5) Coal reserves

According to the detailed exploration report in 1980, the coal reserves at the area of 1.6 km x 0.5 km within 100 m below the surface is estimated at 4.6 million tons for minable reserves($A + B + C_1$) and 6.9 million tons for geological reserves($A + B + C_1 + C_2$). The minable reserves for opencut mining above the groundwater level of 40-50 m below the surface is estimated at 2.6 million tons. In extending areas on the east and west of the deposit, which are covered by Quaternary sediments, it is expected for future exploration works to increase the minable reserves.

6) State of mining

The Zeegt Coal Mine began to mine by small-scale opencut in 1966 and started as a systematic mine in 1977. The total produce until 1993 was 1.26 million tons with an average of 6,000 tons/y and has been utilized by local consumers in Govialtay, Zavhan and Bayanhongor Provinces.

(5) Mogoingol Deposit

1) Locality and topography

The Mogoingol Deposit is within the Middle-North Megablock and near the west border with Zavhan Province in Hovsgol Province. The center of the deposit is in latitude 49° 20'N and in longitude 97° 55', 165 km west-southwest of Moron which is the capital town of Hovsgol Province (Figure 13). The land surface of the deposit forms a forestall hill. The coal seam crops out about 1,900 m above the sea level.

2) History of exploration

1955 : Firstly recorded by Russian geologists

1967 : Exploration with electric prospecting(1 km)

1968 : Exploration by a geological expedition of Hovsgol Province

- drilling : 26 holes, 1,501 m in total
- estimated coal reserves : 50 million tons

1969-70 : Detailed exploration for confirmation

- drilling : 41 holes, 1,559.7 m in total

1976 : Detailed exploration by the Ulaanbaatar expedition

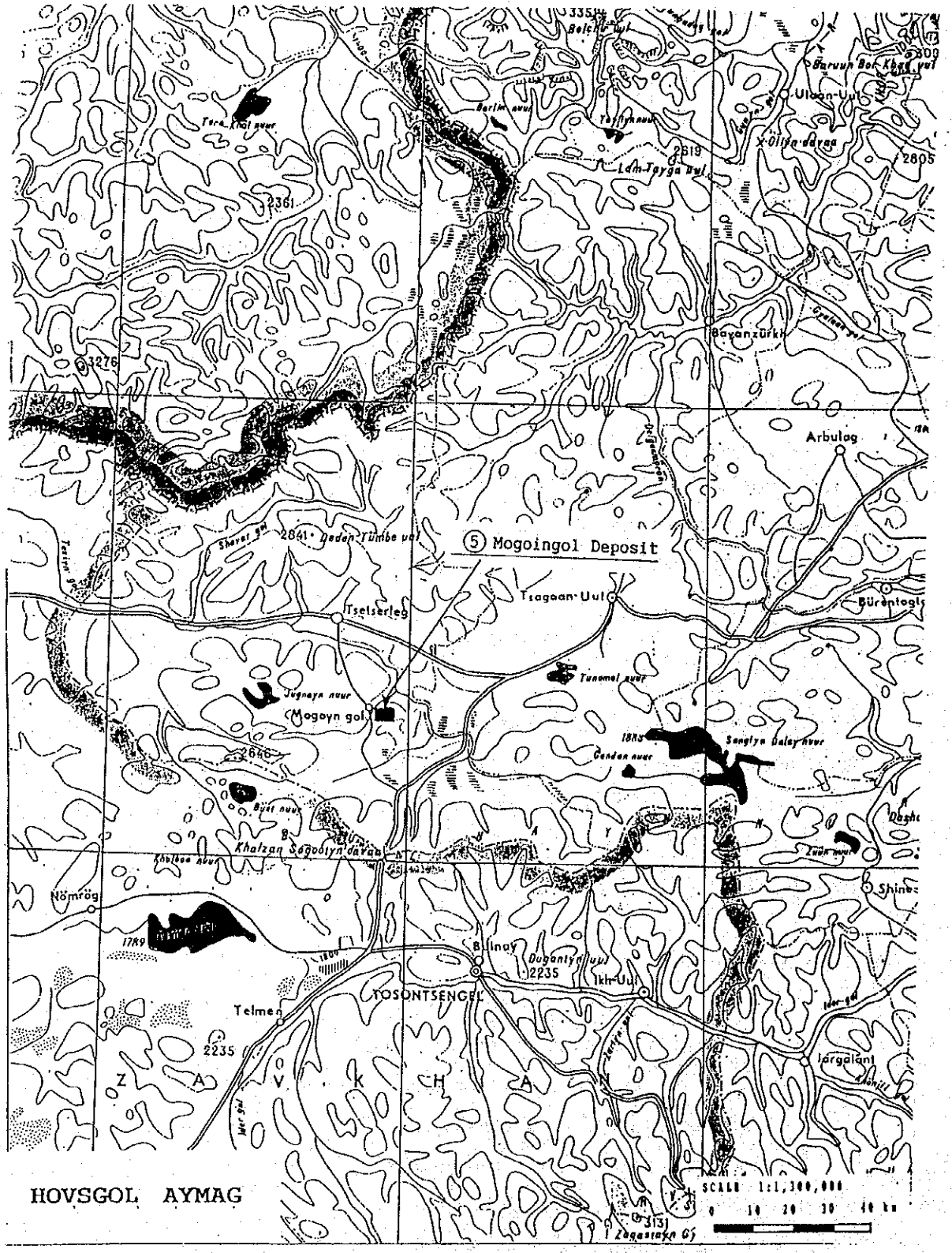


Figure 13 Deposit locality map in Hovsgol Aymag

- drilling : 71 holes, 2,766.0 m in total average length 39 m/hole, max. 95.7 m
- hole interval : 50-200 m
- exploration line interval : 50-250 m
- geophysical logging : 41 holes

3) Coal geology

The Mogoingol Deposit belongs to the Orkhon Selenge Coal-bearing Basin (Region). The deposit shows a half-basin structure opened toward the southeast, and extends for 1.0 km north-south long and 400-600 m wide with an area over 0.5 km. The coal seam is embedded in the formation of Late Carboniferous age. The basic geological structure is formed of a basin structure with a north-south axis. The coal seam occurs restrictively at the northwest corner of the basin and extends about 1.0 km long. The coal seam gently dips 6-12° east and south (Figure 14). In the deposit is only one coal seam ranging in thickness from 3.1 to 20.0 m, averaging 7.8 m. The seam is partially accompanied with two or three partings.

4) Coal quality

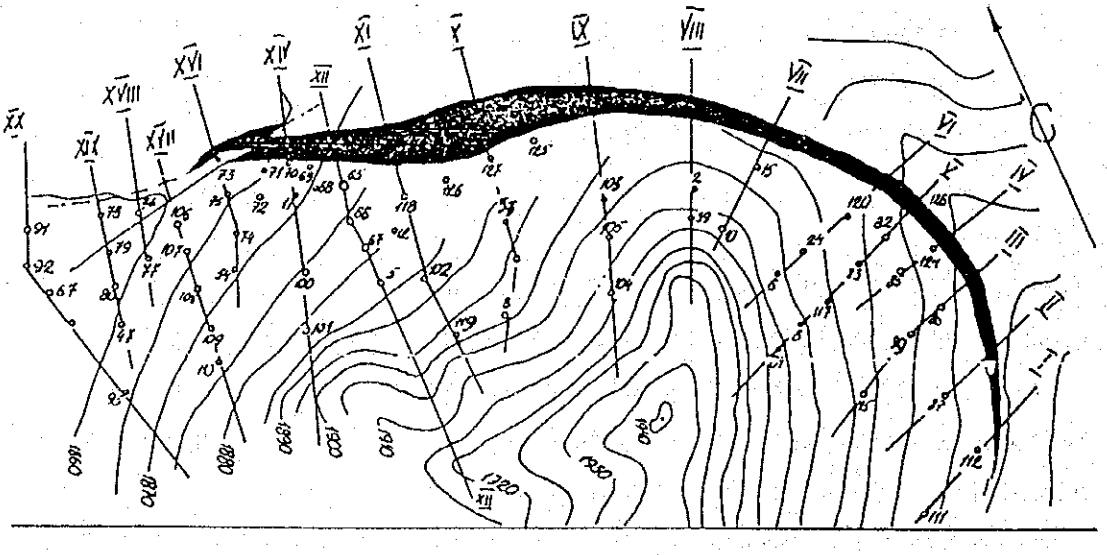
The coal is classified into J (Mongolia, Russia), Subbituminous B-High volatile bituminous C (U.S.A.) or Subbituminous E-Bituminous C (Japan-JIS). The typical coal contains 5.6% moisture (air dried), 18.0% ash (dry), 34.6% volatile matter (dry,ash free), 0.9% sulfur (dry) and 75.2% C, 5.3% H, 16.2% O in element analysis. The calorific value is 5,650 kcal/kg (as received) and 7,350 kcal/kg (dry, ash free).

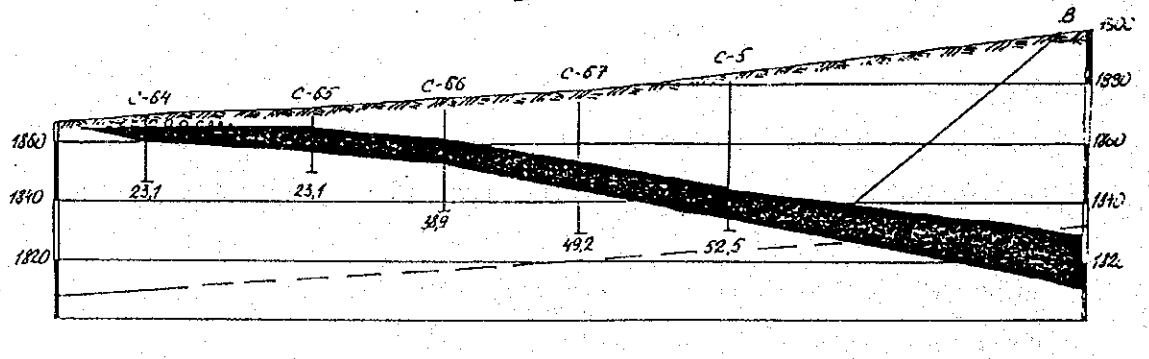
5) Coal reserves

According to the detailed exploration report in 1976, the coal reserves at the area of 1.0 km long within 30-50 m below the surface is estimated at 4.1 million tons for minable reserves($A + B + C_1$) and 15.5 million tons for geological reserves($A + B + C_1 + C_2$).

6) State of mining (Figure 15)

The Mogoingol Coal Mine began to mine by opencut in 1970. The total produce until 1993 was 1.6 million tons with an average of 100,000 tons/y and has been utilized by local consumers restricted in Hovsgol and Zavhan Provinces. In the deposit, there are such a hazard for mining as frozen conglomeratic overburden, increasing of stripping ratio owing to





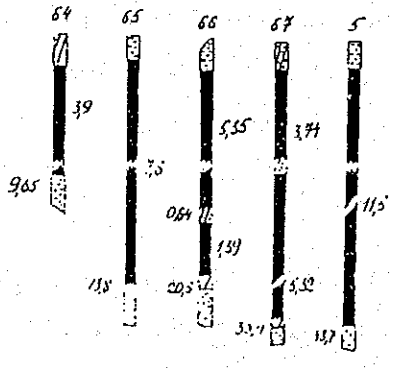


Figure 14 Seam conditions of Mogoingol Mine

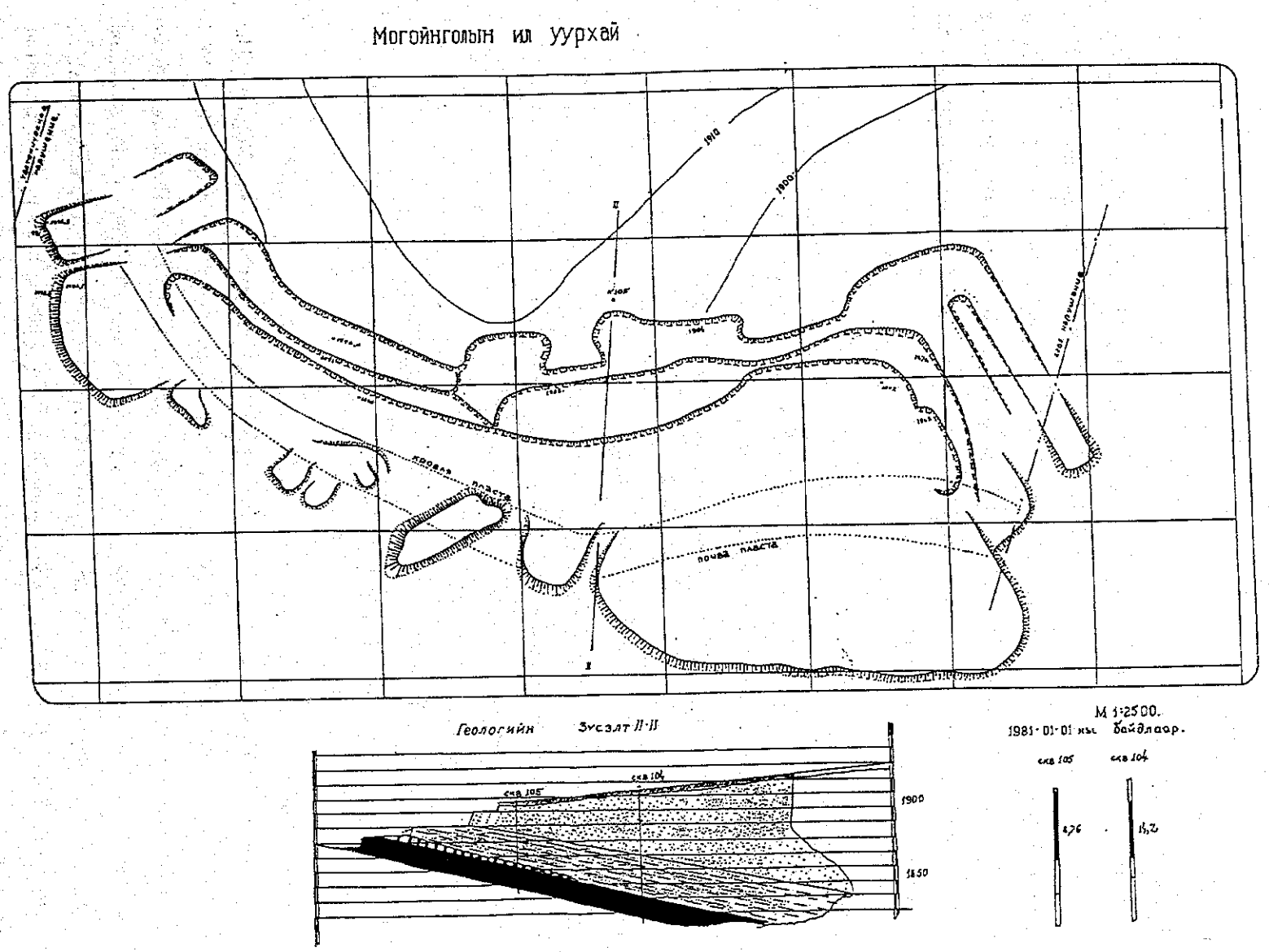


Figure 15 Schematic of Mogoingol Mine

the topographical conditions and variable coal thickness.

(6) Saihan-Ovoo Deposit

1) Locality and topography

The Saihan-Ovoo Deposit is within the Middle-North Megablock and at the west of Bulgan Province. The center of the deposit is in latitude 48° 48'N and in longitude 102° 30', 90 km west of Bulgan which is the capital town of Bulgan Province (Figure 16). The deposit occurs under Mt. Saihan and the coal-bearing formation crops out at the forestall slopes surrounding the mountain. The top of Mt. Saihan is at 1,862 m and the outcrops of coal seams are about 1,600 m above the sea level.

2) History of exploration

1960's : Exploration by a geological expedition of former Soviet Union
- estimated coal reserves at 20 million tons

1961 : Detailed exploration with drilling at west part
- confirmed five minable coal seams
- estimated coal reserves at 2.3 million tons

1965 : Start of underground mining at the west area

1977 : Detailed exploration with drilling at the east area
- estimated coal reserves at 2.0 million tons

1988-89 : Exploration for the whole deposit
- drilling : 25 holes, 4,756.5 m, hole length 200-250 m

1993 : Detailed exploration at the north area

3) Coal geology

The Saihan Ovoo Deposit belongs to the Orkhon Selenge Coal-bearing Basin (Region). The deposit extends for 5.0 km north-south and 3.5 km east-west with an area of about 17.5 km^2. Coal seams are embedded in the formation of Middle Jurassic age. The deposit shows a gentle homoclinal structure dipping 0-3° east, 5° in maximum. The coal-bearing formation ranges in thickness from 130 to 250 m and is covered by a thick basaltic lava bed which forms Mt. Saihan (Figure 17). This basaltic lava influenced the coals to be upgraded in quality.

