1971 Geological mappings at a scale of 1:50,000 and 1:10,000 were conducted.

1971~1973 Geophysical exploration (magnetic survey, gravity survey, newtoron activation method, and I.P. method) was conducted at the western part of the Yuguzer deposit (By the cooperation of Mongolia and USSR).

1975~1977 Geological survey at a scale of 1:50,000, magnetic survey, gravity survey, activation method, I.P. method etc. were conducted. As a result of these surveys, two deposits, Tsentr (W, Mo) and Alonsar deposits, were discovered.

1976~1978 Geological survey at a scale of 1:50,000 and 1:10,000 were conducted near Ar-Bayan.

1977~1979 The preliminary survey was performed in the Tsentr deposit.

1980 Boring was conducted the Ar-Bayan and Ubur-bayan mineral showing areas (W).

1983 Evaluation of eastern part of Yuguzer and ore treatment test were conducted, Ore reserves were calculated concerning Yuguzer and Tzentr deposits. Mining was conducted in the tungsten showing areas such as Urt, Alonsar, Batgui etc., however, the new deposit which has economic potential has not been discovered. The areas around Ar-Bayan and Ubur-bayan were reported to have possibilities of new deposits.

Past exploration works (As of 1983)

trenching	11,100 m^3 (Alonsar), 5,500m^3 (Urt)
boring	2,193 m
tunnel	1,410 m

8. Mining operation (1943~1956)
   (1) Owner of enterprise
   The USSR
   (2) Employees
   Not obvious.
   (3) Scale of production
   Not obvious.
   (4) Mining method
   underground mining.
   (5) Transportation method
   Not obvious.
   (6) Others

The results of the ore treatment test conducted by East Germany using 1,500t of crude ore are as follows.

Ore component	Rate of recovery (%)	Grade of concentrate (%)
WO_3	52~71.5	65.5
Mo	12~90	45.2

As for mineral dressing, the flotation method was applied after the gravity

concentration, it was explained, however, that the mineral dressing will be difficult because the grain size of wolframite was very small ranging 1/4 to 1/5mm. And the reliability of results of mineral treatment tests were doubtfull as the results of for six samples were very fluctuating.

1-3-2 Tsentr deposit ★ (Fig. II-1-9)

1. Location and transportation

Location: Longitude 115°35'18" East, Latitude 45°56'08" North, Elevation 1,167m above sea level. In administrative division terms, the deposit is located in the Erdene-Tsagaan Sum in the Suhbaatar Aimag. The deposit is located about 210km north west of the Yuguzer deposit.

It is about 250km from Baruun-Urt city to the Yuguzer deposit, taking about seven hours by car through the steppe via the dirt road.

2. *Topography*

Elevation of the Shree river which runs 2~3km west of the deposit is about 1,050m above sea level. The highest point of this district is Sain-Os hill (1,171.3m), 1km south-southeast of the deposit. This district is a gentle hilly zone which consists of buried valleys and small hills, 100m~200m higher than the valleys. However, a part of the river side is very steep along the Shree river which runs western side of the deposit.

3. *Climate*

Same as the Yuguzer deposit. The area around the deposit is a highland, southernmost of the DORNOD plain, forming steppe covered by low grasses. There are about 110 frostless days annually, and it is windy for three months from April to June and November with over 40 sandstorm days annually.

4. Geology and deposit

(1) *Mineralization*

This deposit contains tin and tungsten, beryllium, and molybdenum. It mainly occurs as greisen with small amount of quartz veins with wolframite.

(2) Type of deposit

Massive and/or zone type greisen deposit and quartz vein.

(3) Ore reserves and grades; (C_2+C_1)

Ore reserves (t)	Sn (%)	Wo_3 (%)	BeO(%)
approx. 9,000,000t	0.078	0.137	0.120

(4) Size of deposit

There are 38 greisen ore bodies in the greisen zone whose width is about 200m, with the length of over 2,000m. Greisen zones are horizontally transferred about 800m in appearance by the central fault and separated into two blocks, west one and east one. Among the 38 greisen deposits, 30 are in the west block, and eight are in the east block. The sizes of the major ore bodies are as follows.

No. of Ore body	Length (m)	Inclinational Length (m)	Thickness (m)	BeO (%)	WO_3 (%)	Sn (%)	Mo (%)
No.1	140	95	13.4	0.16	0.084	0.125	
No.1-a	70	60	9	0.21	0.11		
No.2	460	230	7.5	0.165	0.169	0.023	0.004

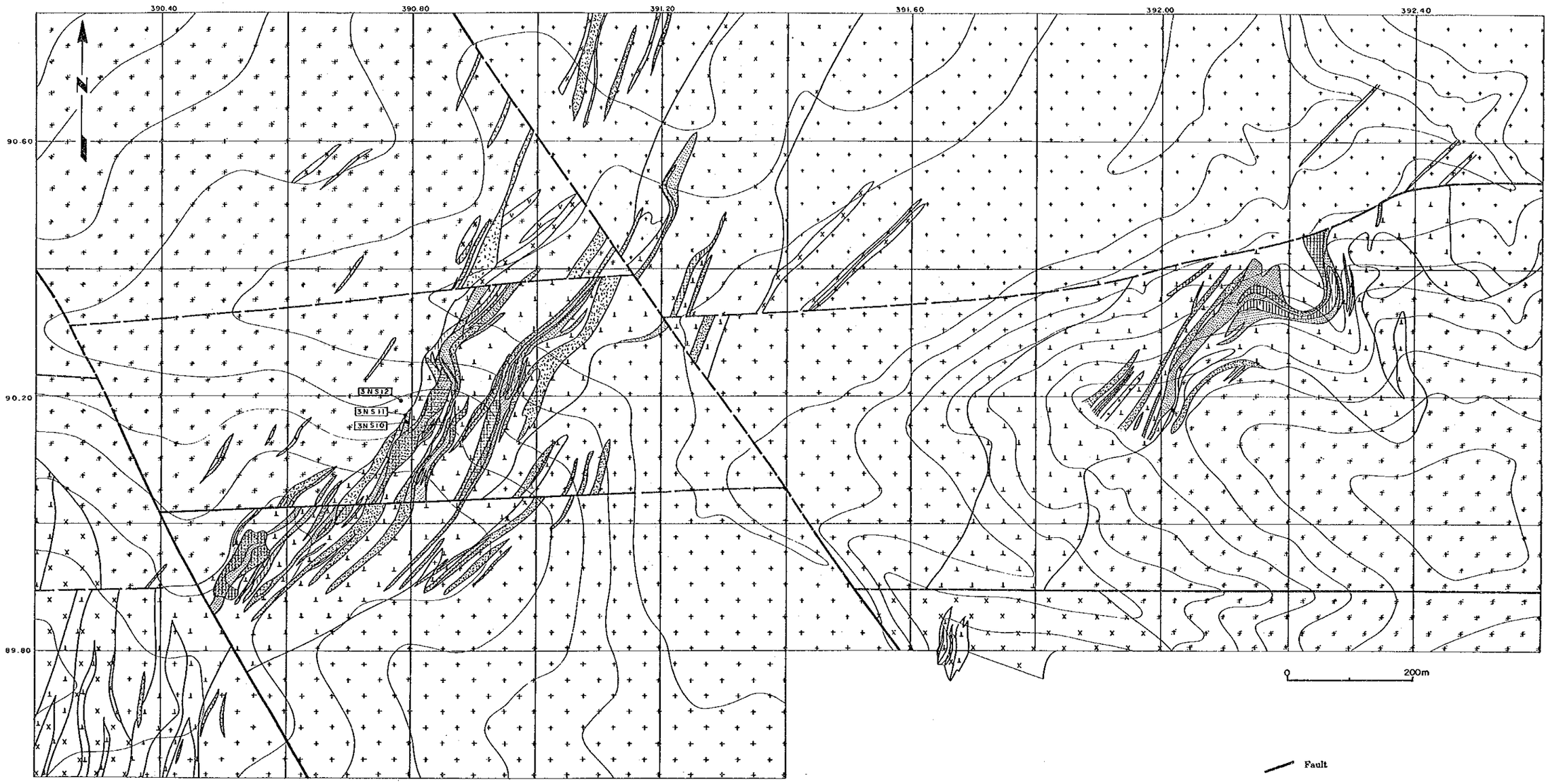


Fig. II-1-9 Geological map of Tsentr

No.4	460	194	?	0.08	0.135	0.044	0.014
No.6	190	50	4.8	0.24	0.25		

(5) Structure of the deposit

Each ore body, generally speaking, is almost parallel to the greisen zone. The structure of two greisen zones, east and west, are as follows.

East block	Strike: N40°E	Dip: 16°~20°SE
West block	Strike: N25~50°SE	Dip: 24°~40°SE

(6) Country rock

Biotite granite and granite porphyry intruded in Carboniferous Period and biotite granite intruded during the end of the Triassic and Jurassic Periods.

(7) Structural control

The deposit occurs only in the greisen zone (old fracture zone, about 200m wide, more than 2,000m long) which cut biotite granite and granite porphyry intruded in Carboniferous Period.

(8) Related igneous rocks

Pegmatitic or aplitic granite intruded during Jurassic Period.

(9) Alteration

Greisenization. It consists of topaz-zinnwaldite-quartz, plagioclase-quartz-zinnwaldite, etc.

5. Water supply

There are wells and rivers at Chonogol, 2km west of the deposit.

6. Hydrology

The ground water table was about 8m below the surface. However, it was lowered by means of pumping to 48m below the surface "Filling speed" in the boring hole is 0.18ℓ/sec.

7. Discovery and history

1975~1977	Geological survey at a scale of 1:50,000, magnetic survey, gravity survey, activation method, and I.P. method were conducted. As a result of these surveys, two deposits, Tsentr and Alonsar were discovered。
1977~1979	The preliminary survey was conducted at the Tsentr deposit.
1983	Evaluation of the deposit and ore treatment test of eastern part of Yuguzer, were conducted and ore reserves concerning Yuguzer and Tsentr deposit were calculated. Mining was conducted at the tungsten showing areas such as Urt, Alonsar, Batgui etc., however, the new deposit which has economic potential has not been confirmed. The district around Ar-Bayan and Ubur-Bayan was reported to have possibilities of new deposits.

Past exploration works (1978~1979)

trenching	2,380m^3	
boring	4,524.4m	(Conducted by grid of 80m×80m or 80m×60m)
sample used for analysis		trenching 2,440 pcs. boring 2,270pcs.

8. Mining operation
None.

1-3-3 Nuhuttin-Tsagaantolgoi deposit★

1. Location and transportation

Location: Longitude 115°48'24" East, Latitude 46°03'17" North, Elevation 1,070m above sea level. In administrative division terms, the deposit is located in the Erdene Tsagaan Sum in the Suhbaatar Aimag. The deposit is located about 210km east-south-east of Baruun-Urt, the capital of the Aimag, and about 48km northeast of the above-mentioned Yuguzer deposit.

It is about 250km from Baruun-Urt city to the Nuhuttin-Tsagaantolgoi deposit, taking about seven hours by car through the steppe via the dirt road.

2. Topography

Elevation of this area near the mine is between 900m and 1,100m above sea level. This district is a gentle hilly zone which consists of buried valleys and small hills, 100m~200m higher than the valleys.

3. Climate

Same as the Yuguzer deposit. The area around the deposit is a highland (about 1,000m above sea level), southernmost of the DORNOD plain, forming a steppe covered by low grasses. There are about 110 frostless days annually, and it is windy for three months from April to June and November with over 40 sandstorm days annually.

4. Geology and deposit
   (1) Mineralization
   This deposit contains beryllium. It occurs as beryl, quartz, muscovite pegmatite.
   (2) Type of deposit
   Pegmatite.
   (3) Ore reserves and grades
   Not obvious.
   (4) Size of deposit
   Lenticular (?) ore body whose length is 10~20m.
   (5) Structure of the deposit
   Not obvious.
   (6) Country rock
   Leucocratic biotite granite.
   (7) Structural control
   Not obvious.
   (8) Related igneous rocks
   Not obvious.
   (9) Alteration
   None.

5. Water supply
Not obvious.

6. Hydrology
Not obvious.

7. Discovery and history
Not obvious.

8. Mining operation
None.

1-3-4 Other ore showings

The following mineral indication areas were discovered by the exploration conducted around Yuguzer and Tsentr since 1939. A series of surveys and evaluation works were conducted on these showing areas. However, they were abandoned after mining or during the exploration stage.

No. Name of showing	Mineralization	Type	Size	Ore reserves and grade
1. Ar-Bayan	W	greisen	320m×100m	WO_3 < 0.1%

The deposit was examined by trenching and boring (200~250m) in 1980. It was concluded that the deposit was of no value. Surveys at a scale of 1:10,000 and 1:50,000 were conducted in 1983, and it was expected that a new deposit could be nearby because NE extension of greisen has not been confirmed yet.

2.	Artan	Mineralization	Type	Size	Ore reserves and grade
		Au, Mo, W, Bi	silicified rock	150m×100m	Au max. 3g/t Mo 0.14% W 0.14% Bi 0.2%

3.	Batgui group	Mineralization	Type	Size	Ore reserves and grade
		W	quartz vein (45 veins)	width 30~50cm length <100m	Not obvious

It was discovered in 1943. It is located in 6km east of Yuguzer. It occurs as a lot of small quartz veins containing wolframite, scheelite. Mined during 1943~1956. Main parts has been mined out. It was surveyed again in 1983. Though boring was conducted for the gravity anomaly, new ore deposit was not discovered.

4.	Bayan-Hairast	Mineralization	Type	Size	Ore reserves and grade
		W	quartz vein (14 veins)	width 0.2~1.25m length 22~230m	WO_3 1~2%, mined out

It was discovered in 1969. It was concluded as useless in 1970, conducting geological survey at a scale of 1:25,000 and evaluation work. The area of ore showings is 50km^2.

5.	Bayan-Uul	Mineralization	Type	Size	Ore reserves and grade
		Be	pegmatite	12~15m×6~8m	beryl max. 70%

6.	Tsagan-Chuluut	Mineralization	Type	Size	Ore reserves and grade
		W	quartz vein (7 veins)	width<15~20m length<60m	W<1%

7.	Mungut	Mineralization	Type	Size	Ore reserves and grade
		W, Mo	quartz vein (10 veins)	width1.5~3m length 300m	W<0.04%, Mo<1%

Quartz veins except the above-mentioned ones are small in size, with the length of less than 50m.

8.	Nuhuttiin	Mineralization	Type	Size	Ore reserves and grade
		W	quartz vein (10 veins)	width0.1~2.5m	WO_3 0.04~0.13% abandoned

10m~20m of trench was conducted for several veins, however, it was abandoned because of their small size.

9.	Ult group	Mineralization	Type	Size	Ore reserves and grade
		W	greisen	4 zones each zone has a diameter of less than 100m	WO_3 0.01-0.06%

Mapping at a scale of 1:25,000 and evaluation were conducted in 1970. It was concluded to have no potential. Lots of trenches and borings were conducted in the supplementary surveys, but it was abandoned because new deposits were not discovered.

10.	Saihan-Ula	Mineralization	Type	Size	Ore reserves and grade
		W	quartz vein (42 veins)	width25~30cm length 25~50m	WO_3 0.18~0.5%

It was discovered in 1954. It was concluded that this deposit was too small and low grade to work.

11.	Tarvagatai	Mineralization	Type	Size	Ore reserves and grade
		Mo, W	greisen	120m×5m 170m×10m	WO_3<0.08% Mo<1%

A small amount of quartz vein that includes molybdenite and cassiterite occurs in greisen.

12.	Uvur-Bayan	Mineralization	Type	Size	Ore reserves and grade
		W	greisen	300m×30m 220m×210m	Mo 0.1~0.3% WO_3 0.04~0.1%

The deposit was evaluated by trenching and boring (200~250m). A geological survey at a scale of 1:10,000 and 1:50,000 was conducted in 1983, and it was expected that new deposits would be discovered nearby.

13.	Dzurh-Ovoo	Mineralization	Type	Size	Ore reserves and grade
		Mo, Sn	garnet skarn silicification	300m×200m	Mo 0.003% Sn 0.008%

1-4 Har-Airag district (Fig. II-1-10)

The Har-Airag district is located in the central and eastern part of Mongolia, which covers an area of 40,000km^2 (200km E-W×100km N-S) that belongs to the administrative divisions of Dornogovi, Dundugobi and Hentii Aimags.

In the southwestern part of Har-Airag district, there is the railway (Soviet-Mongolia-China Railway) which acrosses Mongolian territory and connects Siberian Railway and Tieng-Shin, China. By means of this railway, the district is connected with the capital city, Ulaanbaatar. And from Airag to Bor-Undur, there is a branch railway line with a distance of 45km. It is 8 to 10 hour drive by car via dirt road through the steppe from Ulaanbaatar to this area.

As for topography, the area is located in the eastern Mongolian highland which divides a drainage system into two; one flows into southern Gobi lowland and the other flows towards north forming the Kherlen river drainage. The area forms hilly country with gentle slope and its elevation changes higher towards NE and lower towards SW direction ranging from 1,000 to 1,200m above sea level. The highest point in this area is Mt. Sumber (1,715m), about 45km north of Bor-Undur.

The major climatic index of this district is as follows.

Temperature; annual average temperature; −0.5°C~1°C.
Monthly average temperature*; the highest month is July with 18.8°C, the lowest month is January with −18.0°C.
The highest temperature* observed 35.6°C.
The lowest temprature* observed −38.3°C.

Precipitation*; annual precipitation: 170mm~210mm.

Relative humidity*; monthly average: January 63%, April 33%, July 45%, October 42%.

Wind velocity*; monthly average; January 3.9m/sec., April 5.5m/sec., July 4.2m/sec., October 3.6m/sec.
(Notice) *: * indicates the Mandalgovi's data.

There is a tendency for the annual average temperature to be low in the northern highlands and high in the lowlands in the southern part. On the contrary, the annual precipitation is high in the northern part and low in the southern part. Major precipitation occurs in summer with its peak in July whereas it is dry in winter at its center January. Therefore, the grasses can grow only in summer, and this area is made up of relatively dried steppe and semi-desert. It is particularly windy for two months from April to May, with about 24 sandstorm days annually.

Geology of this area consists of gneiss, schist, crystalline limestone, formed in Proterozoic Era, Carboniferous rhyolite, Permian granite, granite porphry, granodiorite porphry, Jurassic biotite granite, Cretaceous basalt, quartz porphyry, aplite, aplitic granite. Fluorite deposits, such as Bor-Undur, Adag, Aidag, Hongor, Hajyuu-Ulaan are formed within these country rocks. The biggest deposit is the Bor-Undur deposit which has more than 20 million tons of ore reserves. The total amount of fluorite ore reserve is reported to be 50 million tons in this area.

1-4-1 Bor-Undur deposit ★ (Fig. II-1-11)

1. Location and transportation
   No.2 Ore body
   Longitude 109°26'16" East, Latitude 46°15'41" North, Elevation 1,305m above sea level

No.3 Ore body
Longitude 109°25'29" East, Latitude 46°15'21" North, Elevation 1,303m above sea level
No.5 Ore body
Longitude 109°25'32" East, Latitude 46°15'40" North, Elevation 1,300m above sea level
No.11 Ore body
Longitude 109°25'18" East, Latitude 46°16'19" North, Elevation 1,333m above sea level
No.13 Ore body
Longitude 109°25'18" East, Latitude 46°16'19" North, Elevation 1,250m above sea level

In administrative division terms, it is located in Darhan in the Hentii Aimag, about 150km southwest of Undrkhaan, the capital of the Aimag. There is a railway from Ulaanbaatar to Bor-Undur. It takes about 10 hours by car from Ulaanbaatar to the Bor-Undur deposit through a steppe via dirt road.

2. Topography

Elevation around the Bor-Undur deposit is between 1,250m and 1,350m in general. The highest point of the sourrounding area is Mt. Ih-Bor-Undur (1,445.7m), about 2.5km west of the deposit.

As for topography, there are lower land with comparatively gentle slopes towards southeast and a little steep mountainous area towards northwest. The deposits are in between of them.

3. Climate

The Bor-Undur deposit is located at the edge of the northeast part of Gobi in Mongolia. The annual solar radiation is 5,300MJ/m^2, annual average temperature is 0.1°C, and annual precipitation is 160mm. This area belongs to the relatively dried steppe climatic zone.

Elevation of the highland around the deposit is 1,250m~1,350m above sea level, with a relatively poor steppe has formed. There are about 115 frostless days annually and it is relatively windy throughout the year. It is particularly windy for two months from April to May, with about 24 sandstorm days annually.

4. Geology and deposit

(1) Mineralization

This deposit contains fluorite and quartz.

(2) Type of deposit

Vein type

(3) Ore reserves and grades

The ore reserves at the biginning of mining operation was 20,985,670t with a grade of approximately 39.10% Ca F_2. Remained ore reserve is not obvious. Grade of crude ore at present is about 32%Ca F_2.

(4) Size of deposit

33 ore bodies exist in a area of 6km E-W×7km N-S. The size of each ore body is within a range of 200m~500m long and the maximum width is 18m. The major ore bodies are the No.1, 2, 3, 5, 11, and 13.

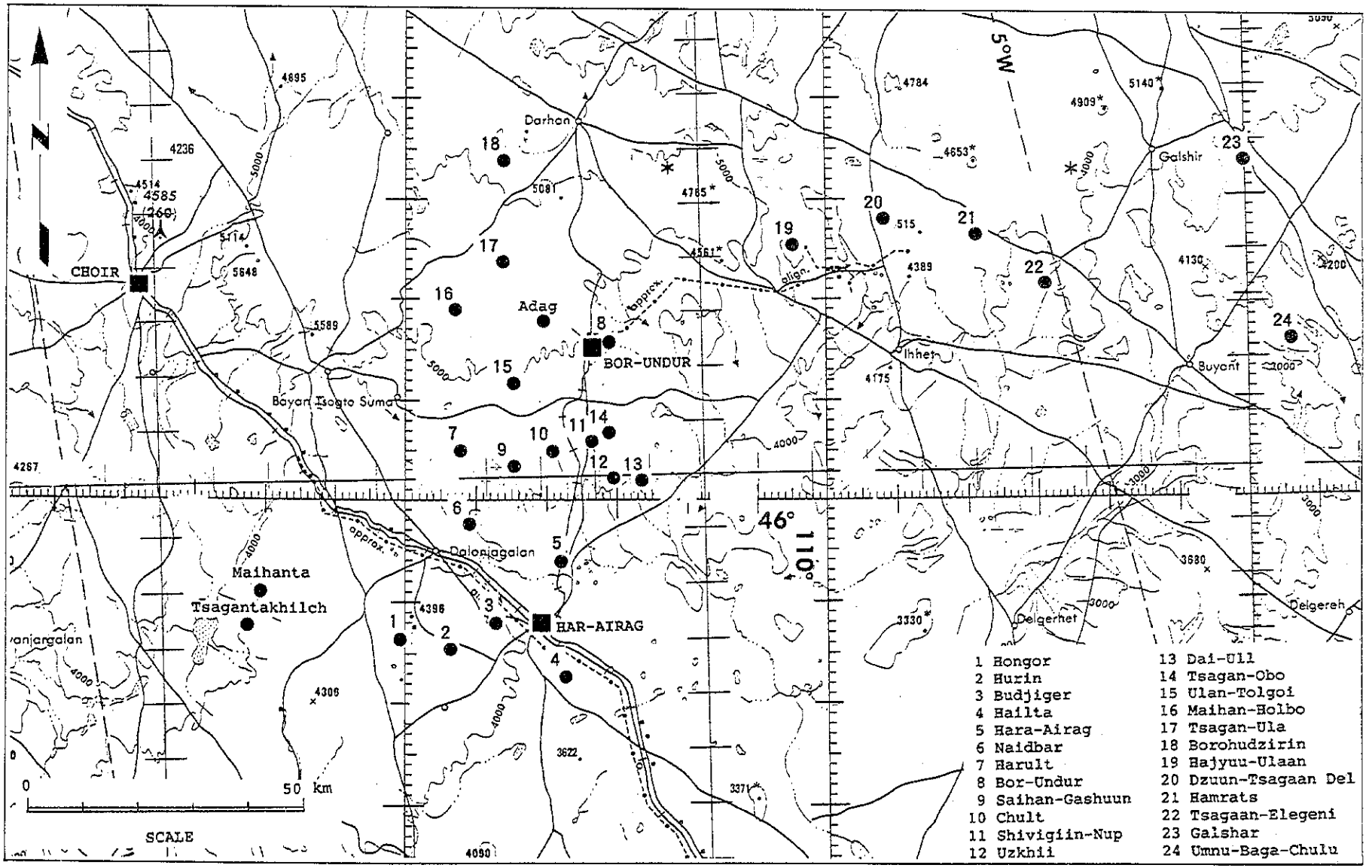
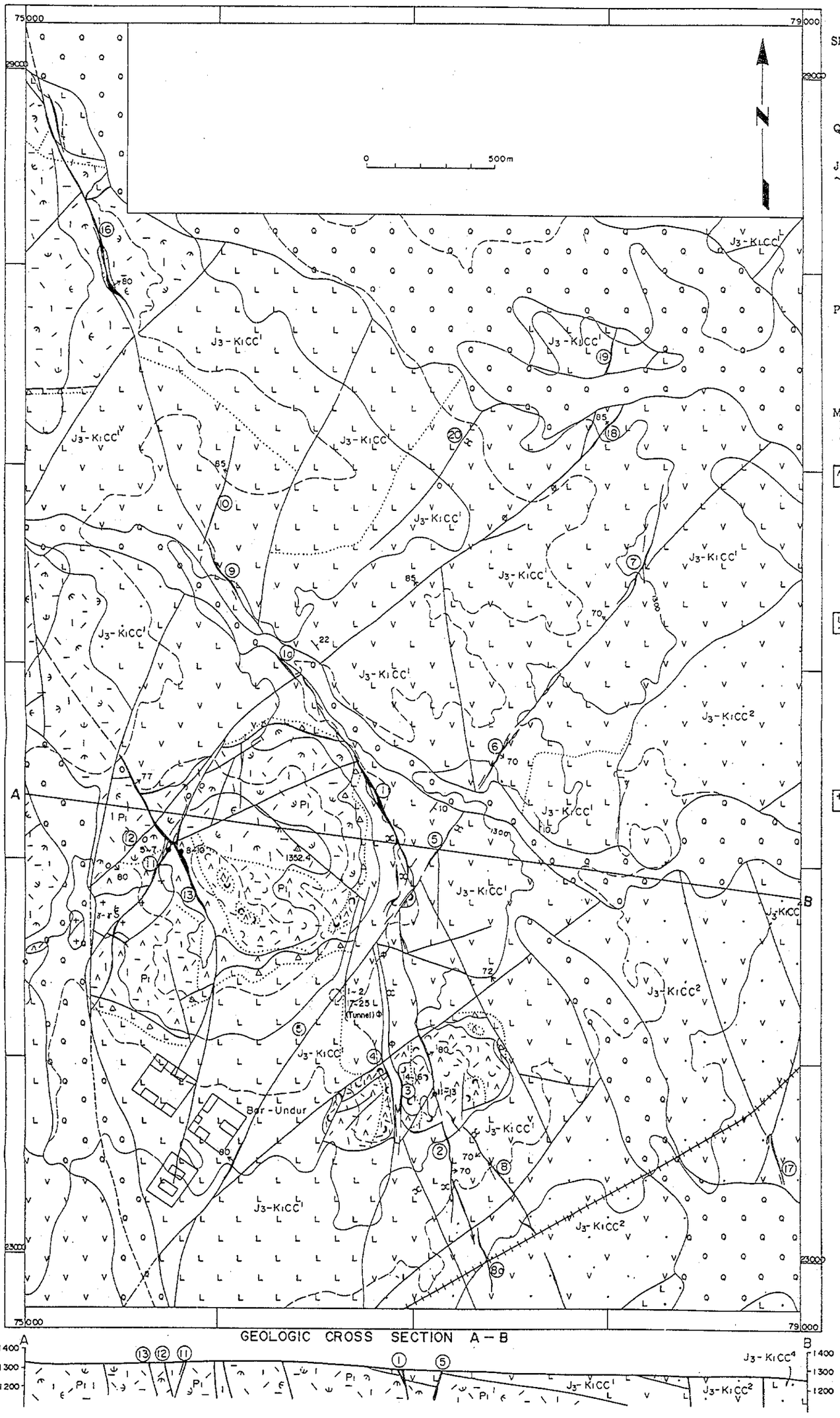


