as 2km along the boundary of granodiorite porphyry. Its width at right angle of the elongation reaches 5m to 70m. The boundary between skarn and granodiorite porphyry is conspicuous and quartz vein lets are occupied in the side of granodiorite porphyry.

Green copper minerals such as malachite and chrysocolla, bornite and chalcopyrite are disseminated, associated with native gold, limonite and hematite.

The mode of occurrence of native gold under the microscope has intergrowth texture with bismuthinite in chalcopyrite filled in interstices of euhedral garnet (Appendix 6). In addition free gold particles are also observed in the copper bearing Fe-Si mineral estimated as the copper secondary mineral.

4-2-2 Vein skarn (end-skarn)

Fractures and joints with the northwest to southeast strike and the steep southeast dip are developed in granodiorite porphyry of the central mineralization. Vein shaped skarn has been formed along to these fractures. It is smaller in size than the above mentioned bedded skarn and exhibits vein shaped in 10cm to 100cm width. Skarnization zone in granodiorite porphyry extends in about several meter to a maximum of 30m width. Skarn minerals are garnet (pale green and pale brown colored), clinopyroxene, prhenite and actinolite.

Ore minerals are green copper minerals such as malachite and chrysocolla, bornite and chalcopyrite pyrite limonite and native gold and covellite, chalcocite and marcasite are also observed by microscopic observation. Gold mineral consists of electrum, occurring in micro cracks and interstices of the garnet skarn as free particles.

Gold – copper mineralization is developed in vein skarn. As a assay result of ore samples, mineralization extends not only vein skarn , also skarnized granodiorite porphyry and altered granodiorite porphyry. Based on field evidences, microscopic observation of gold – copper mineralization and assay results, it is suggested that mineralization is caused in the fracture concentrated zone after skarnization. Then sulfide minerals and electrum have might been precipitated in vein skarn.

4-3 Potentialities of occurrence of ore deposit

The gold deposit potential (C2+P1+P2) in the Kichi-Sandyk ore showing area, which includes both Kichi-Sandyk (central and northern ore zones) and the surrounding ore zones, is estimated, based on the past surveys by the Kyrghyz, as 140 tons.

From the satellite image analysis in this year, it has become clear that lineament and spectral anomaly tend to concentrate in between intrusive of the northeast part and the same complex of the southwest part in this survey area. Kichi-Sandyk mineralization zone is situated in the area with heavy density of lineaments. It has been revealed that there is a promising area for mineral exploration.

As a result of trenching for the central mineralization zone, numerous gold mineralization zones have been detected in the range of about 400m NS direction × about 200m EW direction and in about 100m depth, associated with vein skarn controlled by the fracture with NW strike. It is assumed that the central mineralization zone is the center of the mineralization in this survey area, based on partially existing of high grade zone of gold content at 54 g/t in 1.2m width.

As a result of detailed geological survey for Kichi-Sandyk district including the central mineralization zone, it has become clear that this bedded skarn extends, not continuously, as far as 2km in this survey area. In addition, a few mineralization zone of high grade in gold and copper content are embedded in the same skarn and mineral showings with high potentiality for mineral exploration are entrapped in surrounding of the central mineralization zone.

According to above mentioned field evidences, it is suggested that there are high potentialities for occurrence of gold deposits in this survey area.

Further analysis of the extension of this mineralization zone in both the strike and vertical direction and entrapment of bonanza will be needed in order to make an evaluation of its potential after this.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5-1 Conclusions

1) From the satellite image analysis, it has become clear that the center of the survey area is promising for mineral exploration with a considerable amount of concentration of lineaments and spectral anomaly zones, and the Kichi-Sandyk deposit lies within this promising area. In addition, the area with mineral showings at Turpak-Tushty which is expected to be the second most promising area after Kichi-Sandyk deposit, is located at the southern end of the above mentioned promising area on the extension of the NNW-SSE lineaments which controls mineralization of the Kichi-Sandyk deposit, being accompanied with spectral anomaly zones. These facts together with many mineral showings confirmed on the surface, lead to a conclusion that this too is a promising area for mineral exploration.

2) Trenching survey detected in the central mineralization zone the following gold mineralization (unit: g/t).

Trench T1 :	Au 3.20(620cm),	Au 1.95(250cm),	Au 4.33(460cm)
	Au 1.61(120cm),	Au 2.32(870cm),	Au 1.08(120cm)
	Au 2.14(230cm),	Au 2.81(120cm),	Au 2.61(130cm)
	Au 1.22(200cm),	Au 1.20(90cm),	Au 3.77(110cm)
	Au 8.22(590cm),	Au 3.96(100cm),	Au 3.85(220cm)
Trench T2 :	Au 1.87(300cm),	Au 1.95(100cm),	Au 2.80(190cm)
	Au 2.08(300cm),	Au 2.63(100cm),	Au 1.91(110cm)
	Au 2.78(180cm),	Au1.88(100cm),	Au1 2.60(130cm)
	Au 2.30(100cm),	Au 1.65(350cm),	Au 4.09(320cm)
	Au 1.42(100cm),	Au 1.14(150cm)	

The analysis on the fracture pattern which controls mineralization indicates that the above gold mineralization has the structure with the strike being N45° ~47° W and the inclination being 56° ~74° SW. Given the area in which trenching survey was conducted, it extends at least 200m in the strike direction and 100m below. It will be necessary to figure out the vertical continuity (both structure and size) and conditions of mineralization in order to estimate its potential.

Considering the conditions of few outcrop in this area, thick oxidation and a large amount of waste dump caused by past mining activities, to continue the surface survey further will provide little additional information for obtaining the entire picture of mineralization .

3) Detailed geological survey (1/2,000) of Kichi-Sandyk district has revealed that the bedded skarn of the northern mineralization zone extends, though not continuously, as much as 2km in the SW direction along the boundary between granodiorite porphyry and limestone. This skarn is accompanied in part by high grade copper and gold mineralization, and inclines deeper in the north. It will be the next task in mineral exploration to analyze the structure of this bedded skarn and figure out the magnitude and extent of mineralization.

5-2 Recomamendations for the Second Year Survey

Based on the findings of this year's survey, the following surveys are recommended and proposed for the second year.

1) Drilling survey to confirm the depth and conditions of mineralization at the central mineralization zone of the Kichi-Sandyk deposit.

2) Drilling survey to figure out the magnitude and structure of the bedded skarn which is seen in the northern mineralization zones, as well as detailed geological surveys (1/100-1/500) on the exposed part including surveys with trench and pit.

3) Geological survey of the area which meets most conditions to be judged promising for mineral exploration according to the satellite image analysis, especially mieral showings areas in Turpak-Tushty in the south of the Kichi-Sandyk district.

PART II PARTICULARS

CHAPTER 1　SATELLITE IMAGE ANALYSIS

1-1 Methods for Analysis

1-1-1 Purpose

The satellite image analysis was aimed to obtain the basic geological data for making an exploration plan of the next year by means of satellite image interpretation including of geological units, lineament analysis and extraction of spectral anomaly zone indicating mineralized alteration.

1-1-2 Data for analysis

Image data for the survey are the LANDSAT TM data of Path 153 - Row 31. The data specification of the scene are indicated below.