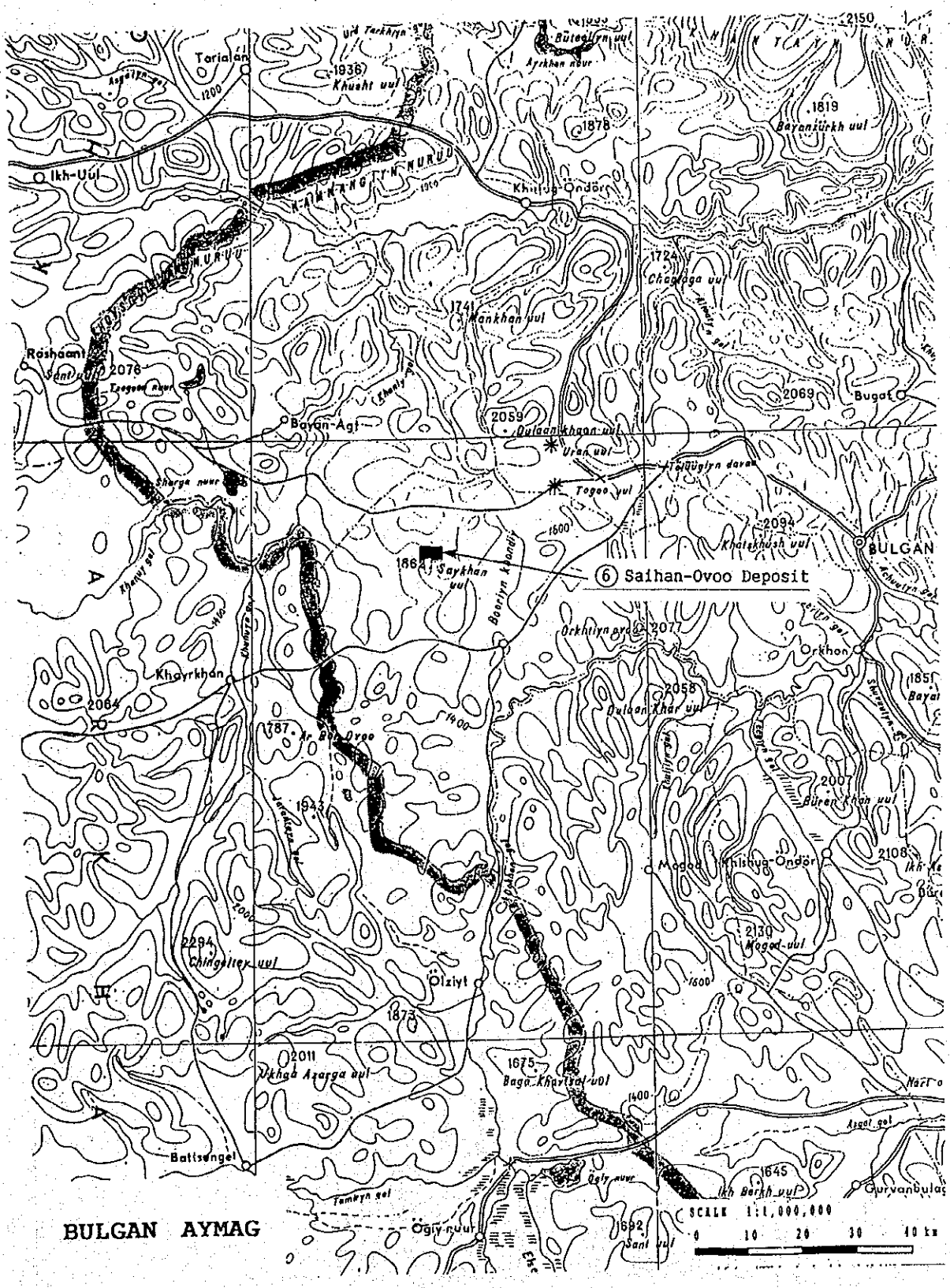


Figure 16 Deposit locality map in Bulgan Aymag

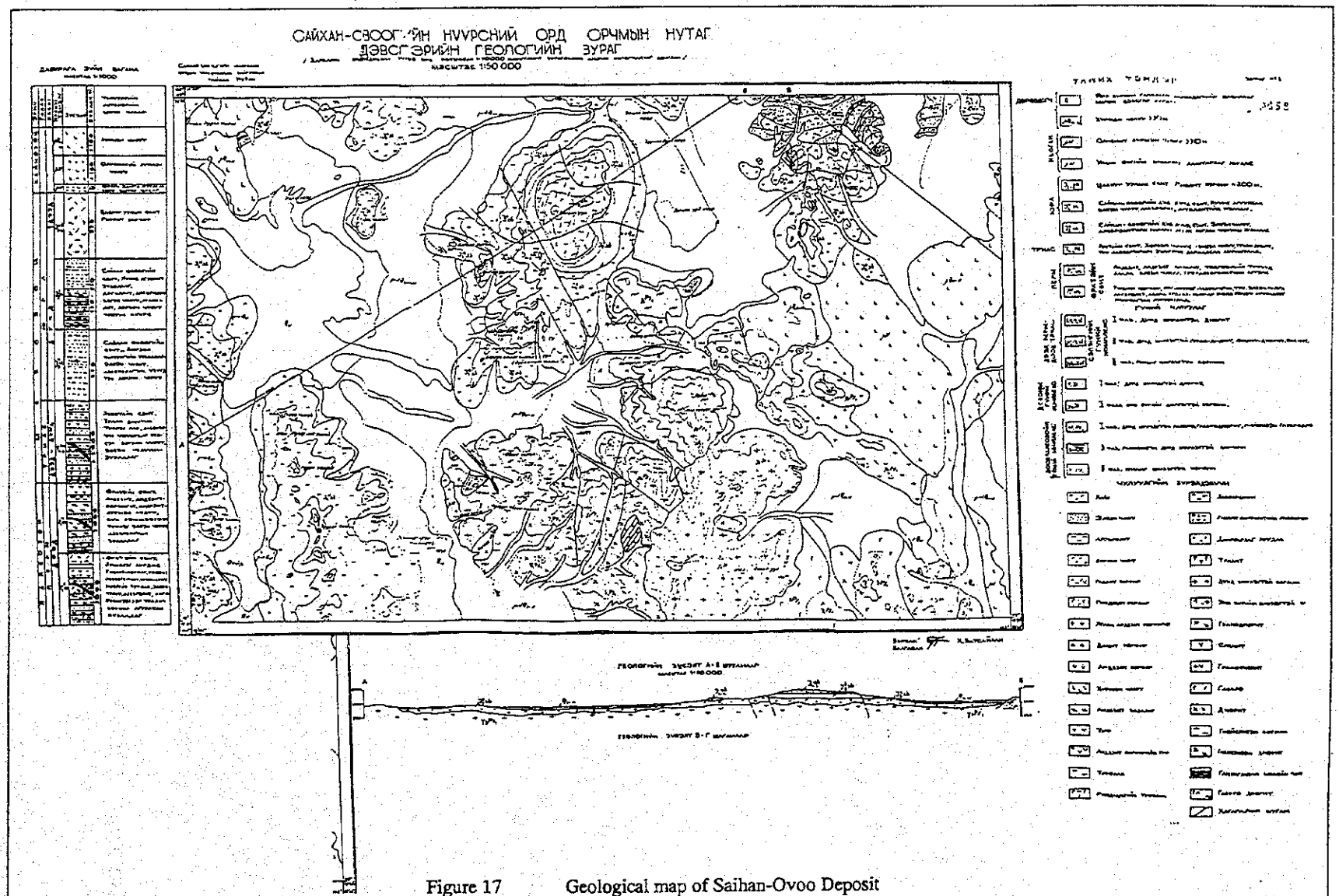


Figure 17 Geological map of Saihan-Ovoo Deposit

In the deposit, numbered coal seams are a total of 8-10 seams: the Seam I to VIII in descending order, ranging in thickness from 0.6 to 5.5 m with characteristics of variable thickness and splitting, of which two coal seams of the Seam II and VI-A are minable. The area at which minable seams are found is restricted at the north half of deposit. The Seam II occurs at the west area and ranges in thickness 0.4 to 2.0 m. The Seam VI-A occurs at the north area and ranges in thickness 0.3 to 2.4 m.

4) Coal quality

Owing to the thermal alteration by basaltic lava flow, the coals show various ranks in degree of coalification. In particular, the contents of volatile matter decrease as much as close to the lava bed. The reflection ratio of Vitrinite increases up to 3.78% in maximum. The coals are classified into K, KJ-A (Mongolia, Russia), Medium volatile bituminous-Anthracite (U.S.A.) or Bituminous C-Anthracite (Japan-JIS). The general coal properties of main two seams are shown as follows:

Items	Seam II	Seam VI-A
- Moisture(air dried)	0.8%	1.3%
- Ash(dry)	11.7%	21.7%
- Volatile(daf)	27.1%	34.6%
- Sulfur(dry)	1.18%	0.62%
- Calorific value(daf)	7,319 kcal/kg	7,288 kcal/kg
- ditto (as received)	6,100 kcal/kg	

5) Coal reserves

In the whole deposit, the reserves of coal seams over 1.5 m thick is estimated at 23.95 million tons for minable reserves (C_1) and 10.71 million tons for geological reserves (C_2).

6) State of mining

The Saihan Ovoo Coal Mine began at the west area in 1965, as the second underground mine following the Nalaikha Mine (Figure 18). The total produce until 1993 was 0.52 million tons with an average of 25,000 tons/y and has been utilized by local consumers restricted in Bulgan and Arhangay Provinces. Mining at the west area was closed in 1993 because of such hard conditions as water seepage and damaged supports by ground pressure. At present, the mine is going to develop a new mining site at the north area.

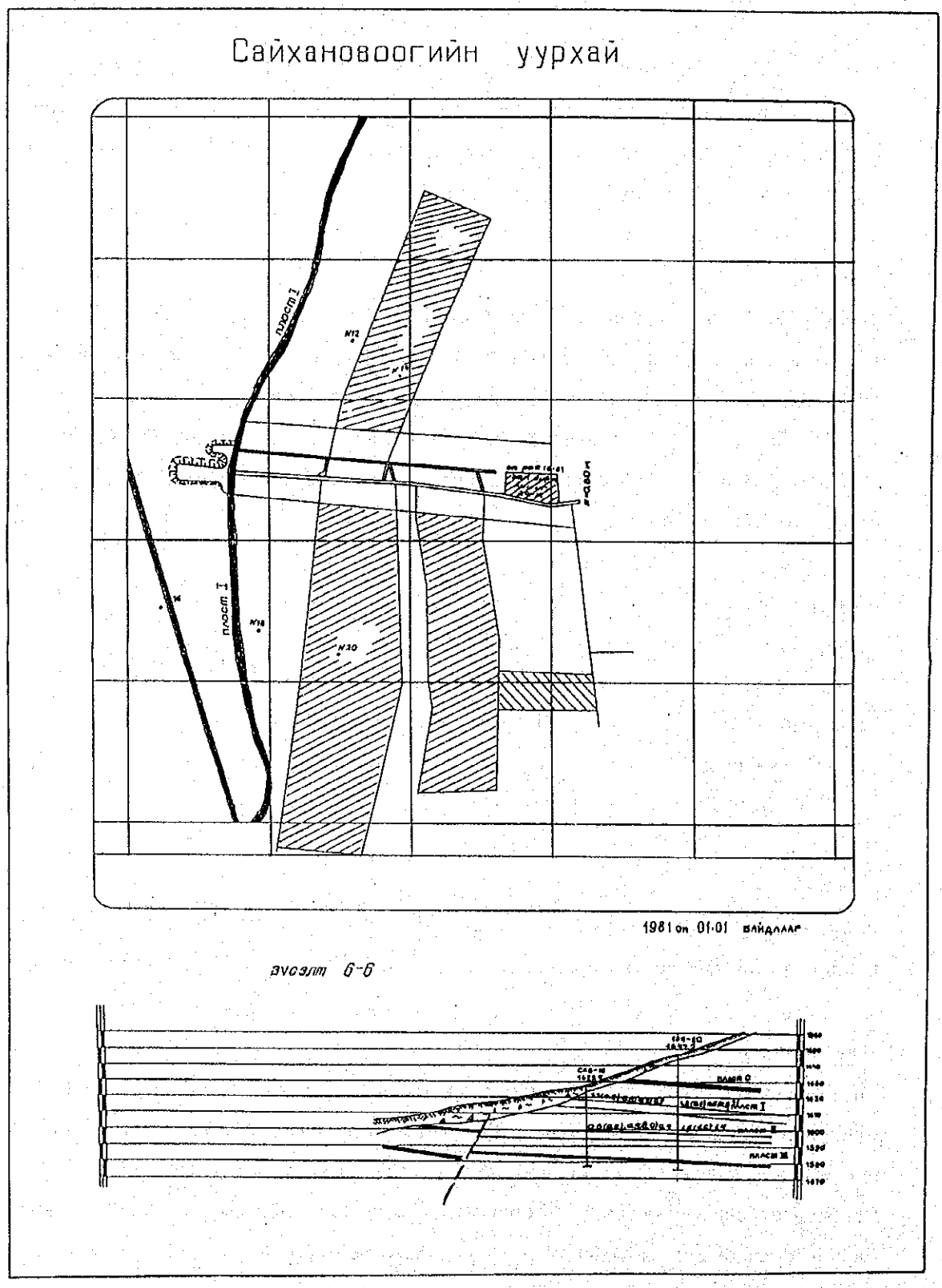


Figure 18 Schematic of Saihan-Ovoo Mine

(7) Bayantsagaan Deposit

1) Locality and topography

The Bayantsagaan Deposit is present within the Middle-North Megablock and in Arhangay Province. The center of the deposit is in latitude 47° 40' N and in longitude 101° 18', 25 km north-northwest of Tsetserleg which is the capital town of Arhangay Province (Figure 19). The land surface of the deposit forms a hilly steppe at about 1,600 m above the sea level.

2) History of exploration

1986 : Exploration with drilling (12 holes)
1989 : Exploration with drilling (15 holes)
1990 : Exploration with drilling (8 holes)
1992 : Approval on development by the government
1994 : Start of tunneling for underground mining

3) Coal geology

The Bayantsagaan Deposit belongs to the Orkhon Selenge Coal-bearing Basin (Region). The deposit extends for about 2.0 km northeast long and 0.3 km wide. Coal seams are embedded in the formation of Jurassic age. The basic geological structure is formed of a homoclinal structure dipping northwest(Figure 20). In the deposit are 6 to 14 coal seams occurring in a coal-bearing zone about 50 m thick. The minable part which coal seams concentrate shows 10 m in seam thickness and 6-8 m in coal thickness.

4) Coal quality

The coals are similar to the Nalaykh coal and classified into B3 (Mongolia, Russia), Subbituminous B(U.S.A.) or Subbituminous E- Lignite(Japan-JIS). The general coals contain 7.3% moisture(air dried), 2.6% moisture(air dried), 6.2-41.4% ash(dry), 26.5-46.8% volatile matter(dry,ash free), 0.59% sulfur(dry). The calorific value is 7,440 kcal/kg(dry, ash free).

5) Coal reserves

The coal reserves at the area of 2.0 km long within 100 m below the surface is estimated at a total of 4.0 million tons for geological reserves: 1.3 million tons (C_2) and 2.7 million tons (P_1). According to the government report in 1993, the total geological reserves above 300 m in depth

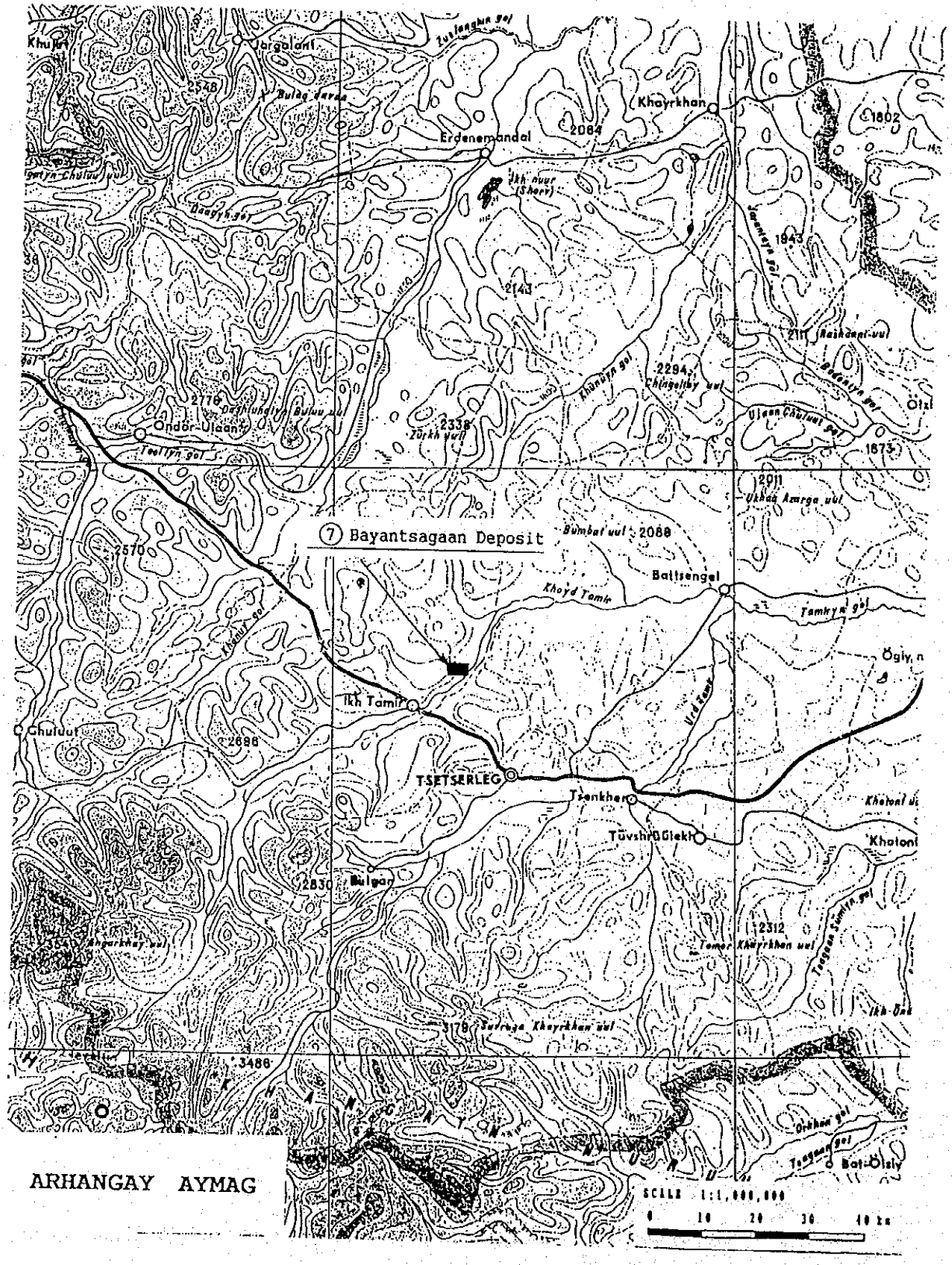


Figure 19 Deposit locality map in Aymag

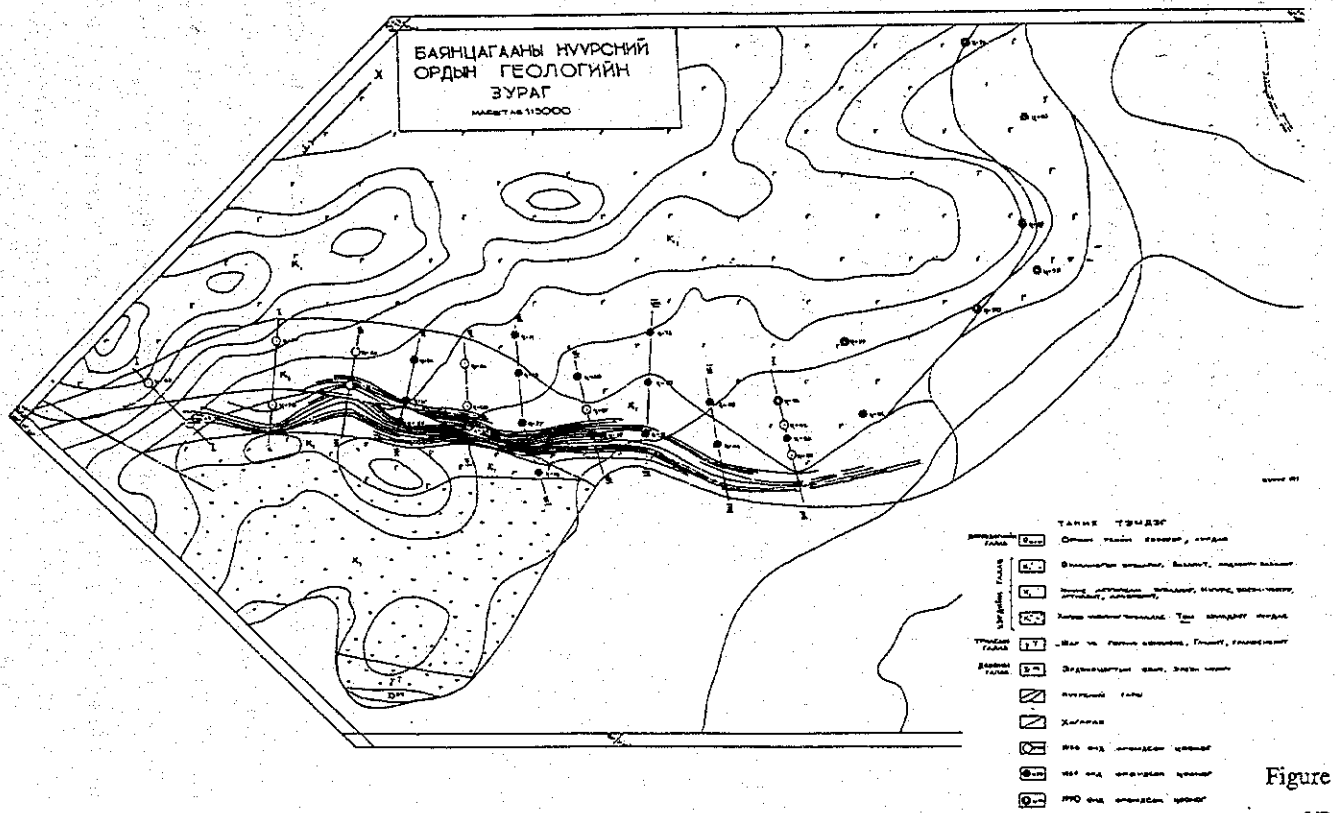
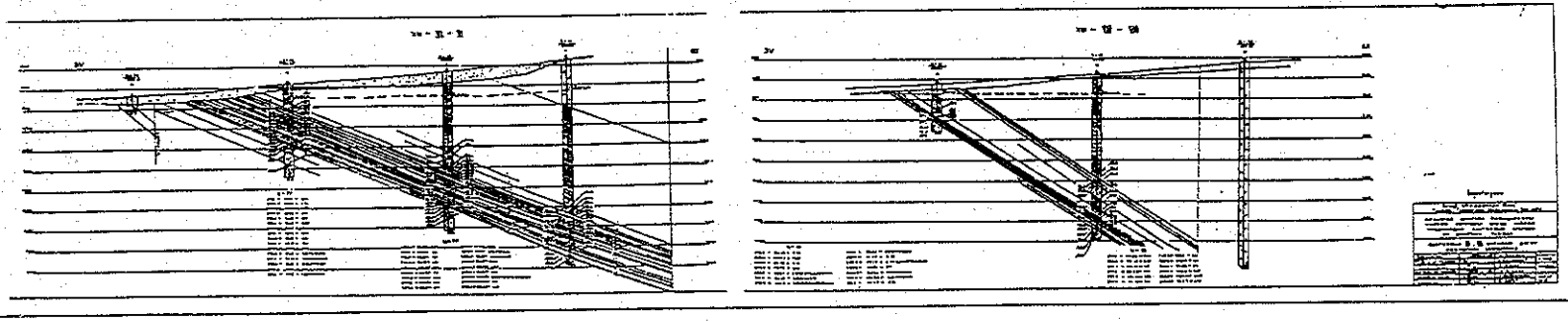


Figure 20 Geological map of Bayantsagaan Deposit



is estimated at 273.2 million tons.