Fig. II-1-10 Location map of fluorite deposits in Har-Airag district



LEGEND

SEDIMENTARY AND VOLCANIC ROCKS

Age		Lithofacies
Quaternary		Gravel, sand, loam
Jurassic ~Cretaceous	J3-K1CC2	Basalt
	J3-K1CC2	Andesite
	J3-K1CC1	Basalt, andesite-basalt
Permian	Pl	Acidic volcanics; Rhyolite, dacite, tuff

INTRUSIVE ROCKS

Mesozoic Boroundur complex	γ-γξ	Leucocratic granite

1. Dacite
2. Rhyolite-dacite
3. Rhyolitic tuff
4. Rhyolitic~dacitic tuff, agglomeratic
5. Dacitic clastic tuff

1. "Basaltic porphyrite"
2. "Andesitic porphyrite"
3. Andesite, trachyandesite
4. Basalt
5. Andesite-basalt
6. Basaltic volcanic breccia

1. "Leucocratic granite"

Fluoritization

Silicification

Chloritization

Argillization

Limonitization

Fault

Inferred fault

Concealed fault

Quartz-fluorite vein

Number of ore body

Sampling point and point nu

Rail way

Fig. II-1-11 Geological map of Bor-Undur ore deposit

Name	Length (m)	Width (m)	Inclinational Length (m)	Remarks
No. 2 ore body	1,100	1.5~4.0	100	open cut mining and underground mining
No. 3 ore body	300	1.2~4.0		open cut mining(1983~84)
No. 5 ore body	900	≦18	400	underground mining the grade diminishes towards depth.
No. 11 ore body	1,200			open cut mining
No. 13 ore body	1,200	2~3		open cut mining

(5) Structure of deposit

Name		Strike	Dip
No. 2	ore body	N12°W	70°~75°E
No. 3	ore body	N13°W	75°E
No. 5	ore body	N36°E	70°~75°NW
No. 11	ore body	N20°~35°E	70°~75°NW
No. 13	ore body	N12°~28°W	75°NE

(6) Country rock

Basalt, quartz porphyry, and fine-grained aplite and aplitic granite formed in Cretaceous Period.

(7) Structural control

The deposits exist along the fissures striking NE-SW or N-S~NW-SE and they often form bonanza at the counter part of the fissures.

(8) Related igneous rocks

Granite and others formed in the Mesozoic Era.

(9) Alteration

Silicification, kaolinitization, limonitization, propylitization, epidotization, chloritization, pyritization are observed.

5. Water supply

There are plural wells within 10~15km away from the deposit. Water in the tunnel is used only for mining purpose and drinking water is supplied by water system from the outside.

6. Hydrology

Water seepage from the underground operation reached 18~20 ℓ/min. at the beginning of mining activity.

7. Discovery and history

1956	The USSR (B.M. Kazakov and others) discovered the deposit, when conducting a geological survey at a scale of 1:200,000.
1957-58	The USSR (U. M. Arsenev and others) conducted the evaluation work.
1972	The USSR (A. A Cherepanov and others) conducted the geological survey at a scale of 1:50,000 and 1:10,000.
1976-79	The USSR (Koshelev and others) conducted geological surveys and geophysical exploration for evaluation at a scale of 1:50,000 and 1:10,000.

1979-81 Conducted a detailed survey.
1982 Ore Reserves ore ($B+C_1+C_2$) = 11,886,270t was calculated.

8. Mining operation
(1) Owner of entreprise
Mongol/Soviet Non-Ferrous Metal Company
(2) Employees
approx. 1000. (geologists 100, miners 175 { 154 underground, 21 surface), others 725, including 200~300 foreigners.
(3) Scale of production
210,000t/y at the grade of crude ore:CaF_2:32%.
(4) Mining method:
Sub-level stoping method with long-hole (hole length 10 to 15m) blasting, about 5,000 tons of ore is produced by one blasting.
(5) Transportation method
A shaft was sunk 300 meters from ground surface and 6 levels of horizontal tunnel with an interval of 50m are developed. Transportation depends on mine cars and shaft winding.
(6) Ore dressing method.
- Processing method: flotation
- Processing capacity: 400,000~450,000t/y by crude ore volume.
- The volume of concentrate, grade and recovery: 120,000t/y, CaF_2 95.5%, Recovery rate 78.6%.
- Problems on mining: Ore recovery decreas when fluorite is fine-grained depending on the mineral vein.

(7) Others.
- Buyer: A cryolite factory at SOVERDOVSK in Ural, the USSR.
- Transportation of the products : by train to Ural in the USSR via Ulaanbaatar.

9. Others.
210,000t of crude ore among the total amount of ore being dressed comes from the Bor-Undur deposit and the rest comes from other mines such as Ulgen, Har-Airag, Hajyuu-Ulaan, etc.

1-4-2 Adag deposit★

1. Location and transportation
Location: Longitude 109°19'32" East, Latitude 46°17'44" North, Elevation 1,500m above sea level.
This deposit is located about 8km northwest of the Bor-Undur deposit. In administrative division terms, the deposit is located in the Darhan Sum in the Hentii Aimag, about 150km south-west of Undurkhaan, the capital of the Aimag.
The railway connects Undurkhaan to the Bor-Undur deposit. It takes about 10 hours by car via the dirt road from Undurkhaan to the Aidag deposit via Bor-Undur.

2. Topography
Elevation of most parts of the area around the Adag deposit are 1,400~1,600m above sea level. The highest point of this area is the Ulgii triangulation station point (1,617.7m).

The area is composed of a relatively steep mountainous area and flat sedimentary valley. The Adag deposit is located in the southern foot of the relatively steep mountainous area of Mt. Ulgii.

3. Climate

The Adag deposit is located in the margin of the northeastern part of Gobi in Mongolia. The Annual solar radiation is 5,300MJ/m^2, annual average temperature is -1°C, and annual precipitation is 160~170mm. This area belongs to the relatively dry steppe climatic zone.

The deposit locates within a highland of 1,500m above sea level, and a relatively scarce vegitation is observed. There are about 115 frostless days annually, and it is relatively windy throughout the year. It is particularly windy for two months from April to May, with about 24 sandstorm days annually.

4. Geology and deposit

(1) Mineralization

This deposit contains fluorite and quartz.

(2) Type of deposit

Vein type

(3) Ore reserves and grades

B+C_1 4,000,000t, CaF_2 40%.

In addition, there are about 6 million tons of ore reserves with C_2 category. There are 3 ore bodies among them. The No. 1 ore body occupies 70% of the ore reserves.

(4) Size of deposit

Length 2,800m, average width 4m (max. 13~18m), depth 250m (No.1 ore body).

(5) Structure of deposit

Strike: N36°W, Dip: 75°~80° NE

(6) Country rock

Aplitic granite or quartz porphyry

(7) Structural control

This deposit is emplaced in the fracture striking NW.

(8) Related igneous rocks

Mesozoic granitic rocks

(9) Alteration

Wall rock alteration is weak and silicification is recognized a little with a very few clay minerals and pyrite.

5. Water supply

There is a well 3km west of the deposit.

6. Hydrology

The underground water table has not been confirmed yet.

7. Discovery and history

1988: Mining has begun. Amount of ore excavated is 500,000t. CaF_2 27%~29%.

8. Mining operation

(1) Owner of enterprise

Mongol/Soviet Non-Ferrous Metal Company

(2) Employees

24~25 (6~7/shift, 3-shift operation)

(3) Scale of production

60,000t/y, grade of crude ore: CaF_2:27%~29%.

(4) Mining method

Open cut mining by the height of 10m-bench. It is planned that open cut mining will be conducted to a level of 1,400m.

(5) Transportation method

The total amount of ore is carried to Bor-Undur by truck.

(6) Ore dressing method

- Processing method: ore flotation at Bor-Undur
- The amount of concentrate, grade and recovery rate: 9,200t/y, CaF_2 95%, recovery rate 73%.
  (It is said that ore dressing is easy, as the ore contains little calcite.)

9. Others

The mine produces only crude ore. Ore flotation is conducted on all this crude ore at Bor-Undur, and all concentrate is sent to the USSR.

1-4-3 Chol-Tsagaan-Del deposit★

1. Location and transportation

Location: Longitude 107°14'21" East, Latitude 46°55'48" North,Elevation 1,440m above sea level.

In administrative division terms, the deposit is located in the Bayantsagaan Sum in the Central Aimag, and about 110km south-southeast of Ulaanbaatar. It is about a four-hour drive by car via the dirt road from Ulaanbaatar to the deposit.

2. Topography

The area around the Chol-Tsagaan-Del deposit is a gentle hilly zone with elevational range of 1,350m~1,500m above sea level. The deposit is located in the southern slope of a slightly elevated hill.

3. Climate

The major climate index of the area around the Chol-Tsagaan-Del deposit is as follows.

Annual solar radiation; 5,150MJ/m^2

Temperature; annual average temperature; −2.4°C

Monthly average temperature*; the highest month is July with 16.2°C, the lowest month is January with −23.3°C

The highest temperature recorded 35.1°C.

The lowest temperature recorded −39.2°C

Precipitation*: annual precipitation; 240mm

Monthly average precipitation; the highest month is July with 78.2mm, and lowest month is January with 1.5mm.

Relative humidity; monthly average : January 68%, April 39%, July 50%, October 46%.

Wind velocity*; monthly average; January 1.3m/sec., April 3.5m/sec., July 2.5m/sec., October 2.1m/sec.

The deposit is located at a highland, about 1,500m above sea level in the northern edge of the Mongolian central flatland. Climate around the deposit is that of a typical steppe climate zone and the steppe is the standard steppe found in Mongolia.

There are about 100 frostless days annually and it is relatively windy for three months from April to June.

*(Notice) *: * indicates the Mandalgovi's data.*

4 Geology and deposit

(1) *Mineralization*

This deposit contains three types of mineralization namely fluorite-quartz type, fluorite-quartz-calcite type and brecciated type.

(2) Type of deposit

Vein type

(3) Ore reserves and grades

1,400,000t, CaF2 40%~53%

(4) Size of deposit

There are 8 ore bodies with a vein width of 3m~4m and two of which, No. 2 and No.5 ore bodies are said to be workable among them. Mining pit size is 400m long, 60m wide and 60m deep and scheduled to excavate to a depth of 100m.

(5) *Structure of deposit*

There are two structural systems. The one is striking N25°E and dipping 75°~80° to the northwest, the other is striking N65°W and dipping 60° to northeast. It is generally said that the intersection of these veins yields high grade ore.

(6) Country rock

It is composed of phyllite, schist, and limestone intercalating lenticular dolomite.

(7) Structural control

As the vein is cut by many crossing faults, it becomes a zigzag arrangement. The junction of N25°E system and N65°W system, forms bonanza.

(8) Related igneous rocks

Not obvious.

(9) Alteration

Silicification, kaolinization, and slight pyritization.

5. Water supply

Both water for mining and drinking is supplied from the well 5km away from the deposit.

6. Hydrology

Not obvious.

7. Discovery and history

1978: The USSR survey team began exploration.

1979: Czechoslovakian survey team began exploration.

1980: A joint venture between Mongolia and Czechoslovakian survey team began trial exploitation.

The amount of ore already mined is 560,000t with a cut off grade of CaF_2 17% and the grade of mined ore CaF_2 40%~53%.

8. Mining operation
   (1) Owner of enterprise: A joint venture between Mongolia and Czechoslovakia
   (2) Number of employee: 90.
   (3) Scale of production; 60,000~70,000t/y, grade of crude ore about CaF_2:40%.
   (4) Mining method: Open cut mining by 10m-high bench. It is planned to mine to a depth of 110m.
   (5) Transportation: The ore is transported by truck between stopes and a crushing plant.
   (6) Ore dressing method.
   Only crushing and classifying. (Amount of waste 30%, recovery 70%)

Size (Ømm)	Grade (CaF2 %)	Remarks
0~20	32~40	screen under size (waste)
20~60	55~57	export
60~300	60	export

9. Others
   The ore of this deposit is not accepted at the mill in Bor-Undur, as it includes many impurities. The ore is transported 110km to Choir by truck and then transported to Czechoslovakia as a crude ore.

1-4-4 Hongor deposit-group ★ (Fig. II-1-12)

1. Location and transportation
   Hongor I Ore body
   Longitude 109°44'51" East, Latitude 45°48'17" North, Elavation 1,250m above sea level
   Hongor II Ore body
   Longitude 109°46'01" East, Latitude 45°48'20" North, Elevation 1,220m above sea level
   Hongor III Ore body
   Longitude 108°53'58" East, Latitude 45°47'58" North, Elevation 1,240m above sea level

In administrative division terms, the deposit is located at the Han-Hongol Sum in the Dornogovi Aimag, and about 135km north-north-west of Sainshand, the capital of Aimag, and about 285km south-south-east of Ulaanbaatar.

It takes about 9 hours by car through the steppe from Ulaanbaatar to the Hongor deposit.

2. Topography
   Elevation around the Hongor deposit is between 1,200m and 1,300m above sea level. The highest point in this area is Mt. Ih Hongol (1,313.1m), about 700m northwest of the Hongor I Ore body, and 3km east-north-east of the Hongor III Ore body. The area is a gentle hilly zone which consists of small hills and flat valleys which are covered by clastics sediments.

3. Climate

The Hongor deposit is located at the margin of the northeastern part of Gobi in Mongolia. Around the deposit, the annual solar radiation is 5,500MJ/m^2, annual average temperature is 1.1°C, and annual precipitation is about 160mm. This area is semi-desert or relatively thin steppe. There are about 126 frostless days annually, and it is relatively windy throughout the year. It is particularly windy from April to May, and there are about 30 sandstorm days annually.

4. Geology and deposit

(1) Mineralization

The ore of this deposit contains fluorite. As to the nature, there are two types, one being the quartz-fluorite type, the other the calcite-quartz-fluorite type.

(2) Type of deposit

Vein type.

(3) Ore reserves and grades

Name	Classification	Ore reserves(t)	Grade(%)
Hongor I	C_1	244,600	CaF_2 34.0
Hongor II	C_1+C_2	661,661	CaF_2 29.3
Hongor III	C_1	470,190	CaF_2 33.0

(4) Size of deposit

Name		Length (m)	Width(m)	Inclinational Length (m)	Remarks
Hongor I		680	4.05	65	
Hongor II			0.68~31.5		22 ore bodies are distributed in the are of 400m×150m
Hongor III	No.1	680	6.89	120	
	No.2	115	5.39	?	
	No.3	140	?	196	
Hongor IV		240	5.6	70	

(5) Structure of deposit

Name		Strike	Dip
Hongor I		N50°W	63°~80°NE
Hongor II		N25°W	21°~55°NE
Hongor III	No.1	N70°~80°W	72°SW
	No.2	N70°~80°W	67°SW
Hongor IV		N35°E	85°~90°SE

(6) Country rock

Hongor deposit is emplaced in schist and crystalline limestone formed in the Late Palaeozoic Era, and rhyolite formed during the Middle to Late Carboniferous Period.

(7) Structural control

The deposit is emplaced along the boundary between schist and crystalline limestone formed in the Late Palaeozoic Era and intermediate~acidic volcanic rocks formed during Jurassic to Cretaceous Period.

(8) Related igneous rocks

Not obvious.

(9) Alteration

Silicification, argillization, kaolinization, sericitization, limonitization, graphitization, propylitization, epidotization, chloritization, and pyritization are observed.

5. Water supply

There is a well within 3km of the deposit.

6. Hydrology

- Hongor I All ore reserves are above the ground water table.
- Hongor II Water has not been confirmed.
- Hongor III ground water table: −48m, filling capacity 2ℓ/sec.

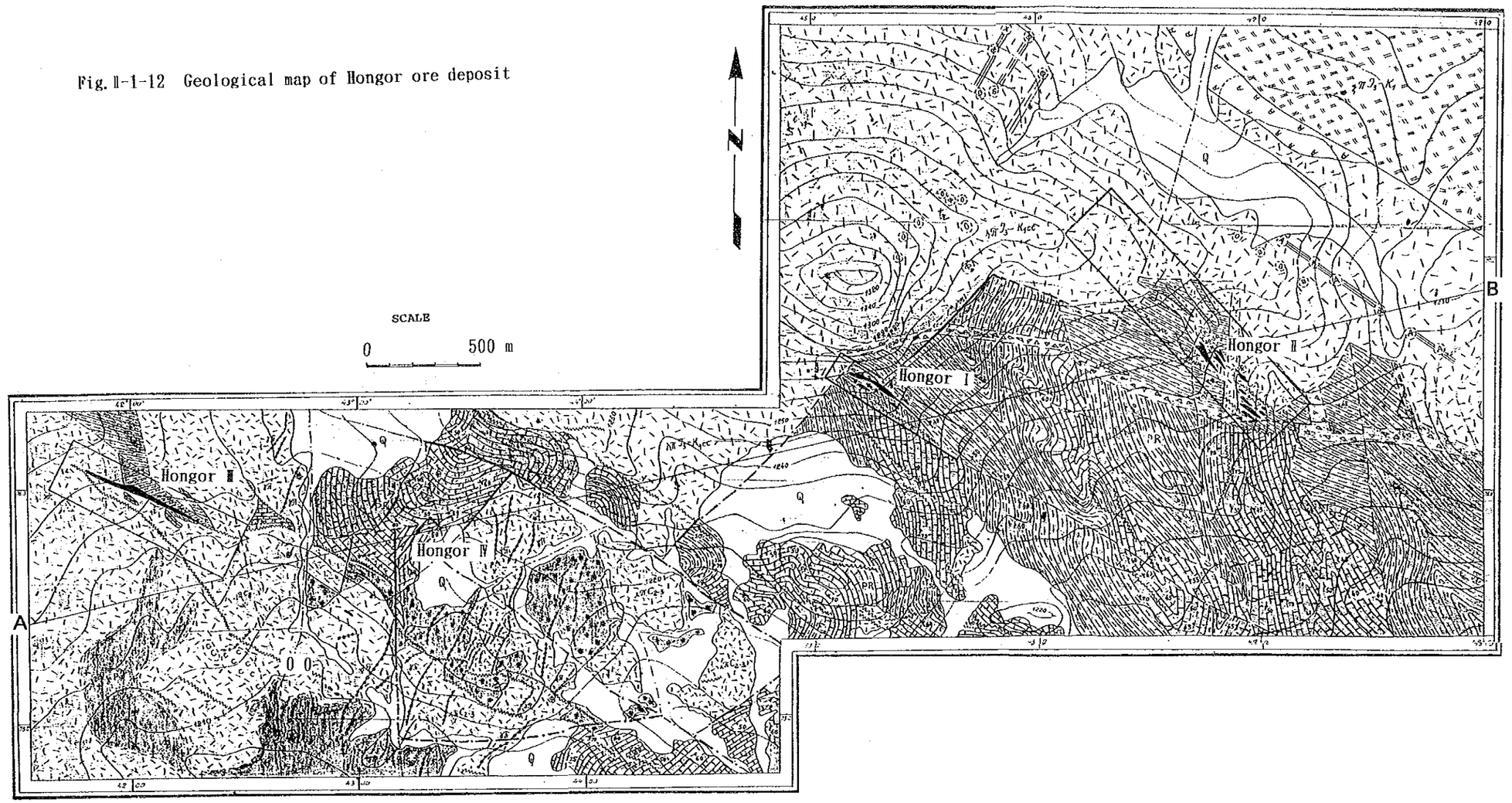
7. Discovery and history

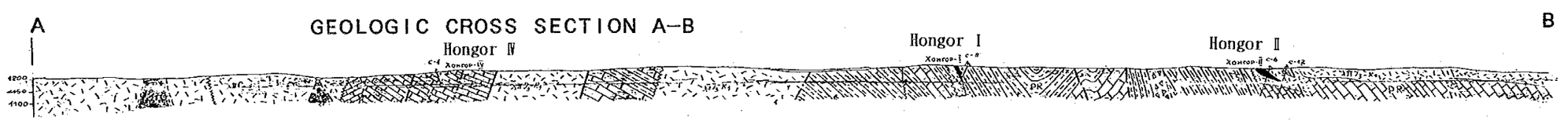
1964	The survey group (By the cooperation of the USSR and Mongolia) discovered five mineralized zones, Hongor I ~ V, while conducting a geological survey at a scale of 1:50,000.
1965	The survey group (By the cooperation of the USSR and Mongolia) conducted geochemical exploration, trenching and boring as well as a geological survey at a scale of 1:10,000.
1971~72	The USSR survey team worked mostly on Hongor II and estimated the possible ore reserves of Hongor II to be 3,100,000t, CaF_2 40.6%.
1974	Mongolian team conducted a survey at a scale of 1:10,000 on Hongor I and II by geological survey, geophysical exploration, boring and trenching.
1974	Development of Hongor II began with open cut mining.
1974-76	Stripping work was conducted on Hongor II.
1976	Mongolia conducted an examining survey on Hongor II.
1977	Mining began (I, II, III, IV) in cooperation with the Har-Airag Fluorite Industry.
1977	Mongolia discovered the ore bodies, Hongor VI, VII, VIII, IX, and X by conducting geological surveys, geophysical exploration, and geochemical exploration.
1977-79	Mongolia completed a feasibility study of the deposits.

Past exploration works (Total amount of exploration works conducted to Hongor I ~ IV during 1974-1980.)

trenching	16,300 m
pitting	160 m
boring	12,000 m
samples for ore dressing	5

Fig. Ⅱ-1-12 Geological map of Hongor ore deposit





LEGEND

- Quarternary
- Jurassic: Dacite
- Jurassic: Liparite
- Jurassic: Secondary quartz
- Caboniferous: Felsite, quartz porphyry
- Proterozoic: Marble
- Proterozoic: Syenite
- Granite porphyry dike
- Iktruzivii complex
- Upper Paleozoic: Syenite
- Upper Paleozoic: Granite
- Epidote-garnet skarn
- Silicification
- Fluoritization
- Kaolinization
- Chloritization
- Argillization
- Pyritization
- a) Brecciated Zone
  b) Cataclastic Zone
- Quartz-fluorite ore body
- Siliceous rock
- a) Fault b) Inferred fault
- Boundary of granite: actualed(a), inferred(b)
- Bedding
- Area of Hongor fluorite deposit

geophysical exploration, preparation of the topographical map, and various laboratory tests, etc.

Results of the ore treatment test

Name of ore deposit	Grade of crude ore (%)	Concentrate by hand picking method (%)	Concentrate of gravitational method (%)	Concentrate of flotation (%)
Hongor I		76.2		94.61
Hongor II	20.85			95.19
	32.23			96.97
Hongor IV			75.92~81.20	

8. Mining operation (Amount of produced ore during 1977-79)

Name	Produced ore (t)	Concentrate (t)	Mining method
Hongor I	24,889	8,238	open cut mining
Hongor II	167,462	55,798	open cut mining
Hongor III	67,378	21,500	open cut mining

1-4-5 Maihanta deposit-group ★ (Fig. II-1-13)

1. Location and transportation

Location

Maihanta I deposit

Longitude 108°38'20" East, Latitude 45°49'50" North, Elevation 1,190m above sea level.

Maihanta II deposit

Longitude 108°39'54" East, Latitude 45°51'22" North, Elevation 1,180m above sea level.

In administrative division terms, the deposit is located in the Dala Dalanjargalan Sum in the Dornogovi Aimag, and about 160km northwest of Sainshand, the capital of the Aimag, and about 270km east-south-east of Ulaanbaatar.

