REPORT
ON
THE MINERAL EXPLORATION
IN
THE ALAY 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 the Government of the Kyrghyz Republic, the Japanese Government decided to conduct a Mineral Exploration in the Alay Area Project and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The JICA and MMAJ sent to the Kyrghyz Republic a survey team headed by Mr. Haruaki Tsuchiya from August 17 to December 28, 1997.

The team exchanged views with the officials concerned of the Government of the Kyrghyz Republic and conducted a field survey in the Alay 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 relation 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.

February, 1998

Kimio Fujita
President
Japan International Cooperation Agency

Hiroaki Hiyama
President
Metal Mining Agency of Japan

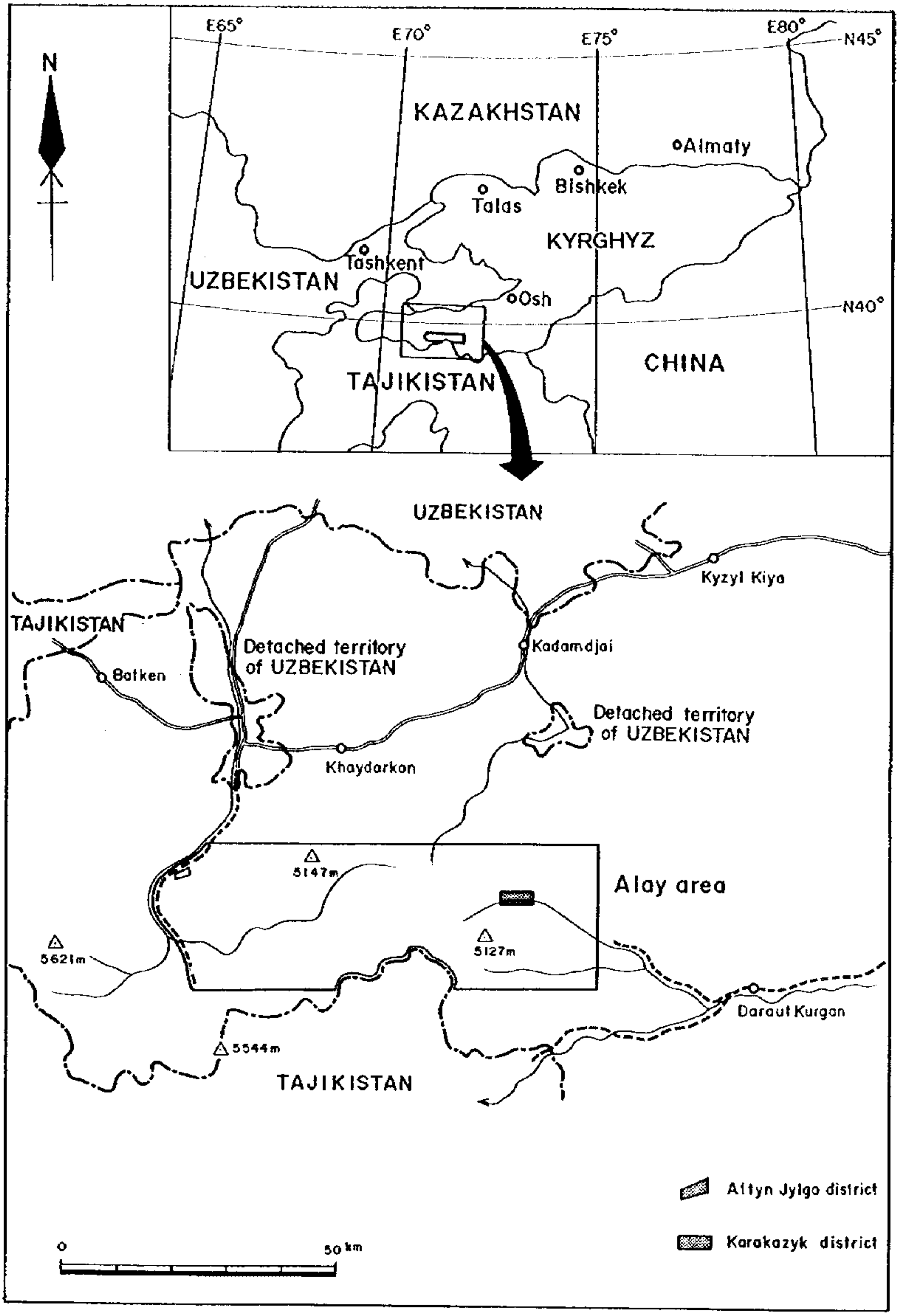

Fig. I-1 Location Map of the Survey Area

РЕЗЮМЕ

Настоящий отчет является сводом результатов фундаментального исследования по программе сотрудничества в освоении недровых ресурсов на первый год, которое было проведено в Алайском регионе Кыргызской Республики. 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 августа по декабрь 1997 г

В рамках исследования на первый год по всему Алайскому региону площадью1900 км^2 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, в Алтин-джилгском и Караказыкском районах была проведена точная геологическая разведка с траншейной разведкой для определения отношения между геологией, геологической структурой и процессом минерализации в пределах площади 2,1 км^2 и 12,0 км^2, соответственно. В Алимнджилгском районе, также, были проведены шахтная разведка в существующих шахтах общей протяженностью 558 м и траншейная разведка протяженностью 380 м для классификации скарнов и изменений с минерализацией и определения отношения между процессом минерализации и системой трещин. В северной части Алтин-Джилгского месторождения провели разведку с разбуриванием 10 скважин (общая глубина 1811,2 м) в целях непосредственного уточнения полосы минерализации на 1940 м - 1750 м, ее масштаба содержания минералов в руде.

В следующем приводим результаты проведенного исследования и наши предложения на второй год:

[Результаты исследования]

По всему региону:

(1) Зона проведения исследования относится к Туркистан-Алайскому региону в южной части Тяньш-шаньского хребта, где развиты складки, идущие с Востока к Западу, и классифицируется как часть продолговатой тектонической зоны, протянутой с Востока к Западу. Геология, характеризующая зону исследования, состоит из осадочных и интрузивных пород, а также покрывающих первые две осадков четвертичной системы.

(2) Как существующие месторождения и потенциальные месторождения,

нам изестны Алтин-джилгская группа месторождений (Au, Cu), Коксуская группа месторождений (Au, Ag, Bi, W, Sb, Pb, Zn), Аудар-габианская группа месторождений (Au, Cu) и Алаудинская группа месторождений (Sn, W).

(3) Результаты дешифрирования изображений, снятых с борта спутника, показали, что 33 геологические единицы хорошо совпадают с геолого-стратиграфическим распределением на существующей геологической карте. Результаты дешифрирования линейных и тектонических структур свидетельствуют о преобладании систем ВЗ и СВ-ЮЗ среди направлений линейных структур в данной зоне. На участке сосредоточения линейных структур системы ВЗ и в его окрестностях расположены Коксуская и Аударская группы месторождений. Исходя из этого, выяснилась связь между разломами системы ВЗ и процессом минерализации по региону в целом.

(4) Поскольку малые спектральные аномалии, расположенные разбросанным образом в юго-западной части зоны исследования, находятся на участке распределения интрузивных пород, которые представляют кольцевую структуру, может быть, отражают процесс минерализации, сопровождающийся интрузией.

По Алтин-джилгскому району:

(1) Месторождения в данном районе являются золотоносными медно-скарновыми, которые образовались на границе между гранодиоритом каракаызкской сложной интрузивной залежи и мрамором девонской системы.

(2) Среди скарнов преобладают моноклинные пироксеновые. В северной части наблюдается большое количество окремненные скарны, образовавшиеся в результате окремнения моноклинных пироксеновых скарнов.

(3) Результаты разведки с разбуриванием на 4-ом скарновом участке в северной части зоны исследования показали, что гранодиоритовая порода увеличивается вниз, а скарновые участки, которые широко распространены вблизи от поверхности, уменьшается на глубине. На 4-ом скарновом участке широко наблюдался процесс минерализации с превращением руды в золото, хотя содержание золота ещё было низко на уровне Au 0,1-0,5 г/т. Не найдены были части с высоким содержанием золота, за исключением отдельных концентраций (макс. содержание золота Au 55,6 г/т, ширина 50 см).

(4) В ходе шахтной разведки 1930 м было повторно уточнено наличие мощного процесса минерализации на 3-ем скарновом участке в центральной части зоны исследования. Найденная здесь полоса минерализации показала содержание золота 5 - 6 г/т и объем месторождения примерно 3000 $м^3$.

(5) Результаты разведки в существующих шахтах в текущем году показали, что на 3-ем скарновом участке преобладают разломы систем СВ-ЮЗ и СЗ-ЮВ. На основе изучения связи между разломами и минерализацией с превращением минералов в золото было предположено, что такой процесс сосредотачивается в части контакта разломов обеих систем.

(6) Проявление золота в виде электрумов размером 5 - 100 мкм наблюдается вдоль трещин в гранате, моноклинном пироксене, кварце, кальците и других жильных минералах или в виде парагенезиса с халькопиритом, борнитом, висмутином, виттихенитом и другими сульфидами меди.

(7) Лампрофирная дайка с особой концентрацией развивается вокруг 3-го скарнового участка. Лампрофир, широко распределенный вокруг Алтинджилгской долины, подвергается воздействия скарнизации и имеет вторичную окисленную руду меди параллельным образом. В отдельных дайках наблюдается минерализация в золото (1,3 - 5,0 г/т).

(8) Радиодатировка гранодиорита почти что совпала с той роговой обманки лампрофира. Они оба относятся к концу каменноугольного периода - началу пермского периода. Лампрофир, судя по его распределению и форме образования, формировался вместе с гранодиоритом в конце периода неоднократной магматической деятельности. Скарновое рудное тело, проникнутое лампрофиром, указывает на то, что эти скарны образовались в конце каменноугольного периода - начале пермского периода.

(9) На 3-ем скарновом участке в центральной части зоны исследования наблюдается сильный процесс минерализации с превращением минералов в золото. Однако эта тенденция показывает общее ослабление к северу. Сравнение процессов минерализации в северной и центральной частях зоны исследования указывает на то, что северная часть характеризуется более сильным процессом окремнения, большим количеством арсенопирита и более низкой температурой гомогенизации, которые являются признаками конца минерализации.

(10) Лампрофирная дайка и разломы системы СВ-ЮЗ считаются имеющими тесное отношение с процессом минерализации с превращением минералов в золото. На ЮЮВ стороне 3-го скарнового участка наблюдается значительные геохимические аномалии золота. Исходя из этого, этот скарновый участок может считаться центром процесса минерализации.

(11) В результате разведки вниз до 1930 м уточнено наличие части высокого содер0,

,жания золота под 3-им скарновым участком. Эта часть расположена на 60 м ниже (1870 м) уровня 1930 м. Ее масштаб и содержание золота - горизонтальная ширина примерно 13 м, среднее содержание золота 25,7 г/т. Кварцевая жила, отсекающая эту часть высокого содержания золота, имеет среднюю температуру гомогенизации 140°C, а кальцит в моноклинном пироксеновом скарне - 151°C. Следует отметить, что эти температурные показатели сравнительно низки для богатой золотом рудной части. Исходя из распределения скарнов и температуры гомогенизации, часть высокого содержания золота на уровне 1870 м может далее продолжаться вниз.

(12) На поверхности грунта в западной части зоны исследования широко развита пироксеновых скарнов (8-ой и 9-ый скарновые участки) в пределах 30 м х 200 м. Здесь получено максимальное содержание золота Au 10 г/т.

По Караказыкскому району:

(1) Левобережное месторождение представляет собой скарновое месторождение с содержанием золота и меди, которое формиловалось в межформационной зоне разломов в контактной части между доломито-мрамором и кальцит-мрамором. Оно также представляет собой скарновое месторождение с содержанием золота и меди, которое формировалось в контактной части между гранодиоритом и мрамором или в метасоматической породе.

(2) Распространение полосы минерализации, уточненное на поверхности грунта, составляет макс. 20 м - 40 м, однако масштаб части высокого содержания золота малы й.

(3) Части высокого содержания золота расположены разбросанным образом, и на данный момент развитие этого района в крупное месторождение, разработка которого носит смысл, считается маловозможным.

[Предложения по исследованию на второй год]

Результаты точной геологической разведки и разведки с рабуриванием показали, что предметом освоения может стать 3-ий скарновый участок Алтин—жилгского месторождения. На глубине этого участка с большой вероятностью могут лежать части с высоким содержанием золота.

Рекомендуется выяснить потенциал 3-го скарнового участка, запасы и другие факторы, которые послужат непосредственным обоснованием для начала работ по освоению месторождения. Конкретно говоря, предлагаем выработать шахту на уровне 1850 м для уточнения состояния 3-го скарнового участка 1930 м глубже, чем 1850 м, а также непосредственно проверить состояние частей высокого содержания золота, которые были найдены в ходе исследования с разбуриванием, и провести вертикальную и горизонтальную разведку в шахте с разбуриванием из шахты 1850 м.

Для уточнения механизма минерализации по всему Алтин-джилгскому месторождению рекомендуется провести горизонтальную разведку в шахте с разбуриванием из продленной шахты 1850 м и проверить 5-ое, 1-ое и 2-ое рудные тела, которые предполагаются быть ядром полосы минерализации. Кроме того, рекомендуется провести поверхностную разведку с разбуриванием для уточнения состояния минерализации между скважиной MJKA-10 и шахтой 1930 м, а также горизонтальную разведку с неглубоким разбуриванием для уточнения пределов месторождения 1930 м.

Судя по общерегиональной тектонической структуре, рекомендуется провести сбор данных и геологическую рзведку для постижения мест формирования месторождения и определения его потенциала относительно Аугулского и Габианского участков с признаками руды, которые имеют одинаковые с Алтин-джилгским условия зарождения месторождения.

SUMMARY

This report is a summary of the results of the Phase I survey of a technical cooperation project for mineral exploration conducted in the Alay area, the Kyrghyz Republic. The survey focused on clarification of the geology and determination of the mineral potential of the area and exploration for new ore deposits. The field survey was conducted from August to December, 1997.

In the Phase I survey, a series of data processing, analysis and interpretation of satellite image of the entire Alay area of 1,900km², has been conducted with the objectives to clarify the regional geological structure including lineament and classification of the rock facies. Detailed geological survey has been carried out in the Altyn-Jylga and Karakazyk districts, 2.1km² and 12.0km², respectively, to assess the relationship between mineralization and geology or geological structure. Especially, in the Altyn-Jylga district, underground geological survey of 558m in length as well as trench survey of 380m in length have been carried out to divide skarn and alteration zones and also to comprehend the relationship between mineralization and fracture. A core drilling survey has been performed to directly confirm mineralization zone in the downward extension of skarn zone at the altitude from 1940m to 1750m in the northern part of the Altyn-Jylga deposit. A total of ten holes were drilled with a length of 1,811.2m.

Results of the survey and recommendation for the Phase II survey are summarized as follows:

【Results of the survey】

Whole area

(1) This survey area belongs to the Turkestan-Alay area in the Southern Tien Shan mountains. The area is divided into several tectonic belts which extend in an E-W direction by thrust faults. The area is underlain by the Paleozoic sedimentary and igneous rocks and Quaternary sediments.

(2) Ore deposits and mineral manifestations in this area are as follows; Altyn-Jylga ore field (Au, Cu), Kokusu ore field (Au, Ag, Cu, Bi, W, Sb, Pb, Zn), Augul-Gavian ore field (Au, Cu) and Allaudin ore field (Sn, W).

(3) Thirty three geological units are classified on the basis of interpretation of false color synthetic satellite image. The result of interpretation has a good agreement with the geological map. Predominant directions of lineaments in the survey area are E-W and NE-SW. The Altyn-Jylga, Kokusu and Augul ore fields are distributed around the lineament swarm zone of an E-W trend. A close

relationship between the mineralization and the E-W trending fractures is suggested.

(4) Small-scale spectral anomalies by satellite image analysis are scattered on the southwestern part of the survey area where the intrusive complex revealing a circular structure is distributed. These anomalies may reflect presence of mineralization accompanied by the intrusive rocks.

