No. 13

REPORT
ON
THE MINERAL EXPLORATION
IN
THE UUDAMTAL AREA
MONGOLIA
(PHASE II)

MARCH 1993

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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PREFACE

In response to the request of the Mongolian Government, the Japanese Government decided to conduct a Mineral Exploration in the Uudam Tal Area Project and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

This year's survey is the second phase of the Uudam Tal Area Project.

The JICA and MMAJ sent a survey team to Mongolia from June 14 to September 23, 1992.

The team exchanged views with the officials concerned of the Mongolian Government and conducted a field survey in the Uudam Tal area. After the team returned to Japan, further studies were made and the present report has been prepared.

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

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

March, 1993

Kensuke Yanagiya

Kensuke YANAGIYA
President
Japan International Cooperation Agency

Takashi Ishikawa

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Р Е З Ю М Е

Настоящий доклад приготовлен на основе данных, полученных в ходе выполнения в регионе Одамтар, Монголия, работ за второй год по основному исследованию возможности эксплуатации минеральных ресурсов. Цель этого исследования заключалась в том, чтобы определить наличие и запас полезных ископаемых в соответствующих местных породах. Полевое исследование на месте было проведено в период с июня по сентябрь 1992 г.

За второй год исследования было осуществлено геологическое исследование, а в частности симптоматическое исследование рудных жил, в зоне площадью 12180 км^2, которая располагается в районе Олзийт. Эта зона была назначена местом исследования в результате полевого геологического исследования и сбора данных, проведенных в предыдущем году. В то же время, в той же зоне, а именно вокруг рудного месторождения Олон-Овоот были осуществлены метапрецизионная геологическая разведка на участке площадью 12 км^2, геофизическая разведка методом "ТЕМ" на участке 12 км^2 и геохимическая разведка на участке площадью 1 км^2. Помимо таких разведок, для района Дорнод провели анализ собранных данных и материалов.

В результате геологического исследования были выявлены масштабные кварцевые и силицидные жилы в каждом из районов Сойриг, Сологой, северной части Хармагтаай. Несмотря на то, что показатель качества обнаруженных пород в названных районах, в общем, составил не более 0,5 г/т по содержанию золота, в многих случаях измерения температура гомогенизации жидких включений не достигала до 200℃ и частично наблюдались кремнистые источниковые отлодения, а также массивные кремнистые породы, что свидетельствует о возможности наличия довольно больших необнаруженных залежей золота.

Для рудного месторождения Олон-Овоот были определены следующие факты:

Результаты метапрецизионной геологической разведки показали, что общая длина данного рудного месторождения достигает до 1000 м и на его участке рудного скопления температура гомогенизации жидких включений лежит в пределах 170℃ ～ 250℃. Сверх того, изменения на границе жидлы приходит, в основном, на хлорит.

Результаты геохимической разведки показали, что золото сосредоточенно включено в кварцевом породе с

качеством жилы по золоту 3,2 г/т, обеспечивая возможность образовать залежную поверхность площадью приблизительно 2500 м².

В результате геофизической разведки было определено, что рудное месторождение Олон-Овоота образует полосу высокого удельного сопротивления, достигающую глубины под поверхностью земли в несколько сотни метроьв под углом наклона свыше 80 град.Исходя из этого можно ожидать скачкообразное увеличение количества добываемой руды за счет глубинной разведки. Также, в подземном слое вдоль сброса найдена полоса высокого удельного сопротивления, а на северо-восточном участке данного района - довольно большая полоса низкого удельного сопротивления.

Исходя из изложенного выше, можно сделать вывод, что рудные залежи в районе Олон-Овоот имеет потенциальные запасы в более несколько сотни тысяч тонн с качеством по золоту 3 г/т. К тому же, в результате геофизической разведки отмечается возможность наличия кварцевой жилы вдоль сброса, а на северо-восточном участке района - залежи из массивных сернистых пород.

Анализ существующих данных пока ничего особенного не показал.

На следующие годы проведения исследования рекомендуется осуществлять геологическое исследование, метапрецизионную разведку, геохимическую разведку и геофизическую разведку по методу "ТЕМ" для оценки потенциала в районах Сойриг, Сологой, а также на северных участках района Хармагтаай. Что касается рудного месторождения в районе Олон-Овоот, то рекомендуется осуществить разведку с бурением для определения максимальной глубины месторождения, а также осуществить геофизическую разведку методом "ТЕМ" для определения его ширины.

Кроме того, для полосы низкого удельного сопротивления, которая находится на северо-западном участке района Олон-Овоот, представляется необходимым осуществление геофизической разведки по методу "ТЕМ", магнитной разведки и разведочное бурение с целью определения плоскостного распространения полосы. Что касается района Дорнод, то рекомендуется обсудить и определить методы разведки после получения и анализа материалов штрокодиапазонной гравитационной разведки, проведенной специалистами бывшего СССР.

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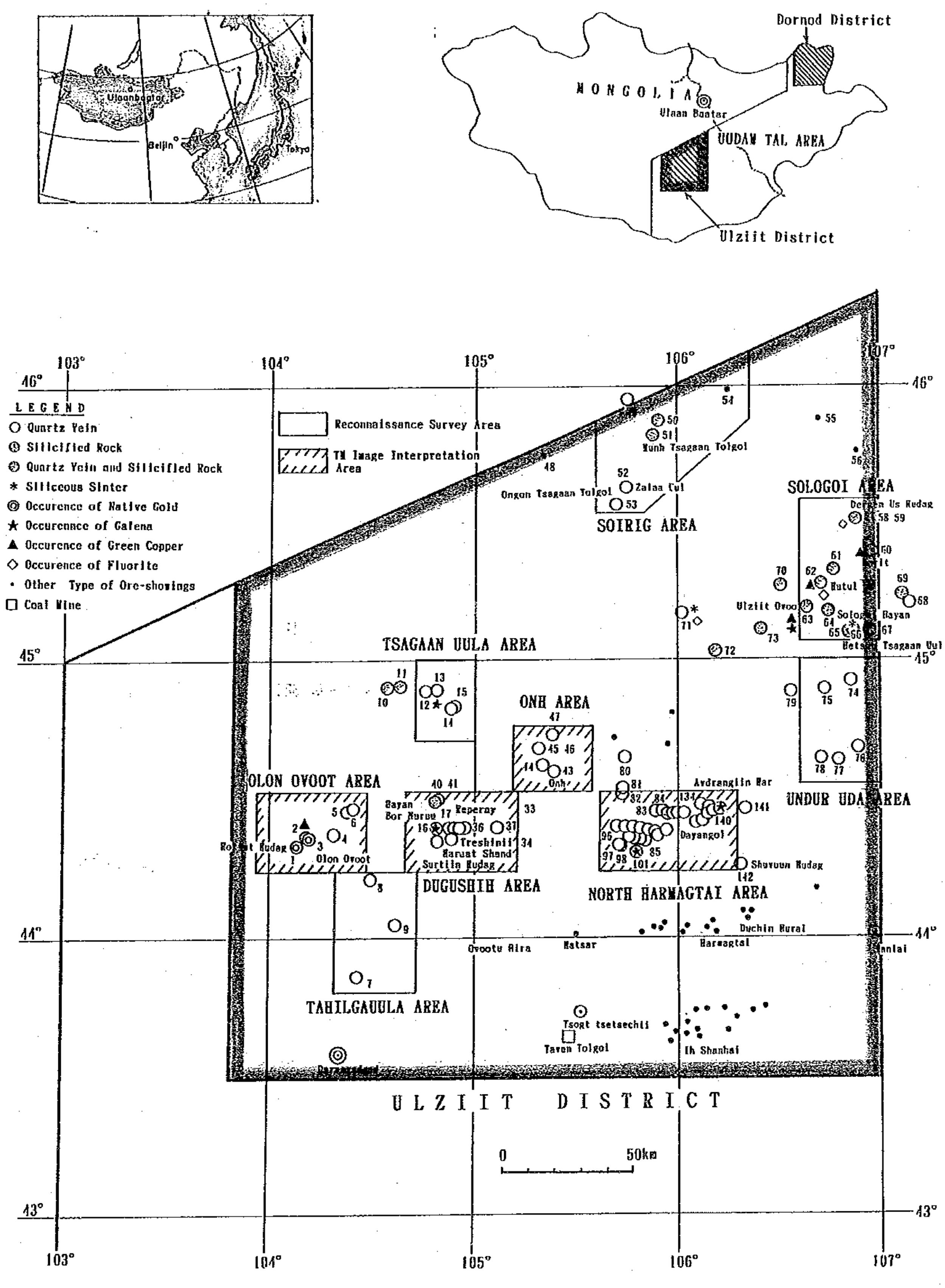


Fig. I-1　Location map of the survey area

Summary

This report deals with the second year's survey results on the mineral resources development survey conducted at Uudam Tal Area in Mongolia.

Purpose of the survey is to clarify geology of the area and to grasp mineral potential of the area.

Field survey was conducted from June to September in 1992.

Target areas and contents of the survey are as follows:
At Ulziit District, reconnaissance geological survey covering an area of 12,180 km^2 with special attention for mineral indications, at Olon Ovoot deposit within the Ulziit District, semi-detailed geological survey and geophysical prospection (TEM) both of them covering an area of 12 km^2 and geochemical survey covering 1 km^2 area and at Dornod District, data collection and analysis of previous works.

Reconnaissance geological survey revealed that big quartz veins and silicified rocks were found at Soirig, Sologoi and North Harmagtai areas. These mineral indications showed less than 0.5 g/t of gold on the surface, but homogenization temperature of fluid inclusion is mostly less than 200 °C and partly there exist massive silicified bodies and siliceous sinter. These phenomena suggest that blind gold deposit could be expected in this region.

Semi-detailed geological survey verified that the Olon Ovoot deposit laterally continues more than 1,000 m and homogenizing temperature of the bonanza ranges from 170°C to 250°C.

As a result of geochemical survey, it was demarcated an area of 2,500 m^2 with average gold value of 3 g/t on the outcrop of the Olon Ovoot deposit.

Geophysical survey suggested that the Olon Ovoot deposit might continue a several hundred meters downward with more than 80° dipping. Ore reserve of the deposit is expected to increase with an exploration of downward.

Aside from that, a large area of geophysical anomaly of low resistivity is found at the northeastern part of the survey area.

Summing up the above-mentioned survey results, the Olon Ovoot deposit is a highly potential ore deposit with ore reserves of more than several hundred thousand tons and gold value of 3 g/t and at the northeastern part of the surveyed area there exists a potential area of massive sulfide deposit.

Recommendation for the future work is as follows:

To the Olon Ovoot deposit, drilling to confirm downward continuation of the deposit and geophysical prospection adopting TEM to check lateral and downward extention of the deposit.

To the geophysical anomaly of the northeastern part of the surveyed area, further detailed geophysical survey to clarify a nature of anomaly.

To mineral indications encountered at Soirig, Sologoi and Harmagtai areas, it is advisable to conduct further geological, geochemical and geophysical survey in order to appraise potential of each mineral indication.

As to Dornod District, it is advisable to obtain previous survey data done by USSR and to conduct integrated analysis of the region.

Part I GENERAL REMARKS

Chapter 1 Introduction

1-1 Background and purpose of the survey

Mongolia is recently pursuing economic policy to open its market for western countries and to introduce their capitals and technologies for the development of the country.

Technical cooperation in the field of mining between Japan and Mongolian People's Republic*1 (MPR) was initiated with an submission of requesting letter as to rare-earth mineral exploration in the Mushgia Hudak area in October 1989. In response to the requesting letter, Japanese government dispatched the first project finding mission in August 1990. The mission confirmed high potentiality of mineral resources in MPR and elements of copper, lead and zinc are also target metals of technical cooperation. In November 1990, additional two projects were proposed from MPR and Japanese government delivered the second mission to MPR in March 1991.

The mission discussed with State Geological Center*2 of MPR and agreed and signed the Scope of Work dated on 16th of March in 1991 which covers 500,000 km² of the eastern part of Mongolia called Uudam Tal Area.

The survey commenced in the fiscal year 1991.

The purpose of the survey is to clarify geology of the area and to grasp mineral potential of the area. Data collection and its interpretation, and regional geological survey including satellite image analysis of the seven selected areas were conducted and promising areas for further study were extracted in the first year's survey.

The second year, the survey was conducted following the previous year's survey results and recommendations.

*1 Name of the country was changed to Mongolia in February, 1992.

*2 SGC was reorganized into Ministry of Geology and Natural Resources in August, 1992.

1-2 Conclusion and recommendation of the first year survey

1-2-1 Conclusion

The survey result of the first year is summarized as follows:

1) Promising mineral deposits found in the survey area are polymetallic ore deposits of Tsav and Ulaan, Tumurtiin Ovoo zinc deposit and Olon Ovoot gold deposit.

2) Tsav, Ulaan and Tumurtiin Ovoo; these three deposits were already conducted by fairly advanced exploration work and it is advisable to apply step-up stage of survey method beyond this Scope of Work.

3) Potential areas for discovering new ore deposit are as follows:

1. Blind polymetallic ore deposit in Dornod District where develops volcanic rocks of Mesozoic age are distributed.
2. Gold deposit which will be expected from Ulziit to Tsagaan Svraga District.

1-2-2 Recommendation

Recommendation for the second year survey are as follows:

1) Previous work data collection and interpretation.

2) Survey for materializing mine development.

1. Production of basic maps for Olon Ovoot gold deposit such as vein pattern map, assay map and geologic map. Confirmation of lateral and vertical extension of gold vein using geophysical prospection.

2. Survey to make appraisal of various gold indications found in the area of E−W 300 km × N−S 600 km from Ulziit to Tsagaan Svraga District, following work shall be conducted:

a. Study on the possibility of becoming ore body to each mineral indications.

b. Study on the loci of mineralization.

c. Study on the age of mineralization.

d. Ground truth survey of the satellite image analysis done by the first year.

3) Conduction of regional gravity survey to the distribution area of Mesozoic volcanic rocks in the Dornod District where are expected to exist big blind polymetallic deposits.

1-3 Outline of the second year survey

1-3-1 Area and content of the survey

The survey of the second year was conducted following the recommendation of previous year as follows.

1) Ulziit District

1. Semi−detailed geological survey to the Olon Ovoot deposit covering an area of 12 km^2 including the work of vein mapping and geochemical survey. Geophysical survey (TEM) to the same area as the above−mentioned to confirm lateral and vertical extention of ore veins. Detailed geochemical survey to the area of 1 km^2 to produce assay map of ore vein.

2. Reconnaissance geological survey for nine areas totalling the area of 12,180 km^2 in order to evaluate many gold ore indications within the Ulziit District. Survey methods are geological, vein−quality and alteration survey together with analysis of ore and measurement of homoginizing temperature of fluid inclusions of the veins.

2) Dornod District

Data collection and interpretation, especially for geophysical survey, was conducted to the whole of Dornod District for extracting promising areas.

1-3-2 Survey method

Outline of each survey method is as follows:

1) Reconnaissance geological survey

Using topographical maps, scale of 1:100,000, prepared by the Mongolian counterpart and equipment of GPS (Global Positioning System), mineral indications in the survey area were plotted on the map and geologically described.

Ground truth was also conducted in comparison with interpretation of satellite image. For a basis of geology, interpretation maps of satellite image with a scale of 1:100,000 were used in the Olon Ovoot, Dugshih, Onh and North Harmagtai areas, whereas in the rest of the area the geological map with a scale of 1:1,000,000 issued jointly with Mongolia and U.S.S.R. was used in the field.

Field survey was conducted by dispatching five times caravan team preparing a base camp at Olon Ovoot. Field survey team is in principle composed of two engineers; one Japanese and one Mongolian counterpart.

Main tasks of survey team were geological checking, rock and ore sampling and positioning of locations on the map.

As for samples to be taken, ore samples for assay were concentrated mainly to the most promising mineral indications which were big enough to warrant further advanced exploration work. Within the mineral indications, sampling space was designed to clarify concentration of gold and silver content, that is, closer spacing of sampling to the part of highly mineralllized portions. For most of the veins, vein character are homogeneous and therefore sampling was conducted with equal intervals. Most of the samples for measuring homogenizing temperature were also collected from the most promising mineral indications and at the same time samples were collected to cover entire Ulziit District to know the pattern of ore forming temperature.

Age determination was aimed for revealing mineralization age.

Size and number of mineral indications confirmed with this survey exceeded than those of initial plan, consequently sampling space remains wide.

Whole the mineral indications were plotted on the map using GPS, and some of the indications described in the documents were not found in the field.

2) Semidetailed geological survey

The survey was conducted an area of E−W 4 km × N−S 3 km covering Olon Ovoot ore deposit. Base camp of the survey was located at Olon Ovoot.

Geological survey was conducted along magnetic north−south direction survey lines which were set every 200 m intervals. Each survey line was measured with a pocket compass and measuring tape to draw a scale of 1:5,000 map to describe geology and total of 598 rock samples taken.

Total number of 500 geochemical samples were collected from the 100 m × 200 m grid points which were set for the measuring points for geophysical survey.

Samples for alteration survey were collected equally to the survey area as far as possible.

Three survey teams were engaged in the survey, each team was composed of one Japanese and one Mongolian geologist.

3) Geochemical survey

Geochemical survey was conducted covering the Olon Ovoot ore deposit with an area of 1 km^2. Base camp for the survey was located at Olon Ovoot.

The survey lines in the direction of magnetic north−south with line spacing every 10 m were measured using a pocket compass and measuring tape.

Total number of 2,076 rock samples were collected along the lines. Sampling interval varies from geological situation; every 2.5 m for quartz vein, 5 ~ 10 m for altered zone and 20 ~ 50 m for the rest.

Fifty samples for alteration survey were collected from the entire survey area with an equal distribution.

Survey team is composed of one Japanese and one Mongolian geologist and three teams were engaged in the survey.

4) Geophysical survey

Geophysical survey of transient electromagnetic system (TEM) was applied to the same area as semidetailed geological survey. Total number of survey points were 540, among them 500 points were 100 m × 200 m grid points to grasp the entire areas structure and 40 points were placed for clarifying detailed vein structure with a grid of 50 m x 25 m. Whole the survey points were measured and plotted on the map of 1:5,000 using a pocket compass and measuring tape.

Measurement was conducted in-loop method for 500 points and out-loop for 40 points. Whole the survey equipment were transported from Japan.

Three survey teams were prepared with one Japanese and one Mongolian engineers for each team, and each was responsible for operating transmitter, receiver and power generator communicating each other through transceivers.

Rock samples for measuring electric conductivity were also collected 56 in numbers.

5) Analysis of previous data

Previous data collection and its analysis were conducted on the whole area of Dornod District. Data were provided by Mongolian counterpart and analysis were conducted with three Japanese geologists and two Mongolian geologists at Ulaan Baatar office.

Main theme of the analysis was centered on geophysical data, since objective of this survey is to select further target area through analysis of regional geological structure and mineral occurrences in the entire Dornod District.