6) State of mining

Arhangay Province is one of few provinces without a coal mine and is importing coals for local boilers from both Bulgan and Ovorhangay Provinces. In order to secure the local coal demand within the province, the Bayantsagaan Mine has started preparation works for underground mining as the first mine under the control of Arhangay Province at the beginning of 1994. At present, however, MEGM controls it as a governmental mine instead of the province, because the province could not continue the underground works at the point of engineering and finance.

(8) Uburchuluut Deposit

1) Locality and topography

The Uburchuluut Deposit is present within the Middle-South Megablock and at the northeast of Bayanhogor Province. The center of the deposit is in latitude 46° 20' N and in longitude 101° 5', 60 km west-northwest of Bayanhongor which is the capital town of Bayanhongor Province (Figure 21). The land surface of the deposit is a hilly steppe at 2,400 m above the sea level.

2) History of exploration

1978 : Exploration (roughly)
Partly mined and closed

1981 : Detailed exploration for the whole area
- bore hole interval : 50-100 m x 200 m

3) Coal geology

The Uburchuluut Deposit belongs to the South Khangay Coal-bearing Basin. The deposit shows a gentle basin with an area of 500 x 800 m, about 0.4 km^2. The coal seams are embedded in the formation of Early Cretaceous age. The deposit shows a gentle basin structure with a west-northwest axis (Figure 22). The coal seams dip 0-5° mostly flat. The surface is covered by Quaternary sediments composed of gravelly sand ranging in thickness from 1 to 10 m (Figure 23).Minable coal seams are composed of two seams: the Seam II and the Seam I in ascending order with an interval of 6-16 m. The Seam II has 8-10 m thick with one to three thin partings, and is generally weathered to alter in coal quality. The Seam I has 6-8 m thick at the wide area, although it shows to split into two to four seams at the west part. The deposit has

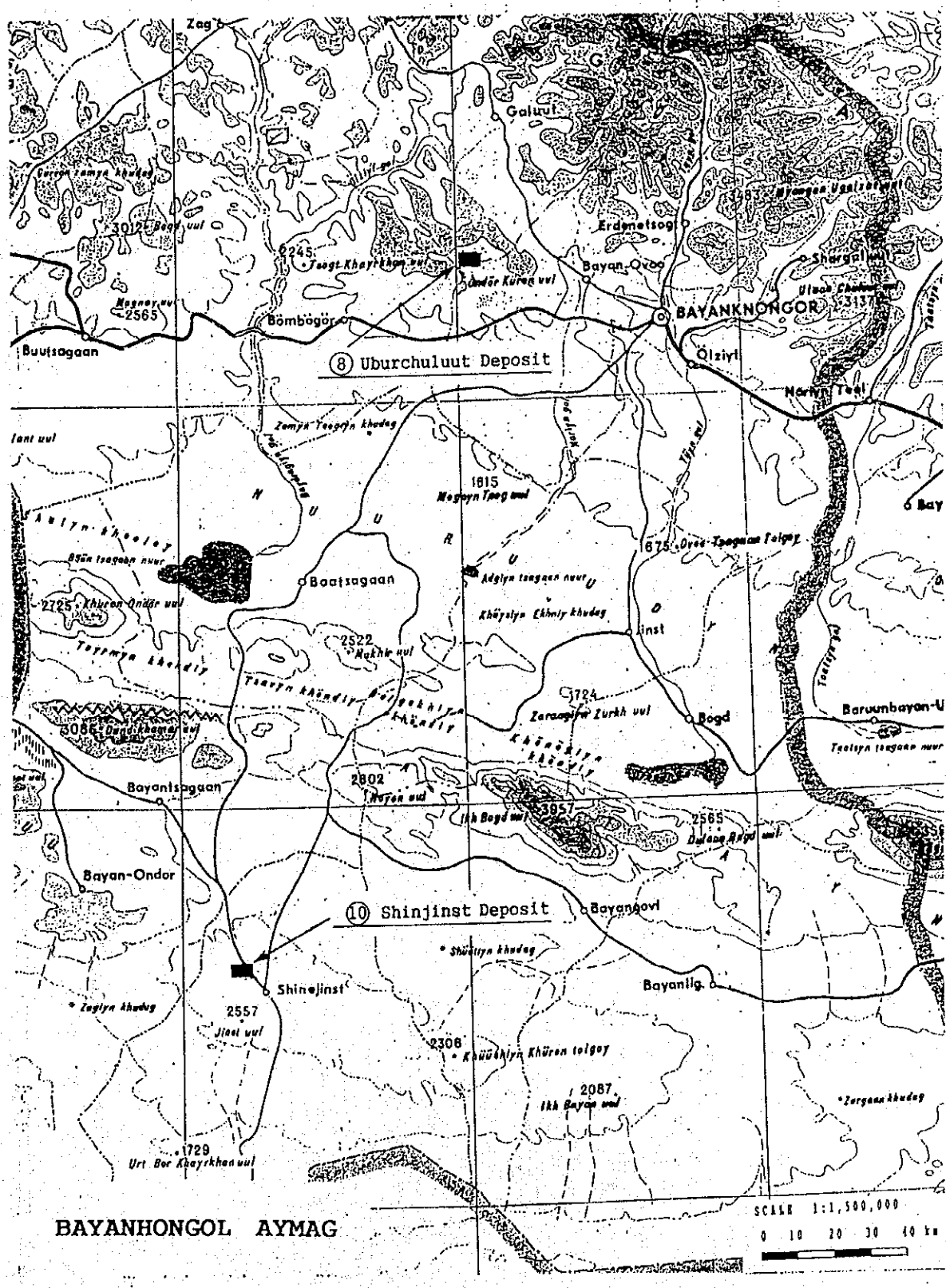


Figure 21 Deposit locality map in Bayanhongol Aymag

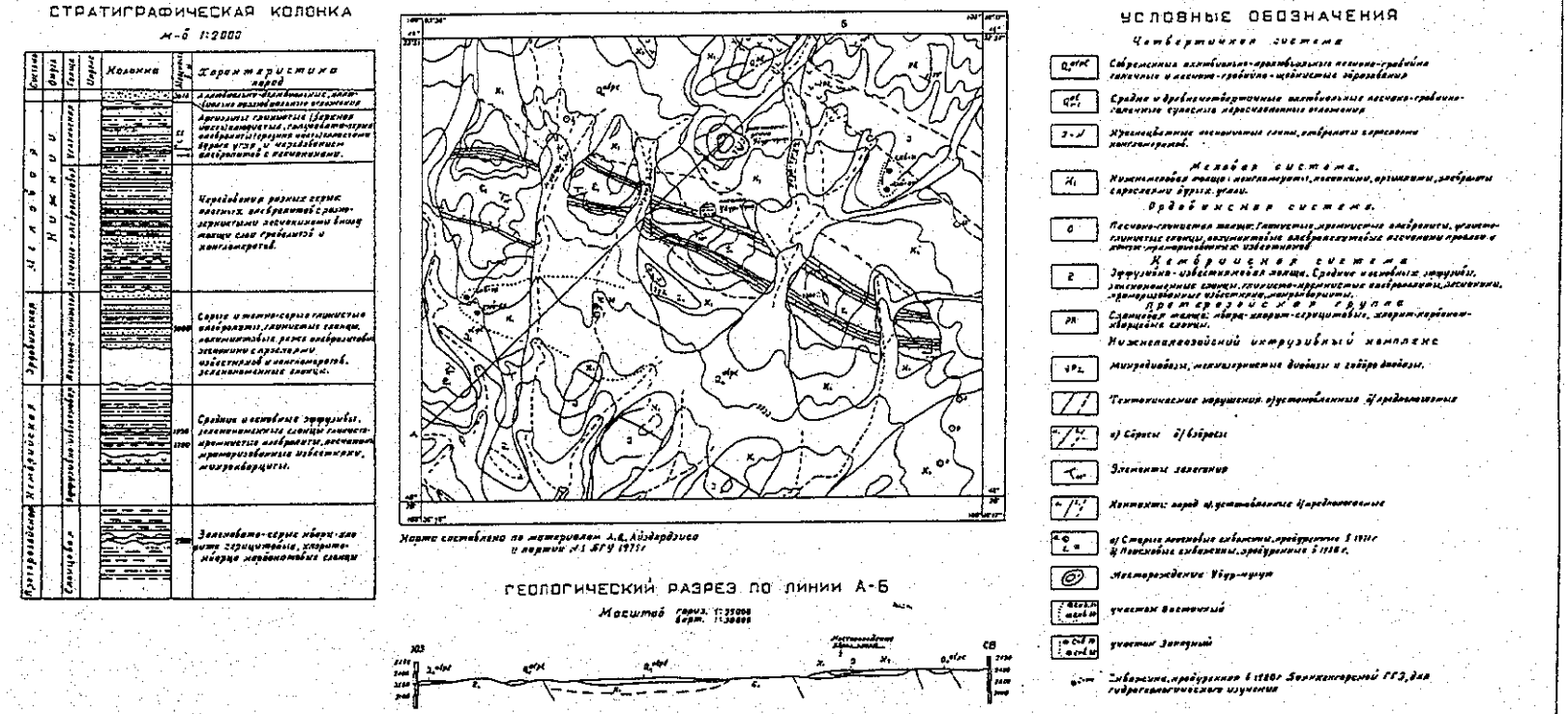


Figure 22 Geological map of Uburchuluut Deposit

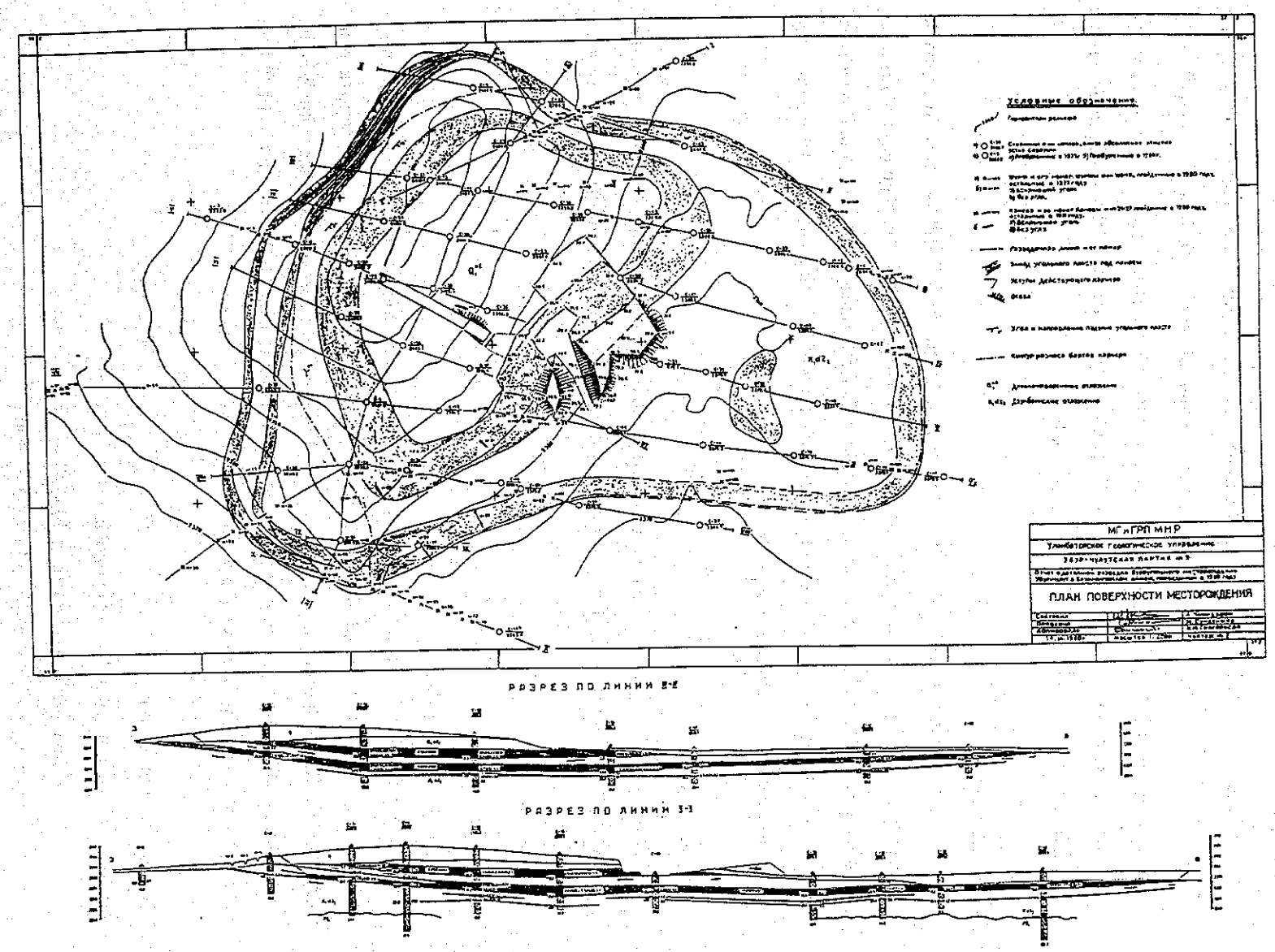


Figure 23 Seam conditions of Uburchuluut Mine

such favorable conditions for mining that the groundwater level is below the coal seams.

4) Coal quality

The coals are classified into Lignite B_2(Mongolia, Russia) sub- bituminous C(U.S.A) and Lignite F_2(Japan -JIS). The general coals contain 30-40% moisture(as received), 14% moisture(air dried), 15.7% ash(dry), 37.7 % volatile matter(dry, ash free), less than 1% sulfur(dry). The calorific value shows 6,170 kcal/kg(dry, ash free), 3,500 kcal/kg(as received) and 2,500 kcal/kg(as received) on weathered coals.

5) Coal reserves

The estimated reserves within 60-70 m below the surface is 3.7 million tons for minable reserves($A + B + C_1$). According to the government report in 1993, the total geological reserves is estimated at 412.5 million tons: 2.1 million tons of minable ones(A) and 410.4 million tons of geological ones($P_1 + P_2$). This geological reserves might be estimated for further wide area including the above-mentioned deposit.

6) State of mining

In 1978 a total of 1,200 tons was temporarily produced by opencut mining. At present, activities as coal mining is interrupted. The provincial government has a desire to utilize the coal for local demand.

(9) Bayanteeg Deposit

1) Locality and topography

The Bayanteeg Deposit is present within the Middle-South Megablock and in Ovorhangay Province, near the west border with Bayanhongor Province. The center of the deposit is in latitude 45° 40' N and in longitude 101° 35', 134 km southwest of Arvayheer which is the capital town of Ovorhangay Province (Figure 24). The land surface of the deposit is at 1,800 m above the sea level and forms a flat steppe.

2) History of exploration

1961 : Discovery of the coal deposit

- surface geological survey : 30 km^2
- drilling : 7 holes with an interval of 500 m

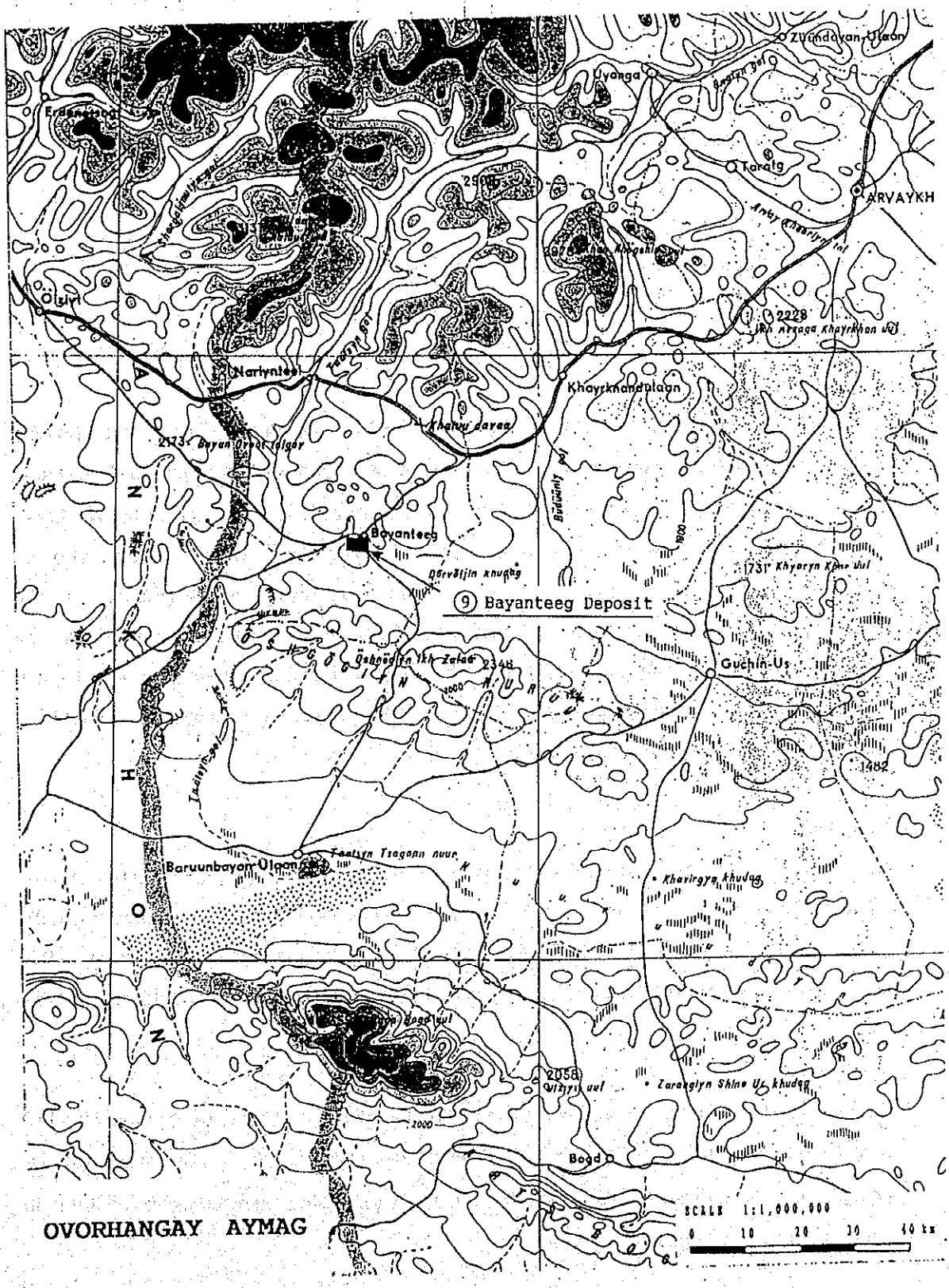


Figure 24 Deposit locality map in Ovorhangay Aymag

1973 : Exploration for groundwater
- corrected the stratigraphy

1977 : Detailed exploration
- drilling : 109 holes, 7,504 m, 50-100 m/hole (max. 300 m)
- prospecting line : 56 lines with an interval of 100 m
- geophysical logging : 80 holes
(natural gamma-ray, density, resistivity, caliper)
- trenching : 100 points

3) Coal geology

The Bayanteeg Deposit belongs to the Ongiyngol Coal-bearing Basin. The deposit shows a elongated half-basin opened toward the east, and extends for about 7.0 km south-east-west long and 1-2 km wide with an area over 10 km^2. The coal seam is embedded in the Bakharsk Formation of Early to Middle Jurassic age. The basic geological structure is formed of an unsymmetrical syncline with a west northwest axis plunging toward the east (Figure 25). The coal seam dips 18-24° south at the north flank and steeply 70-80° north at the south flank. The coal seam is only one seam and shows variable thickness of 31-36 m at the west part, 14 m at the central part and 3-7 m at the east part. In general, the coal seams has a tendency of splitting and thickening partings toward the east.