- Platform:LANDSAT 5
- Path-Low:153-31
- Scene I.D.:52379000000
- Date of Observation:1990/09/04
- Sun Elevation:46°
- Sun Azimuth:136°

The area of the scene and the analysis are shown in Fig.II-1-1. There is no cloud in the area of the analysis and snow fall and glacier are distributed at high elevation area.

1-1-3 Details of analysis

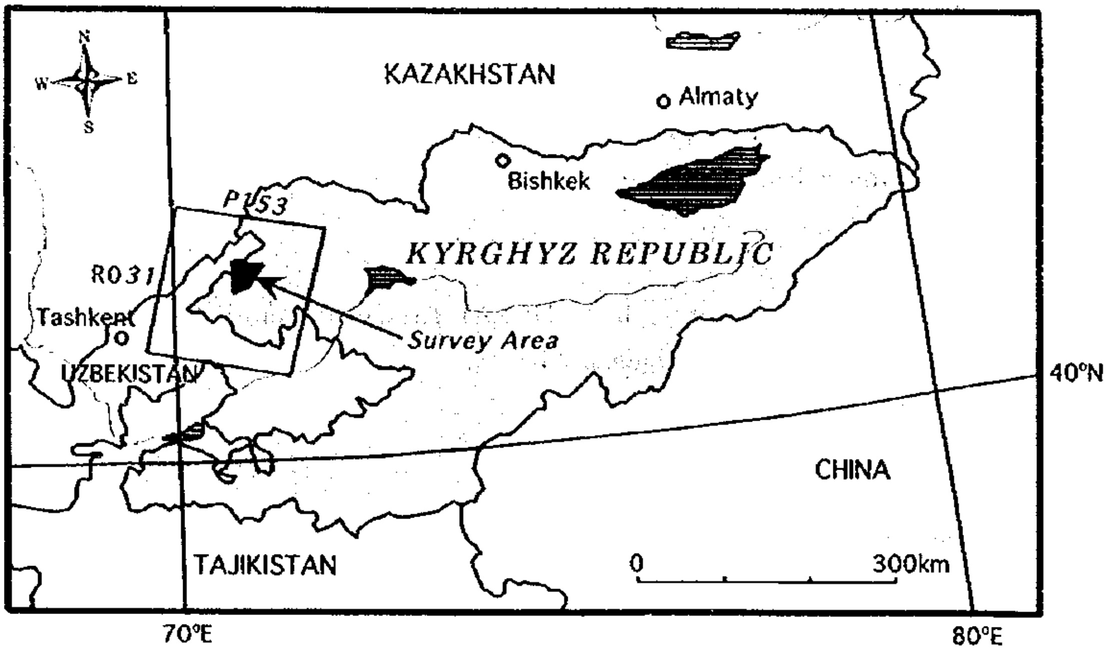
The data analysis has been done in the following procedure.

1) Extraction of the area to be analyzed

Subscene data of 1682 × 1682(50 × 50km, 29.72m/pixel), which cover the whole survey area, were prepared.

2) Preparation of color composite image

Coefficients of correlation between bands were calculated, as well as information entropy by combination of three bands. From combinations of bands which have low correlation coefficients and high information entropy, several kinds of color composite images were produced. From these images, interpretation specialists searched on the monitor screen for the combination of bands most appropriate for geologic interpretation. As the result, it was concluded that the image, for which blue, green and red colors are assigned respectively for Band 1, 4 and 5, best reflects



Specification of Data Used

Satellite: LANDSAT 5
Sensor: TM
Path-Row: 153-31
Scene I.D.: 52315000000
Observation Date(Y/M/D): 90/07/02
Sun El./ Az.(degree): 59/117

Fig. II-1-1 Area of Satellite Image

topographic information and reproduces with higher fidelity changes in the tint corresponding to difference in lithofacies. Therefore, each of Band 1, 4 and 5 was processed with the linear stretching and the edge enhancement filter, to which the blue, green and red colors were assigned, respectively, thereby producing a color composite image that was output in a scale of 1 to 200,000.The Image produced is exhibited in Fig.II-1-2.

3) Preparation of ration image (extraction of alteration zones)

Ratio image was produced in compliance with the following procedures.

a. Elimination of snow and glacier coverage (Band 1=255): The pixels covered by snow fall and glacier are considered to be noise for spectral analysis and are eliminated from the analysis.

b. Conversion to apparent reflectance (logarithmic residuals method): Radiance data obtained from remote sensing data are affected by atmospheric scattering and/or absorption and also by topographic factors, consequently, ground substances cannot immediately be method, while eliminating topographic factors dependent on the position of a pixel and illumination factors dependent on the wave length, pursue reflectance differentials of all pixels from an average reflectance of a subject area, in an effort to find an approximate value of the reflectance.

c. Calculation of NDVI: NDVI (Normalized Differential Vegetation Index) is calculated in the following formula:

NVDI = (Band 4 - Band 3) ÷ (Band 4 + Band 3)

The higher the NVDI is , the more dense the vegetation is reckoned to be.

d. Ratioing-1: Since many of clay minerals and carbonate minerals have absorption characteristics to Band 7 of TM, areas where these minerals occur can be extracted by ratioing in the formula of (Band 5-Band 7) ÷ (Band 5+Band 7).

e. Directed principal component analysis (DCPA): Since vegetation coverage have absorption characteristics to Band 7, principle component analysis by NDVI and Ratioing-1 was made in order to distinguish anomaly of vegetation and/or alteration. In the area of dominant vegetation like this area, it is considered that the first principle component shows quantities of vegetation and the second principle component shows quantities of alteration.

f. Ratioing-2 : To extract iron oxide zones, ratioing was made in the formula of (Band 2-Band 1) ÷ (Band 2+Band 1). Although" Band 3 ÷ Band 1" is generally applied formula for the extraction of iron oxide zones, the ratio of Band 2 to Band 1 was used for the ratioing because iron oxide minerals of certain types are of absorption characteristics to Band 3, as well.

g. Level slice : Of the second principle component of NCPA and ratioing-2, respectively, spectral anomaly areas were extracted from the maximum value, at the thresholds of 1% and 5%. Results of the analysis, composed with the Band 5 monochrome image, were output in a scale of 1:200,000. The image produced is exhibited in Fig. II-1-3.

4) Geologic Interpretation

Based on the 1:200,000 color composite image, the following works was conducted by means of photogeologic analysis:

a. Division into geologic units: A geologic interpretation map in a 1: 200,000 scale was drawn on a basis of photogeologic features on the image such as tone, drainage pattern, ground texture, difference in erosion resistivity and development of bedding and /or schistosity. The interpretation was correlated with the existing geologic map, whereby lithofacies and geologic time of the respective geologic units were decided.

b. Lineament extraction: Continuations of linear valley topography, sharp precipices and saddles appearing in the image, due presumably to geologic factors, were extracted as the lineaments, whereby a 1: 200,000 scale lineament map was drawn. Those which have been indicated as "faults" in the existing geologic map and was extracted on the image as clear lineaments are described as "faults".

5) Elaboration of a lineament density distribution map

The total extension of lineaments per unit area was obtained from the mentioned lineament map, from which lattice data were produced and, in turn, a lineament density distribution map was drawn.