1-3-3 Mission members

1) Planning and negotiation

The second year's survey was planned with the following members:

a. Primary coordination

JAPAN

SAKASEGAWA Toshio	Metal Mining Agency of Japan
METSUGI Hideya	Metal Mining Agency of Japan

MONGOLIA

Zaanhuugiin BARAS	State Geological Center
Jam'jan-TSENDAYUSH	State Geological Center
Tsegdmiin RENCHINDORJ	GEOLOGY Company
Dagva VATBOLD	GEOLOGY Company

b. Discussion at Mongolia

JAPAN

OGITSU Takashi	Metal Mining Agency of Japan
METSUGI Hideya	Metal Mining Agency of Japan
KAMIYA Taro	Metal Mining Agency of Japan
NAITO Koh	Japan International Cooperation Agency

MONGOLIA

Jam'jan-TSENDAYUSH	State Geological Center
Tsegdmiin RENCHINDORJ	GEOLOGY Company
Dagva BATBOLD	GEOLOGY Company
Kishigsuren ENKHTUVSHIN	GEOLOGY Company
Sh BAASANDORJ	GEOLOGY Company
M. DUINHARJAV	Mongolian Geological and Geophysical Co., Ltd.
Tz. CHULUNBAATAR	Mongolian Geological and Geophysical Co., Ltd.
D. LAVDANSUREN	Mongolian Geological and Geophysical Co., Ltd.

2) Field Survey Team

Field survey team was composed of two parties; geological/geochemical and geophysical. The former party was dispatched to the field from June 14th 1992 to September 23rd 1992, and the latter from June 14th to August 26th 1992.

Members of the survey team are as follows:

a. JAPAN

SATO Eitaro	Chief, data analysis, geology/geochemistry	MINDECO
ADACHI Kazuhiro	data analysis, geology/geochemistry	MINDECO
HARADA Haruo	data analysis, geology/geochemistry	MINDECO
WADA Kazusige	geophysics	MINDECO
OKUZUMI Koichi	geophysics	MINDECO
ISHIKAWA Hidehiro	geophysics	MINDECO

b. MONGOLIA

Jam'yan TSEND-AYUSH	Chief, data analysis	SGC
Dagva BATBOLD	geology/geochemistry	GC
Kishigsuren ENKHTUVSHIN	data analysis, geology/geochemistry	GC
Sh. BAASANDORJ	geology/geochemistry	GC
M. DUINHARJAV	geophysics	MGEC
Tz. CHULUNBAATAR	geophysics	MGEC
D. LAVDANSUREN	geophysics	MGEC

MINDECO:	Mitsui Mineral Development Co., Ltd.
SGC:	State Geological Center
GC:	Geology Company
MGEC:	Mongolian Geophysical Exploration Co.

Table I-1-1 Dispatchment of survey mission

Number of engineers	Deperture	Arrival	Term of dispatchment
Geologist 3 persons	June 14	Sept. 23	102 days each
Geophysicst 3 persons	June 14	Aug. 23	74 days each

Table I-1-2 Laboratory works

Testing items	Quantity				Total
	Geological survey		Geochemical survey	Geophysical survey	
	Reconnaissance survey	Semi-detailed survey			
1. Thin section	20	5	3	–	28
2. Polished section	10	5	3	–	18
3. Whole rock chemical analysis	50	5	3	–	58
4. Ore analysis	208	21	–	–	229
5. Geochemical analysis					
1) (Au, Ag)	–	–	1,900	–	1,900
2) (Au, Ag, Hg, As, Sb, W, Mo)	–	500	101	–	601
6. X-ray diffraction test	100	50	50	–	200
7. Dating (K-Ar method)	8	1	1	–	10
8. Fluid inclusion test	74	6	15	–	95
9. Resistivity measurment test	–	–	–	56	56
Total	470	593	2,076	56	3,195

Chapter 2 Geography of the Survey Area

2-1 Location and access

The Ulziit District, the principal target area for the second year survey, is located at the westernmost part of the Uudam Tal Area.

The District occupies an area of 65,000 km^2, covering the following three Aimags; Dundgovi, Uvurhangai and Umnugovi.

It takes 12 to 24 hours by car from Ulaanbaatar to Ulziit in a distance of 500 km of unpaved road passing through a vast area of steppe and desert with an altitude of 1,000 to 1,500 m above sea level. By plane it takes one hour and forty minutes from Ulaanbaatar to Dalanzadgad and then from Dalanzadgad to Olon Ovoot it takes around two hours by car.

Domestic flights were reduced in number due to a severe fuel shortage and airplane service between Ulaanbaatar and Dalanzadgad twice a week in September 1992.

Most of the Ulziit District are covered with a gently rolling semi-desert, therefore everywhere is passable by car. Many mineral indications are found in a scarcely populated semi-desert, so it is indispensable to use plural vehicles for making mineral exploration work in this area.

2-2 Topography and drainage

1. Topography

The second year's survey was conducted in the Ulziit District, which is located at the westernmost part of Uudam Tal Area as is shown in Fig. I-1.

Geographically the Ulziit District is situated at the southwestern part of the Mongolian Highland which forms a gentle vast plateau with an altitude of 1,000 ~ 1,500 m above sea level.

A northern half of the Mongolian Highland is steppe whereas the southern half is semi-desert, due to a meteoritic balance of precipitation and evaporation.

The highest point in the Highland is 2,825 m peak of the Gurvan Saihan Mountains and the lowest is an elevation of 1,030 m in the eastern part of Undol Uda area.

Topographycally the District is divided into following four districts: East Mongolian Highland, Govi Lowland, Gurban Saihan Mountains and Ih-Shanhai Mountains.

The East Mongolian Highland is located in the north of the Govi Lowland and occupies an area of 300 km width × 800 km extension with an elevational difference of 1,000 ~ 1,500 m forming gently rolling hill and plateau. Sporadically it remains monadnock with an altitude of 1,500 ~ 1,700 m above sea level.

To the north and the west, the East Mongolian Highland connects with the Henty Altai and Govi-Altai Mountains and an elevation gradually decreases from NW towards SE.

The Govi Lowland is a structural depression stretching southwestwards from the Dornod Plateau with width ranging from 30 km to 150 km and it forms a desert with an altitude of 900 ~ 1,000 m, having sporadically remained monadnocks with an elevation of 1,000 ~ 1,200 m.

The Govi-Altai Mountains occupies a southwestern tip of the East Mongolian Highland. It branches out such mountain blocks as Gurran Saihan Mountains, Ih-Shanhai Mountains and Ih-Hotgon Mountains, all mountains with an altitude of 1,700 ~ 2,800 m above sea level. Direction of these mountains within the survey area changes from WNW-ESW to E-W and the mountains diminish by an intersection of SW-NE running Govi Lowland.

2. Drainage

No steady flowing water system is found in the Ulziit District. Once it rains, temporary water flows on dry river beds called Sair which develops and pours in the Govi Lowland and/or nearby depressional places and diminishes there.

Folded Paleozoic formation which is composed of alternation of sandstone and shale crops out in the Harmagtai North, Dugshih and Olon Ovoot. In this area E–W extending grid-like and/or parallel water drainage system which reflects underlying geology and geological structure is recognized.

Aside from that, drainage pattern of dendritic is found in volcanic rock zone and feather-like one in the distribution area of Cretaceous sedimentary rocks.

2-3 Climate and vegetation

1. Climate

Climate of the survey area belongs to arid climate zone with subdivision of both steppe and desert climates.

Meteoritic data at Dalanzadgad show the following figures; temperature, yearly average 3.9°C and monthly average ranges from 23.2°C in July to −21.3°C in January.

Within a year temperature fluctuates from maximum 37.5°C to minimum −36.5°C and daily temperature fluctuation is also big, especially in summer time it gains more than 20°C.

Annual precipitation is less than 200 mm with a tendency of more precipitation in the north than in the south. Most of the survey area it is less than 100 mm per year.

Major rainy months are from May to September with maximum precipitation in July whereas in winter monthly downfall is less than a few mm.

Throughout a year it is windy in the Survey area and especially from March to May during a period of three months and November, wind is quite strong having sand storms 40 to 50 days per year.

The Govi area is well known having severe climate of more than 40°C hot wind and sand storm during summer season.

2. Vegetation

Vegetation of the survey area is controlled by a balance of precipitation and evaporation.

Northern part of the East Mongolian Highland shows thickly vegetated steppe since there occurs many precipitation during summer and a few evaporation due to high elevation and latitude, in contrast to that Govi area is a barren desert since there occurs less precipitation and lower elevation and latitude lead to higher temperature.

Between the East Mongolian Highland and Govi area, it forms scarcely vegetated steppe.

The entire area is generally scarce in woody plant, only along oasis and Sair a few trees and big Sair are found. In lowland sometimes occur a small bush of Harmag and "Govi Tree" which are characteristic in Govi Desert.

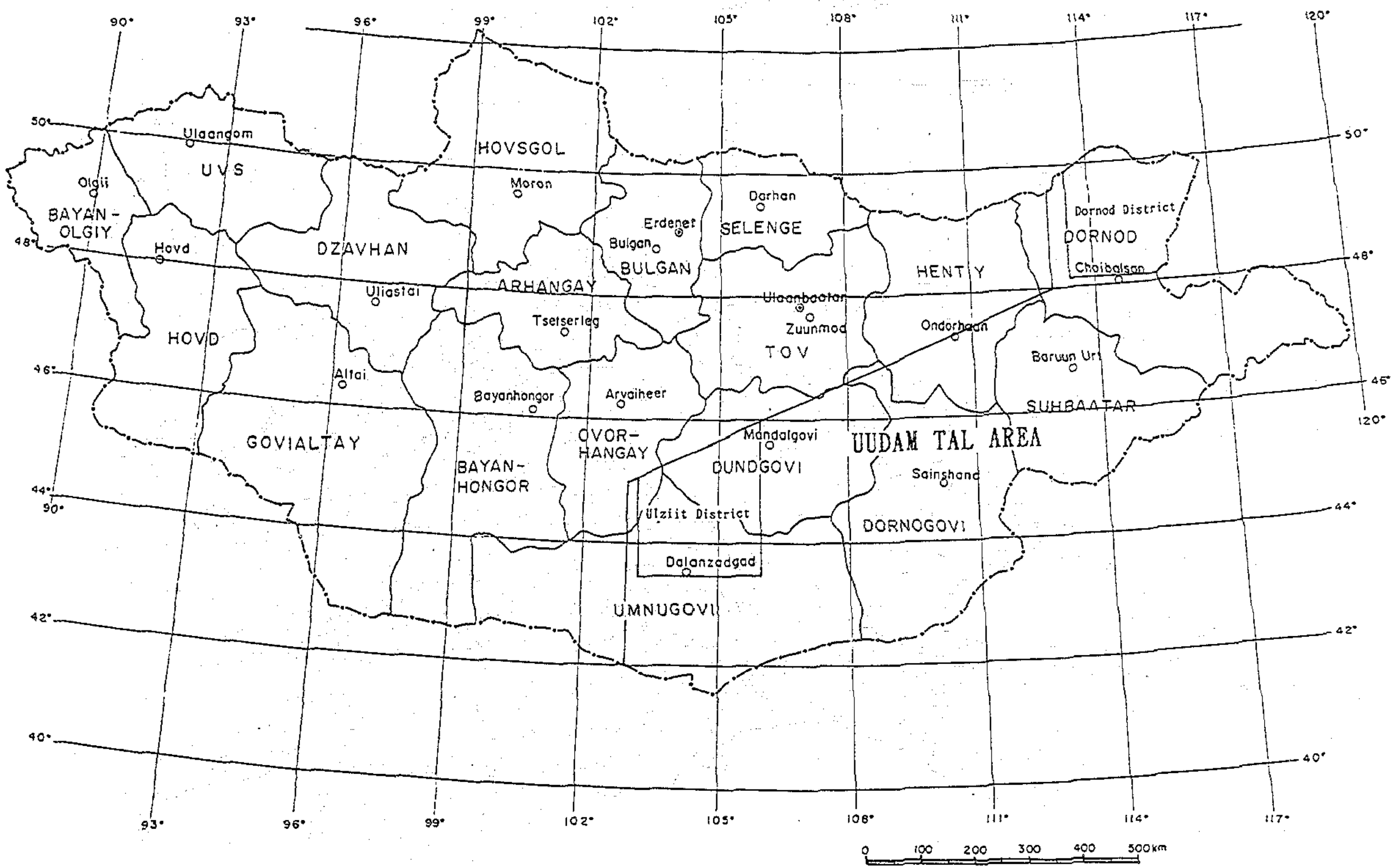


Fig. I-2-1 Administrative division

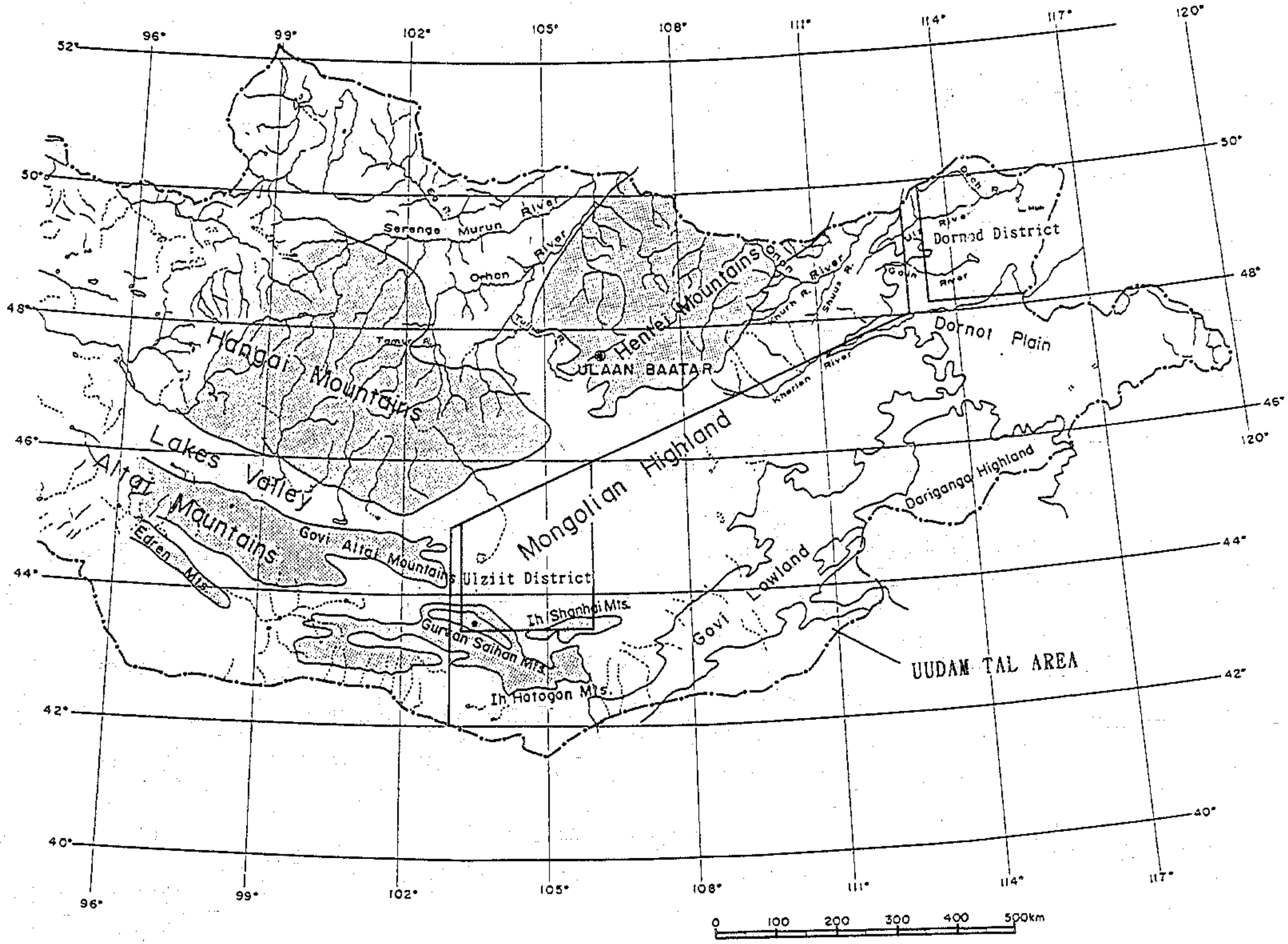


Fig. I-2- 2 Geographical features

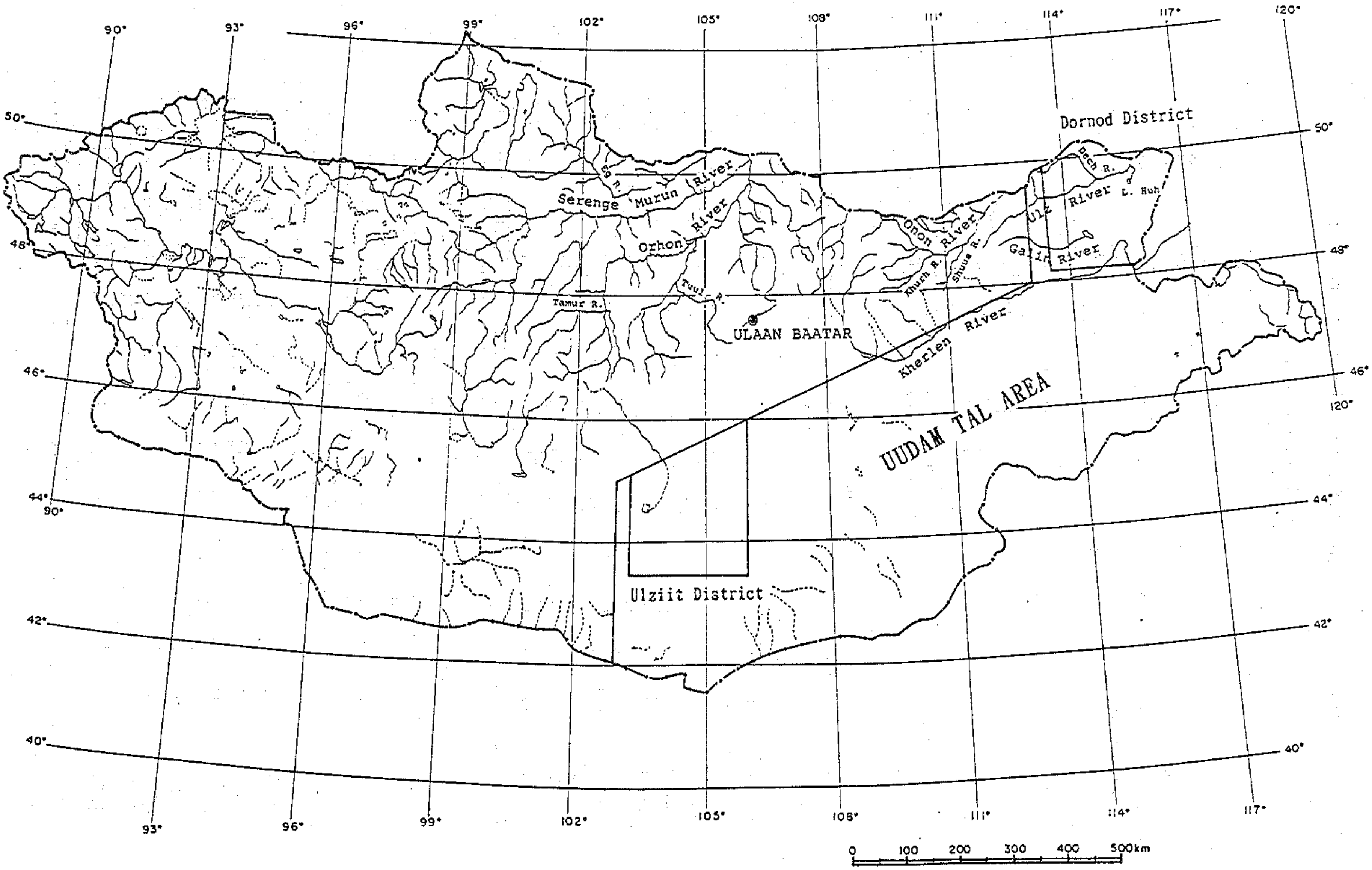


Fig. 1-2-3 Drainage systems

Table 1-2-1 Major climatic indices of the area

Mean Monthly and Annual Temperature (°C)

