REPORT
ON
THE MINERAL EXPLORATION
IN
THE UUDAMTAL AREA
MONGOLIA

CONSOLIDATED REPORT

MARCH 1994

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).

The survey carried out for three year's from 1991 to 1993 by MMAJ in collaboration with Ministry of Geology and Mineral Resources, Ministry of Trade and Industry, Mongolian Government.

This report summarize the results of the survey for three year's. 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 survey team.

March, 1994

Kensuke Yanagiya

Kensuke YANAGIYA
President
Japan International Cooperation Agency

Takashi Ishikawa

Takashi Ishikawa
President
Metal Mining Agency of Japan

CONTENTS

Part I GENERAL REMARKS

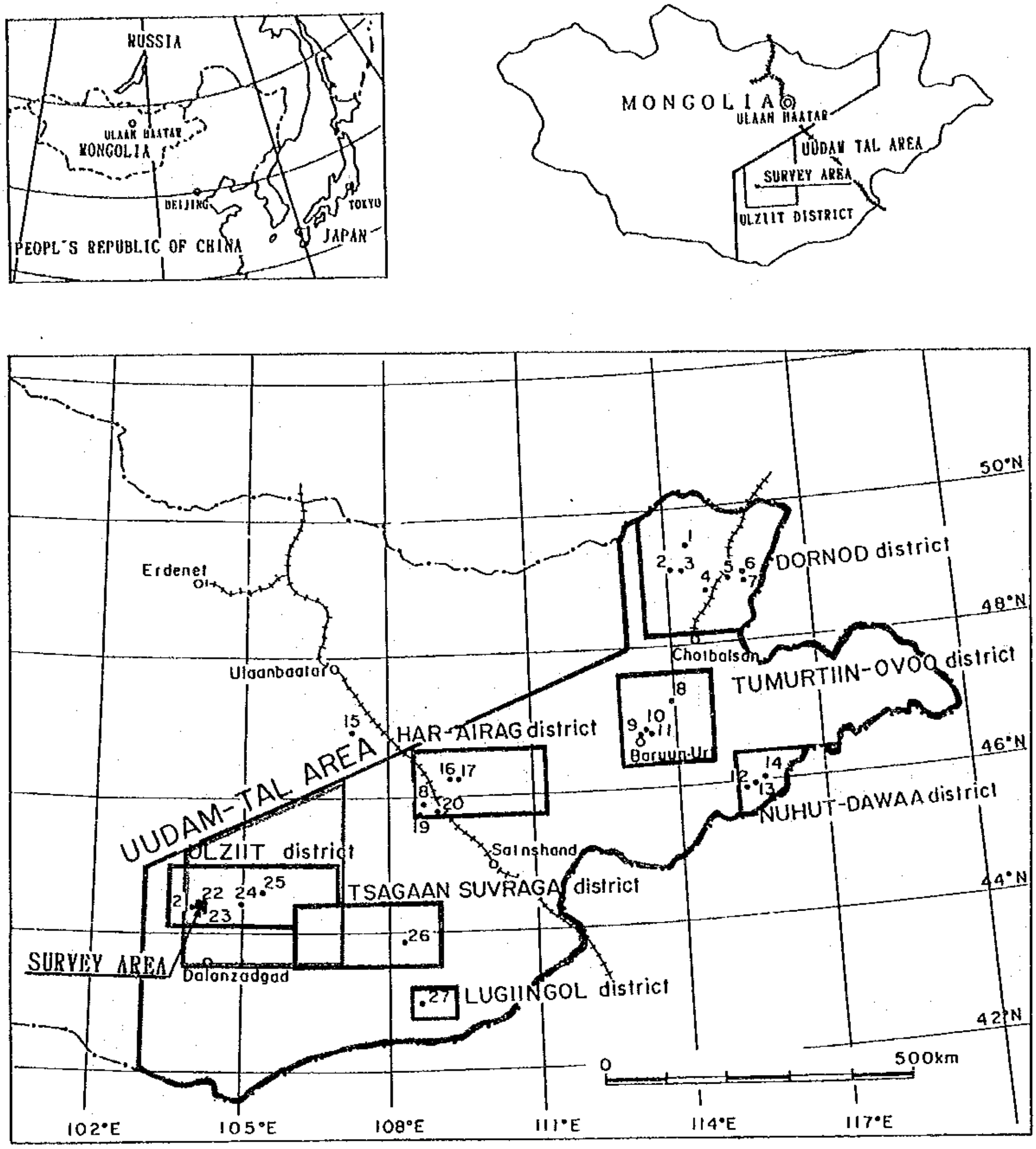
Part II PARTICULARS

Figures

Tables

Plates

Appendices



NAME OF DISTRICTS AND ORE DEPOSITS

LEGEND

- Phase I
- Phase II
- Phase III

DORNOD district
1 Tsagaan-Chuluut Hudag
2 Ulaan
3 Mardai
4 Delger-Munkh
5 Tsav
6 Salhit
7 Bayan-Uul

TUMURTIIN-OVOO district
8 Arin-Nuur
9 Tumurtiin-Ovoo
10 Salaa
11 Salhit

NUHUTT-DAWAA district
12 Yuguzer
13 Tsentr
14 Nuhutiin-Tsagaantolgoi

HAR-AIRAG district
15 Chuluut-Tsagaan-Del
16 Adag
17 Bor-Undur
18 Maihanta
19 Tsagaantakhilch
20 Hongor

ULZIIT district
21 Mushgia-Hudag
22 Olon-Ovoot
23 Bayan-Hushuu
24 Dugshih
25 Onh

TSAGAANSUVRAGA district
26 Tsagaansuvraga

LUGIINGOL district
27 Lugiingol

Fig. I-1-1 Location Map of the Survey Area

SUMMARY

This report has been compiled to demonstrate the results of mineral resources development survey for the three years from June, 1991 to February, 1994 for the purpose of clarifying the geological conditions of Uudam Tal Area, Mongolia, thereby grasping occurrence of useful mineral resources.

The survey area extends over the Mongolian Highlans, Dornod Plain and Govi Lowlands in the southwest of Mongolia, which covers an area of about 500,000 square kilometers or one third of the total area of the country.

Lying between the Siberian and Sino-Korean Tablelands, the area has geological structure composed of the Precambrian group, Paleozoic orogenic belt and Mesozoic terrestrial sediment overlying the former two as the basement. These formations underwent orogenic movements in Baikalian(Late Proterozoic), Caledonian(Early Paleozoic) and Hercynian(Late Paleozoic), intruded by igneous rocks of various ages from Proterozoic to Cretaceous. Such complex geohistory has generated ore deposits of many different types in the survey area.

The survey area was devided by type of ore deposits into the following seven districts:

- Dornod(polymetallic deposits)
- Nuhut-dawaa(rare metals deposits)
- Tumurtiin-ovoo(skarn-type deposits)
- Har-airag(fluospar deposits)
- Lugiin-gol(rare earths deposits)
- Tsagaan-suvraga(porphyry copper deposits)
- Ulziit(complex deposits of rare earths, fluorite and gold)

In Dornod District, many, relatively large-sized polymetallic deposits such as veins formed by acidic volcanic activity(Tsav, Bayan-uul) and mineralized breccia pipes(Ulaan, Mukhar) occur, while gold deposits and greisen-type tin and tungsten deposits also exist. The polymetallic deposits at Tsav and Ulaan are among the most promising in the survey area. In this district, blind polymetallic deposits may be expected from its geological structure.

In Tumurtiin-ovoo District, there occur garnet-skarn type zinc deposits rich in magnetite(Tumurtiin-ovoo, Salhit). Deposits in this district have been surveyed so closely that there remain little room for futher survey.

Nuhut-dawaa District has many greisen type deposits including Yugzer (W, Mo, Be, Bi) and Tub(Sn, W, Be), some of which are relatively large in size. These deposits, including those of low grades, have been sufficiently explored and worked, leaving little attraction from the mining industrial viewpoint.

Har-airag District comprizes Mongolia's largest fluospar zone where major fluispar deposits such as Bor-undur and Adag are located. This district also has been explored relatively well, leaving little room for further survey. Considering the low market prices and Mongolia's geographi-

cal conditions, fluospar can hardly be a mineral upon which the future of national economy could rely.

Lugiin-gol District has Lugiin-gol deposit which accompanies Triassic alkhaline rock. The deposit is a small-scale, vein-type carbonatite deposit containing mainly light rare earths, having low economic viability.

Tsagaan-suvraga District has many copper deposits and indications, constituting Mongolia's second largest porphyry copper zone. The largest is Serven-suhait Ore Body, which has ore reserves of 240 million tons of Cu 0.53%. All the deposits in this district lack secondary enrichment, which represents certain problems, from the mining industrial point of view, in terms of ore grade, characteristics and reserves. Shuten's mineral indication, which is very large in size, should be reviewed as a target of gold exploration due to the characteristics of its alteration zones.

Ulziit District has Mushgia-hudag(REE), Bayan-khushuu(Sr) and many gold indications such as Olon-ovoot. Mushgia-hudag is an aggregate of small vein-/lenticular vein-type ore bodies mainly of light rare earths, accompanying Jurassic alkhaline rocks. The deposit lacks secondary enrichment and is of low grade. Bayan-khushuu is a network type deposit accompanying Jurassic alkhaline rocks, having ore reserves of some 700,000t.

In Olon-ovoot Deposit, gold is concentrated in quartz veins and wall rock by Early Permian mineralization. Since workable primary gold concentration was confirmed by the drilling survey to a depth of 50m below the surface, extension of the deposit further into the deep has become certain. It has been known by the survey that the deposit has potential ore reserves of more than 700,000t(Au 3.2g/t). As the deposit is relatively wide and has outcrops on a hillock, a substantial portion can be mined by open pit operations. From these findings, the deposit, though small in size, is likely to be workable. It is desirable, therefore, to conduct further drilling survey for determination of ore reserves of this deposit and also to carry out heap leaching tests and pit design before feasibility study is implemented.

The survey also revealed that many larger gold indications are widely distributed from Ulziit District over to Tsagaan-suvraga District. These indications are often accompanied by massive silicified rock, hydrofracturing and occasionally by precipitats of hotspring. And , the homogenization temperatures of fluid inclusions are less than 200℃, in general. From these conditions, it can be expected that, in southern Mongolia, there may occur large, blind gold deposits formed by late Paleozoic volcanic activity. It would be necessary for these gold indications to be systematically studied in the future.

With respect to the gold deposits in Dornod district, which still remain at a stage of survey/prospecting of placer gold, survey of the type similar to this survey would be highly likely to lead to discovery of new deposits.

Part I GENERAL REMARKS

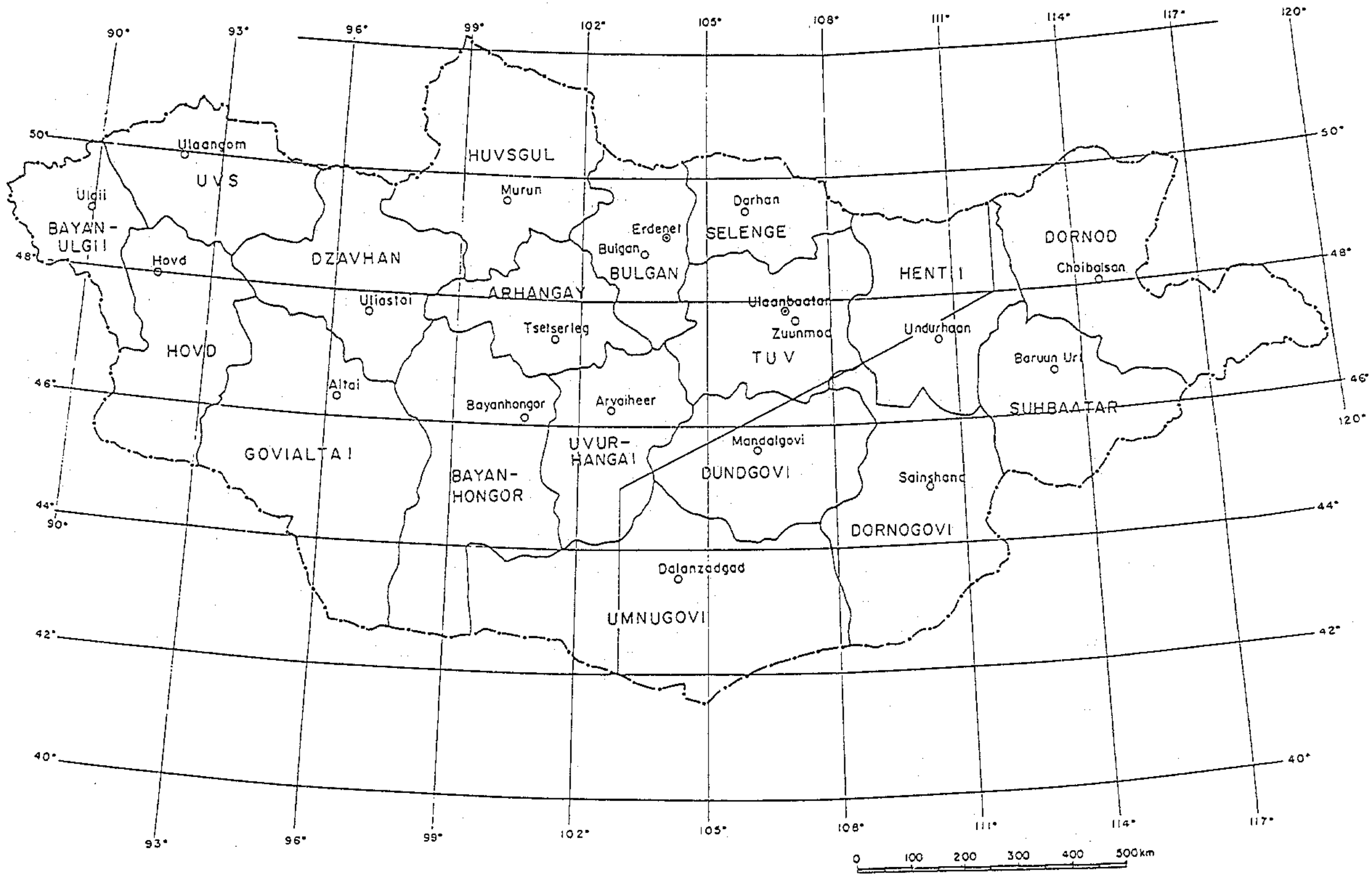


Fig. I-1-2 Administrative Division of MONGOLIA

Chapter 1 Outline of the Survey

1-1 Survey background

In the survey area, geological surveys were conducted energetically in collaboration with ex-USSR and the other COMECON nations since 1939 when a tungsten vein was discovered at Yugzer Deposit. Consequently, a number of ore deposits including polymetallic, skarn, greisen, carbonatite (rare earths), porphyry copper and fluospar deposits were discovered during the decade from 1964 to the mid-1970's. Mining operations started at some of these deposits while many mineral indications discovered were left unexplored due to shortage of funds.

To find a way out of the impasse of the socialist economy, Mongolia has in recent years begun to open the boor to the Western world and to promote introduction of foreign capital and technology.

With regard to technical cooperation with Japan in the field of mining industry, its inception dates back to October, 1989 when Mongolia submitted to Japan an official request for development survey of Mushgiahudag Deposit. Japanese project finding missions were sent to Mongolia in August, 1990 and March, 1991. Between the State Geological Center[1), MPR[2) and the Japanese mission, an agreement was reached as to execution of surveys as from the fiscal 1991, and the Scope of Work dated March 16, 1991 was worked out and signed.

Remarks : [1) As of August, 1992, the State Geological Center was reorganized and upgraded to the Ministry of Geology & Mineral Resources. And, the Ministry of Geology & Mineral Resouces was reorganized to the Ministry of Energy, Geology and Mining in January, 1994.

[2) As of February, 1992, the country's name was changed from the Mongolian Peoples' Republic(MPR) to "Mongolia"

1-2 Survey area and purpose of the survey

The survey area called Uudam Tal Area has a total area of 500,000km^2, 300-400km wide and 1,200km long, demarcated by the meridians passing the two points, ie., long.103° 00′ E-lat.45° 00′ N and long.113° 00′ E-lat.48° 00′ N and by the diagonal lines linking the two points.

Geographically, the area, situated in southeastern Mongolia, is bordered on the north by Russia while on the east and south by China. Topographically, the area consists of the Mongolian Highlands, Dornod Plain and Govi Lowlands. Elevation varies from 560m at Lake Khuh in Dornod District to 2,815m at Gurban Saikhan Mountains in the southwestern tip of the survey area, most parts of which are plateaus of 1,000-1,500m above sea level. In administrative division terms, the area extends over the seven districts (aimag) : Dornod, Sukhbaatar, Hentii, Dornogovi, Dundgovi, Umnugovi and Uvurhangai.

The survey area is located on the Paleozoic orogenic belt between Siberian and Sino-Korean Tablelands. The geology is composed of a small block of the Middle Proterozoic group, the Paleozoic and Mesozoic groups.

Igneous activity extends from Proterozoic to Cretaceous, which formed a variety of ore deposits in the area.

The survey was intended to grasp occurrence of ore deposits by clarifying geological conditions of Uudam Tal Area.

1-3 Survey methods and quantities

Table I-1-1 shows the methods of survey conducted during the 3 years in the area, whilst the Table I-1-2 indicates survey quantities by survey methods. Selection of promising areas was made by the flow chart shown in Table I-1-3.

1-4 Survey period and personnel

Period of field surveys and analysis for the 3 years are as follows:

Fiscal year	Field survey	Analysis
1st year	June/18-Oct/8/91	Oct/9/91-Jan/31/92
2nd year	June/14-Sept/23/92	Sept/24/92-Jan/29/93
3rd year	June/28-Oct/7/93	Oct/8/93-Feb/25/94

Listed below are survey personnel by survey years:

1) 1st year

	Japanese side		Mongolian side	
Survey planning & consultation	SHIMIZU Hiroshi	MMAJ	G.BATTSENGEL	MITI
	KOYAMA Kyoichi	MMAJ	L.NASANBUYAN	MITI
	SAKASEGAWA Toshio	MMAJ	Z.BARAS	SGC
	WADA Mitsuhiro	MFA	J.TSEND-AYUSH	SGC
	IKEDA Shinji	MITI	B.AMARSAIHAN	SGC
	MURAKAMI Kazuyuki	MMAJ	Ts.RENCHINDOR	GEOLCO
	METSUGI Hideya	MMAJ	Sh.BAASANDORJ	GEOLCO
			D.BATBOLD	GEOLCO
General supervision	SATO Eitaro	MINDECO	J.TSEND-AYUSH	SGC
Geological survey	ONISHI Akeo	MINDECO	D.BATBOLD	GEOLCO
	NAKAMURA Kiyoshi	MINDECO	Kh.ENKHTUVSIN	GEOLCO
	SUZUKI Hideo	MINDECO	Sh.BAASANDORJ	GEOLCO
	YAMASAWA Shigeyuki	MINDECO	D.GARAMJAV	GI
			D.TSETSENPIL	GOVICO
			BAYARSAIKHAN	DORNOD CO
Satellite image analysis(in Japan)	YASHIRO Koji	MINDECO		
	ADACHI Kazuhiro	MINDECO		
	WATANABE Hidehisa	MINDECO		