It is about a 10 hour drive by car via the dirt road through the steppe from Ulaanbaatar to the Maihanta deposits.

2. Topography

Elevation around the Mainhanta ore deposit which is composed of two ore bodies, Mainhanta I and Mainhanta II, is between 1,150m and 1,250m above sea level. The highest point of this area is the Khoroot Uhaa triangulation station-point (1,252.2m). Both deposits lay in a plateau facing a structural basin towards west with an elevational differences of 100m. Mainhanta I deposit shows rather steep topography being located at the sholder of plateau, whereas Mainhanta II located on a flat plateau.

3. Climate

The Maihanta deposit is located in the highlands, 1,100~1,200m above sea level, on the margin of the north eastern part of Govi in Mongolia. The annual solar radiation is 5,400MJ/m^2, annual average temperature is 1.1°C, and annual precipitation is about 160mm. This area is semi-desert or relatively thin steppe. There are about 126 frostless

days annually, and it is relatively windy throughout the year. It is particularly windy for two months from April to May, with about 30 sandstorm days annually.

4. Geology and deposit

(1) Mineralization

This deposit contains fluorite. As to the nature of ore, there are two types, namely quartz-fluorite type (Maihanta I), and calcite-quartz-fluorite type(Maihanta II).

(2) Type of deposit

Lenticular type and/or pocket type replacement deposit.

(3) Ore reserves and grades

Name	Classification	Ore reserves(t)	Grade	Remarks
Maihanta I	C_2	2,547,700	CaF_2 36.5%	3 ore bodies
	P_1	340,000		
Total		2,887,700		
Maihanta II	C_2	197,600	CaF_2 33.1%	4 ore bodies

(4) Size of deposit

Maihanta I	Length (m)	Width(m)	Inclinational Length (m)	Grade CaF_2 (%)
No. 1 ore body	920	0.6~9.5	320	
No. 2 ore body	300	1.27~3.77	200~300	
No. 3 ore body	300		100~150	

Maihanta II	Length (m)	Width(m)	Inclinational Length (m)	Grade CaF_2 (%)
No. 1 ore body	200	0.6~12.9	20~70	17.4~31.2
No. 2 ore body	350	1.2~4.4	100~130	21.3~46.2
No. 3 ore body	50	(Small-sized, and not surveyed well. Only a geological survey at surface has been conducted.)		
No. 4 ore body	300	(Small-sized and only a geological survey at surface has been conducted. Trenching was conducted on intervals of 100m.)		

(5) Structure of deposit

Maihanta I	Strike	Dip
No. 1 ore body	N70°E	30°~40°N
No. 2 ore body	N70°E	30°~40°N
No. 3 ore body	N20°E~40°W	30°~40°N

Maihanta II	Strike	Dip
No. 1 ore body	N70°E	80°~88°NW
No. 2 ore body	N70°E	45°~50°NW
No. 3 ore body	?	?
No. 4 ore body	N-S	?

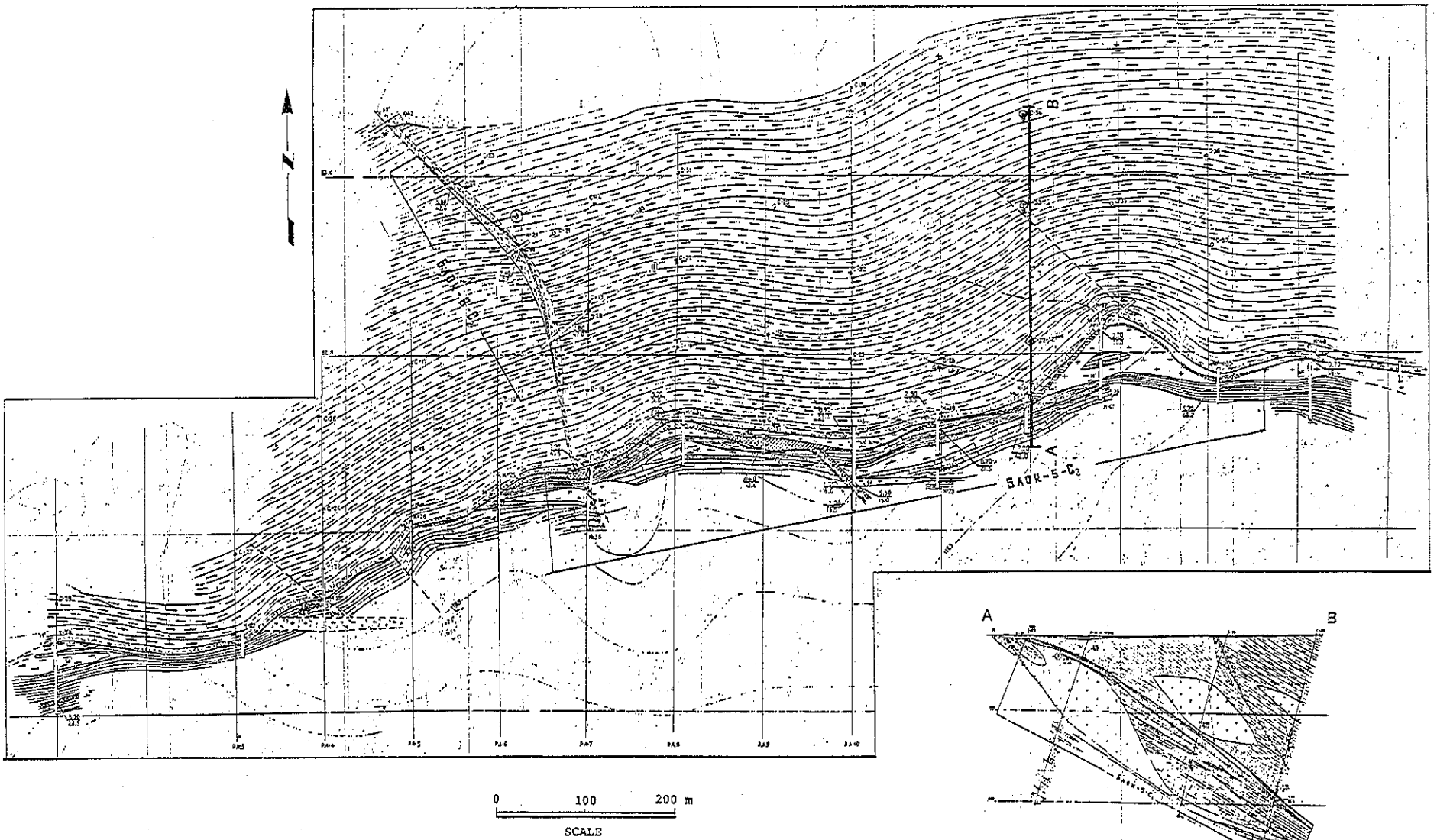


Fig. II-1-13 Geological map of Maihanta ore deposit

(6) Country rock

The country rock of the deposit is composed of biotite gneiss, granitic gneiss, and crystalline limestone formed in the Proterozoic Era and granodiorite porphyry, fine-grained diorite, granite porphyry, and syenite porphyry formed in the Late Palaeozoic Era.

(7) Structural control

The deposit exists in the fructured zone at the boundary between biotite gneiss and crystalline limestone formed in the Proterozoic Era (Maihanta II), or in the fructured zone in the two mica gneiss of Proteozoic period. (Maihanta I)

(8) Related igneous rocks

Not obvious.

(9) Alteration

Silicification, argillization, and limonitization are observed.

5. Water supply

The valleys have no running water. However, there is a carbonate mineral spring, called Khalzangiin alshan, 5km southwest of the deposit. (Flow of spring water is approximately 30~50ℓ/m)

6. Hydrology

Not obvious.

7. Discovery and history

1954 The USSR survey team conducted a geological survey at a scale of 1:200,000.

1963 The USSR survey team conducted a geological survey at a scale of 1:50,000.

1971 The USSR survey team discovered Mainhanta I and II, as well as Tsagantakhilch, by conducting geological surveys at a scale of 1:200,000 and 1:50,000.

1972-73 The USSR conducted evaluation of the ore deposit by trenching and boring.

Past exploration works

Maihanta I	boring	36 holes (60m×70m grid interval)	total	5,500m
Maihanta II	boring	6 holes	total	760m

Ore dressing test

An ore dressing test was conducted on the ore of Maihanta I. Because the ore contains calcite, the grade of concentrate was not so high.

Results of ore flotation test	Grade of concentrate	CaF_2 96.78%
Results of gravity concentration test	Grade of concentrate	CaF_2 93.21% (−25~1.5mm)
		CaF_2 92.6% (−15~+5mm)
	Grade of tailing	CaF_2 2.35%

8. Mining operation

Some parts of the outcrop of Maihanta II have already been mined out. The amount of excavated ore is about several thousand tons.

1-4-6 Tsagantakhilch deposit ★ (Fig. II-1-14)

1. Location and transportation

Location: Longitude 108°37'36" East, Latitude 45°47'46" North, Elevation 1,215m above sea level. In administrative division terms, the deposit is located in the Dalanjargalan Sum in the Dornogovi Aimag, and about 156km northwest of Sainshand city (population 16,000), the capital of the Aimag, and about 270km east-southeast of Ulaanbaatar.

It takes about 10 hours by car on the dirt road through the steppe from Ulaanbaatar to the Tsagantakhilch deposit.

2. Topography

Elevation around the Tsagantakhilch deposit is between 1,100m and 1,220m above sea level. The highest point of this area is a nameless hill (1,221m) located in 1.8km east of the deposit. This district is a mountanous area which is 100m higher than the western structural basin. It is relatively steep as it faces a fault-line scarp.

3. Climate

The Tsagantakhilch deposit is located in the highlands, 1,100~1,200m above sea level, on the margin of the northeastern Govi in Mongolia. Annual solar radiation is 5,500MJ/m^2, annual average temperature is 1.1°C, and annual precipitation is about 160mm. This area is located between the steppe and desert climatic zones. The area is semi-desert which has a relatively scarce steppe. There are about 126 frostless days annually, and it is relatively windy throughout the year. It is particularly windy for two months from April to May, and there are about 30 sandstorm days annually.

4 Geology and deposit

(1) Mineralization

This deposit contains fluorite. It occurs as coarse-grained fluorite-quartz vein.

(2) Type of deposit

Fluorite and quartz vein.

(3) Ore reserves and grades; (ore reserves were calculated in 1987)

Classification*	Ore reserves (t)	Grade(CaF_2 %)
C_2, minable ore	813,900	44.78
C_2, minable ore	154,000	36.95
C_2, subtotal	967,900	43.53
Total of C_2+P_1	1,824,900	40.51

(4) Size of deposit

There are two veins, whose length are 600m and 2,000m. Width ranges from 0.5m to 4m. Max. width is 10m and average is 1.47m. Extension to the direction of inclination is 200m, max. being 450m.

(5) Structure of deposit

Strike N35°~55E°, Dip 85°~90°SE (Vein of hangingwall-side), Strike N60°~80E°, Dip 65°~85°SE (Vein of footwall-side), etc.

(6) Country rock

Medium or coarse-grained biotite granite intruded in Jurassic Period.

(7) Structural control

Not obvious.

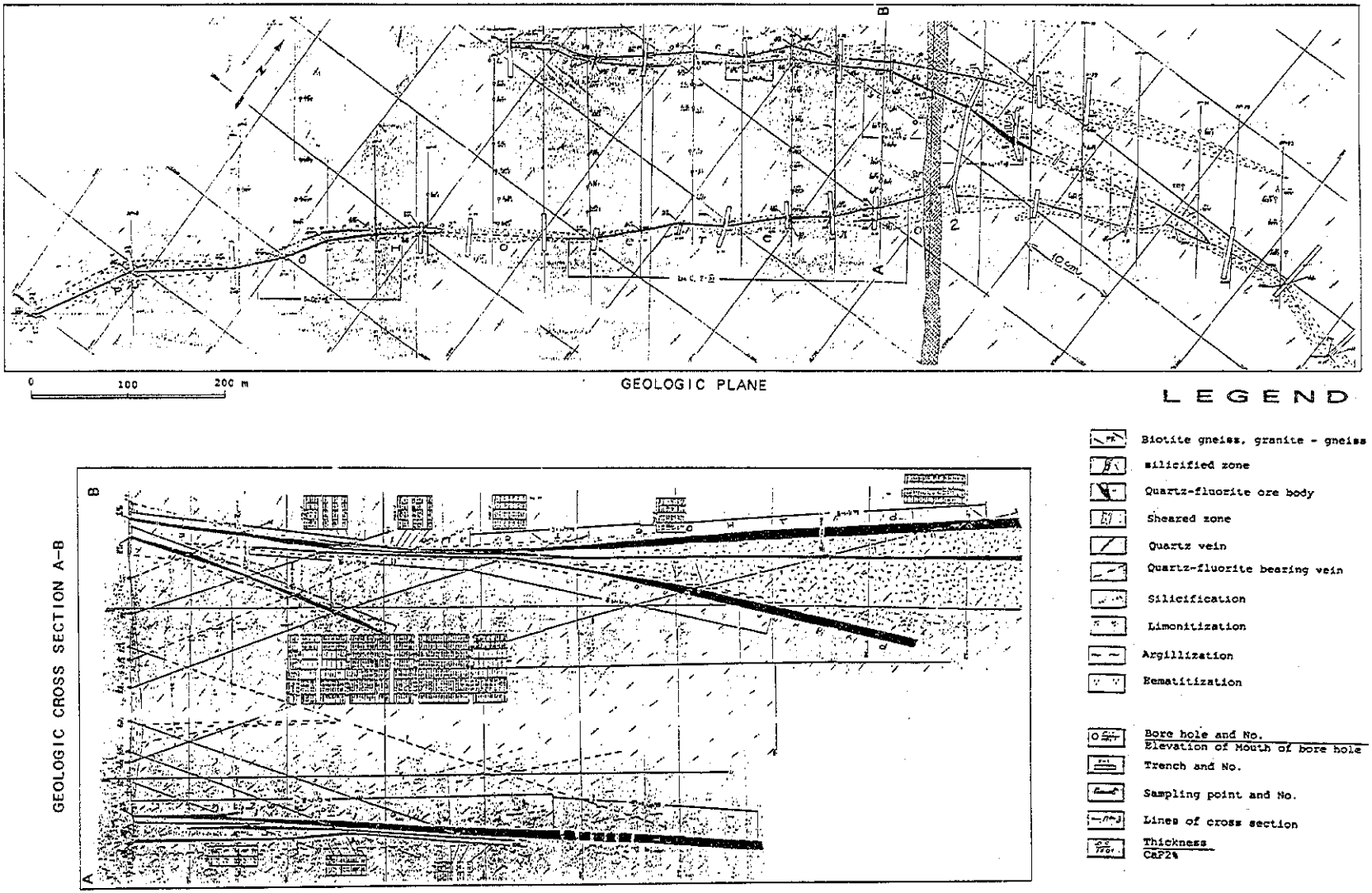


Fig. II-1-14 Geological map of Tsagaantakhilch ore deposit

(8) Related igneous rocks
Not obvious.

(9) Alteration
Silicification, argillization,sericitization, kaolinitization, and limonitization ore observed.

5. Water supply
The valleys have no water. However, there is a mineral spring which is called Khalzangiin alshan, 5km southwest of the deposit. (Flow rate of sping water is approx. 30~50ℓ/m)

6. Hydrology
Underground water table usually exists about 30m below the surface. Filling capacity is about 1ℓ/m (−8m).

7. Discovery and history

1971 The USSR discovered Tsagantakhilch, Mainhanta I and II, while conducting the geological surveys at a scale of 1:200,000 and 1:50,000.

1972-73 The USSR conducted the evaluation work of the deposit by trenching and boring.

trenching	100m
boring	200m×200m interval
geological survey at a scale of 1:25,000 and 1:10,000	
Ore reserves	C_2=1,872,000t

1980-82 A preliminary feasibility survey was conducted
Ore treatment test:
An ore dressing test was conducted for the samples of 528kg obtained from trenching. Ore dressing was easy, as the ore is a coarse-grained fluorite-type and quartz-type.

Results of ore flotation test	Grade of concentrate CaF_2 87.23%
Results of gravity concentration test	Grade of concentrate CaF_2 96.78%

Past exploration works

trenching	47	11,100 m^3	170 samples for analysis
boring	55 holes	6,800 m	384 samples for analysis

geophysical exploration, preparation of the topographical map, and laboratory testing etc.

8. Mining operaiton
None.

1-4-7 Other deposits

Furthermore, following fluorite deposits are known in the Har-Airag district. In addition to them, there are a lot of fluorite mineral showings

No. Name	Classification	Ore reserves(t)	Grade(CaF_2%)	Location
1. Barn-Tsagan-Del	$B+C_1+C_2$	100,000	41.5	25km southwest of Har-Airag deposit
2. Budjiger	$B+C_1+C_2$	385,300	37.9	109°10'30"E, 46°48'25" N
3. Hajyuu-Ulaan	$B+C_1+C_2$	582,100	39.0	109°52'05"E, 46°19'24" N
4. Hailta	$B+C_1$	28,000	47.1	109°21'50"E, 45°45'07" N
5. Hamar-Us	C_1+C_2	1,052,900	47.1	110°10'28"E, 46°25'13" N
6 Tsagaan-Elegeni	possible ore reserves	1,100,000	46.0	30km southeast of Dzuun Tsagaan-Del deposit
7. Dzuun-Tsagaan-Del	$B+C_1+C_2$	6,951,800	32.1	110°02'18"E, 46°22'12" N

1-5 Lugiingol district

The Lugiingol district is located at the southeasternmost of Mongolian Gobi desert. In administrative division terms, it is in 70km E-W×50km N-S range in the Hatanbulag Sum in Dornogovi. It is about 240km southwest of Sainshand, the capital of the Aimag.

From Ulaanbaatar to Sainshand, railway and major roads are available, and it takes about 10 hours by car. It is about 300km from Sainshand city to the Lugiingol district, about 7 hour drive by car through the desert.

This district is a gentle hilly zone whose elevation is 1,040m~1,140m above sea level, south of the Gobi lowlands. It is rocky desert with scarce vegetation, because of the low precipitation throughout the year, and the windy weather in spring. Temperature range is between −40°C and 45°C. The weather condition is harsh, being particularly windy from April to June with about 30 sandstorm days annually.

Geology of the district consists of shale, sandstone of Late Permian and the Triassic Lugingol alkaline complex intruded into Permian System (Fig. II-1-15). Lugiingol ore deposit occurs as carbonatite veins containing lanthanium, cerium, etc.

1-5-1 Lugiingol deposit ★ (Fig. II-1-16, Fig. II-1-17)

1. Location and transportation

Location: Longitude 108°35'04" East, Latitude 42°58'38" North, Elevation 1,113m above sea level. In administrative division terms, the deposit is located in the Hatanbulag Sum in the Dornogovi Aimag. It is about 240km southwest of Sainshand, the capital of the Aimag.

From Ulaanbaatar to Sainshand city, railway and major roads are available, and it takes about 10 hours by car. It is about 300km from Sainshand city to the Lugiingol district, about 7 hour drive by car through the desert.

2. Topography

The elevation of most parts is about 1,040m~1,140m. The maximum elevation of this area is Gants Modn Khayar triangulation station-point (1,178.8m), 6.5km north of the deposit. This district is a gentle hilly zone which consists of buried valleys and small hills that are 100m higher than the valleys. As the valleys have no running water, automobiles can drive almost anywhere.

3. Climate

The annual solar radiation is 6,500MJ/m^2, annual average temperature is 3°C, and annual precipitation is about 116.1mm. This area belongs to the desert climatic zone. It is a rocky desert with scarce vegetation because of the low precipitation throughout the year, and the windy weather in spring. It is windy throughout the year with 140 frostless days annually. It is particularly windy from April to June, with about 30 sandstorm days annually.

4. Geology and deposit

(1) Mineralization

The deposit contains rare earth ore, mainly light rare earth ore such as La, Ce, etc. It also contains a small amount of Pr, Nd, Sm, Eu, Gd, Dy, Tb, Y, etc. The ore is classified into 2 types of mineral assemblege. 1. carbonate, fluorite, apatite, rare earth. 2. carbonate, quartz, rare earth. As for ore, synchisite, parisite, bastonesite, armstrongite, monazite, ilmenorutile etc. are known. The diameter of synchisite ranges 0.7mm~0.8mm. The results of chemical analysis is as follows: La 35.3%, Ce 47.9%, P 4.1%, Nd 10.2%. Grade of the rare earth varies greatly even in the same vein.

As opaque minerals, hematite and pyrite are recognized.

(2) Type of deposit

Carbonatite type (Many carbonatite dikes)

(3) Ore reserves and grades

Kind	Amount (t)	Classification	TREO(%)	Metal content (t)	
oxidized ore	88,000	(C_1+C_2)	3.15	2,800	20% of all ore
primary ore	348,000	(C_1+C_2)	2.79	9,700	80% of all ore
Total	436,000	(C_1+C_2)	2.86	12,500	

The criteria to calculate the amount of ore

Minimum width	0.1m
Cut off	0.5% (TREO)
Lowest average block grade	1.0% (TREO)
Lowest metal grade	0.1%
depth of ore calculation	up to 160m

(4) Size of deposit

60 carbonatite dikes are found. (length 27~850m, maximum width 2m, average 0.3m, Max. length toward dip 250m)

(5) Structure of deposit

Strike: E-W and ENE-WSW (rarely WNW-ESE), Dip 70°~80°.

(6) Country rock

Country rocks (A) are Late Permian shale and sandstone partially altered to hornfels and the Lugiingol alkaline complex consisting of nepheline syenite, syenite etc. Results of K-Ar dating of nepheline syenite show 228±11~234±12Ma, that indicates the Early to Middle Triassic period.

(7) Structural control

The deposits are associated with the oval-shaped Lugiingol Alkaline Complex with a size of 3km×4km, and the distribution of the deposits is limited within this complex. It is considered that the strikes of carbonatite veins indicating clear trend such as E-W and ENE-WSW (scarsely WNW-ESE) show the stress field at the time of ore genesis.

(8) Related igneous rocks

Lugiingol alkaline complex.

(9) Alteration

Hornfels is recognized at the north side of the Lugiingol alkaline complex. Alteration is not seen at the south side of the body.

5. Water supply

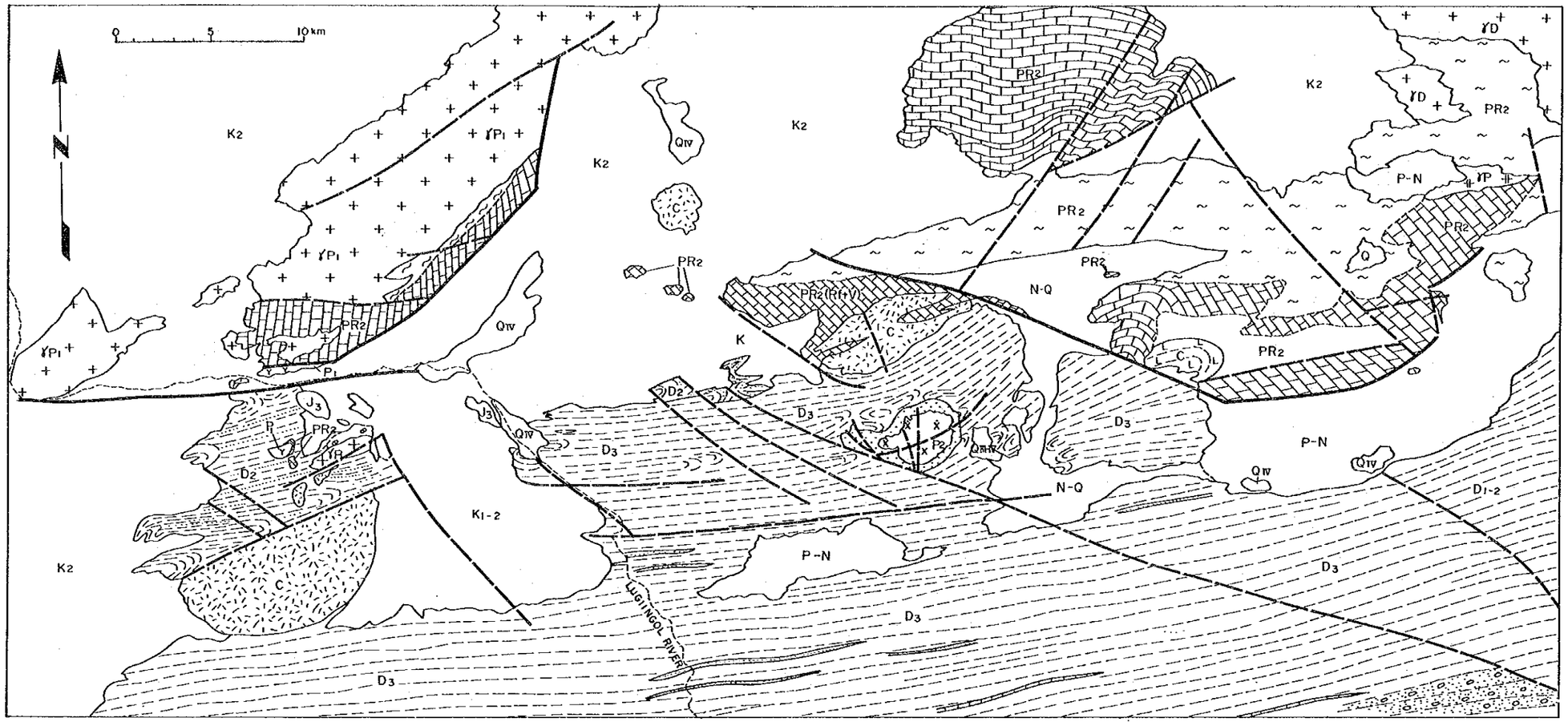
There is no water running in the rivers. However, there is a small pool in the valleys. Drinking water is available from the well 90km away from the deposit.