Meteorological station	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual average
	Mean Monthly												
Altai	-18.9	-17.0	-8.9	-0.5	6.9	12.6	14.0	12.7	6.3	-1.8	-10.8	-16.9	-1.8
Arvaiheer	-15.5	-13.9	-6.6	1.4	8.5	14.2	15.4	14.0	8.4	1.2	-8.2	-14.1	0.4
Baruun Urt	-21.5	-18.6	-8.5	2.9	11.2	17.4	19.9	17.9	11.2	1.3	-10.1	-18.9	0.4
Bayanhongor	-18.4	-16.8	-7.9	1.0	9.3	15.0	15.9	14.4	7.9	-0.8	-10.8	-17.4	-0.7
Bulgan	-21.3	-19.2	-9.5	0.8	8.6	14.7	16.3	14.4	7.5	-1.3	-11.4	-19.2	-1.6
Choibalsan	-21.3	-18.8	-9.1	2.4	11.1	18.0	20.6	18.2	10.7	1.8	-10.5	-18.9	0.4
Dalanzadgad	-15.4	-12.2	-3.2	6.1	13.6	19.4	21.2	19.5	13.2	4.8	-5.8	-14.0	3.9
Hovd	-25.4	-20.8	-7.3	3.8	11.5	17.5	18.9	16.9	10.4	1.3	-10.1	-20.3	0.3
Mandalgov'	-18.0	-15.3	-7.0	2.7	10.6	16.9	18.8	17.2	10.3	1.8	-8.3	-16.8	1.1
Mörön	-23.8	-19.7	-8.3	1.5	9.1	15.7	16.9	14.7	7.8	-1.2	-12.3	-21.5	-1.8
Ölgii	-17.8	-15.2	-6.4	1.9	8.9	14.8	14.5	14.6	8.3	-0.1	-9.1	-16.3	-0.2
Öndörhaan	-23.2	-20.2	-9.5	2.3	10.4	16.8	18.8	16.8	9.7	0.6	-12.2	-21.1	-0.9
Sainshand	-18.4	-14.8	-4.7	5.9	14.0	20.6	23.2	21.1	13.8	4.3	-7.5	-16.5	3.4
Sühbaatar	-23.3	-19.6	-8.0	3.3	10.5	17.2	19.1	16.6	9.8	0.5	-10.0	-19.9	-0.3
Tsetserleg	-15.6	-14.1	-6.9	1.1	8.1	13.3	14.7	13.1	7.4	0.2	-8.4	-14.1	0.1
Ulaanbaatar	-26.1	-21.7	-10.8	0.5	8.3	14.9	17.0	15.0	7.6	-1.7	-13.7	-24.0	-2.9
Ulaangom	-33.0	-30.2	-19.0	-0.2	11.1	17.7	19.2	16.9	10.0	0.1	-11.3	-26.8	-3.8
Uliastai	-23.1	-21.2	-11.3	0.3	7.9	14.1	15.4	13.7	7.1	-1.4	-13.9	-21.6	-2.8
Zuunmod	-20.5	-18.4	-9.9	0.1	7.9	13.8	15.4	13.7	7.4	-0.7	-11.1	-18.9	-1.8

Note: Mongolia's climate is sharply continental. Throughout the year, there are 250 sunny and 9-23 cloudy days. The duration of the period with a mean daily temperature higher than 0°C lasts about 170-190 days, increasing to the south and south-east up to 200-215 days

Mean Monthly Precipitation (mm)

Meteorological station	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total yearly
Altai	1.2	1.8	6.7	9.9	14.1	28.9	44.4	42.2	14.8	7.6	3.3	2.0	176.9
Arvaiheer	0.9	1.8	4.2	8.8	17.1	40.6	91.7	61.9	17.9	4.8	2.8	1.7	254.2
Baruun Urt	2.2	1.7	3.3	7.0	13.7	31.1	57.0	42.1	23.2	5.8	2.7	1.9	191.2
Bayanhongor	1.9	3.2	4.5	9.3	15.2	33.8	66.4	54.5	16.4	7.1	2.6	1.5	216.3
Bulgan	1.4	2.1	3.9	9.4	24.5	57.1	101.0	77.9	30.2	11.4	3.6	1.8	324.3
Choibalsan	1.9	2.4	3.0	6.7	14.8	40.8	75.7	59.4	27.1	8.2	3.3	2.7	246.0
Dalanzadgad	1.1	1.5	2.8	5.6	11.2	23.9	33.5	34.6	12.4	2.9	1.9	1.1	132.5
Hovd	1.6	1.2	1.7	5.4	13.1	17.7	31.5	27.6	9.6	3.2	1.5	2.1	119.0
Mandalgov'	0.7	1.4	2.0	3.3	10.2	33.0	46.5	45.6	14.1	3.8	1.8	1.4	163.8
Mörön	1.5	0.9	2.1	6.4	13.8	46.2	70.1	60.6	22.3	6.2	2.5	1.9	234.5
Ölgii	0.8	0.6	1.2	4.3	10.9	23.5	33.8	15.4	12.2	2.2	0.9	1.3	107.1
Öndörhaan	1.8	2.6	4.7	7.4	15.8	47.0	73.3	58.9	29.5	7.3	3.7	2.2	254.2
Sainshand	0.7	1.4	1.3	4.2	10.4	19.6	34.9	27.0	9.8	4.3	1.5	1.0	116.1
Tsetserleg	2.5	3.7	5.9	17.4	32.5	68.5	90.9	76.0	27.7	11.2	6.0	2.3	344.0
Ulaanbaatar	1.5	1.9	2.2	7.2	15.3	48.8	72.6	47.8	24.4	6.0	3.7	1.6	233.0
Ulaangom	2.2	2.1	3.5	4.2	7.1	23.2	36.0	27.2	14.0	4.5	7.7	3.6	135.3
Uliastai	2.6	2.6	5.6	9.6	15.0	33.8	65.2	42.1	21.9	8.0	4.9	5.7	217.0
Zuunmod	1.4	2.1	3.8	8.9	14.4	49.8	83.8	64.8	29.6	6.0	3.6	2.6	270.8

Note: Precipitation is extremely irregular according to different seasons of the year. During the coldest months (October–March) just 8–10 per cent of the total annual precipitation falls and 67–78 per cent during the three summer months (June–August). The lowest precipitation is in January and the highest in July

Mean Monthly and Annual Wind Velocity

Meteorological station	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual average
	Mean Monthly												
Altai	2.7	3.0	3.4	4.3	4.4	3.8	3.0	3.0	3.1	3.5	3.5	2.8	3.3
Arvaiheer	2.8	3.1	3.6	5.0	4.8	4.0	3.3	3.1	3.4	3.5	3.5	3.0	3.6
Baruun Urt	3.0	3.2	3.6	4.9	4.8	4.4	3.4	3.1	3.5	3.4	4.9	3.1	3.8
Bayanhongor	2.8	2.8	3.0	3.8	3.9	3.1	2.8	2.7	3.0	3.0	3.2	2.9	3.1
Bulgan	0.6	1.7	2.3	3.0	3.0	2.6	2.1	1.9	2.2	2.1	2.0	1.7	2.2
Choibalsan	3.8	4.1	4.5	5.4	4.5	4.1	3.5	2.2	3.7	4.0	4.0	4.3	4.1
Dalanzadgad	3.0	3.5	4.4	5.6	5.6	4.4	4.0	3.6	3.7	3.4	3.8	3.1	4.0
Hovd	0.9	1.3	2.0	2.7	2.8	2.3	1.8	1.7	1.8	1.9	1.7	1.0	1.8
Mandalgov'	3.9	4.2	4.4	5.5	5.8	4.9	4.2	3.7	3.9	3.6	4.0	4.0	4.3
Mörön	1.0	1.4	2.2	3.3	3.2	2.1	1.7	1.6	1.7	1.7	2.1	1.4	1.9
Ölgii	2.4	2.9	2.5	3.2	3.5	3.2	2.5	2.9	2.6	2.9	3.3	2.1	2.8
Öndörhaan	3.4	3.3	3.9	4.8	4.8	4.0	3.7	3.3	3.5	3.5	3.3	3.4	3.7
Sainshand	3.8	4.0	4.7	5.7	5.8	5.0	4.1	3.8	4.0	3.9	4.1	4.2	4.4
Sühbaatar	1.7	1.9	2.4	3.2	3.4	2.8	2.3	2.4	2.5	1.7	2.3	2.2	2.4
Tsetserleg	2.4	2.5	2.8	3.5	3.3	2.4	2.1	2.0	2.4	2.6	2.8	2.5	2.6
Ulaanbaatar	0.9	1.4	2.3	3.4	3.7	3.4	2.6	2.4	2.3	1.9	1.3	0.8	2.2
Ulaangom	0.8	0.9	1.1	1.7	2.3	2.1	1.6	1.5	1.5	1.5	1.3	0.9	1.4
Uliastai	1.2	1.2	1.6	2.6	2.7	2.5	2.3	2.2	2.5	1.7	1.2	1.1	1.9
Zuunmod	1.7	2.2	2.8	3.6	3.7	2.8	2.3	2.0	2.5	2.3	2.5	2.1	2.8

Note: The mean annual wind velocity varies from 2–3 metres per second over a large part of the country's territory to 5 metres per second in the extreme south-east. Throughout the course of the year, it is calm, which is one of the essential peculiarities of the wind regime.

Chapter 3 General Geology

The survey area is located at the southern rim of Siberia massif and belongs to the fold belt, formally called Mongolian Geosyncline.

Geology of the area is composed of, in ascending order; Upper Proterozoic, Paleozoic and Mesozoic which fills a sedimentary basin upon the basement of the former two geologic units. These formations suffered Barkalian Orogeny in Late Proterozoic, Caledonian Orogeny in Early Paleozoic and Hercynian Orongeny in Late Paleozoic, and had been intruded by various granitic rocks since Proterozoic. Igneous activities continue till Mesozoic, and volcanics and granitic rocks of Yenshanian period, late Jurrasic to Cretaceous, occupy an extensive area.

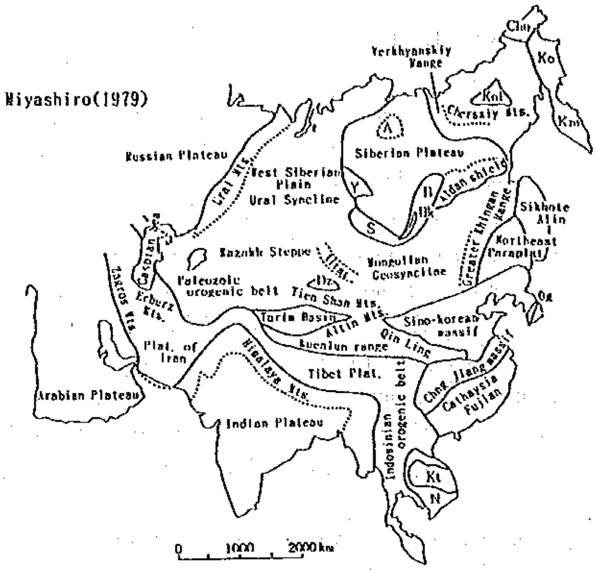
Upper Proterozoic formations are composed of gneiss, schist, crystalline limestone and gneissose granites which intruded above-mentioned rocks. These rocks crop out in the Ulziit District and northern part of Dornod District as fensters, uncomformably covered by Paleozoic-Mesozoic formations.

Paleozoic formations are distributes extensively covering whole the survey area. They are composed of schist, phyllite, sandstone, siltstone and limestone of Silurian, Devonian, Carboniferous and Permian age. Whole the rocks extend in E-W direction with a severe folding. In the central part of the Ulziit District there exist spotted outcrops of serpentinized ultrabasic rocks along a great tectonic line which is parallel to a folding structure. Those formations are intruded by granitic rocks of various ages since Paleozoic.

Mesozoic formations are composed of volcanic rocks and granitic rocks of Jurassic to Cretaceous age, and coal seams bearing inland sedimentary rocks of Cretaceous age.

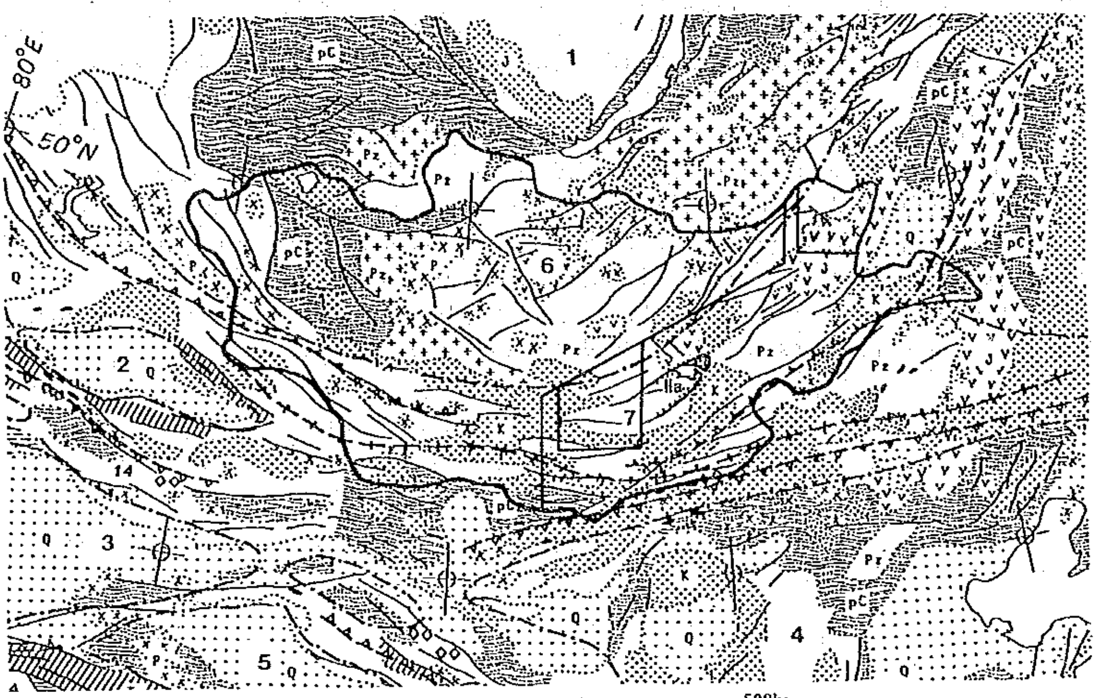
In Ulziit District, a lot of gold indications are found in the Ulziit District in relation to intensive igneous activities of Late Paleozoic and Jurassic to Early Cretaceous.

In Dornod District, a great number of polymetallic and gold mineralization are found in relation to igneous activities of Permian and Jurassic to early Cretaceous age.



LEGEND

A: Anabar Plateau
B: Baikal Mts.
Bk: Lake Baikal
Chu: Chukotskiy Pen.
Dz: Dzungaria Basin
Km: Kamchtka Pen.
Ko: Koryak Mts.
Kol: Kolyma massif
Kt: Kontum massif
N: Hersinian ologenic belt
Og: Ogcheon Geosyncline
S: Sayan Mts.
Y: Yenisei Mts.



Taira and Tashiro(1987)

L E G E N D

Sedimentary rocks

- Quaternary(Nonmarine)
- Palaeozoic(Sedimentary and Metamorphic Rocks)
- Nonmarine Sedimentary Rocks

pC: Precambrian
Pz: Paleozoic
P : Permian
J : Jurassic
K : Cretaceous
Q : Quaternary

Igneous rocks and metamorphic rocks

- Tertiary igneous rocks (chiefly volcanic rocks)
- Mesozoic volcanic rocks
- Permo-Mesozoic Granitic Rocks
- Paleozoic Igneous Rocks
- Precambrian and Early Paleozoic Basement Rocks
- Ophiolites
- Blue Schists
- IIa Har-Airag Block(middle Proterozoic) gneiss, crystalline schist, marble, gneissose granite

- Fault
- Approximate Location of Ancient subduction zone
- Approximate Location of suture zone
- Approximate boundary of continental blocks

1 Siberian Block
2 Junggar Block
3 Tarim Block
4 Sino-korean Block
5 Tsaidam Block
6 Sajany AFB(Early Paleozoic)
7 Altay-Hinggan AFB(Late Paleozoic)

Fig. I-3-1 Geological setting of the area

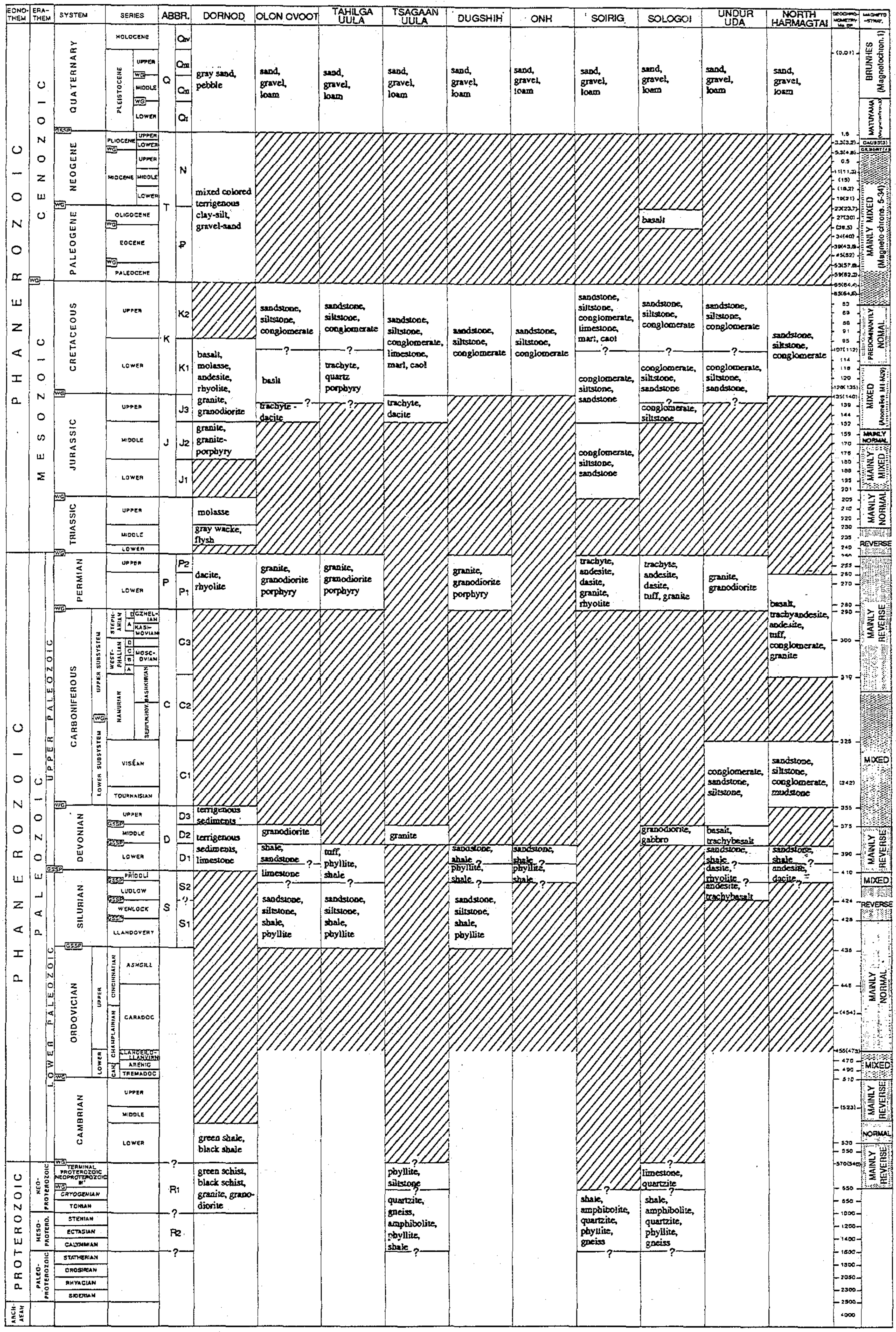


Fig. I-3- 2 Schematic stratigraphic column of the survey area

Chapter 4 Consolidated Analysis of Survey Results

4-1 Geological structure

The survey area is located between Siberian massif and Sino-Korean massif, and severely folded Paleozoic formations of Silurian to Permian age with folding axis of E-W ~ NE-SW direction are widely distributed.