Table I-1-1 Flowsheet of the Survey in the Uudam Tal Area

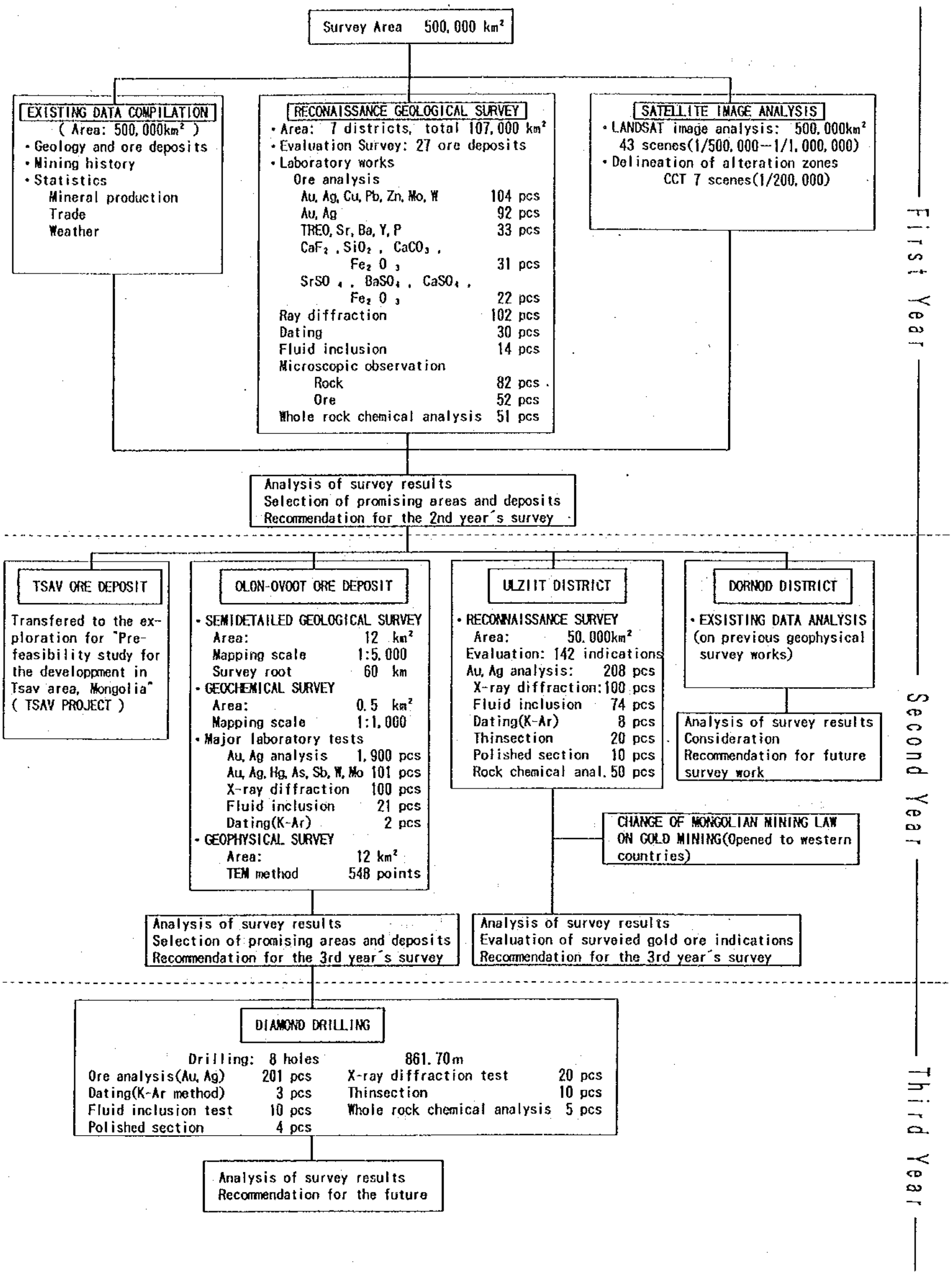
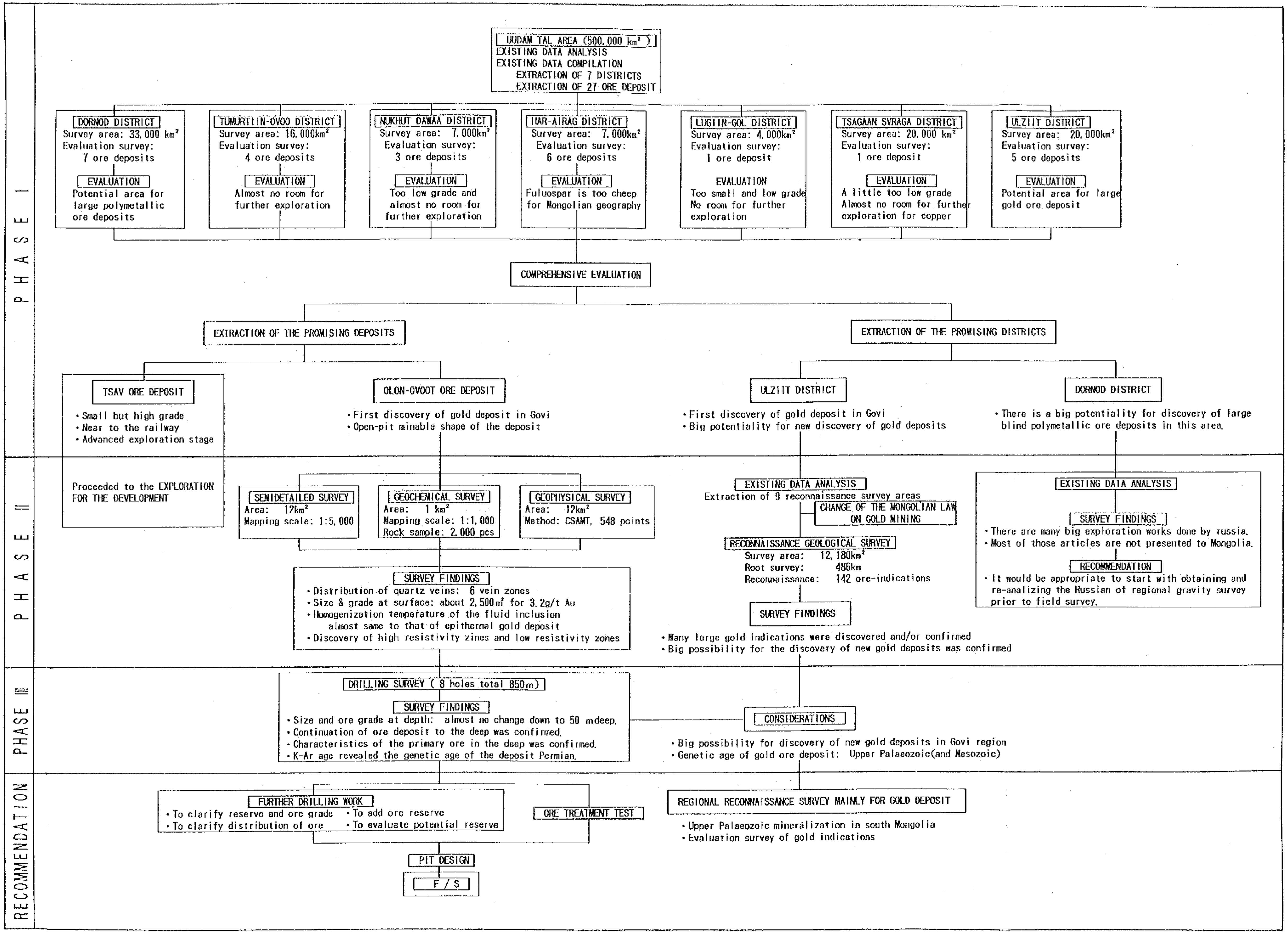


Table Ⅰ-1-2 Quantity of the Survey Works

	Phase Ⅰ (1991)	Phase Ⅱ (1992)	Phase Ⅲ (1993)	Total
Existing Data				
Compilation (km^2)	500,000	—	—	500,000
Analysis (km^2)	—	33,000	—	33,000
Satellite Imagery				
Interpretation (km^2)	500,000	4,650	—	504,650
Analysis (km^2)	200	—	—	200
Geological Survey				
Reconnaissance (km^2)	107,000	50,000	—	157,000
Evaluation survey of deposits	27	142	—	169
Semidetailed (km^2)	—	12	—	12
Detailed (km^2)	—	0.5	—	0.5
Geophysical Survey (km^2)	—	12	—	12
TEM method (m.p.)	—	548	—	548
Geochemical Survey (km^2)	—	0.5	—	0.5
Drilling Survey				
Drilling hole	—	—	8	8
Total length (m)	—	—	861.70	861.70
Laboratory Tests (Sample, pcs)				
Chemical analysis	385	2,501	201	3,087
Thin section	82	28	10	120
Polished section	52	18	4	74
X-ray diffraction analysis	102	200	20	322
Whole rock chemical analysis	51	58	5	114
Fluid inclusion test	14	95	10	119
Absolute age dating	30	10	3	43
Resistivity measurement	—	56	—	56
Fossil identification	1	—	—	1

Table I-1-3 Flow Chart of the Extraction of Promising Areas



2) 2nd year

	Japanese side		Mongolian side	
Preparatory coordination	SAKASEGAWA Toshio	MMAJ	Z.BARAS	SGC
	METSUGI Hideya	MMAJ	J.TSEND-AYUSH	SGC
			Ts.RENCHINDORJ	GEOLCO
			D.BATBOLD	GEOLCO
Consultation between the two sides	OGITSU Tshuyoshi	MMAJ	J.TSEND-AYUSH	SGC
	METSUGI Hideya	MMAJ	Ts.RENCHINDORJ	GEOLCO
	KAMIYA Taro	MMAJ	D.BATBOLD	GEOLCO
	NAITO Koh	JICA	Kh.ENKHTUVSIN	GEOLCO
			Sh.BAASANDORJ	GEOLCO
			M.DUINHARJAV	MGGEC
			Tz.CHULUNBAATAR	MGGEC
			D.LAVDANSUREN	MGGEC
General super-vision	SATO Eitaro	MINDECO	J.TSEND-AYUSH	SGC
			D.BATBOLD	GEOLCO
Geological survey	ADACHI Kazuhiro	MINDECO	Kh.ENKHTUVSIN	GEOLCO
	HARADA Haruo	MINDECO	Sh.BAASANDORJ	GEOLCO
Geophysical survey	WADA Kazushige	MINDECO	M.DUINHARJAV	MGGEC
	ISHIKAWA Hidehiro	MINDECO	Tz.CHULUNBAATAR	MGGEC
	OKUZUMI Koichi	MINDECO	D.LAVDANSUREN	MGGEC

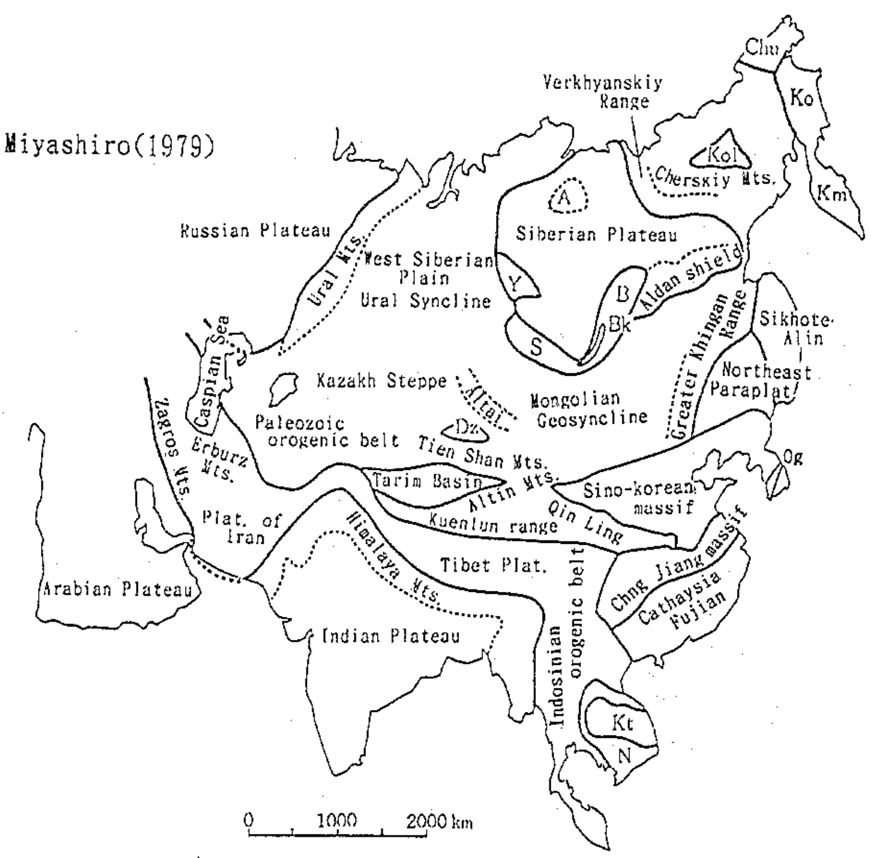
3) 3rd year

	Japanese side		Mongolian side	
Consultation between the two sides	OKAMOTO Nobuyuki	MMAJ	D.SANJAADORJ	MGMR
			G.JAMSRANDORJ	MGMR
			Ts.RENCHINDORJ	GEOLCO
			D.BATBOLD	GEOLCO
General S'vision & drilling survey	SATO Eitaro	MINDECO	D.BATBOLD	GEOLCO
Drilling survey	AOYAMA Tsutomu	MINDECO	Kh.ENKHTUVSIN	GEOLCO
	CHIBA Yukio	MINDECO	D.GANBUD	GEOLCO
	ECHIZENYA Shigeo	MINDECO	D.BATCHULUUN	GEOLCO
			J.ERDENEOCHIR	GEOLCO

[Abbreviations]

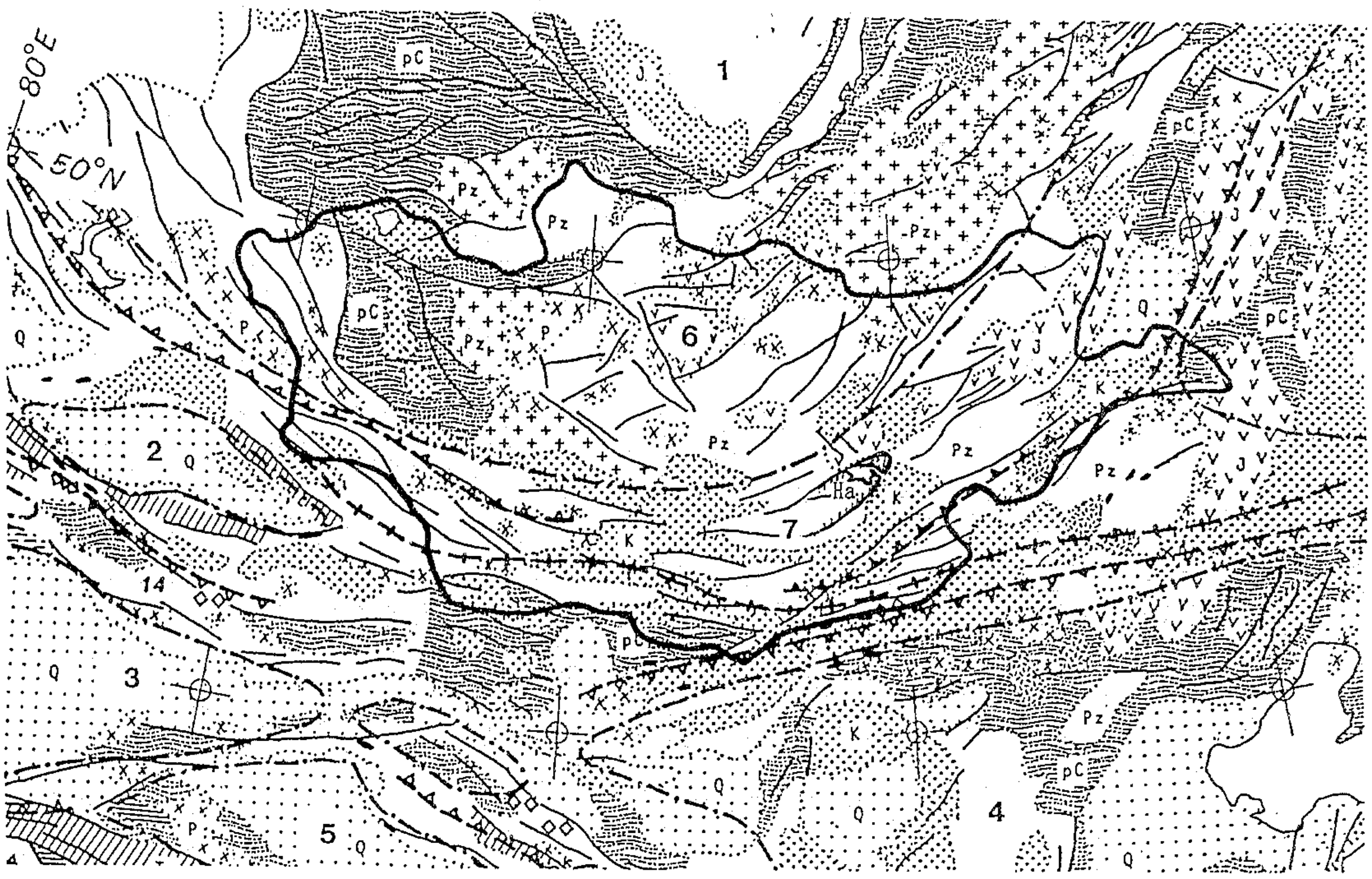
MFA	Ministry of Foreign Affairs	SGC	State Geological Center
MITI	Ministry of International Trade & Industry	GEOLCO	Geology Company
JICA	Japan International Coopeartion Agency	MGGEC	Mongolian Geological & Geophysical Exploration Company
MMAJ	Metal Mining Agency of Japan	GI	Geological Institute
MINDECO	Mitsui Mineral Development Engineering Co. Ltd.	GOVICO	Govi Company
		DORNOCO	Dornod Company
		MGMR	Ministry of Geology & Minerl Reseources

Miyashiro(1979)



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.



0 500km

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
- 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

EONOTHEM	ERATHEM	SYSTEM	SERIES	MPR	DORNOD	NUHUT-DAWAA	TUMURTIIN-OVOO	HAR-AIRAG	LUGIINGOL	TSAGAANSUVRAGA	ULZIIT
PHANEROZOIC	CENOZOIC	QUATERNARY	HOLOCENE	Q_{IV}	grey sand-pebble	grey sand-pebble	grey sand-pebble	grey sand-pebble	grey sand-pebble	grey sand-pebble	grey sandstone, conglomerate
			PLEISTOCENE UPPER	Q_{III}							
			PLEISTOCENE MIDDLE	Q_{II}							
			PLEISTOCENE LOWER	Q_{I}							
		NEOGENE	PLIOCENE UPPER, LOWER; MIOCENE UPPER, MIDDLE, LOWER	N	P-N mixed colored terrigenous	P-N mixed colored terrigenous	P-N mixed colored terrigenous				P-N mixed colored terrigenous
		PALEOGENE	OLIGOCENE, EOCENE, PALEOCENE	P	clay-silt, gravel-sand	clay-silt, gravel-sand	clay-silt, gravel-sand				clay-silt, sand-pebble
	MESOZOIC	CRETACEOUS	UPPER	K_2		red bed-terrigenous-carbonate	red bed-terrigenous-carbonate	red bed-terrigenous-carbonate	red bed-terrigenous-carbonate	red bed-terrigenous-carbonate	red bed-terrigenous-carbonate
			LOWER	K_1	basalt, molasse andesite rhyolite, granite / granodiorite	molasse, (coal bearing) mixed colored clay-silt, gravel-sand	molasse, coal rich, granite, granodiorit	dacite, rhyolite	molasse, continental	molasse(marine and continental)	alkali lava with carbonatite
		JURASSIC	UPPER	J_3	molasse(marine & continental)	granite, granodiorite	basalt, andesite		trachybasalt trachyandesite		alkali lava with carbonatite
			MIDDLE	J_2	graite, granite porphyry			andesite, dacite, rhyolite			
			LOWER	J_1			granite				
		TRIASSIC	UPPER	T_3	molasse, terrigenous sed						
			MIDDLE	T_2	greywacke, flysh						
			LOWER	T_1							
	UPPER PALEOZOIC	PERMIAN	UPPER	P_2	P_1 - P_2 dacite, rhyolite		monzonite, granite, granosyenite	andesite, dacite, rhyolite	syenite / granodiorite, granite / rhyolite, monzonite	alkali granite	andesite, rhyolite
			LOWER	P_1		geosynclinal sediments				sandstone, mudstone, alkali granite	dacite, granite rhyolite,
		CARBONIFEROUS	UPPER SUBSYSTEM: STEPHANIAN (GZHELIAN, KASIMOVIAN); WESTPHALIAN D, C, B, A (MOSCOVIAN)	C_3		granite, granodiorite, andesite, dacite, rhyolite,		andesite, dacite, rhyolite	basalt, andesite	sandstone, mudstone quarz-monzonite	andesite, dacite, rhyolite
			UPPER SUBSYSTEM: NAMURIAN (BASHKIRIAN, SERPUKHOV.)	C_2		andesite, dacite, rhyolite			granodiorite	basalt, andesite	granite, granodiorite
			LOWER SUBSYSTEM: VISÉAN, TOURNAISIAN	C_1				molasse, continental marine, sandstone, congromerate	siliceous shale	basalt, andesite	granodiorite, granite
		DEVONIAN	UPPER	D_3	terrigenous	jasper / quartzite / terrigenous	green schist, black schist, terrigenous / tuff, limestone flysh		granodiorite, / graywacke, flysh, tuff, / terrigenous	basalt, andesite	jasper, terrigenous / graywacke, flysh, tuff, granite
			MIDDLE	D_2	D_{1-2} terrigenous limestone						
			LOWER	D_1						terrigenous limestone	
	LOWER PALEOZOIC	SILURIAN	PRIDOLI, LUDLOW, WENLOCK	S_2			granodiorite / ?				terrigenous / molasse(coal rich)
			LLANDOVERY	S_1							red bed carbonate
		ORDOVICIAN	UPPER: CINCINNATIAN (ASHGILL), CHAMPLAINIAN (CARADOC)								
			LOWER: CAN. (LLANDEILO-LLANVIRN, ARENIG, TREMADOC)								
		CAMBRIAN	UPPER								
			MIDDLE								
			LOWER		green shale, black shale				terrigenous (greywacke, flysh, tuff		
PROTEROZOIC	NEO-PROTEROZOIC	TERMINAL PROTEROZOIC NEOPROTEROZOIC III, CRYOGENIAN, TONIAN		R_3 C_1 / Pz_3	green schist, black schist, granite, granodiorit	?	?	limestone	terrigenous graywacke, flysh, tuff	granodiorite, granite	?
	MESO-PROTEROZOIC	STENIAN, ECTASIAN, CALYMMIAN		Pz_2				crystalline schist, phyllite			
	PALEO-PROTEROZOIC	STATHERIAN, OROSIRIAN, RHYACIAN, SIDERIAN		Pz_1							
ARCHAEAN											

Fig. I -3-2 Schematic Stratigraphic Column of the Uudam Tal Area

Chapter 2 Past Surveys

2-1 A brief history of the survey area

The fiest record of mineral resources exploration and development in Mongolia dates back to the 11th-12th century when gold mining was initiated. In early 1800's gold mining on commercial basis started in the west ward of altai and south Hangai. In the beginning of this century, a Russian-Mongolian joint venture company "Mongolor" was established, which started placer gold mining in the north of Hentii Hills. Since then till the mid-1970's, placer gold mining was the mainstay of the country's mining industry.

Modern geological work in the survey area started in 1939 when Russians engaged in water survey discovered tungaten veins at a part of Yugzer Deposit, which was followed by a series of Soviet surveys conducted in real earnest from 1942 to 43 around Yugzer. Excavation of the deposit started in 1943. While geological survey of Har-airag District was commenced in 1954 with a scale of 1/200,000, surveys in Nuhut-dawaa District played the central role in the country's mineral exploration activities until Yugzer Mine was closed in 1956.

On the other hand, the Soviets discovered Bor-undur Deposit in the same year of 1956, which activated fluospar exploration in Har-airag District.

In 1964, Tsagaan-suvraga Deposit was discovered by local inhabitants, and in the following year, the Soviets commenced regional survey of its surrouding areas. After that , geological survey by the COMECON countries under the Soviet initiatives entered the golden age, which extended all over Uudam Tal Area. In 1971-72, the USSR implemented geological survey of the areas surrounding Tsagaan-suvraga Deposit, which led to the discovery of many copper indications. In 1972, Dornod uranium deposits and Lugiin-gol Deposit were found, followed by the discovery of Tumurtiin-ovoo Deposit(1974), development of Hongor Fluospar Deposit(1974), discovery of Tsav and Bayan-uul Deposits(1975) and of Bayan-khushuu Deposit(1976), and start-up of Dornod Uranium Mine(1980). Thus mineral resources survey in the Uudam Tal Area expanded at an accelerated pace, which led to discoveries of most of the ore deposits so far known, in about ten years till mid-1970's. Afterwards, follow-up surveys were conducted of respective deposits discovered, and production started at the deposits such as Dornod, Bor-undur, Adag, etc.

With the rapid decline of the socialist economies, however, exploration activities had to be curtailed or suspended at many sites of mineral indications.

A chronological table of the Mongolian mining history appears at the end of this volume.

2-2 Outline of past surveys

The surveys executed years ago by the International Geological Survey Corps constituted by the COMECON nations were generally of large scale and systematically organizaed. In an early stage of exploration, airborne magnetic survey was usually carried out and, simultaneously, regional geological maps with a scale of 1/500,000 were compiled, which was then followed by systematic geochemical prospecting with a 1/200,000 scale and regional geological survey based on aerial photo analysis. In case some clues are found by these surveys, further detailed surveys were conducted while through investions using γ-ray spectrummethod, IP, pitting, trenching, drilling, tunneling, etc. Was conducted for periods of 2-3 years. The survey findings mainly by COMECON's International Geological Survey Corps were compiled into reports in the Russian language. The typed, thread-bound reports of some 700 to 2,000 pages(700 pages per volume) are accompanied by drawings(water-colored blue-prints) packed in cases. Some 6,000 of such reports are kept in strict custody at a stack of the ex-IGC building in Ulaan Baartar.