6. Hydrology

Ground water table: −7m~−21m. Water emanating in the tunnel :2.7m^3/sec

7. Discovery and history

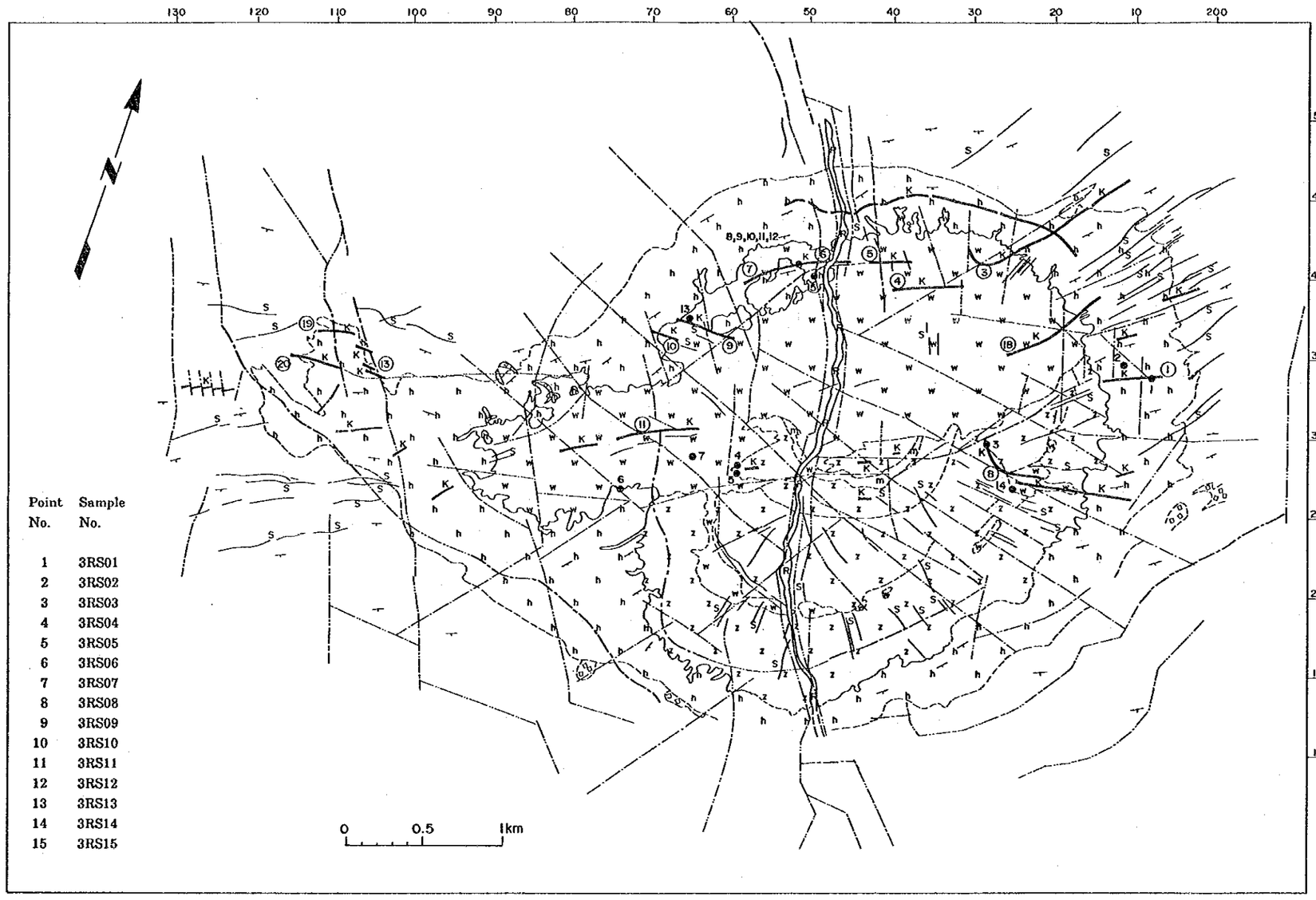
Early 1970's This deposit was discovered by the survey team (By the cooperation of Mongolia and the USSR)



LEGEND

- Andesite ~ basalt
- Basalt
- Rhyolite, rhyolitic tuff
- Flysch; siltstone, mudstone, sandstone (Lugiingol Formation)
- Sandstone, mudstone
- Sandstone
- Limestone
- Conglomerate
- Basal conglomerate
- Hornfels
- Limestone ~ marble
- "Gneissose granite", gneiss, amphibolite, "greenstone"
- Granite
- Alkali granite (Olon-Ovoot body)
- "Plagio granite" (Ulaan-Zeeg body)
- Nepheline syenite (Lugiingol body)
- Nepheline syenite with sericitization (Lugiingol body)
- Fault
- Inferred fault

Fig. II-1-15 Geological map of Lugiingol district



Point No.	Sample No.
1	3RS01
2	3RS02
3	3RS03
4	3RS04
5	3RS05
6	3RS06
7	3RS07
8	3RS08
9	3RS09
10	3RS10
11	3RS11
12	3RS12
13	3RS13
14	3RS14
15	3RS15

LEGEND

- C — Shale
- h — Hornfels and fenitizated shale
- Z — Nepheline syenite
- W — Metasomatized syenite
- m — Alkaline gabbro
- R — Rhyolite dike
- Explosion breccia cemented by syenite
- K — Carbonatite vein
- S — Other dikes
- Big fault
- Middle fault
- Small fault and fissure
- Bedding
- Sampling point and point number
- ① — Number of carbonatite vein

Fig. II-1-16 Geological map of the Lugiingol ore deposit

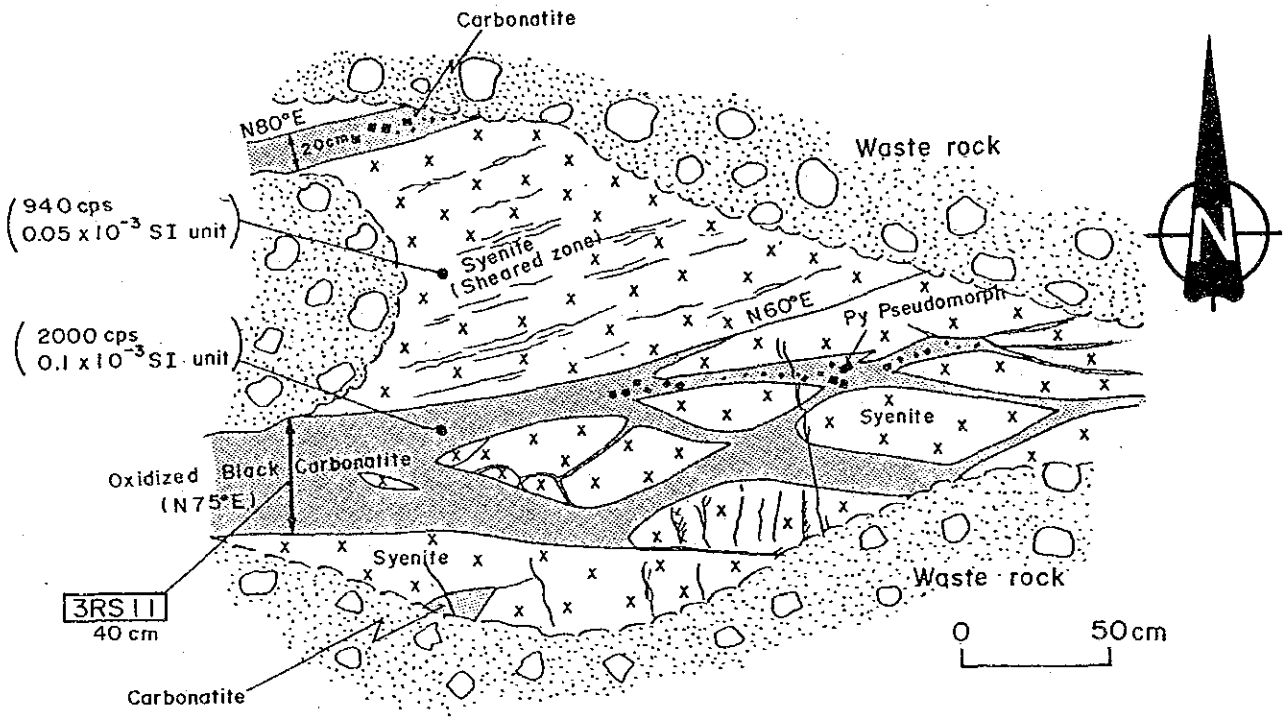


Fig. Ⅱ-1-17 Occurrence of carbonatite vein, Lugiingol

1983	The survey team (cooperation between Mongolia and Poland) conducted the survey, and evaluated that the deposit has potential.
1984~1985	A detailed survey was conducted. (By the cooperation of Mongolia and Poland)
1986~1987	A detailed survey and evaluation was conducted. (By the cooperation of Mongolia and Poland)
1988	A preliminary FS was conducted.
1990	The final report was drawn up. (without consideration on economical aspect)

Past exploration works

Geological survey at a scale of 1:50,000	23.0km^2	
Total length of surveyed area	571.4km	
radiation survey at a scale of 1:50,000	23 km^2	47,900 points
magnetic survey (ground level)	40 km^2	10,886 points
gravity survey	10,886 points	6,107 points
logging by γ-ray	10,382 points	
pit	43 pits	
boring	164 holes	(80m~100m in depth, maximum depth 300m)
rare earth analysis sample	1,540 pcs.	
Geological survey at a scale of 1:500	22 dikes	

8. Mining operation
   None.

9. Others
   Detailed survey was conducted on 22 veins.

1,6,7	Surveyed in detail
1,3,4,11,15,18	Selected as the target of preliminary exploration.
3,4,5,8,11,15,16,18	Survey ceased immediately after it began.
10,12,22	Evaluated as no potential.

1-6 Tsagaansuvraga district

In administrative division terms, the Tsagaansuvraga district is a rectangular shaped area (200kmEW×100kmNS) that extends over Dornogovi, Dundugobi, and Umnugovi Aimag. The Tsagaansuvraga deposit, the major deposit of this district, is located in the Mongolian Gobi desert, and 180km from the railway connecting the Soviet Union, Mongolia, and China, and 320km from Dalanzadgad in direct distance.

There are two ways to go from Ulaanbaatar to Tsagaansuvraga district, one being via Dalanzadgad in Umnugovi, the other being via Sainshand in Dornogovi.

The 48-passenger Antonov airplane departs twice a day from Ulaanbaatar to Dalanzadgad city. The flight takes about 85 minutes one way. From Dalanzadgad to the deposit, it takes 5~13 hours drive by car through steppe and desert.

This district consists of a hilly zone (1,000m~1,500m elevation) and lowlands, and extends over the Govi lowlands, which extends from NE to SW in the southern part of Mongolia, and the southernmost part of the Mongolian Highlands.

The major climate index of theTsagaansuvraga area is as follows. Annual average temperature is 3.4°C, highest and lowest temperatures are 40.8°C and −41.4°C respectively. Precipitation at this area is scarce, being 70mm~120mm annually, and the vegetation is scarce, therefore the hilly zone is rocky desert and the lowlands are dried desert.

This district has a relatively mild temperature for a long period of time, with over 150 frostless days annually, as it is located at the lowest-latitude, and lowest elevation area. However, the weather conditions are severe, as it is very windy from March to May, and in summer the hot wind is over 40°C, and in winter the temperature falls below −40°C.

Geology of this district consists of Middle-Upper Devonian and Lower Carboniferous Systems and Carboniferous to Early Permian granite-syenite intruded into these systems.

The Tsagaansuvraga deposit group whose major deposit is the Serven-Suhait deposit, and many porphyry-copper type deposits and ore showings such as Nalinhuduk, Harmagtai, Ih-Shanhai, Duchin-Hural etc. are distributed in 300km E-W×60km N-S range, accompanied by the acidic igneous rocks of Carboniferous to Permian Periods, forming the second largest porphyry copper belt in Mongolia (Fig. II-1-18).

These deposits and ore showings were discovered mainly in 1971~1972, after the discovery of the Serven-Suhait deposit. The initial exploration was completed by the early 1980s in general. Although the local survey on the ore showings, except the Serven-Suhait deposit, could not be conducted in this fiscal year, the outline of the major ones were written based on the existing literatures as follows.

1-6-1 Tsagaansuvraga deposits ★ (Fig. II-1-19)

1. Location and transportation

Location : Longitude 108°20'47" East, Latitude 43°51'56" North, Elevation 1,188m above sea level. In administrative division terms, the deposit is located in the Mandaha Sum in the Dornogovi Aimag, the very center of the Govi desert.

There are two ways to go from the Ulaanbaatar to theTsagaansuvraga district, one being via Daranzadgad in Umnugovi, the other being via Sainshand in Dornogovi.

It is about 350km from the Daranzadgad city to the deposit, about 12~13 hours by car through the steppe and desert.

2. Topography

This district is a hilly zone, 900m~1,000m above seal level which consists of buried valleys and small hills, about 100m higher than the valleys. The maximum elevation is a

nameless peak (1,006.9m), about 300m south of the No.1 ore body.

The slope of the hilly zone is relatively steep. Automobiles can drive only along the lowlands at the foot of the mountain and valleys.

3. Climate

The major climate index of theTsagaansuvraga district is as follows:

Amount of solar radiation; Annual solar radiation is 6,050 MJ/m^2.

Temperature*; Annual average temperature; 3.4°C.

Monthly average temperature*; the highest month is July with 23.2°C, lowest month is January with −18.4°C

Temperature range is between −31°C and 45.0°C*.

Precipitation*; annual precipitation; 116.1mm

Monthly average precipitation; the highest month is July with 34.9mm, and lowest month is January with 0.7mm.

Relative humidity; monthly average : January 52%, April below 30%, July 40%, October below 40%.

Wind velocity*; monthly average; January 3.8m/sec., April 5.7m/sec., July 4.1m/sec., October 3.9m/sec.

This district has a relatively mild temperature for a long period of time, with over 150 frostless days annually, as it is located at the lowest latitude, and the lowest elevation area. However, it is very windy (wind velocity 2~6m, occasionally 30m/sec.) from March to May. Precipitation of this area is scarce being 70mm~120mm annually, and the vegetation is scarce, therefore the hilly zone is rocky desert and lowlands are dried desert.
(Notice) *: * indicates the Sainshand city's data

4. Geology and deposit

(1) Mineralization

The ore deposit contains copper and molybdenum. Primary copper minerals are chalcopyrite and bonite and they replace colored minerals of syenite, or fili up small fissures as ore film. Molybdenite mainly fills up small fissures as film. And also there are some thin quartz veinlets with these minerals. A small amount of sphalerite, hematite, and pyrite are also found. As for ore, it contains few pyrite, and is mainly made up of primary ore. The secondary enrichment zone is not well developed. As for stockwork ore, it is classified into 2 types. One is the quartz-sulfide type, the other is the quartz-sericite-sulfide type. At the No. 1 ore body (Serven-Suhait deposit), the grade of molybdenum tends to increase towards the deep. Secondary minerals, such as malachite, chalcocite, and covelline, are found.

(2) Type of deposit

Porphyry type copper-molybdenum deposit

(3) Ore reserves and grades; (calculated in 1984)

Nine ore bodies were confirmed at theTsagaansuvraga deposit. Among them the No.1 ore body (Serven-Suhait deposit, Fig. II-1-20) is much superior in terms of amount and grade. The assay results of 19 grab samples obtained from the pile of ore exploited from the exploration adit of the Serven-Suhait deposit in this occasion are as follows:

Cu average 0.465%, Mo 0.020%. It showed the appropriateness of the grade used for ore reserves calculation (Fig. II-1-21).

Name	Amount(t)	Cu (%)	Mo (%)	Remarks
No.1 ore body	240,044,850	0.53	0.018	trenching 11,524m^3, boring: 97 holes, 22,385.55m, adit 580.4m
No.2 ore body	16,000	0.32		boring: 2 holes, total 100m
No.3 ore body	—	0.03~0.46		trenching 2, potassium feldspathization is dominant
No.4 ore body	14,000,000	0.39		calculated to a depth of 200m
No.5 ore body	737,100	0.40		boring: 3 holes, total 510m
No.6 ore body	50,000	0.35		boring: 6 holes, to 7 ore bodies
No.7 ore body	—	0.08~0.4		trenching was carried out.
New No.1	48,000	0.42		trenching 3, boring: 8 holes
New No.2	160,000	0.33		trenching 4, boring: 1 hole, 167m

(4) Size of deposit

Nine ore bodies were distributed in the area of 2km×3.5km.

Name	Length (m)	Width (m)	extension of inclination	Remarks
No.1 ore body	1,980	~500	>470m	seticitized along the hanging wall side
No.2 ore body	~510	~20		potassium feldspatization is dominant
No.3 ore body	~600	~200		potassium feldspatization is dominant, lacking of sericite
No.4 ore body	620~1,180	~90	>200m	4 mineralized ore zones exist
No.5 ore body	180	~45		potassium feldspatization is dominant, lacking of sericite
No.6 ore body	Av. 470	~50		7 mineralized ore zones
No.7 ore body	300	~12		
New No.1	450	~300		potassium feldspatization is dominant, lacking of sericite
New No.2	400	~90		

(5) Structure of deposit

The largest deposit, Serven-Suhit, is divided by the NW-SE~E-W fault with right-lateral dislocation (central fault). Each deposit shows the strikes and dips as follows:

Name	Strike	Dip	Remarks
No.1 ore body	N20°~65°E	40°~50°NW	
No.2 ore body	N45°~55°E	40°~50°NW	
No.3 ore body	N70°E	?	

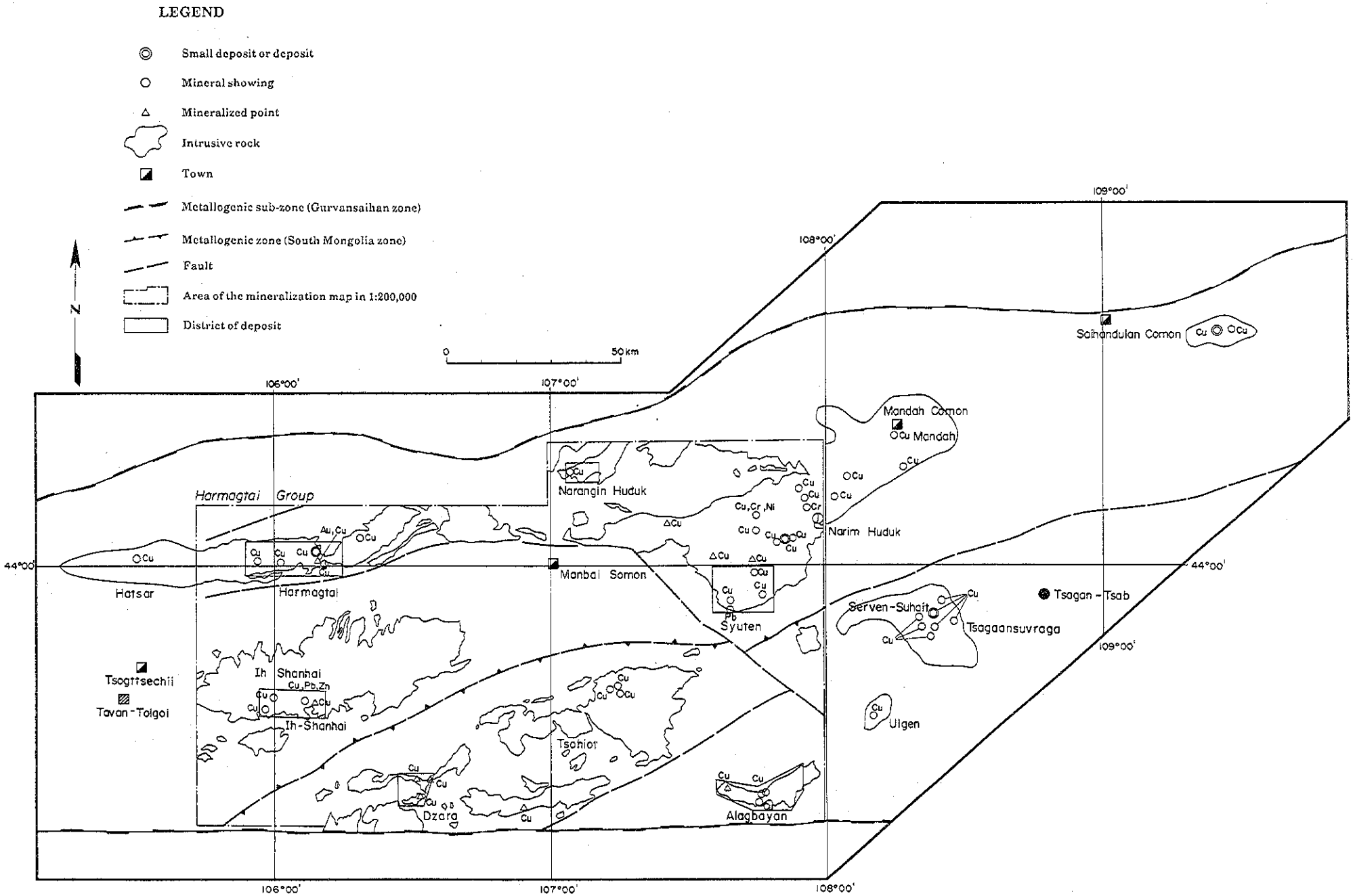


Fig. Ⅱ-1-18 Location of ore deposits in Tsagaansuvraga district

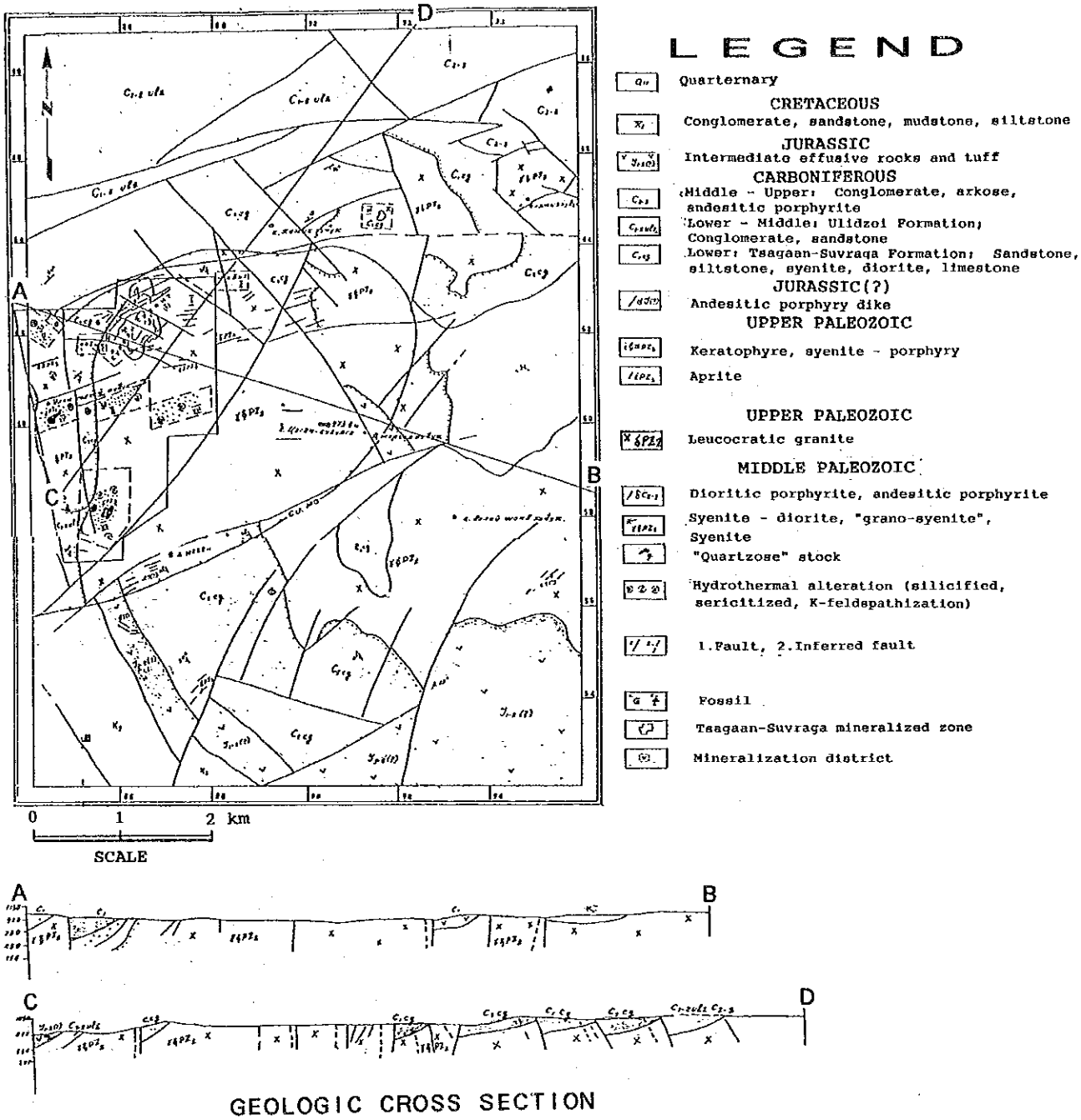
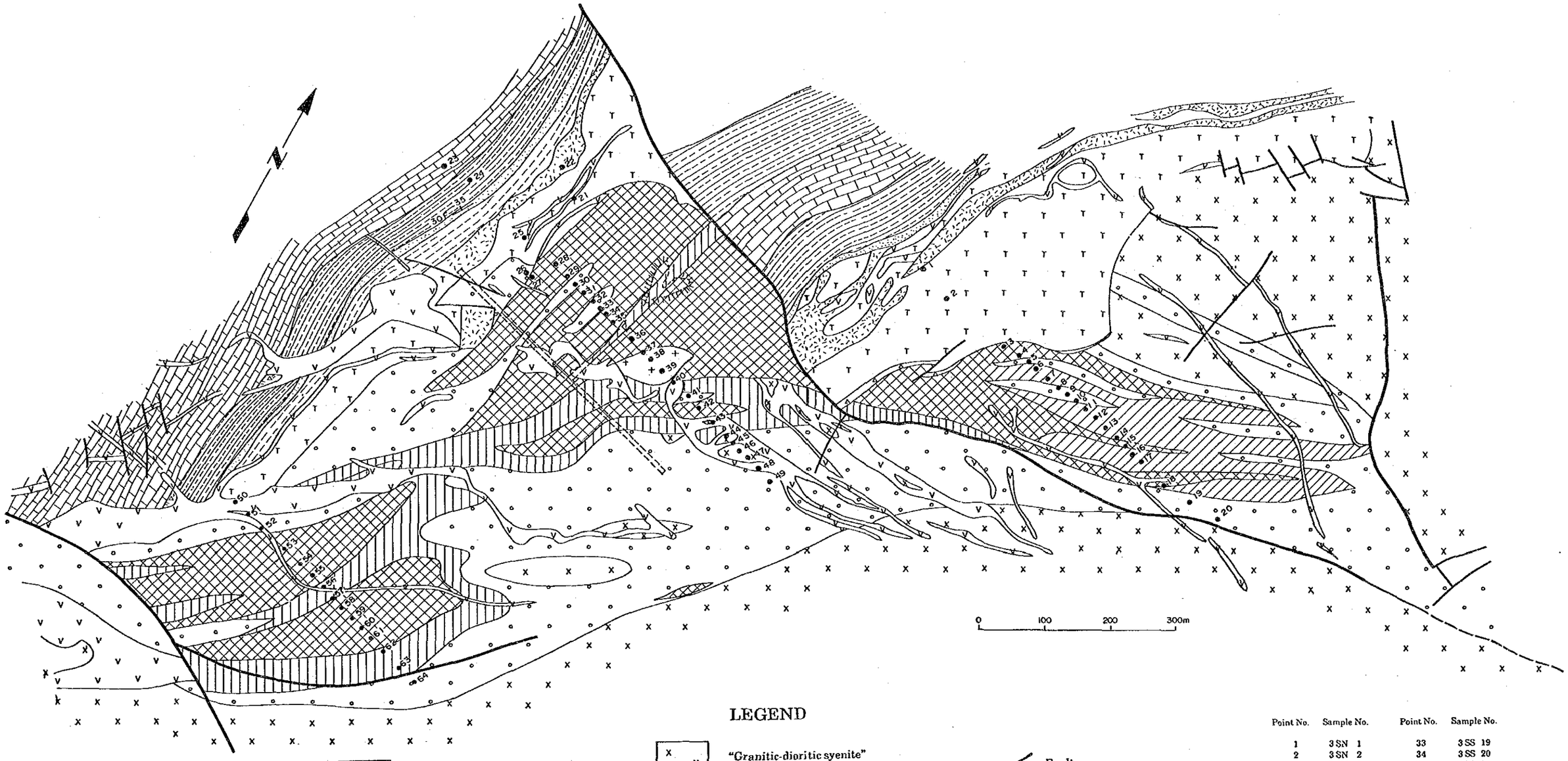