Geology of the survey area is divided into two blocks by the Central Mongolian Tectonic Line (CMTL) running E-W in the middle of the survey area. Northern block consists of crystalline basement rocks of Upper Proterozoic and various volcanic and intrusive rocks of Devonian to Cretaceous age and endowed a lot of mineral deposits. Whereas the southern block lacks crystalline basement rocks and geology of the Ulziit District is mainly composed of severely folded Paleozoic formations with E-W trending folding axis.

As for fault, E-W system is conspicuous which is parallel to CMTL and major folding axis, then NE-SW, NW-SE directions follow.

There exists spotted distribution of inland sedimentary basins caused by a Mesozoic tectonic movement on the folded Paleozoic basement rocks in the survey area. Inland sedimentary basins are filled with flat Jurassic to Cretaceous formations.

4-2 Characteristics of mineralization

There are lots of type of mineralizations in the Ulziit District, such as large scale quartz vein and silicified rock, with carbonatite-type rare earth metals deposit, fluorite deposit, pegmatite deposit and cupriferous skarn deposit.

Among them, quartz vein and silicified rock are distributed in the northern block of CMTL, forming a big gold mineralization area.

In Dugshih, Soirig and Sologoi areas of the Ulziit District crop out Mesozoic inland sedimentary basins associated with acidic volcanism of Jurassic to Cretaceous age. Along rim of the sedimentary basins, found are geothermal indications of old times such as massive silicified rocks and siliceous sinters.

Hydrothermal quartz vein, developed in the northern block of CMTL, shows cymoid-loop and arc shape or massive silicified rock in the Soirig and Sologoi areas.

Hydrothermal quartz veins which are found along the CMTL show chain structure of many quartz veins extending for 15 ~ 30 km along the fault line and they are found in Dugshih and Harmagtai North areas. Many of the hydrothermal quartz veins are scarce in sulfide minerals and country rock is folded Paleozoic formations.

Southern block of CMTL contains minor gold indication and main country rock is severely folded Paleozoic formations.

Vein-quality study revealed that most of quartz veins in Ulziit District is composed of homogeneous milky white quartz and generally is associated with very few accessory minerals such as calcite and adularia. Vein quartz contains, in very few occasion, pyrite at Olon Ovoot, Bayan Bor Nuruu and Hetsuu Tsagaan Tolgoi; green copper mineral at Olon Ovoot, Morit and Hhtul Us; galena at Bayan bor Nuruu and Ulziit Ovoo. Native gold was confirmed at Olon Ovoot and Horimt Hudag. Silver mineralization is weak in this district.

Homogenization temperature of fluid inclusions showed the following two types; one, temperature ranges from 250°C to 300°C found in Harmagtai North, Onh and Undor Uda areas and the other showed wider temperature range of 150°C to 350°C with plural mode of peaks as in the case of Olon Ovoot, Dugshih, Tsagaan Uula, Soirig and Sologoi areas. As a result of alteration study, it is found that sericite-quartz or sericite-chlorite alteration predominates in the Ulziit District quartz vein.

Massive silicified bodies and/or siliceous and calcareous sinters are also found along the margin of Mesozoic sedimentary basin.

4-3 Mineralization control

There is a special control of the hydrothermal mineralization in the survey area; that is CMTL zone and northern block of CMTL are endowed with mineralization whereas the southern block of CMTL is very weakly mineralized.

Hydrothermal quartz veins along CMTL were formed within crystalline schist and vein pattern shows linear chains. Type locality is found in the Harmagtai North area. A closer look of this type deposits disclose that mineralization occur within brecciated fault zone and adjacent anticlinal axis zone.

Hydrothermal quartz veins and massive silicified bodies, which are developed in the northern block of CMTL, are composed of plural quartz veins forming cymoid–loop structure or arcuated quartz veins and isolated massive silicified rocks of Mesozoic age. General pattern of its distribution is either circular or rectangular form.

Homogenization temperature of liquid inclusions reveals that bonanza of Olon Ovoot deposit shows 170°C ~ 250°C, low grade of surface indications in Dugshih and Onh deposits shows higher temperature, and quarts veins of Soirig, Sologoi, Harmagtai North etc. shows lower temperature than Olon Ovoot deposits.

Age determination adopting K–Ar method and alteration mineral study adjacent to vein revealed that large scale hydrothermal mineralization occurred at Permian age in Olon Ovoot, Onh and Harmagtai North areas and at Carboniferous age in Olon Ovoot area. Whereas in Sologoi area hydrothermal activity affecting Cretaceous rocks was recognized. Then the problem concerning the relationship between gold concentration and hydrothermal activities remains unsolved.

4-4 Mineral potential

4-4-1 Ulziit district (Recconaissance survey)

Geology of the district is composed of Upper Proterozoic, Paleozoic and Mesozoic formations with igneous rocks such as granite ~ diorite, monzonite, alkali ryolite and basalte of Late Proterozoic, Devonian ~ Permian, Late Jurassic ~ Early Cretaceous.

Accompanied with above mentioned igneous activities, there are found lots of mineralizations: carbonatite deposit containing REE at Mushgia Hudag, Sr deposit at Bayan Hoshoo, fluorite deposit at Bayan Ovoot, gold deposit at Olon Ovoot and many gold mineralizations at Dugshih, Onh, Bayan Bor Nuruu and others.

Among the mineralizations, Mushgia Hudag, Bayan Hoshoo and Bayan Ovoot areas were previously surveyed and appraisal of the deposit were finished already.

Survey of this year revealed a lot of large scale quartz vein zones at Sologoi, Soirig and Harmagtai North areas. Gold and silver content at the surface of these quartz veins were maximum 0.46 g/t of Au and 22 g/t of Ag which is rather low grade, but the following facts strongly suggest gold mineralization potential in the region; homogenization temperature of fluid inclusion shows below 250°C; sericite alteration zone predominates; vein–chracter is chalcednic milky quartz; broad distribution of hydrofracturings which imply boiling phenomena of solution.

Aside from that mentioned–above, there are various sinters suggesting surface deposition from solution at Sologoi area and massive silicified bodies formed near the earth surface in Sologoi, Soirig, Dugshih and Tsagaan Uula areas.

Total silica volume accumalated by the hydrothermal activity in the Ulziit District is as huge as over five hundred million tons, so large potential of gold mineralization can be expected in the district.

In conclusion, there exist high potential of blind gold deposits in these areas mentioned–

above and the most promising area among them is pyritized Sologoi area.

4-4-2 Semi-detailed survey area

As a result of this year's survey, it is found that the Olon Ovoot deposit is composed of "mesothermal" quartz veins with maximum width of 20 m × total extension of 1,000 m. Superimposing on this mineralized area, silicified and pyritized alteration zones of various epochs are developed with a size of maximum width 200 m × extention 2,000 m. Characteristic of the deposit is as follows: ① native gold in quartz vein is mainly found along fractures within milky quartz, ② altered country rock occationaly produces native gold with abundance to bear naked eye observation, ③ homogenization temperature of fluid inclusion ranges widely with five peaks of temperature, 170°C, 200°C, 260 ~ 270°C, 300°C and 360°C, respectively. The Olon Ovoot deposit is supposed to have been formed through plural mineralization events and concentration and accumulation of gold occurred throughout the process of earlier epoch of silicification-pyritization alteration till later epoch of hydrothermal mineralization. This implies that gold mineralization could be expected not only in quartz veins but also in the depth of silicified-pyritized alteration zone. The wider prospective area suggests a great increase of mineral potential of the deposit.

New discovery of quartz veins with hydrothermal alteration was made at the northwestern part of the survey area. Maximum 1.75 g/t of gold at surface was recognized there and homogenization temperature of fluid inclusion showed lower temperature. The new discovery area is worth while for further exploration work.

Geophysical prospection confirmed that high resistivity zone continues downward over 300 m distance near Tsagaan Tolgoi area. This leads to an assumption that quartz veins of Olon Ovoot deposit might continue downward over a distance of 300 m. Another high resistivity zone was found along the Olon Ovoot fault at 200 m depth which suggests an existence of quartz vein. In northeastern corner of geophysical survey area was found a large area of low resistivity zone with magnetic anomaly. Geologically this anomalous zone corresponds to upper limit of Silurian green schist and Devonian limestone. There is a possibility of existence of stratiform sulfide deposit with magnetite or skarn deposit.

4-4-3 Geochemical survey area

As a result of geochemical survey, gold concentration with an intensity of maximum 30 g/t ~ 50 g/t of gold was proved at the outcrop of the Olon Ovoot deposit. Adopting cut off grade of 0.5 g/t of gold, total area of 2,500 m^2 was calculated with an average grade of 3.2 g/t of gold.

4-4-4 Dornod district (Previous data analysis)

Geology of the Dornod District is composed of Upper Proterozoic, Paleozoic, Mesozoic and Ceozoic formations. Upper Proterozoic to Lower Paleozoic is composed of green to black colored metamorphic rocks of of marine shale origin. These rocks crop out in the northern part of the District with NE trending distribution. Paleozoic formations are Devonian greywacke and Permian formation which is mainly composed of acidic volcanic products. Devonian greywacke is distributed near Upper Proteozoic in the north and Permian formation is scattered in the central part of the Dornod District.

Mesozoic formation is composed of Triassic sedimentary rocks and intermediate to acidic volcanics of Jurassic to Early Cretaceous rocks, and is widely distributed in the central part of the District.

Associated with an intense volcanism of Mesozoic era, lots of mineralization such as polymetallic deposit, gold deposit and greisen type tin deposit occurred at Tsav, Ulaan, Muhol, Delger Munh, Salhiit, Bayan Uul and so forth.

As the central part of the District is covered widely with Mesozoic volcanic products and younger continental sediments, Bayandun–Ulaan–Bayan Uul volcanic area is a highly potential area for blind polymetallic deposits and gold deposits. Especially, high gravity anomalous zone at a periphery of volcanic depression of Mesozoic age is thought to be a promising area.

4-5 Geochemical anomaly and mineralization

4-5-1 Geochemical survey area

The geochemical survey was conducted on 2,076 rock samples, assaying two elements of gold and silver in the area of 1 km^2 where Olon Ovoot deposit is located in its center. The survey revealed that gold concentration of ore grade zone could be demarcated within an area of maximum width 20 m × extension 1,000 m around quartz vein of Tsagaan Tolgoi. Although assay grade fluctuates, maximum grade of gold shows 223 ppm and the area of ore block amounts to 2,500 m^2 with average gold content of 3.2 g/t. Revealing the characteristics of the Olon Ovoot deposit, Silver content is scarce with maximum value of 7.3 ppm and average of 0.13 ppm. Correlation between gold and silver contents is very weak.

4-5-2 Semidetailed survey area

The survey was conducted with a sampling of 500 rock specimen, assaying seven elements of Au, Ag, Hg, As, Sb, W and Mo.

Detecting limit of each element is as follows: Au 1 ppb, Ag 0.2 ppm, Hg 1 ppb, As 2 ppb, Sb 2 ppm, W 10 ppb and Mo 1 ppm.

As a result, gold anomalous value was found around the Olon Ovoot deposit and along the fault running NE–SW of the survey area and gold showed a weak correlation with molybdenite. It is also found that arsenic content is high at the southern part of the area as well as in a doughnut–shaped anomalous zone surrounding the Olon Ovoot deposit. Relationship between gold and other elements is not clear in the survey area.

Chapter 5 Conclusion and Recommendation

5-1 Conclusion

5-1-1 Ulziit District

1. Olon Ovoot deposit

   ① The Olon Ovoot deposit is auriferous quartz vein emplaced in Silurian sandstone–siltstone and diorite intruding them.

   ② Gold is concentrated in/around the quartz veins, and ore block calculated adopting 0.5 g/t of gold content as its cut off grade amounts to an area of 2,500 m^2 with average grade of 3.2 g/t of gold. Mineralized area could be expanded with a further detailed work to the adjacent area.

   ③ The result of geophysical survey suggested that quartz vein might continue up to a depth of 350 m from the surface.

   ④ Age determination using K–Ar method revealed that quartz vein of the Olon Ovoot deposit was formed in early Permian age.

   ⑤ Homogenization temperature of fluid inclusion shows that gold concentration occurred with a temperature ranging 170° to 250°C.

2. Semi–detailed geological survey and geophysical survey area

   ① A wide area of geophysical anomaly of low resistivity was found at the northeastern part of the survey area. This anomaly corresponds to a distribution of Devonian limestone with faults and igneous rocks. There may exist a skarn type deposit with sulfide minerals.

   ② A zone of quartz veins containing gold value of 1.75 g/t was confirmed in the northwestern part of the survey area. Homogenizing temperature of fluid inclusion of the quartz vein is rather low, therefore there is a chance of blind gold ore deposit.

   ③ Geophysical survey revealed that there exists a large scale of high resisitivity zone along the Olon Ovoot fault suggesting a presence of quartz veins.

3. Reconnaissance survey area

   A lot of big quartz veins and silicified rocks were confirmed at Soirig, Sologoi and Harmagtai North areas. Homogenization temperature of fluid inclusion in the area shows mostly below 200°C, suggesting that main gold mineralization might be concealed below the surface.

5-1-2 Dornod District

1. Previous data analysis

   ① Dornod District is endowed with a blind type polymetallic deposits.

   ② The area is covered with an extensive gravity survey done by U.S.S.R.

   The survey result is not obtainable yet. Reasonable survey planning could be made after getting the documents and analyzing them.

5-2 Recommendation to the 3rd year

It is recommended that the following work should be conducted in the 3rd year survey:

1. Drilling to confirm downward continuation of the Olon Ovoot deposit.

2. Drilling to verify the high resistivity anomaly found at the depth of Olon Ovoot fault zone.

3. Geophysical prospection adopting TEM method to confirm lateral extension of the low resistivity anomaly at NE part of the survey area.

4. Mineral indication survey covering whole the area and additional survey area extending towards east of this year's survey.

5. Geochemical survey to confirm an intensity of mineralization to the big quartz veins and silicified rocks at Soilig, Sologoi and North Harmagtai area.

6. Geophysical prospection adopting TEM method to check downward continuation to the area mentioned-above (5).

7. Geophysical prospection (TEM method) to confirm lateral continuation of the Olon Ovoot deposit.

8. Geochemical survey to the mineral indication found at North Olon Ovoot.

Part II PARTICULARS

Chapter 1　Reconnaissance Geological Survey

1-1　Purpose and method of the survey

Objective of the survey is to clarify nature and characteristic of the known gold mineralizations in the Ulziit District which were chosen by the first years survey and to give them mineral potential appraisal.

Geological reconnaissance survey was conducted covering an area of 12,180 km^2 of the Ulziit District paying special attention to nine mineralized areas to uncover characteristics of the mineralization. Survey contents are geological survey, description of location and size of a mineralized area, vein character survey, chemical analysis of the ore, alteration survey, measurement of homogenization temperature of fluid inclusions, age determination and so forth.

Using topographical maps, scale of 1:100,000, prepared by the Mongolian counterpart and equipment of measuring GPS (Global Positioning System), mineral indications in the survey area were plotted on the map and geologically described.

Ground truth was also conducted in comparison with interpretation of satellite image. For a basis of geology, interpretation maps of satellite image with a scale of 1:100,000 were used in the Olon Ovoot, Dugshih, Onh and North Harmagtai areas, whereas in the rest of the area the geological map with a scale of 1:1,000,000 issued jointly with Mongolia and U.S.S.R. was used in the field.

Field survey was conducted by dispatching five times caravan team preparing a base camp at Olon Ovoot. Field survey team is in principle composed of two engineers; one Japanese and one Mongolian counterpart.

Main tasks of survey team were geological checking, rock and ore sampling and positioning locations on the map.

As for samples to be taken, ore samples for assay were concentrated mainly to the most promising mineral indications which were big enough to warrant further advanced exploration work. Within the mineral indications, sampling space was designed to clarify concentration of gold and silver content, that is, closer spacing of sampling to the part of highly minerallized portions. For most of the veins, vein character are homogeneous and therefore sampling was conducted with equal intervals. Most of the samples for measuring homogenization temperature were also collected from the most promising mineral indications and at the same time samples were collected to cover entire Ulziit District to know the pattern of ore forming temperature.

Age determination was aimed for revealing mineralization age.

Size and number of mineral indications confirmed with this survey exceeded than those of initial plan, consequently sampling space remains wide.

Whole the mineral indications were plotted on the map using GPS, and some of the indications described in the documents were not found in the field.

1-2　Geology

The survey area is located in Paleozoic fold belt between Siberian massif and Sino-Korean massif.

Geology is composed of, in ascending order, Upper Proterozoic, Paleozoic and Mesozoic which deposited in inland sedimentary basins upon the former two geologic units.

These geological formations suffered orogenic movements such as Baikalian at Late Proteozoic, Caledonian at Early Paleozoic and Hercynian at Late Paleozoic and have been intruded by various intrusive rocks since Protenozic. Igneous activity continued till Mesozoic and volcanics and granitic rocks of late Jurassic to Cretaceous, Yenshanian Period, are widely distributed in the area. (Fig. II-1-1)

Upper Proteozoic ~ Cambrian formations are composed of gneiss, schist, crystalline limestone and gneissose granites which intruded the former rocks. Those formations crop out as a fenster in the northern part of the district.

Paleozoic formations of Silurian to Permian age are composed of folded sandstone, shale, limestone and intermediate to basic volcanic rocks and also of granites which intruded the rocks mentioned-above. Paleozoic formations cover extensively whole the Ulziit District.

Mesozoic formations are composed of Jurassic to Cretaceous sedimentary rocks which are partly associated with alkali volcanic rocks. Those Mesozoic formations were deposited in inland depressions caused by tectonic movement of Mesozoic age.

The Ulziit District is divided into two parts by the Central Mongolian Tectonic Line (CMTL) which runs E-W in the middle of the District. The northern part of CMTL contains crystalline basement of Upper Proteozoic to Lower Paleozoic and also volcanics and intrusives of Devonian to Cretaceous age, with a lot of hydrothermal quartz veins and silicified rocks. The southern part, on the contrary, lacks in crystalline basement rocks and is mainly composed of severely folded Paleozoic formations with E-W trending fold axes.