6) Extraction of spectral anomaly zones

In the ratio image areas, in which pixels of showing a maximum figure to 1 % of (Band 2-Band 1)/ (Band 2+Band 1) are distributed with having a spread area, are extracted as anomaly zone.

1-2 Results of analysis

1-2-1 Division into geologic units

The geologic interpretation map drawn from the color composite image is

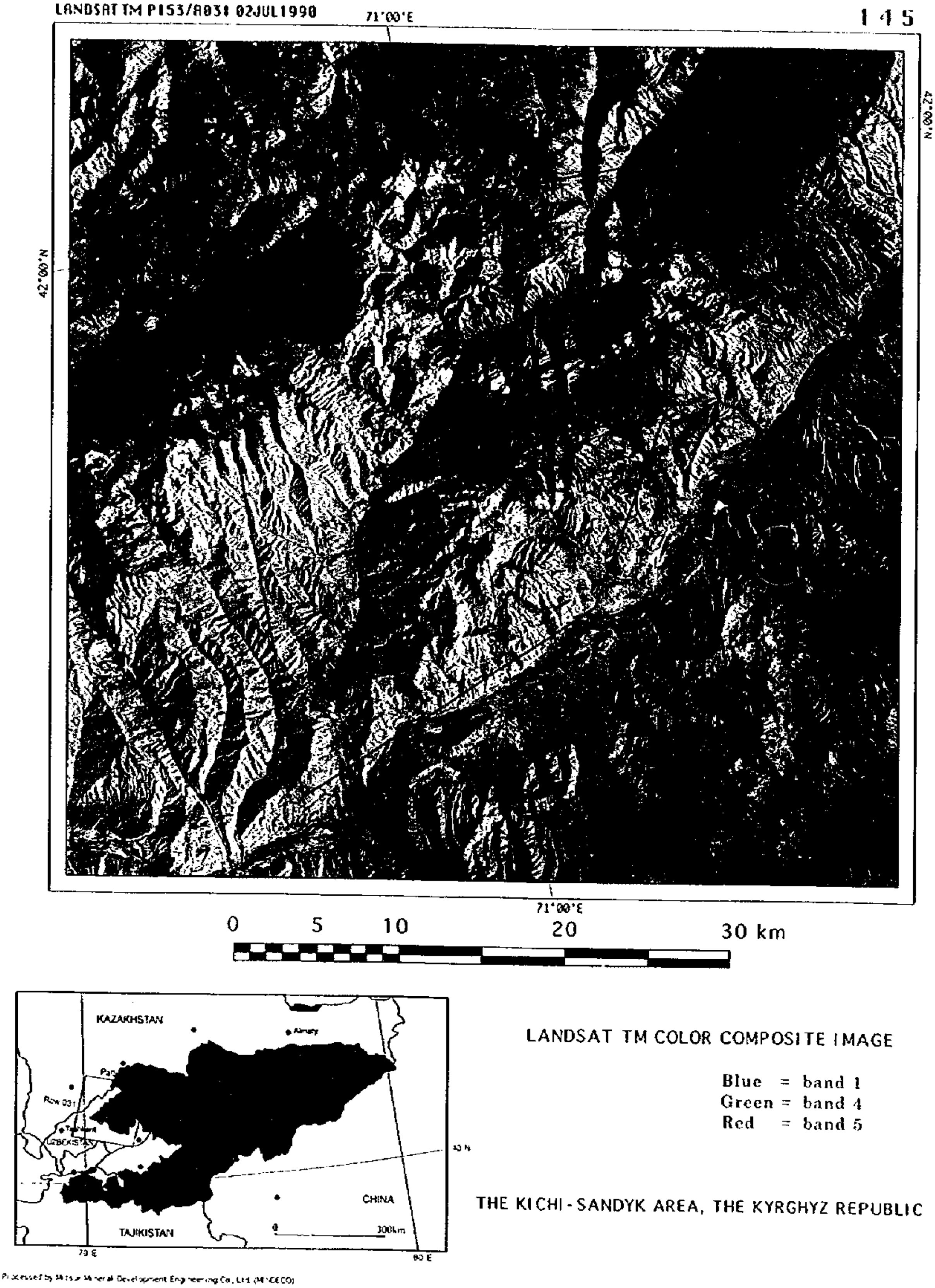
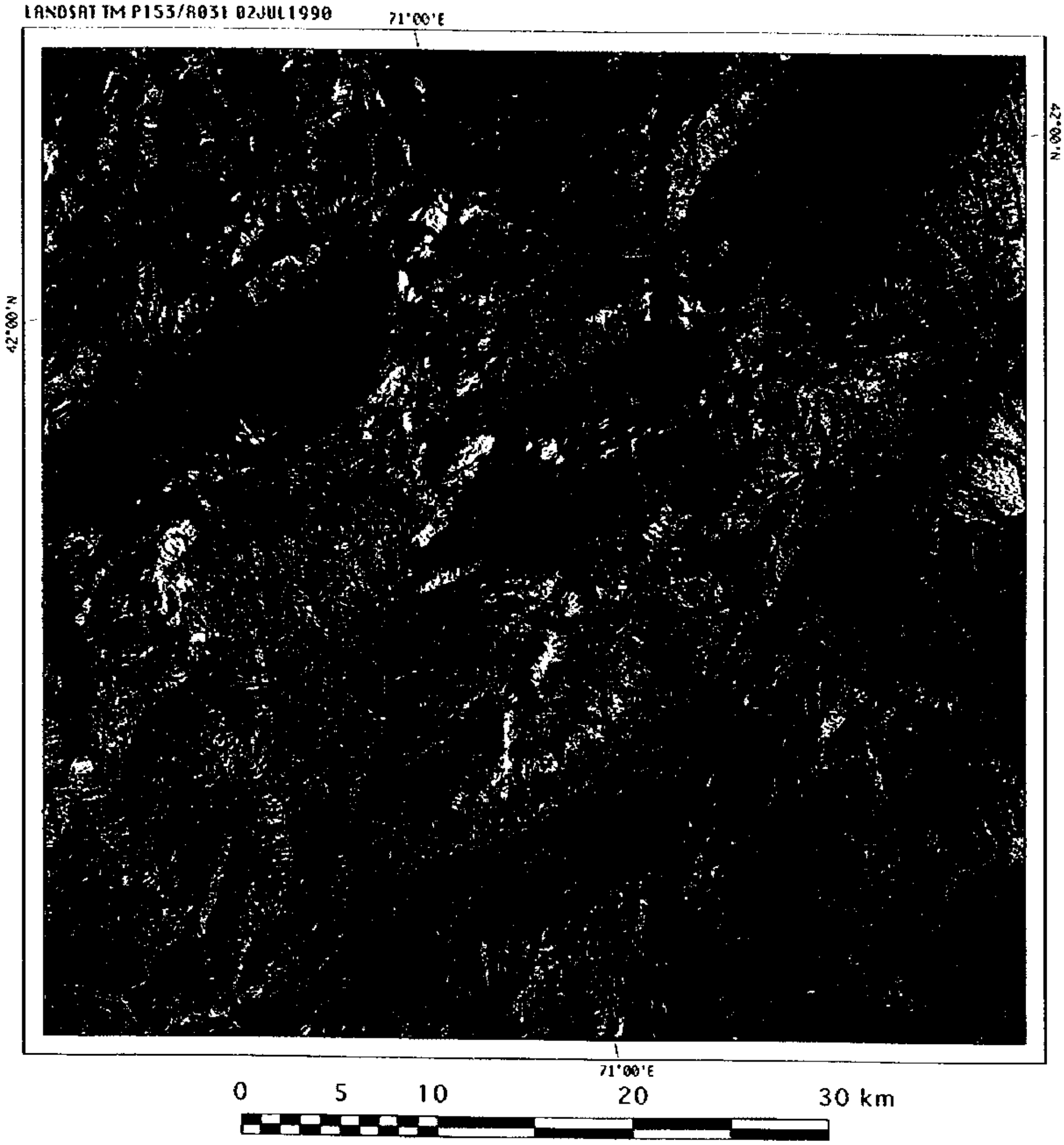
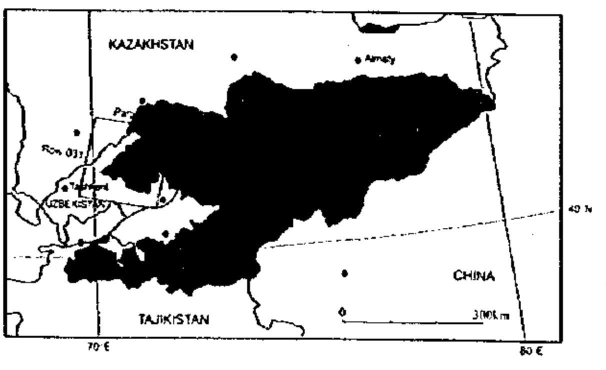