Altyn-Jylga district

(1) The deposit in this district is gold-copper bearing skarn deposit which has been formed in the contact zone between granodiorite of the Karakazyk complex and the Devonian limestone.

(2) Skarn is made chiefly of clinopyroxene skarn. Silicified skarn which has formed from clinopyroxene skarn by silicification occurs commonly in the northern part of this district.

(3) The drilling survey has been performed in No.4 skarn orebody in the northern part of the deposit. As the results of the survey, it has been confirmed that granodiorite body is more widespread in the deep than near the surface. On the other hand, skarn zone becomes scaled down in the deep. Although gold mineralization is widely recognized in the skarn body, gold concentration in skarn ore is generally low, ranging from 0.1 to 0.5 g/t Au. Except a small-scale high gold concentration (highest grade 55.6 g/t Au in width of 50cm), large-scale high gold orebodies has not been confirmed.

(4) It has been reconfirmed by the underground geological survey of the previous 1930m level adit that gold mineralization is predominant in No.3 skarn orebody. Mineralization zone confirmed there has average grade of 5-6 g/t Au with an area of about 3,000km^2.

(5) According to the underground geological survey of the previous adit, fractures showing the NE-SW and NW-SE trends are dominant in No.3 skarn orebody. Considering the close relationship between gold mineralization and fracture, gold mineralization is assumed to be concentrated around the intersection of both trends.

(6) Electrum, ranging from 5 to 100 μ m in size, occurs along fissures and grain boundaries of garnet, clinopyroxene, quartz and calcite. Electrum coexists closely with chalcopyrite, bornite, bismuthinite and wittichenite.

(7) A dyke swarm of lamprophyre crops out around No.3 skarn orebody. A lamprophyre dyke around the Altyn-Jylga gully has undergone skarnization accompanied with secondary copper oxides. Gold mineralization, ranging from

1.3 to 5.0 g/t Au in grade, has been recognized in a part of lamprophyre dyke.

(8) K-Ar ages of both hornblende from granodiorite and lamprophyre in the Altyn-Jylga deposit are almost identical (282-299 Ma), and they correspond to latest Carboniferous to earliest Permian. Based on its distribution and occurrence, lamprophyre has formed in a later stage of igneous activity produced granodiorite. Skarn orebody has been intruded by lamprophyre. Therefore, skarn is presumed to be formed in latest Carboniferous to earliest Permian.

(9) Gold mineralization is dominant in No.3 skarn orebody situated in the central part at the district, but the mineralization commonly trends poor to the north. The mineralization in the northern part is characterized by silicification, rich in arsenopyrite and low in homogenization temperature as compared with the mineralization in the central part. The above-mentioned facts suggest that the northern part represents a margin of the mineralization.

(10) Both the lamprophyre dykes and the fractures of NE-SW trend is thought to have a close relationship with gold mineralization. Geochemical anomalies detected in the south-southeast of No.3 skarn orebody is thought to correspond to a center of mineralization.

(11) High grade gold ore has been confirmed in the lower extension of No.3 skarn orebody by the previous drillings from 1930mL. The high grade ore is located at the lower position of 60m from 1930mL (1870mL). It has 13m in width and average grade of 25.7 g/t Au. Homogenization temperature of fluid inclusions in quartz veinlet, which has cut high grade ore, centers around 140℃. Homogenization temperature of fluid inclusions in calcite accompanied with clinopyroxene, centers around 151℃. These homogenization temperatures are rather low as compared with a common homogenization temperature of gold bonanza. It is suggested that the high grade gold mineralization at 1870mL would continue to the most favorable orebody in the downward extension, on the basis of the distribution and structure of orebody and the homogenization temperature, although it is not conclusive because of only a few measurements.

(12) The western part of the district is underlain widely by the pyroxene skarn zone with sulfides (No.8 and No.9 skarn orebody) with an area of 30m×200m, which has a high gold concentration of 10 g/t Au.

Karakazyk district

(1) The Left Bank deposit is a gold-copper bearing skarn deposit, which has been formed along shear zone bordering the dolomitic and calcitic marbles. The Karakazyk deposit is a gold-copper bearing skarn deposit, which has been

formed in the contact zone between granodiorite and marble, or metasomatic zone associated with shear zone.

(2) Although the mineralization zone at the surface extends about 20m × 40m in a case of maximum size, the high grade zone occupies only a small part.

(3) It is concluded that the deposits in this district could be hardly developed as things stand, because high grade ore occurs as spot in skarn body.

【Recommendation】

As the results of the detailed geological and drilling survey in the Phase I, it is concluded that the No.3 skarn orebody of the Altyn-Jylga deposit could be developed and high grade ore would continue in the downward extension.

The Phase II survey is hoped to be carried out to clarify a potential of No.3 skarn orebody and is hoped to be aimed to a mining development in connection with much increase of minable reserves. As definite exploration method, it is recommended that a new adit on 1850mL is hoped to be opened and driven to confirm directly the gold mineralization of the high grade ore of No.3 orebody confirmed by previous drilling on the 1930mL. Horizontal and inclined drilling surveys from the 1850mL are hoped to be conducted to clarify the mineralization of deeper extension.

To grasp an entire mechanism of the mineralization in the Altyn-Jylga deposit, a drift on 1850mL is hoped to be extended to the lower extensions of No.5, No.1 and No.2 orebodies which are presumed as a center of the mineralization zone, and underground horizontal drillings are hoped to be conducted.

As prospective spaces in the Altyn-Jylga deposit, surface drillings are hoped to be conducted to clarify the mineralization between MJKA-10 hole and the adit of 1930mL, and horizontal drillings are hoed to be conducted to define an area of the orebody on 1930mL.

Moreover, it is proposed that information on the geology and the ore deposit is hoped to be collected and a reconnaissance geological survey is hoped to be carried out concerning mineral manifestations as Augul and Gavian which have been considered to be under the same mineralization conditions as the Altyn-Jylga deposit on the basis of regional geologic structure.

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PART I

GENERAL REMARKS

CHAPTER 1 INTRODUCTION

1-1 Background and purpose

The Kyrghyz Republic is composed mainly of metamorphic and sedimentary rocks from the Precambrian to Paleozoic group which are widely intruded by granite. Potential for the existence of metal deposits is high and gold, silver, copper, lead, zinc, mercury, antimony, tin, tungsten and rare earth minerals occur.

Although the Kyrghyz Republic has many kinds of mineral resources, a lot of deposits have been undeveloped and mining was not promoted during the days of the now defunct USSR, except for mercury and antimony exploitation.

After destruction of USSR, the Kyrghyz Republic have focused its policy on mining, especially, gold mining which is very competitive in the free market economic world. For example, the Kumtor gold mine has been developed with cooperate of Western mining company.

Japan and the Kyrghyz Republic had successfully conducted on the bilateral technical cooperation program for mineral exploration in Talas area from 1994 to 1997.

The Ministry of Geology and Mineral Resources (presently the State Agency of Geology and Mineral Resources) which evaluated the cooperated survey with Japan, had requested a new technical cooperation program for mineral exploration in Alay area in December, 1996. It includes the Altyn-Jylga and Karakazyk districts which have possibilities of developing mine. For this purpose, a delegation was organized among the Ministry of International Trade and Industry (MITI), Japan International Cooperation Agency (JICA) and Metal Mining Agency of Japan (MMAJ) for the preliminary survey. This delegation was dispatched to the Kyrghyz Republic from June to July, 1997. On June 27, 1997, an agreement on the scope of work for the Alay area project was signed between the parties.

The purpose of the survey was to explore the survey area and assess the potential for mineral occurrence and find the new deposit. Another purpose was to transfer Japanese technique of survey and analysis to the Kyrghyz Republic.

1-2 Outline of the Phase I survey

The entire survey area of the Phase I was approximately 1,900 km^2 (Fig. I-1). The Phase I survey involved analysis of satellite images, detailed geological survey and drilling survey. Methods and content of Phase I survey were summarized in Table I-1.

TableI-1 Methods and Contents of Survey

Methods	Contents			
Satellite Images Analysis	[Alay area]			1,900km²
Geological Survey	[Altyn-Jylga District]		Scale	1/2,000
	Surveyed Area			2.1km²
	Route Length			21.6km
	Trench Survey			380.0m
	Adit Survey			558.0m
	[Karakazyk Area]		Scale	1/10,000
	Surveyed Area			12.0km²
	Route Length			30.0km
Drilling Survey	[Altyn-Jylga District]			
	Surface Drilling			
	Drillhole No.	Length(m)	Direction	Inclination
	MJKA-1	160.1	105°	0°
	MJKA-2	244.5	105°	−40°
	MJKA-4	162.3	105°	0°
	MJKA-6	160.1	105°	0°
	MJKA-13	175.1	105°	−20°
	MJKA-7	281.0	105°	−45°
	MJKA-8	101.1	105°	0°
	MJKA-9	210.2	105°	−55°
	MJKA-10	111.9	105°	0°
	MJKA-11	204.9	105°	−45°
	Total	1,811.2		

(Laboratory Studies)

Methods	Items	Quantity
Geological Survey	[Altyn-Jylga District]	
	Observation of Thin Section	23pcs
	Observation of Polished Section	10pcs
	Chemical Analysis	102pcs
	Ore Assay(Au, Ag, Cu, Pb, Zn, Mo, As, Sb)	
	X-ray Diffraction Analysis	13pcs
	Dating	2pcs
	Fluid Inclusion	7pcs
	[Karakazyk District]	
	Observation of Thin Section	10pcs
	Observation of Polished Section	10pcs
	Chemical Analysis	21pcs
	Ore Assay(Au, Ag, Cu, Pb, Zn, As)	
	X-ray Diffraction Analysis	5pcs
	Dating	2pcs
	Fluid Inclusion	4pcs
Drilling Survey	[Altyn-Jylga District]	
	Observation of Thin Section	20pcs
	Observation of Polished Section	20pcs
	Chemical Analysis	1,170pcs
	Ore Assay(Au, Ag, Cu, Pb, Zn, Mo, As, Sb)	
	X-ray Diffraction Analysis	20pcs
	Fluid Inclusion	5pcs

Purposes of the Phase I survey were summarized as follows:

(1) To comprehend the regional geological structure with the analysis of satellite images.

(2) To comprehend a relationship between mineralization and geology or geological structure in the Altyn-Jylga and Karakazyk districts by detailed geological survey. Especially, in the Altyn-Jylga district, to comprehend classification of skarn, alteration zone and a relationship between mineralization and fissures by trench and underground geological surveys.

(3) To comprehend the grade and scale of mineralization at the altitude from 1750m to 1940m in the northern part in the Altyn-Jylga deposit by drilling survey.

(4) To clarify the further prospective subjects based on the survey results.

1-3 Organization of the survey team

The representative from Japanese government for the preliminary survey, were dispatched to Kyrghyz during the period from June 22 to July 2, 1997. The delegation members and their counterparts in Kyrghyz are shown below:

From Japan:

Mr. Toshio KOIZUMI	Metal Mining Agency of Japan
Mr. Naohide TSURUKAWA	Ministry of International and Trade Industry
Mr. Tohru NAWATA	Japan International Cooperation Agency
Mr. Masayoshi KAMEYAMA	Metal Mining Agency of Japan

From Kyrghyz:

Mr. Bayseit T. TURSUNGAZIEV	SAGMR*
Mr. Sheyshenaly M. MURZAGAZIEV	SAGMR
Mr. Vladimir P. ZUBKOV	SAGMR
Mr. Alexander G. KONYUKHOV	SAGMR
Mr. Victor P. ROGALSKY	SAGMR

* SAGMR: State Agency of Geology and Mineral Resources

The field survey team was dispatched from August 17 to December 28, 1997. The team members from Japan and their counterparts from Kyrghyz are shown below. The survey was implemented with cooperation of South Kyrghyz Geological Expedition and its subsidiary organizations, such as Shuran geological team and Kokusu geological team.

From Japan:

Mr. Haruaki TSUCHIYA	OMRD* ; Leader of field survey team
Mr. Masaharu MARUTANI	OMRD ; Geology and drilling
Mr. Iwao NAKAGAWA	OMRD ; Geology
Mr. Tetsuo YOSHIDA	OMRD ; Drilling
Mr. Akimitsu TAKEBE	OMRD ; Geology

* OMRD : Overseas Mineral Resources Development Co., LTD

From Kyrghyz:

Mr. Sheyshenaly M. MURZAGAZIEV	SAGMR; Leader
Mr. Vladimir P. ZUBKOV	SAGMR; Geology
Mr. Victor P. ROGALSKY	SAGMR; Drilling
Mr. Ivan I. SOLOSHENKO	SKGE* ; Geology
Mr. Ysmanaly MANSUROV	SKGE ; Drilling
Mr. Nikolay A. PYKHOTA	SKGE ; Geology

* SKGE : South Kyrghyz Geological Expedition

CHAPTER 2 GEOGRAPHY OF THE SURVEY AREA

2-1 Location and access

The survey area is located in the southwestern part of the Osh province. Location map of the survey area is shown in Fig. I-1.

The survey area is surrounded by 39° 47' N at the northern end, 39° 33' N at the southern end, 71° 53' E at the eastern end and the Sokh river at the western end. The area has a total area of approximately 1,900km². It belongs to the Kadamdjai, Batken and Chon-Alay regions administratively

The survey area is located in the Alay mountains among the Turkestan-Alay mountains which is a part of the Southern Tien Shan mountains. The most mineral deposits of this area are distributed in the Altyn-Jylga district of the western part and the Karakazyk district of the eastern part. The distance between both districts are about 70km. But due to separating them by the Turkestan-Alay mountains which are very steep and higher than 4,500m, access to each other is entirely different.

Osh where South Kyrghyz geological Expedition (hereinafter called SKGE) has head office, is located in about 300km southwest of the capital Bishkek. It takes about one hour from Bishkek to Osh by airplane. Osh is the center of the Osh province and has about 220,000 population.

(1) Altyn-Jylga district

Route to this area is to pass through Kyzyl-Kiya, Kadamdjai, Khaydarkan and Sokh where are located in the southwest of Osh.

Distance on paved road from Osh to Khaydarkan is about 174km, taking about 3 hours by automobile. Distance on road from Khaydarkan to this district is about 50km along the Sokh river. Because distance on unpaved road from Sokh to this district is 30km, it takes about one and half hours by automobile.

Some villages are distributed along the Sokh river valley from Sokh to this distance. The nearest village of this district is Sary-Talla where there are copper slug dumps. So mining is presumed to be very popular from ancient times in this district.

There are an antimony production complex and the head office of Shuran geological team in Kadamdjai. There are a mercury production complex and repair plant of Shuran geological plant in Khaydarkan.

The route from Osh to this district passes through two Uzbekistan territories.

One is situated at the entrance to Kadamdjai. Another is located in Sokh village.

(2) Karakazyk District

The survey district is located in about 130km southwest of Osh. Distance on road from Osh to this district is about 330km because of passing through the Alay mountains.

The route from Osh to this district passes along the Tardyk river, through the Chigirchik pass and reaches the Tereck village with distance of 113km. Then it reaches Sary-Tash about 50km through the 3,615m pass. At Sary-Tash with 4,280m in altitude, the army strictly checks smuggling of drugs to Kyrghyz. So it takes one or two hours to pass through the check point.

Distance between Sary-Tash and Daraut-Kurgan is about 100km along the Kyzurusu river. It takes totally about six or eight hours from Osh to Daraut-Kurgan by automobile. Daraut-Kurgan is the center of the Chon-Alay region, with 2,800m in altitude.

The route from Daraut-Kurgan to base camp for field survey in the Karakazyk district is 47km along the Kokusu river. It takes two hours by automobile because of bad road. It takes further 1 hour from base camp to Karakazyk deposit by horse.

2-2 Topography and drainage

The Kyrghyz Republic is known for the Tien Shan mountains marking 7,000 m class in altitude, which is one of the highest mountain ranges in the world. The country stretches the E-W direction along the extension of the Tien Shan mountains for hundreds of kilometers in southern Central Asia. The longest distance between the east and west points is 925 km and the longest one the north and south points is 454 km. Total area is 198,500km^2 which is approximately half area of Japan.