Major fault system in the District is E-W direction which is parallel to both CMTL and fold axis and subordinate fault systems are NE-SW and NW-SE. Tectonic movement at Mesozoic formed inland sedimentary basins filled with Jurassic to Cretaceous sediments.

Mineralization in the District are mainly hydrothermal quartz veins and silicified rocks formed at Permian and Jurassic to Cretaceous age. Big scale quartz veins and massive silicified rocks were encountered in Soirig, Sologoi and Harmagtai North areas.

Vein character survey revealed that the most of quartz veins are massive milky-white-colored quartz veins and are in general lacking in sulfide minerals, calcite, adularia and/or clay minerals and lacking in banded structures. Gold occurrences which is discernible by naked-eye observation are found at Hormit Hudag and Olon Ovoot in Olon Ovoot areas.

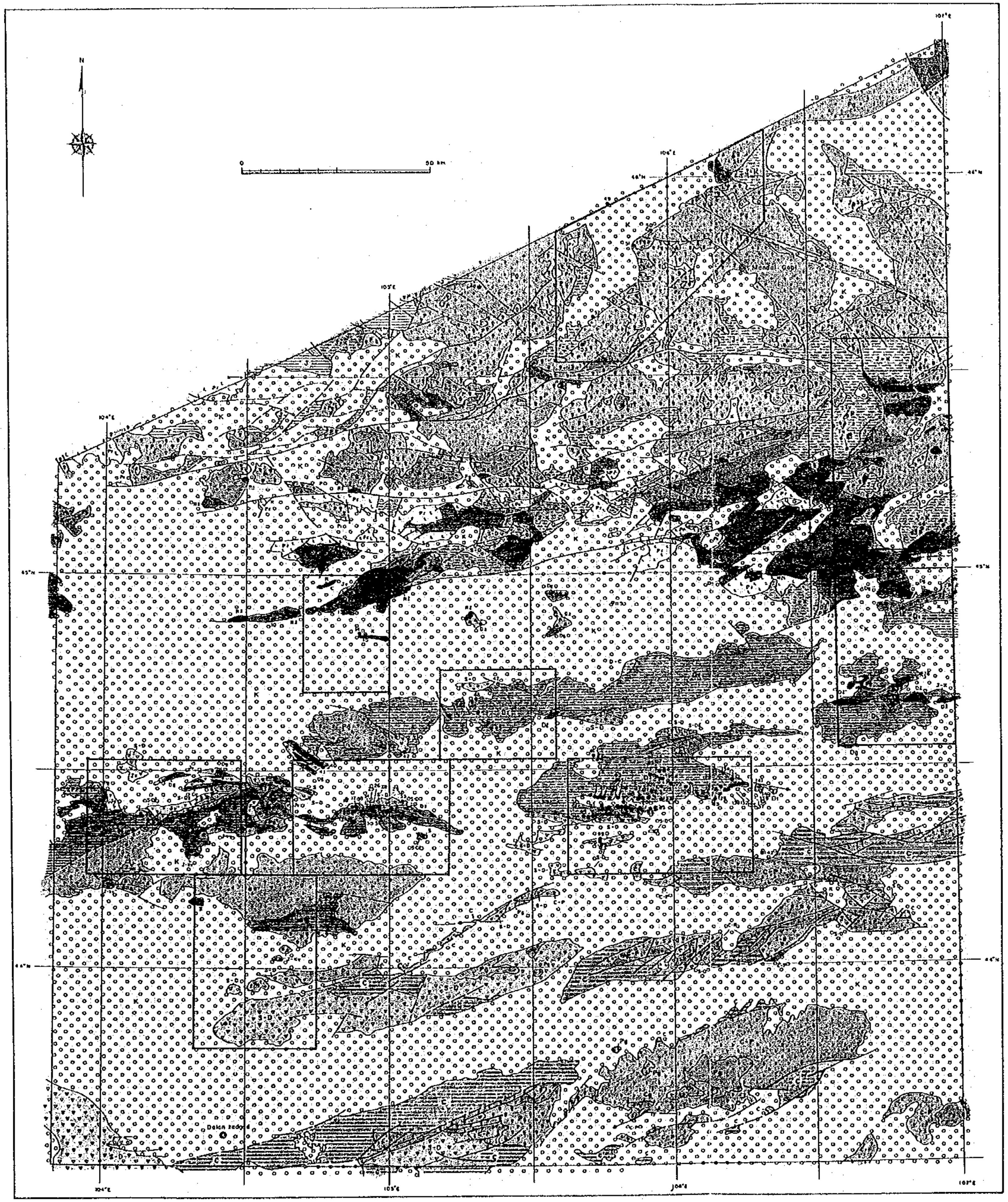
As a result of ore analysis of total 200 samples collected from nine mineralized areas, gold concentrations with a degree of 1 g/t of gold and above were found at the following localities: at Olon Ovoot North and Hormit Hudag in the Olon Ovoot areas, at a small indication in the Tahilga Uula area and at Zuun Hailhan Hul in the Tsagaan Hula area.

Homogenization temperature of fluid inclusion at gold concentrated part of Olon Ovoot and Hormit Hudag showed ranging from 140°C to 250°C. The temperature higher than 250°C predominates at the northern and eastern parts of Olon Ovoot area, at the eastern part of Tsagaan Uula, at the southeastern part of Onh and the central to western part of Dugshih area, whereas low temperature ranging from 120°C to 220 °C are observed in Soirig, Sologoi and North Harmagtai areas.

Alteration survey revealed that chlorite predominates at Olon Ovoot and Hormit Hudag whereas quartz and sericite dominate in the rest of the District. Kaolinite is partly found at Olon Ovoot, Horimt Hudag, Undur Uda and Delsen Us Hudag in Dugshih area. Pyrophyllite is found at Sologoi Bayan in Sologoi area.

Table II-1-1 Laboratory works of the reconnaissance geological survey

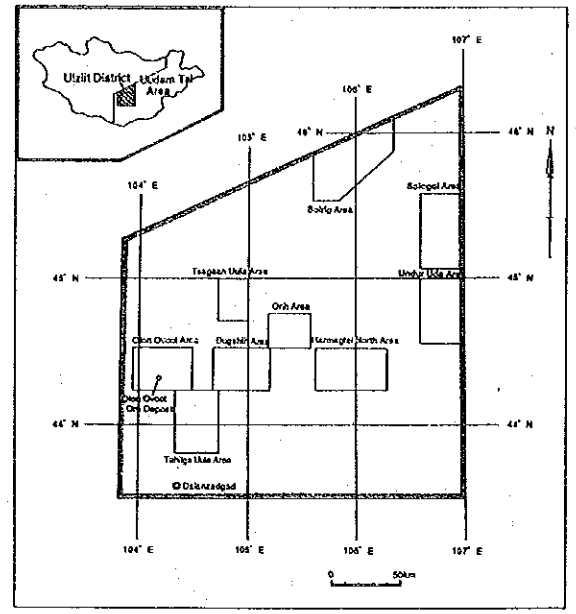
Area	Testing items							Note
	T	P	W	O	F	D	X	
Olon Ovoot	1	1	1	10	7	1	6	T : Thin section
Tahilga Uula	3	–	4	4	–	–	–	P : Polished section
Tsagaan Uula	2	–	2	12	2	–	8	W : Whole rock chemical analysis
Dugshih	3	2	7	32	16	–	20	O : Ore analysis
Onh	1	1	3	13	7	2	9	F : Fluid inclusion test
Soirig	3	1	7	20	9	2	4	D : Dating (K-Ar method)
Sologoi	3	3	13	55	14	2	15	X : X-ray diffraction test
Undur Uda	2	1	7	4	–	–	3	
North Harmagtai	2	1	6	50	19	1	35	
Total	20	10	50	200	74	8	100	



PL. II－1－1

MINERAL EXPLORATION
IN
THE UUDAM TAL AREA, MONGOLIA (PHASE II)

Geologic Map of the Ulziit District



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JANUARY 1993

LEGEND

Geologic Age	Geologic Unit	Symbol	Rock Types
Tertiary	Tv		olivine basalt, tuff
Cretaceous	K		sandstone, siltstone, conglomerate, limestone, coal
Jurassic-Cretaceous	J-K		conglomerate, siltstone, sandstone
	J-Kv		basalt, trachybasalt-trachyandesite, trachyte
Jurassic	J		conglomerate, siltstone, sandstone
	Jv		trachyte-dacite, trachyrhyolite
Permian	P		trachyte, andesite, trachyandesite, dacite, tuff
Carboniferous-Permian	C-P		basalt, trachyandesite, andesite, tuff, conglomerate
Carboniferous	C		sandstone, siltstone, conglomerate, mudstone
Devonian-Carboniferous	D-C		tuffaceous conglomerate, sandstone, siltstone
Devonian	Dl		limestone
	D2		basalt, trachybasalt, andesite, dacite, rhyolite, tuff
	D1		sandstone, shale, siltstone
Silurian-Devonian	S-Dl		limestone
	S-D		dacite, rhyolite, andesite, tuff
Silurian	S		sandstone, siltstone, shale, phyllite
Undifferentiated Paleozoic	PZ		sandstone, siltstone, clayey shale
Ripheian	Rl		limestone
	R		quartzite, phyllite, sandstone, gneiss, amphibolite
Intrusive Rocks	Pγ		granite, granosyenite
	Pr		rhyolite, rhyolitic breccia, quartz porphyry
	Dγ		granite, granodiorite

● ore showing

Symbol	Explanation
	unit name and boundary
	strike and dip direction
	anticline
	syncline
	fault
	inferred fault
	thrust fault

Fig. II-1- 1 Geologic map of the Ulziit district

1-3 Survey results

1-3-1 Olon Ovoot area

1. Geology

The area is located in the zone of Central Mongolian Tectonic Line and geology is composed of, in ascending order, Silurian (S_{1-2}), Devonian (D, D_1, D_2g), Carboniferous (C_{2-3}), Permian (Pg), Jurassic (J) and Cretaceous (K).

Among them Paleozoic formations crop out in the central part of the area as an uplifted block extending E-W to N70°E direction (Fig. II-1-2).

Silurian formation is composed of blue-grey colored sandstone, siltstone, greenschist, dark grey colored pelitic schist and limestone. Whole the rocks suffered a dynamic metamorphism causing severely folded and schistose structures. The formation is a country rock of the Olon Ovoot deposit.

Devonian formation (D, D_1) is composed of more than 50 m thick limestone bearing abundant crinoid fossils. The formation is also highly folded but structure is quite disharmonic with that of Silurian. Relationship between Silurian and Devonian is therefore thought to be an unconformity. In this surveyed area the Devonian lacks basal conglomerate and has sharp contact with the underlying Silurian formation.

D_2g is composed of graphic granite cropping out in the northeastern part of the area. K-Ar age determination showed 392 ± 75 Ma.

Permian (Pg) is composed of medium ~ coarse grained granodiorite and occupies a southern part of the area, forming a batholith. Age determination of the rock done by the previous year survey showed 292 ± 15 Ma adopting K-Ar method.

Jurassic formation (J) is composed of volcanic rocks such as lithoidite and basalt and crops out around uplifted Paleozoic blocks, forming the lowermost of Mesozoic formations.

Cretaceous formation (K) is composed of weakly solidified rocks of conglomerate, sandstone and mudstone. The formation is widely distributed in the northern half and the southeastern part of the area burying Mesozoic basin.

The area is characterized by abundant small intrusives of diorite to granodiorite.

2. Ore deposits and mineral indications

In this area there exist ore deposits such as Mushgia Hudag (REE), Bayan Hushuu (Sr) and Bayan Ovoot (Fluorite) and also the following gold mineral indications; Olon Ovoot, Horimt Hudag, Unegt Uul etc. The survey was conducted paying special attention to make an appraisal of gold mineralization in the area.

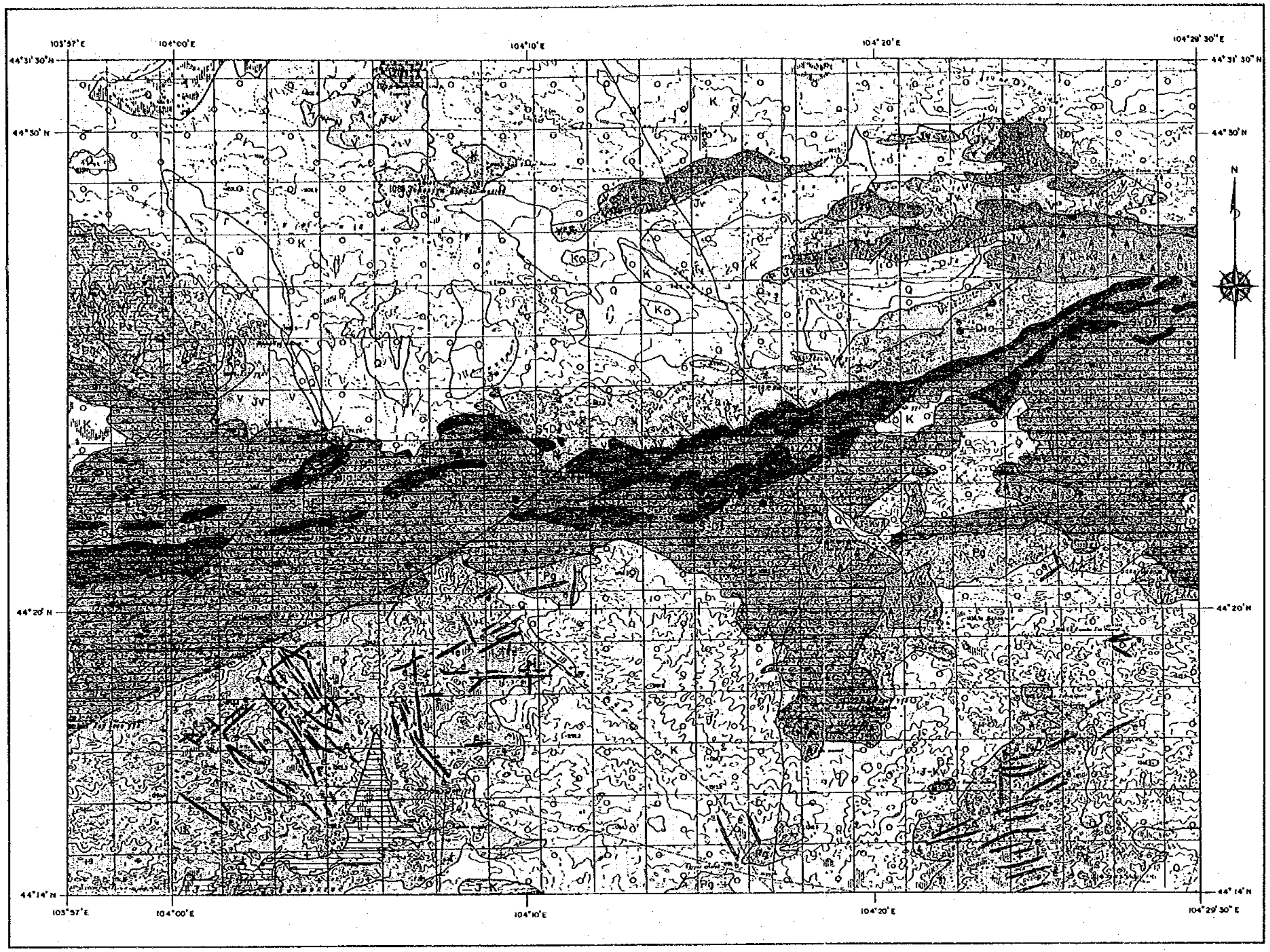
Gold mineralization of the area shows milky white quartz veins within uplifted blocks of Paleozoic formations. Most of the quartz veins extend E-W direction.

Homogenization temperature of fluid inclusions of quartz veins shows 230° ~ 370°C at Unegt Uul and to the north and the east of Olon Ovoot and 100° ~ 230°C to the west of North Olon Ovoot and at Hormit Hudag.

Alteration of the area is dominated by quartz-chlorite facies and partly chlorite-sericite facies. Kaolinite is found at Olon Ovoot and Hormit Hudag.

Assay results of 10 samples show maximum gold value of 16.58 g/t and silver 1.8 g/t. The most conspicuous gold concentration is found at North Olon Ovoot and Hormit Hudag.

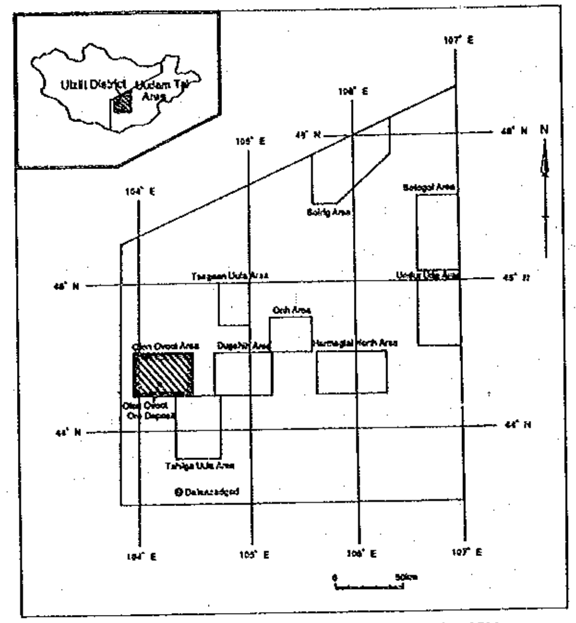
The results of the Survey are summarized in the Table II-1-2.