Fig. Ⅱ-1-19 Geological map of Tsagaansuvraga ore deposit

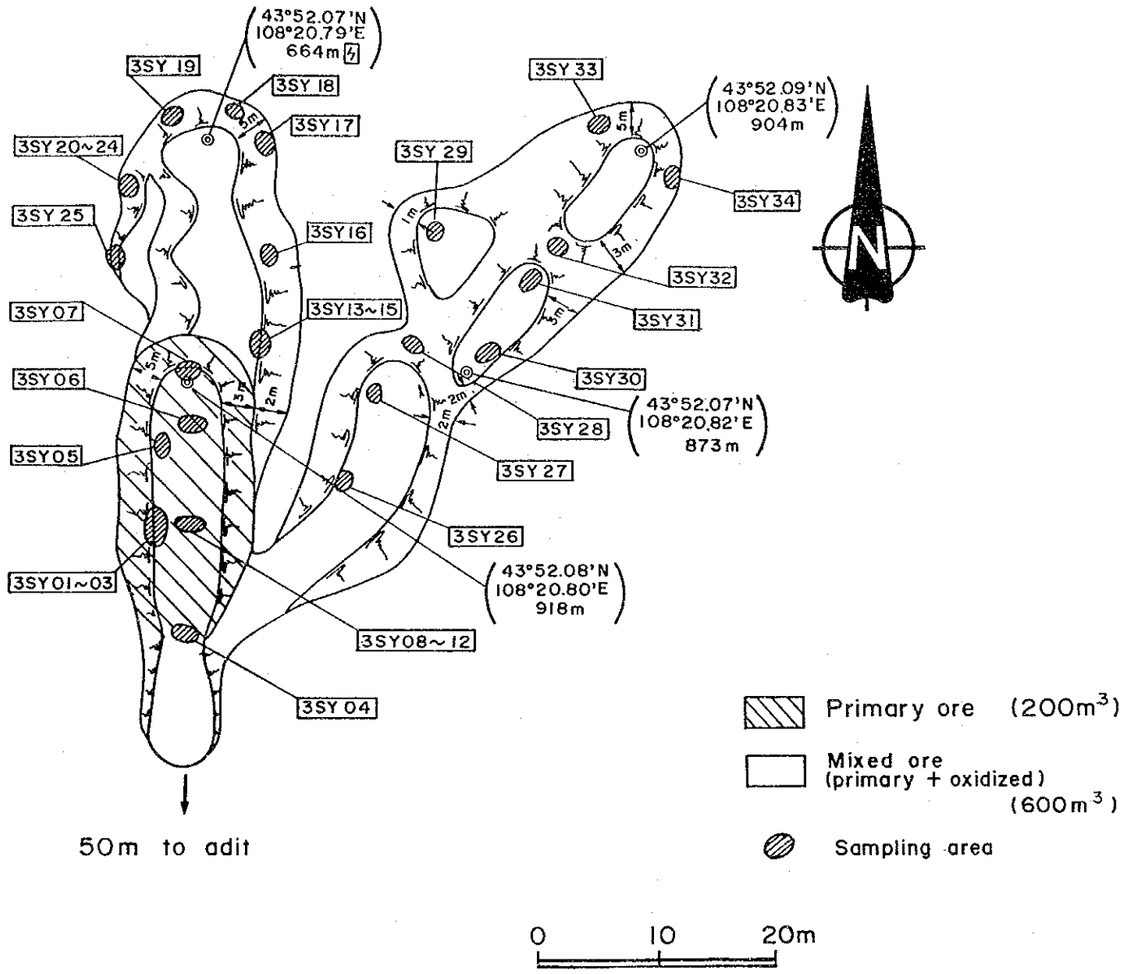


LEGEND

- Limestone
- Mudstone
- Sandstone
- Siltstone
- Tuff breccia
- Tuff
- "Granitic-dioritic syenite"
- "Granitic-dioritic syenite" with quartz, sericite and Cu
- "Granitic-dioritic syenite" with quartz, sericite and low grade Cu
- "Granitic-dioritic syenite" with quartz and sericite
- Leucocratic granite
- Keratophyre
- Brecciated zone
- Fault
- Sampling point and point number
- Tunnel
- Waste pile

Point No.	Sample No.	Point No.	Sample No.
1	3SN 1	33	3SS 19
2	3SN 2	34	3SS 20
3	3SN 3	35	3SS 21
4	3SN 4	36	3SS 22
5	3SN 5	37	3SS 23
6	3SN 6	38	3SS 24
7	3SN 7	39	3SS 25
8	3SN 8	40	3SS 26
9	3SN 9	41	3SS 27
10	3SN 10	42	3SS 28
11	3SN 11	43	3SS 29
12	3SN 12	44	3SS 30
13	3SN 13	45	3SS 31
14	3SN 14	46	3SS 32
15	3SN 15	47	3SS 33
16	3SN 16	48	3SS 34
17	3SN 17	49	3SS 35
18	3SN 18	50	3SS 36
19	3SN 19	51	3SS 37
20	3SN 20	52	3SS 38
21	3SS 7	53	3SS 39
22	3SS 8	54	3SS 40
23	3SS 9	55	3SS 41
24	3SS 10	56	3SS 42
25	3SS 11	57	3SS 43
26	3SS 12	58	3SS 44
27	3SS 13	59	3SS 45
28	3SS 14	60	3SS 46
29	3SS 15	61	3SS 47
30	3SS 16	62	3SS 48
31	3SS 17	63	3SS 49
32	3SS 18	64	3SS 50

Fig. II-1-20 Geological map of Serven-Suhait ore body



ASSAY OF CHIP SAMPLES FOR MICROSCOPIC OBSERVATION

SAMPLE NO.	Cu %	Mo %	Au ppm	Ag ppm
3 SY 1	3.210	0.079	0.040	16
3 SY 3	0.323	0.001	0.020	<2
3 SY 12	0.980	0.009	0.075	4
3 SY 14	3.250	0.040	0.185	12
3 SY 15	1.005	0.005	0.040	4
3 SY 21	1.090	0.006	0.045	2
3 SY 22	1.125	0.003	0.070	2
3 SY 24	5.040	0.042	0.230	22

ASSAY OF ORE-STOCK PILE

SAMPLE NO.	Cu %	Mo %	Au ppm	Ag ppm
3 SY 4	0.630	0.020	0.130	16
3 SY 5	0.383	0.005	0.025	2
3 SY 6	0.275	0.003	0.035	2
3 SY 7	0.475	0.006	0.035	2
3 SY 8	0.632	0.018	0.065	8
3 SY 13	0.374	0.068	0.025	2
3 SY 16	0.457	0.023	0.025	2
3 SY 17	0.375	0.017	0.040	<2
3 SY 20	0.350	0.025	0.030	<2
3 SY 25	0.400	0.006	0.020	2
3 SY 26	0.483	0.015	0.030	2
3 SY 27	0.376	0.024	0.025	<2
3 SY 28	0.718	0.020	0.050	2
3 SY 29	0.562	0.014	0.020	<2
3 SY 30	0.570	0.012	0.055	<2
3 SY 31	0.480	0.031	0.030	<2
3 SY 32	0.515	0.028	0.020	<2
3 SY 33	0.308	0.047	0.015	<2
3 SY 34	0.475	0.004	0.025	<2
AVERAGE	0.465	0.020	0.037	2.6

Fig. II-1-21 Assay of ore pile by grab samples at Serven-Suhait ore body

No.4 ore body	N55°E	?
No.5 ore body	N50°~65°E	?
No.6 ore body	N35°~45°E	?
No.7 ore body	N60°E	?
New No.1	?	?
New No.2	?	?

(6) Country rock

The country rock of this deposit consists of Middle-Upper Devonian and, Lower Carboniferous Systems and quartzmonzonite of Late Carboniferous to Early Permian Period intruded into these systems.

(7) Structural control

The distribution of deposits is generally limited in the quartz monzonite. Each deposit is elongated to NE-SW direction. The deposit is controlled by NE-fault system formed in the pre-mineralization period and is dislocated by NW fault system after ore formation.

(8) Related igneous rocks

Quartz monzonite of the Carboniferous period (K-Ar age; 339±17Ma)

(9) Alteration

At ore body I (Serven-Suhait deposit), there are weak white argillization along hanging wall, and potassium feldspthization is widely distributed.

Potassium feldspathization is dominant, at the other deposits.

5. Water supply

Drinking water is available from the spring water (800 liters/m) at Tsagaan-Tsav, about 50km southwest of the deposit.

6. Hydrology

Groundwater table exists in the fault zone at depth of −6m~−24m. Permeability is low, except the fault zone. The filling ratio is 0.2~0.5ℓ/m. Water quality is as follows: residue on evaporation, 0.9~2.2g/ℓ; pH 7.1~8.5.

7. Discovery and history

1964 This deposit was discovered by the local people.

1965 The USSR conducted air-borne magnetic survey, but anomalies were not detected.

1965~67	The USSR conducted a geological survey at a scale of 1:50,000.
1971~72	The USSR conducted a geological survey, and discovered 20 ore showings. It was concluded that Narinhuduk and Hungut etc. had the potentiality of mineral resources.
1973	The USSR conducted the F/S, by detailed geological survey, and ore dressing tests.
1975	The Tsagaansuvraga Geological Survey Team was established in order to explore the South Govi copper belt.
1976~77	Magnetic survey, electrical exploration, and geological survey at a scale of 1:20,000 were conducted.

1977~78 A geological survey (1/50,000) was conducted at Tsagaansuvraga, Narinhuduk, and Hungut etc. Ore reserves (C_1, C_2) were calculated by the 42 boring (100~150m, intervals) on the 8 survey lines (180~220m, intervals).

$C_1 + C_2 = 214,800,000t$, Cu 0.56%, Mo 0.02%.

1981 An additional survey was conducted, and evaluated again.

$C_1 + C_2 = 309,600,000t$, Cu 0.45% (Cut off grade 0.2%)

1979~82 A detailed survey was conducted on the Tsagaansuvraga district. Additionally, new diamond drilling for 55 holes (with length between 86m to 382m) has been carried out on 7 survey lines. So, in total, it becomes 97 drilling holes on 15 survey lines.

1981~8 Tunnel exploration was conducted. 345 tons of rock samples were obtained, and an ore dressing test was conducted at the Erdenet mine.

Past Exploration Works	Total until 1991		
geological survey	1/50,000	560	km^2
	1/10,000	27.6	km^2
	1/2,000	2	km^2
trenching		11,524.3	m^3
pitting		54.5	m^3
percussion drilling		451.1	m
boring	97 holes	22,385.55	m
tunnel		580.4	m
sample for ore dressing test		2	t
sample for ore dressing test(semi-production test)		345	t

The cumulative total cost of the exploration up to 1987 was 10,178,700 Tugriks.

8. Mining operaiton
None.

1-6-2 Duchin-Hural deposit (Fig. II-1-22)

1. Location and transportation

Location : Longitude 106°18'00"~106°20'25" East, Latitude 44°04'30"~44°05'50" North. It is located about 165km west of Tsagaansuvraga and 45km west of Manlai. In administrative division terms, the deposit is located in the Manlai Sum in the Umnugovi Aimag. It takes about 5 hours by car from Daranzadgad to the deposit.

2. Topography

The district is a hilly zone at an elevation of about 1,000m which consists of hills 100m higher than the valleys.

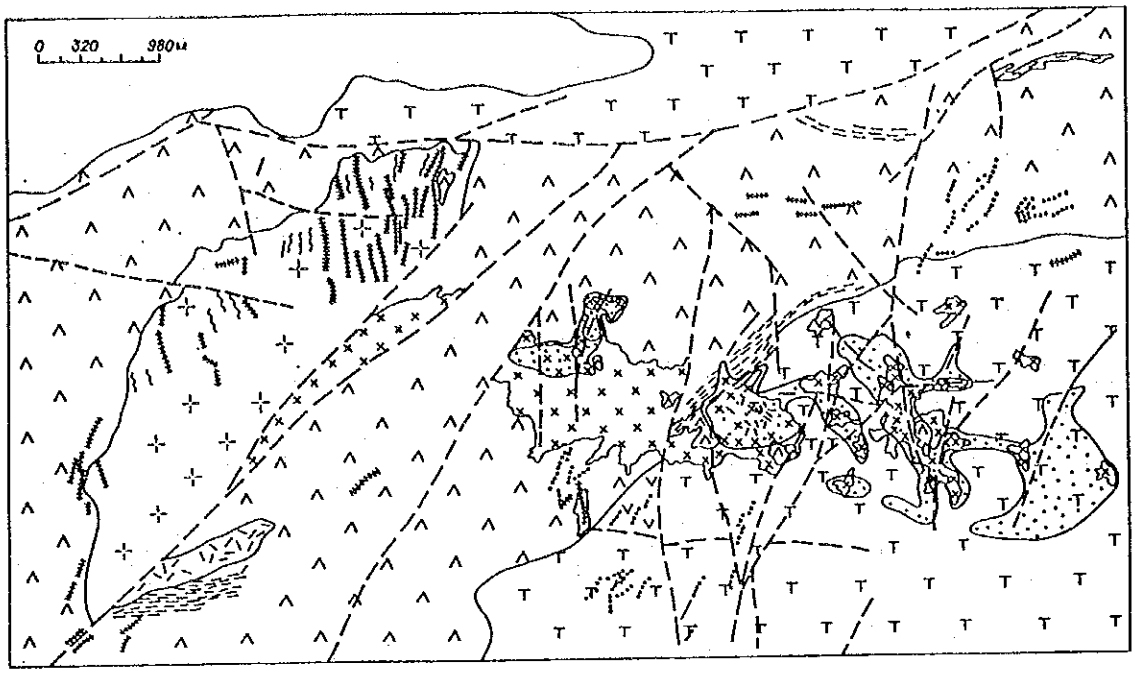
3. Climate

Precipitation is a little higher than Tsagaansuvraga. It is made up of thin steppe with leek and semi-desert.

4. Geology and deposit

(1) Mineralization

The ore of this deposit contains copper. Primary copper ore is chalcopyrite, and it is



L E G E N D

1 Barungoiot Formation(K_2), red clay, calcaleous sandstone

2 Ugomur formation($D_{1\sim2}$), tuff, tuffaceous sandstone, tuff breccia

3 Andesite

4 Tuff

5 Diorite porphyry dike

6 Granodiorite porphyry dike

7 Granodiorite porphyry

8 Granodiorite

9 Diorite porphyry

10 Quartz-serisite zone

11 Crushed and silicified zone

12 Vein(a quartz, b quartz-tourmaline)

3, 4 Duchin-obo formation

3~9 Late-Carboniferous Formation

Fig. Ⅱ-1-22 Geological map of the Duchin-Hural

classified into 2 types, disseminated type and stockwork quartz type. Chalcopyrite, bornite, cuprite, malachite, crysocholla, anglesite, pyromorphite, molybdenite, scheelite, and hematite were formed.

(2) Type of deposit
Vein type?

(3) Ore reserves and grades
2,600,000t, Cu 0.31%

(4) Size of deposit
200~400m×5~20m , (fault /fracture zone around granodiorite porphyry is mineralized)

(5) Structure of deposit
The deposit is made up of several mineralization zones striking N12°E.

(6) Country rock
It consists of andesite lava flow and pyroclastic rocks of Upper Carboniferous to Lower Permian systems, and granodiorite porphyry of Late Carboniferous to Early Permian Period.

(7) Structural control
The distribution of the deposits is controlled by the fissures striking N15°E.

(8) Related igneous rocks
Granodiorite porphyry.

(9) Alteration
Potassium felspathization and sericitization is dominant. Weak silicification and many veinlets of tourmaline are also recognized.

5. Water supply
There are oases at Tsogt-tsechii, about 70 km southwest of the deposit, and Manlai, 45km east of the deposit.

6. Hydrology
Not obvious.

7. Discovery and history

1971	This deposit was discovered when the geological survey at a scale of 1:50,000 and 1:10,000 was conducted. (Mongolia)		
1976:	Geological survey at a scale of 1:16,000.	43.1	km^2
	IP method, magnetic survey	7.6	km
1978:	Geological survey at a scale of 1:50,000.	38.6	km^2
	Soil geochemical exploration(300m×50m grid)	7	km^2
1981:	Geological survey at a scale of 1:10,000, geochemical exploration, IP method, and magnetic survey	34	km^2
	well logging: (No. 1, 2 holes, No.2, 1 hole)	3	holes
	boring: 12 holes , total	1,681.6	m
	trenching: 32 locations	2,971.6	m^3

pitting	36 holes	104.2 m³
Sample obtained by boring		4,430 pcs

8. Mining operation
None

1-6-3 Harmagtai deposit (Fig. II-1-23~25)

1. Location and transportation
Location : Longitude 106°08'40"~106°10'00" East, Latitude 44°01'30"~44°02'20" North. It is located about 175km west of Tsagaansuvraga and 60km west of Manlai. In administrative division terms, the deposit is located in the Tsogt-tsechii Sum in the Umnugovi Aimag. It takes about 4~5 hours by car from Daranzadgad city to the deposit.

2. Topography
This district is a hilly zone with the elevation of about 1,000m which consists of hills, 100m~200m higher than the valleys.

3. Climate
Precipitation is a little higher than at Tsagaansuvraga. It is made up of thin steppe with short leek and semi-desert.

4. Geology and deposit
(1) Mineralization
The ore deposit contains copper. Primary copper mineral is chalcopyrite, and it is classified into 2 types, disseminated type and stockwork quartz type. Chalcopyrite, bornite, malachite, chrysocolla, azurite, pyrite etc. are seen.

(2) Type of deposit
Porphyry copper type deposit.

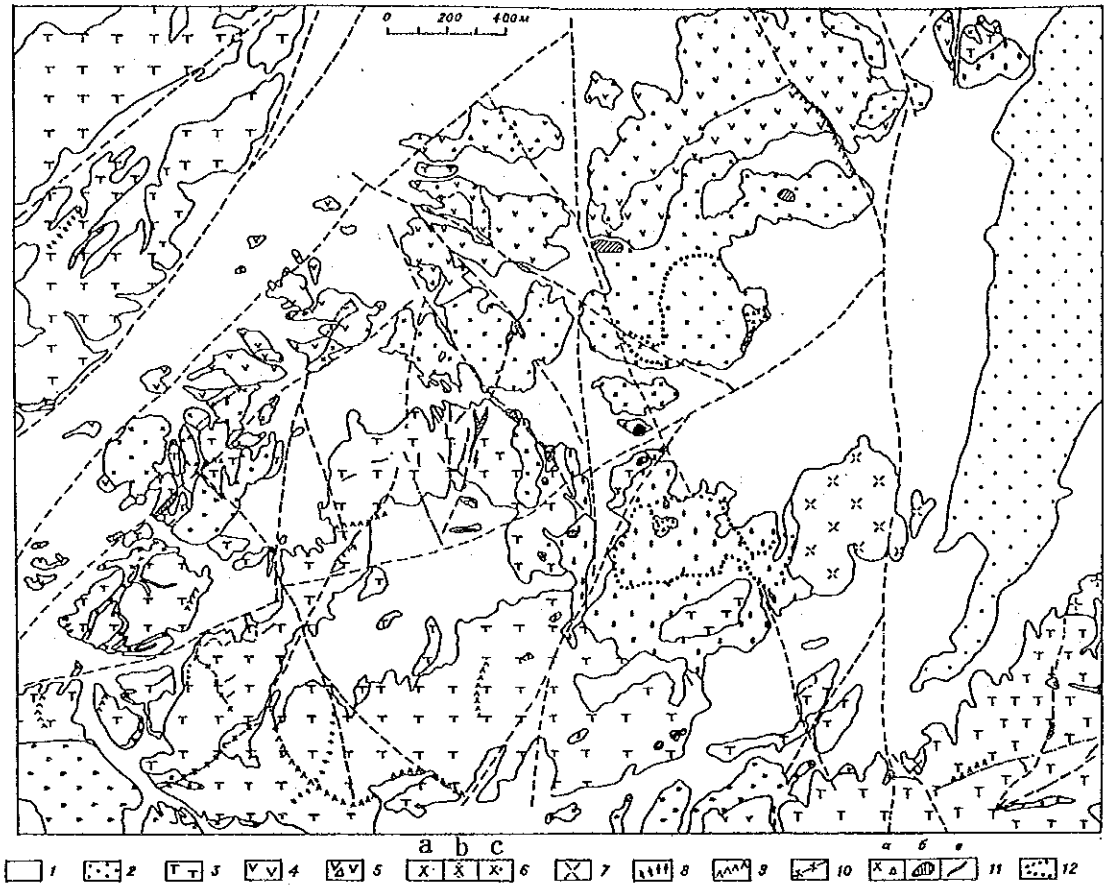
(3) Ore reserves and grades
139,600,000t, Cu 0.25%

(4) Size of deposit
550m×250m, 400m×300m (stockwork quartz vein)

(5) Structure of deposit
It is extended to the direction of N15°E, the high grade portions are arranged in E-W direction conforming an elliptic shape ore body. The deposit stands virtically. Near ground surface, with the depth about 25 to 40m, the ore is oxidized and the mineralization is proven to continue more than 200m length.

(6) Country rock
It consists of Upper Carboniferous to Lower Permian andesite lavas and pyroclastic rocks and the Late Carboniferous to Late Permian diorite porphyry intruded into them.

(7) Structural control
The distribution of the deposits is limited in the diorite porphyry bodies.



