3.1.2 Major coal deposits

In the Master plan study, a total of 27 coal deposits have been selected as main coal deposits in Mongolia, and studied in terms of coal geology. These deposits comprise 17 deposits being mined by MEGM, 2 deposits under preparing coal mines by MEGM, 3 deposits being mined by private sectors and 4 deposits that have a possibility of developing in the future. As a matter of convenience in the report, these selected 27 deposits are subdivided into five megablocks based on such a similarity as locality, geological age of deposition, coal quality and degree of consolidated infrastructure as shown both in Table 3.2 and Figure 3.2. All the boundaries of megablocks, without a part of west boundary of Middle-East Megablock, are overlapped on boundaries of provinces.

Summary of properties for appreciating above-mentioned main coal deposits is shown in Table 3.3, and the outline and coal geology on major deposits selected in short list in the section 3.2.3 and Sharyngol are reported the following.

(1) Tavantolgoi Deposit

1) Locality and topography

The Tavantolgoi 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'E, 540 km south of Ulaanbaatar and 96 km east of Dalanzadgad which is the capital town of Omnogovi province (Figure 3.3). The land surface of the deposit forms a gently undulated semidesert at 1,490-1,560 m above the sea level.

2) History of exploration

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

1940 : Exploration by the former Soviet Union

1949 : Sampling survey by the former Soviet Union

1950 : Sampling survey by former Soviet Union

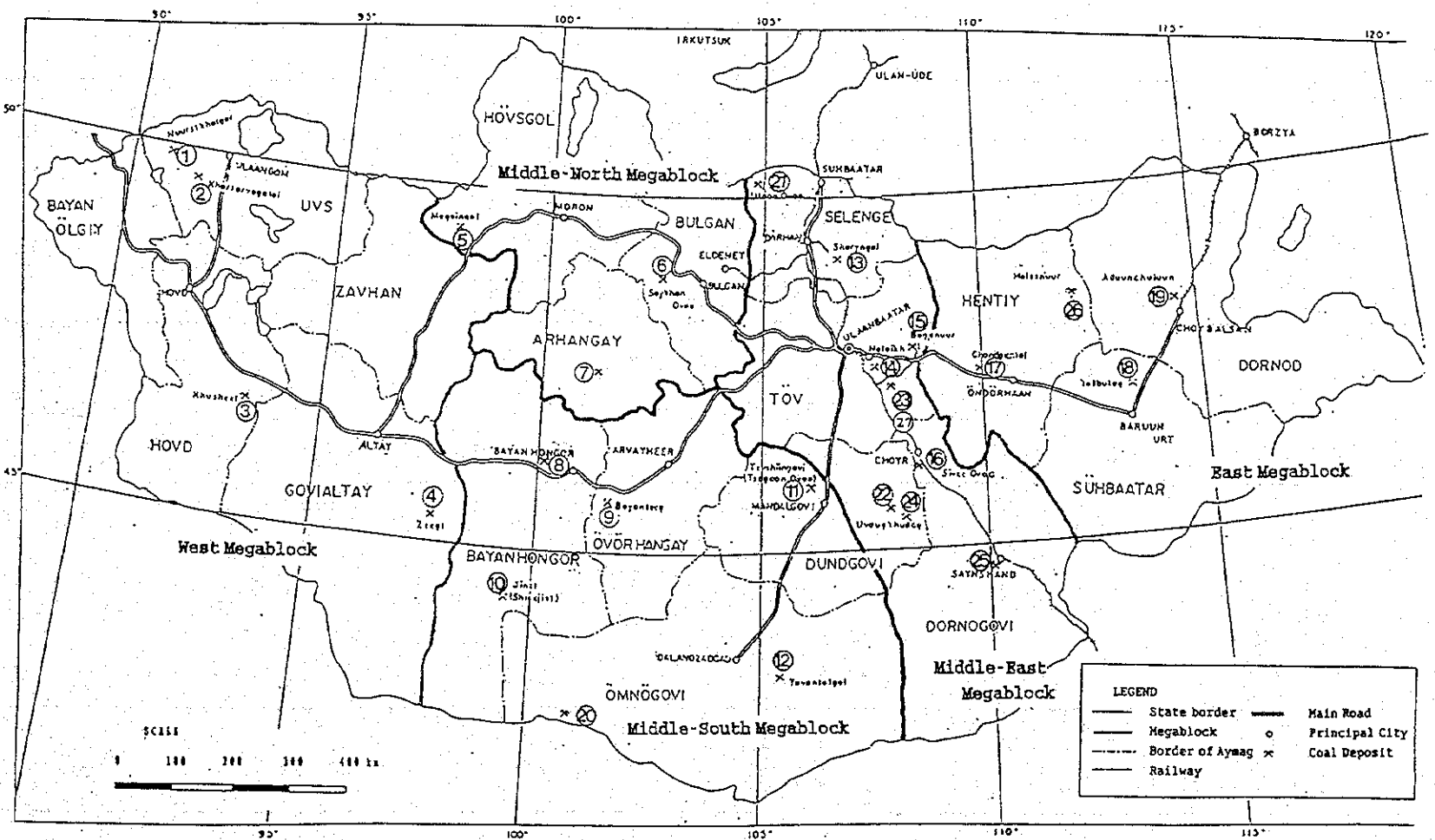
- evaluated as showing a coking property
- recommended a necessity of detailed exploration