PL. II – 1 – 2

MINERAL EXPLORATION
IN
THE UUDAM TAL AREA, MONGOLIA (PHASE II)

Geologic Map of the Olon Ovoot Area



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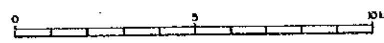

LEGEND

Geologic Age	Geologic Unit	Symbol	Rock Types
Quaternary	Q		sand, gravel, loam
Tertiary	Tv		olivine basalt
Cretaceous	K		sandstone, siltstone, conglomerate, limestone, coal
Jurassic-Cretaceous	J-K		conglomerate, siltstone, sandstone
	J-Kv		basalt, trachybasalt-trachyandesite, trachyte
Jurassic	J		conglomerate, siltstone, sandstone
	Jv		trachyte-dacite, trachyrhyolite
Permian	P		trachyte, andesite, trachyandesite, dacite, tuff
Carboniferous-Permian	C-P		basalt, trachyandesite, andesite, tuff, conglomerate
Carboniferous	C		sandstone, siltstone, conglomerate, mudstone
Devonian-Carboniferous	D-C		tuffaceous conglomerate, sandstone, siltstone
Devonian	D2*l*		limestone
	D2		basalt, trachybasalt, andesite, dacite, rhyolite, tuff
	D1*l*		limestone
	D1b		sandstone, shale, siltstone
	D1a		shale, siltstone, sandstone

Silurian-Devonian	S-D*l*		limestone
	S-D		dacite, rhyolite, andesite, tuff, phyllite, shale
Silurian	S		sandstone, siltstone, shale, phyllite
Undifferentiated Paleozoic	PZ		sandstone, siltstone, clayey shale
Ripheian	R*l*		recrystallized limestone
	R2		quartzite, phyllite, siltstone, sandstone, amphibolite
	R1-2		shale, amphibolite, quartzite, phyllite, gneiss
Intrusive Rocks	e		granodiorite porphyry
	d		diorite, microdiorite, diorite porphyry
	Pg		granite, granosyenite
	Pr		rhyolite, quartz porphyry
	C-Pg		granite, granodiorite, granosyenite, diorite
	D2g		granite, granodiorite
	D2d		diorite, gabbro
	D1r		rhyolite, dacite

● ore showing

K	unit name and boundary
	strike and dip directon
	anticline
	syncline
	fault
	inferred fault
	thrust fault

Fig. II-1- 2 Geologic map of the Olon Ovoot area

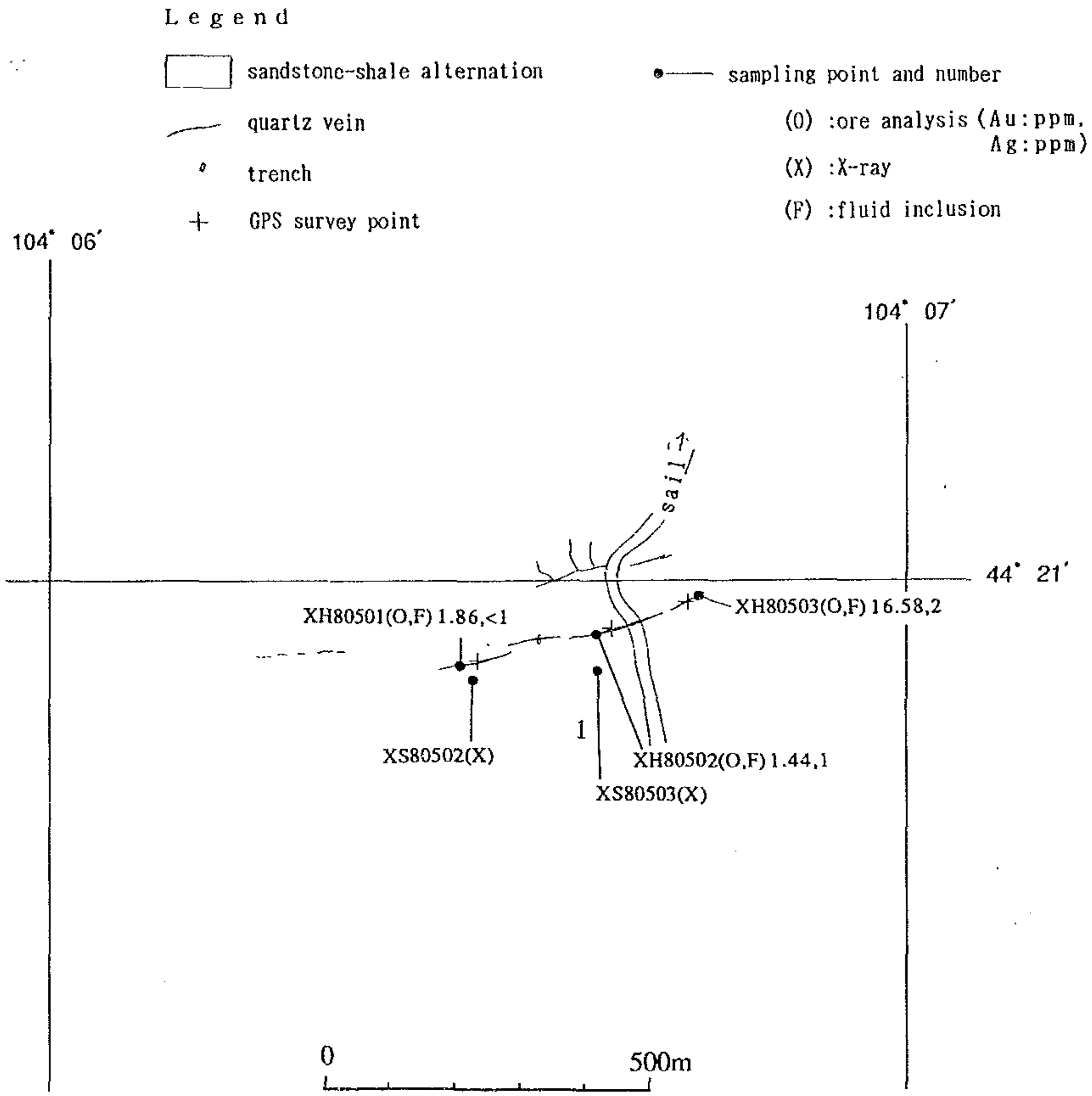


Fig. II-1- 3 Geologic map of ore-showing No. 1 (Horimt Hudag)

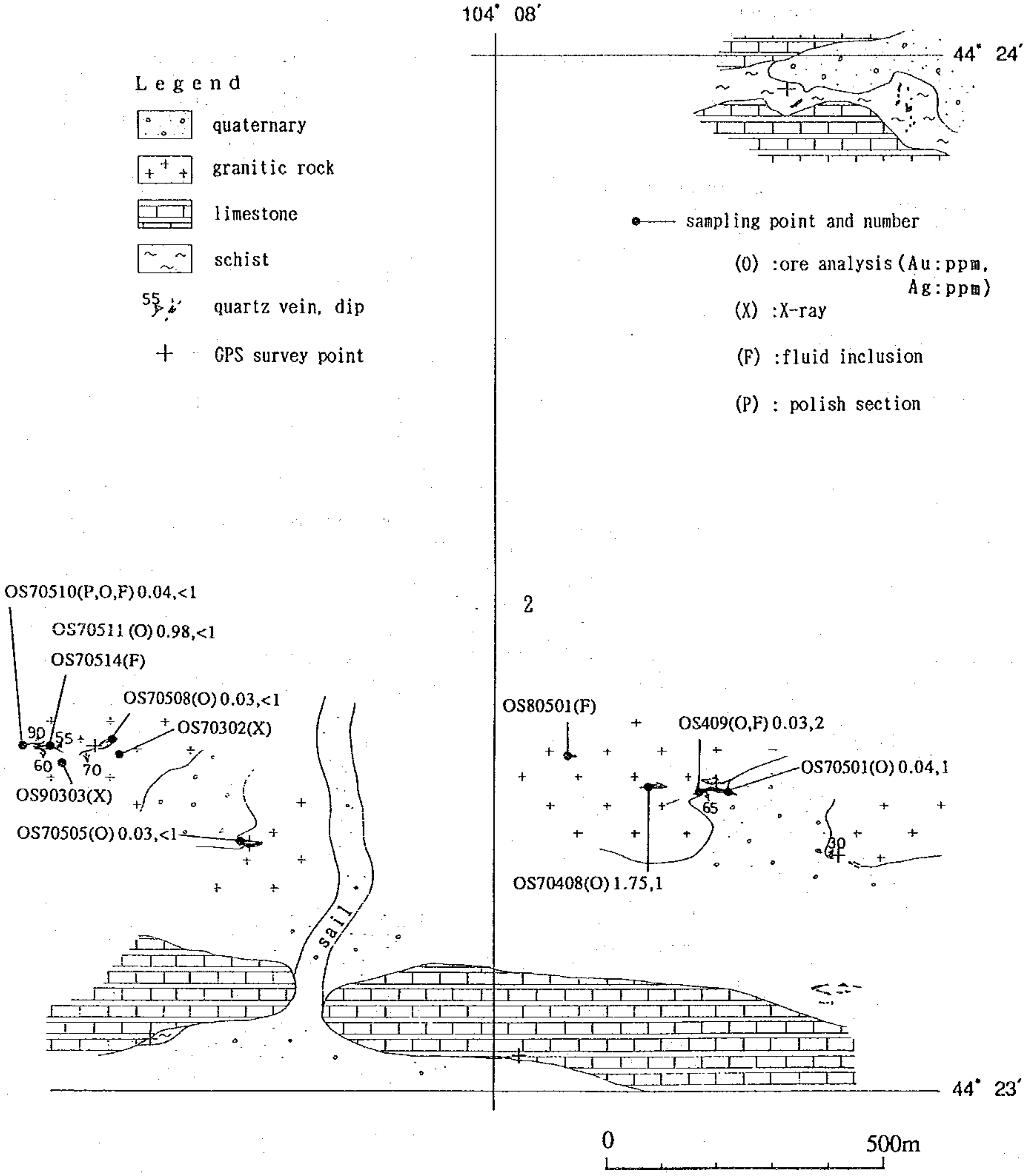


Fig. II-1- 4 Geologic map of ore-shoing No. 2 (North Olon Ovoot)

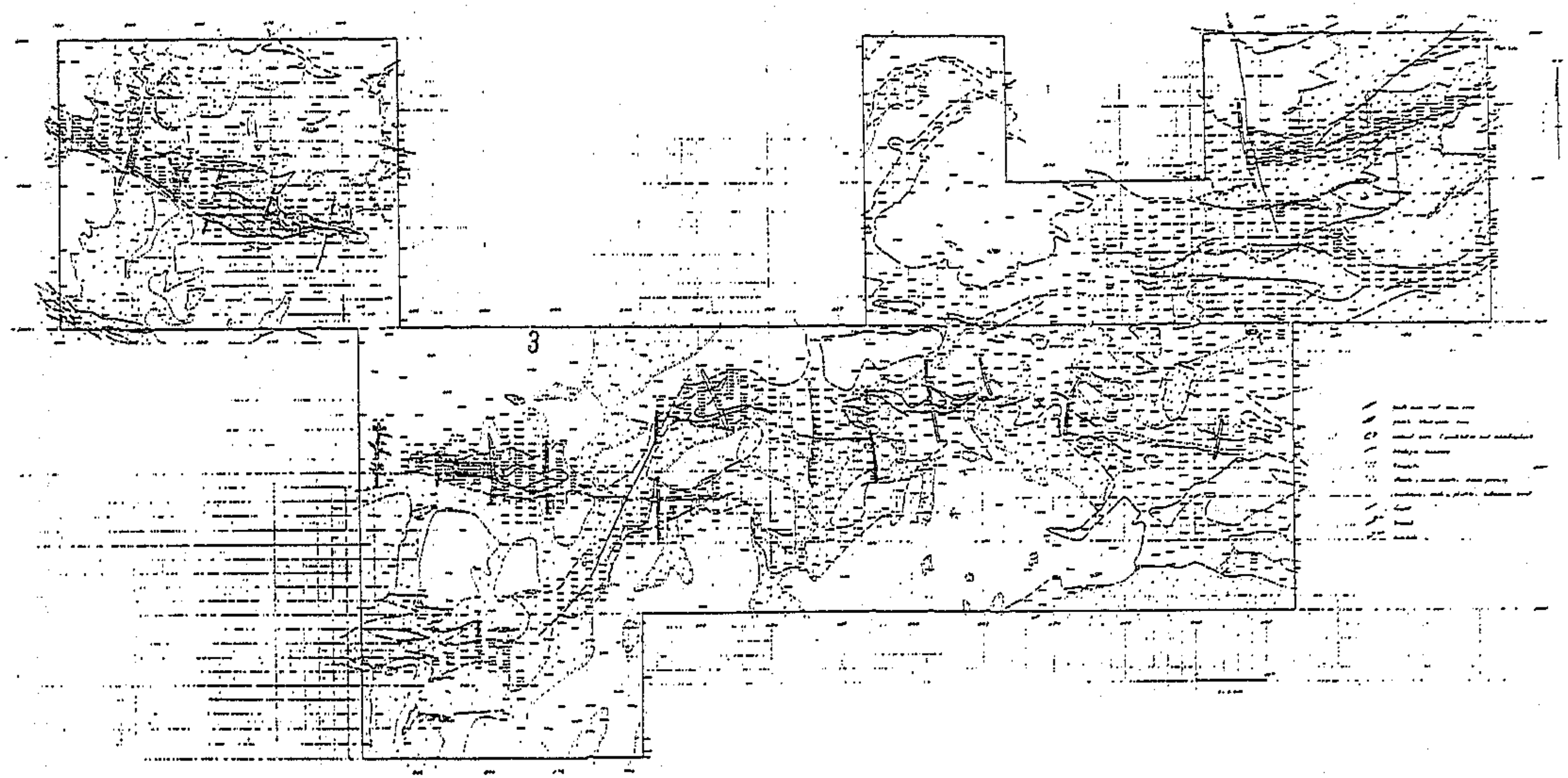


Fig. II-1- 5 Geologic map of ore-showing No. 3 (Olon Ovoot)

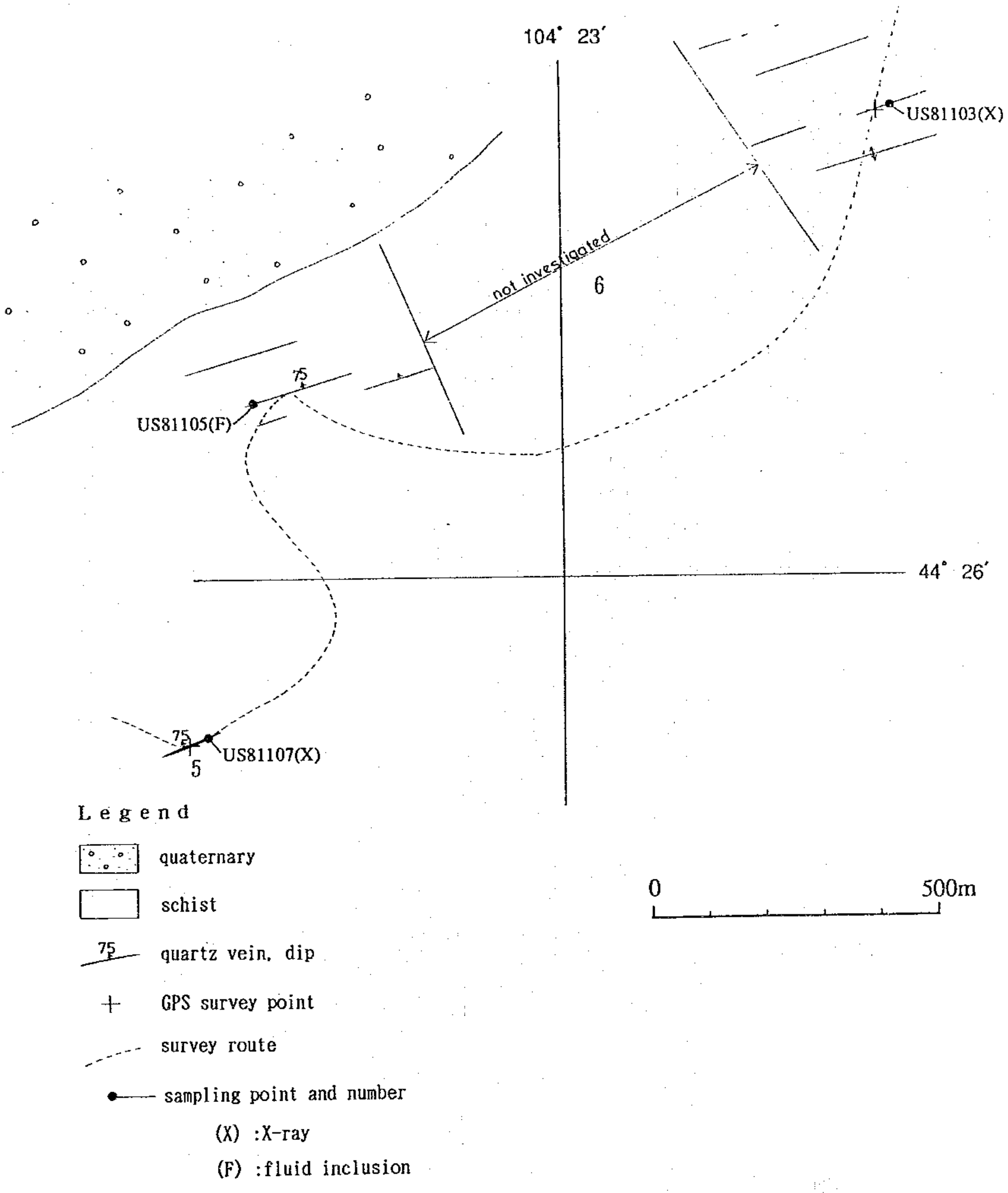


Fig. Ⅱ-1- 6 Geologic map of ore-showings No. 5, No. 6 (Unegt Uul)

Table Ⅱ-1- 2 Ore-showings in the Olon Ovoot area

No.	Name of deposit	Mineral	Type of Deposit	Coodinate		Characteristics and Size	Host Rock	Assay			Filling	Alteration	Note
				Longitude	Latitude			Au(g/t)	Ag(g/t)	pcs	Temp ℃	type	
1	Horimt Hudag	Au	Qz-v	104°05′40″	44°20′58″	parallel quartz veins unit vein size Max. 2m×200 m Seven major veins are known within four mineralized zones. vein zone: 200m×1,200 m Vein quartz is characterized by coarse grained comb quartz and semi-transparent quartz.	siltstone, sandstone of S_{1-2} Mandal Ovoo F.	1.44 ~ 16.58	0.6 ~ 1.7	3	138 ~232	Qz-ka-Ser py	Strike: E-W ~N80°E. dip : 60°~80°N discocery: 1979-1982 Three trenches and two drillings were done. Small diorite rock bodies are seen around the veins. Visible gold occurs.
2	North Olon Ovoot	Au	Qz-v	104°08′03″	44°23′18″	nine quartz veins scattered in the area of 2km ×0.5km unit vein size Max. 12 m×30m Vein quartz is characterized by chalcedonic~tourmaline-bearing milky quartz.	siltstone, sandstone of S_{1-2} Mandal Ovoo F.	0.30 ~ 1.75	0.4 ~ 1.9	7	102 ~323	Qz-chl	Strike: E-W ~N80°E. dip : 60°~80°N reen copper pccurs
3	Olon Ovoot	Au	Qz-v	104°09′42″	44°22′21″	consists of six major quartz vein zones scattered in the area of 1km×0.4km Vein quartz is characterized by semi-transparent ~milky quartz. Pyritization is commonly seen in the wall rocks. Many diorite~granodiorite rock bodies are seen around.	siltstone, sandstone of S_{1-2} Mandal Ovoo F.	up to 223g/t	up to 7.2g/t M<0.2	2.500	148 ~356 Av=256℃	Qz-chl, Qz-ser-chl	Strike: N60°W-E-W ~N80°E dip : steeply dipping to north or south discovery: 1990 twenty eight trenches and several drillings were done by Geology company. visible gold occures K-Ar age of sericite: 283 ±14 Ma, 301±15 Ma
4	Boroodon	Au	Qz-v	104°16′49″	44°22′16″	single quartz vein vein size Max. 1.5 m×40 m Vein quartz is characterized by chalcedonic milky quartz.	siltstone, sandstone of S_{1-2} Mandal Ovoo F.	–	–	–	–	(Qz-chl)	Strike: N55°E. dip : 55°S discovery: 1979-1982
5	Unegt Uul West	Au	Qz-v	104°22′31″	44°25′51″	single quartz vein vein size Max. 4 m×100 m unit vein size Max. 12 m×30m milky white mono quartz. no sulfide(segregation vein?)	dark gray phyllite S_{1-2} Mandal Ovoo F.	–	–	–	–	(Qz-ser)	Strike: N70°E. dip: 75°N
6	Unegt Uul	Au	Qz-v	104°23′25″	44°26′26″	more than eight parallel quartz veins are distributed in the area of 1.2km×0.2km . Vein quartz is characterized by milky white compact mono-quartz very poor in sulfide.	carbonaceous pelitic schst S_{1-2} Mandal Ovoo F.	–	–	–	228 ~368 Av=285	Qz-ser	Strike: N75°~80°E. dip: 75°N-90°

1-3-2 Tahilga Uula area

1. Geology (Ref. Fig. II-1-7)

The survey area is located in the southern side of CMTL and geology is composed of, in ascending order, Silurian (S), Siluro-Devonian (S-D), Permian (P, Pg), Jurassic-Cretaceous (J-K) and Cretaceous (K) formations. Paleozoic formations crop out in the centeral part of the area forming an uplifted block with E-W extention.