The Tien Shan mountains are divided into three ranges, that is the Northern Tien Shan, Middle Tien Shan and Southern Tien Shan mountains. The survey area is located in the western part of the Alay mountains of the Southern Tien Shan mountains.

The Altyn-Jylga district is located in the right bank of the Sokh river, with ranging from 1,800m to 2,200m in altitude. The topography is characterized by steep mountains with 3,200m to 4,500m in altitude and deep valley. Turkestan mountains which are located in the border on Tajikistan with 5,000m class in altitude, can be seen form this district.

Most deposits in the Karakazyk district are located in the higher than 3,400m in altitude. High mountains lie at both banks of Kokusu valley and are covered with snow during whole year. The highest mountain with 5,259m in altitude, is located in the left bank. The Abramov glacier which is largest in this area lies at the upstream of the Kokusu river. An observatory in USSR times was located there, but nowadays it has stopped researching activities. There are lots of avalanche in spring due to steep mountains. So the period of field survey is limited from May to September.

The Sokh river in the Altyn-Jylga district originates from the border on Tajikistan. It is estimated to have wide stream at ancient times because the river terrace covers thick on the both banks. The annual average volume of water is 50-60m^3/s and the river rises in spring. Very fine sands are included from spring to autumn. So it is not available to use for water supply of drinking. Four villages near the Altyn-Jylga district are located in both banks of the Sokh valley. Water from valleys is valuable for drinking to the local people.

The Kokusu river in Karakazyk flows into the Kyzurusu river which is the origin of Amu Darya. The annual average volume of water is unknown, but it is estimated to be large in spring by observing big meanders.

2-3 Climate and vegetation

The climate of the survey area is typical continental type. It is characterized by the difference of temperatures between day and night, and it is very cold in winter and very hot in summer.

The monthly average temperature in Altyn-Jylga ranges from -25°C to -20°C in February, from 30°C to 35°C in July. The annual average rain fall ranges from 250mm to 300mm and the monthly average rain fall is from 8mm in August and 69mm in June. It is covered with snow from the end of October to April. It recorded the 220 fine days per year.

The snowy season in the Karakazyk district continues from the middle of October to the middle of May. It is unstable weather in spring, and has much rain with sleet. Snow falls 27cm to 184cm. The annual average rain fall is 721mm and the monthly average rain fall is 19mm in August and 100mm in March and May on the data of the Abramov glacier observatory. Temperature recorded 25°C in August.

Bushes mostly grows until 3,000m in altitude. Beyond that altitude, lots of needle grass grows. Pine and poplar trees grow along the valley.

CHAPTER 3 GEOLOGIC INFORMATION OF THE SURVEY AREA

3-1 Outline of previous survey

The geological studies in the survey area have been conducted partially. Regional geology is summarized in the 1:500,000 geological map of Kyrghystan of USSR published in 1980.

(1) Altyn-Jylga district

Ancient mined places are situated in the Altyn-Jylga district which had been mined in small-scale. Slag of copper smelting process are observed around the Sary-Talla village located 2.5 km north of the mineralization zone.

The first investigation of the Altyn-Jylga deposit was made by Veber in 1909. In 1941 Freiberger reported for the first time that arsenopyrite vein was associated with gold mineralization. He concluded to be interested with the deposit because high grade ore had 37 g/t Au, though the gold mineralization was weak wholly.

During 1956-1957, the Sokh geological team carried out a full-scale research. Geological survey in this district was implemented in 1:10,000 scale. At the same time, geological survey in mineralized zone in 1:1,000 scale and geochemical survey of heavy mineral were carried out. Detailed trench survey was conducted in the mineralization zone. The survey concluded that 1 ton of gold reserves would be expected in the mineralization zone (Smirnov and Fedoroskaya, 1958).

During 1968-1970, the Turkestan-Alay geological team made a regional revision work. During 1987-1991, the Eastern-Turkestan team conducted a detailed geological survey and suggested that productive mineralization would be situated in the central part of the deposit.

In 1994 the Altyn-Jylga geological team started an evaluation work of the central part of the deposit with trench, geophysical and geochemical surveys. Tunnel prospecting with a total length of 500m of drifts and crosscuts was conducted during 1995-1996.

(2) Karakazyk district

In 1935 Moskvin reported mineralization zone of the Karakazyk district for the first time. A 1:200,000 scaled reconnaissance survey headed by Marshikin was conducted as preliminary systematic research during 1954-1956.

During 1966-1967 the Daraut-Kurgan team carried out a 1:25,000 geological survey along the Kokusu valley and confirmed an existence of gold in ore.

During 1970-1972 a study for classification of igneous rocks was performed, and ore deposits and manifestations such as the Left Bank, Karakazyk deposits

Zaid reported copper-gold skarn ore in the Left-bank deposit in 1976.

After a composite survey composed of regional geology, geochemical prospecting, geophysical survey, trench and drilling survey including underground work of 800m was conducted there during 1980-1983, any survey has not been worked.

3-2 General geology

(1) Tectonics of the Kyrghyz

The Kyrghyz is divided into five tectonic belts composed of the Northern Tien Shan, Middle Tien Shan, Southern Tien Shan, Northern Pamir blocks and the northern margin of the Tarim platform (Fig. I-2). The Northern Tien Shan block is mainly of the Caledonian orogenic belt (Early Paleozoic), and the Middle and Southern Tien Shan blocks are of Hercynian orogenic belt (Late Paleozoic). The Northern Pamir block is of the Alpine fold zone in Cenozoic orogenic belt. The Tarim platform is a stable block after late Proterozoic.

The Southern Tien Shan block is divided into the eastern and western blocks by the Talas-Fregan fault. The eastern block is called the Kokshaal, and the western block is called the Turkestan-Alay where the survey area is located (Fig. I-2). Regional geology including the survey area is described the followings on the basis of information from the Kyrghyz counterpart.

(2) Turkestan-Alay region

The Turkestan-Alay area is underlain by the sedimentary rocks from Proterozoic to Cenozoic. Geological structure is controlled by faults and folding which principally direct E-W. The area is divided into several tectonic belts which extend an E-W by thrust faults. These tectonic belts are separated into eugeosyncline zone of the northern side and miogeosyncline zone of the southern side on the thesis of classic geosyncline orogeny. Eugeosyncline zone has been thrust over miogeosyncline zone by the east-west directing faults such as the Kaurau, Tegermach and Khaydarkan faults. These geological structure is recently presumed to be formed by the subduction of the ocean-floor and by the continued collision of the continents during Devonian to Carboniferous; a active continental margin of the northern side has been collided and thrust over a passive continental margin of the south (Windley et al., 1990).

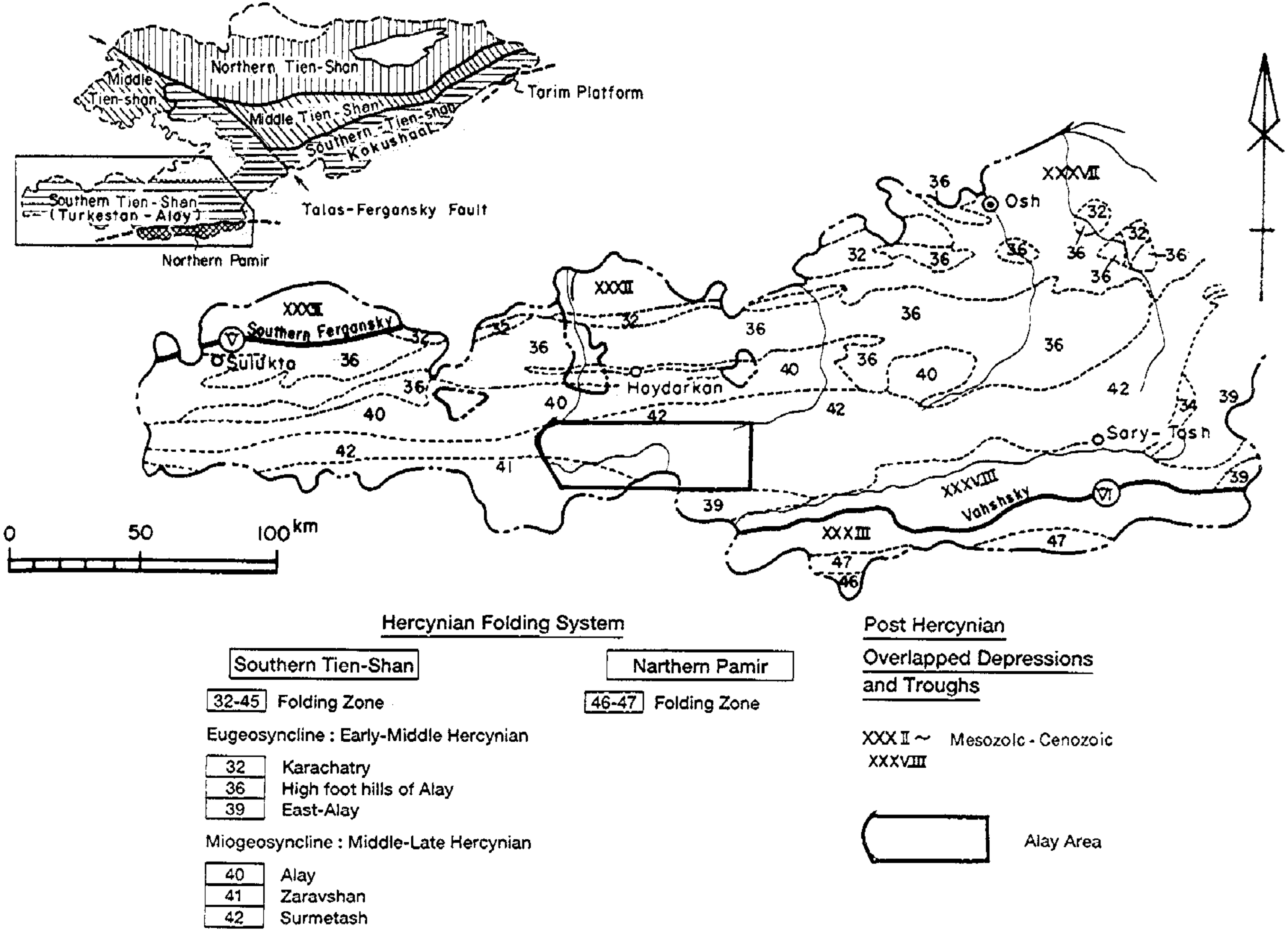


Fig. I-2 Tectonic Divisions of the Turkestan-Alay

In the Turkestan-Alay area, both eugeosyncline and miogeosyncline zones are divided into the lower, middle and upper formations, respectively on stratigraphic classification. Lower formations in both zones are made of the Silurian pelagic sediments. Spilitic volcanic rocks are partially observed in eugeosyncline zone, but the rocks are absent in miogeosyncline. Fine terrigenous deposits are partially formed in the latter. Middle formations in the both zones are characterized by thick sequences of thousands meter from Late Silurian to Middle Carboniferous* . The middle formations consist of limestone, graywake and trachybasalt and basalt in eugeosyncline, and is made chiefly of carbonate rocks in miogeosyncline. Upper formations in both zones are composed of carbonate rocks and terrigenous flysh facies of Middle Carboniferous.

* : Although Carboniferous period is divided into early Carboniferous (Mississippian) and late Carboniferous (Pensylvanian) in a standard stratigraphy in Europe, Bashkirian and Moscovian stages in middle Carboniferous are set up in geological time unit in defunct USSR.

(3) Geology of the Alay area

1) Stratigraphy

The Alay area is situated in above-described miogeosyncline zone. The Southern Tien Shan mountain belong to the Hercynian orogeny and is strong transformed. Sequence is subdivided into several blocks by faults. Large-scale thrust and nappe are formed there. Because the rocks in same geological age show remarkable lateral transition among different blocks, a correlation with detailed stratigraphy is difficult. Therefore, a stratigraphy in Kyrghyz has been classified by so-called "geological unit". Geological unit is of geologic combination together with blocks recognized common stratigraphy. Common stratigraphy in each geological unit is named "type section" of each unit. Generalized geological map of the survey area is shown in Fig. 1-3.

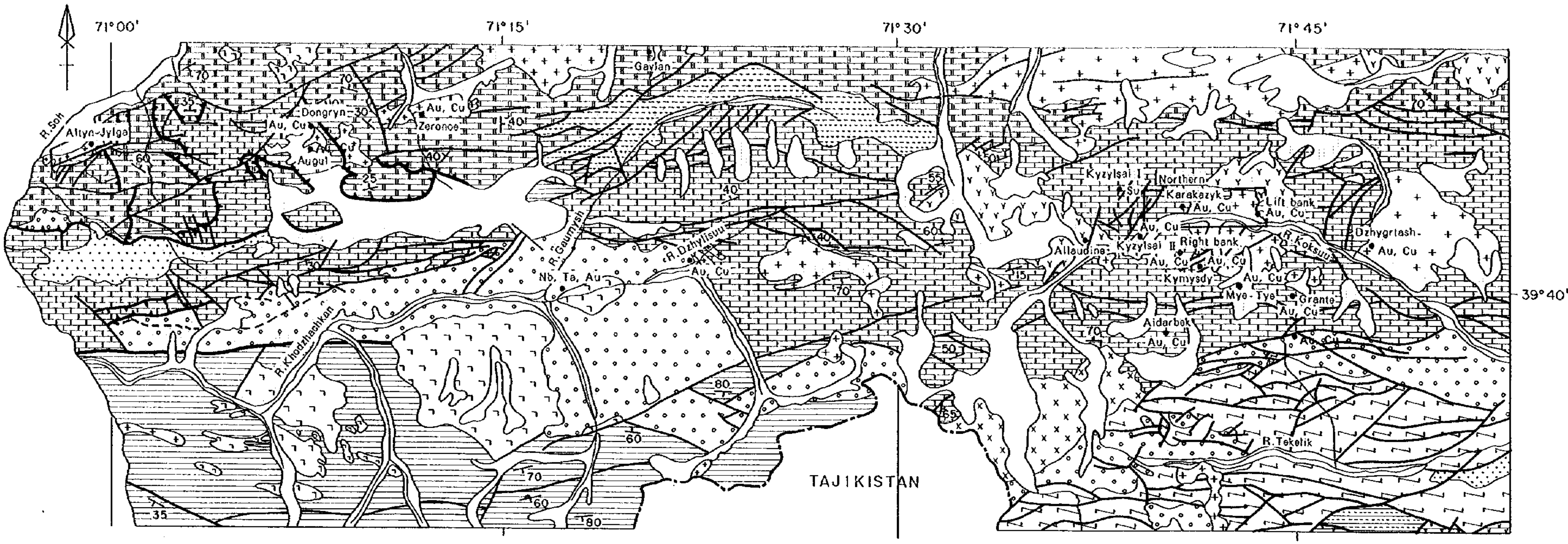
The Paleozoic group in the Alay area is divided into the following geological units;

① Khodzhachkan

② Alay

③ Gaumysh

④ Dzhylisuu-Kalmakasuu



LEGEND

- silt, sand, gravel, talus
- carbonate-terrigenous deposits
- molasse-flysh deposits
- terrigenous-carbonate-siliceous deposits
- limestone-dolomite
- limestone
- terrigenous-carbonate siliceous deposits
- volcanic-carbonate siliceous deposits
- terrigenous-subaqueous slumping deposits
- carbonete-siliceous-terrigenous deposits

Late Carboniferous-Early Permian

- Karakazyk complex — gabbro-monzodiorite-granodiorite
- Archabashin complex — monzonite-granite
- Surmetash complex — monzonite-monzodiorite

Early-Late Permian

- Matchai complex — granite, syenite

- thrust
- major fault
- fault
- 50 strik, dip
- Altyn-Jylga Au Cu — Ore deposit or mineral manifestations

- Alay area
- Altyn-Jylga district
- Karakazyk district

0 10 20 km

Fig. I-3 Generalized Geological Map of the Survey Area

⑤ Sarablak
⑥ Gorundin
⑦ Zaravshan

① Khodzhachkan

The Khodzhachkan unit covers the basins of the Dzhylisuu and Gaumysh rivers. It consists of terrigenous carbonate deposits from the Upper Silurian system (Luddlov series) to the Middle Carboniferous system (Moscovian stage). The total thickness exceeds 1900m.