The main literature utilized for this survey are listed at the end of this volume.

Chapter 3 Outline of Geology

3-1 Geological setting of the survey area

Mongolia is located on the orogenic belt once called "Mongolian Geosyncline" lying between the Siberian and Sino-Korean Table Lands. Sediments of the geosyncline range from Precambrian to Paleozoic, undergoing orogenic movements of Baikalian(Late Proterozoic), Caledonian(Early Paleozoic) and Hercynian(Late Paleozoic) times.

On the east side of the orogenic belt, there is the Northeast Paratableland(Breya Block), whilst a Precambrian block called "Sino-Korean Massif lines to the south of the belt. The three basins of Jungar (Dzungar), Tarim and Tsaidam located on the west side of the Sino-Korean Massif are all covered with thick(several to 10km) Phanerozoic formations and, in the deep, there lines Precambrian metamorphic basement. Between these basins, mountain ranges composed of rocks deformed and metamorphosed in the Hercynian time, such as Altai, Tenshan and Kunlun, extend east and west.

From these facts, the Mongolian orogenic belt has been considered to be an accretionary zone to the Siberian Tablelands by the subduction of an oceanic plate throughout the Paleozoic era.

3-2 General geology of the survey area

The survey area is situated on the Paleozoic orogenic belt in the south to southeast margins of Siberian Tablelands. The geology is constituted by the Middle to Upper Proterozoic, Paleozoic and Mesozoic groups. The formations in or before the Paleozoic time underwent the orogenic movements of Baikalian, Caledonian and Hercynian ages, into which granitic rocks of various times in or after the Proterozoic intrude. Igneous activity lasted to Mesozoic; volcanic and granitic rock of late Jurassic to Createaceous(Yenshan period) are widely distributed.

The Middle Proterozoic group covered unconformably with Paleozoic and Mesozoic groups out as inlier, in an area 80km(E-W) x 30km(N-S) in southweatern Har-airag district. It consists mainly of gneiss, schist and crystalline limestone, and of gneissose granite intruding into them, which form country rock of the fluorite deposits at crystalline schist presumably of Proterozoic are distributed in the northeast and near Tsav Deposit in the east.

The Paleozoic group is distributed all over Uudam Tal Area, which consists of marine sediments of schist, phyllite, sandstone, siltstone, limestone and chert of Silurian, Devonian, Carboniferous, Permian, ages. These are distributed along the Siberian Tableland, folding intensively and forming an arc; convexly with a southern aspect.

In Govi district, serpentinized ultrabasic rock is scattered along a tectonic line "Main Mongolian Lineament" parallel with the fold axis. Into these sediments, granitic rocks of various ages in or after Paleozoic intrude. In the survey area, ore deposits such as Tsagaan-suvraga(315±16 Ma-315±16Ma) and Olon-ovoot(283±14Ma) were formed by Paleozoic igneous activity.

The Mesozoic group is broadly distributed in Govi and Dornod districts, consisting mainly of Jurassic to Cretaceous(Yenshan period) volcanic and granitic rock and Cretaceous continental sediments. With the Mesozoic igneous activity, the Dornod polymetallic deposits, Tumurtiin-ovoo skarn deposit, Har-airag fluospar deposits, as well as the rare earths deposits accompanying alkaline rock at Lugiin-gol, Mushgia-hudag, Bayan-khushuu, etc., were formed. It is said that most of those deposite hove genetic relation to the Mesozoic tectonic movement.

Govi and Dornod districts where the Mesozoic group reaches 3,000m in thickness, are known for oil shale and oil production. Many coal filds are also formed there accompanying the inland sediments.

Thanks to the gentle topography and favorable accesses, the survey area has so far been most closely surveyed and covers most of Mongolia's major known deposits zones.

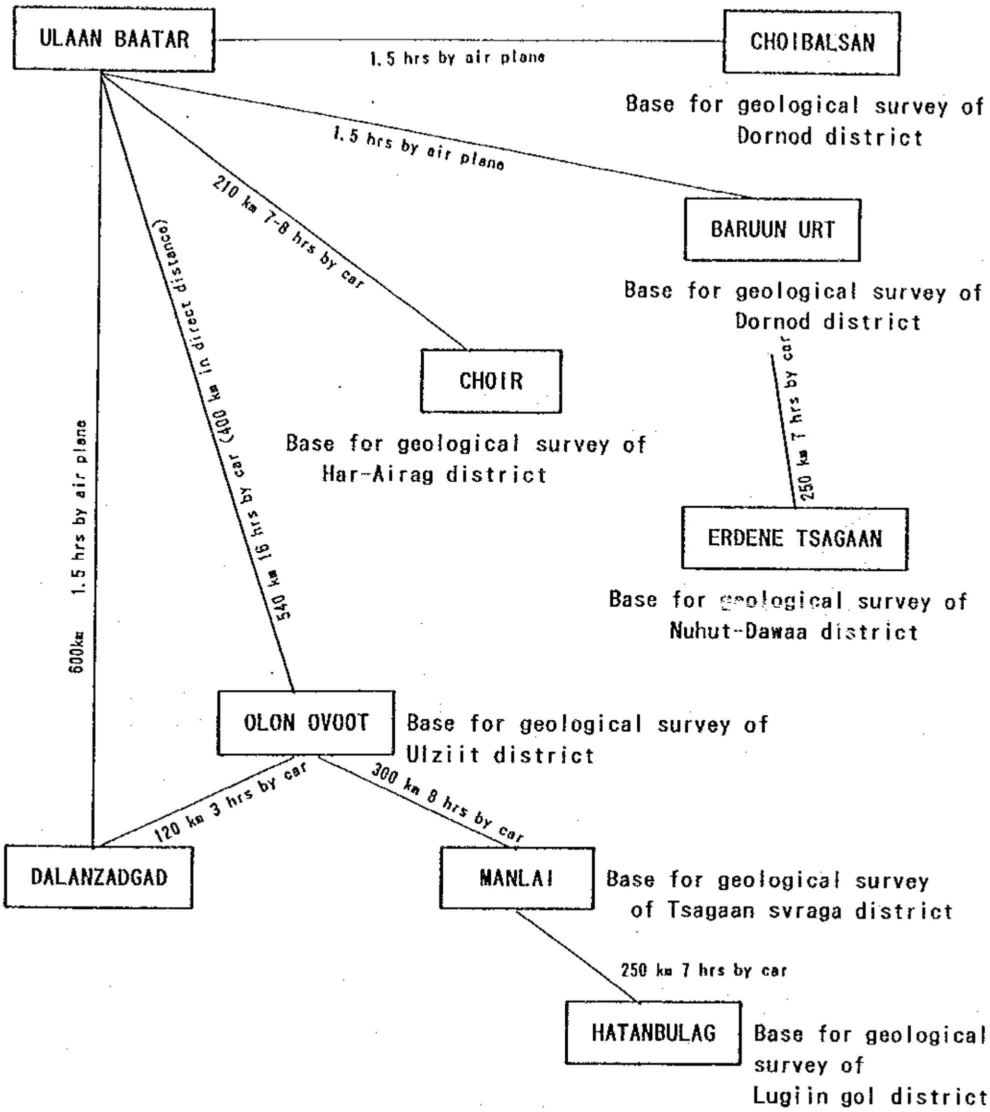


Fig. I-4-1 Summarized Accessibility of the Survey Area

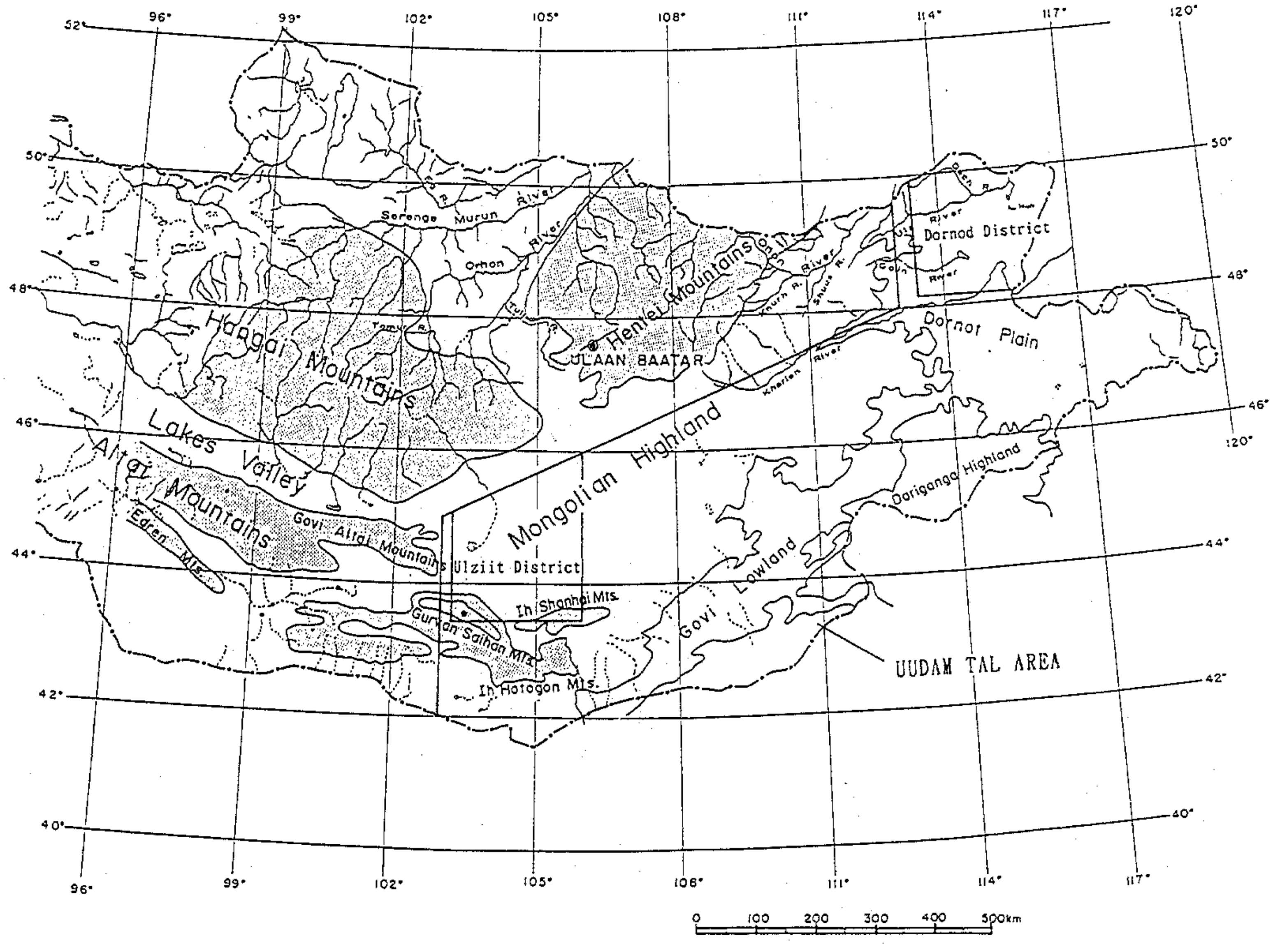


Fig. I-4-2 Geographical Features

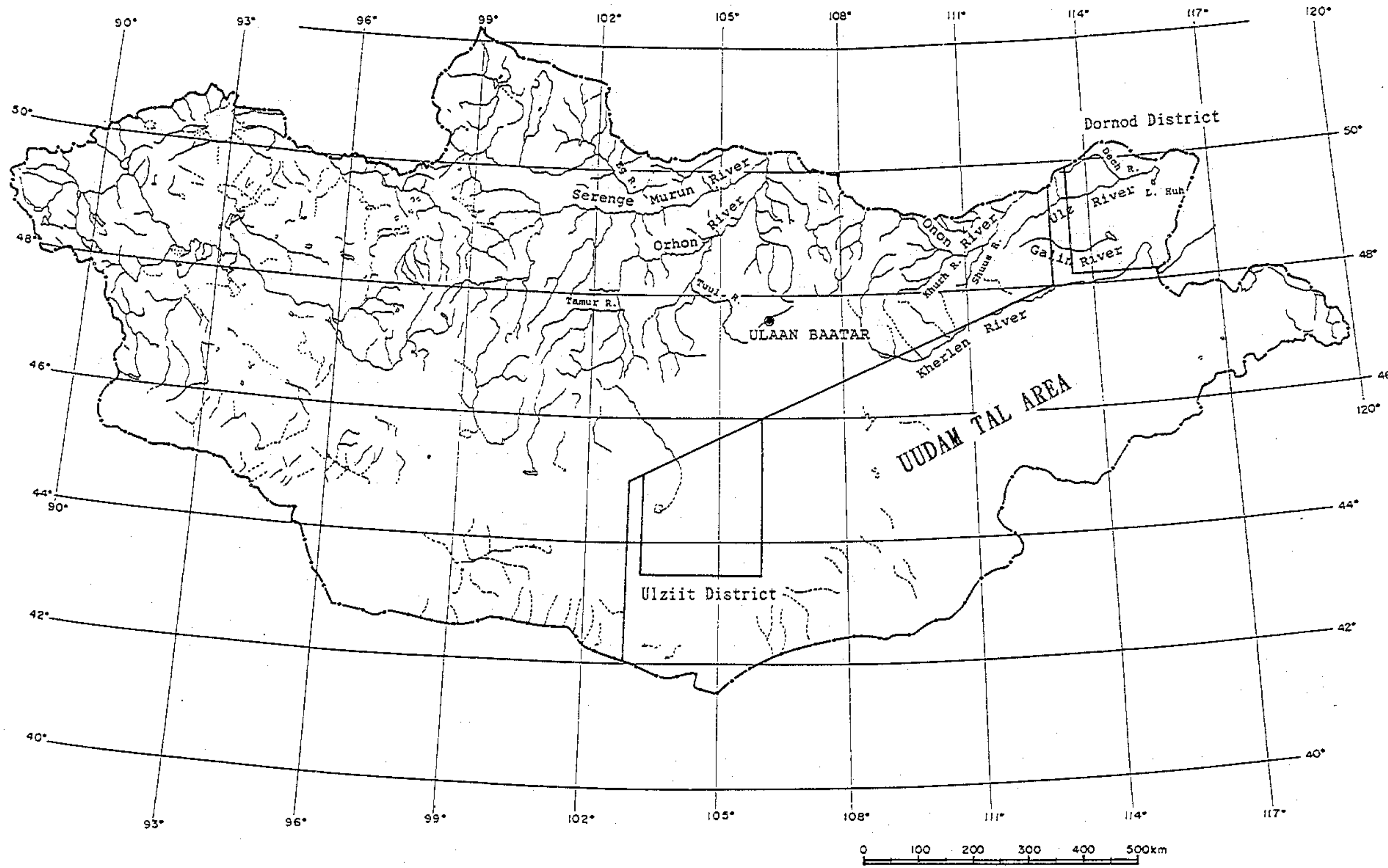


Fig. I-4-3 Drainage Systems

Chapter 4 Local Conditions

4-1 Location and access

The survey area is located in southeastern Mongolia and has the total surface area of 500,000 km^2 . In terms of administrative division, it extends over the seven districts(Aimag): Hentiti, Dornod, Sukhbaatar, Dornogovi, Dundgovi, Umnugovi and Uvurhangai.

To go to the survey area from Tokyo, the usual route is the one via Beijin and Ulaan Baatar. From Narita to Beijin, there are daily flights, which takes 3 hours and 25 minutes(one way), and it takes an hour and 50 minutes from Beijin to Ulaan Baatar. In August, 1991, the Chinese International Airways commenced the service, whereby the number of flights between Beijin and Ulaan Baatar increased from one to four in a week.

From Ulaan Baatar to the survey area, vast steppe-desert areas, 1,000-1,500m high, extend, where cars can run freely practically anywhere. But roads are not yet well prepared; average driving speed is around 40kmph. It is possible to fly over to several major local cities. In case a car is used, however, the car must be brought from Ulaan Baatar.

Domestic flights from Ulaan Baatar to major local cities which can serve as base points for visiting the survey area as follows:

	Weekly flights	Flight hours
Ulaan Baatar - Choibalsan	1-2 flights (both ways)	1 hr 25 min (one way)
Ulaan Baatar - Baruun-urt	2 flights (both ways)	1 hr 25 min (one way)
Ulaan Baatar - Dalanzadgad	2 flights (both ways)	1 hr 40 min (one way)

Since most parts of the survey area are thinly populated steppe-deserts, two or more vehicles are indispensable for movement, especially in the summer and winter months.

4-2 Topography and drainage

The survey area is mostly a vast plain(so-called Mongolian Highlands) with the elevation of 700-1,500m. The lowest point is 560m high in the Lake Khuh whereas the highest is 2,825m on the Gurvan Saikhan Mountains. Topographically, the area can be divided into the lowest Dornod Plain in the north, Govi Lowlands extending southwestwards from Dornod Plain, East Mongolian Highlands extending northwards from Govi Lowlands, Dariganga Highlands located to the south of Govi Lowlands, and Govi-Altai Mountains in the southwest.

Dornod Plain is a wast flatland with the elevation of 600-1,000m, the lowest in the survey area, studded with 1,000-1,200m high monadnocks.

Govi Lowlands are tectonic lowlands, 30-150km in width and 900-1,000m in elevation, extending southwestwards from Dornod Plain, with sporadic upheaved blocks with the elevation of 1,000-1,200m.

East Mongolian Highlands consists of gentle hills or plains of some 300km in width, 800km in length and 1,000-1,500m in elevation, extending to the north of Govi Lowlands. The highlands is bordered on the north and west by Hentii, Altai and Govi-Altai districts and has the increasing elevation towards the northeast.

Dariganga Highlands, a plateau, 1,000-1,200m high, located in the southwestern Dornod Plain and to the south of Govi Lowlands have sporadic monadnocks of 1,500-1,700m in altitude and widely covered with plateau basalt.

Govi-Altai Mountains, located at the southwestern tip of East Mongolian Highlands, are divided into several masses of 1,700-2,800m class mountains such as Gurvan Saikhan and Ih-shanhai. Govi-Altai Mountains change the direction from WNW-ESE to E-W within the survey area and disappear, cut by Govi Lowlands extending from SW to NE.(Fig.I-4-2)

4-2-2 Drainage

Main drainage systems in the survey area are confined to Dornod Plain extending over Dornod and Hentei districts in the northeast of the area, which consists of the Ulz, Galin, Kherlen and Khalkhin rivers. These manifest water systems, excepting the Galin River, run through the Russian and Chinese territories and flow into the Amur River. To the south of East Mongolian Highlands, large perennial drainage systems are lacking. Wadis flow into Govi Lowlands or nearby basins in various places and disappear. (Fig.I-4-3)

4-3 Climate and Vegetation

4-3-1 Climate

The survey area spreads over the steppe and the desert climatic zones. The average annual temperature ranges from -1.6℃ in Choibalsan to 3.9℃ in Dalanzadgad, while the maximum and minimum average monthly temperatures range from 23.2℃ in Sainshand in July to -21.3℃ in Choibalsan in January. The annual fluctuation range of temperature is normally 80℃ or so. In the survey area, the maximum temperature in Govi area is 45-47℃ in contrast to Choibalsan's minimum temperature of -43℃.

Annual precipitation generally is in a range of 100mm to 250mm, the highest being 246mm in Choibalsan while the precipitation in Govi area is less than 100mm a year. On the whole, precipitation decreases towards the south. The seasonal distribution of precipitation is uneven, heavily concentrated in the 5 summer months from May to September, while winter is the dry season havinh monthly precipitation below several millimeters. The survey area, in general, is windy throughoust a year. The Govi desert is especially windy from March to May and in November, having 40-50 days of sandstorm in a year. This area has extremely harsh climate; in summertime, hot wind of 40℃ or more blows there.

Table I-4-1 Meteorology of the Survey Areas

Mean Monthly and Annual Temperature (°C)

Meteorological station	Mean Monthly												Annual average
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
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	34.5	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	Mean Monthly												Annual average
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
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.

4-3-2 Vegetation

The vegetation in the survey area is controlled largely by the balance between precipitation and evapotranspiration. Dornod Plain and the northern East Mongolian Highlands where precipitation is relatively high and temperature is rather low(lower evapotranspiration) have steppes covered relatively densely with relatively tall grass. In contrast, Govi area with minimal precipitation and high temperature is a desert owing to the extremely dry weather, while areas in-between are steppes thinly covered with low grass or semi-deserts. On the whole, the survey area is very poor in arbors, which can be seen only at oases and along wadis.

Table I-5-1 Genetic Age of Ore Deposits in the Uudam Tal Area

NAME OF THE DISTRICTS	GENETIC AGE OF THE ORE DEPOSITS (Ma)						
	POLY MTL	GREIZEN	SKARN	FLUORITE	CARB-REE	POR-Cu	GOLD ORE
DORNOD	109.3 Tsav Ore pile Pb-Pb 116.1 Tsav Ore pile Pb-Pb 131.7 Tsav No.4 trench Pb-Pb 170.1 Ulaan Ore pile Pb-Pb						154 ±8 K-Ar K-fel in Wall rock
NUHUT-DAWAA		T_3 - J_1					
TUMURTIIN-OVOO			125.3 Salaa Ore, Pb-Pb 191 ±10 Tumurtiin-Ovoo, Gr, K-Ar				
HAR-AIRAG				J-K			
LUGIIN-GOL					228 ±11 biotite K-Ar 234 ±12 nepheline K-Ar		
TSAGAAN-SV.		354±18 muscovite K-Ar				315±16 K-fel K-Ar	
ULZIIT		Olon-ovoot, Muscovite in auriferous Qz v Olon-ovoot, whole rock in auriferous alt Dio			132 ±7 Mushgia-hudug nepheline		283 ±14 K-Ar 284 ±14 K-Ar

Abbreviations:

POLY MTL: Polymetallic ore deposit, GREIZEN: Greizen-type rare metal ore deposit, SKARN: Skarn ore deposit, FLUORITE: Fluorite ore deposit
CARB-REE: Carbonatite type rare-earth ore deposit, POR-Cu: Porphyry copper
GOLD ORE: Hydrothermal gold ore deposit, TSAGAAN SV.: Tsagaan-suvraga
Pb-Pb: Pb-Pb method, K-Ar: K-Ar method, K-fel: K-feldsper, Gr: Granite,
Dio: Diorite, T_3 - J_1 : Upper Triasic to Lower Jurassic, J-K: Jurassic to Cretaceous

Chapter 5 Conclusions and Recommendations

5-1 Conclusions

5-1 Mineralization characteristics

In the survey area, there are a great variety of mineragenetic provinces with different geological backgrounds or origins, ranging from polymetallic deposits contaning mainly silver, lead and zinc(Dornod District); greisen-type tungsten-molybdenum deposits(Nuhut-dawaa District); magnetite-bearing garnet-skarn type zinc diposits(Tumurtiin-ovoo District); fluorite deposits(Har-airag District); carbonatite-type rare earths deposits(Lugiin-gol District); and, porphyry-type copper deposits(Tsagaan-suvraga District), to Poly mineralization zones consisting of carbonatite-type rare earths deposits, fluorite deposits, auriferous quartz veins and other gold deposits.