4) Coal quality

The coals are classified into B3-D(Mongolia, Russia), Subbituminous B-A(U.S.A.) or Subbituminous E-Lignite F(Japan-JIS). The general coals contain 2.2% moisture(air dried), 5.2% moisture(as received), 22.6% ash(dry), 51.9% volatile matter(dry,ash free), 1.0% sulfur(dry). The calorific value is 4,680 kcal/kg(as received) and 7,230 kcal/kg(dry, ash free).

5) Coal reserves

According to the detailed exploration report in 1976, the coal reserves at the area above 100-110 m in depth is estimated at 29.7 million tons for minable reserves($A + B + C_1$). The governmental report in 1993 indicates a total of 845.5 million tons for geological reserves above 300 m in depth of the whole deposit.

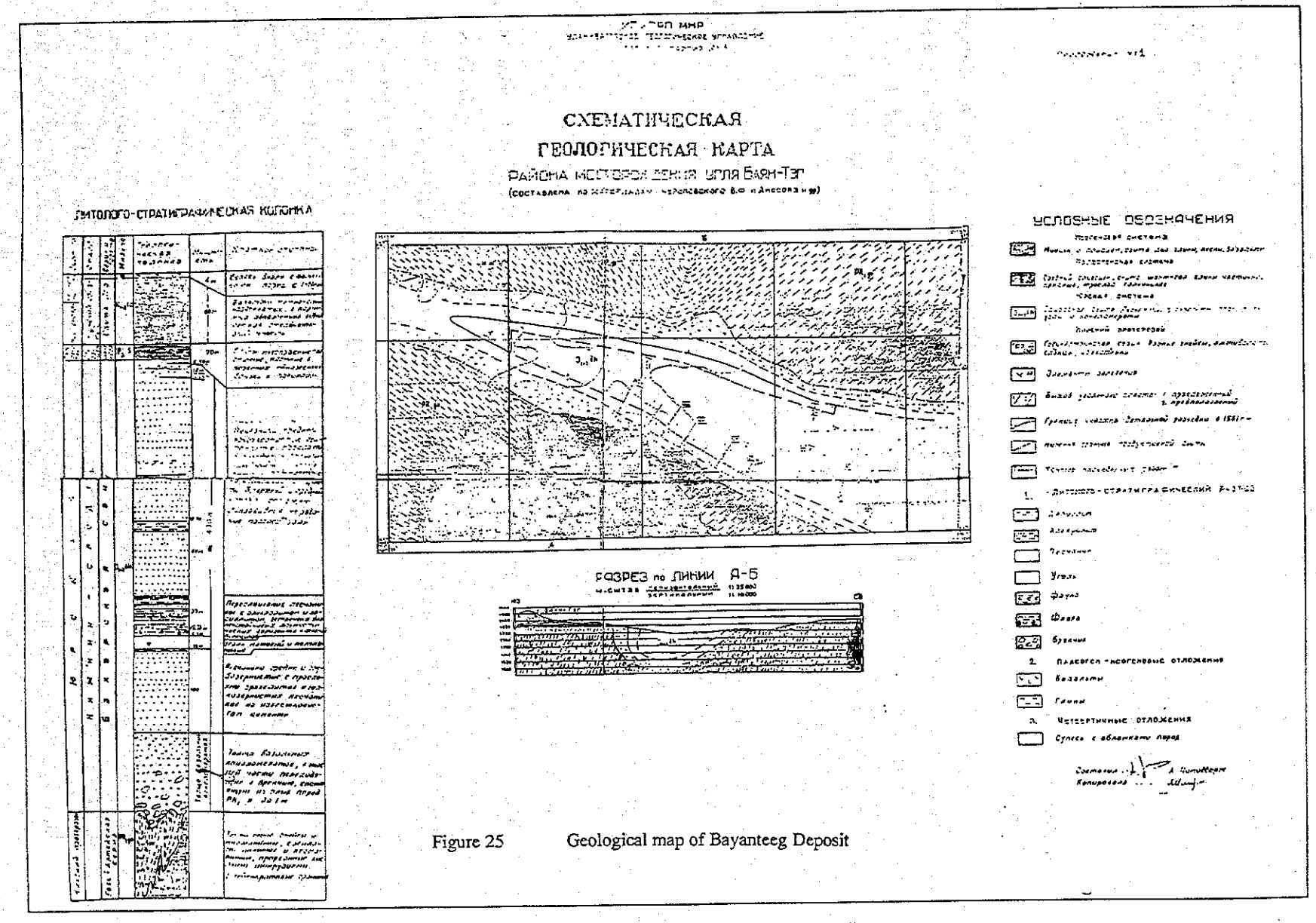


Figure 25 Geological map of Bayanteeg Deposit

6) State of mining

The Bayanteeg Coal Mine began to mine by opencut in 1962. The total produce until 1993 was 4.0 million tons with an average of 150,000 tons/y and has been utilized by local consumers restricted in Ovorhangay, Arhangay and Govialtay Provinces (Figure 26). The mining area has been restricted above 10-20 m only in depth owing to the hazard of groundwater.

(10) Shinjinst Deposit

1) Locality and topography

The Shinjinst Deposit is within the Middle-South Megablock and at the south of Bayanhongor Province. The center of the deposit is in latitude 44° 35' N and in longitude 100° 13', 7 km northwest of Shinjinst and 250 km southwest of Bayanhongor which is the capital town of Bayanhongor Province (Figure 21). The land surface of the deposit forms a flat steppe at 2,180 m above the sea level.

2) History of exploration

1977-78 : Detailed exploration with drilling by Mongolia

- exploration area : 1 km^2

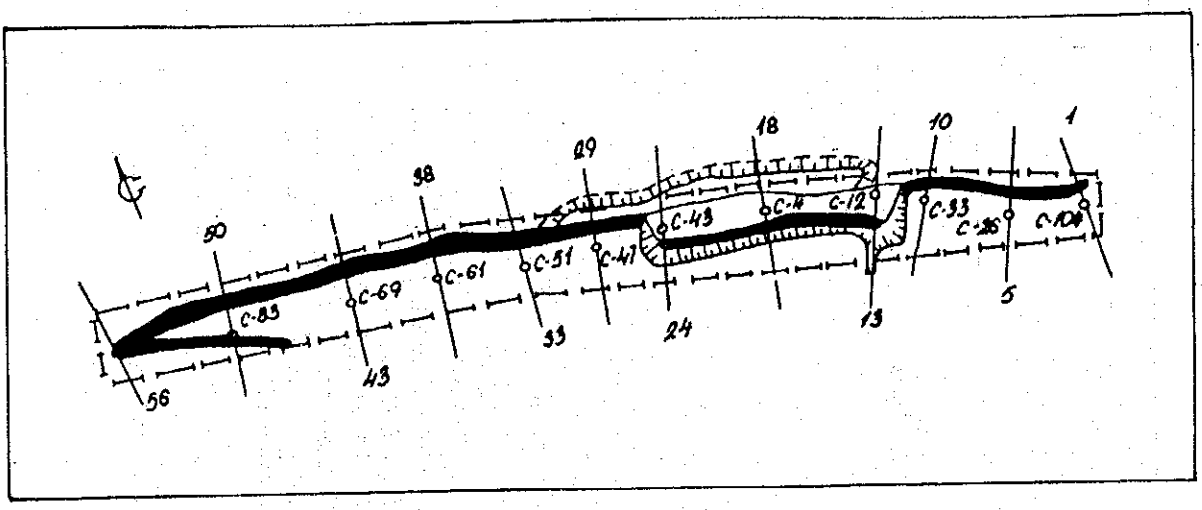
1991 : Start of mining (production : 2,000-3000 t/y)

3) Coal geology

The Shinjinst Deposit belongs to the Big Bogdyn Coal-bearing Basin. The deposit extends in a east-west direction over 9 km long and 1 km wide with an area over 9 km^2. There is a possibility of extending both toward the east and west, because the geological prospecting has not yet performed. Coal seams are embedded in the formation of Early to Middle Jurassic age (Figure 27). In regard with the geologic age, there is a different view as of Permian age. The basic geological structure is formed of a homoclinal structure dipping 30-40° north (Figure 28). The minable coal seam is composed of one seam of 42-49 m thick at the present mining area, which is accompanied with many partings. The seam splits into 3 to 7 seams at the west area.

4) Coal quality

The coals are classified into G-J(Mongolia, Russia), High volatile bituminous B(U.S.A.) or Bituminous C(Japan-JIS). The general coals contain 6.1% moisture(as received), 13.1% ash(dry), 33.8% volatile matter(dry,ash free), 0.58% sulfur(dry). The calorific value is 4,500



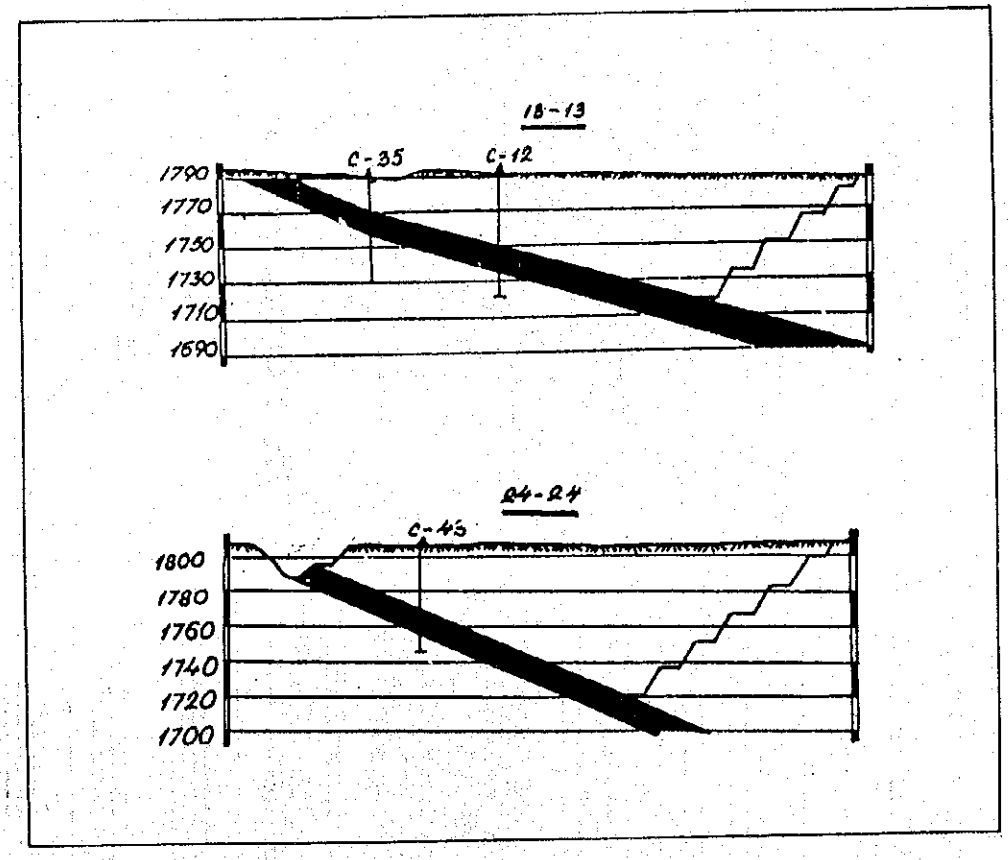


Figure 26 Seam conditions of Bayanteeg Mine

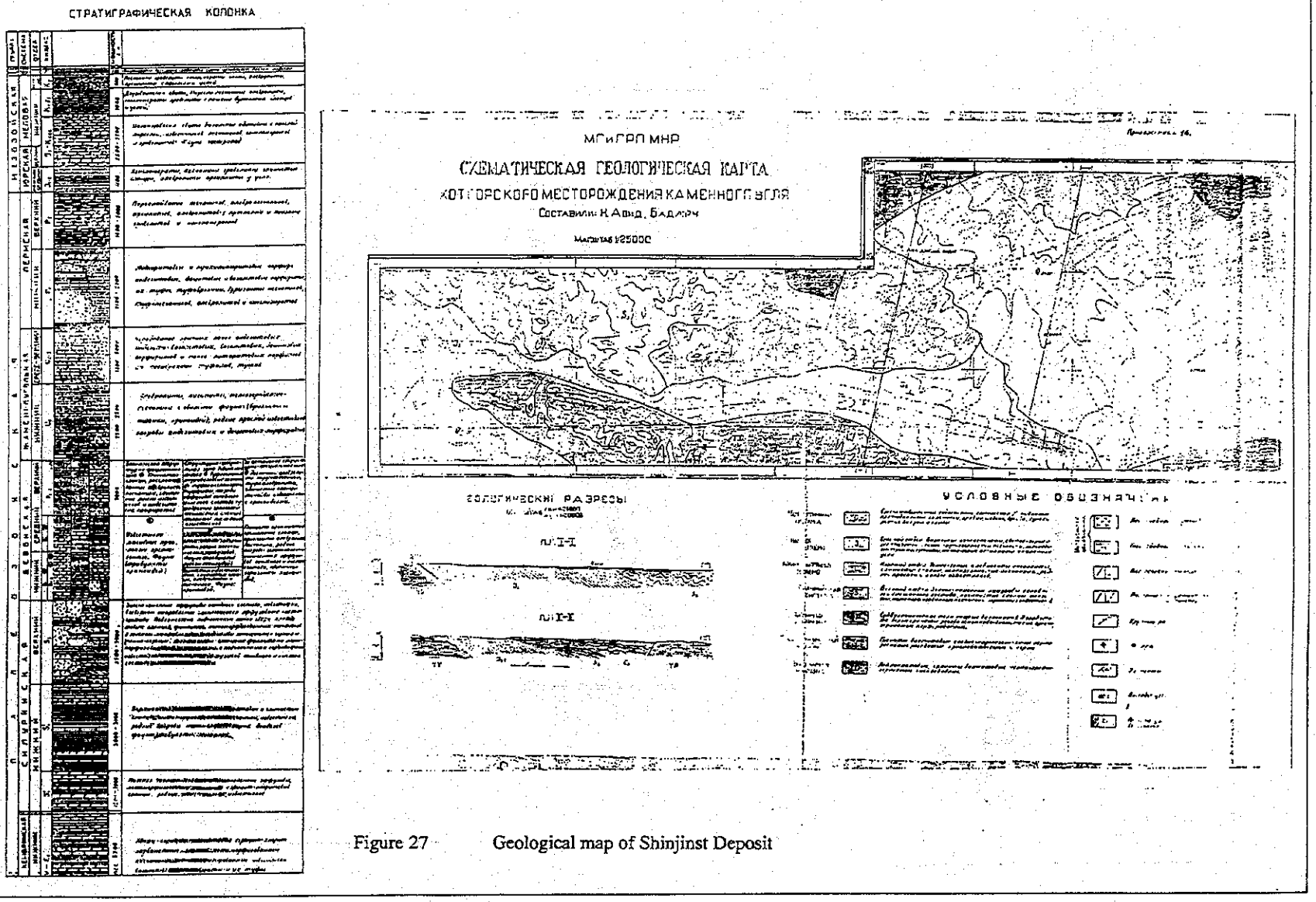


Figure 27 Geological map of Shinjinst Deposit

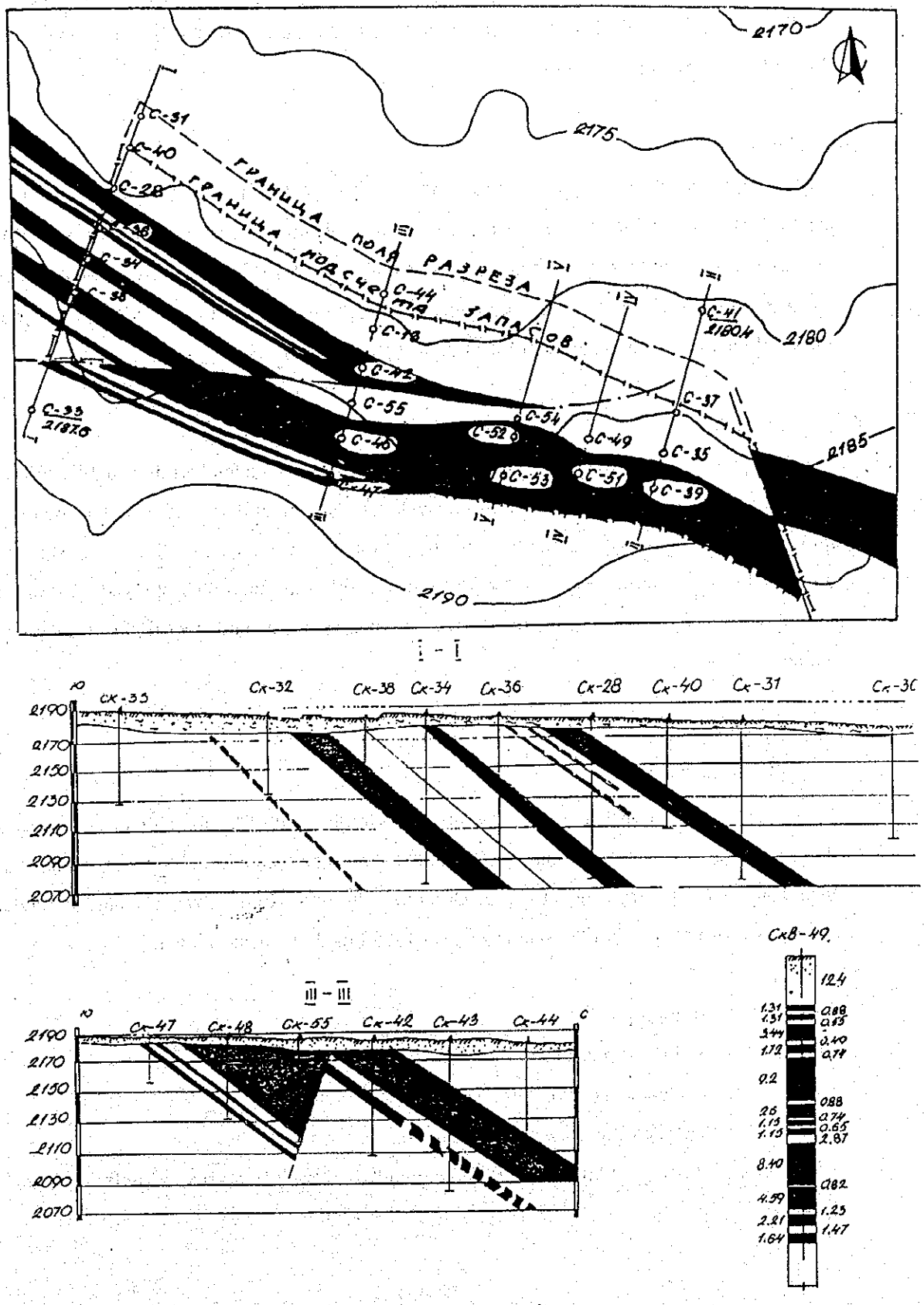


Figure 28 Seam conditions o Shinjinst Mine

kcal/kg(as received) and 8,310 kcal/kg(dry, ash free). Showing such a feature of high degree in coalification as low volatile matter contents and high calorific value, the coal seam appears to be formed older than Jurassic time.