Silurian (S) crops out in the northern part of the area and was intruded by Permian granite (Pg).

Silurian is composed of blue-grey colored sandstone, siltstone and limestone, and suffered a dynamic metamorphism producing severely folded schistose rocks with E-W trending fold axes.

Siluro-Devonian (S-D) was also intruded by Permian granite (Pg) and occupies a south-eastern part of the area. This formation is folded and composed of blue-grey colored sandy and silty schists.

Permian (P) crops out in the northern part of the area. The formation is folded and composed of blue-grey colored sandstone, siltstone and dark grey colored pelitic schist. Andesite dikes intruded them.

Permian (Pg) occupies the northern part of the area as a batholith and also crops out in the centeral part of the area as a small exposure. It is pinkish to grey white, medium to coarse-grained hornblende-biotite granite which was intruded by fine-grained diorite dikes with N15°W and E-W trend in the northern part of the area.

Jurassic to Cretaceous (J-K) shows a small exposure in the centeral part of the area as a grey colored alkali rhyolite lava dome which is slightly dissected.

Cretaceous formation (K) is composed of weakly solidified conglomerate, sandstone and mudstone. The formation is distributed in the centeral to southwestern part of the area, burying Mesozoic sedimentary basin and forming flat topography.

2. Ore deposits and mineral indications

Main mineral indication in the area is quartz veins. Maximum assay value of 1.7 g/t of gold is found but in general mineralization and alteration are weak and of a small scale.

The results of the survey are shown in the Table II-1-3.

1-3-3 Tsagaan Uula area

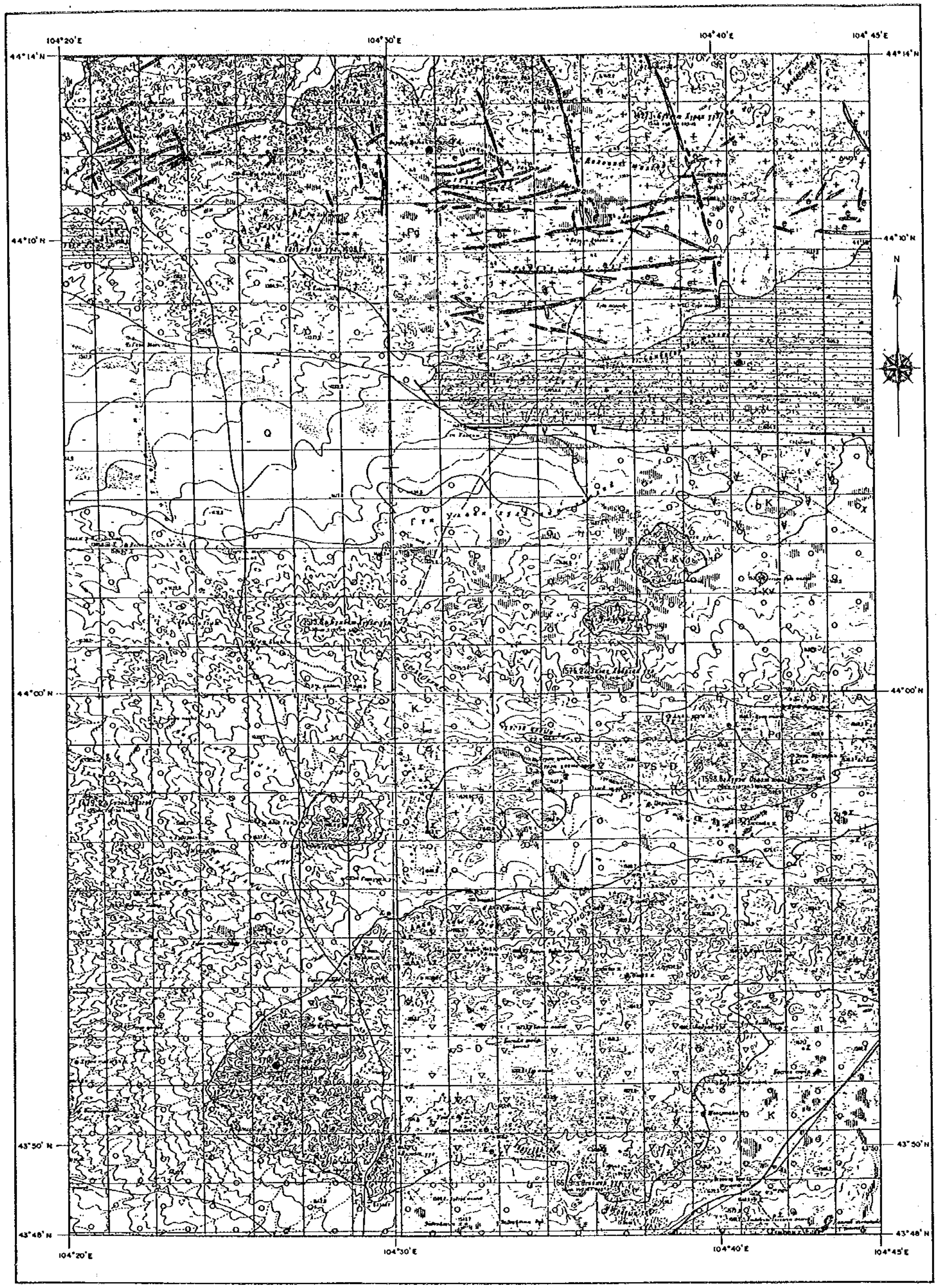
1. Geology (Ref. Fig. II-1-8)

The area is located in the northern part of CMTL. Geology of the area is composed of, in ascending order, Lower-Middle Proterozoic (PR_{1-2}), Upper Proterozoic (PR_2), Devonian (D_2g), Jurassic (J) and Cretaceous (K). Among them, Devonian and lower formations crop out in the northeastern and in the east-central parts of the area forming uplifted elongate blocks with directions of E-W ~ N70°E.

Lower-Middle Proterozoic (PR_{1-2}) crops out in the northeastern and east-central parts of the area. The formation is composed of crystalline schists derived from sandstone, siltstone, mudstone and limestone.

Upper Proterozoic (PR_2) crops out in the northeastern part of the area, surrounding PR_{1-2}. The formation is composed of crystalline schists derived from limestone, sandstone, siltstone and pelitic rock.

Devonian (D_2g) is made of medium-grained granodiorite which crops out in the northeastern part of the area intruding PR_{1-2} and PR_2.



LEGEND

Geologic Age	Geologic Unit	Symbol	Rock Types
Quaternary	Q		sand, gravel, loam
Tertiary	Tv		olivine basalt
Cretaceous	K		sandstone, siltstone, conglomerate, limestone, coal
Jurassic-Cretaceous	J-K		conglomerate, siltstone, sandstone
	J-Kv		basalt, trachybasalt-trachyandesite, trachyte
Jurassic	J		conglomerate, siltstone, sandstone
	Jv		trachyte-dacite, trachyrhyolite
Permian	P		trachyte, andesite, trachyandesite, dacite, tuff
Carboniferous-Permian	C-P		basalt, trachyandesite, andesite, tuff, conglomerate
Carboniferous	C		sandstone, siltstone, conglomerate, mudstone
Devonian-Carboniferous	D-C		tuffaceous conglomerate, sandstone, siltstone
Devonian	D2l		limestone
	D2		basalt, trachybasalt, andesite, dacite, rhyolite, tuff
	D1l		limestone
	D1b		sandstone, shale, siltstone
	D1a		shale, siltstone, sandstone
Silurian-Devonian	S-Dl		limestone
	S-D		dacite, rhyolite, andesite, tuff, phyllite, shale
Silurian	S		sandstone, siltstone, shale, phyllite
Undifferentiated Paleozoic	PZ		sandstone, siltstone, clayey shale
Ripheian	Rl		recrystallized limestone
	R2		quartzite, phyllite, siltstone, sandstone, amphibolite
	R1-2		shale, amphibolite, quartzite, phyllite, gneiss
Intrusive Rocks	e		granodiorite porphyry
	d		diorite, microdiorite, diorite porphyry
	Pg		granite, granosyenite
	Pr		rhyolite, quartz porphyry
	C-Pg		granite, granodiorite, granosyenite, diorite
	D2g		granite, granodiorite
	D2d		diorite, gabbro
	D1r		rhyolite, dacite

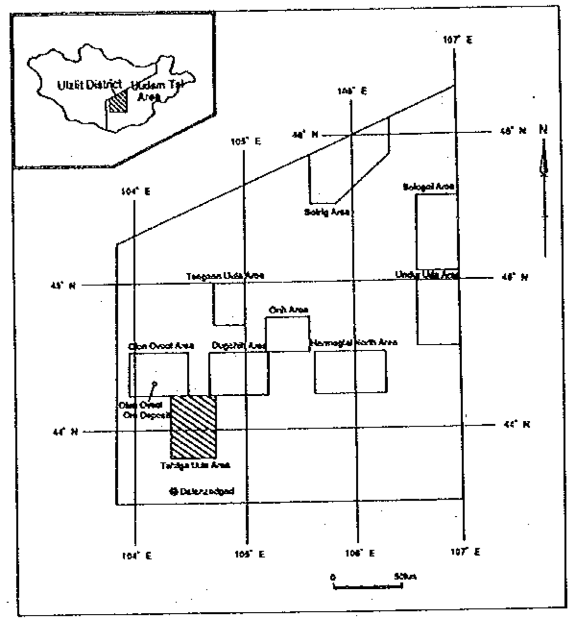
● ore showing

K	unit name and boundary
	strike and dip directon
	anticline
	syncline
	fault
	inferred fault
	thrust fault

PL. II－1－3

MINERAL EXPLORATION
IN
THE UUDAM TAL AREA, MONGOLIA (PHASE II)

Geologic Map of the Tahilga Uula Area



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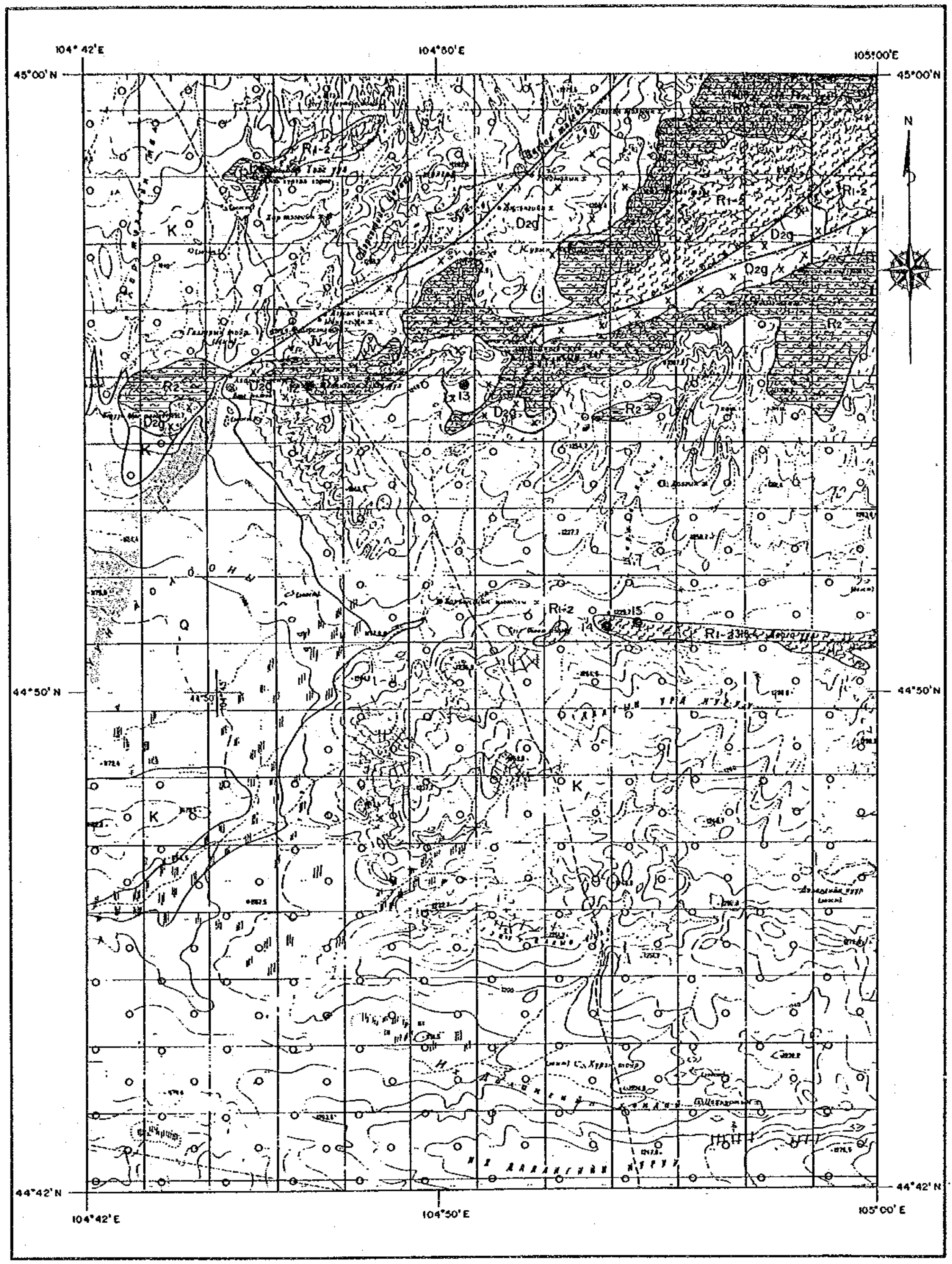
0 5 10km

Fig. II-1- 7 Geologic map of the Tahilga Uula area

Table Ⅱ-1-3 Ore-showings in the Tahilga Uula area

No.	Name of deposit	Mineral	Type of Deposit	Coodinate		Characteristics and Size	Host Rock	Assay			Filling Temp ℃	Alteration type	Note
				Longitude	Latitude			Au(g/t)	Ag(g/t)	pcs			
7		Au	Qz-v	104°26′23″	43°51′43″	small quartz veins vein size Max. 0.15m×15m Some veinlets are sporadically seen in the area of 30m×300 m. Vein quartz is characterized by chalcedonic milky quartz very poor in sulfide.	siltstone, sandstone (C_3-P_1)	0.04 ~ 3.29	0.4 ~ 1.1	2	–	(Qz-ser-chl)	strike: N5°E dip : 40°E Very poor in quartz vein and wall rock alteration.
8		–	Qz-v pegmatite	104°31′21″	44°11′58″	aplite dike cut by the veinlets of pegmatitic quartz. size of dike Max. 20 m×100 m	granite (C_{2-3})	–	–	–	–	(K-fel)	strike: N-S *dip : vertical?* No value for exploration
9		Au	Qz-v	104°40′52″	44°07′14″	single mono quartz vein size of the vein: 0.4 m×40m silicified zone:Max. 2 m×40m wall rock alteration is very small and weak.	dark gray schist(D_1)	–	–	–	–	Silicification	strike: N30°E dip: 65°W No value for exploration



LEGEND

Geologic Age	Geologic Unit	Symbol	Rock Types
Quaternary	Q		sand, gravel, loam
Tertiary	Tv		olivine basalt
Cretaceous	K		sandstone, siltstone, conglomerate, limestone, coal
Jurassic-Cretaceous	J-K		conglomerate, siltstone, sandstone
	J-Kv		basalt, trachybasalt-trachyandesite, trachyte
Jurassic	J		conglomerate, siltstone, sandstone
	Jv		trachyte-dacite, trachyrhyolite
Permian	P		trachyte, andesite, trachyandesite, dacite, tuff
Carboniferous-Permian	C-P		basalt, trachyandesite, andesite, tuff, conglomerate
Carboniferous	C		sandstone, siltstone, conglomerate, mudstone
Devonian-Carboniferous	D-C		tuffaceous conglomerate, sandstone, siltstone
Devonian	D2ℓ		limestone
	D2		basalt, trachybasalt, andesite, dacite, rhyolite, tuff
	D1ℓ		limestone
	D1b		sandstone, shale, siltstone
	D1a		shale, siltstone, sandstone
Silurian-Devonian	S-Dℓ		limestone
	S-D		dacite, rhyolite, andesite, tuff, phyllite, shale
Silurian	S		sandstone, siltstone, shale, phyllite
Undifferentiated Paleozoic	PZ		sandstone, siltstone, clayey shale
Ripheian	Rℓ		recrystallized limestone
	R2		quartzite, phyllite, siltstone, sandstone, amphibolite
	R1-2		shale, amphibolite, quartzite, phyllite, gneiss
Intrusive Rocks	e		granodiorite porphyry
	d		diorite, microdiorite, diorite porphyry
	Pg		granite, granosyenite
	Pr		rhyolite, quartz porphyry
	C-Pg		granite, granodiorite, granosyenite, diorite
	D2g		granite, granodiorite
	D2d		diorite, gabbro
	D1r		rhyolite, dacite

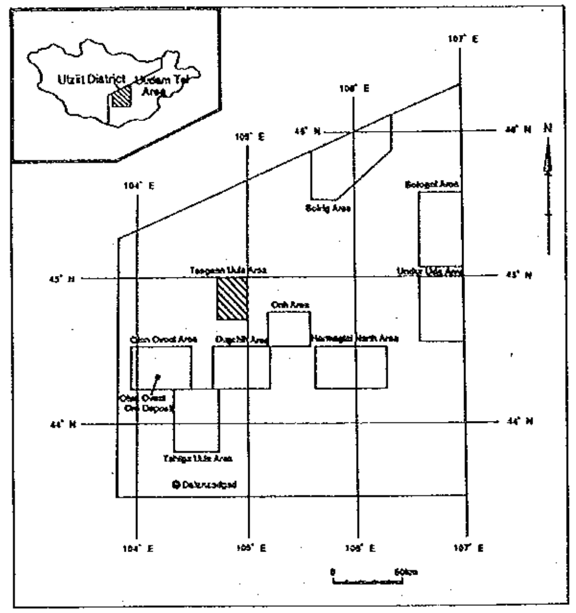
● ore showing

Symbol	Explanation
K	unit name and boundary
	strike and dip directon
	anticline
	syncline
	fault
	inferred fault
	thrust fault

PL. II－1－4

MINERAL EXPLORATION
IN
THE UUDAM TAL AREA, MONGOLIA (PHASE II)

Geologic Map of the Tsagaan Uula Area



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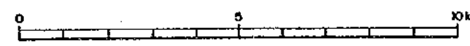