Table I-5-1 demonstrates relationship between respective ore deposit zone and mineralization age.

5-1-2 Mineralization control

Mineralization in the seven sidtricts enumereted above has formed distinctive mineragenetic province distribution areally controlled. The K-Ar dating has revealed the following facts about mineralization in the survey area:

i) In late Paleozoic, mineralization of porphyry copper and gold took place, which corresponds to the time when the Siberian and the Sino-Korean Massifs collided whereby the subject area was continentalized.

ii) Many of the ore deposits such as greisen-type deposits, skarn-type zinc deposits, polymetallic deposits, carbonatite-type rare earths deposits and fluospar deposits are accompanied by Mesozoic igneous activity, which corresponds to the time when the subject area became a part of the Asian Continent and alkali rock magma was activated.

5-1-3 Potentialities for occurrence of ore deposits

a) Dornod District

From the first year's survey results, Tsav Deposit, though rather small in size, was considered as the one having the highest development possibility because the deposit has the highest grade ores, its exploration had reached the most advanced stage and it is located near a railroad.

In Dornod District, Jurassic to Cretaceous volcanic rocks are distributed along the margins of Choibalsan Sedimentary Basin, where many polymetallic deposits containing silver, lead and zinc, such as Ulaan, Mukhar, Dergermunkh, etc. are formed. It appears that these deposits have little denudation as seen in Mukhar which is a blind deposit.

On the other hand, the central part of Choibalsan sedimentary basin is broadly covered with the Middle to Upper Cretaceous rock, which possibly is a zone of blind polymetallic deposits.

b) Govi area

In the so-called Govi, extending from Tsagaan-suvraga District over to Ulziit District, many large-scale gold indications are distributed, which are left unexplored. It has been geologically evidenced that these indications were formed near the surface since the homogenization temperatures of their fluid inclusion are lower than that of Olon-ovoot and they are accompanied by hot spring precipilates of various types. The erratic filling ratios of their fluid inclusion and the commonly seen hydrofracturing indicate that Ore-forming fluid was once boiling, which provided faverable conditions to gold concentration. From these facts, it is considered highly possible that this area embraces blind gold deposits.

According to existing literature, gold occurs in the outcrops of Harmagtai, Shuten, Ovoot-hira, etc. Above all, Shuten gold indication is composed mainly of large scale, massive silicified rock accompanied partially by alunite, on which a survey aimed at gold deposits should desirably be conducted.

In the meantime, Mongolia opened the door in 1992 to the Western countries in respect of the mining of gold resources, as well.

c) Other ore deposits

Other ore deposits in the survey area have certain difficulties/questions in terms of type of minerals, size, grade, or characteristics; therefore, they could not be objects of the survey for development.

5-2 Recommendations

5-2-1 Promising districts

a) Govi area

There is high possibility of occurrence of gold deposits formed in the Late Paleozoic in Ulziit District and southern Mongolia including Tsagaan-suvraga District. In this area, regional surveys should desirably be conducted for evaluation of the gold indications.

b) Dornod district

Concerning exploration of the blind polymetallic deposits in Dornod District, it would be appropriate to start with obtaining and re-analysing the Russian data of regional gravity survey prior to field survey or exploration. Gold resources survey is considered also significant.

Currently, topographic mapping of this district in 1/50,000 and 1/25,000 scales is underway. It would therefore be significant to conduct basic surveys starting with regional gravity survey after completion of the topographic mapping.

5-2-2 Promising deposits

a) Olon-ovoot Deposit

The survey revealed that Olon-ovoot Deposit has primary gold concentration and continues into the deep, whereby workability of the deposit has been enhanced. The findings are important as it gives guidance for gold prospecting in Govi area. It is therefore recommended that further drilling survey should be carried out to clarify occurrence of this deposit whilst various ore tests as well as feasibility study should be undertaken.

b) Tsav deposit

As the result of the first year's survey, this deposit was given the top priority of development because it has the highest ore grade though rather small in size and has the most favorable conditions for development such as infrastructure. In those days, however, information on gold resouces was undisclosed to foreigners. Based on the priority, the survey in collaboration with Japan called "Pre-feasibility study for the Development in Tsav Area, Mongolia" was commenced from the fiscal 1992.

Part II PARTICULARS

Chapter 1 General Geology

1-1 Compilation of existing data (phase I)

1-1-1 Purpose

Past relevant information and data accumulated in Mongolia were collected, sorted out and analysed so that they might serve as basic reference for formulating policies for the subsequent surveys. Main points of the analysis were as follows:

i) Outline of the past and ongoing surveys in the survey area.
ii) Outline of operating mines and mine development projects.
iii) Outline of ore deposits and mineral indications, as well as their occurrence in the survey area.
iv) Problems in survey for mineral resources development in Mongilia.

1-1-2 Analytical work

The work was done mainly at the State Geological Center, MPR in Ulaan Baatar (currently, the Information Center of Mongolia) of the reference literature selected and presented by the Mongolian side in line with the purports of analysis. The following items were checked concerning metallic and nonmetallic minerals, and coal resources in the survey area.

i) History of geological survey and minig industry.
ii) Outline of the geology of survey area.
iii) Known ore deposits and mineral indications.
iv) Statistical data of production and external trade of minerals.

The analysis was conducted by the chief of Japanese survey team in collaboration with Mongolian personnel in charge. Four Japanese engineers in charge of geological survey also took part in the analytical work for 15 days prior to the start of field survey.

1-1-3 Results of analysis

The results of analysis, which formed the back bone of the first year's survey, were reflected in the planning field survey and used as the basic reference for descriptions and evaluation of geology, ore deposits and mineral indications.

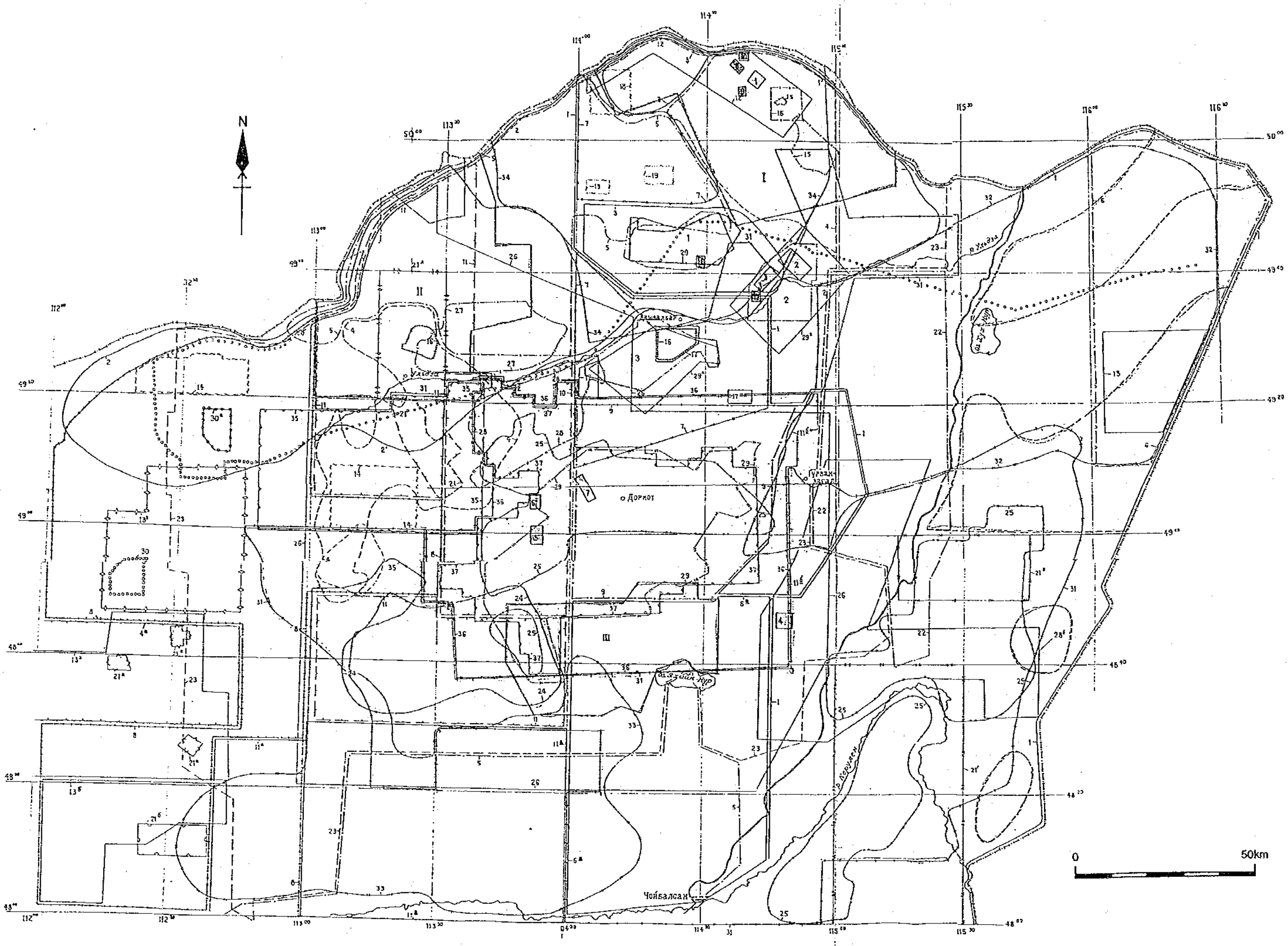
The statistics of mineral production and external trade are exhibited in Appendices to this volume.

1-1-4 Observation

Until recently, information on Mongolia's geology and mineral industry was hardly available to the western countries, In order for Japan and Mongolia to implement the joint surveys of mineral resources under such circumstances, it was essential for the Japanese side to grasp the geology, ore deposits, the history and current situations of

Table II-1-1 List of Previous Survey Works in the Dornod District

No.	Reg. No.	Survey Method	Performance	Age	Purpose	Conductor	Results
1	1264	Gravity Survey line span 3 ～4 km point distance 1km gravimetorГКА No. 27 accuracy 0.5mgal	9,800 km^2 (whole Choibalsan basin)	1952	Oil	Ministry of Petroreum Industry, USSR КВАНОВА	①Gravvity map(1:100,000 2mgal intvl ②discovery of Sumin-nuur basin ③no density data
2	1762	Aero-magnetic Surv. line span 1.8 km flight alt 200±20m magnetmeter АММ-13 navigation topo map	205,000 km^2 E area 156,000km^2 W area 49,000km^2	1966 ～ 1967	general prospective	Ministry of Mining, MPR. В.Н. [illegible] А.Н. [illegible]	①Magnetic anomaly map 1: 200,000 1:1,000,000
3	2060	Gravity Survey line span 3 ～4 km presumed D. 2.67 gravimetor ГКА-7Т	5,700 km^2 measuring 738 pts Ulz R. to Imalkin R.	1972 ～ 1973	Sn, W granite pluton- greisen	MPR-USSR JV	A blind pluton was predicted near by Chuluun Haraat. no density data
4	2447	Aero γ-rayl: 25,000 Auto γ-rayl: 10,000 〃 1: 25,000 〃 1:200,000 Man γ-ray Radio Act. 1: 10,000 Trench	32,600 km^2 647 km^2 2,392 km^2 1,062 km^2 5,291 pts 71 km^2 168,800 m^3	1972 ～ 1974	U	Ministry of Geology, USSR / MPR JV	Aero- γ-ray map 1: 25,000 Aero-magnetic map 1: 50,000 1:200,000 83 anomalies were extracted.
5	2416	Gravity Survey Car borne Man borne	600 km^2 487 km^2 113 km^2	1976 ～ 1977	U	Ministry of Geology, USSR / MPR JV	Many Uranium ore-showings were discovered.
6	2459	Root Geol. Surv. Geochemical Surv. Trenci Boring γ-logging Radio Activation M. Erectric(I.P., S.P.) Car-Magne(1/10,000, 1/25,000)	2,912 km 26,734 pcs 287,904 m^3 113,929 m 112,929 m 106,890.5 m 402.6 km 563 km^2	1986 ～ 1989	Poly-metal	Ministry of Geology, USSR / MPR JV	Ore-reserve of Ulaan and Muhar was increased. Avtartolgoi ore deposit was discovered.
7	4441	Geol Surv. 1:50,000 〃 (Root) Geochemical Survey Panning Trench Pit Boring Magnetic Survey	1,250 km^2 17,115 km 42,292 pcs 3,708 pcs 456,474 m^3 277.5 m 2,226.1 m 644 km	1986 ～ 1990	Poly-metal	Mongolia O. Gombobaatar B. Tsogtsaihan	Geologic map (1: 50,000) Many polymetallic ore deposit such as Altan Tolgoit, Salhiit, Umnug were discovered.
8	4555	Geol. Surv. 1:200,000 〃 1: 50,000 Geophys-Geochm cplx	40,000 km^2	1989 ～ 1990	Poly-metal, Ag, Sb, F	Minstry of geo-	discovery of Baits (poly metal) and Huhur(Cu-Au, Cu-Sn)



No.	Contor	Author	Year	Scale
1		Marinov, N.A. et al.	1943	1:1,000,000
2		Jelubonokii, U.O.	1943	1:1,000,000
3		Kalenoa, A.D. et al.	1944	1:200,000
4		Ivanov, A.H., Anpilov, M.A	1945	1:200,000
4 а		Pomazov, N.D.	1945	1:200,000
5		Litenko, S.T. et al.	1952	1:200,000
6		Danilov, B.I.	1953	1:200,000
6 а		Kireichev, V.D.	1953	1:200,000
7		Byazovov, U.S., Alekseev, T.A.	1958	1:200,000
8		Blagonravov, V.A. et al.	1968	1:200,000
9		Amgaa, J. et al.	1972	1:200,000
10		Togtoh, D. et al.	1973	1:200,000
11		Togtoh, D. et al.	1974	1:200,000
11 а		Maslennikov, E.A. et al.	1954	1:200,000
11 б		Maslennikov, E.A. et al.	1953	1:50,000;1:100,000
12		Borkov, F.Ts. et al.	1959	1:50,000
13		Linikov, V.I.	1953	1:50,000
13 а		Norovsambuu, Ts. et al.	1981-84	1:50,000
13 б		Norovsambuu, Ts. et al.	1984-86	1:50,000
13 в		Chuluunsuh	1984-87	1:50,000
14		Varlamov, V.A., Gorobov, V.A.	1961	reconnaissance survey and evaluation
15		Vanzragch, J., Baibob	1968-69	
16		Anufriev, I.F., Sokolov, K.M., Nyam. B.	1969	
17		Suhbaatar, H., Altangerels, Nyam, B.	1970	
18		Zahai, T., Lavrinenko, L.	1970	
19		Kuznetsov, V.A., Obolenskii, A.A.	1977	
20		Tumursuh, Z., Sumiyana, D., Udina, A.	1980	ditto
21		Dolgor, Ya. et al.	1983	ditto
21 а		Norovsambuu, Ts.	1981-82	1:10,000
21 б		Avid, N.	1980-81	1:25,000
21 в		Gombobaatar, Sanjsugar, Terebilo	1986	1:50,000
21 г		Ganbaatar, Arslin, Snetkov, M.Y.	1988	1:50,000
21 д		Anhbayar et al.	1986	1:50,000
Airborne Geophysical Map				
22		Markov, A.I., Chirtsov, L.D.	1981	1:200,000
23		Markov, A.I., Chirtsov, L.D.	1970-80	1:25,000
γ-ray Spectrometry Survey				
24		Samovich, D.A., Chirtsov, L.D.	1970-74	1:200,000
25		Chirtsov, L.D., Malevich, D.Z.	1971-75	1:10,000-1:25,000
Geological Map				
26		Vladimirskii, G.M. et al.	1976-79	1:200,000
27		Lecherkin, U.N. et al.	1975-76	1:50,000
28		Gusev, A.I., Rogutenok, R.K. et al.	1976-77	1:50,000
29		Pecherkin, U.N. et al.	1972-80	1:50,000
29 а		Mironov, U.B. et al.	1978-88	1:50,000
29 б		Soloviev, N.S. et al.	1987-89	1:200,000
Revised Survey Work				
30		Tsekin, V.V., Tsekina, A.I.	1974-85	1:100,000
30 а		Margai, A. et al.	1971-76	1:25,000
Gravimetric Map				
31		Glyaniko, N.K., Kuznetsov, A.G., Levitskaya, A.I.	1982-85	1:500,000;1:200,000
32		Ivanova, B.A. et al.	1952	1:200,000
33		Gerenblat, T.M. et al.	1954	1:200,000
34		Zorin, U.A., Turutanov, E.H.	1973	1:200,000
35		Tudev, Lurevdorj, Dagvadorj et al.	1981-83	1:100,000
36		Zlobin, V.P., Semenov, G.G., Ivannikov, V.N. et al.	1974-83	1:200,000;1:50,000

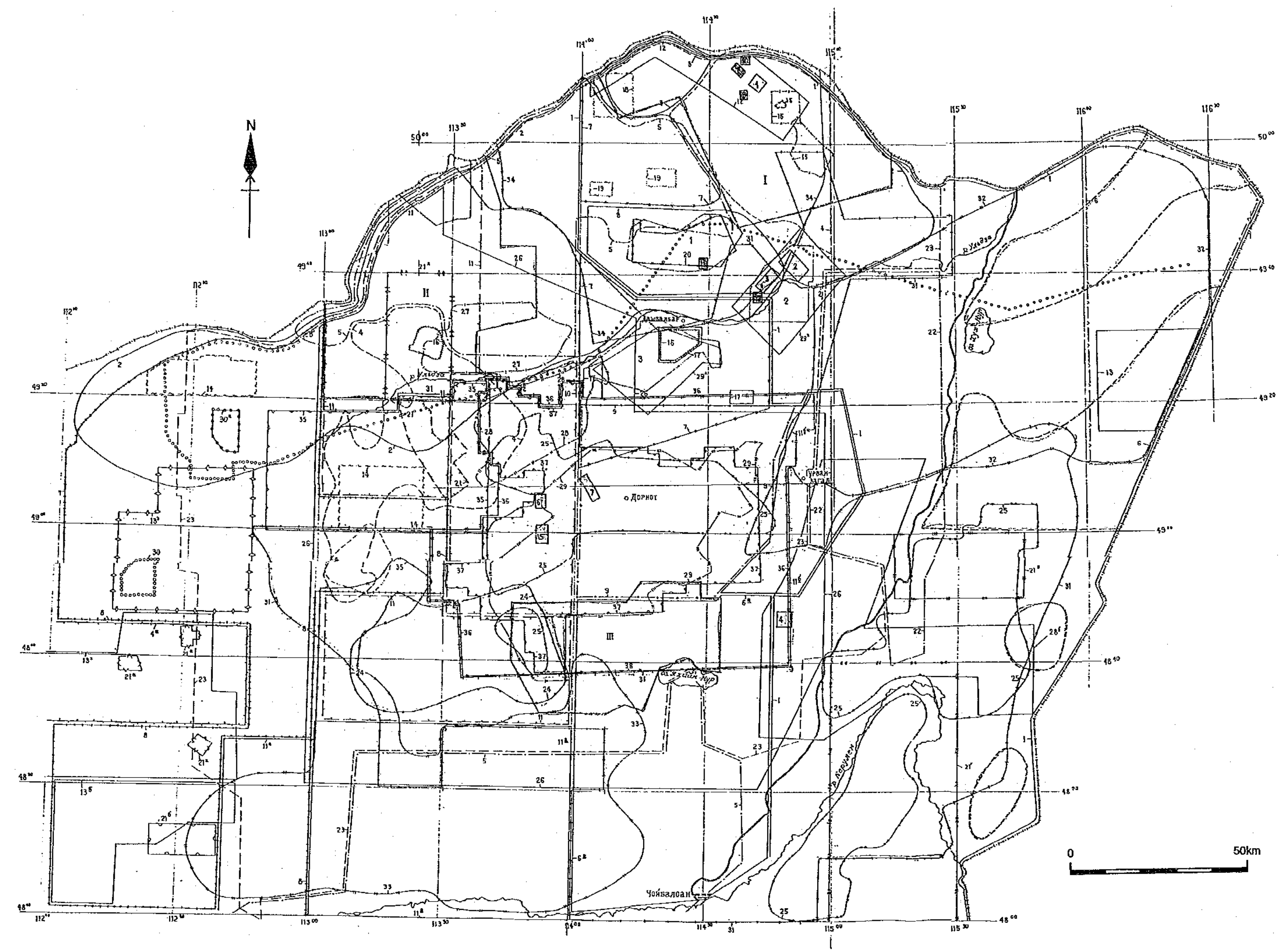
1 — Geologic mapping scale 1:50,000
geochemical sampling, trench and drilling
1 - Arshanskaya, 2 - Uldeinskaya (gravity survey, drilling),
3 - Dashibalbarskaya (short drilling)

I — Geologic mapping scale 1:200,000
I - Yujino Aginskaya, II - Turganskaya,
III - Yahiin Nurskaya

Reconnaissance survey
scale 1:500,000 - 1:1,000,000

After Ministry of Geology, USSR (1990)
"- North Choibalsan Area -
Location Map of Geological and Geophysical Study Area"