5) Coal reserves

According to the detailed exploration report in 1978, the coal reserves at the restricted area within 100-110 m below the surface is estimated at 2.44 million tons for minable reserves($A + B + C_1$) and 4.10 million tons for geological ones($A + B + C_1 + C_2$). The governmental report in 1993 estimates a total of 1,741.9 million tons for geological reserves above 300 m in depth at the whole deposit (called the Khotgor Deposit in the report).

6) State of mining

The Shinjinst Coal Mine began to mine by opencut in 1991. The total produce until 1993 was 32.9 thousand tons and has been utilized by local consumers restricted near the mine. At present, the mine has moved most of mining equipments to the Uburchuluut Coal Mine and decreased the production, because the local steam boilers of main user stopped working by recent economical reasons. Only one shovel remains at the site and is working for little local demand.

(11) Tevshiingovi Deposit

1) Locality and topography

The Tevshiingovi Deposit is present within the Middle-South Megablock and in Dundgovi Province. The center of the deposit is in latitude 46° N and in longitude 106° 7', 30 km north of Mandalgovi which is the capital town of Dundgovi Province (Figure 29). The land surface of the deposit forms a gently depressed steppe at 1,450 m above the sea level.

2) History of exploration

1940-50's : Exploration by former Soviet Union
- evaluated as a hopeless deposit

1981-82 : Detailed exploration by Mongolia
- drilling : more than 130 holes, length of 150-200 m(max. 300-400 m)/hole

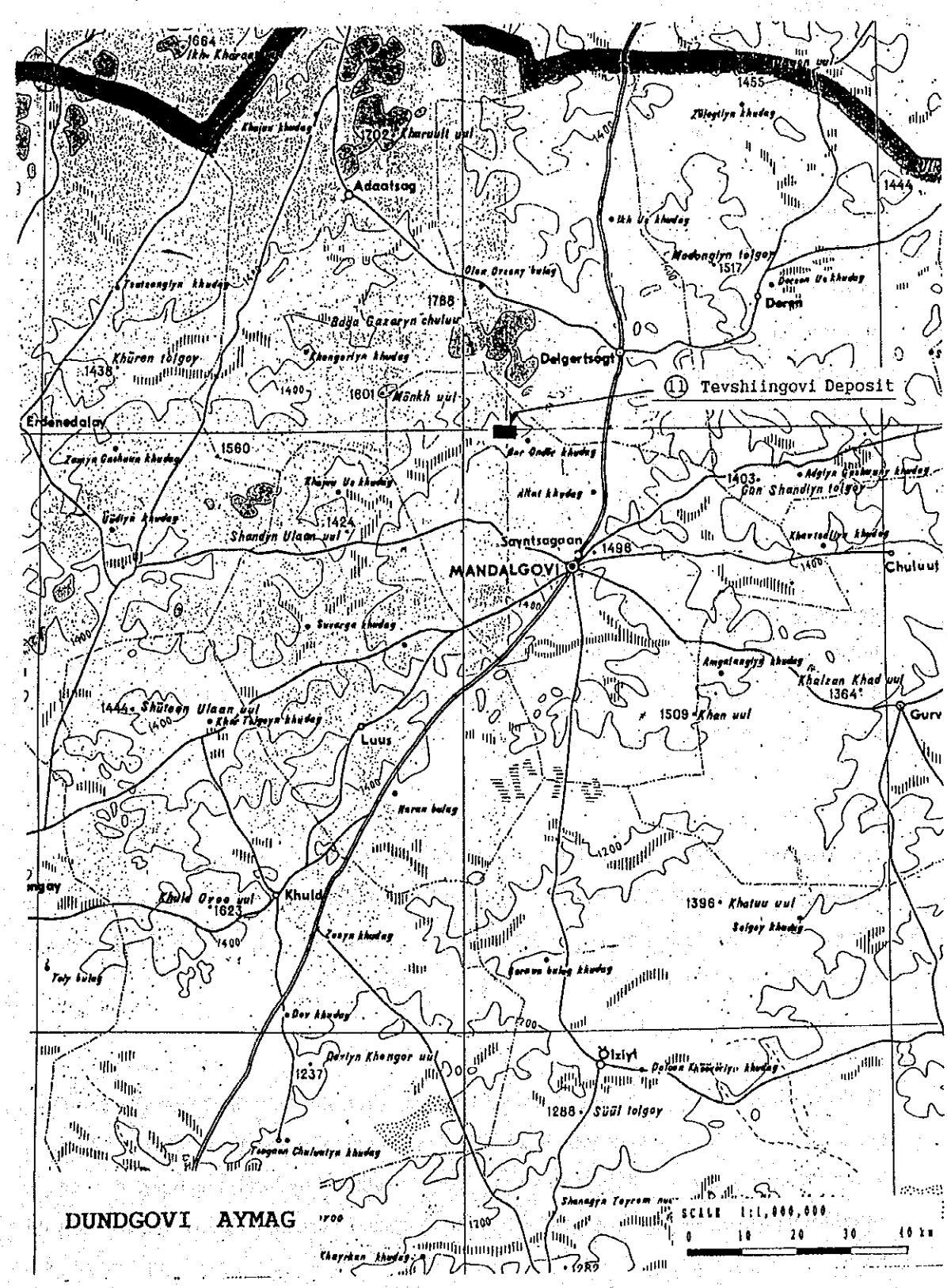


Figure 29 Deposit locality maop in middle of Dundgovi Aymag

3) Coal geology

The Tevshiingovi Deposit belongs to the Choir-Niarga Coal-bearing Basin. The deposit shows a gentle basin structure extending for 12 km east-west long and 6 km north-south wide with an area of about 70 km^2. Coal seams are embedded in the Tevshiingovi Formation of 400-450 m thick, which is comprised in the Dsunbayan Group of Early Cretaceous age. The basic geological structure is formed of a synclinal basin structure with a north-south axis (Figure 30). The coal seams dip 10-15° near the surface. Most of coal seams characteristically show to split and vary in thickness. The main coal seams are composed of five seams: the Seam I to V in ascending order, and are subdivided into two groups: the Lower Group of the Seam I to III, the Upper Group of the Seam IV and V. These seams have such a trend to split toward the west and south, and finally pinch out at the south flank of the syncline. The seam thickness ranges from 10 to 25 m in general, however the Lower Group combines into one seam attaining 230 m thick at the east area. At the present mining area, the Seam IV only has been worked.

4) Coal quality

The coals are classified into B2(Mongolia, Russia), Subbituminous C(U.S.A) or Lignite F(Japan-JIS). The general coals contain 30.5% moisture(as received), 15-20% ash(dry), 45.5% volatile matter(dry,ash free), 0.7% sulfur(dry). The calorific value is 3,370 kcal/kg(as received) and 6,450 kcal/kg(dry, ash free).

5) Coal reserves

The coal reserves at the whole deposit within 300-350m below the surface is estimated at 587.7 million tons for minable reserves($A + B + C_1$) and 960 million tons for total geological reserves. The minable coal reserves of the present mining area, 1 km x 0.75 km above the groundwater level of 20m in depth, is estimated at 10.0 million tons.

6) State of mining

The Tevshiingovi Coal Mine began to mine by opencut as an attached mine of the Tsagaan-Ovoo Coal Mine in 1963 and was independent in 1990. The total produce until 1993 was 1.2 million tons with ana average of 100,000 tons/y and has been utilized by local consumers restricted in Dundgovi and Ovorhangay Provinces. The mine intends to work the coal up to the groundwater level.

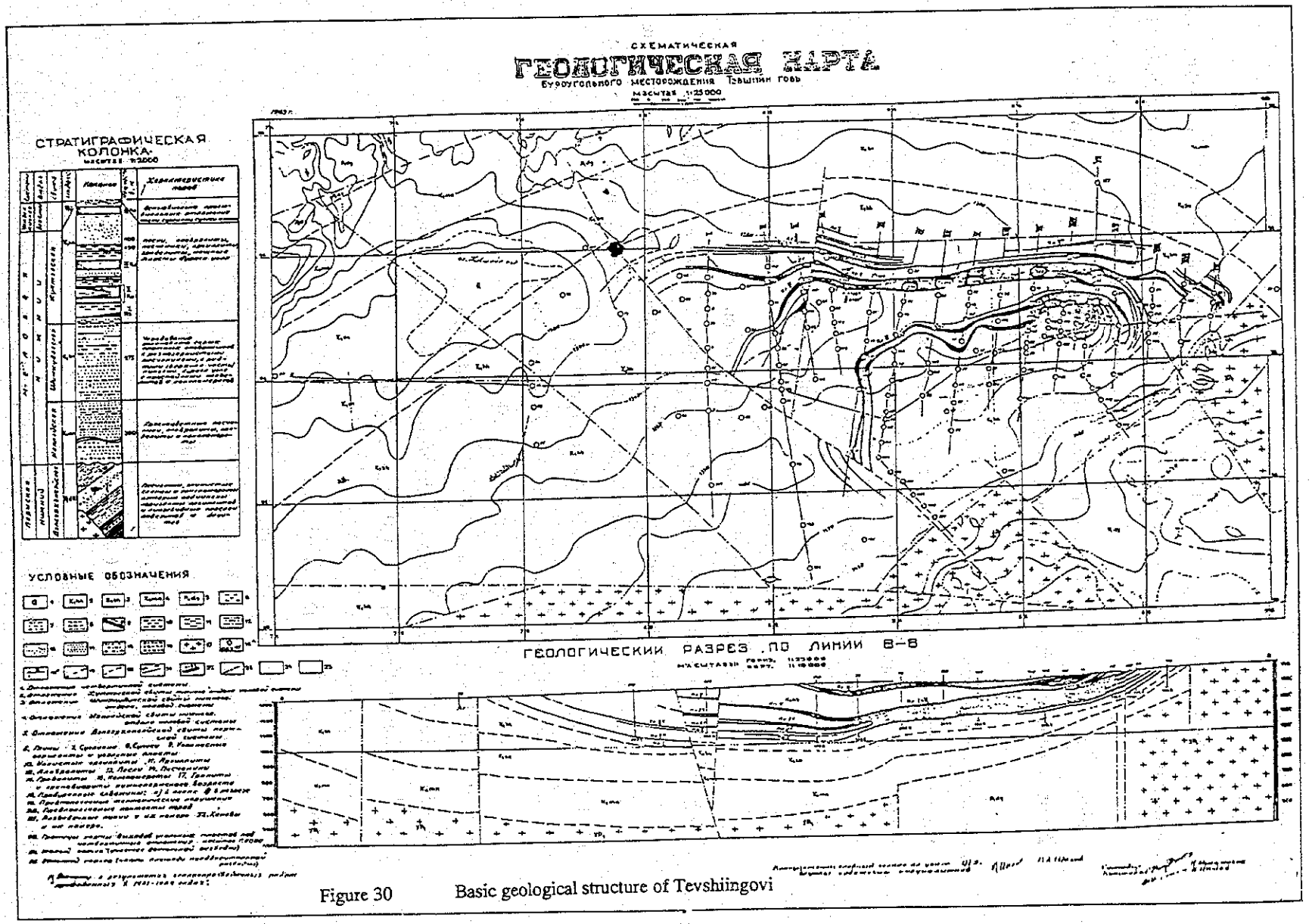


Figure 30 Basic geological structure of Tevshiingovi

(12) Tavantologoi Deposit

1) Locality and topography

The Tavantologoi Deposit is present within the Middle-South Megablock and at the middle east in Omnogovi Province of the South Govi District. The center of the deposit is in latitude 43° 35' N and in longitude 106° 30', 540 km south of Ulaanbaatar and 96 km west of Dalanzadgad which is the capital town of Omnogovi Province (Figure 31). The land surface of the deposit forms a gently undulated semidesert at 1,490-1,560m above the sea level.

2) History of exploration

1890 : Firstly recorded by a geologist of U.S.A.

1940 : Exploration by former Soviet Union

1949 : Sampling survey by former Soviet Union

1950 : Sampling survey by former Soviet Union
- evaluated as showing a coking property
- recommended a necessity of detailed exploration

1953-56 : Detailed exploration by a geological expedition of former Soviet Union
- confirmed the continuity of 18 minable coal seams at the central area by drilling
- estimated coal reserves of 950 million tons (C_1) and 866 million tons ($+C_2$)

1974-75 : Sampling survey by the Bulgarian expedition
- sampled each 5 tons from 4 seams at the central area
- evaluated the Seam áW as coking coal

1975(?) : Decided to develop at the meeting of COMECON

1978-90 : Exploration by Mongolia under former Soviet Union's advice
- total drilling work : 2,000 holes, 200 km
- total cost : 150 million Tugrug

1978-81 : Exploration at the narrow area
- exploration area : 90 km^2
- drilling interval : 1.0-1.5 km

1981-84 : Detailed exploration for an area of 35 km^2 at the northeast and west areas
- drilling interval : 700-750m

1984-86 : Detailed exploration for an area of over 10 km^2 at the northeast area
- drilling interval : 350m

1984-87 : Exploration at the east area Detailed exploration at the north area (10 km^2)

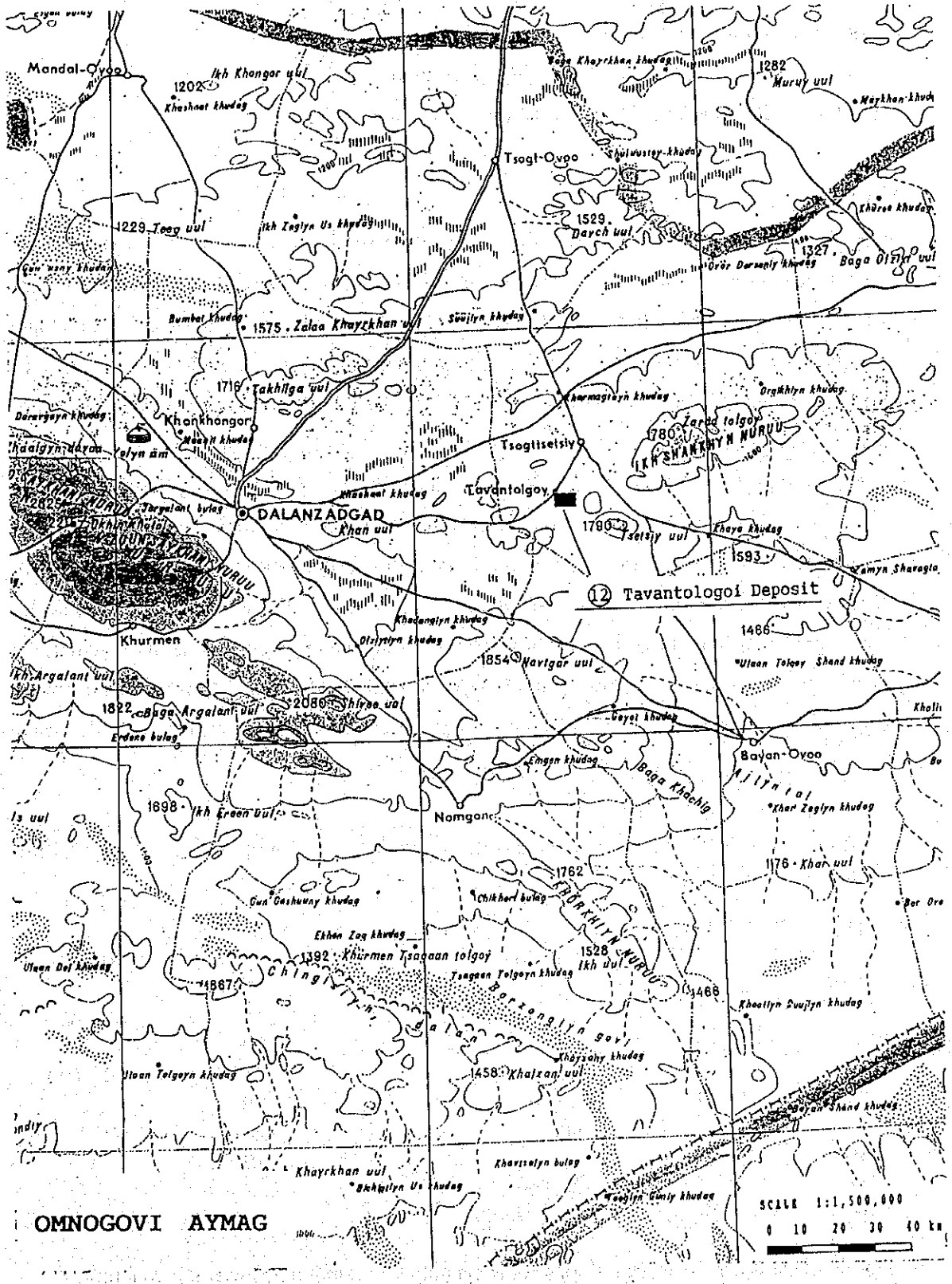


Figure 31 Deposit locality map in east of Omnogovi Aymag

1988-90 : Detailed exploration at the central and east areas

1990 : Feasibility study by former Soviet Union

- study cost : 8 million Tugrug (7 Tg/us$)

1992 : Reconnaissance survey for the Baruun-Omno area

3) Coal geology

The Tavantologoi Deposit belongs to the South Govi Coal-bearing Basin. The deposit extends for 60 km east-west long and 6-16 km north-south wide, over an area of 600 km^2. This is the largest coal deposit in Mongolia. Coal seams are embedded in the upper part of the Tavantologoi Formation of Late Permian age. The Tavantologoi Formation is 1,500m in thickness and the upper part of coal-bearing has 600-1,000m thick. The basic geological structure is formed of several gentle synclinal structures with faulting (Figure 32). The formation mainly trends east-west, and dips 0-15° at the north and 30° at the south. The coal-bearing part contains a total of 16 seams of 3-30m in average thickness and 165m in total average thickness. The coal seams are numbered from the Seam 0 to Seam XV in ascending order, and 12 seams except the Seam I, II, VI and VII are minable coal seams in the deposit. Most of coal seams characteristically have variable seam thickness and partially show splitting and/or pinching out. In particular, the Seam VIII and á\ show remarkable splitting toward the southeast and toward the northwest respectively. However, the Seam III and IV are comparatively stable in thickness. The seam thickness and seam intervals of minable coal seams is below:

Seam	Thick.(m)	Interval(m)	Seam	Thick.(m)	Interval(m)
X	2 - 10		XV	2 - 5	
		50 - 70			20 - 30
IX	2 - 72		XIV	2 - 6	
		60 - 70			20 - 30
VIII	2 - 50		XIII	2 - 20	
		40 - 60			60 - 80
V	2 - 10		XII	2 - 20	
		40 - 50			60 - 100
IV	3 - 20		XI	2 - 10	
		60			60 - 110
III	2 - 15		X	2 - 10	
		20 - 40			
0	2 - 30				

Figure 33 shows the seam conditions at the central part including the existing coal mine.