② Alay

The Alay unit is composed of sequence from the Lower Silurian (Landovery series) to the Middle Carboniferous (Moscovian stage). It is characterized by a thick carbonate rocks from the Upper Silurian system to the Middle Carboniferous system (lower Moscovian stage). The bottom part of the unit is made of a volcanic-terrigenous sediments and the upper part of the unit is made of terrigenous deposits. In the survey area, it is subdivided into the Asangavar and Ekkidavan subunits. The Asangavar subunit is composed of limestone, dolomite and evaporite with volcanic rocks. This subunit has been formed on local rift in middle Devonian. The Ekkidavan subunit predominantly consists of limestone and dolomite.

③ Gaumysh unit

The Gaumysh unit covers to the south of the Alay unit and widely spreads from the western part of the survey area to the eastern part. This unit consists of sequence from the Upper Silurian system (Ludlow series) to the Middle Carboniferous system (Moscovian stage). The unit is mostly made of limestone and the bottom of the unit is made of volcanic-terrigenous deposits. The Upper Silurian (Ludlow series) and Middle Devonian (Eifelian stage) systems are interbedded with terrigenous deposits and silty sediments. The upper parts of the Middle Carboniferous system (Moscovian stage) are basically made of terrigenous deposits.

④ Dzhylisuu-Kalmakasuu units

Theses units crops out the water basins of the Tekelik and Kokusu rivers. They consist of terrigenous deposits, carbonate silty sediments from the Upper Silurian system (Ludlow series) to the Middle Carboniferous system (Moscovian stage). It has been formed under ocean floor and continental slope (of the Alay micro-continent). Sequence from the Devonian to Lower Carboniferous partially contains basic submarine volcanic rocks. The total thickness is about 1100m.

⑤ Sarablak

This unit is confined to the water basins of the Kyzyrusu river in the south-eastern part of the survey area. Sequence is of the Lower Devonian to Middle Carboniferous system (lower Moscovian stage), and are composed of basalt-dolerite complex, submarine sliding sediments, carbonates, terrigenous and silty sediments formed on continental slope. The total thickness of the unit is about 1300m.

⑥ Gorundin

This unit is formed on the abyssal territory. It consists of the Gorundin turbidite formation of the Lower-Middle Ordovician and the Karasuu formation of the Silurian composed of submarine sliding sediments of terrigenous deposits. The thickness of both formations is 850m.

⑦ Zaravshan

This unit is composed of carbonates, silty-terrigenous deposits from the Lower Paleozoic to Middle Carboniferous. Sequence is formed near the margin of the Afghan-Tajik paleo-continent. Volcanic-terrigenous turbidite of the Lower Paleozoic has been metamorphosed into the green schist facies. The thickness is about 1200m. The Carboniferous system is accretionary zone

Apart from the above-described units, the survey area is fragmentarily underlain by small blocks including olistostrome. The above-described units are unconformably overlain by flysh-molasse deposits of the Upper Paleozoic, red terrigenous sequence of the Lower-Middle Jurassic and carbonate terrigenous Cretaceous system.

2) Intrusive rocks

Within the Alay area, the following orogenic granitoid was intruded; Karakazyk, Archabashin, Surmetash and Trumsuy complexes. They intruded under the condition of compression of late Carboniferous to early Permian. As a post orogenic activity, alkaline rocks intruded; Matchai, Ulukol and Gaumysh complexes. Characteristics of these complexes are as follows;

① Karakazyk complex

This complex widely crops out the survey area and belongs to the I-type granite of calc-alkalic rock series. Its association represents gabbro-diorite-granodiorite. The complex is composed of gabbro, quartz diorite, monzodiorite, diorite and adamellite. Most of the rocks intrude around anticline axes.

② Archabashin complex

This complex belongs to calc-alkaine rock series and show characteristics of an in-between the I-type granite and S-type granite. It is composed of porphyritic monzodiorite, granodiorite and granite.

③ Surmetash complex

This complex belongs to alkai-calcic rock series and its association represents gabbro-monzonite-syenite. Succession from monzonite to non-alkaic granite occur and occurrence of latite is accompanied. Activity of the Surmetash complex is considered to be the same age of the Karakazyk complex.

④ Trumsuy complex

The Trumsuy complex belongs to calc-alkalic rock series and its association represents gabbro-diorite-granodiorite. The complex is composed of monzonite-monzodiorite. The complex is related to an activity of the Surmetash complex. Quartz monzonite of this complex is considered to be occurred at the same age of the second phase granite of the Karakazyk complex and the third phase granosyenite of the Surmetash complex.

⑤ Matchai and Ulukol complex

Both complexes belong to alkali rock series and are composed of monzonite, syenite and lamprophyre

⑥ Gaumysh complex

This complex belongs to alkali rock series and is made of a small-scale dyke of alkali basalt.

3) Mineralization

In the Turkestan-Alay area, gold, silver and polymetal mineralization is associated with the calc-alkalic rock series as the Karakazyk complex. Tin and tungsten mineralization is formed by association with the alkali-calcic rock series as the Surmetash complex. Rare metals are accompanied with pegmatite and metasomatic rocks around alkali intrusives.

Representatives of ore deposit and manifestation in this area are as follows;

① Altyn-Jylga ore field (Au, Cu)

The most significant ore object is a skarn deposit of the Altyn-Jylga deposit related to the Altyn-Jylga intrusive rocks of the Karakazyk complex.

② Augul-Gavian ore field (Au, Cu)

The ore field is located to the east of the Altyn-Jylga deposit, and consists of ore deposits and manifestations of Dongruk, Augul and Gavian. Skarn and quartz-vein are confined to limestone and dolomite of Ekkidavan formation and olistostrome of Gangidavan formation of the Middle Carboniferous, and are confined to the Karakazyk complex intruded the system. Gold grade of ore is reported 56 g/t in maximum grade.

③ Kokusu ore field (Au, Ag, Bi, W, Sn, Pb, Zn)

The ore field includes gold deposits of Right Bank, Kymysdykta, Karakazyk, Aidarbek and Left Bank and lots of manifestations of gold, silver, bismuth, tungsten, tin, lead and zinc. Most deposits and manifestations are formed in skarn at the contact between carbonate rocks of the Gaumysh unit and intrusive rocks of the Karakazyk complex

④ Allaudin ore field (Sn, W)

The ore field is formed mineralization of tin, tungsten, thorium, uranium, lithium, beryl and fluorite by the Allaudin granitoid of the Surmetash complex. Quartz-tourmaline-cassiterite veins and scheelite bearing skarn are formed in the ore field.

⑤ Tekeli ore field (Au, Sb, W)

The ore field is related to diorite porphyry and granodiorite of the Karakazyk and Archabashin complexes. Many mineralization and geochemical anomalies of gold, antimony, tungsten, silver, molybdenum, arsenic and copper are distributed in the ore field.

CHAPTER 4 COMPREHENSIVE ANALYSIS

4-1 Geological structure, and characteristics and controlling factors of mineralization

This survey area belongs to the Turkestan-Alay area in the Southern Tien Shan mountains. The Turkestan-Alay area is divided into several tectonic belts which extends E-W direction by thrust faults.

In the survey area, granitic rocks of the Karakazyk and Trumsuy complexes of the Hercynian orogeny, have been related with copper-gold, gold-arsenic, silver-polymetal and tungsten mineralization. Ore deposits and mineral manifestations in this area are confirmed as follows; Altyn-Jylga ore field (Au, Cu), Kokusu ore field (Au, Ag, Cu, Bi, W, Sb, Pb, Zn), Augul-Gavian ore field (Au, Cu) and Allaudin ore field (Sn, W).

Predominant directions of lineaments in the survey area are E-W and NE-SW. Gold-copper deposits and manifestations in the Altyn-Jylga, Kokusu and Augul ore fields are distributed around the lineament swarm zone of an E-W trend. A close relationship between the mineralization and the E-W trending fractures is suggested.

A drilling survey has been done in No.4 skarn orebody in the northern part of the Altyn-Jylga deposit. As the result of the drilling survey, it has been confirmed that granodiorite body is more widespread in the deep near the surface and that skarn zone becomes scaled down in the deep. As the combined results of the underground geological survey and the previous drilling survey in No.3 skarn orebody, the orebody has dipped 70° E. A formation of skarn zone is presumed to be controlled by a shape of granodiorite body.

As the results of isotopic ages by K-Ar methods, both ages of granodiorite and lamprophyre are almost identical (282-299 Ma). They correspond to be from latest Carboniferous to earliest Permian. A dyke swarm of lamprophyre crops out around No.3 skarn orebody. Based on its distribution and occurrence, lamprophyre has formed in a later stage of igneous activity produced granodiorite. Skarn orebody has been intruded by lamprophyre. Therefore, skarn is presumed to be formed latest Carboniferous to earliest Permian.

Dominant intrusive planes of lamprophyre dyke trend N-S to NE-SW and dip east in the northern and central parts, and trend E-W and dip south in the southern part. Dykes are considered to be intruded into fracture in the surrounding rock. According to the zone of dyke swarm and the axial trend of intrusive plane, the center of the intrusive activity is presumed to be situated to southeast of the central and south parts in the Altyn-Jylga deposit.

Lamprophyre dyke around the Altyn-Jylga gully has undergone skarnization accompanied with secondary copper oxides. Gold mineralization, ranging from 1.3 to 5.0 g/t Au in grade has been recognized in a part of lamprophyre dyke.

According to the underground geological survey in the previous adit, fractures showing the NE-SW and NW-SE trends are dominant in No.3 skarn orebody. Considering the close relationship between gold mineralization and fracture, gold mineralization is assumed to be concentrated around the intersection of both trends.

According to the microscopic observation, electrum ranging from 5 to 100 μ m in size, occurs along fissures and grain boundaries of garnet, clinopyroxene, quartz and calcite. Electrum coexists closely with chalcopyrite, bornite, bismuthinite and wittichenite. By the study of the Kyrghyz side, electrum also coexists with quartz and calcite.

The above-mentioned facts suggest that the skarnization and the gold mineralization in the Altyn-Jylga deposit are controlled by the intrusion mechanism of granodiorite and lamprophyre dyke and the fracture trending NE-SW and NW-SE.

The Left Bank deposit in the Karakazyk district is a gold-copper bearing skarn deposit. It has been formed along shear zone bordering the dolomitic and calcitic marbles. The Karakazyk deposit is a gold-copper bearing skarn deposit, which has been formed in the contact zone between granodiorite and marble, or metasomatic zone associated with shear zone. Although the mineralization zone at the surface extends about 20m × 40m in a case of maximum size, the high grade zone occupies only a small part. It is concluded that the deposits in this district could be hardly developed as things stand, because high grade ore occurs as spot in skarn body.

4-2 Potential of an existence of ore deposits

Gold, silver and copper bearing ore deposits and mineral manifestations, such as the Altyn-Jylga, Kokusu, and Augul-Gavian ore fields, are located in this survey area.

As the results of the Phase I survey, it is concluded that the No.3 skarn orebody of the Altyn-Jylga deposit could be developed.

Since 1995, the South Kyrghyz Geological Expedition had explored No.3 skarn orebody in the central part of the Altyn-Jylga by means of drifts and crosscuts at 1930mL, and had confirmed the high gold mineralization zone. Gold-bearing skarn at the underground has an area of about 300m in length, ranging from 10 to 15m in width. Possible reserves (C2) of No.3 orebody had been estimated to be 1,138 thousand tons, 8.6 tons of gold and average grade 7.6 g/t Au, as of January, 1997 by the South Kyrghyz Geological Expedition.

High grade gold ore has been confirmed in the lower extension of No.3 skarn orebody by the previous drilling from 1930mL. The high grade ore is located at the lower position of 60m from 1930mL (1870mL). It has 18.5m in mineralized width (13m in horizontal width) and average grade of 25.7 g/t Au. Homogenization temperature of fluid inclusion in quartz veinlet, which has cut high grade ore, centers around 140°C. Homogenization temperature in calcite accompanied with clinopyroxene, centers around 151°C. These homogenization temperatures are rather low than a common homogenization temperature of gold bonanza. It is suggested that the high grade gold mineralization at 1870mL would continue to the most favorable orebody in the downward extension, on the basis of the distribution and structure of orebody and the homogenization temperature, although it is not conclusive because of only a few measurements.

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5-1 Conclusion

5-1-1 Whole area

(1) This survey area belongs to the Turkestan-Alay area in the Southern Tien Shan mountains. The area is divided into several tectonic belts which extend in an E-W direction by thrust faults. The area is underlain by the Paleozoic sedimentary and igneous rocks and Quaternary sediments.

(2) Ore deposits and mineral manifestations in this area are as follows; Altyn-Jylga ore field (Au, Cu), Kokusu ore field (Au, Ag, Cu, Bi, W, Sb, Pb, Zn), Augul-Gavian ore field (Au, Cu) and Allaudin ore field (Sn, W).

(3) Thirty three geological units are classified on the basis of interpretation of false color synthetic satellite image. The result of interpretation has a good agreement with the geological map. Predominant directions of lineaments in the survey area are E-W and NE-SW. The Altyn-Jylga, Kokusu and Augul ore fields are distributed around the lineament swarm zone of an E-W trend. A close relationship between the mineralization and the E-W trending fractures is suggested.

(4) Small-scale spectral anomalies by satellite image analysis are scattered on the southwestern part of the survey area where the intrusive complex revealing a circular structure is distributed. These anomalies may reflect presence of mineralization accompanied by the intrusives.

5-1-2 Altyn-Jylga district

(1) The deposit in this district is gold-copper bearing skarn deposit which has been formed in the contact zone between granodiorite of the Karakazyk complex and the Devonian limestone.

(2) Skarn is made chiefly of clinopyroxene skarn. Silicified skarn which has formed from clinopyroxene skarn by silicification occurs commonly in the northern part of this district.

(3) The drilling survey has been performed in No.4 skarn orebody in the northern part of the deposit. As the results of the survey, it has been confirmed that granodiorite body is more widespread in the deep than near the surface. On the other hand, skarn zone becomes scaled down in the deep. Although gold mineralization is widely recognized in the skarn body, gold concentration in skarn ore is generally low, ranging from 0.1 to 0.5 g/t Au. Except a small-scale high gold

concentration (highest grade 55.6 g/t Au in width of 50cm), large-scale high gold orebodies has not been confirmed.

(4) It has been reconfirmed by the underground geological survey of the previous 1930m level adit that gold mineralization is predominant in No.3 skarn orebody. Mineralization zone confirmed there has average grade of 5-6 g/t Au with an area of about 3,000km^2.

(5) According to the underground geological survey of the previous adit, fractures showing the NE-SW and NW-SE trends are dominant in No.3 skarn orebody. Considering the close relationship between gold mineralization and fracture, gold mineralization is assumed to be concentrated around the intersection of both trends.

(6) A dyke swarm of lamprophyre crops out around No.3 skarn orebody. A lamprophyre dyke around the Altyn-Jylga gully has undergone skarnization accompanied with secondary copper oxides. Gold mineralization, ranging from 1.3 to 5.0 g/t Au in grade, has been recognized in a part of lamprophyre dyke.

(7) K-Ar ages of both hornblende from granodiorite and lamprophyre in the Altyn-Jylga deposit are almost identical (282-299 Ma), and they correspond to latest Carboniferous to earliest Permian. Based on its distribution and occurrence, lamprophyre has formed in a later stage of igneous activity produced granodiorite. Skarn orebody has been intruded by lamprophyre. Therefore, skarn is presumed to be formed in latest Carboniferous to earliest Permian.

(8) Gold mineralization is dominant in No.3 skarn orebody situated in the central part at the district, but the mineralization commonly trends poor to the north. The mineralization in the northern part is characterized by silicification, rich in arsenopyrite and low in homogenization temperature as compared with the mineralization in the central part. The above-mentioned facts suggest that the northern part represents a margin of the mineralization.