Fig. II-1-1-1 Location Map of the Previous Survey Works in the Dornod District



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3		Kalenoa, A.D. et al.	1944	1:200,000
4		Ivanov, A.H., Angilov, M.A	1945	1:200,000
4 a		Pomazov, N.D.	1945	1:200,000
5		Lizenko, S.T. et al.	1952	1:200,000
6		Danilov, B.I.	1953	1:200,000
6 a		Kirelchev, V.D.	1953	1:200,000
7		Byzovov, U.S., Alekseev, T.A.	1958	1:200,000
8		Blagonravov, V.A. et al.	1968	1:200,000
9		Amgaa, J. et al.	1972	1:200,000
10		Togtoh, D. et al.	1973	1:200,000
11		Togtoh, D. et al.	1974	1:200,000
11 a		Maslennikov, B.A. et al.	1954	1:200,000
11 б		Maslennikov, E.A. et al.	1953	1:50,000;1:100,000
12		Borkov, P.Ts. et al.	1959	1:50,000
13		Linikov, V.I.	1953	1:50,000
13 a		Norovsambuu, Ts. et al.	1981-84	1:50,000
13 б		Norovsambuu, Ts. et al.	1984-86	1:50,000
13 в		Chuhsuren	1984-87	1:50,000
14		Varlamov, V.A., Gorohov, V.A.	1961	
15		Vanzragch, J., Bathub	1968-69	
16		Anufriev, I.F., Sokolov, K.M., Nyam, B.	1969	reconnaissence survey and evaluation
17		Suhbaatar, H., Altangerels, Nyam, B.	1970	
18		Zahal, T., Lavrinenko, L.	1970	
19		Kuznetsov, V.A., Obolenskii, A.A.	1977	
20		Tumursuh, Z., Sumiyana, D., Udina, A.	1980	ditto
21		Dolgor, Ya. et al.	1983	ditto
21 a		Norovsambuu, Ts.	1981-82	1:10,000
21 б		Avid, N.	1980-81	1:25,000
21 в		Gombobaatar, Sanjsugar, Terebilo	1986	1:50,000
21 г		Garbaatar, Arslin, Snetkov, M.Y.	1988	1:50,000
21 д		Anhbayar et al.	1986	1:50,000
		Airborne Geophysical Map		
22		Markov, A.I., Chirtsov, L.D.	1981	1:200,000
23		Markov, A.I., Chirtsov, L.D.	1970-80	1:25,000
		γ-ray Spectrometry Survey		
24		Sarovich, D.A., Chirtsov, L.D.	1970-74	1:200,000
25		Chirtsov, L.D., Malevich, D.Z.	1971-75	1:10,000-1:25,000
		Geological Map		
26		Vladimirskii, G.M. et al.	1976-79	1:200,000
27		Lecherkin, U.N. et al.	1975-76	1:50,000
28		Gusev, A.I., Rogutenok, R.K. et al.	1976-77	1:50,000
29		Pecherkin, U.N. et al.	1972-80	1:50,000
29 a		Mironov, U.B. et al.	1978-88	1:50,000
29 б		Soloviev, N.S. et al.	1987-89	1:200,000
		Revised Survey Work		
30		Tsekin, V.V., Tsekina, A.I.	1974-85	1:100,000
30 a		Margal, A. et al.	1971-76	1:25,000
		Gravimetric Map		
31		Glyanko, N.K., Kuznetsov, A.G., Levitskaya, A.I.	1982-85	1:500,000;1:200,000
32		Ivanova, B.A. et al.	1952	1:200,000
33		Gerenblat, T.M. et al.	1954	1:200,000
34		Zorin, U.A., Turutanov, E.H.	1973	1:200,000
35		Tudev, Lurevdorj, Dagvadorj et al.	1981-83	1:100,000
36		Zlobin, V.P., Semenov, G.G., Ivanrikov, V.N. et al.	1974-83	1:200,000;1:50,000

1 — Geologic mapping scale 1:50,000
geochemical sampling, trench and drilling
1 - Arshanskaya, 2 - Uldeinskaya (gravity survey, drilling),
3 - Dashibalbarskaya (short drilling)

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Reconnaissance survey
scale 1:500,000 - 1:1,000,000

After Ministry of Geology, USSR (1990)
"- North Choibalsan Area -
Location Map of Geological and Geophysical Study Area"

Fig. II-1-1-1 Location Map of the Previous Survey Works in the Dornod District

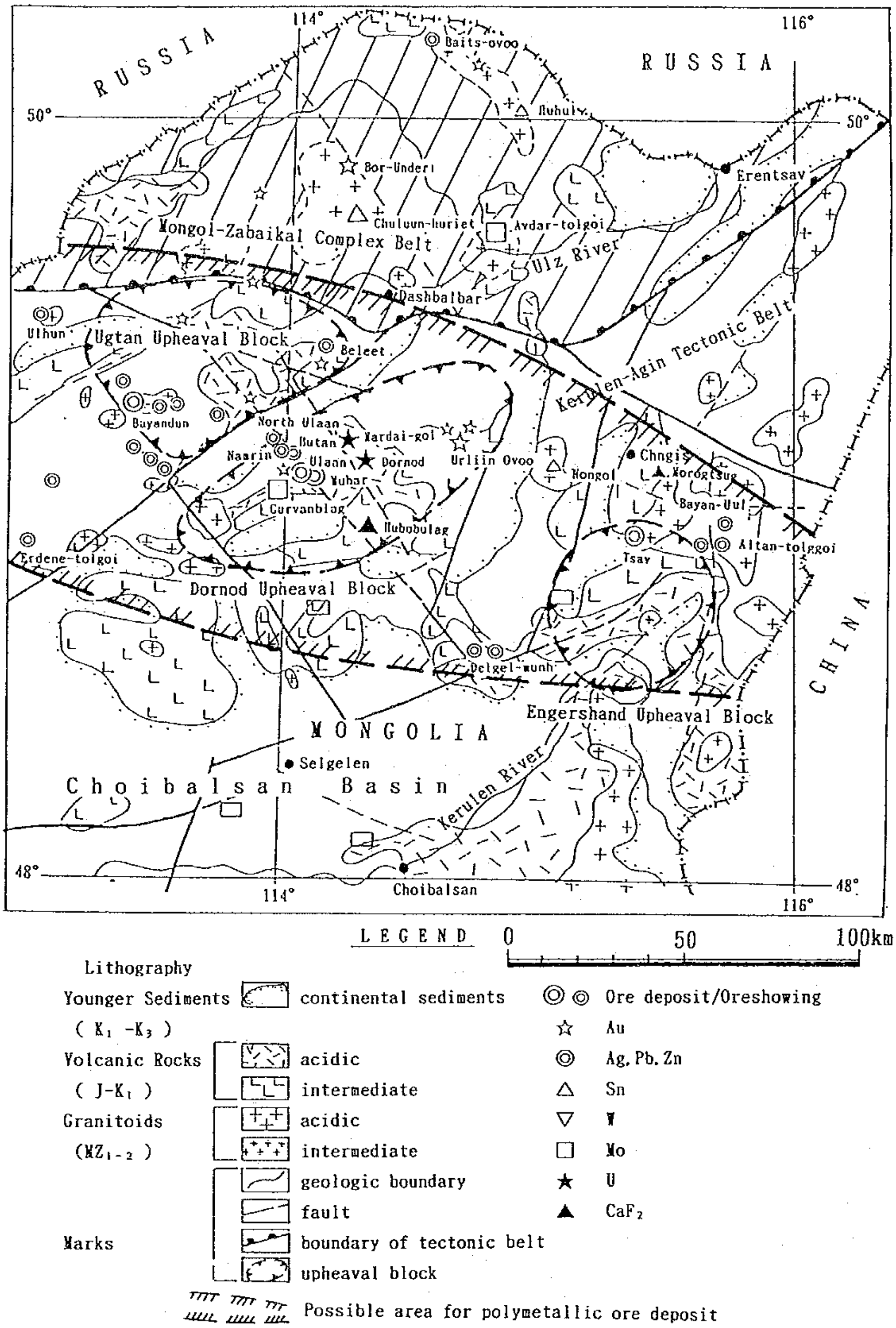


Fig. II-1-1-2 Interpreted Map of the Existing Data in the Dornod District mining industry in Mongolia as precisely as possible, inasmuch as such information is indispensable for formulating appropriate survey policies and for executing effective survey.

In this sense, it was of great significance and effect to have first conducted the existing data compilation upon the start of joint suvey.

1-2 Satellite image analysis (phase I,II)

1-2-1 Photo-geological interpretaion(PGI)

a) purpose

PGI was intended to study regional geological structure, faults, folds, intrusive rocks, etc. of the entire survey area.

b) Data used

Table II-1-2 indicates the used data and their particulars,and the locations of image data are shown in Fig.II-1-2-1. As numbers of data were limited in many cases, it was not always possible to select data of image quality, season and satellite, as desired.

c) Data processing

From the available data of 43 scenes, 17 scenes of MSS data two scenes of TM data were picked out and obtained in the form of positive films of false color images. with regard to the remaining 26 scenes, positive color films were made from the monochrome films of MSS bands 4, 5 and 7 by analog composition. The scale of images used for the interpretation was 1/500,000.

d) Image interpretation

Using the false color images in a 1/500,000 scale, lineament extraction and classification of rock facies were made with photo-geological techniques. Interpretation results were compiled with a scale of 1/1,000,000.(PL II-1-2 and PL II-1-3)

e) Lineament analysis findings

In areas where formations above the upper Cretaceous are distributed, clear lineaments are not recognizable, whilst the lineament density is high in areas where older formations are distributed. In the southwestern part of the survey area, east-west lineaments and faults are conspicuous, but, in the central part, the direction shifts somewhat to NE-SW and, in the northeastern part, NE-SW lineaments are prominent. These directions correspond to the paleozoic orogenic belt of the area.

In Olon-ovoot Area, mineral indications are distributed around ENE-WSW faults and portions of dense lineaments. This suggests that deposition of the ore minerals was controlled by fissures.

f) Findings of geological unit interpretation

The boundary between the upper Cretaceous soft rock and the underlying hard rock is clearly observed on the images, as well as distribution of granitic rock and limestone.

It can be seen from distribution of mineral indications in compar-

Table Ⅱ-1-2 LANDSAT Data for Geological Interpretation

	Sensor	Data Form	Satellite	Path	Row	Date	Distributor
1	MSS	1/1,000,000 color film	L4	126	27	Oct.17,1990	EOSAT
2	TM	1/1,000,000 color film	L5	126	29	Oct.25,1990	China
3	MSS	1/1,000,000 color film	L4	127	26	Oct.08,1990	EOSAT
4	MSS	1/1,000,000 color film	L4	127	27	Oct.08,1990	EOSAT
5	TM	1/1,000,000 color film	L5	127	28	Apr.07,1990	China
6	MSS	1/1,000,000 color film	L4	129	27	Oct.22,1990	EOSAT
7	MSS	1/1,000,000 color film	L5	130	27	Mar.30,1991	EOSAT
8	MSS	1/1,000,000 color film	L5	130	28	Sept.03,1990	EOSAT
9	MSS	1/1,000,000 color film	L5	130	29	Sept.03,1990	EOSAT
10	MSS	1/1,000,000 color film	L5	132	28	Sept.01,1990	EOSAT
11	MSS	1/1,000,000 color film	L5	132	30	Sept.01,1990	EOSAT
12	MSS	1/1,000,000 color film	L5	132	31	Sept.01,1990	EOSAT
13	MSS	1/1,000,000 color film	L3	132	27	Jul.20,1981	NASDA
14	MSS	1/1,000,000 color film	L2	133	27	Aug.01,1979	NASDA
15	MSS	1/1,000,000 monochrome film	L2	134	27	May 07,1975	EOSAT
16	MSS	1/1,000,000 monochrome film	L2	134	28	May 25,1975	EOSAT
17	MSS	1/1,000,000 monochrome film	L2	135	25	Apr.20,1975	EOSAT
18	MSS	1/1,000,000 monochrome film	L3	135	26	May 08,1975	EOSAT
19	MSS	1/1,000,000 color film	L2	135	27	May 12,1981	EOSAT
20	MSS	1/1,000,000 color film	L2	135	28	May 12,1981	EOSAT
21	MSS	1/1,000,000 monochrome film	L2	136	25	Aug.01,1976	EOSAT
22	MSS	1/1,000,000 monochrome film	L2	136	26	May 09,1975	EOSAT
23	MSS	1/1,000,000 monochrome film	L1	136	27	Nov.06,1973	EOSAT
24	MSS	1/1,000,000 monochrome film	L1	136	28	Nov.06,1973	EOSAT
25	MSS	1/1,000,000 monochrome film	L2	137	25	Sept.02,1977	EOSAT
26	MSS	1/1,000,000 monochrome film	L1	137	28	Dec.13,1973	EOSAT
27	MSS	1/1,000,000 monochrome film	L1	137	29	Dec.13,1973	EOSAT
28	MSS	1/1,000,000 monochrome film	L1	137	30	Dec.13,1973	EOSAT
29	MSS	1/1,000,000 monochrome film	L2	138	27	May 11,1975	EOSAT
30	MSS	1/1,000,000 monochrome film	L1	138	28	Nov.26,1973	EOSAT
31	MSS	1/1,000,000 monochrome film	L1	138	29	Dec.14,1973	EOSAT
32	MSS	1/1,000,000 monochrome film	L1	138	30	Dec.14,1973	EOSAT
33	MSS	1/1,000,000 monochrome film	L1	138	31	Dec.14,1973	EOSAT
34	MSS	1/1,000,000 monochrome film	L1	139	28	Dec.15,1973	EOSAT
35	MSS	1/1,000,000 monochrome film	L1	139	29	Dec.15,1973	EOSAT
36	MSS	1/1,000,000 monochrome film	L1	139	30	Dec.15,1973	EOSAT
37	MSS	1/1,000,000 color film	L3	139	31	Sept.21,1979	EOSAT
38	MSS	1/1,000,000 monochrome film	L1	140	31	Dec.03,1972	EOSAT
39	MSS	1/1,000,000 monochrome film	L1	141	28	Jan.04,1974	EOSAT
40	MSS	1/1,000,000 monochrome film	L1	141	29	Jan.04,1974	EOSAT
41	MSS	1/1,000,000 monochrome film	L1	141	30	Feb.14,1973	EOSAT
42	MSS	1/1,000,000 monochrome film	L1	141	31	Jan.09,1973	EOSAT
43	MSS	1/1,000,000 monochrome film	L1	142	29	Jun.03,1973	EOSAT

ison with geological interpretation map that, in Ulziit District, many mineral indications are distributed in Devonian or Silurian formations. It can be also seen that, in the southeastern part of district, many copper indications are distributed accompanying Carboniferous small-size granitic rocks.

1-2-2 Extraction of alteration zones

a) Purpose

This work was intended to distinguish alteration zones and lithofacies and to extract details of geological structure such as faults, foldings, beddings, intrusives, etc.

b) Data used

The used data and their particulars are shown on Table II-1-3 while Fig.II-1-2-2 indicates the locations.

c) Data processing

Two types of color composite images of bands 2, 3 and 4, and 4, 5 and 7 were prepared. On the other hand, spectral analysis of the surface reflectance was done to see the spectrum characteristics by lithologic characters. Based upon the results, image processing was done using combinations of bands effective for distinguishment of lithofacies.

d) Image interpretation

Interpretation of images in a 1/200,000 scale of Ulziit District was done, the results of which are shown in PL.II-1-4. As the result, it was found to be difficult to extract alteration zones on an image. It was confirmed by surface survey that the difficulty is due to the small size of alteration zones. Information on geological structures and fault displacement were captured on the images with certain clearness.

Fig.II-1-2-3 and II-1-2-4 show the DPCA imags and results of interpretation of the area surrounding Tsagaan-suvraga Deposit. With the processing, distribution of the Devonian nepheline syenite rock bodies, the country rock of deposit, were more clearly observed.

1-2-3 Observation

This area has poor vegetation, which makes it an ideal field for remote sencing. Beddings, faults and intrusions could be clearly extracted from satellite images.

Hydrothermal alteration zones accompanying metallic ore deposits were hard to be extracted on images mainly for the reasons that, concerning porphyry copper, argillized zones have already been eroded, and that other ore deposits in the survey area are not accompanied by large alteration zones.

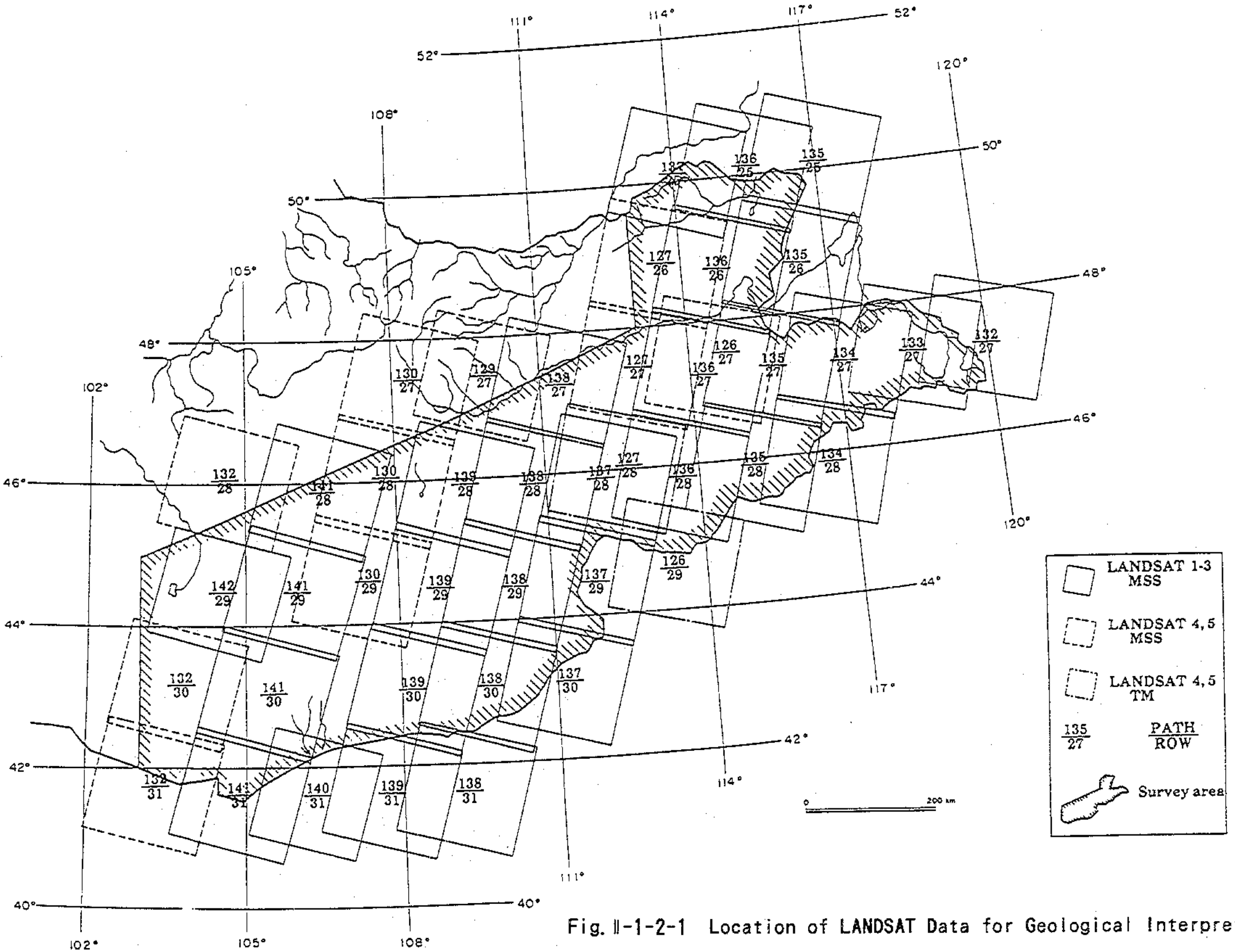


Fig. II-1-2-1 Location of LANDSAT Data for Geological Interpretation

Table II-1-3 LANDSAT Data for Delineation of Alteration Zones

	Sensor	Data Form	Satellite	Path	Row	Date	Distributor
1	TM	CCT	L4	125	26	Jun.20,1987	China
2	TM	CCT	L4	129	29	Sept.20,1987	China
3	TM	CCT	L4	129	30	Sept.06,1988	China
4	TM	CCT	L5	130	29	Sept.03,1990	EOSAT
5	TM	CCT	L4	130	30	Dec.18,1988	China
6	TM	CCT	L5	131	29	Apr.19,1990	EOSAT
7	TM	CCT	L5	132	29	Sept.17,1990	EOSAT