L E G E N D

1 Quaternary sediments

2 Barungoiot formation(K_2), red clay, calcareous sandstone

3 Ugomur formation(D_{1-2}), tuff, tuffaceous sandstone, tuff breccia

4 Andesite

5 Brecciated lava of andesite

6 Diorite porphyry (a, b, c, fine-, medium-, coarse-grained)

7 Granodiorite porphyry

8 Andesite dyke

9 Diorite porphyry dyke

10 Granodiorite porphyry dyke

11 Breccia

- a explosion
- b quartz-hematite-tourmaline stockwork
- c quartz-hematite-tourmaline vein

12 Hydrothermal alteration zone

Fig. Ⅱ-1-23 Geological map of the Harmagtai

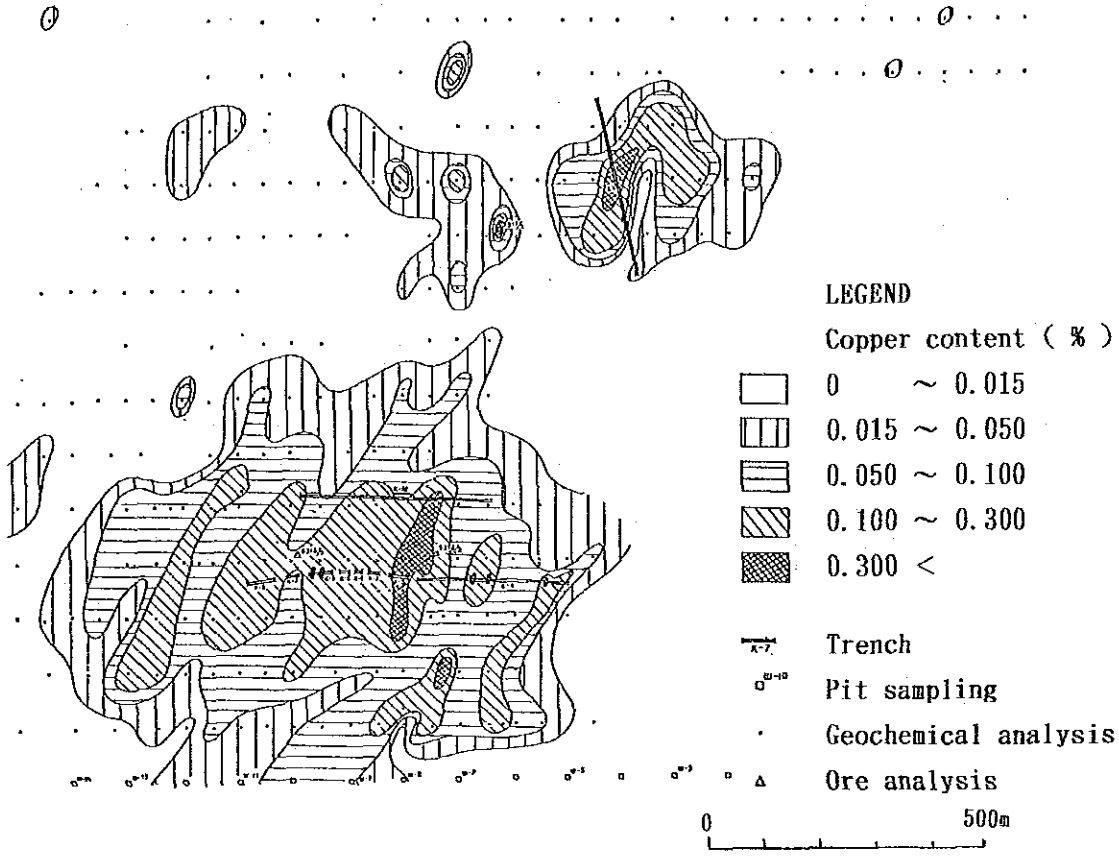
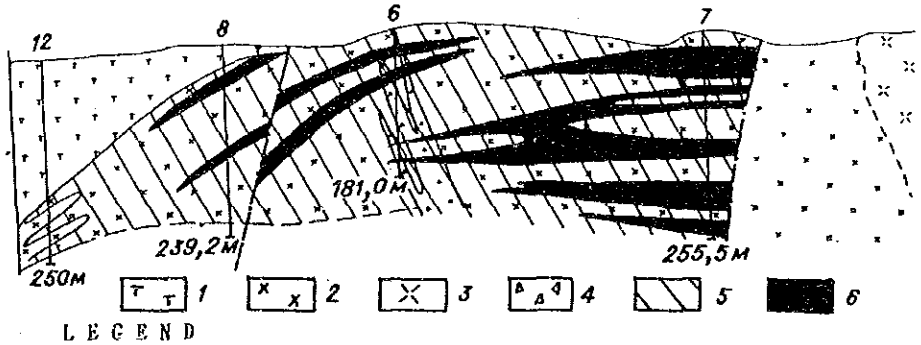


Fig. Ⅱ-1-24 Assay map of the Harmagtai ore deposit



L E G E N D

1 Ugomur formation($D_{1\sim2}$), tuff, tuffaceous sandstone, tuff breccia

2 Diorite

3 Granodiorite porphyry

4 Breccia dyke

5 0.1% ≦ Cu < 0.3%

6 Cu > 0.3%

Fig. Ⅱ-1-25 Geological profile of the Harmagtai ore deposit

(8) Related igneous rocks
Diorite porphyry

(9) Alteration
Epidotization, carbonatization, propylitization, potassium feldspathization, argillization, tourmalinization are recognized. All of these are accompanied by pyritization.

5. Water supply
There are oases at Tsogttsechii, about 60 km southwest of the deposit, and Manlai, 60km east of the deposit.

6. Hydrology
It is not obvious even though the survey was conducted by borings in 1983 (2 holes, total 314.2m).

7. Discovery and history
1971: This deposit was discovered by the geological survey at a scale of 1:50,000, and 1:10,000 (Mongolia).

1976~78:	geological survey at a scale of 1:50,000	619.6	km^2
1976	geological survey at a scale of 1:5,000	9.1	km^2
	boring: 3 holes, total	548	m
	trenching	150	m^3
	IP method at a scale of 1:5,000	2.3	km^2
	magnetic survey 1:5,000	6.4	km^2
1979~80	geological survey at a scale of 1:50,000	362.7	km^2
1981	geochemical exploration, IP method, magnetic survey, gravity survey at a scale of 1:10,000	17	km^2
	boring: 14 holes in total	2,834.5	m
	trenching	1,404	m^3

8. Mining operation
None

9. Others
There is an auriferous quartz-tourmaline zone (witdth 0.4~20m×length 10~40m, Au 4g/t, Ag 10g/t, Au 0.5~3.1g/t, Ag 5.2~6.5g/t). Gold is confirmed by panning from the ore in Harmagtai district.

1-6-4 Ih-Shanhai deposit (Fig. II-1-26)

1. Location and transportation
Location : Longitude 106°00'00" East, Latitude 43°40'20" North. It is located about 190km west of Tsagaansuvraga. In administrative division terms, the deposit is located in the Tsogt-tsechii Sum in the Umnugovi Aimag. It takes about 4~5 hours by car from Daranzadgad city to the deposit.

2. Topography

The district is a hilly zone (elevation,about 1,000m) which is made up of hills that are 100m~200m higher than the valleys.

3. Climate

Precipitation is a little higher than Tsagaansuvraga. The district is made up of thin steppe with short leek and semi-desert.

4. Geology and deposit

(1) Mineralization

The ore deposit contains copper. Primary copper ore is chalcopyrite, and it is classified into 2 types, disseminated type and stockwork quartz type. Ore contains gold (max. 3g/t).

(2) Type of deposit

Porphyry copper type deposit

(3) Ore reserves and grades

Ore reserves have not been calculated. Cu 0.01~2.55%, Ag 0.15~10g/t, Au 0.03~3g/t.

(4) Size of deposit

1500m×5~10m, 100m×30m, 300m×10m etc.

(5) Structure of deposit

Swarmed stockwork mineralized zones

(6) Country rock

It consists of the Late Devonian to Eearly Carboniferous andesite, tuff and siltstone and the Carboniferous to Permian granite, granodiorite and granodiorite porphyry intruded into them.

(7) Structural control

The distribution of the deposits is limited within granodiorite porphyry.

(8) Related igneous rocks

Granodiorite porphyry.

(9) Alteration

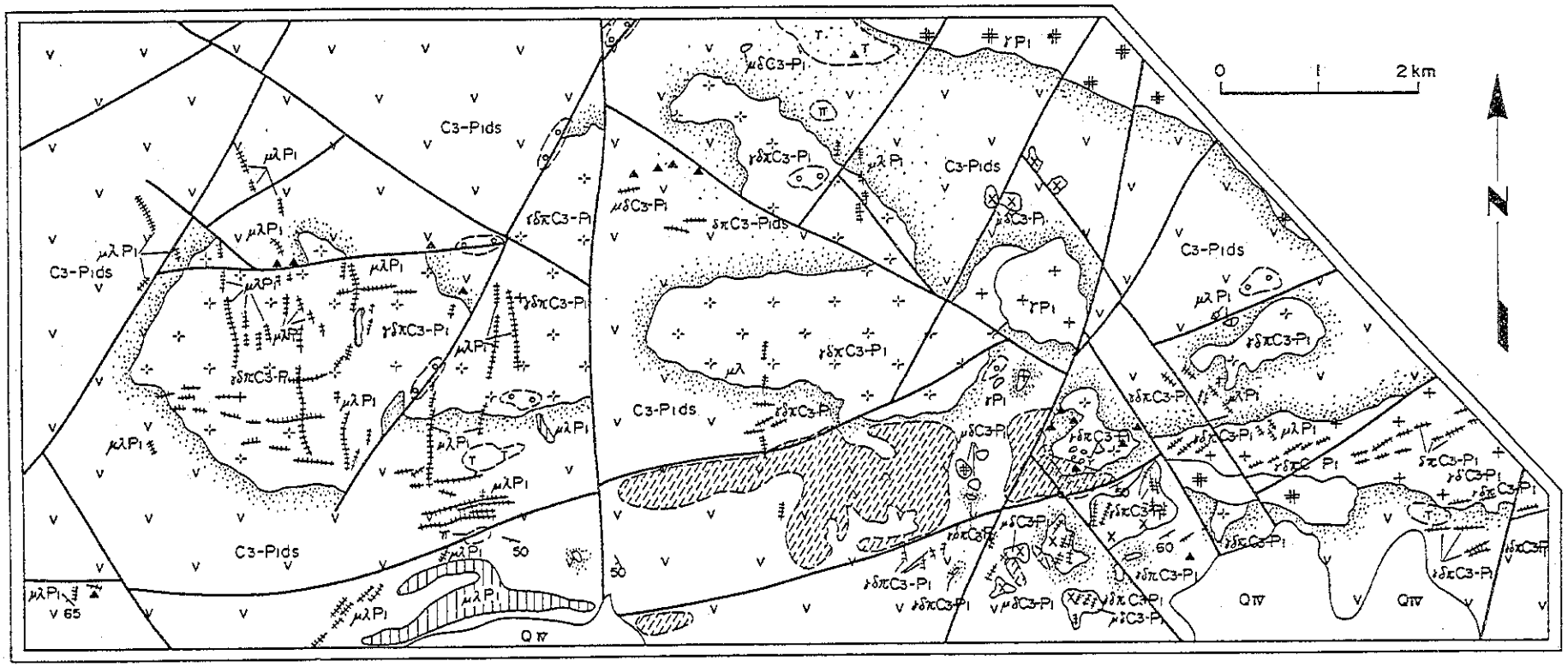
Silicification, kaolinization, carbonatization, potassium feldspathization, argillization, tourmalinization are seen and all of them are accompanied by pyritization.

5. Water supply

There is Tsogttsechii village (oases) about 40km west-northwest of Ih-Shanhai.

6. Hydrology

Not obvious



LEGEND

Qiv	Quaternary: Gravel, sand, loam	γP_1	Early Permian: Granite, granite-aplite, "granosyenite"	"Secondary quartzite" Quartz, kaolinite, hematite	Geochemical anomaly in bedrock (Cu)
C_3-P_1ds	Late Carboniferous~ early Permian: (Dusinobin formation) Andesite with tuff thin layer, siltstone	$\gamma\delta C_3$-P_1	Late Carboniferous~ early Permian: Granodiorite	Silicification zone	Geochemical anomaly in bedrock (Mo)
$\mu\lambda P_1$ (a) (b)	Early Permian: Rhyolite (a) stock, (b) dike	$\gamma\delta\pi C_3$-P_1 (a) (b)	Late Carboniferous~ early Permian: Granodiorite, granite porphyry, diorite porphyry (a) stock, (b) dike	Tourmaline rich zone	Fault
$\mu\delta C_3$-P_1	Late Carboniferous~ early Permian: Diorite, Porphyrite			Pyrite rich zone	65 Dip and strike

Fig. I-1-26 Geological map of Ih-Shanhai

7. Discovery and history

1971 This deposit was discovered by Mongolian survey team when the geological survey at a scale of 1:50,000 and 1:10,000 was conducted (Mongolia).

After that, Czechoslovakian survey team conducted the following survey, and concluded that this deposit is hopeless.

• air-borne magnetic survey	interval of survey line	2 km (1/20,000)
• IP method	It was conducted on ore showings on a small scale.	
	length of survey line	10 km
	interval of survey line	200 m
	interval of survey point	50 m

8. Mining operation

None

1-6-5 Narinhuduk deposit (Fig. II-1-27, Fig. II-1-28)

1. Location and transportation

Location : Longitude 107°11'00" East, Latitude 44°14'10" North. It is located about 45km west of Tsagaansuvraga. In administrative division terms, the deposit is located at the Mandaha Sum in the Dornogovi Aimag. It takes about 9~10 hours by car from Daranzadgad city to the deposit.

2. Topography

This district is a hilly zone which consists of hills, 100m~200m higher than the valleys. Elevation of the area is about 1,000m above sea level

3. Climate

Same as Tsagaansuvraga mine.

4. Geology and deposit

(1) Mineralization

The ore deposit contains copper. It occurs as disseminated ore, and/or veinlet whose primary ores are chalcopyrite, pyrite, and small amount of bornite and magnetite. As secondary minerals, it contains malachite, covelline, chrysocolla. Veinlets have assemblage of quartz-sulfide, quartz-sericite-sulfide and quartz-tourmaline-sulfide.

(2) Type of deposit

Porphyry copper type deposit.

(3) Ore reserves and grades

Possible ore reserves: 8.6 million tons, Cu 0.58%.

(4) Size of deposit

Central ore zone There are 6 ore bodies, (thickness 6~23m×length 100m~400m) (Cu 0.3 ~1.17%)

Northern ore zone Thickness 20m×length 300m (Cu 0.36%)

Southern ore zone Thickness 50m×length 300m (Cu 0.01~0.41%)

(5) Structure of deposit
Strike: E-W and NE-SW, Dip 75°~80°N

(6) Country rock
It consists of Upper Devonisn to Lower Carboniferous tuff breccia, Middle to Late Carboniferous andesitic porphyrite and Early Permian granodiorite, syenite and diorite.

(7) Structural control
The mineralization occurred along the fault striking E-W and NE-SW and dipping 75°-80° toward north.

(8) Related igneous rocks
Granite and/or granodiorite formed during Late Carboniferous to Early Permian Periods.

(9) Alteration
Feldspathization (potassium feldspar) is dominant. Alteration zone composed of sericite, chlorite, epidote, tourmaline, plagioclase etc. is observed along faults.

5. Water supply
Spring water (800liters/m) is available as drinking water at Tsagaan-Tsav, about 60km south of Nalinhuduk. Also, there are wells at Mandaha, 38km northwest of the deposit.

6. Hydrology
Not obvious

7. Discovery and history

1965-67	Geological survey at a scale of 1:50,000 was conducted.
1971	This deposit was discovered when the geological survey at a scale of 1:50,000 and 1:10,000 was conducted.
1977	IP method. (interval of survey line 25m, surveying point at every 20m)

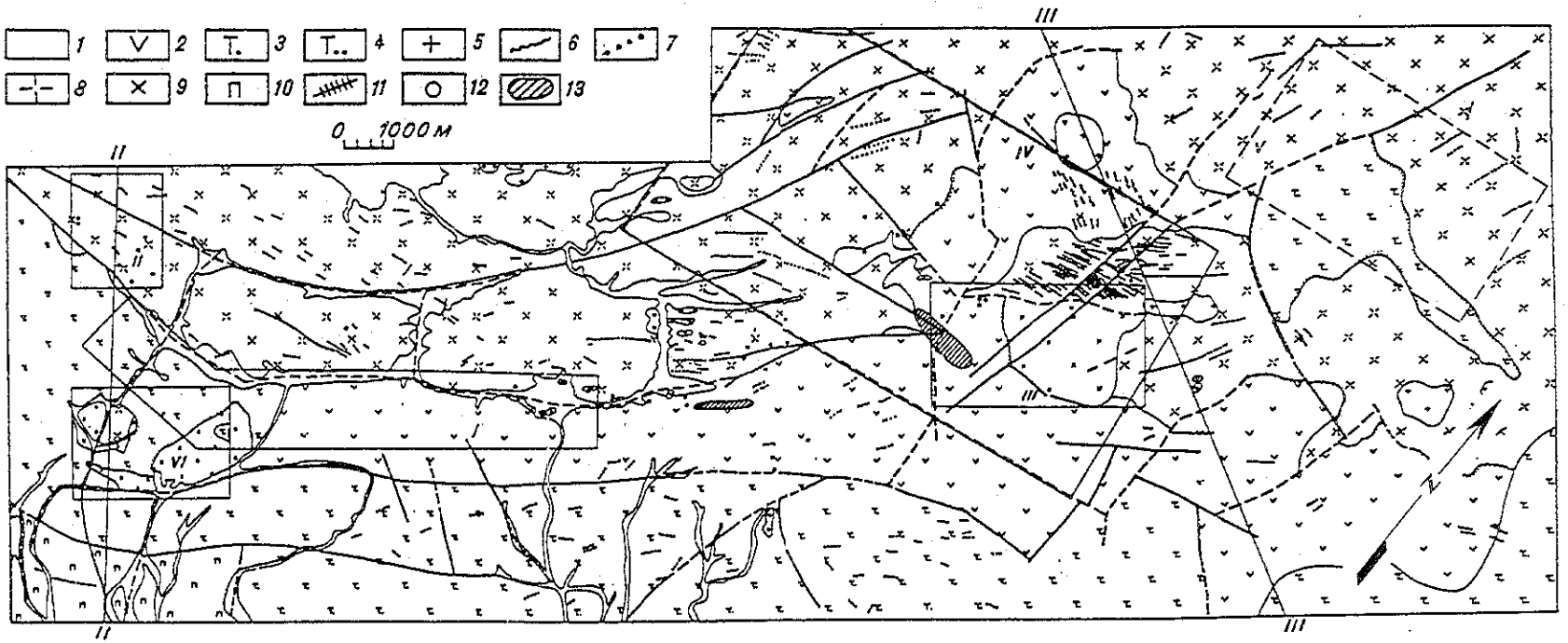
8. Mining operation

None

1-6-6 Ovootu-Hira ore showing

1. Location and transportation
Location : Longitude 105°02'10" East, Latitude 44°01'05" North. It is located about 130km east northeast of Daranzadgad city. In administrative division terms, the deposit is located in the Tsogttsechii Sum in the Umnugovi Aimag. It takes about 4 hours by car from Daranzadgad city to the deposit.

2. Topography
The district is a hilly zone (elevation,about 1,000m) which is made up of hills that are 100m higher than the valleys.



L E G E N D

1 Quaternary sediments

2 Andesite, brecciated lava, tuff breccia, sandy tuff(C_2 ~C_3)

3 Sandy tuff, silty tuff

4 Sandy siltstone, andesite, tuff

5 Upper Permian complex, granite

6 Quartz porphyry

7 Diorites, andesitic porphyry

8 Granodiorite

9 Diorite

10 Quartz vein

11 Small ore showing

12 Copper aureole Cu>0.5%

13 Ore showing

I South geophysical anomaly

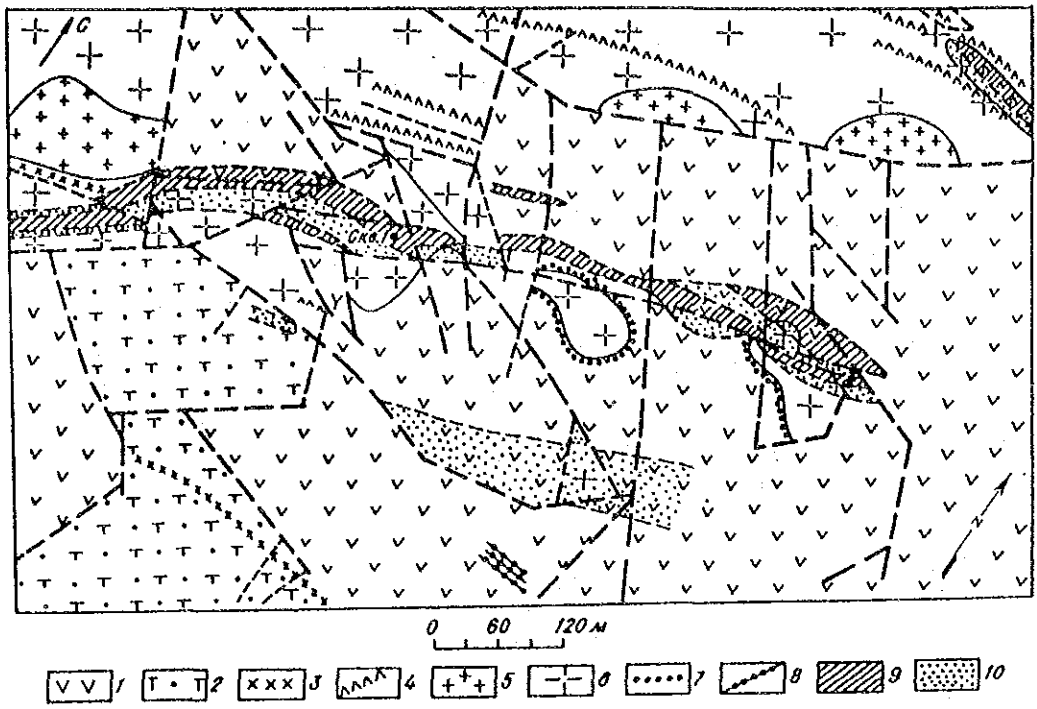
II Bunhan-huduk

III Tsagan-obo and Ulan-del

IV Hailhan-ula

V Ulan-tolgoi

Fig. II-1-27 Geological map of the Narinhuduk



L E G E N D

1 Andesite, tuff($C_2 \sim C_3$)

2 Tuffaceous sandstone, tuffceous conglomerate, tuff breccia(C_1)

3 Quartz porphyry dyke

4 Fine-grained diorite and diorite porphyry

5 Fine-grained granite (P_2)

6 Granodiorite and "granosyenite"

7 Hornfels

8 Quartz-tourmaline vein

9 Cu ≧0.3%

10 0.1≦Cu<0.3%

Fig. Ⅱ-1-28 Geological map of the central part of the Narinhuduk

3. Climate

Annual precipitation is 100~150mm. It is made up of thin steppe and semi-desert.

4. Geology and deposit

(1) Mineralization

The ore deposit contains copper. It is disseminated type ore that contains chalcopyrite and malachite.

(2) Type of deposit

Porphyry copper type deposit (quartz stockwork)

(3) Ore reserves and grades

The amount of ore has not been calculated. The grade at the outcrop: Cu 0.05~0.3%, Ag 0.2~0.6 g/t, Au Max. 5 g/t.

(4) Size of deposit

200m×300m

(5) Structure of deposit

Not obvious.

(6) Country rock

Upper Devonian and Lower Carboniferous Series and granodiorite porphyry intruded into them.

(7) Structural control

The distribution of the deposits is nearly limited in "granitic syenite".

(8) Related igneous rocks

Granodiorite porphyry

(9) Alteration

Silicification, pyritization, sericitization, chloritization, and feldspathization (potassium feldspar).

5. Water supply

There are oases at Manlai, about 70km east of the deposit, and at Tsogttsechii, about 45 km west-southwest of the deposit.

6. Hydrology

Not obvious.

7. Discovery and history

1971 The deposit was discovered.

1976 Geological survey at a scale of 1:16,000 (50.3km^2), boring 1 hole, IP method, and magnetic survey were conducted.

1981 Geological survey at a scale of 1:10,000, geochemical exploration, IP method, magnetic survey, and well logging were conducted for the area of 27km^2.

boring;	4 holes	641 m
trenching	17 locations	1,984 m^3

8. Mining operation
None

1-6-7 Shuten deposit (Fig. II-1-29)

1. Location and transportation
Location : Longitude 107°21'15" East, Latitude 43°36'25" North. It is located about 62km west northwest of Tsagaansuvraga. In administrative division terms, the deposit is located in the Manlai Sum in the Umnugovi Aimag. It takes about 8~9 hours by car from Daranzadgad city to the deposit.

2. Topography
The district is a hilly zone (elevation,about 1,000m) which is made up of lowlands with dune and hills that are 100m~200m higher than the lowlands.

3. Climate
Same as Tsagaansuvraga deposit.

4. Geology and deposit
(1) Mineralization
The ore deposit contains copper. Primary copper mineral is chalcopyrite. Native gold are seen in the ore from the Shuten and Hanbogt districts (107°40'E, 43°50'N) by panning.

(2) Type of deposit
Porphyry copper type deposit.

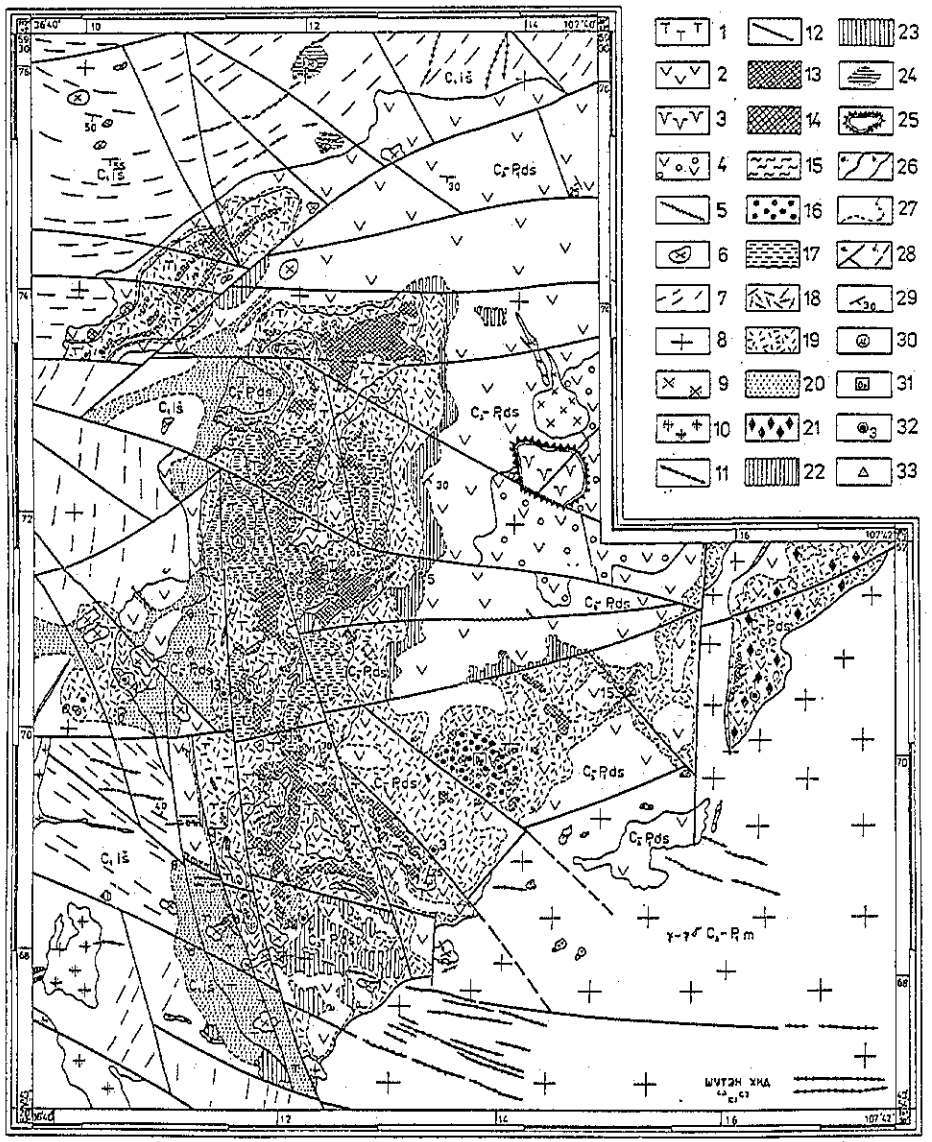
(3) Ore reserves and grades
Possible ore reserves, 12.6 million tons, Cu 0.31%

(4) Size of deposit
There are 12 mineral showings. In general, their grades are low as follow: 200m×100m Cu 0.33%, 30m×0.3m Cu 0.1%, 60m×2m Cu 0.8% Ag 6.0 g/t, 20m×5m Cu 0.05%~0.15%, 10m×3m Cu 0.3%, 300m×5m Cu 0.01%~2.0% etc.