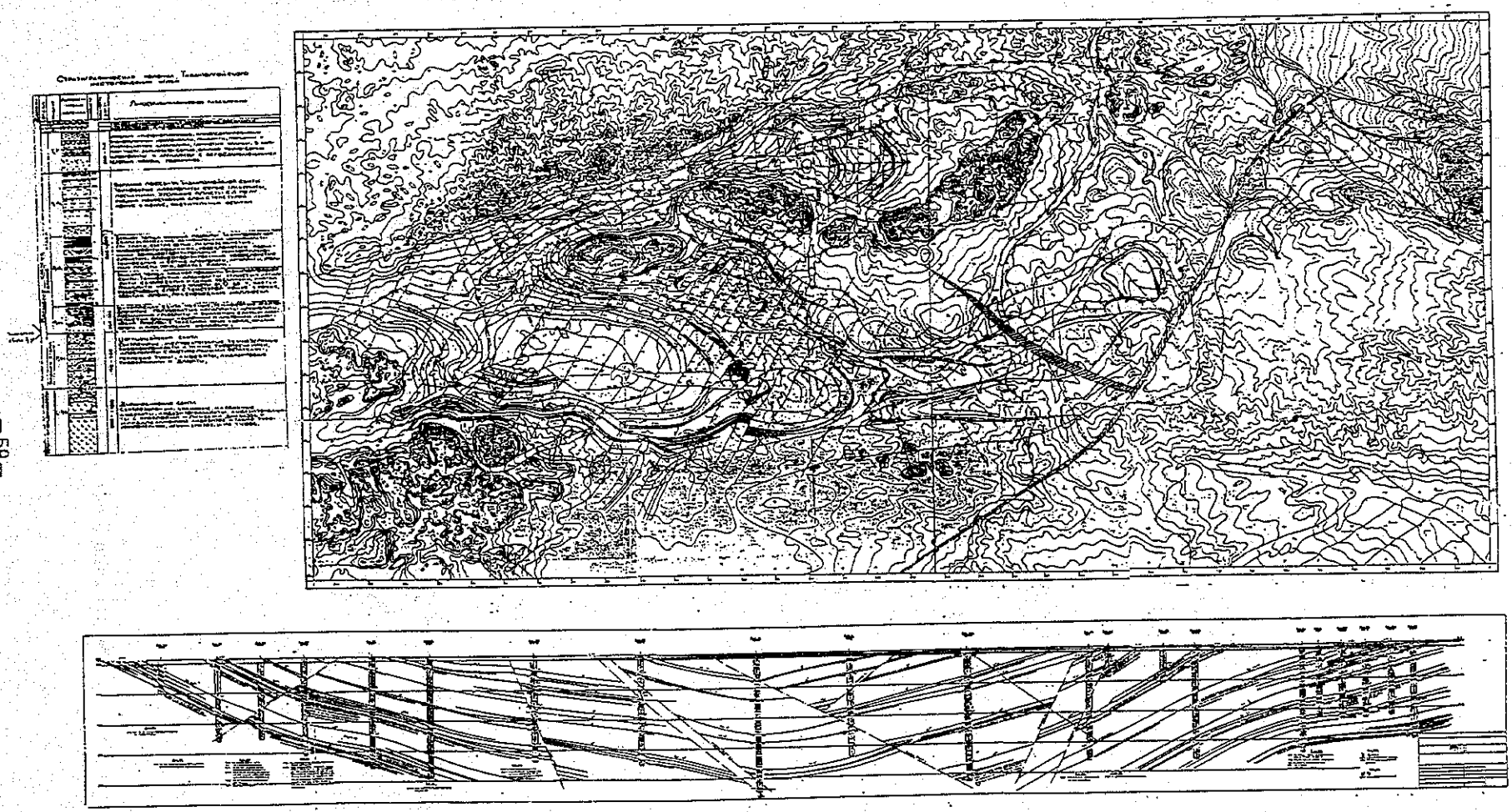
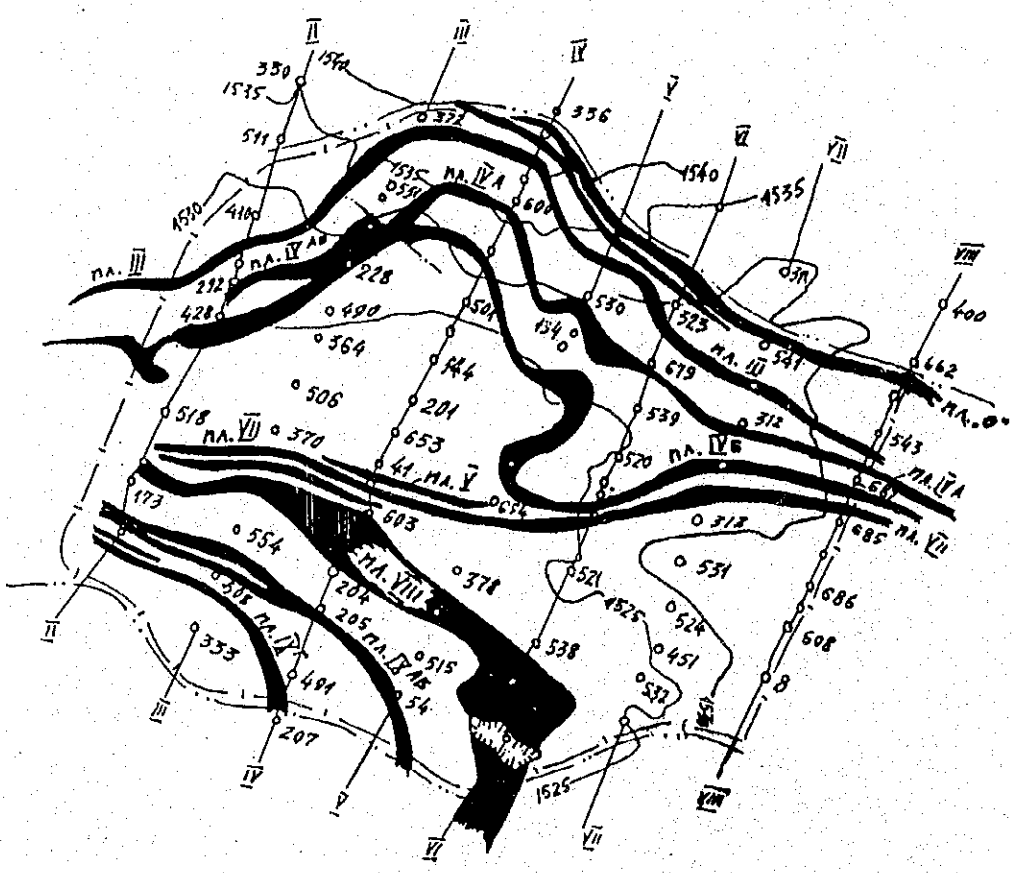


Figure 32 Geological map of Tavantolgoi Deposit



РЛ IV

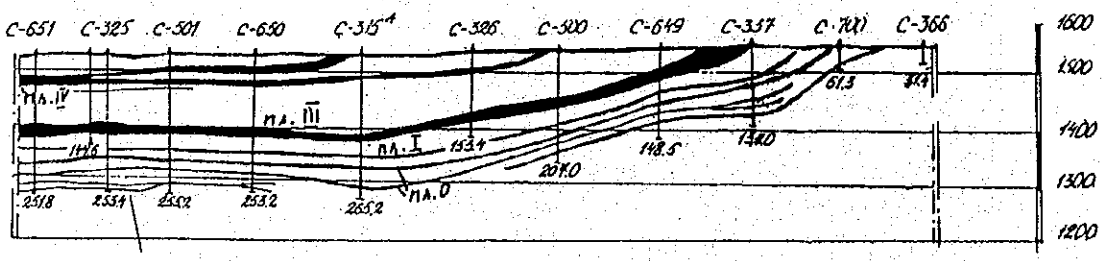


Figure 33 Seam conditions of Tavantolgoi Mine

4) Coal quality

The coals are classified into G-KJ(Mongolia, Russia), High volatile bituminous C-Low volatile bituminous(U.S.A.) or Bituminous B- Subbituminous E(Japan-JIS). These coal seams are subdivided into two groups at the point of coal quality: the coals of the upper group composed of the Seam X to XV belong to steaming coal, and the coals of the lower group of the Seam 0 to IX show favorable coking property. Actually produced coals contain 11.5% moisture(as received), 21.2% ash(dry), 25.0% volatile matter(dry,ash free), 0.7% sulfur(dry). The calorific value is 5,110 kcal/kg(as received) and 8,110 kcal/kg(dry, ash free).

The following is coal analysis data of the coals showing coking property.

Items	Seam 0	Seam III	Seam IV	Seam VIII	Seam IX
- Raw coal-					
- Moisture % (ad)	0.5	0.6	0.7	0.3	0.7
- Ash % (db)	23.6	20.0	21.6	25.4	24.2
- Volatile % (daf)	21.3	25.9	26.1	29.8	30.7
- Sulfur % (db)	0.66	0.67	0.72	0.69	0.59
- Calorific value					
kcal/kg (daf)	7,930	8,820	8,040	8,170	8,220
- Clean coal (ash 10%)-					
- Yield %	30-70	52-92	67	40-50	79
- Moisture % (ad)	0.5	0.5	0.6	0.8	1.1
- Volatile % (daf)	22.0	24.4	27.6	31.4	33.7
- Sulfur % (db)	0.6	0.6	0.6	0.6	0.5
- Phosphorus % (db)	0.020	0.074	0.053	0.044	0.034
- Y index mm	11	16	18-20	17	12
- F.S.I.	6	6	6	6	6
- Roga index	42	52	48	51	47
- Gray-King	G2	G6	G8	G8	G4
- Dilatation	T.C	45	120	40	18
- Micum Teet					
M25	85	88-91	87-88	84-85	74
M10	13.8	7-8	8-9	9.5	14
- Vitrinite Ro %	1.2	1.2	1.0-1.2	0.96	0.87
- Inertinite %	45-50	35-40	30-35	30-35	30-35
- Coal Type					
(Mongolia)	KJ,OC	K,KJ	K,KJ	K,KJ	GJ
(ISO)	422,432	433,434	434,435	533,534	633

5) Coal reserves

The coal reserves at the exploration area above 1,000 m up to the sea level, within 500 m below the surface is estimated at 6,500 million tons for total geological reserves ($A + B + C_1 + C_2 +$

P), and the reserves including surrounding area expected of coal existing is assumed to be 10 billion tons. For the exploration area above 300 m in depth, the minable reserves($A + B + C_1$) is 3,500 million tons, of which 1,000 million tons is estimated for coking coal reserves. According to the feasibility study in 1990, the minable reserves within 300 m below the surface was calculated a total of 1,888.3 million tons: 1,016.8 million tons for steaming coal and 866.5 million tons for coking coal. The study estimates at 20 years of mining life under 3.6 of stripping ratio and 20 million tons of annual production.

6) State of mining

The Tavantolgoi Coal Mine began to mine by opencut in 1966. The total produce until 1993 was 2.09 million tons with an average of 120,000 tons/y and has been utilized by local consumers restricted in Omnogovi and Dornogovi Provinces. The schematic of mining site is shown at Figure 34.

(13) Sharyngol Deposit

1) Locality and topography

The Sharyngol Deposit is within the Middle-East Megablock and in the Selenge Province. The center of the deposit is in latitude 49° 12' N and in longitude 106° 27', 50 km southeast of Darhan which is one of main stations along the Trans-Mongolian Railway (Figure 35). The land surface of the deposit forms a forestall hill. The highest elevation is 975 m above the sea level and the lowest is 790 m.

2) History of exploration

1958-61 : Detailed exploration
- 59 holes, 9,280 m in total

1963-68 : Detailed exploration

1974 - drilling : 157 holes, 10,741 m in total

1976-78 : Detailed exploration
- drilling : 59 holes, 8,237 m in total

3) Coal geology

The Sharyngol Deposit belongs to the Orkhon Selenge Coal-bearing Basin (Region). The deposit extends for 3 km northeast and 1.5 km northwest with an area of about 4.5 km^2. Coal

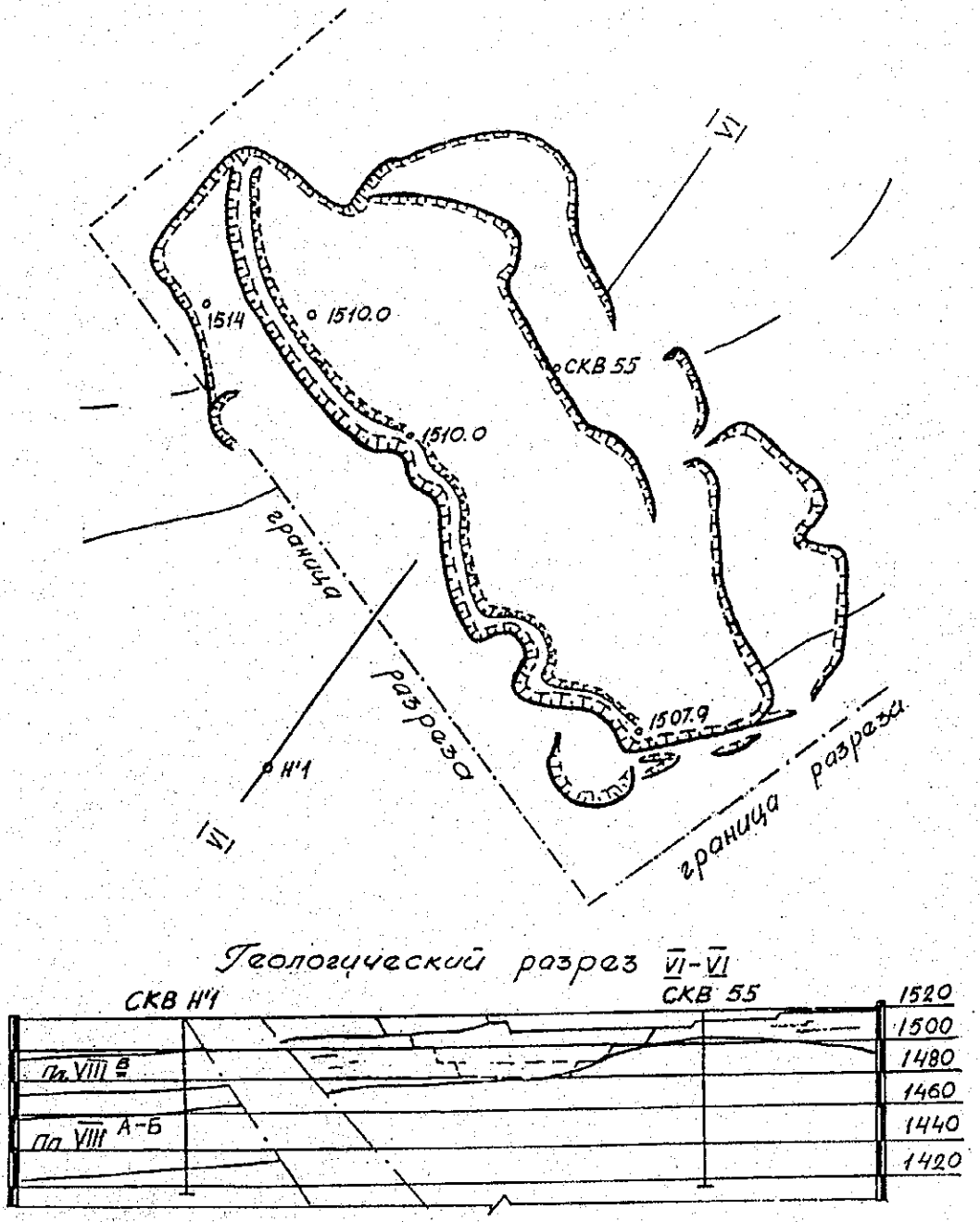


Figure 34 Schematic of Tavantolgoi Mine

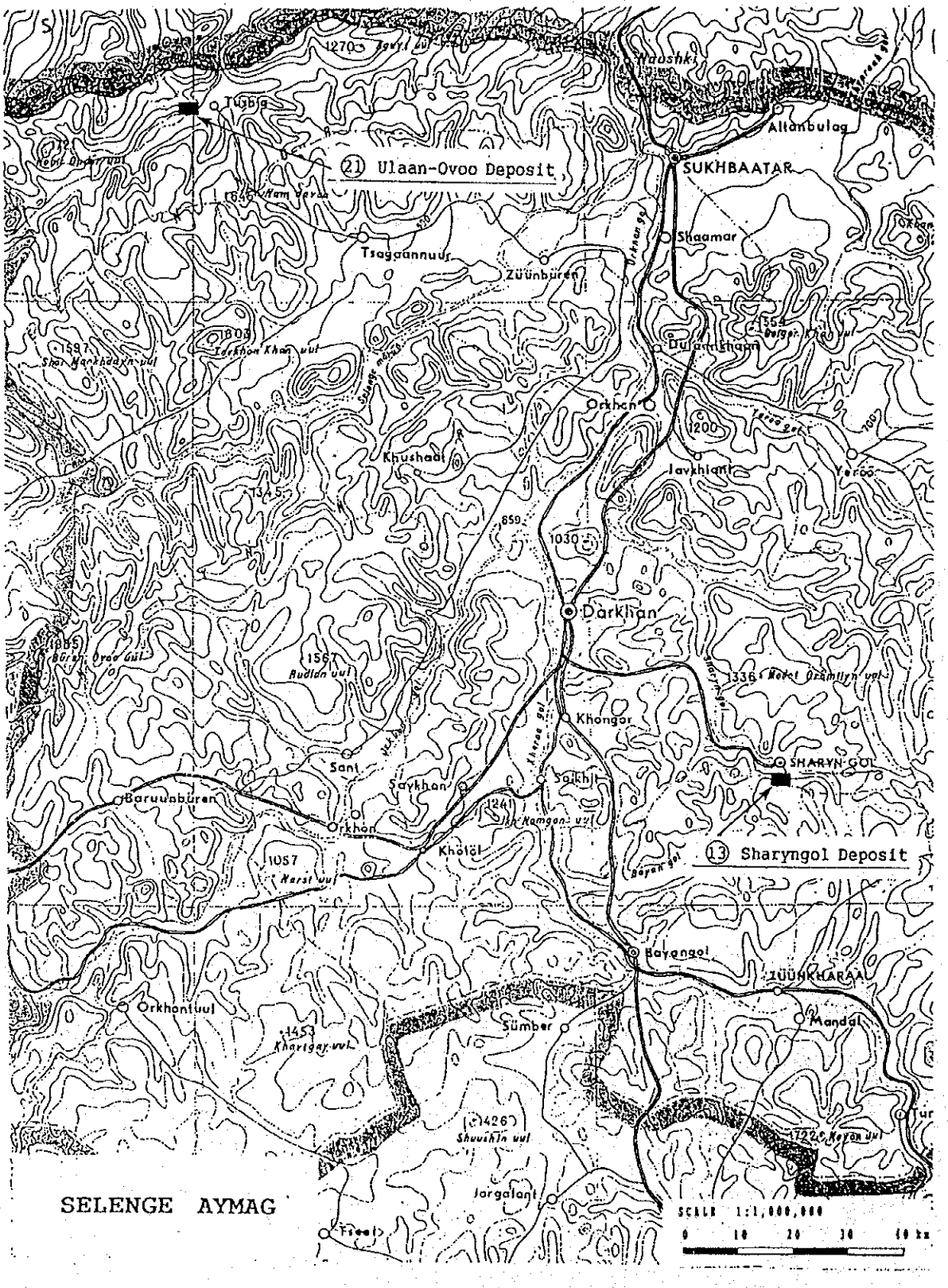


Figure 35 Deposit locality map in Selenge Aymag

seams are embedded in the Sharyngol Formation of Middle-Late Jurassic age on the basement of Carboniferous sediments. The Sharyngol Formation has 420-500 m in thickness and contains six coal seams (Figure 36). The deposit is divided by two faults into three areas: the main area which has been mined, the northeast area and the west area. The basic geologic structure is formed of a gentle homoclinal structure. The coal seams strike N 60° W and dips 6-9° SW at the main and northeast areas. At the west area, the seams trend east northeast and dip southeast.