Fig. II-1-2 LANDSAT TM Color Composite Image

LANDSAT TM P153/R031 02JUL1990





LANDSAT TM RATIO IMAGE

Ratio (band2-band1)/(band2+band1)

● 1 % from maximum ratio

○ 5 % from maximum ratio

The second principal component of PCA by (band4-band3)/(band4+band3) and (band5-band7)/(band5+band7)

1 % from maximum DN

THE KICHI-SANDYK AREA, THE KYRGHYZ REPUBLIC

Processed by Mitsui Mineral Development Engineering Co., Ltd (MINDECO)

Fig. II-1-3 LANDSAT TM Ratio Image

exhibited Fig.II-1-4. The area for analysis was segmented into 7 units. It is hard to grasp correctly the distribution of each rock facies because of heavy concentration of vegetation coverage and not reflecting the differences of rock facies in spectral characteristics. The Paleozoic formation(P2), surrounding the southeast part of the granite body in northeast of this area, was distinguished from other Paleozoic formations by reason of showing more developed bedding and diversity of rock facies.

- Unit Q: The unit extending along the main drainage system forms gentle sloped, horizontal topographics in this survey area and is interpreted as alluvium.
- Unit T: It occurs mainly in the southern part of this area and forms a gentle slope and terrace. It shows a thick vegetation. It is interpreted as soft sediment and correlated with the molasse deposit of Cenozoic era in the existing geologic map.
- Unit P1: It occurs widely in central to northern part in this area. It looks reddish pink-colored in the image and has moderate erosion resistivity. Bedding structure is partly observed, but not developed. It is correlated with the sedimentary rocks (molasse, limestone, crystalline schist) of Paleozoic era.
- Unit P2: It occurs widely in central to northeast part in this area surrounding the mentioned latter unit D. It is correlated with the sedimentary rocks (molasse, limestone, crystalline schist) of Paleozoic era the same as unit P1.
- Unit PR: It occurs in the northwest part in this area. It looks dark colored in tint and has relatively high erosion resistivity. It is correlated with the metamorphic complex of Proterozoic era in the existing geologic map.
- Unit G: It occurs in the western part of this area and forms high the ridges. It looks light reddish pink-colored and has relatively high erosion resistivity. It is correlated with the granite to adamellite of late Carboniferous period in the existing geologic map.
- Unit D: It occurs in the northeast, western and southern parts of this area. It has moderate erosion resistivity and forms a gentle slope. It is correlated with the diorite porphyry to granodiorite complex of Permian era.

I-2-2 Lineament analysis

Results of lineaments interpretation are shown in Fig. II -1-5. Trends in

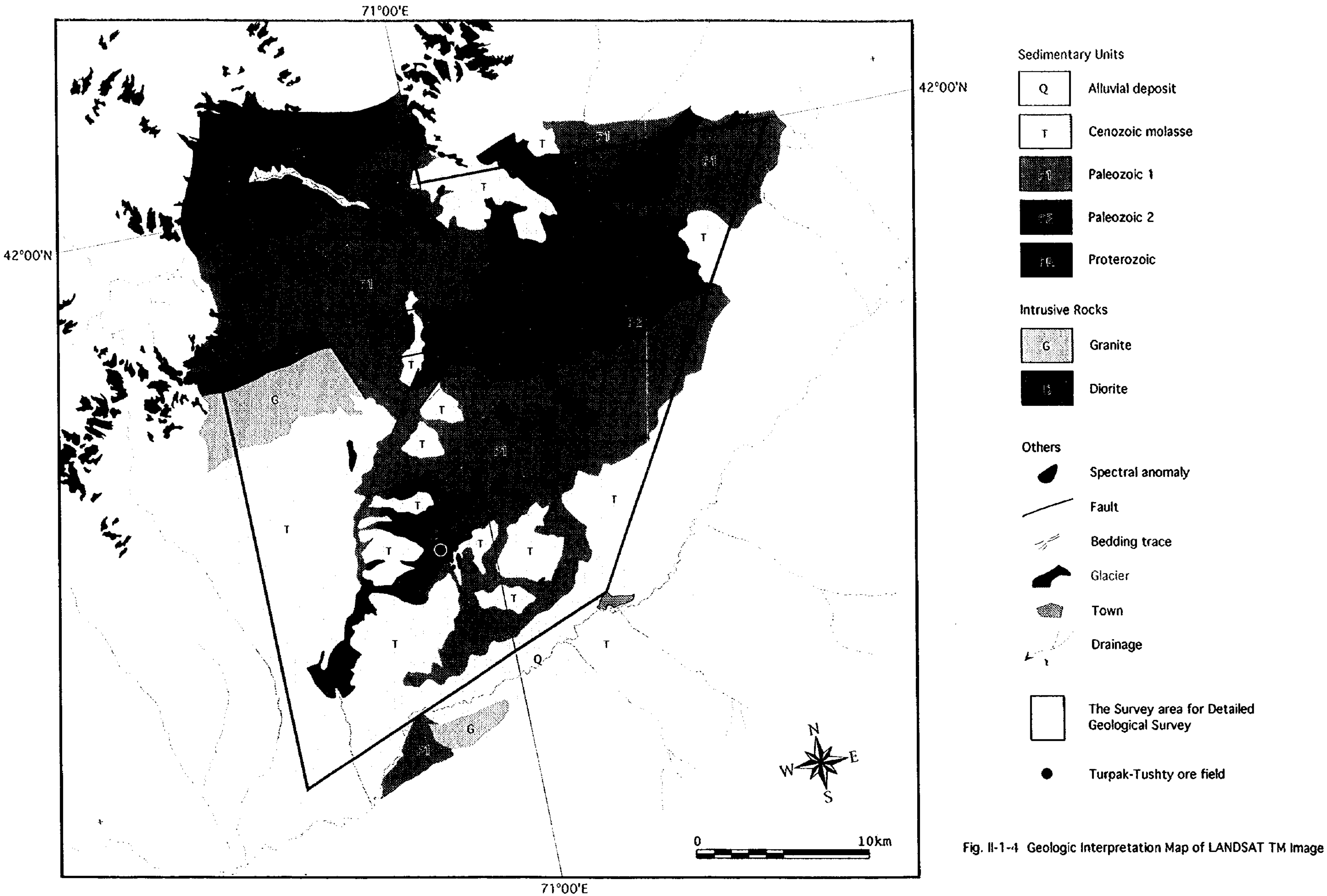


Fig. II-1-4 Geologic Interpretation Map of LANDSAT TM Image

distribution of lineaments extracted from the area for analysis may be summarized as follows:

a. Numerous lineaments in parallel to a main drainage system are extracted.

b. Half-circular structure in approximate 10 km radius develops in Paleozoic formation of eastern part in this area.

c. Kichi-Sandyk deposit is located on the lineament extending to NNE-SSW direction intermittently. In particular, this area has a heavy concentration of lineaments.

1-2-3 Spectral analysis

As the result of spectral analysis to extract the alteration zone, it has become clear as follows:

a. Argillic alteration and carbonatization : as a result of DCPA analysis, no spectral anomaly area with possibility of alteration exists in this survey area.

b. Oxidized iron zone: The distribution of spectral anomalies suggesting the exist of oxidized iron zone tends to be as follows:

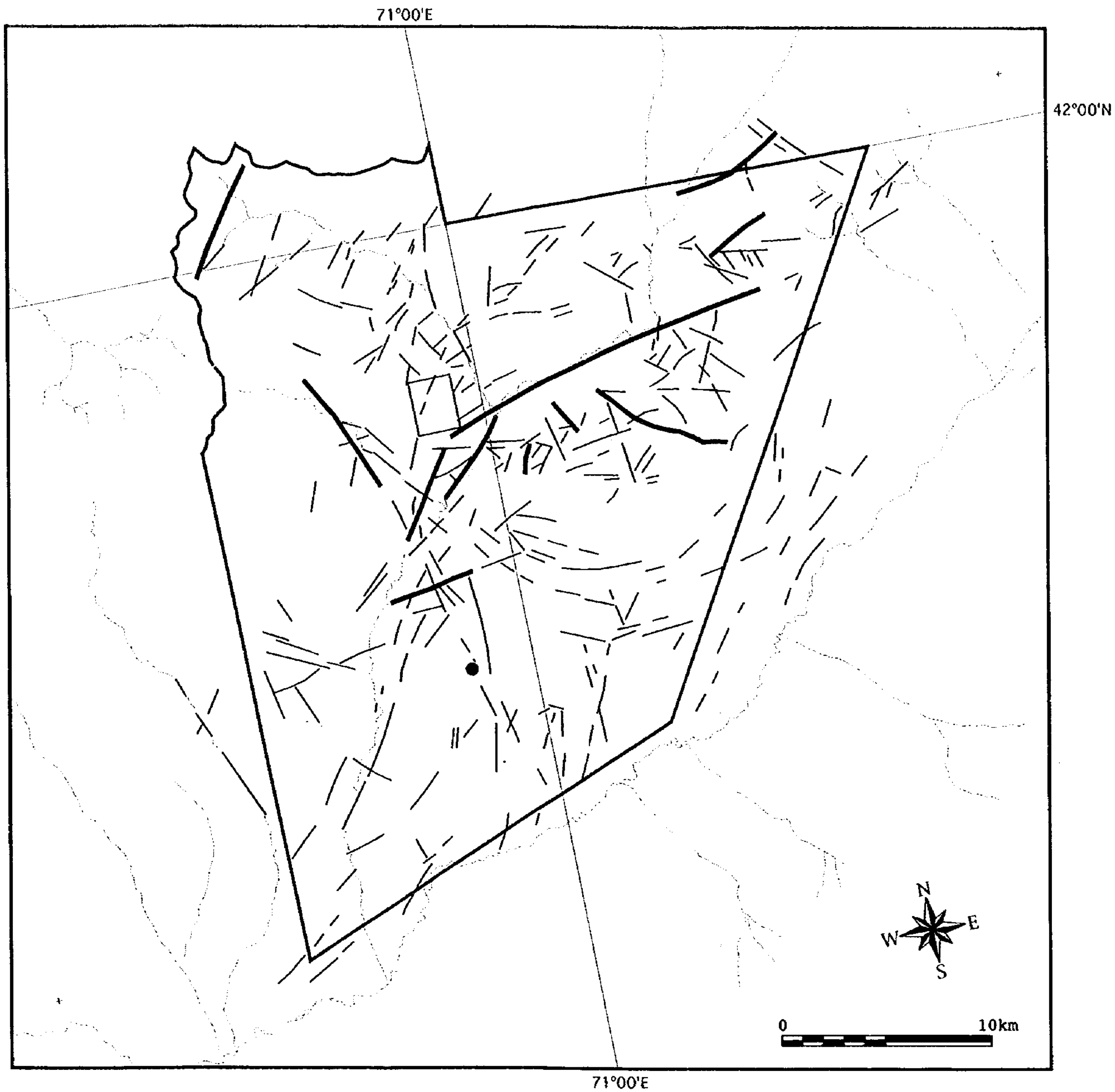
- The distribution tends to concentrate around existing ore deposits like Kichi-Sandyk
- It extends along intermittent lineaments in NNW-SSE direction.
- It occupies surrounding unit D in the northeast part of this area.
- It scatters in Paleozoic formation P2, showing a clear bedding and diverse of rock facies.

1-3 Comments

An integrated interpretation map is exhibited in Fig.II-1-6, which indicates the distribution (unit D and G) of intrusive rocks, faults and lineaments, spectral anomaly and lineament density.

It has become clear that lineament and spectral anomaly tend to concentrate in between diorite to granodiorite complex (unit D) of the northeast part and the same complex of the southwest part in this survey area.

As a result of this analysis, lineament density and the distribution of spectral anomaly may be controlled by the distribution of intrusive. The area which has more than 3000 (m/km2) of lineament density are extracted as promising area for mineral exploration, because there might be has high possibility of the existing of mineralization in the high density zone of lineament.