Fig. II-1- 8 Geologic map of the Tsagaan Uula area

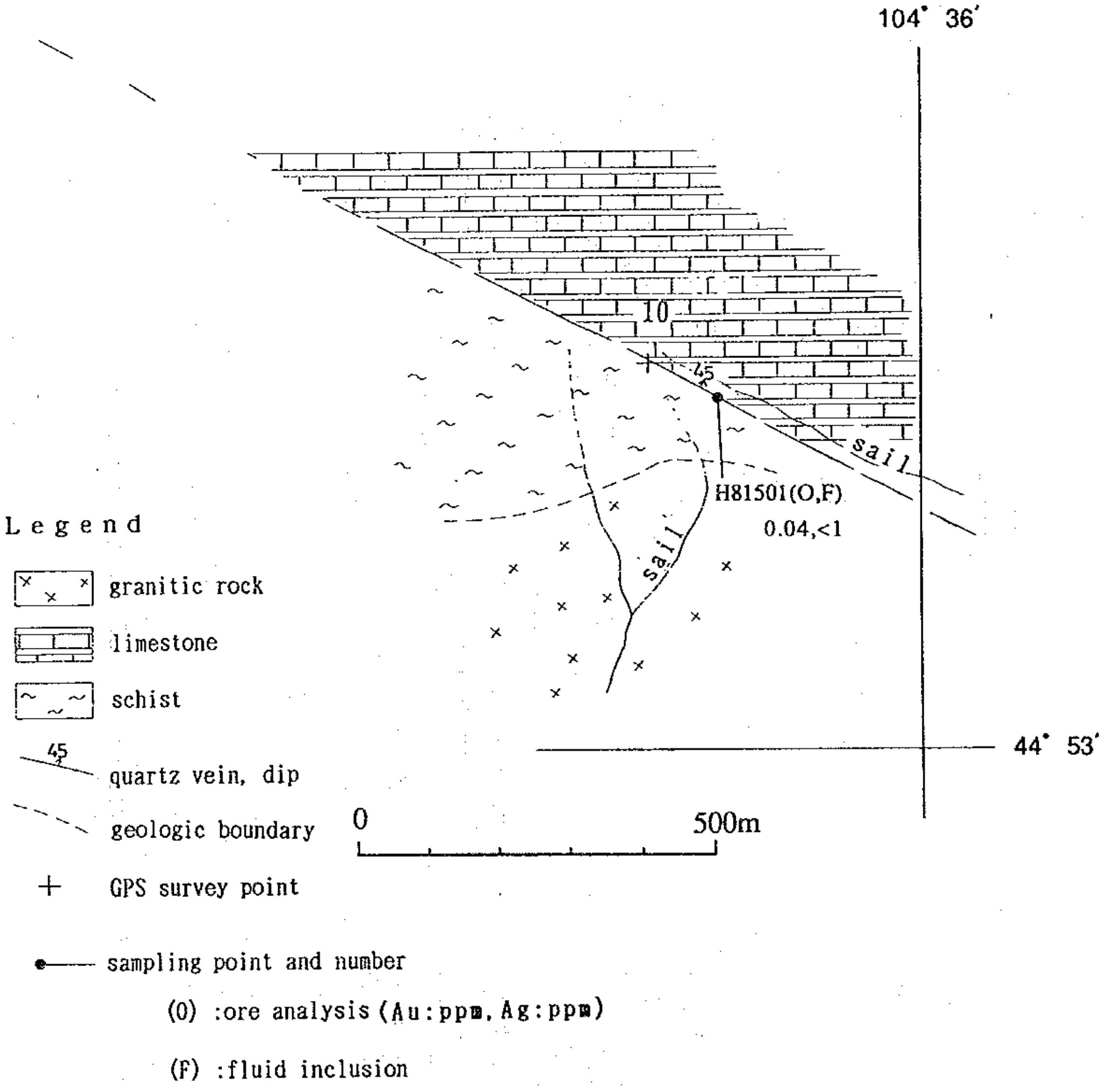


Fig. Ⅱ-1- 9 Geologic map of ore-showing No. 10

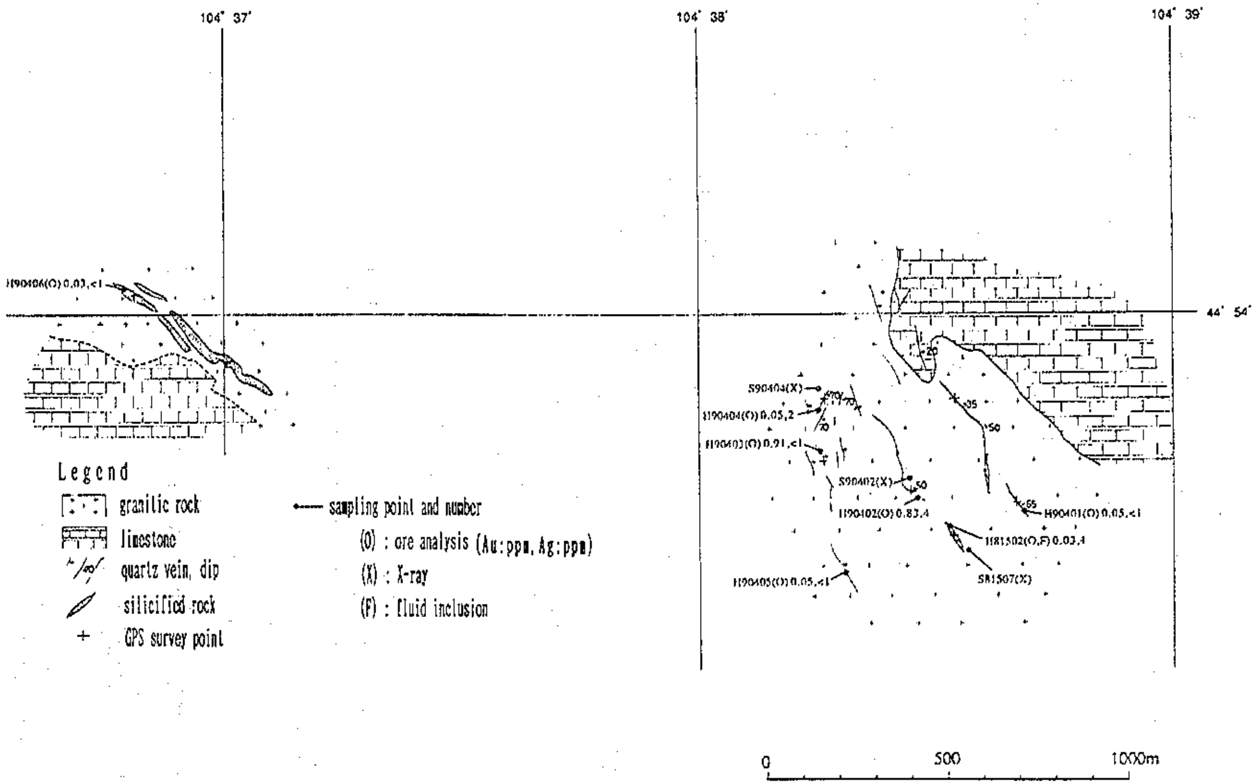


Fig. II-1-10 Geologic map of ore-showing No. 11

Table II-1-4 Ore-showings in the Tsagaan Uula area

No.	Name of deposit	Mineral	Type of Deposit	Coodinate Longitude	Coodinate Latitude	Characteristics and Size	Host Rock	Assay Au(g/t)	Assay Ag(g/t)	Assay pcs	Filling Temp ℃	Alteration type	Remarks
10	Zuun hailhan Uul	Au	Qz-v	104°35′44″	44°53′18″	single quartz vein vein size Max. 4.5 m×1500m Vein quartz is characterized by chalcedonic milky quartz.	limestone, siltstone of Yendian-Cambrian	0.04	0.8	1	–	Qz-cal	Strike: N60°W, dip: 45°N emplaced in the fault
11	Nutuliin Tol-goi	Au	Qz-v	104°38′32″ ~ 104°36′49″	44°53′40″ ~ 44°54′02″	quartz vein swarm vein size Max. 20 m×450 m vein zone 500 m×2,600 m milky white mono quartz	phyllite, limestone, granite (Y-C)	0.03 ~ 0.91	0.4 ~ 3.8	7	98~150 Av. 118	Qz-ser	Strike: N30°-45°W, dip: 50°-70°NE
12	Nakangiin Hur-en Uul	Au	Qz-v	104°47′08″	44°55′00″	Four milky mono quartz veins are aligned along the boundary between limestone and granite. vein size Max. 6m×60 m length of vein zone 350 m	granite and limestone	0.03	3.2	1	–	Qz-pl-K-fel-ser	Strike: N35°W, dip: 50°NE
13	Daaga Uul	Au	Qz-v	104°50′41″	44°55′00″	About twelve quartz veins are distributed in the area of 200 m× 300m. Milky white vein quartz is disseminated by small amount of galena.	limestone and schist	0.06	0.9	1	259~298 Av. 276	Qz-chl-cal	Strike: NS-N60°E, dip: 30°NW-50°SE
14		Au	Qz-v	104°53′50″	44°51′07″	stockwork of milky white quartz veinlets vein size Max. 2m× 40 m stock work: 30m×70m	pelitic schist	0.04	0.6	1	–	Qz-pl-ser-cal	Strike: N80°E, dip: 90° (champion vein)
15		Au	Qz-v	104°54′32″	44°51′10″	four parallel quartz veins are seen in the area of 100 m× 100 m vein size Max. 6 m×30m Veins are characterized by milky white mono quartz and development of hydro-fracturing.	limestone.	0.03	0.6	1	–	Qz-Ser-chl	Strike: N80°E, dip: 90°? This area is mostly covered by aluvial deposit.

Jurassic (J) is porous basaltic andesite lava which has a small exposure at the north of Mt. Makangiin hairhan in the northern part of the area.

Cretaceous (K) is composed of weakly consolidated rocks of conglomerate, sandstone and mudstone. The formation crops out in the major parts of the southern and the western parts of the area, burying Mesozoic sedimentary basins.

2. Ore deposits and mineral indications

Mineral indications of quartz veins are found in the uplifted basement blocks of Proterozoic rocks. Vein system of the quartz vein is classified into three; NW system such as Hutuliin Toigoi and Zuun hairhan Uul, E–W system and NE system. The former one is large scale whereas the rest are small scale veins. Twelve samples were analysed and maximum gold content of 0.9 g/t was obtained at Hutuliin Tolgoi which is about 15 km away from the area towards west and the rest of values were less than 0.06 g/t in the area.

Homogenization temperature of fluid inclusion revealed that the temperatureare 100° ~ 150°C at Zuun hairhan Uul in the west and 255° ~ 300°C at galena locality of eastern part of the area.

Quartz–sericite facies predominates as an alteration product in the area.

The survey results are shown on the Table II–1–4.

1-3-4 Dugshih area

1. Geology (Ref. Fig. II–1–11)

The area is located on the zone of CMTL and geology of the area is composed of, in ascending order, Silurian (S), Siluro–Devonian (S–D), Devonian (D_1l, D_1b), Permian (Pg) and Cretaceous (K). Paleozoic formations crop out in the central part of the area forming an E–W elongated uplifted block.

Silurian (S) is composed of crystalline schists derived sandstone, siltstone and mudstone. Whole the rocks are severely folded and intruded by small bodies of granodiorite and diorite of later age. The formation shows an elongated distribution with E–W direction in the centeral part of the survey area, forming a southern rim of the uplifted block.

Siluro–Devonian (S–D) is composed of highly folded phyllites and crystalline schists derived from alternated sandstone, siltstone and mudstone and limestone (S–De). The formation shows an elongated distribution in the central part of the area, forming a northern rim of the uplifted block with an E–W direction and also crops out in the northwestern part of the area as an isolated uplifted block.

Devonian (D_1l) is composed of thick limestone beds which contain lots of crinoid fossils.

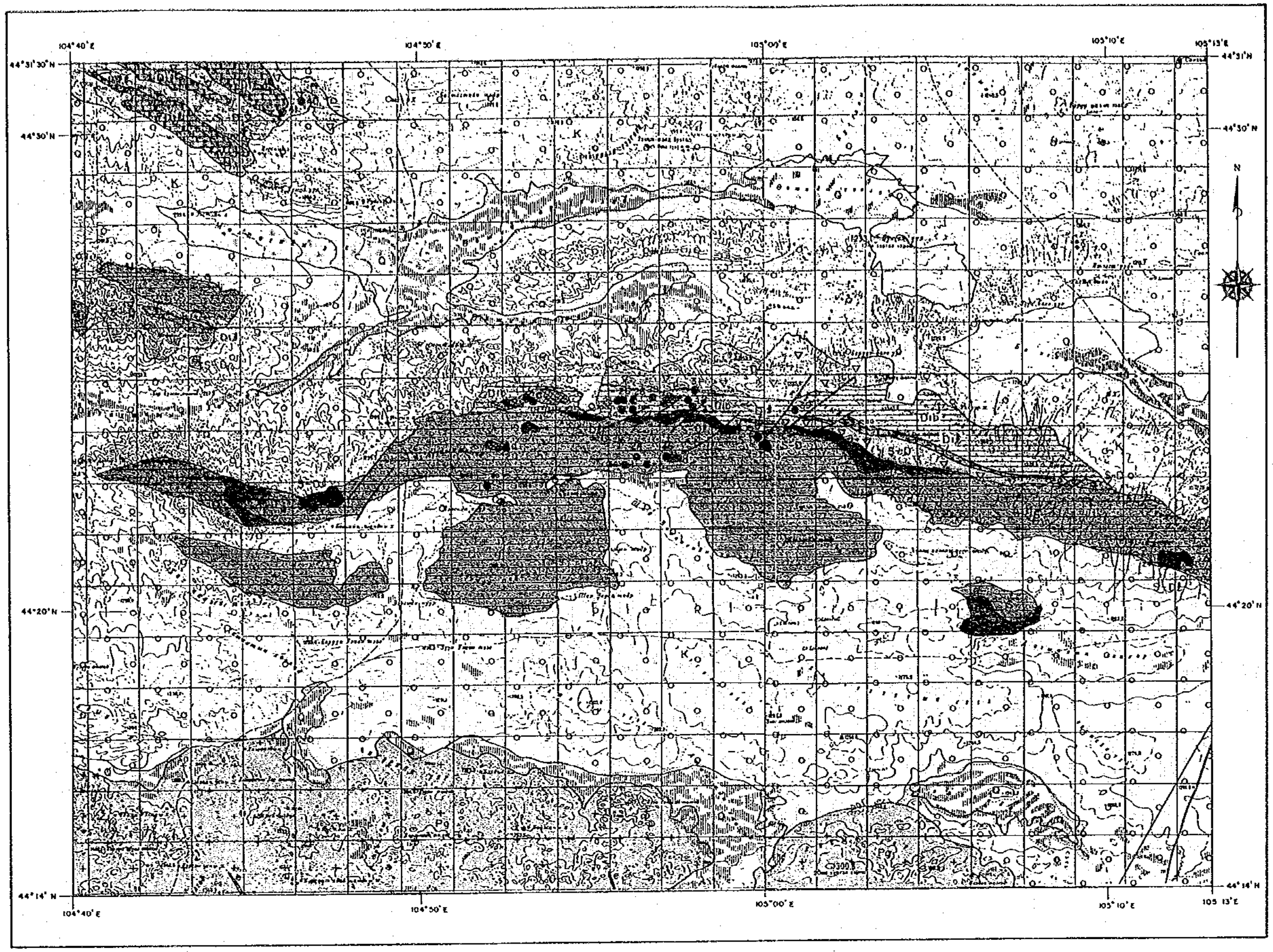
Permian (Pg) is composed of medium ~ coarse–grained granodiorite which is widely distributed in the southern part of the area as a batholith.

Cretaceous (K) is composed of weakly consolidated conglomerate, sandstone and mudstone. The formation occupies the northern half and the southern part of the area forming flat topography and abuts on uplifted Paleozoic blocks.

In this area there exit lots of small intrusives of diorite ~ granodiorite which follow Olon Ovoot area in abundance.

2. Ore deposits and mineral indications

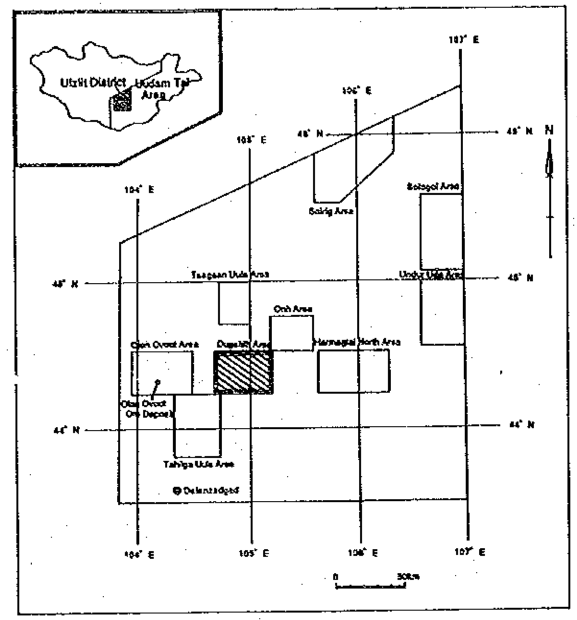
Quartz veins are main mineral indications in the area with subordinate amount of silicified rocks. The former mineralization is observed abundantly in the uplifted Paleozoic block of the central part of the area and subordinately in the Paleozoic



PL. II – 1 – 5

MINERAL EXPLORATION
IN
THE UUDAM TAL AREA, MONGOLIA (PHASE II)

Geologic Map of the Dugshih Area



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LEGEND

Geologic Age	Geologic Unit	Symbol	Rock Types
Quaternary	Q		sand, gravel, loam
Tertiary	Tv		olivine basalt
Cretaceous	K		sandstone, siltstone, conglomerate, limestone, coal
Jurassic-Cretaceous	J-K		conglomerate, siltstone, sandstone
	J-Kv		basalt, trachybasalt-trachyandesite, trachyte
Jurassic	J		conglomerate, siltstone, sandstone
	Jv		trachyte-dacite, trachyrhyolite
Permian	P		trachyte, andesite, trachyandesite, dacite, tuff
Carboniferous-Permian	C-P		basalt, trachyandesite, andesite, tuff, conglomerate
Carboniferous	C		sandstone, siltstone, conglomerate, mudstone
Devonian-Carboniferous	D-C		tuffaceous conglomerate, sandstone, siltstone
Devonian	D2l		limestone
	D2		basalt, trachybasalt, andesite, dacite, rhyolite, tuff
	D1l		limestone
	D1b		sandstone, shale, siltstone
	D1a		shale, siltstone, sandstone

Silurian-Devonian	S-Dl		limestone
	S-D		dacite, rhyolite, andesite, tuff, phyllite, shale
Silurian	S		sandstone, siltstone, shale, phyllite
Undifferentiated Paleozoic	PZ		sandstone, siltstone, clayey shale
Ripheian	Rl		recrystallized limestone
	R2		quartzite, phyllite, siltstone, sandstone, amphibolite
	R1-2		shale, amphibolite, quartzite, phyllite, gneiss
Intrusive Rocks	e		granodiorite porphyry
	δ		diorite, microdiorite, diorite porphyry
	Pγ		granite, granosyenite
	Pr		rhyolite, quartz porphyry
	C-Pγ		granite, granodiorite, granosyenite, diorite
	D2γ		granite, granodiorite
	D2δ		diorite, gabbro
	D1r		rhyolite, dacite

● ore showing

	unit name and boundary
	strike and dip directon
	anticline
	syncline
	fault
	inferred fault
	thrust fault

0 5 10km

Fig. II-1-11 Geologic map of the Dugshih area