In the deposit, six coal seams are named the Velikan Seam, Seam 0, Seam 1, Seam 2, Seam 3 and Seam 4 in ascending order. The lowest seam, the Velikan Seam, is of minable seam at the main and northeast areas. The seam thickness is 30-40 m in general and trends to split and thin toward the dipping direction. The uppermost seam, the Seam 4, is of minable seam at the west area and ranges in thickness from 0.3 to 4.6 m.

4) Coal quality

The coals are classified into B3-D(Mongolia, Russia), Subbituminous B-A(U.S.A.) or Subbituminous E-Lignite(Japan-JIS). The general coals contain 15.0% moisture(as received), 17.5% ash(dry), 41.0% volatile matter(dry,ash free), 0.6% sulfur(dry). The calorific value is 3,900-4,200 kcal/kg(as received) and 7,200 kcal/kg(dry, ash free).

5) Coal reserves

The coal reserves of the main area within 250 m below the surface is estimated at 32 millon of minable reserves for opencut mining under 10 of stripping ratio. The geological reserves(C_2) is estimated at 30 million tons for underground mining at the deeper main area, and is estimated at 20 million tons at the northeast area above 150 m in depth. Of 20 million tons at the northeast area, 5 million tons coal is present within 50 m below the surface and might be mined by opencut.

6) State of mining

The Sharyngol Coal Mine began to mine by opencut in 1965. The total produce until 1993 was 42 million tons with an average of 1,500,000 tons/y and has been mainly utilized by power plants at Ulaanbaatar, Darkhan and Erdenet. The schematic of mining site is shown at Figure 37. The recent annual produce is decreasing such as over 2.0 million tons in 1988 to 1.2 million tons in 1993, although the original production capacity is 2.5 million tons per year. It mainly

Figure 36 Geological map of Sharyngol Deposit

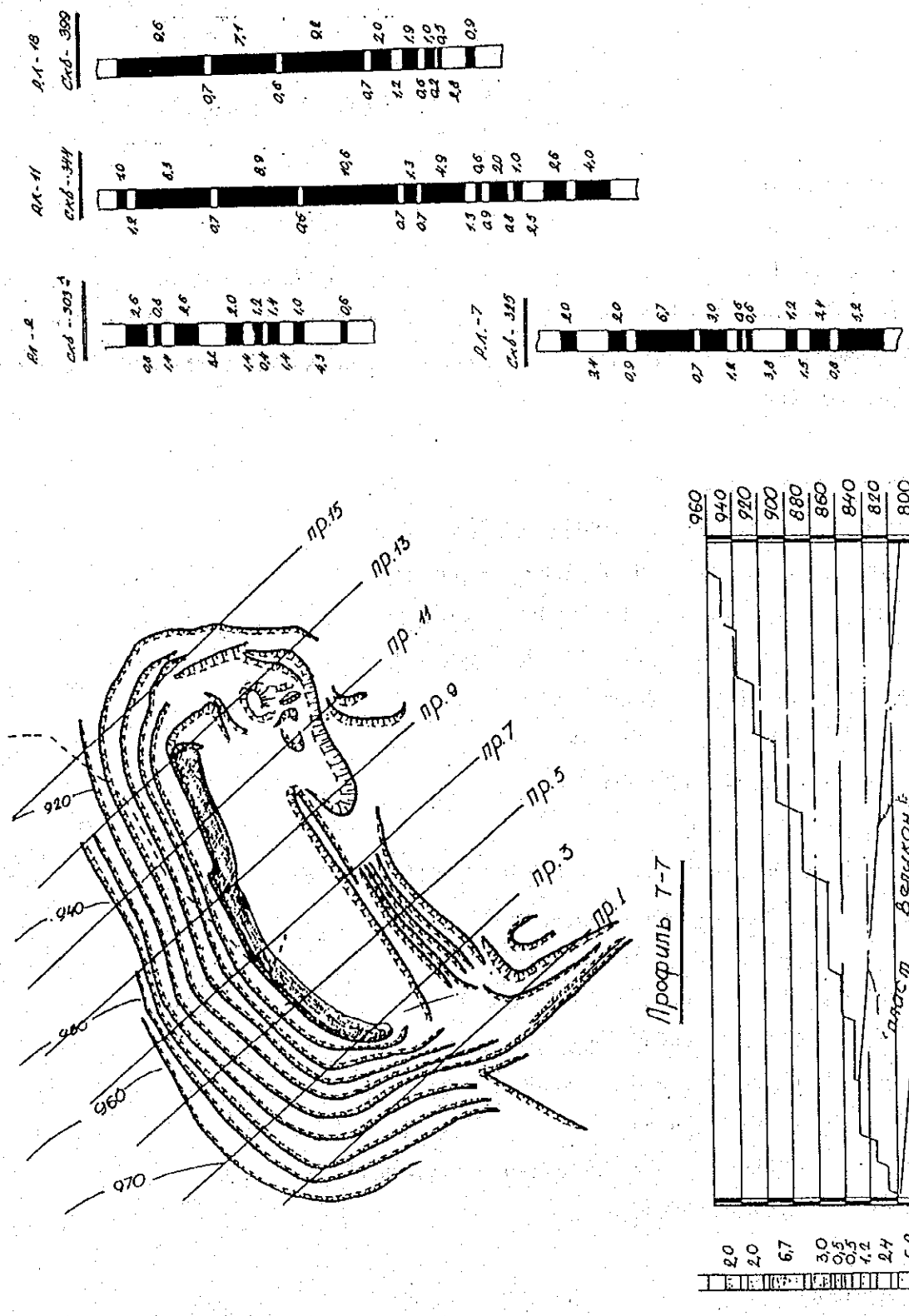


Figure 37 Schematic of Sharyngol Mine

depends on the shortage of mining materials and increasing of stripping volume.

(14) Nalaykh Deposit

1) Locality and topography

The Nalaykh Deposit is present within the Middle-East Megablock and in Tov Province. The center of the deposit is in latitude 47° 40' N and in longitude 107° 18', 37 km southeast of Ulaanbaatar (Figure 38). The land surface of the deposit forms a hilly steppe at 1,410-1,500 m above the sea level.

2) History of exploration

1912 : Start of opencut mining by Chinese
1918 : Start of underground mining by Chinese
1922 : Start of underground mining by Mongolia
1925-26 : Exploration by former Soviet Union
1931 : Detailed exploration
- area : 1.5 km x 250-300 m
1944 : Detailed exploration
- area : 7 km^2
- estimated reserves : 19.5 million tons ($A + B + C_1$)
1949 : Additional detailed exploration
1954 : Additional detailed exploration
1959-60 : Detailed exploration for the Seam I
1965-66 : Detailed exploration at southeast area
1970-76 : Detailed exploration at southwest area
1977-78 : Detailed exploration
- drilling : 93 holes, 2,831 m, max.138 m/hole
1989 : Detailed exploration

3) Coal geology

The Nalaikh Deposit belongs to the Choir-Niarga Coal-bearing Basin. The deposit extends for 10 km east-west long and 3.5 km north-south wide, with an area of about 35 km^2. Coal seams are embedded in the coal-bearing bed of Early Cretaceous age. The basic geological structure is formed of a homoclinal structure tending northwest and dipping 8-10° southwest. The coal-

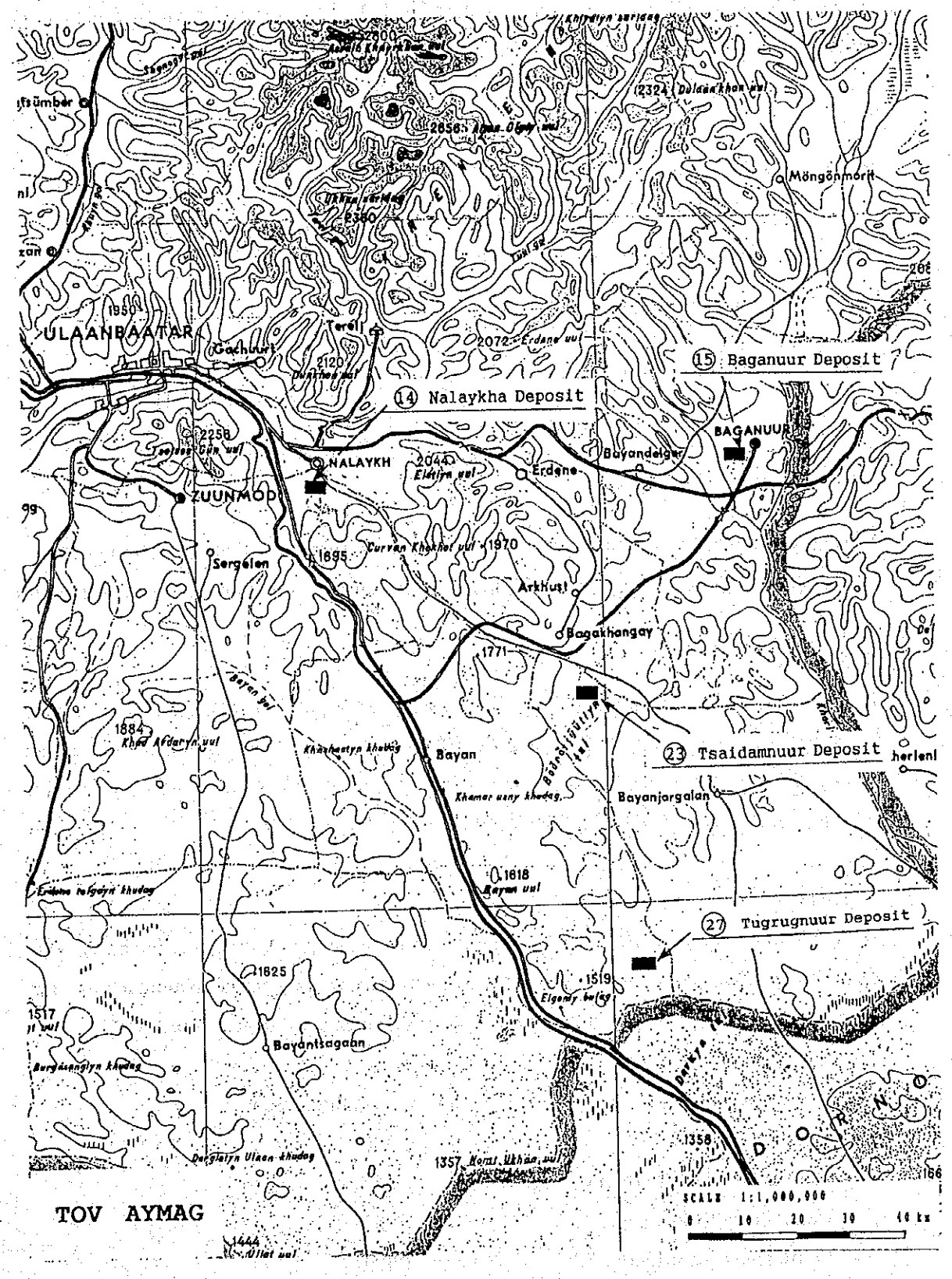


Figure 38 Deposit locality map in Tov Aymag

bearing bed is 280-350 m in thickness and contains 11 coal seams, of which 5 seams are minable seams in the deposit. They are named the Seam I, II, III, IV and V in descending order. The average thickness and intervals are below:

Seam	Thickness	Interval(m)
I	1.5 m (2-3 m at the west)	
		15-20 m (0 m at shallows)
II	2.6 m (splitting into 2-17 seams)	
		10-60 m
III	3.0 m (0.05-4.85 m)	
		8-15 m
IV	3-4 m (2.15-3.27 m)	
		0-20 m (2-5 m at the west) (12-29 m at the center) (28-38 m at the east)
V	8.0 m	

The interval between the Seam I and the Seam V ranges from 90 to 210 m. The Seam I shows pinching out at portions deeper than 400 m below the surface, although it is the thickest seam.

4) Coal quality

The coals are classified into B3(Mongolia, Russia), Subbituminous B(U.S.A.) or Lignite F(Japan-JIS). The general coals contain 21.0% moisture(as received), 5.0% moisture(air dried), 16.5% ash(dry), 45.0% volatile matter(dry,ash free), 0.7% sulfur(dry). The calorific value is 3,900 kcal/kg(as received) and 6,620 kcal/kg(dry, ash free).

5) Coal reserves

According to the report in 1991 that is presently on investigation of the government, the total minable reserves at the area within 350 m below the surface is estimated at 76 million tons. The preserved reserves for the present underground mining area is estimated as follows:

Area (coal seam)	Reserves (million tons)
- East area (Seam IV, V)	6.788
- West area (Seam II, III, IV, V)	1.243
- Central area (Seam V)	1.852
- South area (Seam II, III, IV)	4.892

6) State of mining

The Nalaikh Coal Mine started as the first governmental underground coal mine in 1922, although Chinese had partially mined since 1912. The produce until 1993 was a total of 25.5 million tons with an average of 400,000 tons/y and has been mainly utilized by power plants at Ulaanbaatar since 1950's. The recent mining activities have been restricted and decreased the produce owing to such a hazard as gas seepage, spontaneous combustion, groundwater seepage etc. The production cost has attained up to 6,000 tugurg per ton in 1993 though it was 1,200 tugurg in 1990. MEGM has decided to close the mine and to open its mining right to private sectors. Figure 39 shows the underground structure of the mine.

(15) Baganuur Deposit

1)Locality and topography

The Baganuur Deposit is within the Middle-East coal Megablock and at the east of Tov Province. The center of the deposit is in latitude 47° 45' N and in longitude 108° 23', 120 km east-southeast of Ulaanbaatar (Figure 38). The existing coal mine is connected with Ulaanbaatar by the railway and the network of Central Electric System. The land surface of the deposit forms a flat steppe at 1,370 m above the sea level.

2) History of exploration

1925-26 : Firstly recorded by former Soviet Union

1931 : Exploration by former Soviet Union
- evaluated as a hopeless deposit

1964 : Exploration by former Soviet Union
- drilling : 7 holes
- trenching : 7 sites, 26 holes
- evaluated as a promising large deposit

1974-75 : Detailed exploration on the whole deposit by former Soviet Union
- prospecting line : 20 lines, interval of 500 m

1976 : Feasibility study by former Soviet Union

1982 : Start of opencut mining

1988 : Additional exploration by Mongolia

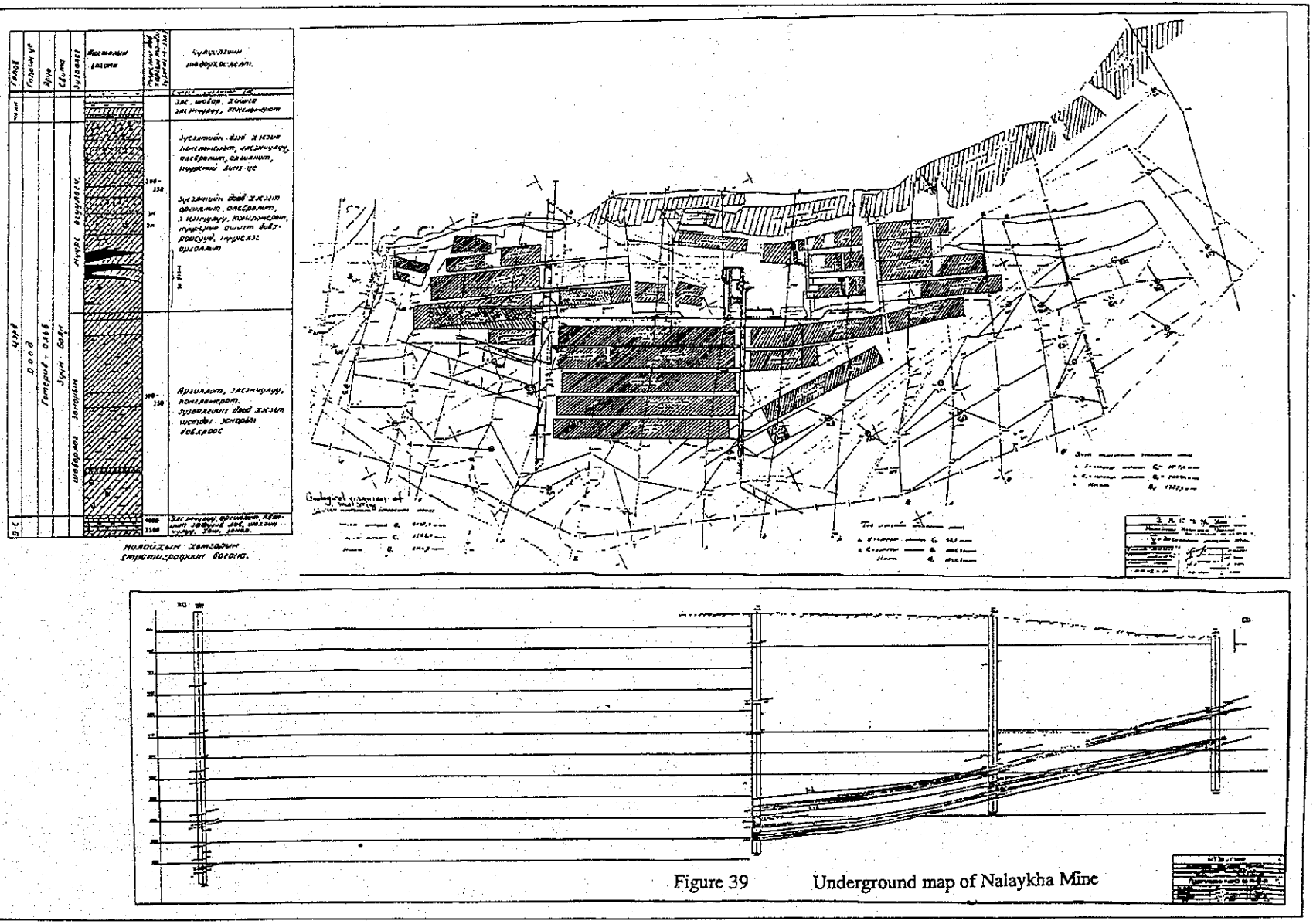


Figure 39 Underground map of Nalaykha Mine

3) Coal geology

The Baganuur Deposit belongs to the Choir-Niarga Coal-bearing Basin. The deposit shows a elongated basin extending for 12 km north-northeast long and 3.5 km west-northwest wide, over an area of 40 km^2. Coal seams are embedded in the Tevshiingovi Formation, 500 m thick, which is comprised in the Dsunbayan Group of Early Cretaceous age. The basic geological structure is formed of a synclinal basin structure with a north-northeast axis (Figure 40). There are three main faults tending north-northeast and dipping 60-70° with displacement ranging from 40 to 140 m. The coal seams dip 8-10° in general and 15-20° partially or more than 20° near the faults (Figure 41). The deepest portion of coal seams is about 350 m below the surface. There are embedded a total of 11 coal seams, which characteristically show to split and vary in thickness. Minable coal seams are composed of three seams: the Seam 2, Seam 2a and Seam 3 in ascending order. The thickness and intervals are below:

Seam	Thickness	Interval
3	25.0-97.8 m (contains 25 partings)	
		84 m
2a	2.4-52.7 m (thickens toward the deep)	
		10-18 m
2	3.4-29.2 m (thickens toward the deep)	