(5) Structure of deposit
The deposit is distributed in the alteration zones of silicification and argillization. (Strike: N-S, width 2km, length 8km)

(6) Country rock
Lower Carboniferous "eugeosynclinal" sedimentary rocks and Late Carboniferous to Early Permian intermideate~acidic volcanic rocks, diorite, granite, syenite, granodiorite, porphyrite, aplite, etc.

(7) Structural control
Alteration zone consisting of silicification and argillization extends N-S and N60°E direction. Copper mineralization is recognized in the intermediate volcanic rocks.



L E G E N D

1～6 Dusinob Formation (C_3 ~P_1 ds) :
- 1 Pyroclastic rocks, brecciated lava
- 2 Andesite, andesitic porphyrite
- 3 Andesite (neck)
- 4 Andesitic agglomerate
- 5 Rhyolite-porphyry
- 6 Diorite, "Syeno-diorite porphyrite"

7 Iheshanhai Formation (C_1 is): Eugeosynclinal tuffaceuos sediments and sedimentary rocks

8～10 Intrusive Mantah Complex (C_3 ~P_1 m):
- 8 Granite and granitic rocks(Syuten Mass)
- 9 Diorite
- 10 Granite, syenite-porphyry
- 11 Granodiorite-porphyry
- 12 Quartz vein

13～23 Hydrothermal alteration zones
- 13 Silicified zone
- 14 Ferrous silicified rockzone
- 15 Tourmaline-bearing silicified rock zone
- 16 Quartz-diaspore zone
- 17 Quartz-alunite zone
- 18 Quartz-pyrophyrite zone
- 19 Quartz-sericite zone
- 20 Quartz-clay zone
- 21 Quartz-andalusite zone
- 22 Propyrite zone
- 23 Quartz-tourmaline zone

- 24 Silicified rocks of Ihesyanhai Formation
- 25 Center of volcanic activity
- 26 Geologic boundary
- 27 Boundary of the alteration zones
- 28 Fault: a/Assured, b/inferred
- 29 Strike and dip of bedding
- 30 Alunite zone
- 31 Diaspore zone
- 32 Drilling hole

0 1 2KM

Fig. Ⅱ-1-29 Geological map of Shuten.

(8) Related igneous rocks

Late Carboniferous to Early Permian granitic rocks.

(9) Alteration

Silicification, alunitization, diasporization, pyrophyllitization, sericitization, tourmalinization, propylitization, and potassium feldspathization.

5. Water supply

Drinking water is available from the spring water (800 liters/m) at Tsagaan-Tsav, about 50km south-southeast of the deposit.

6. Hydrology

Not obvious.

7. Discovery and history

1971	This deposit was discovered when the geological survey at a scale of 1:50,000 and 1:10,000 was conducted.
1972-73	The survey team (Cooperation between Mongolia and Czechoslovakia) conducted a detail survey on 12km^2, and discovered four ore bodies.
1981-82	Geological survey at a scale of 1:10,000 was conducted on No. 10 ore showings.

8. Mining operation

None.

1-6-8 Uhaa-Hudak ore showing (Fig. II-1-30)

1. Location and transportation

Location : Longitude 106°12'30" East, Latitude 44°01'45" North. It is located about 175km west-northwest of the the Tsagaansuvraga deposit and 60km west of Manlai. In administrative division terms, the deposit is located in the Tsogt-Tsechii Sum in the Umnugovi Aimag. It takes about 4~5 hours by car from Daranzadgad city to the deposit.

2. Topography

The district is a hilly zone (elevation,about 1,000m) which is made up of hills that are 100m~200m higher than the valleys.

3. Climate

Precipitation is a little higher than Tsagaansuvraga. It is made up of thin steppe with short leek and semi-desert.

4. Geology and deposit

(1) Mineralization

The ore of this deposit contains copper. Ore mineral consists of chalcopyrite, bornite, chalcocite, arsenopyrite, pyrite, and small amount of malachite. There are 2 types, i.e., disseminated type and stockwork type. Some of them are accompanied by tourmaline breccia dike containing copper ore.

(2) Type of deposit

Porphyry copper type deposit.

(3) Ore reserves and grades
Ore deserves was not calculated: The grade are Cu 0.05%~3%, Ag 0.1~12.3 g/t

(4) Size of deposit
450m×350m (Stockwork quartz vein), 2,000m×600m (Low grade ore showings)

(5) Structure of deposit
Mineralized part are distinctly elongated to N50°E direction.

(6) Country rock
Upper Carboniferous~Lower Permian andesite lavas and pyroclastic rocks, and Late Carboniferous to Late Permian granodiorites.

(7) Structural control
The distribution of the deposit is limited in the diorite porphyry rock body.

(8) Related igneous rocks
Granodiorite

(9) Alteration
Silicification, feldspathization (potassium feldspar), tourmalinization.

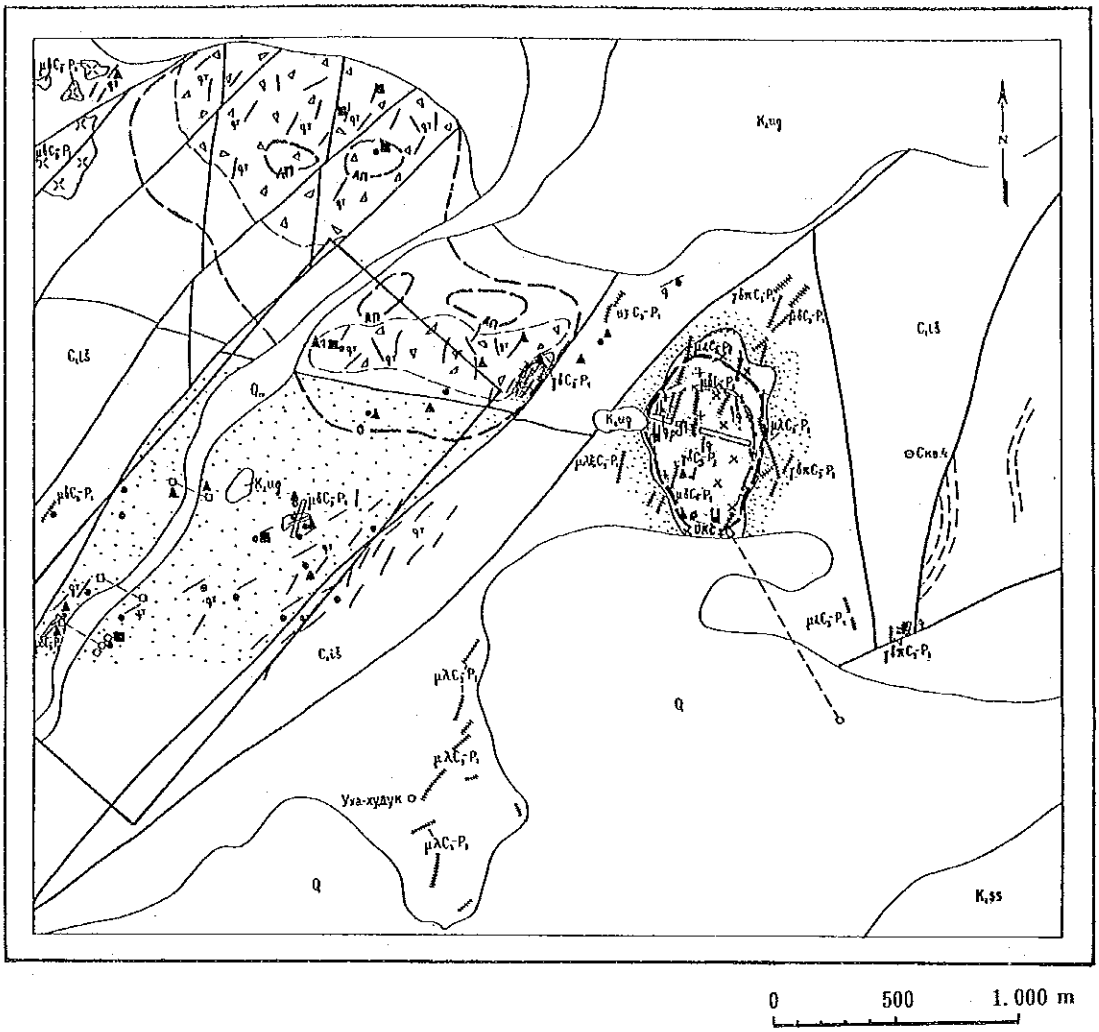
5. Water supply
There are oases at Manlai, about 60km east of the deposit, and at Tsogt-Tsechii, about 60 km southwest of the deposit.

6. Hydrology
Not obvious.

7. Discovery and history.

1971	The deposit was discovered when the geological surveys at a scale of 1:50,000 and 1:10,000 were conducted.	
1976-77	geological survey at a scale of 1:16,000	62.5 km^2
	boring (1 hole)	178 m
	IP method and magnetic survey were conducted on 2 sections	
1981	Geological survey at a scale of 1:10,000	17.3 km^2
	boring: 3 holes, total	519.3 m
	trenching	1,181.2 m^3
	pitting	60.2 m^3

8. Mining operation
None.



L E G E N D

Quaternary
- Q: Alluvium, Diluvium — Clay, silt, sand, gravel, loam

Cretaceous
- K₂ug: Upper part of Ulangovi F.: Red clay, sand, muddy tuff
- K₁ss: Lower part of Sainshand F.: Clay, sand, conglomarate

Late Carboniferous ~Early Permian
- C₃-P₁ds: Dusin-obo F.: Andesite, dacite, brecciated lava, tuff

Early Carboniferous
- C₁sh: Iheshanhai F. Sandstone, siltstone, gravel, conglomerate

Early Devonian
- D₁ug: Ugonur F.: Claystone, conglomerate, andesitic tuff, siltstone

Late Carboniferous ~Early Permian
- Sub-volcanic Rocks
  - Rhyolite(μl), rhyolite~dacite(μlf): a/dyke, b/mass
  - Andesite dyke
  - Diorite-porphyry: a/dyke, b/mass
- Intrusive Bodies
  - Granodiorite-porphyry: a/dyke, b/mass
  - Porphyritic granodiorite

- Quartz vein(q), hematite-tourmaline-quartz vein(qt)
- Breccia zone
- Hornfels
- Hydrothermal alteration zone: silicification (Q), argillization (A), pyritization (P), K-feldspatization (K), serisctization (S)
- Fault
- Strike and dip of bedding
- Strike lines of the bed
- Quartz stockwork with copper mineralization
- Discovery point of copper minerals outside of stockwork
- Shaft
- Trench
- Drill hole
- Ore-test point
- Spot sampling point
- Area of ore-reserve calcuration

Fig. Ⅱ-1-30 Geological map of Uhaa-Hudak

1-7 Ulziit district

In administrative division terms, the Lugiingol district is in the vicinity of E-W 250km×N-S 80km which extends over Umnugovi and Dundgovi.

The 48-passenger Antonov airplane departs twice a day from Ulaanbaatar to Daranzadgad city, in the southwestern end of the Ulziit district, taking about 85 minutes one way. It takes 2~6 hours one way by car from Daranzadgad to the survey areas on the semi-desert or desert road.

As for topography, this district is located at Mongolian Highland, the juncture of "lake swamp valley" which runs along north of Gobi Altai mountainous areas, and Gobi lowland. It is a hilly land (1,100m~1,200m elevation) with about 100m elevation difference.

In regard to the weather, annual average temperature is 3°C~4.5°C, temperature ranges between −36.5°C and 37.5°C (Daranzadgad city). Annual precipitation is about 80mm~120mm. Because of the low precipitation, vegetation is scarce and the mountainous area is rocky desert. It has about 130 frostless days annually, and is particularly windy the two months from April to May, with 40 sandstorm days a year.

Geologically, the area consists of schist and granite of Silurian and Devonian period, granite and diorite of Late Carboniferous to Permian period, and syenite and syenite porphyry, rhyolite and gabbro etc. of Late Jurassic era. Many ore deposits and showings such as Mushigia-Hudak deposit (rare earth), Bayan-hoshoo deposit (strontium), Bayan-Ovoot deposit (fluorite), Olon-Ovoot deposit (gold), Dugsih deposit , Onh deposit (gold), Bayan-Bor-Nuruu deposit (gold) etc. are formed with above-mentioned igneous activities.

Many volcanic activites were repeatedly occured. As the result, this district has particular mineralized zone composed by various mineralization such as carbonatite, vein type fluorite and widely spread deposits and ore showings all over the area.

1-7-1 Mushgia-Hudak deposit★ (Fig. II-1-31)

1. Location and transportation

Location: Longitude 104°00'16" East, Latitude 44°23'41" North, Elevation 1,610m above sea level. In administrative division terms, the deposit is located in the Mandal-Ovoo Sum in the Umnugovi Aimag, of the Gobi desert.

It is about 100km from Dalanzadgad city to the Mushgia-Hudak deposit, about 3-hour drive car ride through the semi-desert and desert area.

2. Topography

As for geographical features, it consists of a hilly zone (elevation,about 1,100m~1,200m) which is made up of hills that are 100m higher than the valleys. Alkaline rock containing carbonatite forms lower flat hollw compared to the surrounding area, and it's surface is covered by the debris. The outcrops of the carbonatite form small hills, which is about 20m higher than the surroundings, and they are scattered like islands in the desert. The maximum elevation around the deposit is Hurutel Harna triangulation station-point (1,321.3m), about 4.5km south west of the deposit. The hilly area is relatively steep and of rocky, but automobile can drive almost anywhere.

3. Climate

The major climate index of the Mushgia-Hudak district is as follows:

Amount of solar radiation; Annual solar radiation is 5,700MJ/m^2.

The annual average temperature*; 3.4°C.

Monthly average temperature; the highest, is in July with 21.2°C; the lowest is in January with −15.4°C

Temperature range is between −36.5°C and 37.5°C*.

Precipitation*; annual precipitation: 132.5mm

Monthly average precipitation; the highest is in July with 33.5mm, and the lowest is in January with 1.1mm.

Relative humidity; monthly average : January <40%, April <30%, July <40%, October <40%.

Wind velocity*; monthly average; January 3.0m/s, April 5.6m/s, July 4.0m/s, October 3.4m/s.

There are about 131 frostless days annually around the deposit. However, it is particularly windy the two months from April to May with its sandstorm days being more than 40 days annually. The steppe is scarce vegetation and the mountain area is rocky desert.

(Notice) *: * indicates Daranzadgad city's results.

4. Geology and deposit

(1) Mineralization

The ore deposit contains rare earth chiefly consist of Lanthanium series. The ore types are divided as follows:

I . Carbonatite type: ①mineralized breccia ② carbonate series

II . Apatite type: ③ magnetite + apatite, ④apatite + phlogopite, ⑤apatite + microcline ⑥ alkaline rock + apatite

Another classification is as follows.

No. Type	SrO%	BaO%	TREO%
I mineralized breccia [1]	0.08~1.9	0.01~8.6	0.17~2
II carbonatite	0.08~5.7	0.1~8.2	0.52~9
III carbonatite + fluorite	0.14~4.4	0.1~14.8	1.22~7.2(1.9)[2]
IV carbonatite + silicate	0.06~2.8	1.3~14.1(4.8)	0.3~4.6(0.9)
V magnetite + apatite	Max. 4.6(1.9)	4.1(1.5)	2.3~14.2(3.1)
VI phosphate	Max.5.6(2.4)	~6.8(2.5)	4.4~13.3(7.5)

[1]: It mainly contains bastnaesite and also contains apatite, and fluorite etc.

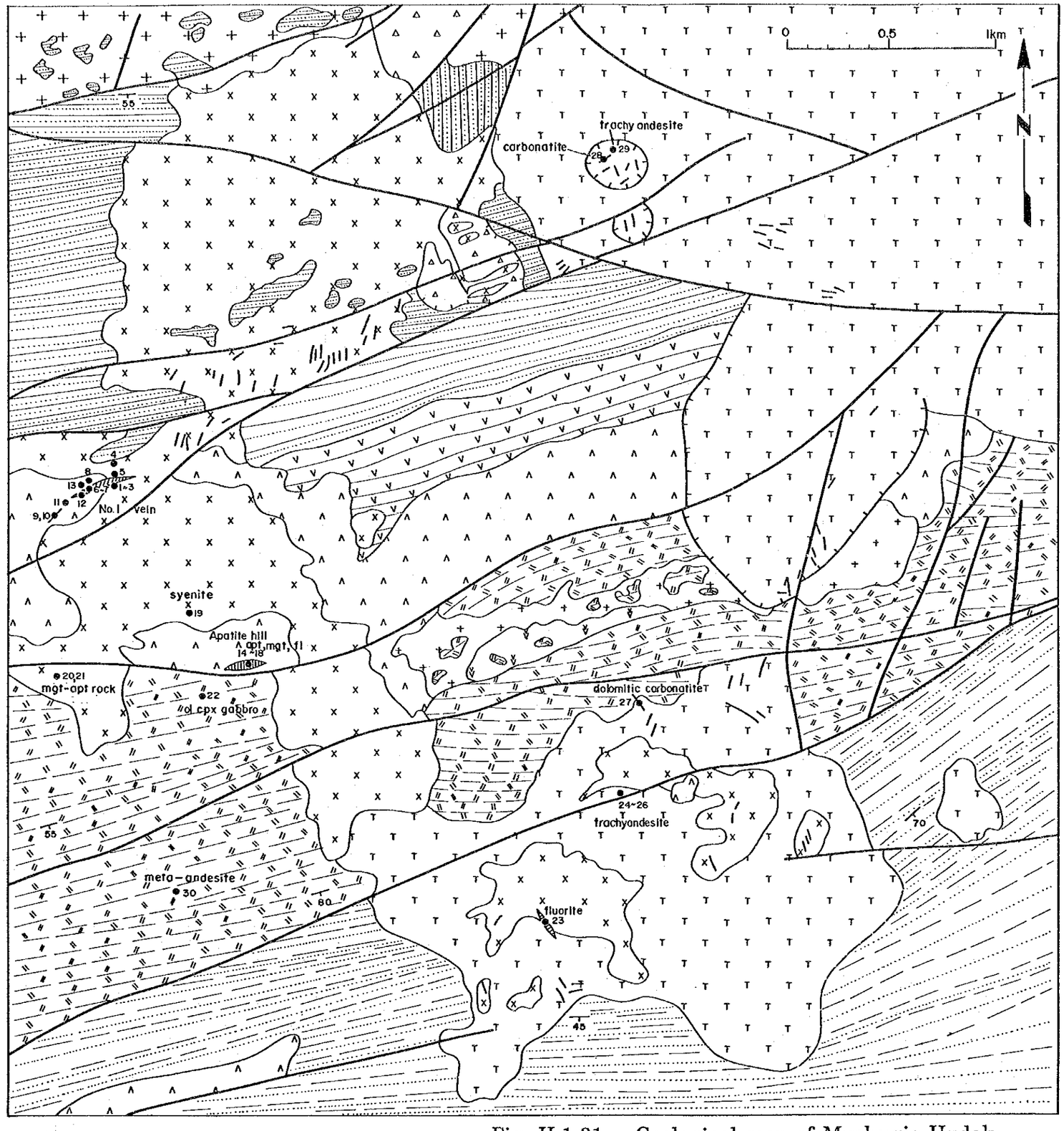
[2]: The figures in the ( ) indicates the average.

It mainly consists of primary ore, and the secondary enrichment zone is not well-developed.

(2) Type of deposit

carbonatite (vein type and/or lenticular type)

(3) Ore reserves and grades; (reference: calculated in 1984, cut off=0.5% TREO, Additional survey showed that it is divided into many small ore bodies of carbonatite breccia. It is reported that the ore reserves decreased to a large extent, but its estimated figure is not available.)



LEGEND

J3ul	Upper Jurassic (Ulgei F.)		Trachyte, leucocratic trachyte Conglomerate, volcanic breccia
Dlir2	Lower Devonian (Irtinbayanhural F.)		Sandstone, siltstone, limestone, conglomerate
Dlir1			Acidic tuff, shale, sandstone, limestone
S2-D1mh	Middle Silurian ~ Lower Devonian (Manhanul F.)		Rhyolite, dacite, acidic tuff, conglomerate, sandstone
S1-2mn	Middle ~ Lower Silurian (Mandalobin F.)		Sandstone, siltstone, limestone, conglomerate
μpD1	Early Devonian		Dacite
ξJ3	Late Jurassic		Syenite, melano-syenite
γP1	Early Permian		Leucocratic porphyritic granite
γD2	Middle Devonian		Plagio-granite
νD2			Mdg gabbro
			Carbonatite vein
			Circular structure
			Fault
			Sampling point and number

Point No.	Sample No.	Point No.	Sample No.
1	3US 01	16	3US 16
2	3US 02	17	3US 17
3	3US 03	18	3US 18
4	3US 04	19	3US 19
5	3US 05	20	3US 20
6	3US 06	21	3US 21
7	3US 07	22	3US 22
8	3US 08	23	3US 23
9	3US 09	24	3US 24
10	3US 10	25	3US 25
11	3US 11	26	3US 26
12	3US 12	27	3US 27
13	3US 13	28	3UN 18
14	3US 14	29	3UN 19
15	3US 15	30	3UN 20

Fig. II-1-31 Geological map of Mushugia-Hudak

Type of deposit	Ore reserves (C2+P1 t)	grade (%)	amount of TREO(t)
apatite type deposit	44,500,000	3.37	1,500,000
carbonate deposit	353,500,000	1.30	4,600,000
Total	398,000,000	1.53	6,100,000

(4) Size of deposit

60m×100m (magnetite+apatite), 50m×300m (apatite), and other small-sized (width 0.1m~3m) carbonatite veins are distributed in the range of 1,700m×200m~500m of syenite ore bodies formed in Late Jurassic.

(5) Structure of deposit

Most of the deposits show NE-SW direction, same as the major faults.

(6) Country rock

Syenite and/or syenite porphyry formed during the Late Jurassic period.

(7) Structural control

The distribution of the deposits is limited in the syenite and/or syenite porphyry formed during the Late Jurassic period.

(8) Related igneous rocks

Upper syenite and/or syenite porphyry formed in Jurassic. The results of dating test of nepheline syenite shows 132±7Ma by K-Ar, that means Early Cretaceous.

(9) Alteration

It is not extinguishable.

5. Water supply

There are wells about 5km southwest of the deposit, and 3km east-south-east of the deposit.

6. Hydrology

Not obvious.

7. Discovery and history

1974-77 The deposit was discovered when the geological survey (1/200,000) was conducted by the survey team. (By the cooperation of the USSR and Mongolia)

1979-82 Geological survey (41,500km^2) was completed by the survey team.

1983 The joint survey team conducted the geological and radio-active exploration and at a scale of 1:25,000 and 1:10,000, and made 5 trenches, 45 pits. Ninety nine samples were analized and described.

1982-84 The joint venture (the USSR and Mongolia) conducted boring (20 holes, total 2,800m). As a result, they reported the discovery of a massive deposit. (Ore reserves {C2+P1} 398 million tons, TREO grade 1.53% {TREO 6.1 million tons})

1989-90 The Choir expedition conducted boring (more than 100 holes, total 15,000m), and trenching (100,000m^3). As a result, it was found that the deposit is divided into many small ore bodies, and the estimated ore reserves decreased dramatically.

8. Mining operation
None

1-7-2 Bayan-Hoshoo deposit ★ (Fig. II-1-32)

1. Location and transportation

Location: Longitude 104°21'19" East, Latitude 44°20'17" North, Elevation 1,129m above sea level. In administrative division terms, the deposit is located in the Mandal-Ovoo Sum in the Umnugovi Aimag, of the Gobi desert and about 29km east-south-east of Mushgia-Hudak.

It is about 100km from Daranzadgad city to the deposit, about 3 hour drive by car though the semi-desert and desert area.

2. Topography

This deposit consists of a hilly zone (elevation,about 1,100m~1,200m) with about 100m elevation differenc. Syenite and related ores contaning carbonatite and strontium ore (celestite) formes a small hill. The outcrop of the strontium deposit forms a gentle hill which is about 10m higher than the surroundings. The maximum elevation around the deposit is a nameless hill (1,247.8m), about 250m north west of the deposit.