(9) Both the lamprophyre dykes and the fractures of NE-SW trend is thought to have a close relationship with gold mineralization. Geochemical anomalies detected in the south-southeast of No.3 skarn orebody is thought to correspond to a center of mineralization.

(10) High grade gold ore has been confirmed in the lower extension of No.3 skarn orebody by the previous drillings from 1930mL. The high grade ore is located at the lower position of 60m from 1930mL (1870mL). It has 13m in width and average grade of 25.7 g/t Au. Homogenization temperature of fluid inclusions in quartz veinlet, which has cut high grade ore, centers around 140 ℃.

Homogenization temperature of fluid inclusions in calcite accompanied with clinopyroxene, centers around 151℃. These homogenization temperatures are rather low as compared with a common homogenization temperature of gold bonanza. It is suggested that the high grade gold mineralization at 1870mL would continue to the most favorable orebody in the downward extension, on the basis of the distribution and structure of orebody and the homogenization temperature, although it is not conclusive because of only a few measurements.

(11) The western part of the district is underlain widely by the pyroxene skarn zone with sulfides (No.8 and No.9 skarn orebody) with an area of 30m×200m, which has a high gold concentration of 10 g/t Au.

5-1-3 Karakazyk district

(1) The Left Bank deposit is a gold-copper bearing skarn deposit, which has been formed along shear zone bordering the dolomitic and calcitic marbles. The Karakazyk deposit is a gold-copper bearing skarn deposit, which has been formed in the contact zone between granodiorite and marble, or metasomatic zone associated with shear zone.

(2) Although the mineralization zone at the surface extends about 20m×40m in a case of maximum size, the high grade zone occupies only a small part.

(3) It is concluded that the deposits in this district could be hardly developed as things stand, because high grade ore occurs as spot in skarn body.

5-2 Recommendation for the Phase II survey

As the results of the detailed geological and drilling survey in the Phase I, it is concluded that the No.3 skarn orebody of the Altyn-Jylga deposit could be developed and high grade ore would continue in the downward extension.

The Phase II survey is hoped to be carried out to clarify a potential of No.3 skarn orebody and is hoped to be aimed to a mining development in connection with much increase of minable reserves. As definite exploration method, it is recommended that a new adit on 1850mL is hoped to be opened and driven to confirm directly the gold mineralization of the high grade ore of No.3 orebody confirmed by previous drilling on the 1930mL. Horizontal and inclined drilling surveys from the 1850mL are hoped to be conducted to clarify the mineralization of deeper extension.

To grasp an entire mechanism of the mineralization in the Altyn-Jylga deposit, a drift on 1850mL is hoped to be extended to the lower extensions of No.5, No.1 and No.2 orebodies which are presumed as a center of the mineralization zone, and underground horizontal drillings are hoped to be conducted.

As prospective spaces in the Altyn-Jylga deposit, surface drillings are hoped to be conducted to clarify the mineralization between MJKA-10 hole and the adit of 1930mL, and horizontal drillings are hoed to be conducted to define an area of the orebody on 1930mL.

Moreover, it is proposed that information on the geology and the ore deposit is hoped to be collected and a reconnaissance geological survey is hoped to be carried out concerning mineral manifestations as Augul and Gavian which have been considered to be under the same mineralization conditions as the Altyn-Jylga deposit on the basis of regional geologic structure.

PART Ⅱ

PARTICULARS

CHAPTER 1 ANALYSIS OF SATELLITE IMAGE

1-1 Purpose and methods of survey

1-1-1 Purpose

With the objectives to obtain geological structure including lineament and classification of rock facies of the Alay area, a series of data processing, analysis and interpretation of satellite image, has been conducted.

1-1-2 Used data

Three scenes of SPOT data of Column 187-198 / Line 270 have been used for this analysis. The area of these scenes and the data are shown in Fig. II-1-1 and Table II-1-1.

High altitude area in the used scenes are covered with snow and glacier. The eastern part of the survey area, which correspond to the scene of column 189 / line 270, is covered with cloud. The data of cloud is masked and excepted from the image analysis, because cloud is harmful in ratioing process.

1-1-3 Details of analysis

The data analysis has been done in the following procedure.

(1) Image processing

As the objective area is divided into three scenes in the satellite image, a digital mosaic data to cover the whole area into one scene have been prepared on the UTM coordinates. On the digital mosaic procedure, a DN value histogram of each band is adjusted to not show an unbalanced color tone between two scenes. After a linear stretching has been conducted Band 1, 2 and 3 of the connected mosaic data, the false color synthetic image of Band 1 (blue), 2 (green), and 3 (red) was out into film. A paper print with the scale of 1:200,000 was produced and used for interpretation (Fig. II-1-2).

Ratioing has been done in order to extract alteration zones in the digital mosaic image. Selecting Band 1 and 2 as indicators of iron oxides, a normalized ratioing (Band 2 − Band 1 / Band 2 + Band 1) has been conducted.

(2) Photogeologic interpretation

A classification of geological units, an extraction of lineament and geological structure have been carried out by photogeologic technique, using a 1:200,000 false color synthetic image.

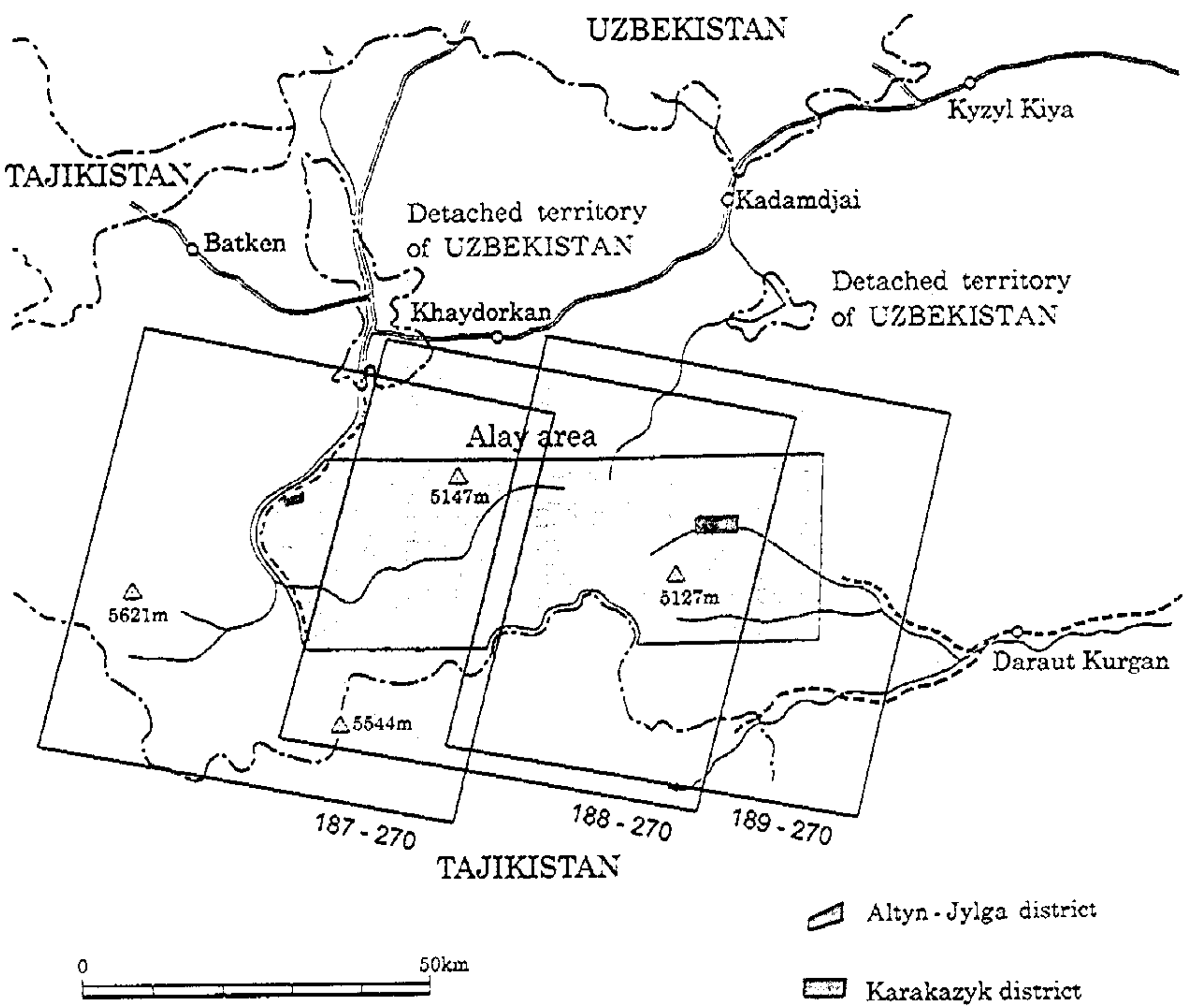
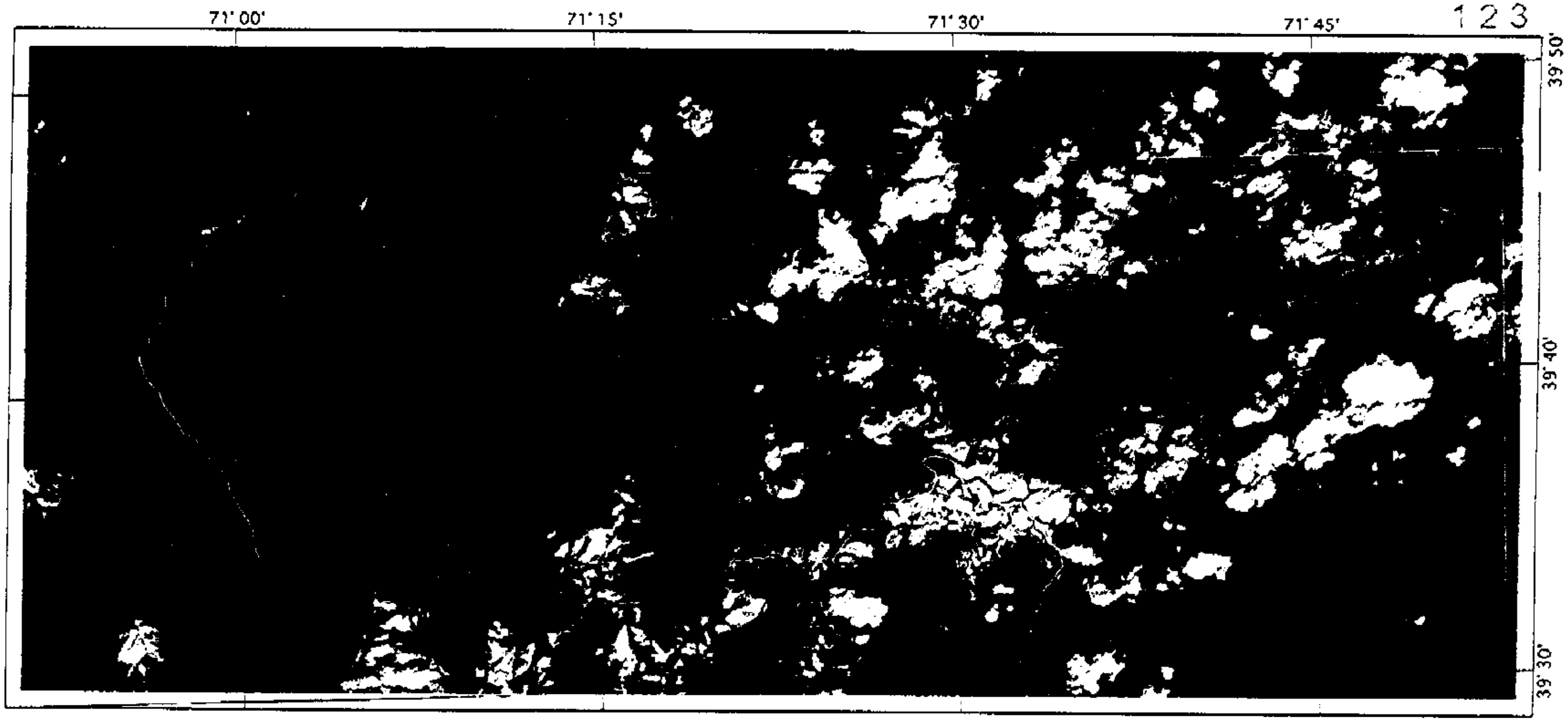
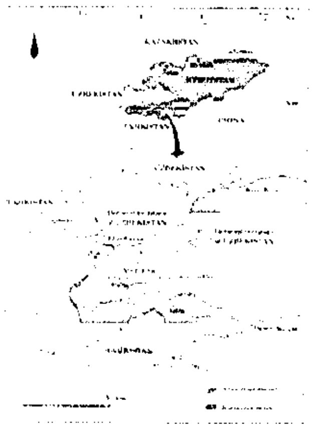


Fig. II-1-1 Ground Coverage of Satellite Data





COLOR COMPOSITE IMAGE

Band 1 : Blue
Band 2 : Green
Band 3 : Red

0 10 20 30km

SATELLITE : SPOT
INSTRUMENT : HRV 1, HRV 2
SCENE ID : 3 187 - 270 96/08/25 06:12:58 1 X
1 188 - 270 86/07/01 06:14:55 2 X
1 189 - 270 86/08/17 06:11:10 1 X

THE ALAY AREA, THE KYRGHYZ REPUBLIC

Japan International Cooperation Agency
Metal Mining Agency of Japan
1998

Fig. II-1-2 False Color Digital Mosaic Spot Image

Table II-1-1 Specification of Original Satellite Data

	Scene parameters		
	1	2	3
Scene ID	3 187-270 96/08/25 06:12:58 1 X	1 188-270 86/07/01 06:14:55 2 X	1 189-270 86/08/17 06:11:10 1 X
K-J identification	187-270	188-270	189-270
Date	96/08/25	86/0701	86/008/17
Time	06 h 12 mn 58 s	06 h 14 mn 55 s	06 h 11 mn 10 s
Instrument	HRV 1	HRV 2	HRV 1
Spectral mode	XS	XS	XS
Number of spectral bands	3	3	3
Spectral band indicators	XS1 XS2 XS3	XS1 XS2 XS3	XS1 XS2 XS3
Sun angles(degrees)	Azimuth: 148.9 Elevation: 057.8	Azimuth: 136.3 Elevation: 068.9	Azimuth: 145.8 Elevation: 060.4
Number of lines	3002	3003	3002
Number of pixels per line	3147	3151	3144
	Scene Center Location		
Latitude	39°38'02" N	39°37'59" N	39°37'59" N
Longitude	71°00'05" E	71°23'43" E	71°40'20" E

1) Classification of geological unit

Base on photogeologic characteristics such as a color tone on the image, a drainage pattern, a texture of ground surface, a difference of resistance for erosion and development of bedding or schistosity, a classification of geological unit has been done. On interpretation of units, a published 1:500,000 geological map (Ministry of Geology, USSR, 1980) and a unpublished 1:50,000 geological map were used to compare with geological units.

2) Lineament and geological structure

Continuances of linear ravine, steep cliff or saddle from the image which were presumed by geological factors, have been extracted as lineaments. In case strike and dip of stratum were extracted clearly from the image, these directions have been drawn on a lineament map.

1-2 Results of analysis

1-2-1 Geologic interpreted units

Thirty three geological units are classified on the basis of interpretation of false color synthetic satellite image. Photogeologic characteristics of each interpreted unit are shown in Table II-1-2, and geological interpretation map is shown in Fig. II-1-3. As above described, snow, glacier and cloud are widely covered with the eastern part of the survey area. Snow, glacier and cloud are harm to identify a correlation and a continuation of geological units. On the other hand, though snow, glacier and cloud are hardly observed in the western part, vegetation has grown well in comparison with the eastern part. Vegetation is harm to classify geological units on the basis of color tones. The result of interpretation has a good agreement with the published geological map. The comparison between photogeologic characteristics of units and presumed lithofacies based on the geological map, is described as follows:

(1) Unit Q

This unit is distributed around main rivers and glaciers. This unit is presumed to be Alluvium, terrace deposit, talus and glacial sediment.