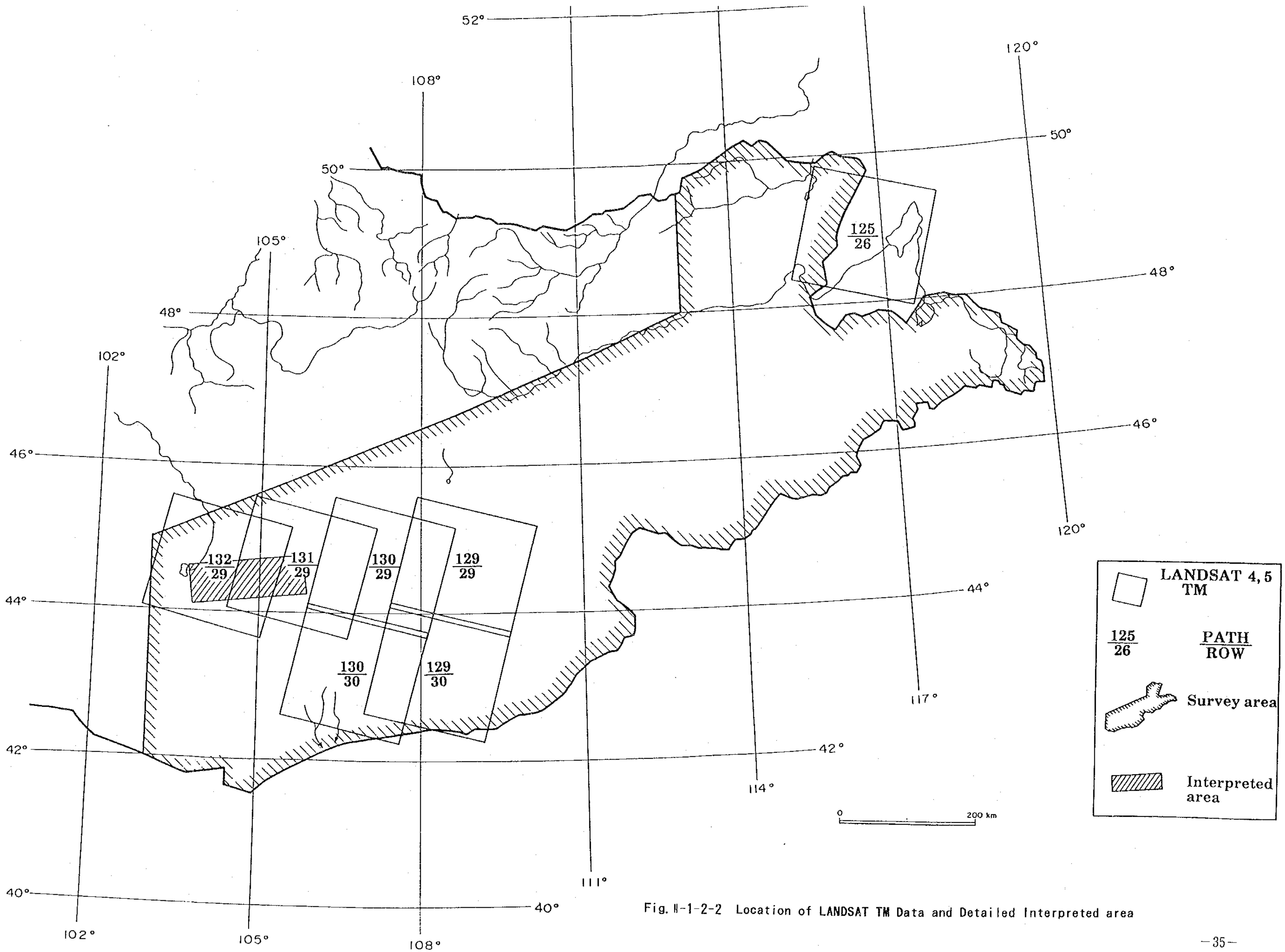
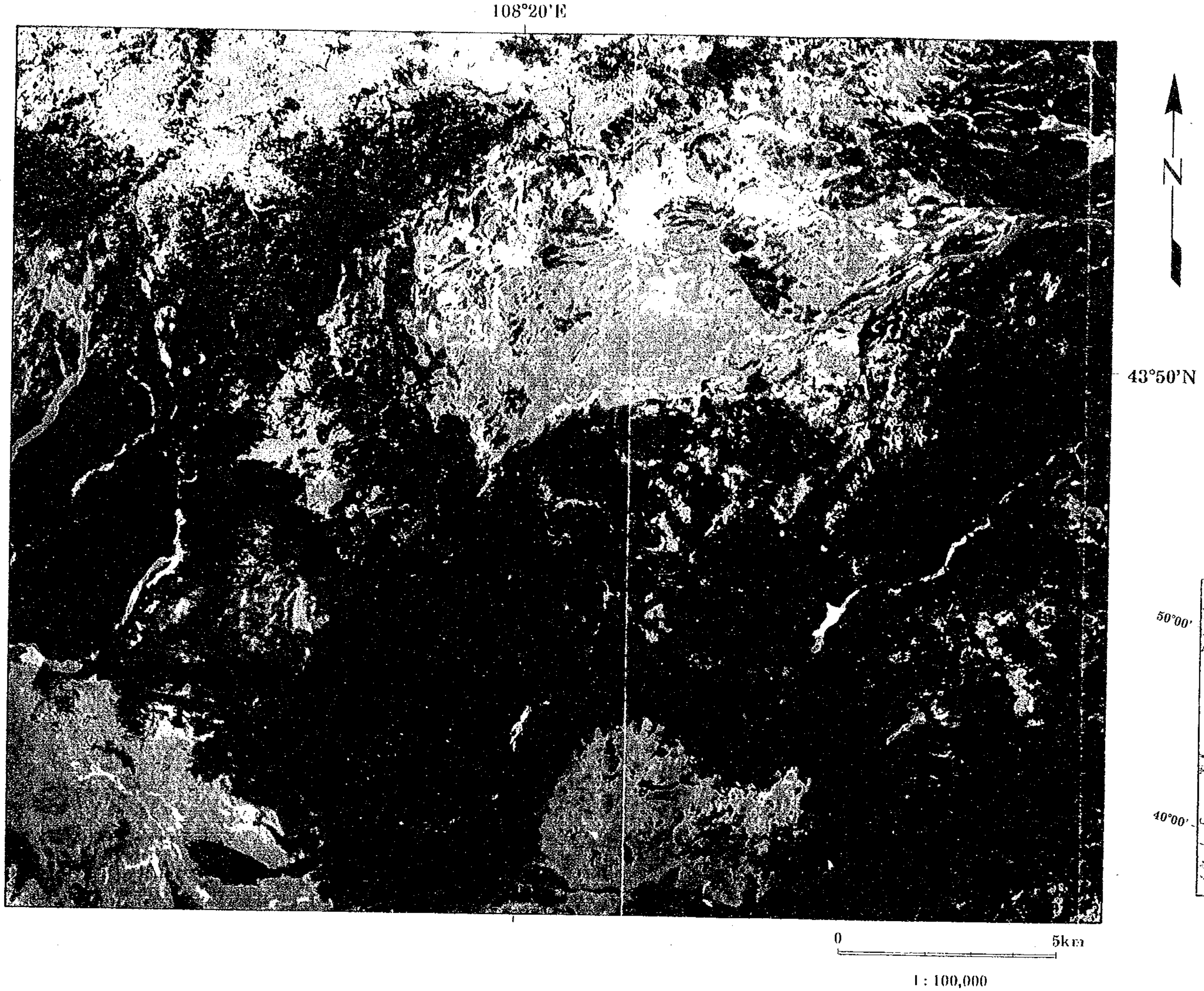


Fig. II-1-2-2 Location of LANDSAT TM Data and Detailed Interpreted area



This image was produced by principal component analysis from LANDSAT TM 5/7 and 4/3 ratio. The first principal component is displayed as red and the second as green.

Data acquisition: Sep. 6, 1988
China
Path : 129
Row : 30

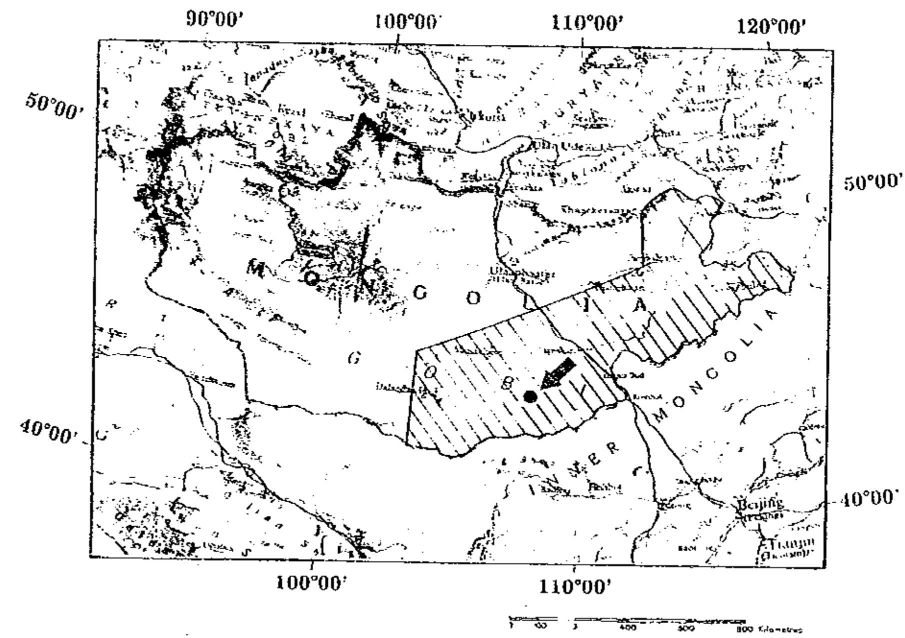


Fig. II-1-2-3 Rationing / Principal Component Analysis Image of LANDSAT TM of Tsagaan-suvraga Ore Deposit and Adjacent Area

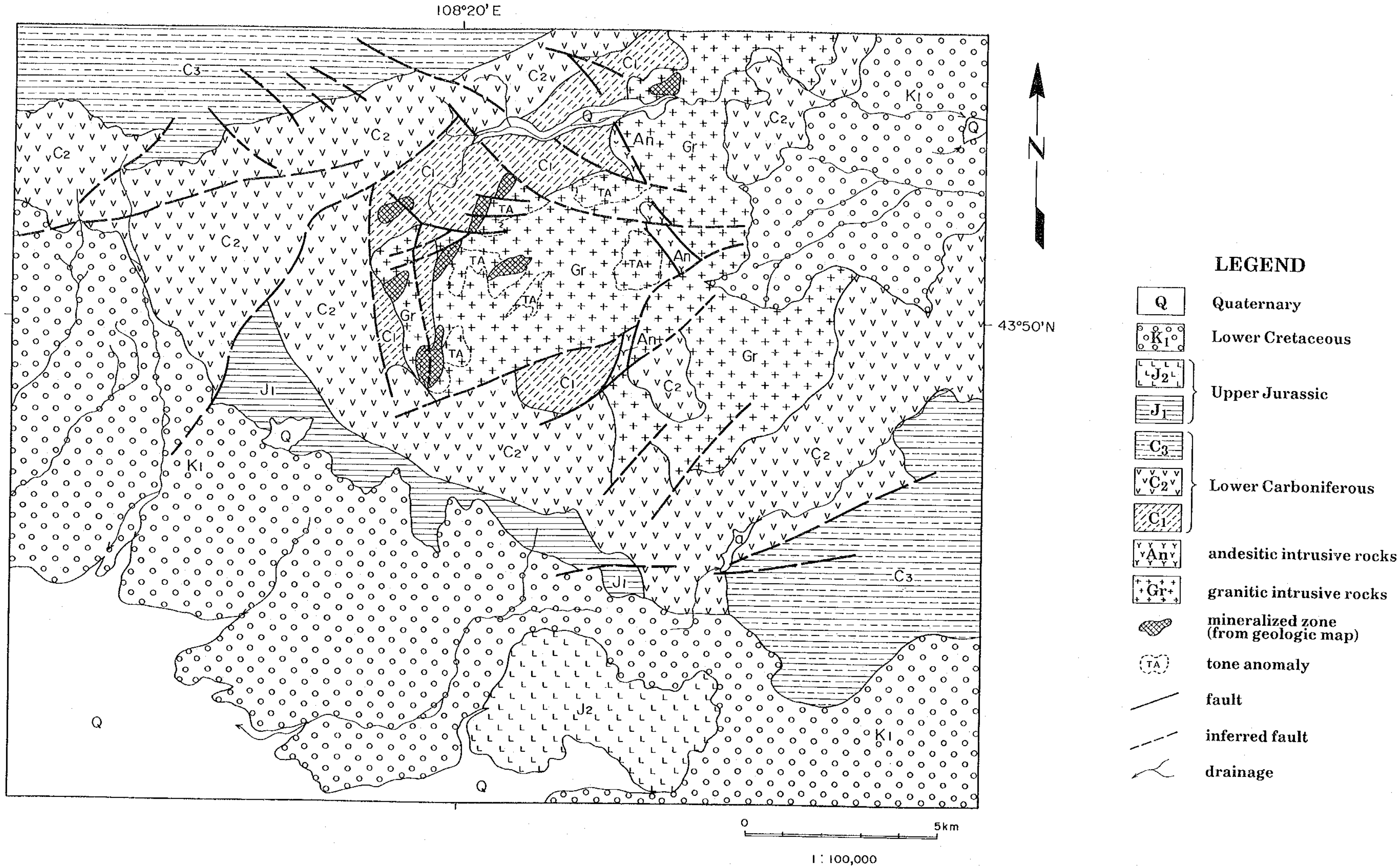


Fig. II-1-2-4 LANDSAT TM image Interpretation of Tsagaan-suvraga Ore Deposit and Adjacent Area

Chapter 2 Reconnaissance Geological Survey(1st & 2nd Years)

Reconnaissance geological survey was conducted, which formed a part of the first and second yers' survey.

The Reconnaissance geological survey involved field survey of major ore deposits and mineral indications, as well as confirmation of geological units, with the aim to clarify geological conditions in Uudam Tal Area and to grasp occurrence of ore deposits.

The first year's Reconnaissance geological survey was executed on the major deposits and indications in the seven districts selected on the basis of existing data. The survey consisted of preliminary observation by the team leader and survey work by the geological survey team. For the field survey, the GPS was used while trucks and jeeps were used for movement. Topographic maps in a 1/100,000 scale provided by the Mongolian side was utilized. The survey area was divided by type of ore deposits into seven districts, for each of which descriptions and mineral resouces evaluation were made.

The second year's Reconnaissance geological survey was conducted on major gold indications in the nine areas of Ulziit District selected from the first year's existing data compilation. Field survey was carried out in the same way as that of the first year. Survey findings were described by respective district, and evaluation of respective mineral indication was made.

2-1 Dornod District

2-1-1 Location and access

Donrnod District, situated in the extreme northeast of Mongolia, is an administrative division in the northern Dornod Aimag, having an approximate area of 33,000km^2 . A railroad connecting the Trans-Siberian Railroads and Choibalsan City, the capital of Aimag, run through the central part of district north to south, and its branch line extends east to west from Chingiskhaan to Mardai. Thus, the district has relatively well established infrastructure. From Ulaan Baatar to Choibalsan, domestic flight takes one and half hours, one way.

2-1-2 Topography and drainage system

This district with the elevation ranging from 560 to 1,300m above sea level is the lowest area in Mongolia. Most parts of this district are made up of gentle, hilly areas with altitude of 700-900m. The topography may be roughly summarized that, in the central part of district, there are lowlands stretching north to south and both the east and west sides of the lowlands are elevated.

The district has perennial rivers such as the Ulz, Kherlen and Galin, of which the Ulz and Kherlen flow into the Pacific Ocean, while the Galin is an inland river flowing into the Lake Yakh.

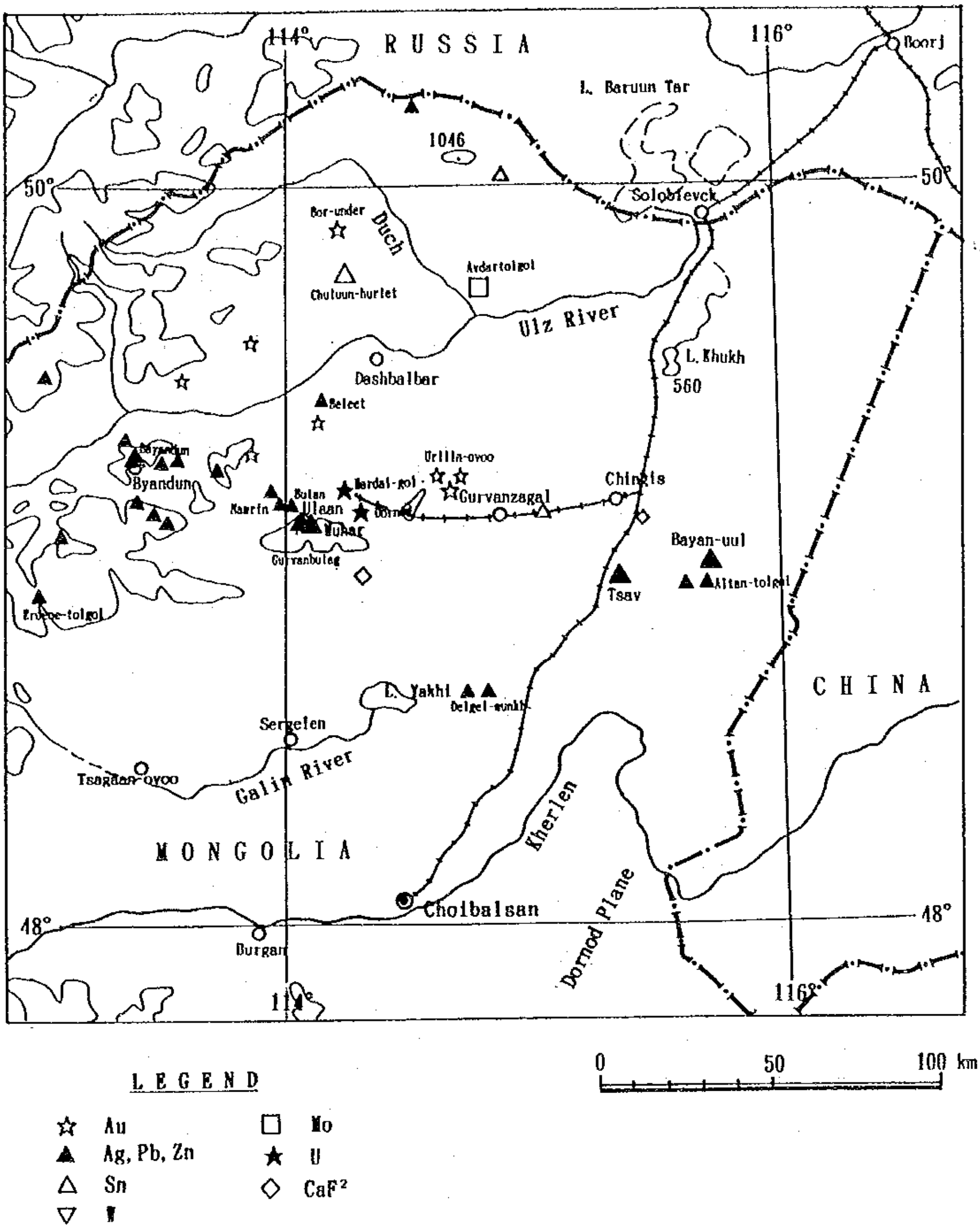
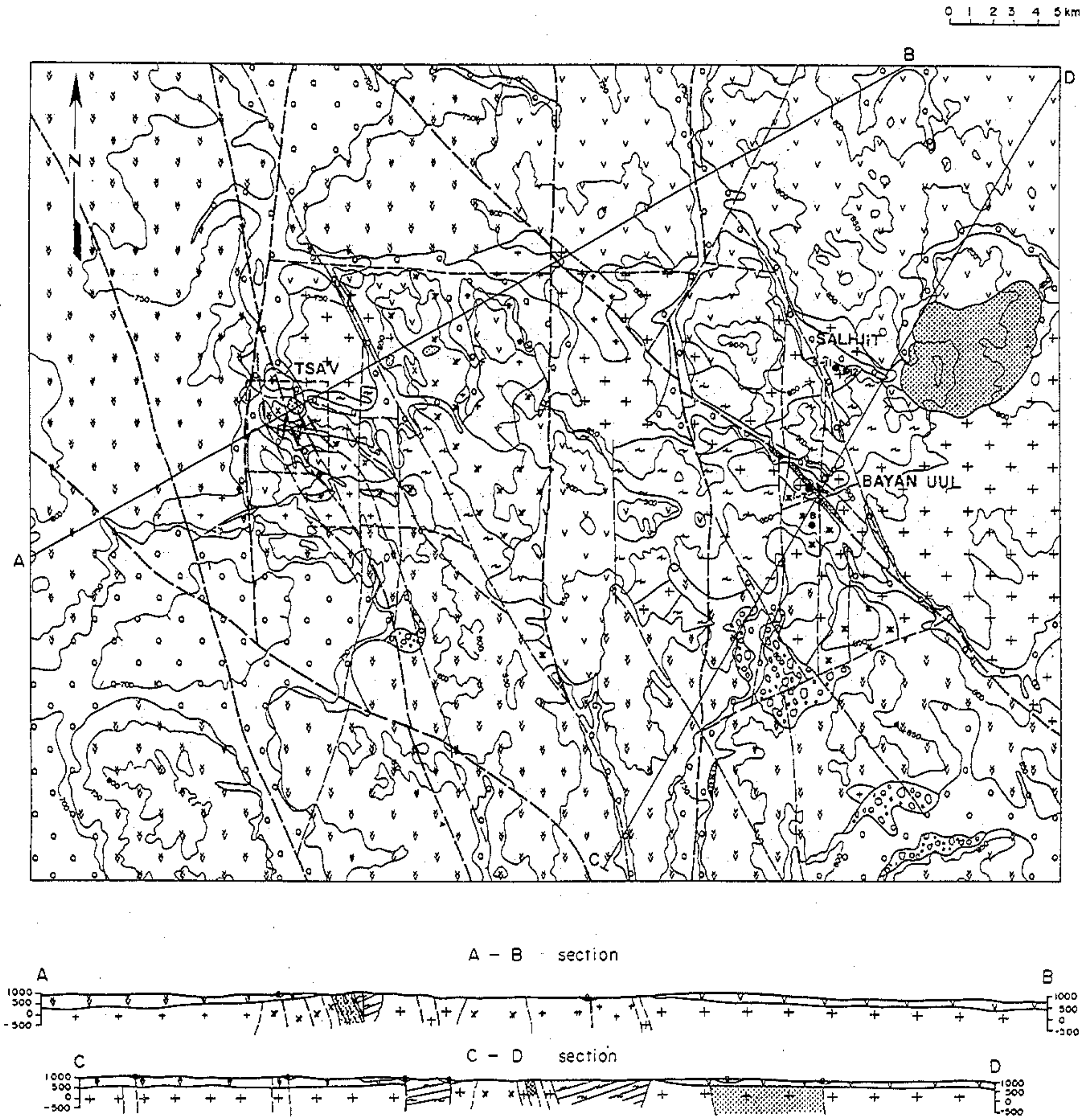
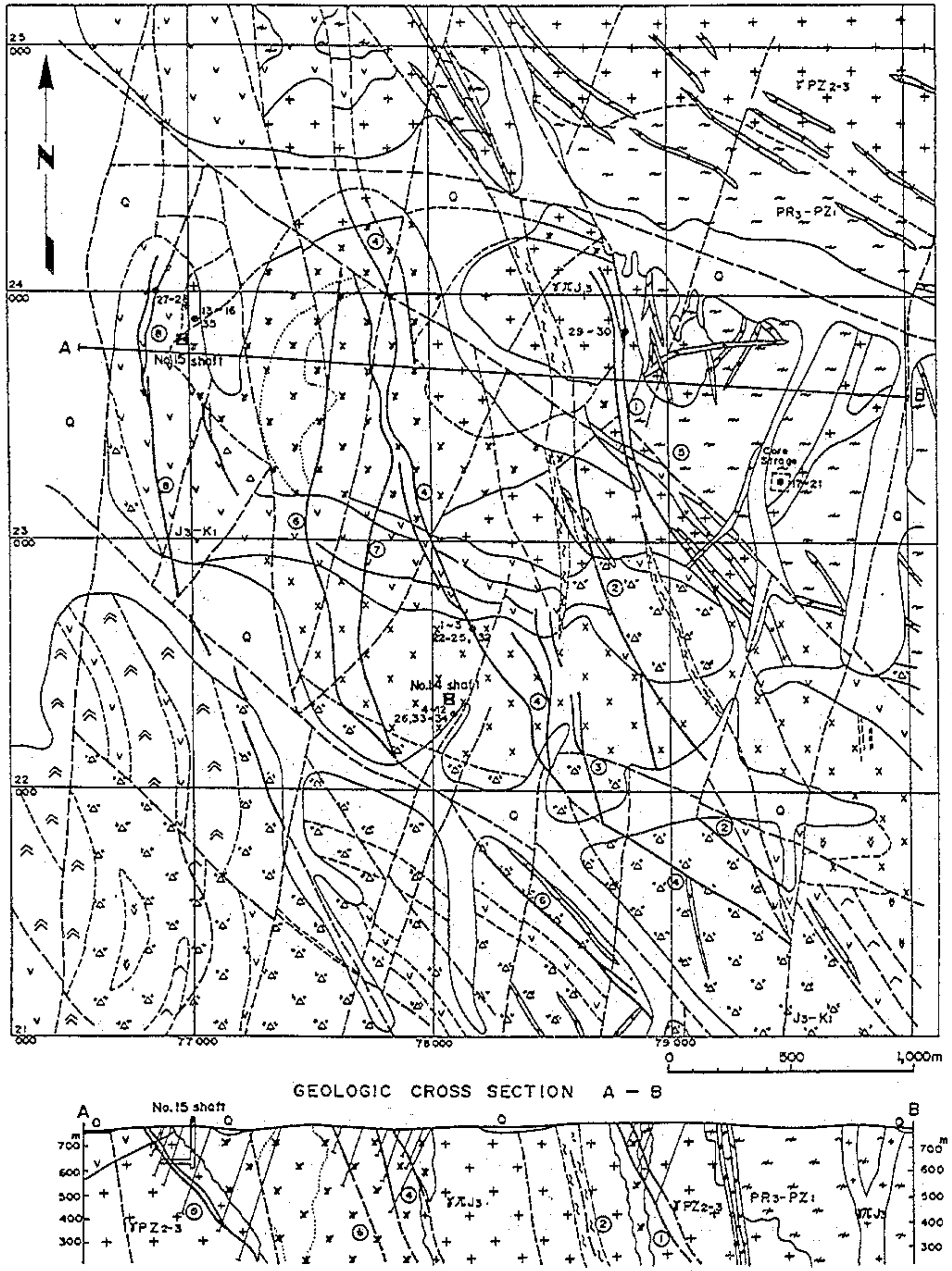