As for topography, it is relatively gentle, and automobiles can travel drive anywhere.

3. Climate
Same as Mushgia-Hudak deposit

4. Geology and deposit

(1) Miniralization

The ore contains strontium and rare earth. It occurs as medium~coarse-grained strontianite and/or celestite+quartz stockwork deposit and carbonatite. Strontianite and/or celestite form stockwork deposit, as a veinlet (several~30cm width) in argillized country rocks with barite. As for rare earth ore, it mainly consists of synchisite, and abundant in Ce.

(2) Type of deposit

Stockwork type. A small carbonatite deposit exists near the deposit as well.

(3) Ore reserves and grades

Ore reserves : about 700,000t , SrO: 40~50%, TREO 0.5~4%. At the outcrop, the vein ratio of strontianite and celestite veins is about 2 to 3 %.

(4) Size of deposit

80m×100m×80m (depth)

(5) Structure of deposit

Strike: N60°W, Dip: 35°~70° toward south. Mineralization was confirmed to a depth of 300m by boring.

(6) Country rock

Late Jurassic rhyolite, rhyolitic tuff, diorite and diorite porphyry

(7) Structural control

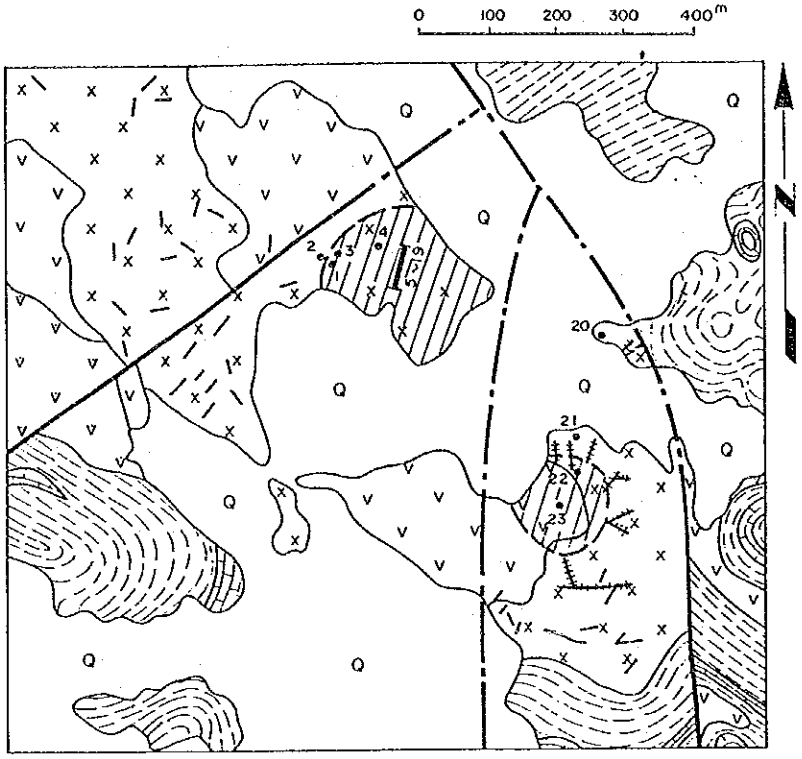
Not obvious

(8) Related igneous rocks

Late Jurassic syenite and/or syenite porphyry

(9) Alteration

Argillization, silicification.



Point No.	Sample No.
1	3US 81
2	3US 82
3	3US 83
4	3US 84
5~19	3US 85~99
20	3US 100
21	3US 101
22	3US 102
23	3US 103
24	3US 104

LEGEND

Quarternary
- Q — Alluvium and Diluvium

Late Jurassic
- Conglomerate, sandstone, siltstone
- Limestone
- Rhyolite, acidic tuff
- Trachyte, trachytic tuff
- Syenite
- Stockwork of carbonatite and celestite

- Carbonatite vein
- Quartz vein
- Fault
- Concealed fault
- Trench
- Sampling point and number

Fig. II-1-32 Geologicai map of Bayan-Hoshoo

5. Water supply
There are wells at the Bayan-Hoshoo village, about 2.5km northwest of the deposit.

6. Hydrology
Not obvious.

7. Discovery and history
1976 The deposit was discovered when the geological survey at a scale of 1:200,000 was conducted by the USSR.

1981~84 The USSR conducted twenty borings, and many pitting, and trenching to a large extent.

8. Mining operation
None.

9. Others
The bottom of strontium network deposit is converted into gypsum deposit below 80m.

1-7-3 Olon-Ovoot deposit★ (Fig. II-1-33)

1. Location and transportation
Location: Longitude 104°09'44" East, Latitude 44°22'28" North, Elevation 1,205m above sea level. In administrative division terms, the deposit is located in the Mandal-Ovoo Sum in the Umnugovi Aimag, of the Govi desert and about 13km east south east of Mushgia-Hudak.
It is about 100km from Daranzadgad city to the deposit, about 3 hour drive by car through the semi-desert and desert area.

2. Topography
This deposit consists of a hilly zone (elevation,about 1,100m~1,200m) which is made up of hills that are 100m higher than the valleys. The maximum elevation around the deposit is a nameless hill (1,253.4m), about 800m south of the deposit.
As for topography, this area is relatively steep, but automobile can drive along the mountanous stream.

3. Climate
The major climate index around the Olon-Ovoot deposit is as follows:
Annual solar radiation is 5,700MJ/m^2, annual average temperature is 3.4°C, and annual precipitation is 132.5mm. Annual frostless days are about 130. It is particularly windy two months from April to May, with more than 40 sandstorm days annually. The steppe is scarce vegetation and the mountainous area is rocky desert, as the precipitation is scarce.

4. Geology and deposit
(1) Mineralization
The deposit contains gold. As for the nature, it is mesothermal (old vein type) auriferous quartz vein. It does not contain much sulfide. Dendritic native gold often occures along the fissures, and it is also found in the altered country rocks.
(2) Type of deposit
Stockwork type vein.
(3) Ore reserves and grades

Ore reserves and grades are not clear because the exploration was not sufficient. The following are the assay results of 68 samples obtained at the outcrop and by trenching (Fig. II-1-34~42).

below 3 g/t	57 pcs (2.60, 2.53, 2.12, 1.92, 1.78 g/t and others)
3 g/t~10 g/t	5 pcs (4.11, 4.32, 5.00, 5.21, 5.21, 8.77 g/t)
10 g/t or more	6 pcs (10.7. 12.9, 13.0, 16.4, 19.3, 32.8 g/t)

Ore block has not been set, because the gold contents largilly fractuate from place to place.

(4) Size of deposit

More than four quartz veins exist in the vicinity of 900m (length)×500m (width). The size of each quartz vein is around 50~100m (length)×20~50m (width)×30~50m (depth)

(5) Structure of deposit

Stockwork deposit. Strike: N70°~80°W, Dip: Not obvious. Mineralization is confirmed to a depth of 30m~40m by boring.

(6) Country rock

Sedimentary rocks (black sandstone, siltstone, shale) formed in Silurian, and gabbro and diorite etc. formed in Devonian.

(7) Structural control

Strike: E-W, Dip:60°~80°N or Strike: N70°E, Dip:80°N~S, or Strike:N60°~70°W

(8) Related igneous rocks

It is considered to be related to gabbro and diorite formed in Devonian.

(9) Alteration

Sericitization, pyritization, argillization, silicification.

5. Water supply

There are wells about 5km north of the deposit.

6. Hydrology

Not obvious.

7. Discovery and history

1979-82 The USSR discovered quartz veins when conducting a geological survey (1/200,000), and confirmed and noted the occurence of gold to a maximum of 20g/t.

1989-90 Geology Company, a Mongolian company, confirmed high-grade gold, when conducting a survey (1/50,000) on 1,800km^2.

1991 Geology Company, a Mongolian company, conducted boring (5 holes, max. depth 70m/hole), and trenching (11 trenches, max. grade 340g/t).

8. Mining operation.

None.

9. Others.

Alluvial gold is detected from the sand in the valley in the vicinity of 22m×7km by panning.

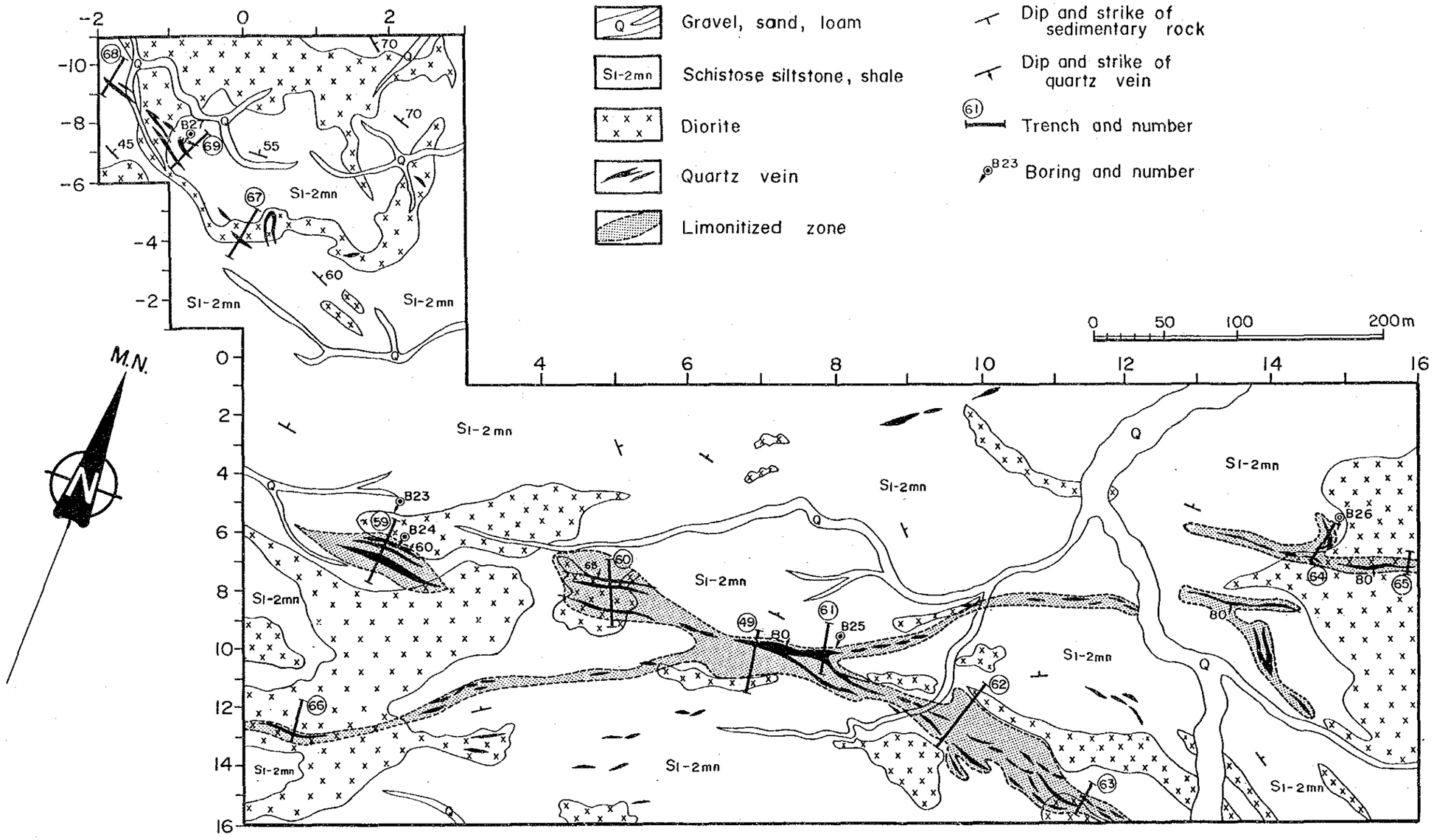
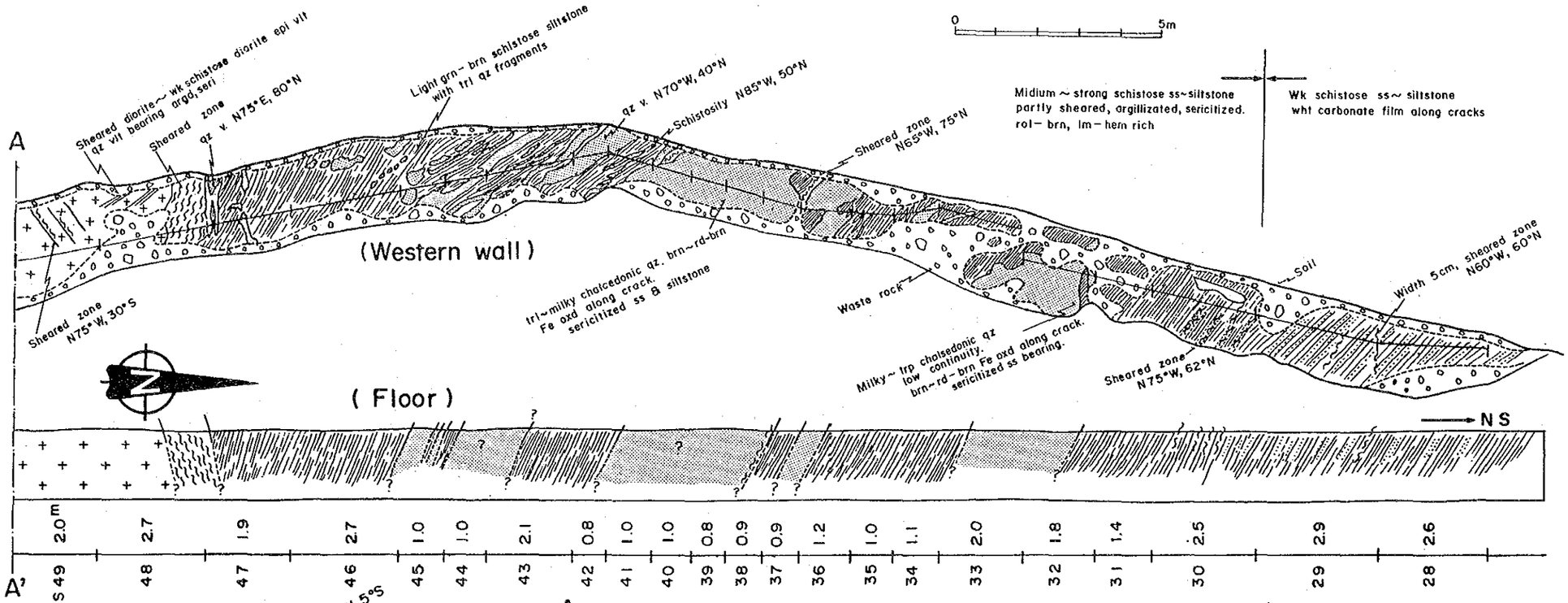
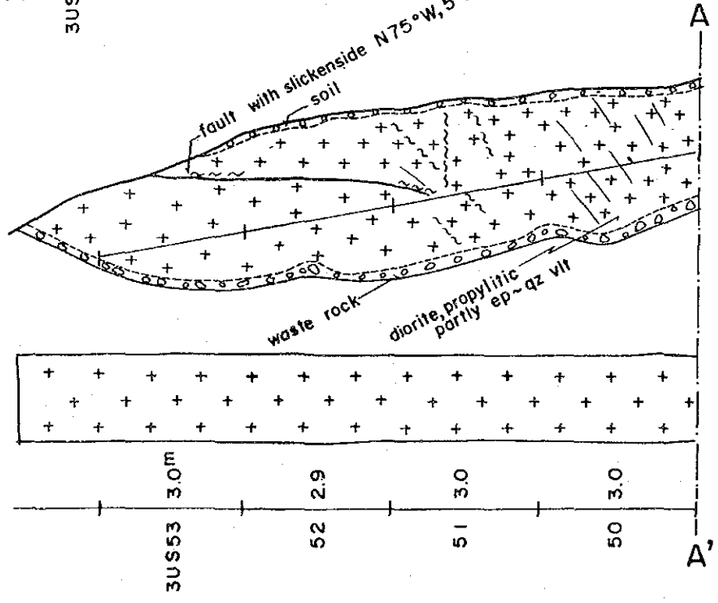


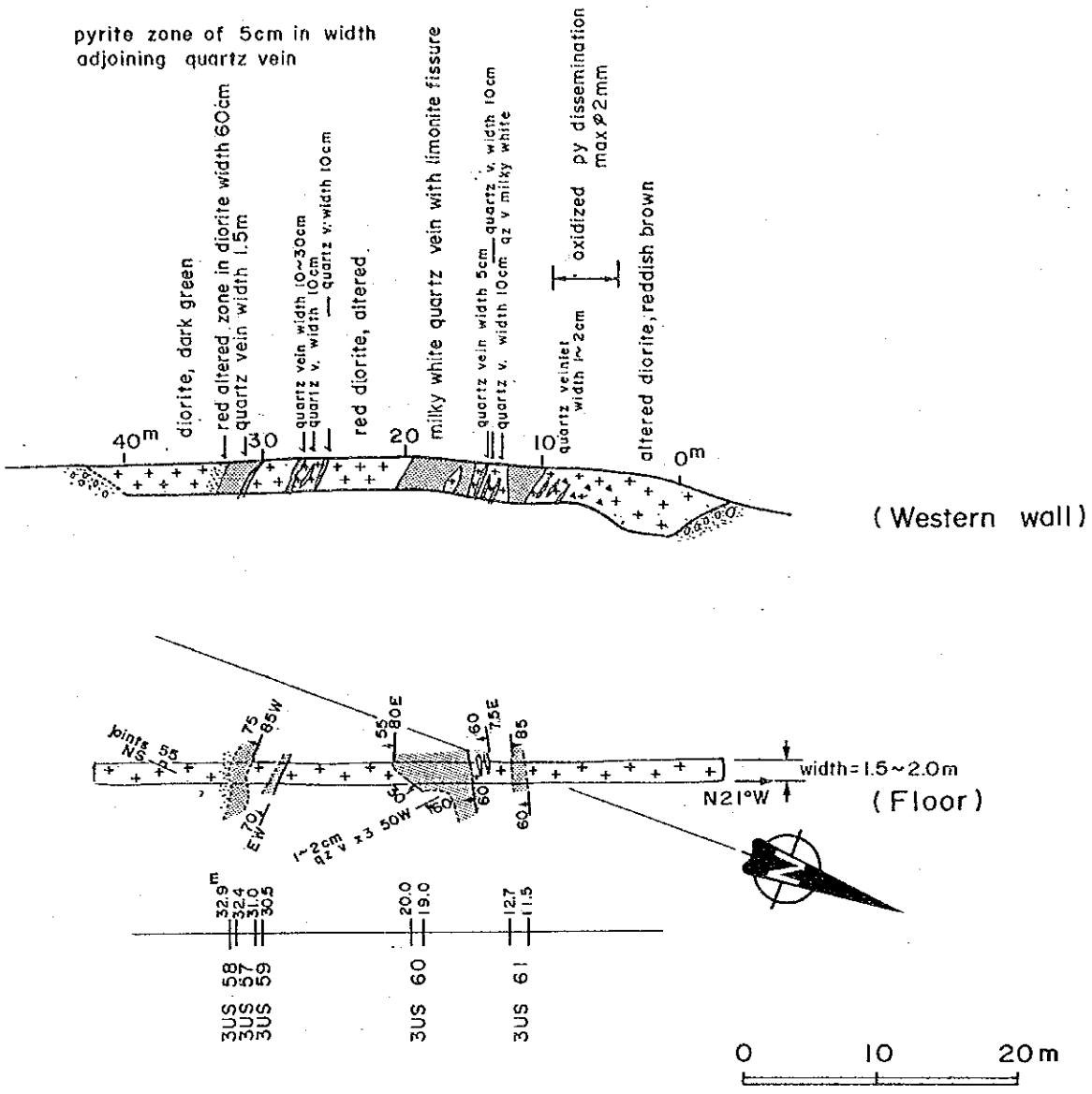
Fig. II-1-33 Geologicai map of Olon-Ovoot





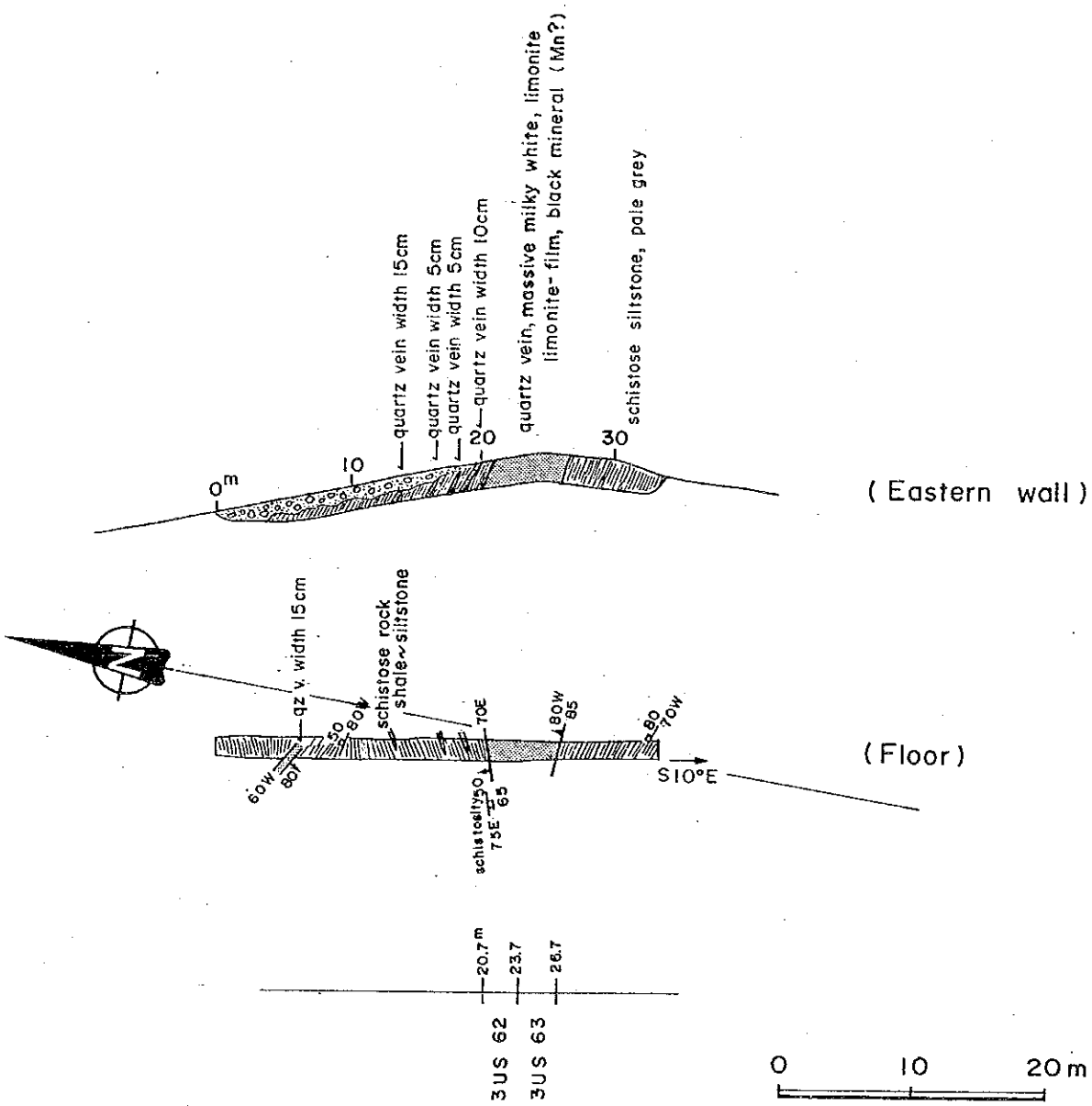
Sample No	width m	Au g/t	Ag g/t	Note	Sample No	width m	Au g/t	Ag g/t	Note
3US53	3.0	<0.07	<0.5	diorite	3US38	0.9	0.55	<0.5	qz v.
3US52	2.9	<0.07	<0.5		3US37	0.9	0.34	<0.5	
3US51	3.0	<0.07	<0.5		3US36	1.2	2.12	<0.5	
3US50	3.0	<0.07	<0.5		3US35	1.0	6.71	<0.5	slt + qz v
3US49	2.0	<0.07	<0.5		3US34	1.1	5.00	<0.5	
3US48	2.7	1.58	<0.5	diorite + qz v.	3US33	2.0	1.10	<0.5	
3US47	1.9	4.32	<0.5	slt + qz v.	3US32	1.8	0.14	<0.5	qz v.
3US46	2.7	8.77	<0.5		3US31	1.4	0.82	<0.5	slt
3US45	1.0	0.14	<0.5	qz v.	3US30	2.5	0.27	<0.5	
3US44	1.0	5.21	<0.5		3US29	2.9	<0.07	<0.5	
3US43	2.1	0.41	<0.5		3US28	2.6	<0.07	<0.5	
3US42	0.8	16.40	<0.5						
3US41	1.0	32.80	<0.5						
3US40	1.0	0.07	<0.5						
3US39	0.8	0.27	<0.5						

Fig. II-1-34 Assay of trench No. 59, Olon-Ovoot



Sample No.	width m	Au g/t	Ag g/t	Note
3US 58	0.5	10.70	< 0.5	diorite
3US 57	1.4	0.48	< 0.5	qz v.
3US 59	0.5	12.90	< 0.5	diorite
3US 60	1.0	13.00	< 0.5	qz v.
3US 61	1.2	0.21	< 0.5	qz v.

Fig. Ⅱ-1-35 Assay of trench No. 60, Olon-Ovoot



Sample No	width m	Au g/t	Ag g/t	Note
3US 62	3.0	1.44	< 0.5	qz v.
-3US 63	3.0	0.14	< 0.5	qz v.

Fig. II-1-36 Assay of trench No. 61, Olon-Ovoot