(2) Unit M1 and M2

This unit covers the right bank of the Khodzhaachkan river in the western part of the survey area. Unit M1 displays brown on the false color image, and has low erosion resistance and fine surface texture. Unit M2 shows red and has moderate erosion resistance. Unit M1 and Unit M2 are presumed to be molasse sediments (siltstone, sandstone and conglomerate) of Tertiary and Cretaceous, respectively.

(3) Unit C1, C2, C4 and C6

These units cover the western part (C1 and C2), the basin of the Gaumysh river of the central part (C4) and the central and eastern parts (C6) of the survey area. Unit C1 and C4 have moderate to high erosion resistance and coarse surface texture. Unit C2 and C6 have fine surface texture. Bedding is undeveloped in all the units. These units correspond to the Lower to Middle Carboniferous mudstone and sandstone.

(4) Unit C3 and C5

Unit C3 is characterized by fine surface texture and low erosion resistance, and Unit C5 has coarse surface texture and high erosion resistance. Both units are presumed to be the Middle to Upper Carboniferous molasse (mudstone, sandstone and conglomerate).

(5) Unit C7

This unit covering the eastern part, has high erosion resistance and has a well bedding. It corresponds to the Carboniferous limestone and dolomite.

(6) Unit Cud

This unit covers the southeastern part of the area. As being difficult to classify in detail by vegetation area and cloud, the unit is lump as Unit Cud. It corresponds to area underlain by Carboniferous.

(7) Unit D1～D4, D6～D8

These units cover the western part (D1～D), the central part (D6) and from the central to the eastern parts (D7, D8) of the survey area. Unit D1, D4, D7 and D8 have coarse to moderate surface texture and high-moderate erosion resistance. Unit D2 and D3 have fine surface texture and low to moderate erosion resistance. These units correspond to the Devonian limestone, dolomite and marble.

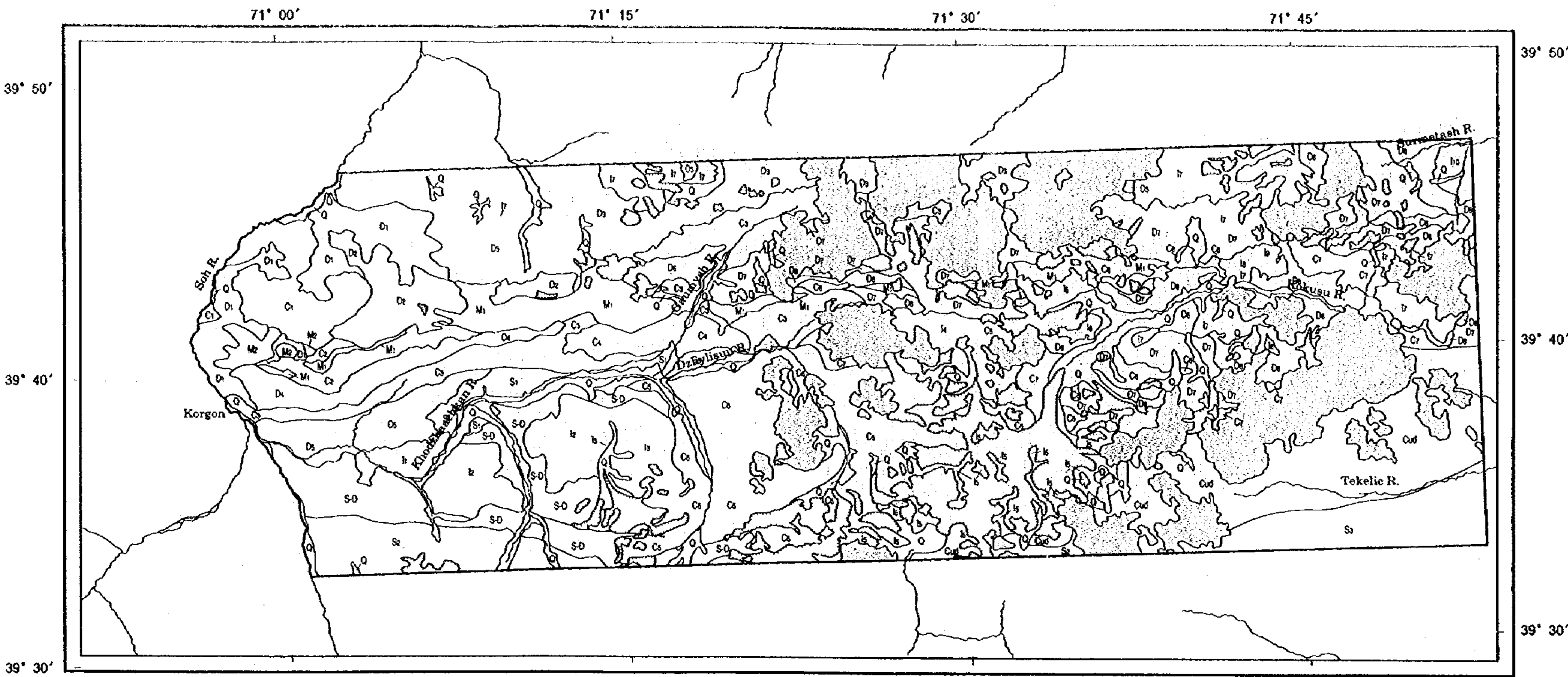
(8) Unit D5

This unit covers the western part, and has fine surface texture and low erosion

Table II-1-2 Photogeologic Characteristics of Interpretation Units

Units	Photocharacteristics		Drainage		Geomorphologic aspects		Correlation	Rock Types
	Color	Texture	Pattern	Density	Resistance	Bedding		
Q	gray to dark brown	fine	parallel	very low	very low	none	Quaternary	sand, gravel
M1	brown	fine	dendritic	low	low	none	Tertiary, Cretaceous	slst, ss, cgl
M2	red	moderate	dendritic	high	moderate	poor	Cretaceous	slst, ss, cgl
C1	red	coarse	dendritic	high	moderate	none	L-M Carboniferous	mdst, ss
C2	dark gray	fine	subparallel	moderate	low	none	L-M Carboniferous	mdst, ss
C3	dark gray to red	fine	subparallel	moderate	low	none	M-U Carboniferous	mdst, ss, cgl
C4	reddish gray	coarse	subparallel	high	high	none	L-M Carboniferous	mdst, ss
C5	dark gray	coarse	dendritic	high	high	poor	M-U Carboniferous	mdst, ss, cgl
C6	dark brown	fine	dendritic	moderate	moderate	none	L-M Carboniferous	mdst, ss
C7	dark brown	moderate	subdendritic	high	high	well	L-M Carboniferous	ls, dol
Cud	red	moderate	dendritic	high	moderate	poor - well	Carboniferous	ss, cgl, ls, dol
D1	reddish gray	coarse	subdendritic	high	high	none	Devonian	ls, dol, ma
D2	dark gray	fine	subparallel	moderate	low	none	Devonian	ls, dol, ma
D3	dark gray	fine	subdendritic	moderate	moderate	partially well	Devonian	ls, dol, ma
D4	red to pinkish brown	coarse	subparallel	moderate	low	none	Devonian	ls, dol, ma
D5	dark gray	fine	subparallel	moderate	low	none	Devonian	mdst, ss
D6	red to pinkish brown	coarse	subparallel	moderate	low	none	Devonian	ls, dol, ma
D7	gray to dark brown	coarse	subdendritic	high	high	none	Devonian	ls, dol, ma
D8	light gray	moderate	subdendritic	high	high	poor	Devonian	ls, dol, ma
S-D	dark gray	coarse	subdendritic	high	very high	poor	Silurian - Devonian	marble
S1	dark gray	fine	subdendritic	moderate	low	none	Silurian	mdst, ss
S2	dark gray	coarse	subdendritic	high	high	none	Silurian	mdst, ss
S3	red to reddish gray	moderate	dendritic	moderate	moderate	partially well	Ordovician - Silurian	mdst, ss
I1	reddish pink	coarse	subdendritic	high	very high	none	L-U Permian	Matchai complex
I2	dark gray	coarse	annular	high	very high	none	L-U Permian	Matchai complex
I3	dark gray	coarse	subtrellis	high	very high	none	L-U Permian	Matchai complex
I4	dark brown	fine	dendritic	moderate	moderate	none	U Carb. -L Perm.	Karakazyk complex
I5	dark brown	moderate	dendritic	moderate	high	none	U Carb. -L Perm.	Archabashin complex
I6	dark brown	coarse	subdendritic	high	moderate	none	U Carb. -L Perm.	Surmetash complex
I7	dark brown	coarse	subdendritic	moderate	moderate	none	U Carb. -L Perm.	Karakazyk complex
I8	dark brown	moderate	subparallel	moderate	moderate	none	U Carb. -L Perm.	Ulukkol complex
I9	dark brown	fine	dendritic	moderate	moderate	none	U Carb. -L Perm.	Ulukkol complex
I10	dark brown	coarse	subparallel	moderate	moderate	none	U Carb. -L Perm.	Surmetash complex

Abbreviation; slst: siltstone, ss: sandstone, mdst: mudstone, cgl: conglomerate
ls: limestone, dol: dolomite, ma: marble



Photogeologic Characteristics of Interpretation Units

Units	Photocharacteristics		Drainage		Geomorphologic aspects		Correlation	Rock Types
	Color	Texture	Pattern	Density	Resistance	Bedding		
Q	gray to dark brown	fine	parallel	very low	very low	none	Quaternary	sand, gravel
M1	brown	fine	dendritic	low	low	none	Tertiery, Cretaceous	slst, ss, cgl
M2	red	moderate	dendritic	high	moderate	poor	Cretaceous	slst, ss, cgl
C1	red	coarse	dendritic	high	moderate	none	L-M Carboniferous	mdst, ss
C2	dark grey	fine	subparallel	moderate	low	none	L-M Carboniferous	mdst, ss
C3	dark grey to red	fine	subparallel	moderate	low	none	M-U Carboniferous	mdst, ss, cgl
C4	reddish gray	coarse	subparallel	high	high	none	L-M Carboniferous	mdst, ss
C5	dark grey	coarse	dendritic	high	high	poor	M-U Carboniferous	mdst, ss, cgl
C6	dark brown	fine	dendritic	moderate	moderate	none	L-M Carboniferous	mdst, ss
C7	dark brown	moderate	subdendritic	high	high	well	L-M Carboniferous	ls, dol
Cud	red	moderate	dendritic	high	moderate	poor - well	Carboniferous	ss, cgl, ls, dol
D1	reddish gray	coarse	subdendritic	high	high	none	Devonian	ls, dol, ma
D2	dark gray	fine	subparallel	moderate	low	none	Devonian	ls, dol, ma
D3	dark gray	fine	subdendritic	moderate	moderate	partially well	Devonian	ls, dol, ma
D4	red to pinkish brown	coarse	subparallel	moderate	low	none	Devonian	ls, dol, ma
D5	dark gray	fine	subparallel	moderate	low	none	Devonian	mdst, ss
D6	red to pinkish brown	coarse	subparallel	moderate	low	none	Devonian	ls, dol, ma
D7	gray to dark brown	coarse	subdendritic	high	high	none	Devonian	ls, dol, ma
D8	light gray	moderate	subdendritic	high	high	poor	Devonian	ls, dol, ma
S-D	dark gray	coarse	subdendritic	high	very high	poor	Silurian - Devonian	marble
S1	dark gray	fine	subdendritic	moderate	low	none	Silurian	mdst, ss
S2	dark gray	coarse	subdendritic	high	high	none	Silurian	mdst, ss
S3	red to reddish gray	moderate	dendritic	moderate	moderate	partially well	Ordovician - Silurian	mdst, ss
I1	reddish pink	coarse	subdendritic	high	very high	none	L-U Permian	Matchai complex
I2	dark gray	coarse	annular	high	very high	none	L-U Permian	Matchai complex
I3	dark gray	coarse	subtrellis	high	very high	none	L-U Permian	Matchai complex
I4	dark brown	fine	dendritic	moderate	moderate	none	U Carb. -L Perm.	Karakazyk complex
I5	dark brown	moderate	dendritic	moderate	high	none	U Carb. -L Perm.	Archabashin complex
I6	dark brown	coarse	subdendritic	high	moderate	none	U Carb. -L Perm.	Surmetash complex
I7	dark brown	coarse	subdendritic	moderate	moderate	none	U Carb -L Perm.	Karakazyk complex
I8	dark brown	moderate	subparallel	moderate	moderate	none	U Carb -L Perm.	Ulukkol complex
I9	dark brown	fine	dendritic	moderate	moderate	none	U Carb. -L Perm.	Ulukkol complex
I10	dark brown	coarse	subparallel	moderate	moderate	none	U Carb -L Perm.	Surmetash complex

Abbreviation; slst: siltstone, ss: sandstone, mdst: mudstone, cgl: conglomerate
ls: limestone, dol: dolomite, ma: marble

0 10 20km

LEGEND

- Interpretation unit and boundary
- Glacier, snow cover
- Cloud
- Drainage
- Alay area

Fig. II-1-3 Geological Interpretation Map of Spot Image

resistance. It can be the Devonian mudstone and sandstone.

(9) Unit S-D

This unit covers the southwestern part, and has coarse surface texture and very high erosion resistance. It corresponds to marble from Silurian to Devonian.

(10) Unit S1 and S2

These units cover the western part. Unit S1 has fine surface texture and low erosion resistance. Unit S2 has coarse surface texture and high erosion resistance. They corresponds to the Silurian mudstone and sandstone.

(11) Unit S3

This unit covers the southwestern part. It corresponds to mudstone and sandstone of the Ordovician- Silurian systems.

(12) Unit I1, I2 and I3

These units cover the southwestern part. It is characterized by coarse surface texture and very high erosion resistance. Circular structures were observed in part of the units, as later described. They corresponds to granites of the Matchai complex.

(13) Unit I4 and I7

Unit I4 covers the central part, and Unit I7 covers from the northwestern part to the northeastern part widely. Unit I4 has fine surface and Unit I7 has coarse surface. Both erosion resistance show moderate. They corresponds to granites of the Karakazyk complex.

(14) Unit I5

The area underlain by this unit is distinctly covered with snow and glacier. The unit is restricted in a narrow area of ridge. Showing high resistance and difference of color tone, it can be separated with another unit. It corresponds to the Archabashin complex.

(15) Unit I6 and I10

These units cover the upstream of the Kokusu river of the eastern part (I6), and cover the upstream of the Surmetash river of the northeastern margin (I10) of the area. They have coarse surface and moderate resistance. They correspond to alkali granites of the Surmetash complex.

(16) Unit 18 and 19

Both units cover around the Karakazyk district. They are clearly distinguishable from surrounding limestone and marble (D8) representing light tone. The units are confirmed to be syenite (18) and monzonite (19) of the Ulukkol complex.

1-2-2 Lineament and geological structure

Lineament and geological structure extracted from false color image is shown in Fig. II-1-4. An E-W direction (WNW-ESE and ENE-WSW directions) and a NE-SW direction (NNW-SSE and NE-SW directions) are predominantly distributed in the survey area. Length of each lineament ranges from several hundred meters to several kilometers. Extracted lineaments concentrate in some zones, where lineaments are met same direction continue intermittently. Those lineaments have been extracted at the following four zones:

① Lineament zone of N80° W direction, running from the Karakazyk district to the Korgon village on the left bank of the Sokh river in the western margin.
② Lineament zone of N85° W direction, distributing from the east of the Altyn-Jylga district to the central part.
③ Lineament zone of N70° W direction, distributing from the Korgon village to the south of the central part.
④ Lineament zone of N15° E direction, running from the east of the Altyn-Jylga district to the Korgon village.

On the left bank area of the Dzhlisuu and Khodzhaachkan rivers where located in the central part to the western part, circular or subcircular structure, having more than several kilometers in diameter, have been extracted.