Fig. II-2-1-1 Location Map of the Ore Deposits in Dornod District (phase I)



Point No.	Sample No.	Point No.	Sample No.
1	3DN22	7	3DY12
2	3DY07	8	3DY13
3	3DY08	9	3DS11
4	3DY09	10	3DS12
5	3DY10	11	3DY05
6	3DY11	12	3DY06

Fig. Ⅱ-2-1-2 Geologic Map of Tsav — Bayan Uul



Quaternary

Gneiss, schist

VOLCANIC ROCKS

Basalt, basaltic andesite

Andesite, andesitic porphyrite

Dacite, dacitic porphyry

Andesitic "tuff-lava"

Dacitic porphyry

Volcanic breccia

INTRUSIVE ROCKS

Granite, granite porphyry

Syenite — diorite

Monzodiorite

DIKES

Andesitic porphyrite

Granite, felsite, syenite

Vein

Number of vein

Shaft

Fault

Fault with sheared zone

Sampling point and point number

Point No.	Sample No.	Point No.	Sample No.
1	3DN01	21	3DN21
2	3DN02	22	3DS01
3	3DN03	23	3DS02
4	3DN04	24	3DS03
5	3DN05	25	3DS04
6	3DN06	26	3DS05
7	3DN07	27	3DS06
8	3DN08	28	3DS07
9	3DN09	29	3DS08
10	3DN10	30	3DS09
11	3DN11	31	3DS10 (tunnel)
12	3DN12	32	3DY01
13	3DN13	33	3DY02
14	3DN14	34	3DY03
15	3DN15	35	3DY04
16	3DN16		
17	3DN17		
18	3DN18		
19	3DN19		
20	3DN20		

Fig. II-2-1-3 Geologic Map of Tsav Ore Deposit

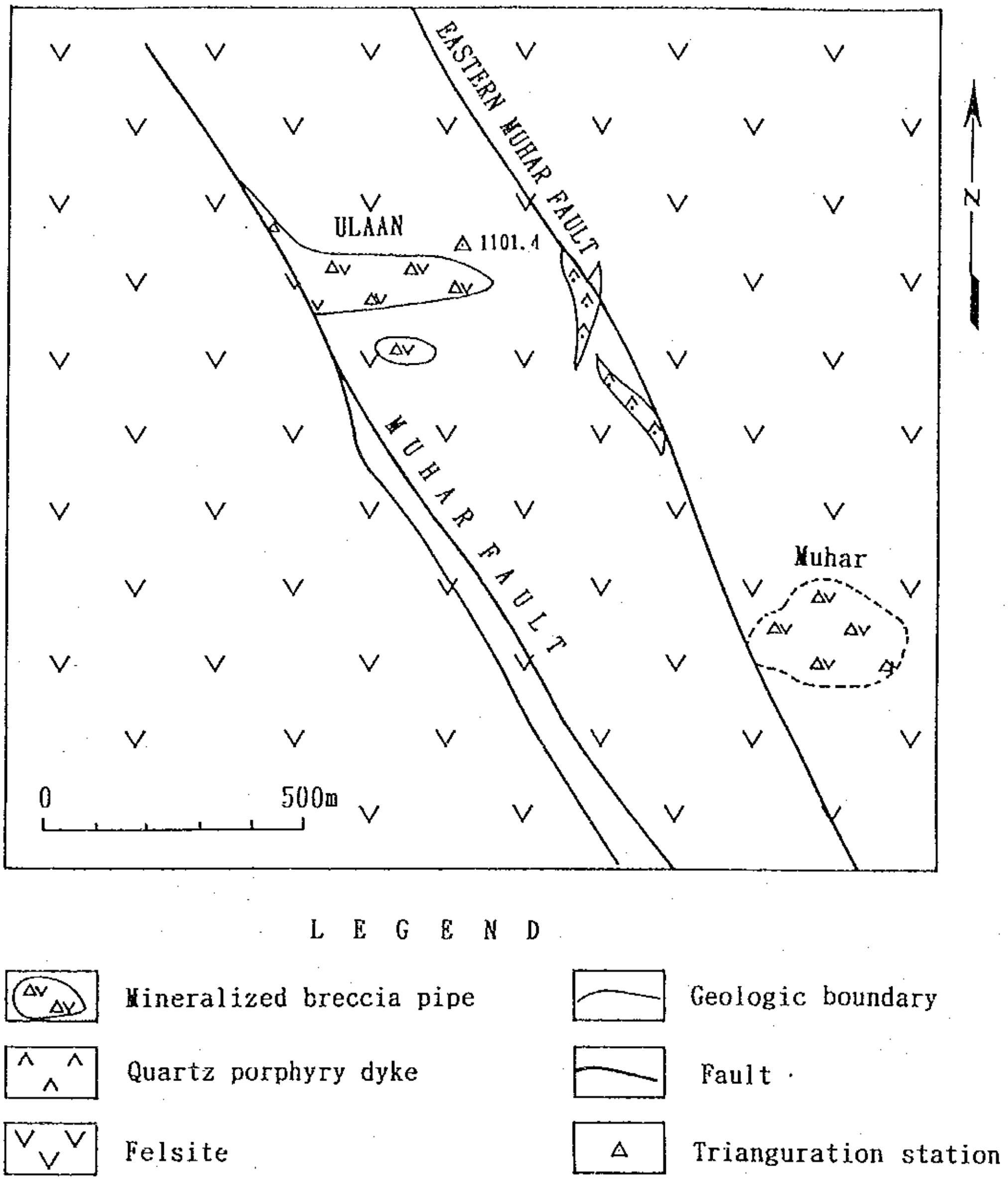
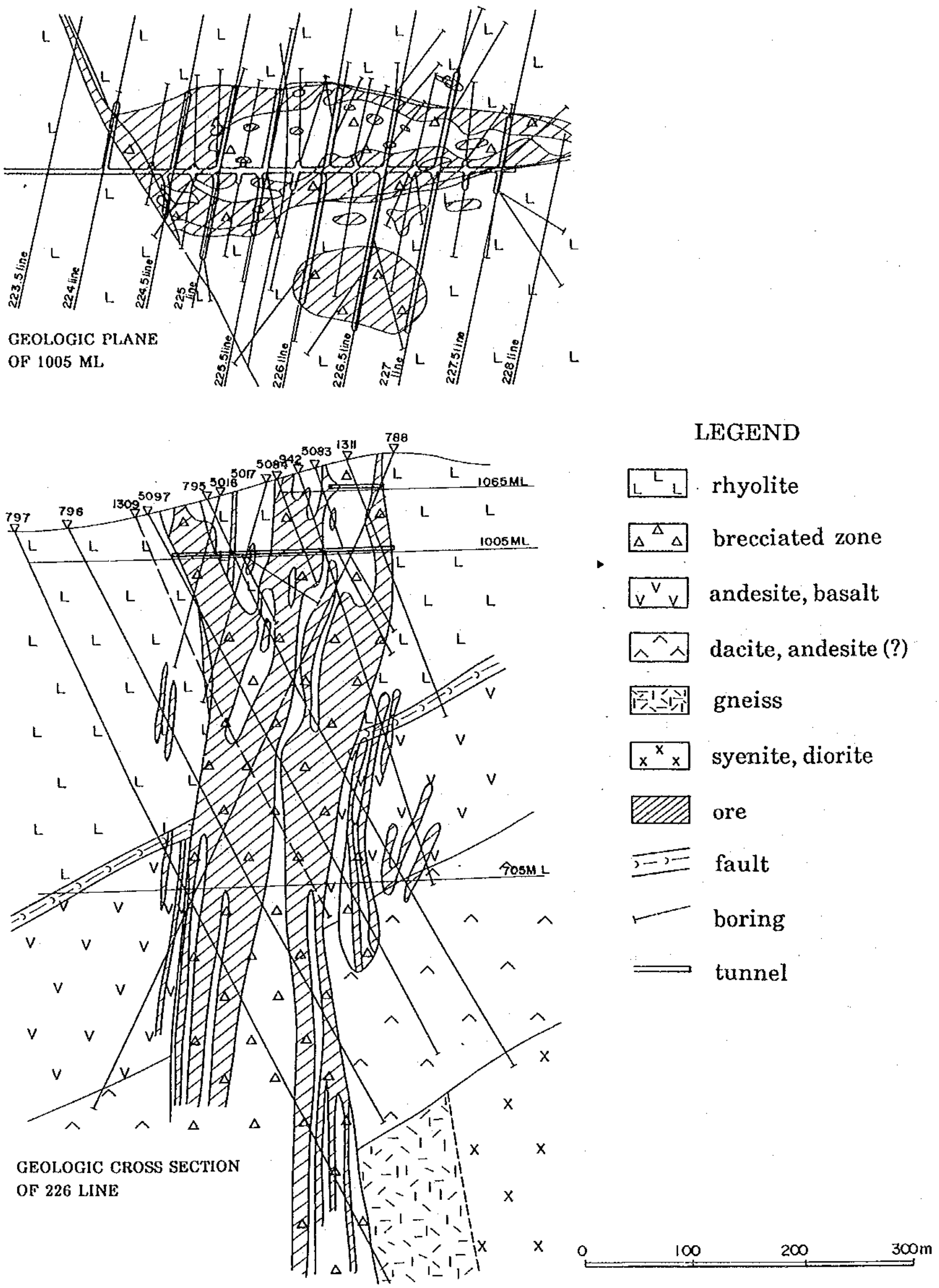


Fig. II-2-1-4 Geologic Map of Ulaan and Muhar



Modified from the data offered by MPR

Fig. II-2-1-5 Geologic Map of the Ulaan Ore Deposit

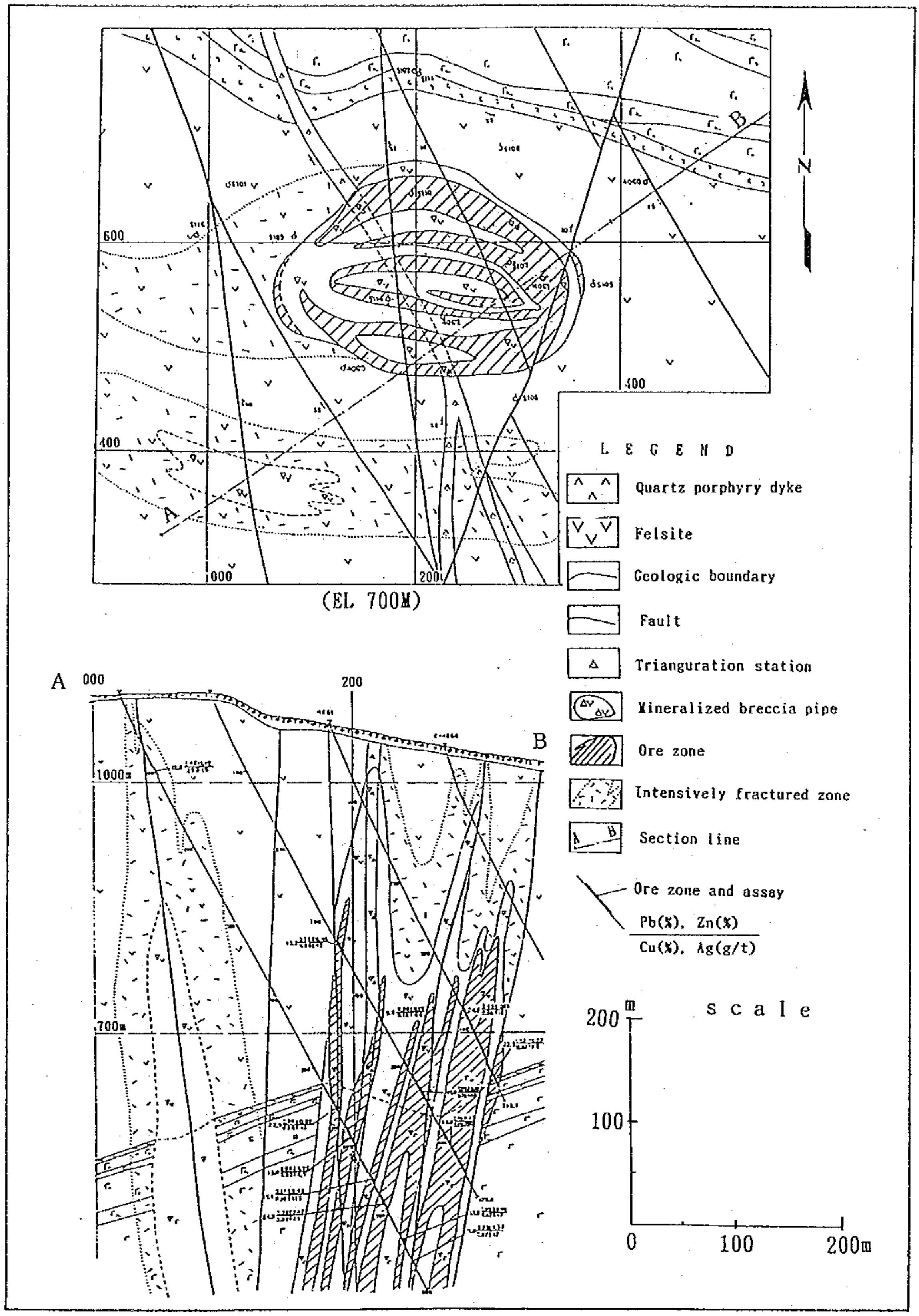


Fig. II-2-1-6 Geologic Map of the Mukhar Ore Deposit

2-1-3 Climate and Vegetation

Climatic indices vary considerably within the district depending on localities. The average annual temperature falls within a range of +0.3℃ to -1.5℃. The average monthly temperatures vary from 19-21℃ in July to -21~-23 ℃ in January. Annual precipitation is ±250mm. The district forms a steppe covered with relatively thick vegetation thanks to the moderate precipitation during summertime.

2-1-4 Geology

The geology is composed of the proterozoic and paleozoic basement and the overlyng Mesozoic.

The proterozoic and paleozoic groups consist of gneiss, schist and various sedimentary rocks of Silurian and Devonian periods, and Late Paleozoic intrusives. Such formation, forming the basement of this district, is distributed widely on the north side of the Ulz river and east side of the Choibalsan railroads.

The Mesozoic group consists of Cretaceous terrestrial formation intercalating Late Jurassic to Early Cretaceous igneous rocks and lignite beds and is distributed widely in Choibalsan Sedimentary Basin in the southwest of district. Main ore deposits in this district are polymetallic deposits formed by Mesozoic intermediate to acidic igneous activity, Besides, there occur quartz veins and uranium deposits.

2-1-5 Ore deposits

Major ore deposits in Dornod District are shown in Table II-2-1-1.

2-1-6 Observation

With the relatively large polymetallic deposits including Tsav, Ulaan and Mukhar, Dornod District constitutes a metallogenetic province dominated by polymetallic deposits. These deposits were formed by Late Jurassic to Early Cretaceous ingneous activity. The southwestern part of the deposit zone is overlain by younger formations. Therefore, occurrence of blind polymetallic deposits is highly likely in this district.

The district was explored intensively by Russians and others which involved mainly airborne magnetic suvey, γ-ray survey and geochemical survey. Such exploration, however, might have overlooked blind polymetallic deposits. It is desirable to conduct regional exploration initiated by gravity survey in this district in pursuit of blind polymetallic deposits.

At the stage of the first year's survey, Tsav Deposit was considered to have the highest possibility of development as it has high-grade ores though somewhat small in size and located near the railroad. Feasibility studies of Ulaan and Mukhar Deposits, which should include a review of cutoff grades, are also desirable.

Table Ⅱ-2-1 Ore Deposits and Ore-showings in Dornod District(1)

NAME	MINERALS	TYPE	RESERVE (M.t)	ORE GRADE (%, Au, Ag:g/t)	LOCATION			NUMBER OF ORE BODY	SIZE OF ORE BODY (m)	EXPLORATION STAGE					AGE OF DEPOSIT (Ma)	HOST ROCK (youngest)	DISCOVERY AND NOTES
					LONGITUDE	LATITUDE	ALT			SUR	TRC	DRL	ADT	EPT			
* TSAV	Pb, Zn, Ag	vein	7.68 C_2-P_1	Pb:6.4, Zn:4.6 Ag:222	115° 20′ 16′	48° 55′ 27′	770	10	0.2~3.0 ×3,500max	○	○	○	○	—	131.0 109.3 116.1 (Pb-Pb)	Gns, Schi, Dior, Gr, An, Bas.	1975, USSR Intensive -ly ex-plored
* ULAAN	Pb, Zn, Ag	pipe stock-work + skarn	93.1	Pb:0.95, Zn:1.9 Ag:49	114° 05′ 47′	49° 05′ 12′	1,159	9	pipe: 425×200 O.B.: 400×70 ×700	○	○	○	○	—	170.1 (Pp-Pp)	J_3 felsite,	1973, USSR Intensive -ly ex-plored
MKHAR	Pb, Zn, Ag	pipe (stock -work)	25.5	Pb:0.6, Zn:3.4 Ag:113	114° 06′ 47′	49° 04′ 11′	1030 1100		pipe: 300×200 ×400+	○	○	○	—	—	Jurassic ?	felsite, (J_3)	1973?, USSR Blind ore deposit
* BAYAN-UUR	Au, Ag, Pb, Zn	Qz-V	61.1	Pb+Zn:1.5, Ag:80, Au:0.3 Cu:0.10~0.13	115° 41′ 16′	48° 54′ 11′	920	2	1700×5, 1700×13 ×300 in 5,700 ×60 max	○	○	○	—	—		Gr(Pz), Dior(Mz)	1975, USSR Insuffi-ciently explored
* SALHIIT	Ag, Pb, Zn	Qz-V	—	Ag:15g/t at the outcrop	115° 41′ 01′	48° 57′ 37′	732	> 1	300×1	○	○	○	—	—	Jurassic	Schist, Gr Grd, An(Pz) Gr, An(J)	1988 Abondoned
* DERGER-MUNH	Pb, Zn, Ag	Qz-V	—	Pb:4-6	114° 48′ 21′	48° 46′ 58′	917	> 1	?	○	○	○	—	—	Jurassic?	An, Shale, Ss, Cgl	198?, USSR Under ex-ploration
* TSAGAAN-CHULUUT-HUDAG	Au	Placer + Qz-V	Au:4 t as placer ?	Au 0.3g/t?	113° 25′ 00′	49° 28′ 00′	860	2	1-1.5×160 ×9,000, 2 ×200 ×16,000	○	○	○	○	—	154± 8 host rock of Qz V.	Alluvium	1973 Under ex-ploration

Table Ⅱ-2-1 Ore Deposits and Ore-showings in Dornod District(2)

NAME	MINERALS	TYPE	RESERVE (M.t)	ORE GRADE (%, Au,Ag:g/t)	LOCATION			NUMBER OF ORE BODY	SIZE OF ORE BODY (m)	EXPLORATION STAGE					AGE OF DEPOSIT (Ma)	HOST ROCK (youngest)	DISCOVRRY
					LONGITUDE	LATITUDE	ALT			SUR	TRC	DRL	ADT	EPT			
*MARDAI	U	Vein + ?	?	U203 :0.1%?	114°21′30′	49°06′20′	900	2?	200 ×400 ×30?	○	○	○	○	○	135-150	Rhy, An, Bas of Jurassic (J_3)	1972

2-2 Tumurtiin-ovoo District

2-2-1 Location and access

Tumurtiin-ovoo District is located in Suhbaatar Aimag in eastern Mongolia, having an approximate area of 16,000km² . Domestic passenger flights are available from Ulaan Baatar to Baruun-urt, the capital of Aimag, which takes some one and half hours, one way. Movement/transportation in the field has to depend on cars running on wheel tracks.

2-2-2 Topogrphy and drainage system

The district is made up of hilly zones with elevation of 900-1,100m and is situated in the position where the Govi Lowlands placed bewteen Eastern Mongolian Highlands in the north and Dariganga Basaltic Platform in the south border on Dornod Plain in the east.

The district has no perennial river. Only wadis, in which water flows only at the time of rainfall, form small water systems with parallel or stripe patterns in sedimentary rock zones and in a dendritic pattern in igneous rock zones, which flow into the nearest lowlands to extinguish.

2-2-3 Climate and vegetation

Climatic indices vary within the district depending on localities. The average annual temperature is 1 - 5℃, while the maximum and minimum teperatures in a year is 40.8℃ and -41.4℃, respectively-ly. The number of frostless days in a year is 120-140.

Annual precipitation ranges from 90-175mm, with an increasing trend toward the north. The district is windy especially in the three months from March to May and also in November, having 30 to 50 sandstorm days per year.

The south of district is desert, while, from the central to northern parts, it changes to semi-desert and to steppe.