The Survey area for Detailed Geological Survey

Turpak-Tushty ore field

Fault

Lineament

Drainage

Fig. II-1-5 Lineament Extraction Map

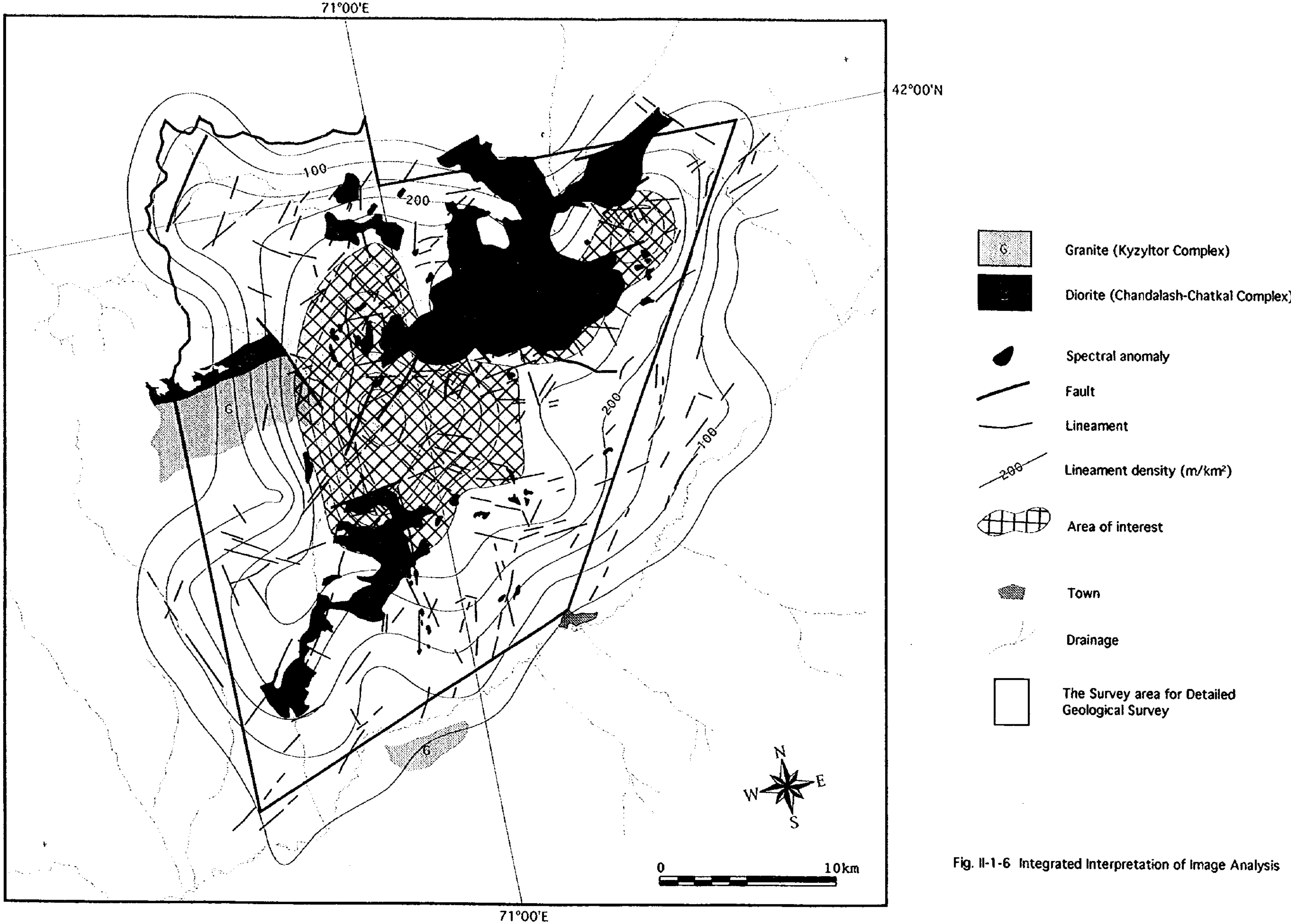


Fig. II-1-6 Integrated Interpretation of Image Analysis

1-4 Conclusions

Kichi-Sandyk deposit, in which detailed geological survey was carried out in 1997, is included in the above mentioned promising area and spectral anomalies are scattered in the surroundings. We propose to execute the geological survey in these spectral anomaly area in order to verify a relation between mineralization and spectral anomaly.

Furthermore, given the fact that it lies in the south end of the above promising area in the extension of the NNW-SSE lineament and that spectral anomaly was detected around it, coupled with the mineralization on surface, mineral showings in Turpak-Tushty too are promising for mineral exploration.

CHAPTER 2 COMPILATION OF EXISTING GEOLOGICAL DATA

2-1 Geology

The survey area is situated in the Middle Tien-Shan folding zone of Hercynian folding system which extends from the central Kyrghyz to the western Kyrghyz. It is in the west of the dividing Talas-Fergansky fault, near the border with the Republic of Uzbekistan. It lies on the southern slopes of the Pskem mountains, in the right bank of upper stream of Chatkal river.

The Middle Tien-Shan folding zone lies between the Northern Tien-Shan folding zone of Caledonian folding system and the Southern Tien-Shan folding zone of the Hercynian age. It is believed that the geosyncline had been formed to produce land at least partially by the middle Proterozoic (Ripheian age). A regional tectonic map of this survey area is shown in Fig. I -3-1.

The stratigraphy, intrusive activity and geological structure of the survey area are described below.

2-1-1 Sedimentary rocks

1) Proterozoic formations

(1) Uzunbulak formation (middle Proterozoic: Ripheian system)

These strata consist mainly of molasse and are divided into two parts, the lower and the upper. The thickness of this formation is 100m～600m. Lower molasse distributed in the Chandalash mountains is characterized by poor succession to the strike direction, conglomeratic slate with large rock fragments and sandstone in various size. Conglomeratic slate looks greenish gray, and contains medium to coarse grained pebble which consist of chart, siliceous silt, granite, shale and basic igneous rocks. The lower conglomeratic sediments bearing coarse pebble become gray green sandstone, shale, and rhythmic interbeds of sandstone and shale with occasional thin layers of limestone as they go higher.

Mineralization in this formation is specialized for gold and copper. There are good possibilities for discovering placer deposits in fine-grained sandstone, siltstone and silty shale.

(2) Mursash formation （Upper Proterozoic : Vendian system）

This formation consists of carbonaceous conglomeratic shale, trachybasalt, trachyandesite and terrigenous deposits. It occurs around the watershed of the Pskem mountain range,with its thickness reaching 150m～200m.The lowest part of this formation consists of conglomerate and conglomeratic sandstone lying on the erosion surface of tonalite, plagioclase granite and granodiorite. Going up from the bottom it changes into volcanic rocks and sediments with its thickness reaching 100m. It consists of tuff, tufaceous shale, crushed lava, trachybasalt, trachyandesite and trachyte.

The upper part of this formation consists of sandstone -mudstone beds (100m in thickness), rarely intercalated with thin carbonate beds. Although characteristics of mineralization in this formation are not clear, deposits of porphyry copper - molybdenum ore may be expected in the trachybasalt - trachyandesite formation.

(3) Shorashuy formation (Upper Proterozoic : Vendian system)

These strata consist mainly of mudstone and carbonate rocks, and are divided into the upper and the lower parts. The thickness of this formation is estimated 450m～800m. In the Pskem mountain range this formation overlies the Mursash, and in the Chandalash mountain range it overlies the Uzunbulak. Poorly sorted tillite, bearing boulders in 1.5m diameter and pebbles composed of granitic rocks, carbonate rocks, meat-shale, slate and lava, occur at the bottom of this formation. The upper strata consist of fine grained, carbonaceous, crushed terrigenous sediments and are divided into beds sandstone (graywacke, arkose sandstone, quartz-feldspar sandstone and quartz sandstone) and shale (quartz-feldspar silt, quartz silt, silt-argillaceous shale, sericite shale and chlorite-sericite shale). They exhibit rather poor exposure on the surface.