1-2-3 Ratioing

Ratioing image of Spot is shown in Fig. II-1-5. Spectral anomalies of red color on the image, representing absorption of Band 1, are widely distributed in the eastern part of the survey area. On the other hand, a wide distribution of those spectral anomaly has been not recognized in the western part. Spectral anomalies distribute along a E-W direction, continuing intermittently from the central part to the western part. The left bank of the Dzhlisuu river in the southwestern part, are studded with small spectral anomalies.

1-3 Consideration

Compilation of satellite image analysis is shown in Fig. II-1-6.

Gold deposits and manifestations such as the Left Bank, Karakazyk, Zernoe, Augul, Dongruk and Altyn-Jylga deposits, are distributed around zone where lineaments of a E-W trending through the survey area are swarmed. This zone concentrated lineaments of the E-W direction, is crossed by another zone where concentrated a N-S lineaments running to the east of the Altyn-Jylga district.

As was mentioned in Part I, the Turkestan-Alay area including the survey area, is controlled by an E-W trending structure. The above described zone concentrated lineaments is one of those fracture system directing E-W. A close relationship between the mineralization and the E-W trending fractures is suggested.

As the result of ratioing, spectral anomalies are distributed along a E-W zone in the central part to the western part. The distribution of spectral anomalies has a good agreement with an area occupied by interpreted Unit M1. Unit M1 is made of molasse sediments of Tertiary, but contains some intercalated red terrigenous deposit. Therefore, the spectral anomaly may reflect those specific sequence, but may be not related to hydrothermal alteration.

Spectral anomalies extended in the eastern part, are distributed on steep ridges. Those anomalies may not be related to hydrothermal alteration, as topographic factor has affected a reflect spectrum.

Small-scale spectral anomalies on the left bank of the Dzhlissu river, are distributed in intrusives of Matchai complex revealing circular structure. The Matchai complex is composed of alkali rocks such as syenite, nepheline syenite. Though few mineral manifestations are reported around this complex, an alkali rocks in the Turkestan-Alay area accompany mineralization related to pegmatite and metasomatism. These spectral anomalies may indicate a presence of mineralization accompanied intrusive rocks.

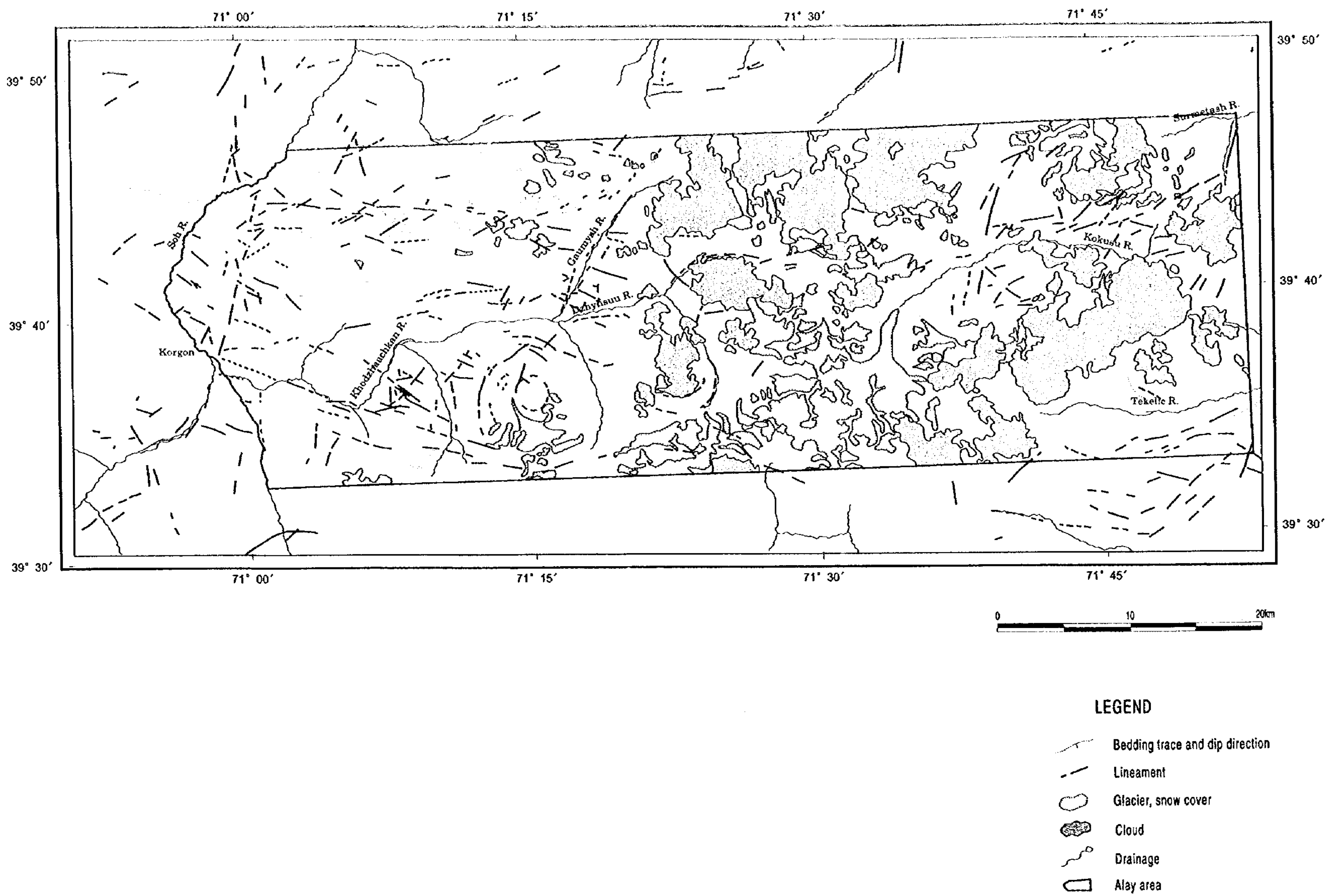
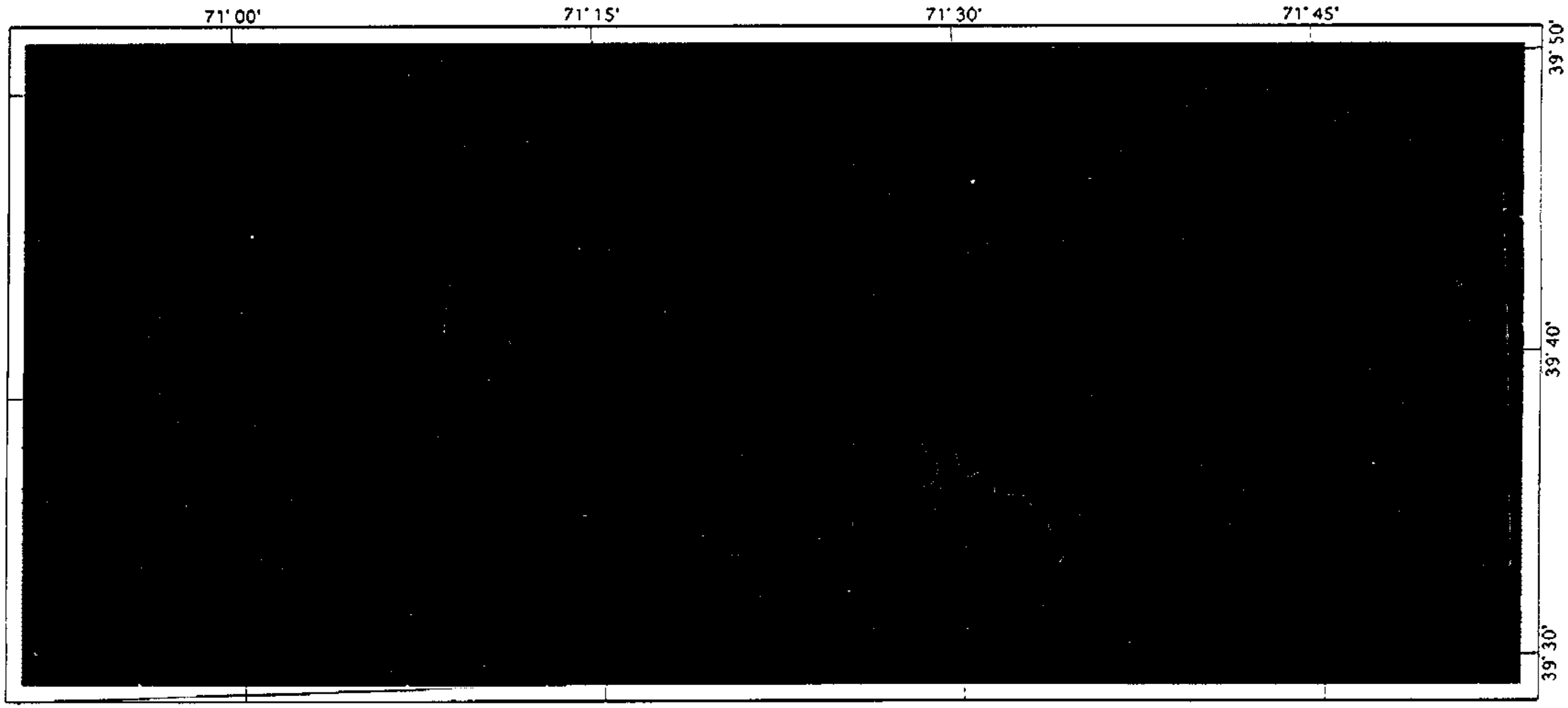
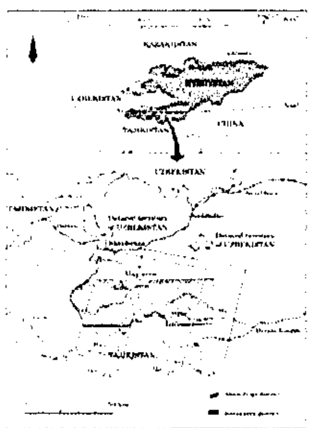


Fig. II-1-4 Lineament and Geological Structure Map of Spot Image





RATIO IMAGE

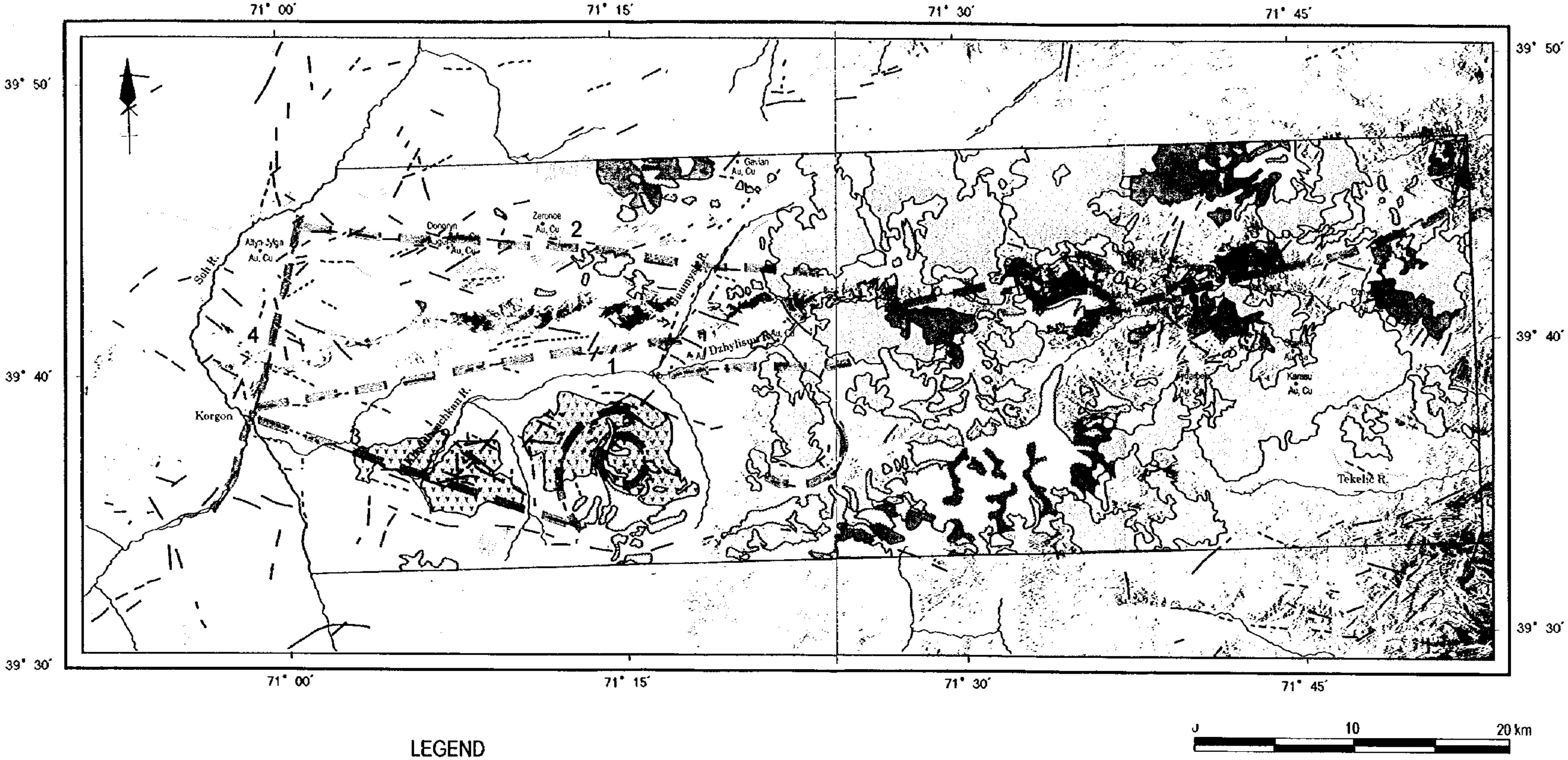
Band 3 : Blue
Band 2 : Green
(Band 2 - Band 1) / (Band 2 + Band 1) : Red

SATELLITE : SPOT
INSTRUMENT : HRV 1, HRV 2
SCENE ID : 3 187 - 270 96/08/25 06:12:58 1 X
1 188 - 270 86/07/01 06:14:55 2 X
1 189 - 270 86/08/17 06:11:10 1 X

THE ALAY AREA, THE KYRGHYZ REPUBLIC

Japan International Cooperation Agency
Metal Mining Agency of Japan
1998

Fig. II-1-5 Ratioing Spot Image



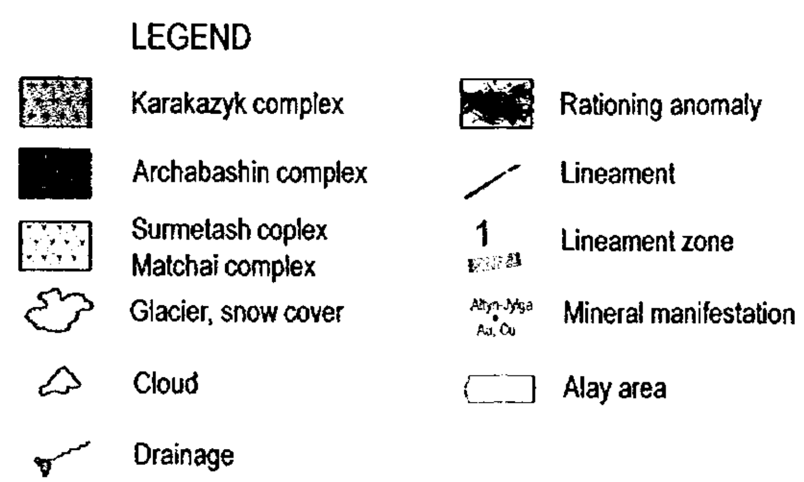


Fig. II-1-6 Complication of Satellite Data Analysis

CHAPTER 2 ALTYN-JYLGA DISTRICT

2-1 Outline of geology and ore deposit

2-1-1 Outline of geology

This survey district is underlain by the Paleozoic sedimentary and intrusive rocks and by the Quaternary sediment. The geological map around the Altyn-Jylga district is shown in Fig. II-2-1. Schematic geological column of this district is given in Fig. II-2-2.