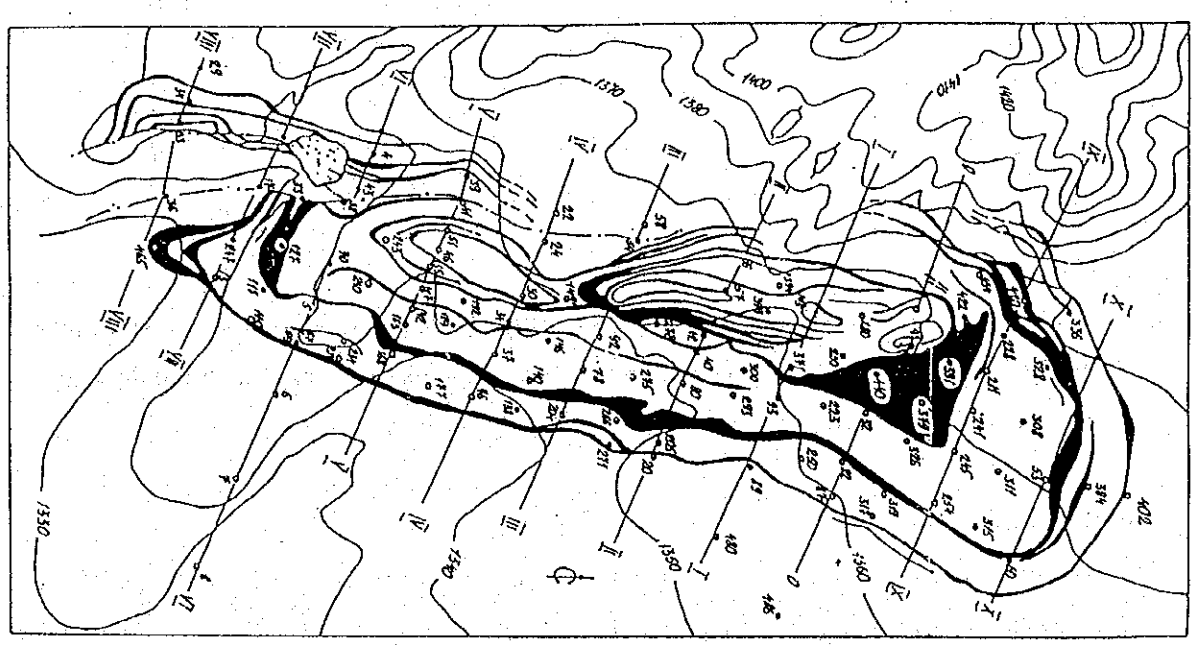
4) Coal quality

The coals are classified into B2(Mongolia, Russia) Sub-bituminous C coal(U.S.A) and Lignite F(Japan-JIS). The general coals contain 31.0% total moisture(as received), 9.2% moisture(air dried), 12.1% ash(dry), 44.6% volatile matter(dry, ash free), 0.4% sulfur(dry). The calorific value is 3,870 kcal/kg(as received) and 7,070 kcal/kg(dry, ash free). The following is the results of coal quality analysis which was conducted in Japan on January, 1995.

Items	Seam 2	Seam 2a	Seam 3
- Moisture %			
(as received)	35.3	37.2	31.6
(air dried)	15.7	14.5	15.7
- Ash (air dried) %	12.3	11.4	8.8
- Volatile matter (air dried) %	32.0	33.6	44.0
- Sulfur (air dried) %			
total S	0.83	0.66	0.45
incombustible S	0.66	0.64	0.41
combustible S	0.17	0.02	0.04
- Calorific value			

Figure 40

Geological map of Baganuur Deposit



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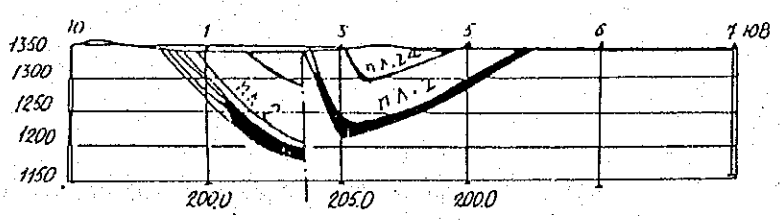


Ра III-III

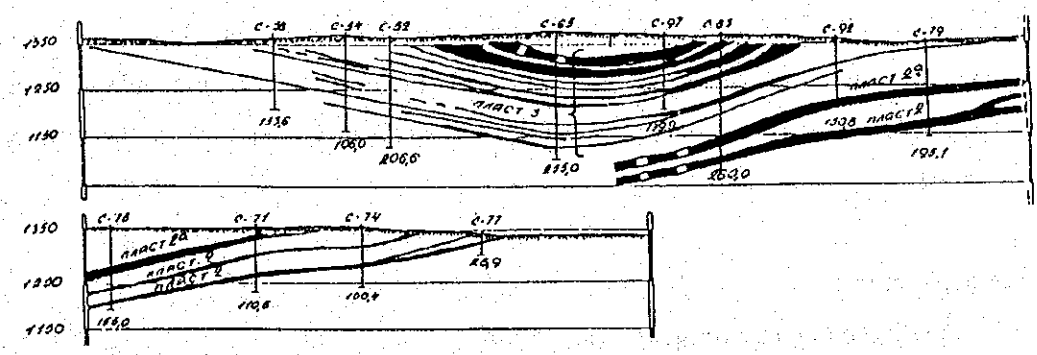


Figure 41 Seam conditions of Baganuur Mine

kcal/kg			
(air dried)	5,120	5,210	5,150
(dry,ash free)	7,110	7,030	6,820
- Ultimate analysis (dry)			
Ash %	14.6	13.3	10.5
C %	64.4	64.6	65.5
H %	4.2	4.2	4.2
O %	15.7	17.0	19.0
N %	0.9	0.9	0.8
S %	0.2	0.1	0.1

5) Coal reserves

According to our report of Part I: Renovation Study, the coal reserves of main three seams at the whole deposit is estimated at 567 million tons for geological reserves, and 296 million tons for minable reserves at the area within 150 m below the surface.

6) State of mining

The Baganuur Coal Mine began to mine under the former Soviet Union's advising in 1978. The total produce until 1993 was 34.5 million tons with an average of 4,000,000 tons/y and has been mainly utilized by power plants at Ulaanbaatar. The details of mining status is shown on the report of Part I.

(16) Shivee Ovoo Deposit

1) Locality and topography

The Shivee Ovoo Deposit is within the Middle-East Megablock and at the north of Dornogobi Province. The center of the deposit is in latitude 46° 10' N and in longitude 108° 33', 250 km southeast of Ulaanbaatar and 20 km southeast of Choir which is one of main stations and settlements along the Trans-Mongolian Railway connection with Ulaanbaatar (Figure 42). The railway traverses from the northwest to the southeast on the deposit. The land surface of the deposit forms a gently undulating steppe at 1,100-1,200 m above the sea level on the north of the Govi Desert.

2) History of exploration

1957 : Firstly recorded by former Soviet Union
- evaluated as a hopeless deposit because of high ash contents

1980's : Exploration for water resources by former Soviet Union

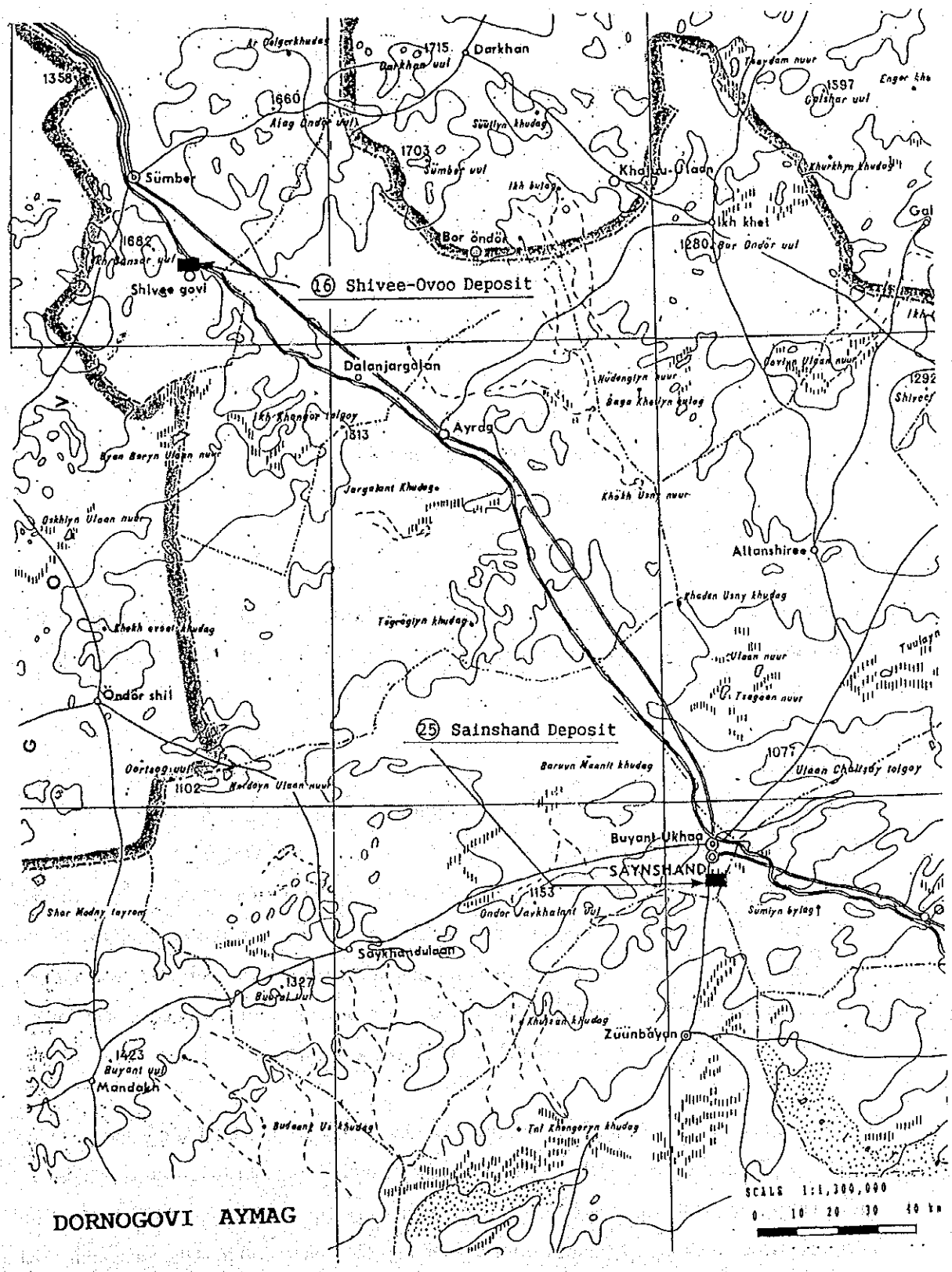


Figure 42 Deposit locality map in Dornogovi Aymag

- discovered thick coal seams by drilling

1986 : Exploration for the whole deposit by Mongolia
- drilling : 72 holes, 16,221.56 m in total
hole interval of 2-4 km

: Detailed exploration for the Shineus Area
- drilling : 65 holes, 5,452.1 m in total
hole interval of 250 m

1987 : Detailed exploration for the Shineus Area
- drilling : 80 holes, 15,152.5 m in total
hole interval of 500 m
line interval of 250-500 m

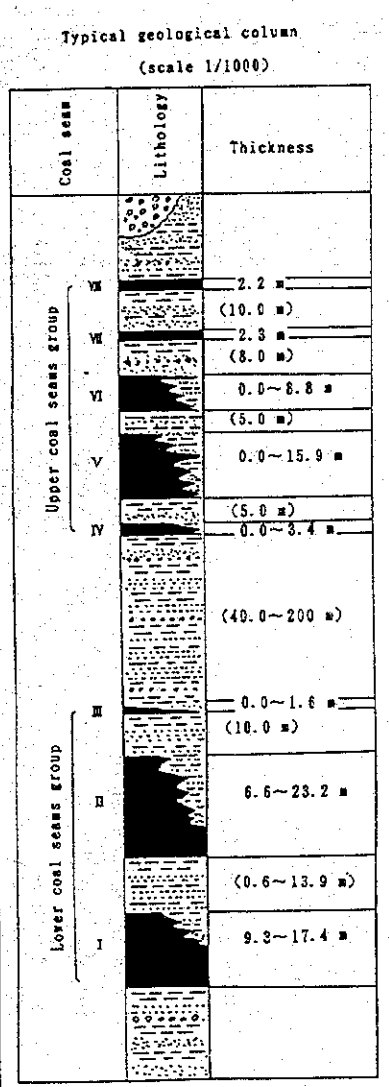
: Detailed exploration for the first mining site
- drilling : 54 holes, 9,472.0 m in total
hole interval of 250 m

At the Sineus Area situated at the northwest corner of the deposit with an area of 5 km x 7 km, the detailed exploration works have been carried out by drilling with 100-150 m of drill hole intervals.

3) Coal geology

The Shivee Ovoo Deposit belongs to the Choir-Niarga Coal-bearing Basin. The deposit shows a basin extending for 25 km northwest long and 17 km northeast wide, with an area of about 350 km^2.Coal seams are embedded in the Tevshiingovi Formation, about 500 m thick, which is comprised in the Dsunbayan Group formed in an intramontane basin during the Early Cretaceous time. The basic geological structure is formed of a synclinal basin structure with an axis tending north-northwest (Figure 43). The coal seams dip gently 6-10° in general. The lowest seam level in the deposit is estimated at 350 m below the surface.

The coal seams which have well continuity in the whole deposit are a total of eight seams : the Seam I to VIII in ascending order. These seams are subdivided into two groups : the lower group composed of the Seam I to VIII, and the upper group of the Seam IV to VIII. The interval between both groups ranges from 40 m at the east area to 200 m at the west area. All the seams are characterized by a variable thickness and splitting. There is shown such a



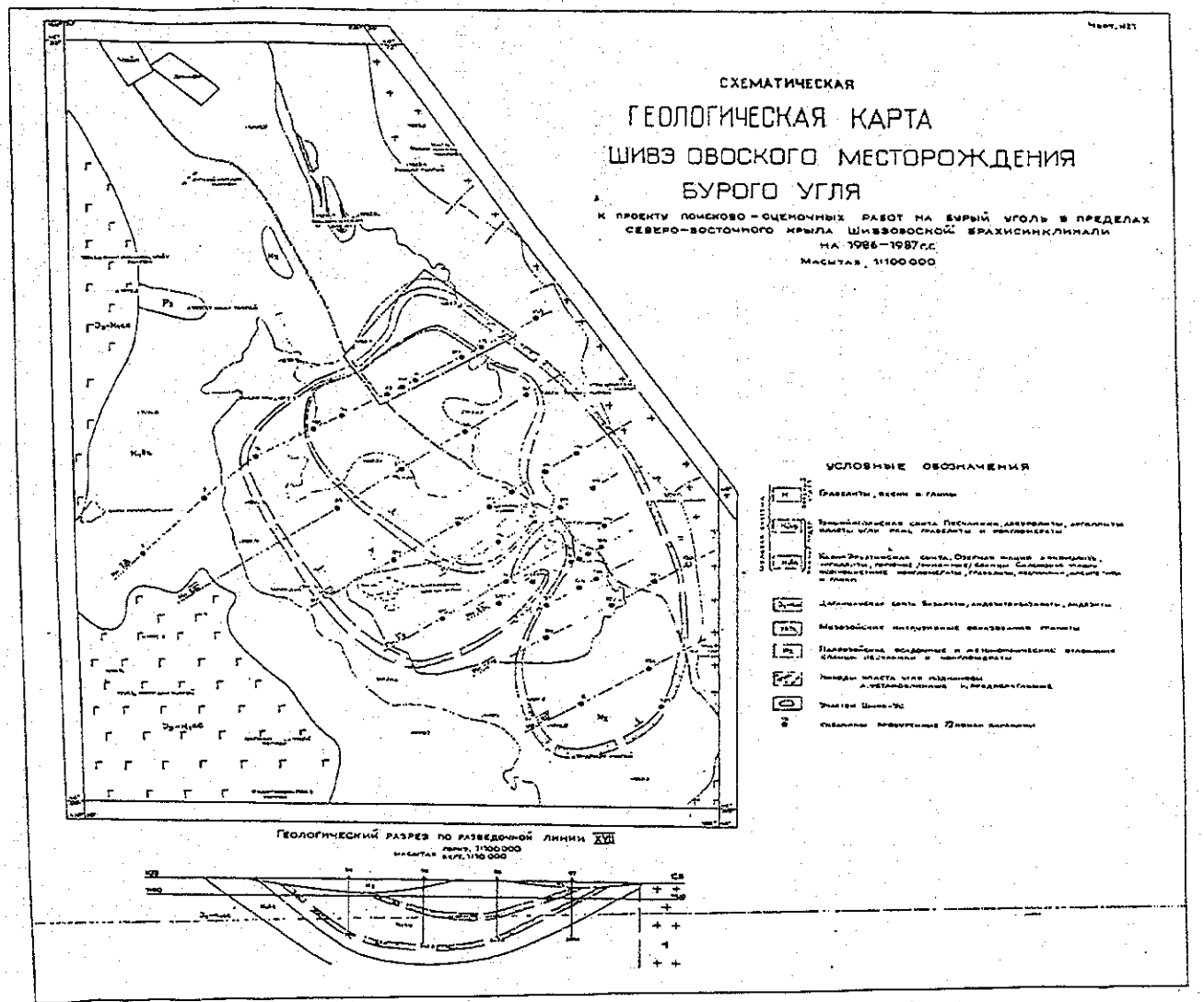


Figure 43 Basic goelogical structure of Shivee Ovoo

tendency that most of seams come to thick and close up the intervals at the northeast area and to split toward the west and south.

The minable coal seams are a total of 4 seams : the Seam I, II, V and VI, which show such a varying thickness as 9.3-17.4 m, 6.6-23.2 m, 0-15.9 m and 0-8.8 m respectively at the detailed exploration area. Excepting the Sineus Area at the northwest corner of the deposit, the central area formed of an anticlinal structure is regarded as a potential mining site. There are two coal seams with an interval of 100 m, striking northwest and dipping 6-8°. The upper coal seam ranges in thickness from 4 to 8 m, 6 m in average. The lower coal seam ranges from 4 to 13 m, in average 8 m at the east flank and 6 m at the west flank.

4) Coal quality

The coals are classified the same as the Baganuur coal into Lignite B2(Mongolia, Russia) sub-bituminous C(U.S.A) and Lignite F(Japan-JIS). The typical coals are regarded as containing 37.3% total moisture(as received), 9.8% ash(dry), 44.0% volatile matter(dry, ash free), 0.8% total sulfur(dry) and to show a calorific value of 3,700 kcal/kg(as received) and 6,700 kcal/kg(dry, ash free). The following is the results of coal quality analysis which were recently conducted in Mongolia and Japan.

Core Sample Products Analyzes in Japan

Items	(1994.3)	(1993.6)	(1994.10)	(1995.1)
- Moisture %				
(as received)	34.5	43.6	15.5	30.2
(air dried)	10.4	6.0	14.5	18.3
- Ash %				
(air dried)	-	-	21.6	17.5
(dry)	8.7	17.3	25.2	20.4
- Volatile matter %				
(air dried)	-	-	33.2	34.8
(dry,ash free)	44.0	45.7	52.0	51.3
- Sulfur (air dried) %				
total S	-	-	1.47	0.72
incombustible S	-	-	0.86	0.71
combustible S	-	-	0.61	0.01
total S (dry)	0.5	0.9	-	-
- Calorific value kcal/kg				
(as received)	3,610	2,690	-	-
(air dried)	-	-	4,210	4,610
(dry,ash free)	6,700	6,660	6,580	6,790