Based on the fact that this formation is overlain by the Chandalash formation of the lower Cambrian to the middle Oldovician age, it has been confirmed that this formation is from the Vendian age.

This formation is intruded by middle Carboniferous diorite-granodiorite which tends to be associated mineralization of gold, tungsten, molybdenum, copper, polymetals, silver, antimony and others. Therefore, close attentions are paid to this formation and the upper Chandalash formation as embedding placer deposits of precious and rare metals.

2) Paleozoic groups

(1) Chandalash formation (Lower Cambrian Series～Middle Oldovician Series)

These strata consist mainly of terrigenous deposits (tillite and siliceous shale), limestone and dolomite, are distributed widely in the Chandalash and Pskem mountain ranges.

In the tillite and siliceous shale at the bottom of this formation occur rhythmically altering beds of argillaceous limestone and siliceous shale. There are some pieces of fossil contained in those beds, and geologic age have been determined by those fossils. The thickness of this formation varies from 80 m to 350m.

Mineralization in this formation is specialized for bedded polymetals accompanied with silver, vanadium and uranium. There are good possibilities for discovering bedded polymetals deposits in the areas occupied by tillite and siliceous shale which overlie the Beshtor body bearing copper, lead, zinc and precious metals.

The beds of tillite and siliceous shale change into beds of carbonaceous limestone-dolomite and carbonaceous, siliceous shale-terrigenous deposits as they go higher, and are overlain by the siliceous shale.

The carbonaceous, siliceous shale and terrigenous deposits are composed of tillitic conglomerate, tillite and carbonaceous, and siliceous shale, and reach as thick as 100m to 200m. At the middle part of this formation, occurs silty carbonaceous limestone, and the upper part is occupied by silt and the lens of silty limestone. Geologic ages of this formation have been determined by the fossils of graptolites.

In the Chandalash mountain range, this formation is composed of dark gray-black argillaceous, carbonaceous silty shale, limestone and argillaceous shale. Its thickness is estimated to be 1,000m～1,500m.

On the southern slope of Pskem mountain range, lower beds of this formation (tillitic conglomerate) lie on the upper Shorashuy, and as it goes higher it becomes interbedded silt and argillaceous shale or dolomitic limestone with intercalated sandstone beds.

At the valley of Shorashuy river the tillite (50m in thickness) of this formation occurs on the gravel of weakly eroded Shorashuy formation, changing upward into carbonaceous and siliceous shale including lenses of dolomite. The thickness of this formation is 180m. Geologic ages of this formation have been determined by the fossils.

(2) Ayutor formation (Middle～Upper Oldovician Series)

This formation consists of flysch which is composed mainly of interbedded sandstone and shale, and is distributed in the Chandalash and Pskem mountain ranges. It is graywacke at the bottom and changes into rhythmically interbedded graywacke (1～15m) and siliceous sandstone (2～3m). The thickness of this formation reaches a maximum of 440m.

(3) Tulkubash formation (Lower～Middle Devonian Series)

This formation consists mainly of terrigenous carbonate sediments, and is distributed in the Pskem and Chandalash mountain ranges. According to the existing data, this formation is divided into the lower and the upper parts. The lower part consists of conglomerate, graywacke and sandstone. Its thickness ranges from several meters to 630 meters. The upper part consists of arkose sandstone and slate, being accompanied with thin and lens shaped medium-grained conglomerate. Argillaceous shale and marl lie at the top. Their thickness reaches 350m～700m. The upper part of this formation has good possibilities for placer deposit as well as copper and barite-copper deposits. High probabilities of gold deposits are also suggested.

(4) Carbonaceous limestone (Upper Devonian Series : Fammennian series)

This formation is distributed on the ridges of the Chandalash mountains, and is divided into the biogenic limestone (100m～200mthick and the carbonaceous limestone (200m～250m thick). This formation is considered to be related with bedded copper-barite deposits. Occurrence of gold deposits is expected with high probabilities especially in the area where this formation overlies Chandalash formation directly or lies near it.

(5) Carbonaceous, biogenic limestone - dolomite (Lower Carboniferous : Tournaisian series)

This formation consists mainly of carbonate rocks, and is divided into the lower part of limestone-dolomite and the upper members of limestone-calcareous breccia. The total thickness of this formation is 1,200m～1,300m. Characteristics of mineralization in this formation are not clear.

In the central Asia silver bearing polymetal deposits are embedded in carbonaceous-biogenic limestone and dolomite in the Lower Carboniferous. Similar mineralization may be expected in the carbonate rocks of the upper Devonian and the lower Carboniferous which are distributed widely in the ridge areas of the Pskem mountains.

(6) Silty limestone - carbonaceous sediments (Lower Carboniferous :

Visean series)

Silty limestone contains light brown silt and shows platy to massive forms. Its thickness is 600m. It bears a number of fossils of brachiopods, crinoids and foraminifera. Therefore, geologic ages of this formation have been determined by those fossils. Carbonaceous sediments consist of slaty, carbonaceous, silty limestone, shale and slate, and are as thick as 2,000m. Characteristics of mineralization in this formation are not clear.

(7) Carbonaceous limestone - pyroclastic, molasse (Lower～Middle Carboniferous: Visean ～Serpukhovian series)

The lower part of this formation is biogenic limestone being composed of the medium limestone and the limestone with interbedded thin slate. The thickness of this formation is 700m～850m. In the middle part, brecciated limestone and a thin layer of dolomitic limestone are found.

(8) Silt - limestone (Lower～Middle Carboniferous: Visean～Serpukhovian series)

This formation consists of light gray to gray colored limestone accompanied with dark thin layers of slate. Its thickness is 400m to 500m.

The upper and lower parts of this formation are occupied by crushed organic limestone, and in the middle part thin layers of carbonaceous dolomitic limestone are interbedded. Just below this formation are carbonaceous limestone and sediments of pyroclastic molasse which consist of rhythmic alternating beds of limestone, tuffaceous shale, slate and sandstone. Their total thickness is 310m. Characteristics of mineralization in this formation are not clear.

(9) Minbulak formation (Middle Carboniferous : Bashkirian series)

This formation consists of andesite lava, trachyandesite and tuff, and is distributed in the bottom of Turpak-Tushty valley. At its bottom lies pyroclastic conglomerate.

3) Cenozoic groups

(1) Alamuyum and Musabek formation (Neogene : lower Miocene series)

This formation is divided into two parts based on the lithofacies and the structure. The lower part consists of terrigenous carbonate rocks, and the upper part of terrigenous deposits. It is characteristically interbedded with alluvium, deltaic deposits and lake deposits, and is 1,500m thick. It is suggested that formation of these sediments is related with the activities of uplifting continent.

(2) Terrigenous molasse (Quaternary : Pleistocene ~Holocene series)

This formation consists of unsolidificated terrigenous molasse, and is separated by four unconformities. There are great differences in their origin, structure and constituents. Placer deposits occur in the alluvium and deltaic sediments in each stage.