According to a stratigraphy of the Turkestan-Alay area, the Paleozoic group around the Altyn-Jylga district, is divided into the Alay and Gaumysh units. The Ekkidavan subunit is a subunit of the Alay unit and is in fault contact with main part of the latter. The Gaumysh unit has been thrust over the Alay unit as nappe.

The survey district is underlain by dolomite and limestone of the Kumbel formation which is made of the Ekkidavan subunit and corresponds to the Lower to Middle Devonian, and shale, siltstone and sandstone of the Sarychashma formation which corresponds to the Upper Carboniferous. Near intrusive rocks, the Kumbel formation has been completely altered to marble and skarn with silicification, and altered product has formed as country rock of ore deposit.

The intrusive rocks is composed of stocks of granites (herein after called Altyn-Jylga body) and dykes of lamprophyre and diorite porphyry of the Karakazyk complex. These rocks have intruded the Paleozoic sediments. The Altyn-Jylga body is composed predominantly of granodiorite. The body is generally elongated in the N-E to E-W directions. Dykes trend NE-SW. Igneous activity is considered to take place during late Carboniferous to early Permian

The Quaternary system is made chiefly of talus, which covers the slope of the foot of mountain.

2-1-2 Outline of ore deposit

The skarn deposit has been formed in the contact zone between granodiorite of the southeast part of the Altyn-Jylga body and limestone of the Kumbel formation. Skarn is composed mostly of pyroxene skarn and silicified skarn. Ore deposits and mineral manifestations in the survey district are shown in Fig. II-2-5.

Skarn consists of pyroxene-garnet skarn and garnet skarn as well as pyroxene skarn, and is accompanied with disseminated sulfide minerals. Pyroxene skarn is dark green and is made mainly of fine, compact clinopyroxene. Garnet skarn is brown with red tint and is made chiefly of andradite.

Ore deposits are distributed near the Altyn-Jylga gully. No.1 to No.4 skarn orebodies are located in around 1,900m to 2,050m in altitude. In the western part of the district, No.8 and No.9 skarn orebodies are situated in around 2,000m to 2,100m in altitude. These deposits contain gold with silver and copper. Average grade of outcrops of No.3 orebody is 9.4 g/t Au, and highest grade is 121 g/t Au. The orebody dips 60° to 70° southeast.

Since 1994 South Kyrghyz Geological Expedition (hereinafter called SKGE) has been conducted a tunnel prospecting of No.3 skarn orebody. An outline of mineralization has been clarified. According to the underground prospecting, gold-bearing skarn body ranges from 10m to 15m in width, with about 300m in length. SKGE reported that possible reserves (C2) of No.3 skarn orebody were estimated to be 1,138 thousand tons, 8.6 tons of gold and average grade 7.6 g/t Au on the basis of cut-off grade 1 g/t Au, as of January 1997. Electrum, chalcopyrite, pyrite, magnetite pyrrhotite were reported as ore minerals.

2-2 Geological survey

2-2-1 Purpose of survey

The purpose of survey is to assess the relationship between mineralization and geology or geological structure in the Altyn-Jylga district by detailed geological survey, as well as trench and underground surveys. Detailed geological survey is carried out with 2.1km².

2-2-2 Method of survey

Topographic maps on a scale of 1:2,000 prepared by SKGE, is used as base maps for a field survey and an indoor analysis. A surveying route was decided referring to previous data. The filed survey in the northern, central and southern parts was done by a dense route. The survey was carried out using a surveying transit compass or clinocompass, altitude barometers and measuring tape. Geological observations were recorded on a field map.

Previous trenches which dug by SKGE were reinvestigated. A closed measuring line was drawn around the detail investigated trenches, combined with making a relative position of each trench and mineralized outcrop accurate. Before investigating, trenches were made clean and cropped out. Geological observations were sketched on a scale of 1:100.

Roof and both sidewalls of the previous adit which was driven by SKGE during 1995 to 1996, was sketched on scale of 1:200. Classification of skarn and a

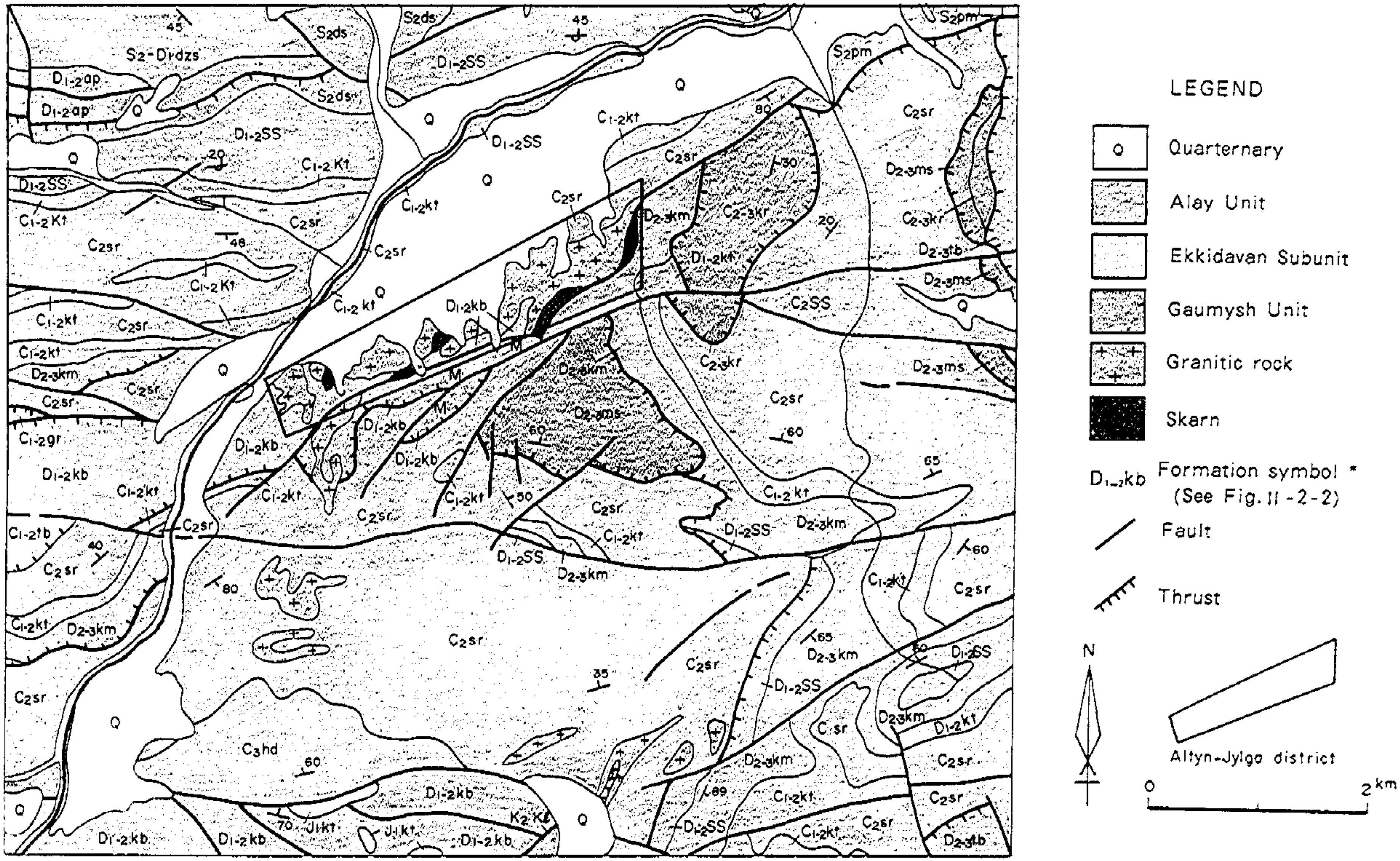
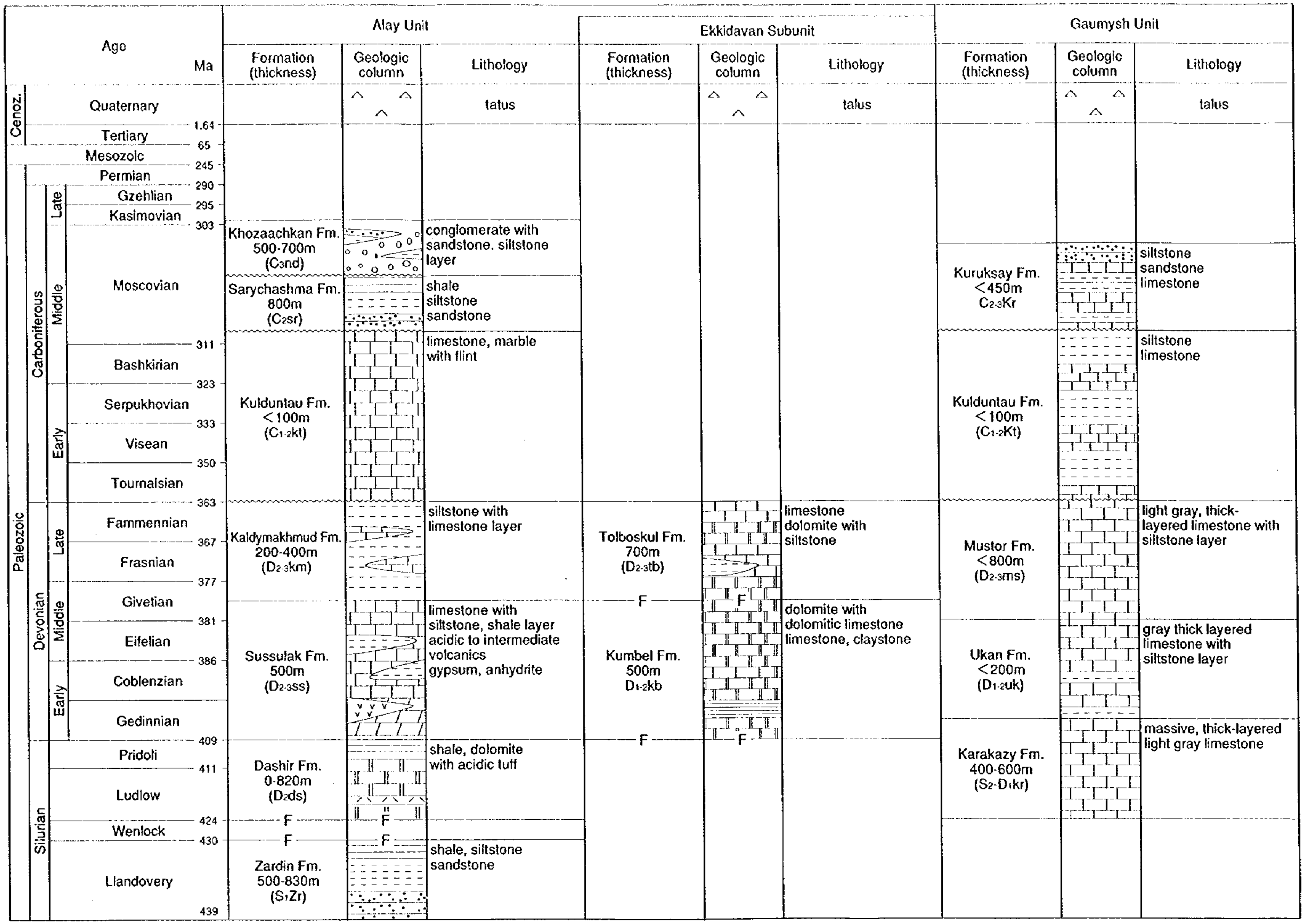


Fig. II-2-1 Geological Map around the Altyn-Jylga District



・F：fault contact　Fm：Formation.
・Time scale：after Har land, W. B. et al., 1990

Fig. II-2-2　　Schematic Geological Column of the Altyn-Jylga District

relationship between the mineralization and the fissure system were investigated intensively.

Base camp for the survey was set up at 1,700m in altitude in the Altyn-Jylga district.

Samples were collected for assay in length of one meter in principle. Chemical analysis was performed by the Laboratory of SKGE. Eight elements of gold, silver, copper, lead, zinc, arsenic, antimony and molybdenum were analyzed there. After drying naturally, samples were crushed into less than 1mm by a jaw crusher and a roller crusher. Finally, spindle mill crushed samples in less than 0.074mm.

Gold was at first analyzed by the spectral gold analysis. Only sample more than 0.5 g/t Au was re-analyzed by the fire assay.

Method	Range	Accuracy	Applied Sample
(a) Spectral gold	0.012 - 10 g/t	±70%	Low grade ore, rock
(b) Fire assay	0.2 g/t - max.	±30%	Ore

Seven elements of silver, copper, lead, zinc, arsenic, antimony and molybdenum were analyzed by the atomic absorption. Detection limit are as follows;

Ag 0.1 g/t, Cu 0.001%, Pb 0.0001%, Zn 0.003%, As 0.012%, Sb 0.003%, Mo 0.00012%

2-2-3 Result of survey

(1) Geology

Geological map and cross sections of the Altyn-Jylga district are revealed in Fig. II-2-3 and Fig. II-2-4.

1) Paleozoic group

The Kumbel formation covers in the southeast to the Altyn-Jylga body trending NE. Limestone of the Kumbel formation is white or gray. Banded structure made of carbon materials were often observed in limestone. As above mentioned, limestone has almost undergone skarnization and silicification at the contact zone of the Altyn-Jylga body by replacement and metamorphism. Moreover, limestone is largely replaced by marble near zone of the Altyn-Jylga body. Limestone hardly represents original texture. Marble is white and shows granoblastic texture consisting of carbonate minerals with some centimeters. On the left bank of the Altyn-Jylga gully, limestone and marble of the Kumbel formation distribute in a small scale.

The Sarychashma formation is made of dark gray to black shale. It covers the northwestern side of the Altyn-Jylga body. It crops out at the northwest side of the above-described limestone and marble of the Kumbel formation and at the western mountainside. At the western mountainside, the Sarychashma formation has been intruded by granodiorite. Pyroxene skarn replaced by serpentine has been produced at the contact zone between the Sarychashma formation and granodiorite.

2) Intrusive rocks

The Altyn-Jylga body has intruded as stock which extends a NE-SW trend with dimensions of 0.5km by 1.2km in the eastern part of the survey district (the northeast body). In the western part of this district, the Altyn-Jylga body has been contact with the Kumbel formation along 2km by intrusive plane of trending E-W (the southwest body). Northern side of the southwest body is underlain by talus widely. A relationship between the southwest body and their intruded rocks have been unknown. Granodiorite dyke is distributed as branches with several meters to several ten meters in width along the connect zone with the northeast and southwest bodies

Further, granodiorite has intruded into the Kumbel formation as small dyke swarm with several meters in width in an area among the northern, central and southern parts. Dominant directions of dyke are N-S to NE-SW. Most predominant direction is NNE-SSW.

Surrounding rock of the Altyn-Jylga body has undergone skarnization. The granodiorite body is also subjected to skarnization slightly.

Rock facies of the Altyn-Jylga body is made chiefly of granodiorite, associated with monzodiorite, quartz diorite and granite. Under the microscope of typical granodiorite (Apx. 1-3, 7T0008), it shows holocrystalline and equigranular texture, and is composed of quartz, potassium feldspar, plagioclase, biotite, hornblende and clinopyroxene. As altered minerals, sericite, chlorite and calcite are observed.

In the western part of the district, olivine pyroxenite occurs at several meters in width in granodiorite. Pyroxenite grades into granodiorite. Under the microscope (Apx. 1-3, 7T0017), it shows equigranular texture, and is composed of olivine, clinopyroxene, plagioclase, biotite and hornblende. Pyroxenite is assumed to be xenolith in granodiorite.

Lamprophyre occurs as dyke ranging in width from several ten centimeters to several meters. It distributes in the northern, central and southern parts, especially a dyke swarm crops out the central and southern parts. Under the microscope of typical lamprophyre (Apx. 1-3, 7N0040), it is composed of plagioclase, biotite and hornblende, with minor amount of quartz and apatite. Being hardly observed