2-2-4 Geology

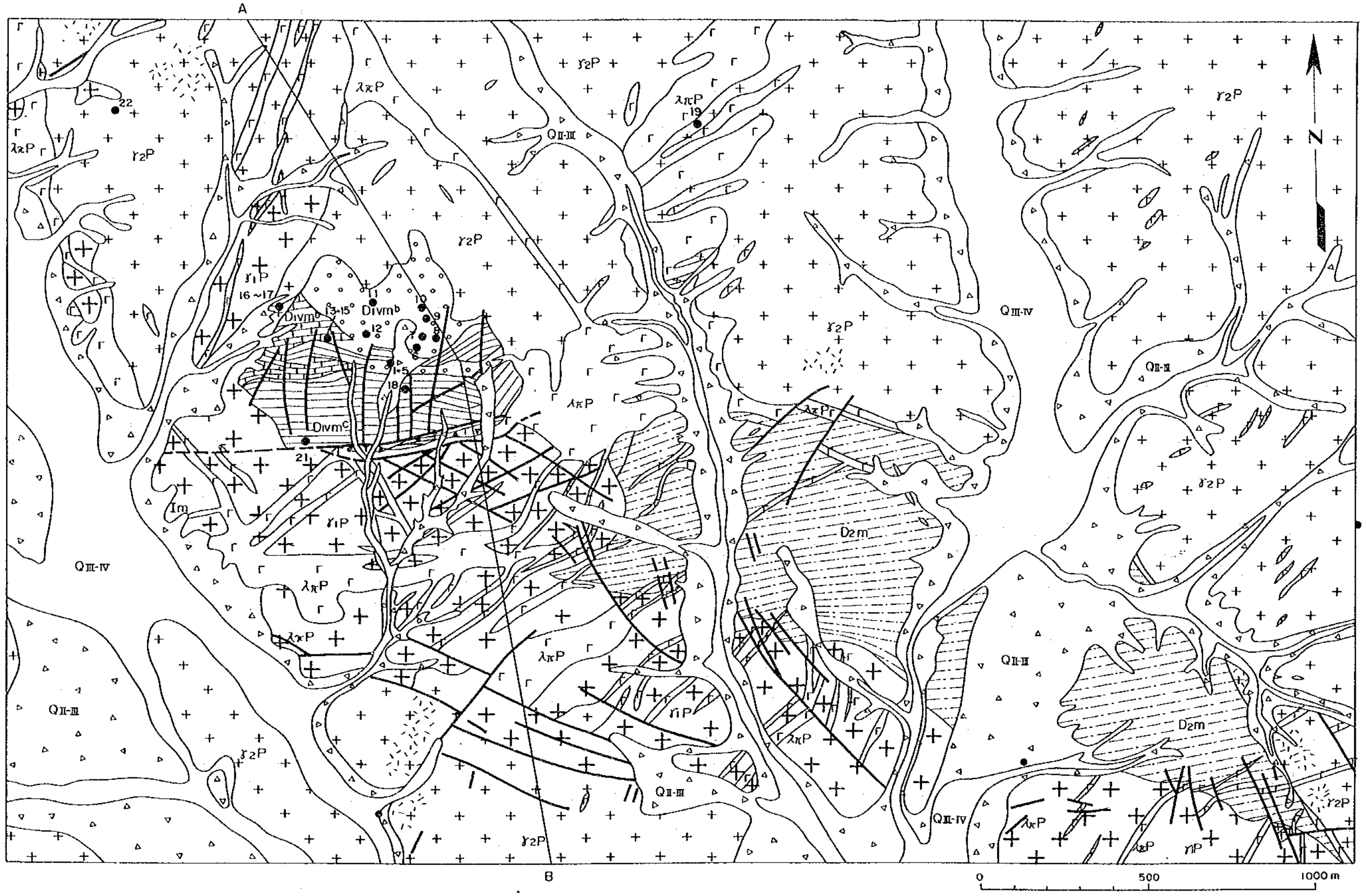
The geology of district is composed of Devonian, Permian and Cretaceous, into which Upper Permian to Jurassic igneous rocks intrude. Accompanying the Late Paleozoic to Early Mesozoic acidic igneous activity, high temperature-type deposits such as skarn-type zinc deposits at Tumurtiin-ovoo, Salhit, etc., greisen-type molybdenum deposits at Arin-nuur and tungsten-bearing quartz veines at Salaa were formed.

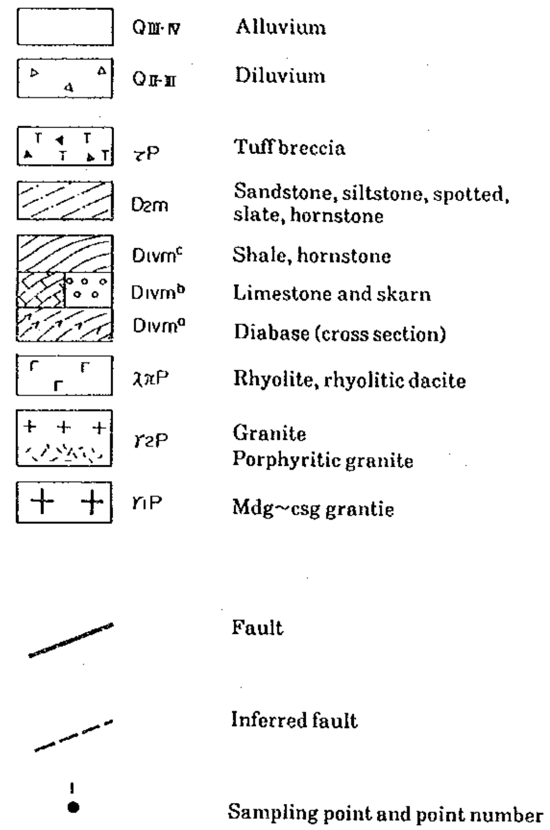
2-2-5 Ore deposits

Major ore deposits in this district are shown in Table II-2-2.

2-2-6 Observation

Skarn-type deposits in the district bear large amounts of magnetite. Therefore, major skarn-type deposits have presumably been





Point No.	Sample No.	Point No.	Sample No.
1	3TN01	16	3TS28
2	3TS14	17	3TS29
3	3TS15	18	3TS30
4	3TS16	19	3TS31
5	3TS17	–	–
6	3TS18	21	3TY02
7	3TS19	22	3TY04
8	3TS20		
9	3TS21		
10	3TS22		
11	3TS23		
12	3TS24		
13	3TS25		
14	3TS26		
15	3TS27		

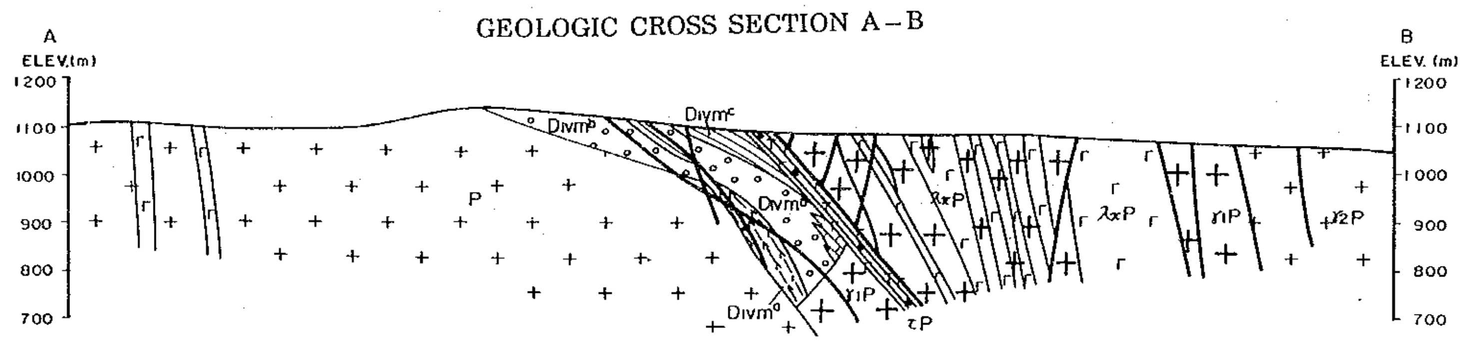
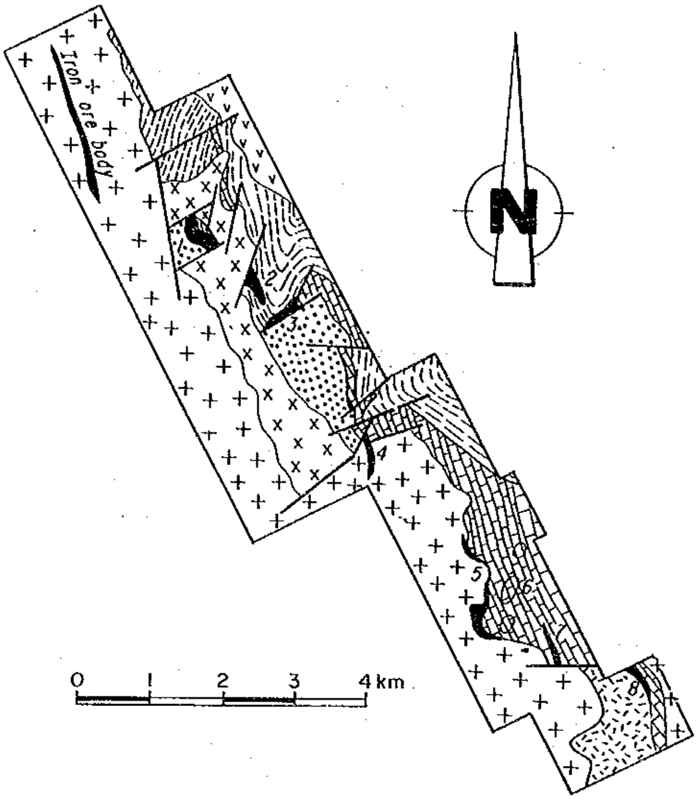


Fig. II-2-2-1 Geologic Map of Tumurtiin Ovoo



(from D. Ayush, E. E. Petrenko, 1972)

LEGEND

Cretaceous	Acidic effusive rock
	Intermediate effusive rock
Early~Middle Devonian	Clayey shale and siliceous shale
	Carbonate rock
	Sandstone and shale
Jurassic	Granite porphyry and granodiorite porphyry
Permian	Leucocratic granite

- Fault
- Zn mineralized zone and number
- Geochemical anomaly

Fig. II-2-2-2 Geologic Map of Salhit

Table II-2-2 Ore Deposits and Ore-showings in Tumurtiin-ovoo District

NAME	MINERALS	TYPE	RESERVE (M.t)	ORE GRADE (%, Au,Ag:g/t)	LOCATION			NUMBER OF ORE BODY	SIZE OF ORE BODY (m)	EXPLORATION STAGE					AGE OF DEPOSIT (Ma)	HOST ROCK	DISCOVERY
					LONGITUDE	LATITUDE	ALT			SUR	TRC	DRL	ADT	EPT			
* TUMURTIIN -OVOO	Zn, Fe	Skarn Ga-sk Mass-ive	7.57	Zn: 11.5	113°19′29′	46°47′44′	1,030	1?	300 × 600 × 5〜40	○	○	○	○	−	191±10	Liestone, Siluro-Devonian	1974, GDR/MPR 113 drill-ings
* SALHIIT	Zn	Skarn Ga-sk	0.92	Zn: 6.4	113°30′05′	46°48′02′	1,074	8	800 × 300 max. as a zone	○	○	○	○	−	125.3 (Pb-Pb)	Liestone, Siluro-Devonian	1966 by Hungarian
* Salaa	W(Wolfram-ite)	Qz-V	0.17	WO_3 1.35	113°26′06′	46°48′49′	1,070	12 quartz veins	100 〜400 ×0.35〜1.2	○	○	○	○	○	Jurassic	Carbonate (D_1- D_2.) Gr(P-J), Gr, Ap, Qp (J_3), Dio, Diab, (K?)	1966 by UPR/MPR Mined out
* ARIN-NUUR	Cu, Mo	Greiz	24.1	Mo:0.107 Cu:0.06	113°57′31′	47°13′44′	1,006	4 ore-zones	400 × 700 ×30〜100	○	○	○	○	○	Jurassic ?	Gr, Grd, Jurassic〜	1967 UPR Mined out

captured by the past exploration mainly with magnetic survey. Tumurtiin-ovoo Deposit, being a metasomatic deposit replacing a Devonian limestone xeno-block, has little potentiality for a further expansion.

Extensive exploration has been conducted of greisen deposits, which have mineralization partially cropping out. Chances seem to be slim for new discovery of a large greisen deposit in this district.

The granite, about 1 km northeast of Tumurtiin-ovoo Deposit, which has been said to be Permian, showed the K-Ar dating of 191±10Ma (Early Jurassic). Its mineralization time may possibly be rejuvenated to Mesozoic.

2-3 Nuhut-dawaa District

2-3-1 Location and access

Nuhut-dawaa District is located at Erdene-Tsagaan Village in southeastern Suhbaatar Aimag and has an approximate area of 7,000km^2. From Ulaan Baatar to Baruun-urt, the capital of Aimag, it takes some one and half hours by air and, from Baruun-urt to Nuhut-dawaa District, it takes six to seven hours by car running on wheel tracks in the steppe.

2-3-2 Topogrphy and drainage system

The district is a hilly area with elevation of 900-1,200m, located in the extreme north of Dariganga Plateau. There is no perennial river in the district. Wadis flow into the nearest lowlands to extinguish, which form small drainage systems with the parallel or stripe patterns in sedimentary rock zones while with a dendritic pattern in igneous rock zones.

2-3-3 Climate and vegetation

The average annual temperature is 0-1℃; number of frostless days in a year is 105-115; and, the maximum and minimum temperatures in a year are 39 ℃ and -40.1℃, respectivery. Annual precipitation is 230-270mm. Precipitation is higher in summer and minimal in winter. In the three months from April to June and November, it is especially windy. Number of sandstorm days exceeds 40 days in a year.

The district has steppes somewhat densely coverd with vegetation.

2-3-4 Geology

The geology of district is composed of Ordovician sandstone and schist, Triassic to Jurassic biotite granite, etc. Accompanying the Mesozoic igneous activity, numerous greisen-type tungsten-molybdenum deposits, tungten-bearing quartz veins and pegmatite-type beryllium deposits are formed at Tsentr, Yugzer, etc.

The district constitutes a metallogenetic province of rare metal minerals.

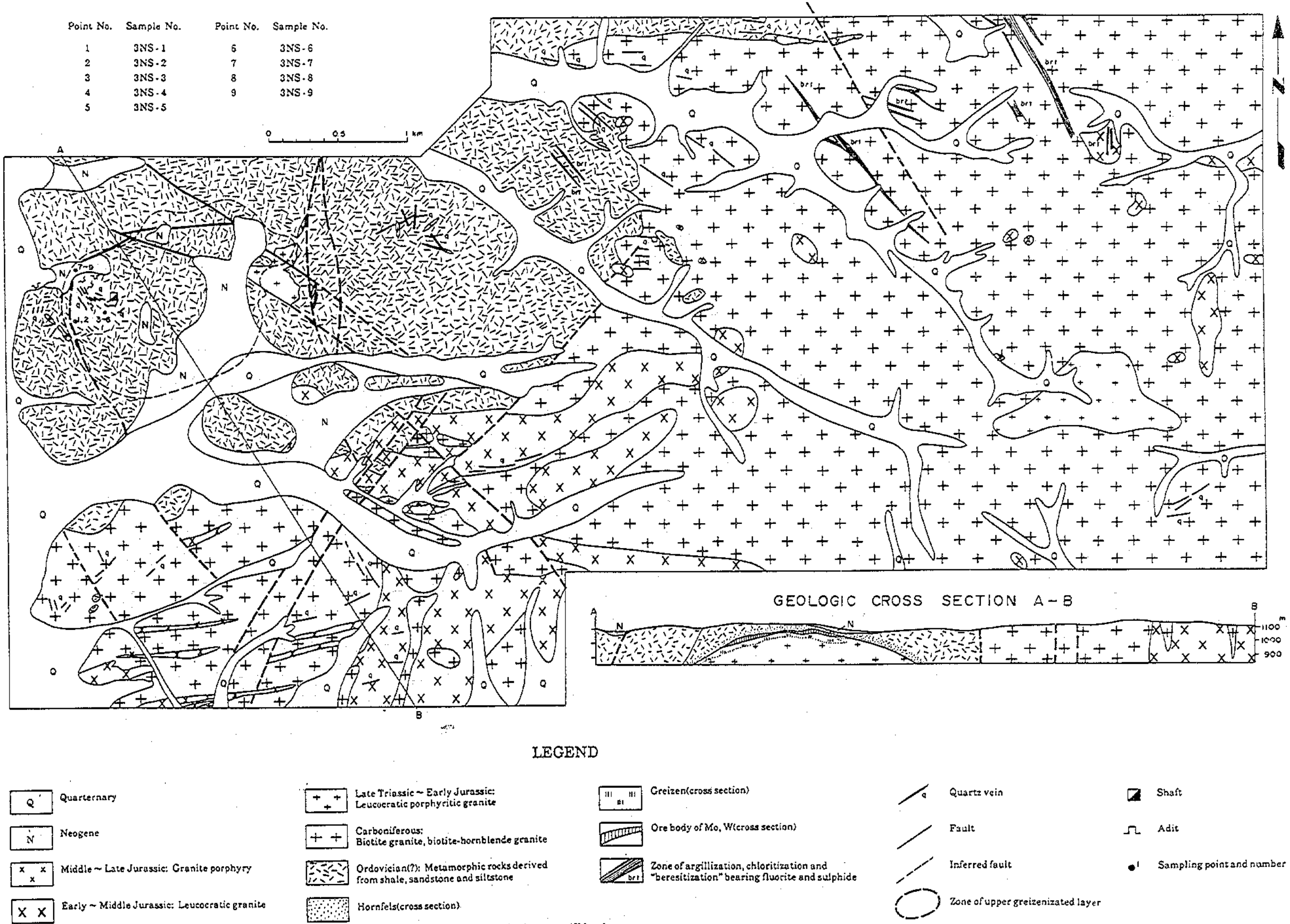


Fig. Ⅱ-2-3-1 Geologic Map of Yuguzer

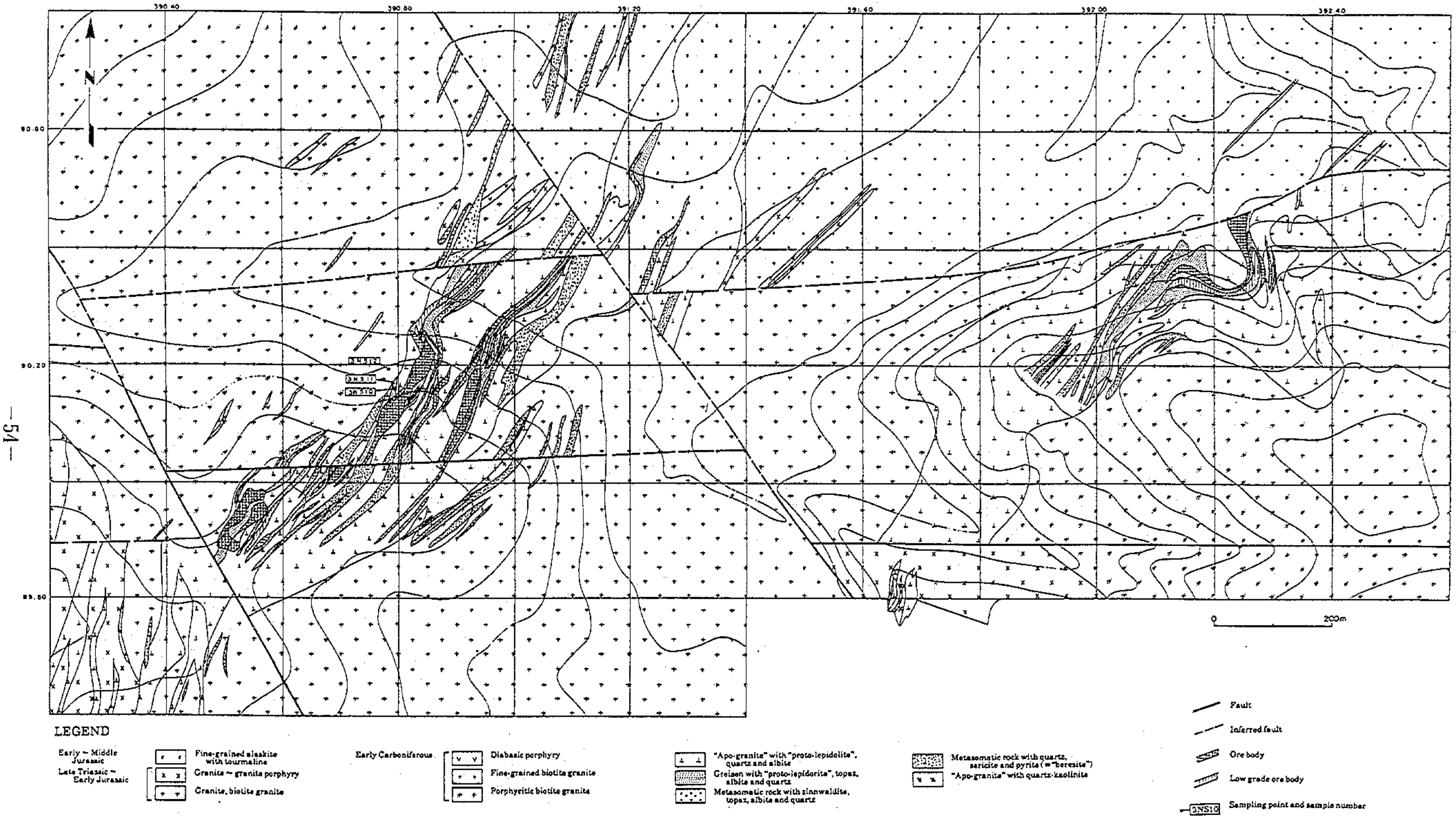


Fig. Ⅱ-2-3-2 Geologic Map of Tsentr(Tub)

Table Ⅱ-2-3 Ore Deposits and Ore-showings in Nuhut-dawaa District(1)

NAME	MINERALS	TYPE	RESERVE (M.t)	ORE GRADE (%, Au, Ag:g/t)	LOCATION			NUMBER OF ORE BODY	SIZE OF ORE BODY (m)	EXPLORATION STAGE					AGE OF DEPOSIT (Ma)	HOST ROCK	DISCOVERY
					LONGITUDE	LATITUDE	ALT			SUR	TRC	DRL	ADT	EPT			
* YUGUZER	W, Mo, Be,	Greiz + Qz-V	21.58	WO_3 0.197, Mo 0.056, Bi 0.132, BeO 0.08	115°24′02′	45°54′27′	1,181	12 greizen deposits & 45 quartz veins	1,450 ×4 900 ×8.9 Max.	○	○	○	○	○		Granite, Triassic~Jurassic	1939 USSR Mined by under-grownd mining
* TSENTR	Sn, W, Be, Mo Wolframite +cassite-rite	Greiz	9.00	Sn 0.078, WO_3 0.137, BeO 0.120	115°35′18′	45°56′08′	1,167	38 ore-bodies in the area of 2,000 ×200	460 ×230 ×7.5 Max	○	○	○	○	○		Gr(C), Gr(Trias~Jura)	1977 Very in-tensively explored, abondoned
* NUHUTTIN -TSAGAAN -TOLGOI	Be (Beryl)	Pegma -tite lens	?	?	115°48′24′	46°03′17′	1,070	1	10~20m long, lenticul-er sahape	○	○	—	—	—		Granite	?
AR-BAYAN	W	Greis	—	—				1	320 ×100	○	○	○	—	—		Granite	1980
ALTAN	Au, Mo, W, Bi	Sili-cifi-ed r.	?	Au max. 3g/t Mo 0.14 W 0.14 Bi 0.2					150 ×100	○	○	○	—	—		Granite	1943 ?
BATGUI-GROUP	W	Qz-V	—	?	6km east	of YUGUZER		45 Qz-V	0.3 ~0.5 ×<100	○	○	○	○	○			1943 Mined uot during 1943-1956
BAYAN-BAIRAST	W	Qz-V	—	WO_3 1~2 %				14 Qz-V in the area of 50km²	0.2 ~1.2 ×22~230	○	○	○	○	○			1969 Mined uot