2-1-2 Intrusive Rocks

Various types of igneous activities in Kyrghyz, such as the ones caused by subduction of the plate and alkaline magma of the inner continent, are known to have existed from the Proterozoic era to the late Paleozoic era. In the Kichi-Sandyk area , igneous rocks of late Paleozoic (Carboniferous and Permian) is distributed broadly. Isotopic ages of major intrusive rocks in the survey area are shown in Table II-2-1.

(1) Beshutor bodies (Early Proterozoic ?)

These bodies consist of tonalite, plagioclase granite and granodiorite. Most of them show light gray to pinkish color with porphyritic texture, and are composed of sericite and two-mica granitic rocks. They intrude along the axis of the Chandalah anticline located northeast of the watershed of the Pskem Mountain range. It extends 3 to 7km in width and 35km in elongation. Granodiorite in the above mentioned granitic rocks has an average 0.06 g/t and a maximum of 0.32 g/t gold in content. These bodies are related with gold deposits accompanied with copper and hydrothermal gold deposits in this area.

(2) Tunduk bodies (Late Proterozoic)

These bodies consist of small bodies and/or dikes of gabbro, diabae and dolerite. They are distributed in the Pskem and Chandalash mountains, and partly in the Chatkal mountain. They intrude Beshutor bodies, the Uzunbulak of middle Proterozoic and the Shorashuy of the upper Proterozoic, and are overlain by the Chandalash of the lower Cambrian to the middle Oldovician. They are related with mineralization of nickel, cobalt, platinum and titanium.

(3) Alabuka body (Late Silurian)

This body consists of granodioritic rock. It occurs in one place in the Chatkal mountains located in the southeast of the survey area. It may belong to the

Table Ⅱ-2-1 Isotopic Ages of Intrusive Rocks in Chandalash-Chatokal Region

Name of Intrusive	Rock Body	Rock Name	Media	Sample No.	Isotopic Age (Ma)	Geological Age
Chalmansay	Kichi-Sandyk	Granodiorite porphyry	whole rock	T1-212*	261±13	Permian
	Kichi-Sandyk	Granodiorite porphyry	whole rock	T2-226*	262±13	Permian
	Kichi-Sandyk	Granodiorite porphyry	whole rock	A-018*	274±14	Permian
Chandalash-Chatkal	Ikhnach-Karakorumsky	Granodiorite	biotite		278±10	Early-Permian
	Lower Chandalashsky	Granodiorite	biotite		283±9	Early-Permian
	Middle Chandalash	Granodiorite porphyry	whole rock	A-134*	304±15	Carboniferous
Alabuka	Alabukinsky	Granodiorite	biotite		450±12	Ordovician
	Alabukinsky	Granodiorite	biotite		480±13	Ordovician
Tunduk		No data				Late-Proterozoic
Beshtor	Besftorsky	Granite	muscovite		800±25	Early-Proterozoic
	Beshtorsky	Pegmatite	muscovite		830±18	

* : Phase I survey in Kichi-Sandyk Area, 1997

Calcdonian orogene of the early Paleozoic. It intrudes the Chandalash of the lower Cambrian to the middle Oldovician.

(4) Chandalash-Chatkal complex (Late Carboniferous)

These bodies consist of diorite and granodiorite. They are widely distributed in the Chandalash and Pskem mountains, and partly in the Chatkal mountains. Major known bodies include the Middle Chandalash body which is adjacent to the Kichi-Sandyk ore showing from southeast, Karayangryk body in the north of the Middle Chandalash, Lower Chandalash in the south of Kichi-Sandyk, Kayinsuy body, Ikhnach-Karakorum body in the west of Kichi-Sandyk ore showing, Jayaktor body, Tayalmysh small body, and Muzbel body at the upper stream of Chandalash river.

This complex shows a horizontally long and slender shape, and intrudes the folding structure discordantly. It has been identified as belonging to the activity of the late Carboniferous (303-326 million years) by isotopic dating of radioactive minerals, and intrudes as far as the Minbulak of the middle Carboniferous (Bashikirian series).

Most of t he deposits and ore showings in this area, particularly gold, tungsten, bismuth and copper bearing skarnization are related with this complex.

(5) Kyzylsay bodies (Late Carboniferous)

These bodies consist of coarsely grained porphyritic granodiorite and granite. They are widely distributed in the Chandalash and Chatkal mountains. There are two relatively large bodies - Almasay body in the west of Kichi-Sandyk ore showing and Kzyltor body in the southeast of the Chatkal mountains.

Skarn with mineralization of polymetals has relations to the intrusions of Kyzylsay bodies.

(6) Chalmansay complex (Early Permian)

This complex consists of coarsely grained porphyritic granodiorite and granite. They are similar to the first phase of Kyzylsay bodies. It frequently forms small stocks. Major bodies of this complex include Kichi-Sandyk body which forms main mineralization zone of Kichi-Sandyk ore showing, Kurutegerek small body on the upper stream of Chandalash river, and Kachalator body in the south of the Chatkal mountains

Many skarn deposits with mineralization of polymetals related to many dikes and small stocks of the Chalmansay complex are known. Copper-gold mineralization zones occur in Kichi-Sandyk and Kurtegerek ore showings.

2-1-3 Geological Structure

The Kyrghyz Republic has undergone remarkable diastrophism four times (Baikal age, Caledonian age, Hercynian age and Alpine age), and is made up of several blocks separated with each other by faults and lineaments which accompanied these tectonic movements. There was no large diastrophism until the late Mesozoic after the Hercynian age, and the peneplain was formed once in Kyrgyz. Present mountain topography has been formed because of block movements and upheavals of the blocks.

The survey area is situated within the Middle Tien-Shan folding zone of Hercynian folding system, in the western Kyrghyz on the western side of the dividing Talas-Fergansky fault. It is located in the right bank of the upper stream area of Chatkal river, adjacent to the border with the Republic of Uzbekistan.

Geological Structure of the Kichi-Sandyk area has been complicated by many folding structures. Chandalash large syncline, which include the whole survey area, is continuous 30～40km in width and more than 180km in length. Pskem anticline is located in the northwest of the survey area, in the center of which Beshtor granitic body of the early Proterozoic intrude. Molasse sediments are distributed on the eroded surface of Beshtor and Tunduk granitic bodies, and change upward into tillite, volcanic and terrigenous deposits of the middle to the late Proterozoic.
A tectonic belt of the Caledonian age is 7km in length is formed by carbonate, silt and terrigenous deposits of the Cambrian to the middle Ordovician system and volcanic terrigenous flysch sediments of the middle to the upper Ordovician system. Red sandstone beds of the middle to the upper Devonian cover it unconformably.
The deposits of parageosyncline of the early Hercynian age change into terrigenous carbonate sediments of the upper Devonian system, carbonate rocks of the lower Carboniferous system and silt-carbonate rocks of the lower to the middle Carboniferous system, toward the upper strata. The thickness of this formation reaches 4,500m.

These sediments are intruded by many stocks and dikes of the Chandalash-Chatkal and Kyzylsay bodies of the late Carboniferous and Chalmansay complex.

Developments of sediments in the late Hercynian orogeny are rather poor with limited surface distribution of Middle Carboniferous andesite and reddish molasse of the upper Carboniferous to the lower Permian system, and appear 500m in thickness.