1953-56 : Detailed exploration by a geological expedition of the 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 ($+C_2$)

Table 3.2 Megablocks of Coal Deposit

Megablock	West	Middle-North	Middle-South	Middle-East	East
Coal Deposit	① ② ③ ④	⑤ ⑥ ⑦	⑧ ⑨ ⑩ ⑪ ⑫ ⑳	⑬ ⑭ ⑮ ⑯ ㉗ ㉑ ㉒ ㉓ ㉔ ㉕	⑰ ⑱ ⑲ ㉖
Aimag	BAYAN OLGIY UVS ZAVHAN HOVD GOVIALTAY	HOVSGOL BULGAN ARHANGAY	BAYANHONGOR OVORHANGAY OMNOGOVI DUNDGOVI (west half)	SELENGE TOV DORNOGOVI DUNDGOVI (east half)	HENTIY DORNOD SUHBAATAR
Geological Age	Carboniferous	Carboniferous Jurassic	Permian Jurassic Cretaceous	Jurassic Cretaceous Permian(?)	Cretaceous
Coal Rank	Bituminous	Bituminous Subbituminous Anthracite (partially)	Bituminous Subbituminous -Lignite(⑩)	Subbituminous -Lignite	Subbituminous -Lignite
Infrastructure	poor	poor	poor	rather well	partially well



① Nuursthotgor Deposit
② Khartarvagatai Deposit
③ Khusheet Deposit
④ Zeegt Deposit
⑤ Mogoingol Deposit
⑥ Saihan-Ovoo Deposit
⑦ Bayantsagaan Deposit
⑧ Uburchuluut Deposit
⑨ Bayanteeg Deposit
⑩ Shinjinst Deposit
⑪ Tevshiingovi Deposit
⑫ Tavantologoi Deposit
⑬ Sharyngol Deposit
⑭ Nalaykha Deposit
⑮ Baganuur Deposit
⑯ Shivee-Ovoo Deposit
⑰ Chandagantal Deposit
⑱ Talbulag Deposit
⑲ Aduunchuluun Deposit
⑳ Narynsohait Deposit
㉑ Ulaan-Ovoo Deposit
㉒ Khoot Deposit
㉓ Tsaidamnuur Deposit
㉔ Ovdok-Huduk Deposit
㉕ Sainshand Deposit
㉖ Hulstnuur Deposit
㉗ Tugrugnuur Deposit

Figure 3.2 Main Coal Deposits in Mongolia

Table 3.3 Main Coal Deposit in Mongolia (1/2)

Coal Deposit	Age	Geological Structure Basics	Strike	Dip	Number	Mineable Coal Seams Thickness	Characteristic	Classification of Coal Mongolia (Russia)	ASTM (U.S.A.)	JIS (Japan)	Moisture (ar) %	(ad) %	Ash (d) %	Vol. (daf) %	S (d) %	Calorific Value (ar) kcal/kg	(daf) kcal/kg
(1) Nuursthotgor Deposit	C2-C3	basin	NS (west) EW (north)	45° E (west) 5-25° W (east)	8	2-50m	variable thickness, no coal (south)	D-G	SB(B)-HV(C)	E-C	1.4-2.1	0.7-0.8	19-36	31-44	0.3-0.5	4,100-5,000	7,560-8,430
(2) Khartarvagatai Deposit	C2-C3	fold with faulting	NE	30-40° (west wing) 50-70° (east wing)	1	80-85m	few parings (0.1-0.2m, 2-4 beds)	D-G	SB(B)-HV(C)	E	16.0	3-5	15-25	40-45	0.5	5,500	7,450
(3) Khusheet Deposit	C2-C3	syncline	NS	45° (west wing) 50-65° (east wing)	2	15.5-34.9m	outcropped (no capping)	D-G	SB(B)-HV(C)	E-B1	7.0	3-4	33130	20-27	0.5	5,400-6,300	8,590
(4) Zeegt deposit	C2-C3	fold with faulting	NW	0-40°	1	9-16m	many partings, variable thickness	J	HV (A)	E-C	10.0	0.2-13.3	18.4	30-34	0.4	4,880	8,200
(5) Mogoingol Deposit	C 3	basin	NS EW (north)	6-12°	1	2-20m av. 7-8m	variable thickness,	J	SB(B)-HV(C)	E-C	6.5	5-6	18.0	34.6	0.9	5,300-5,600	7,350
(6) Saihan Ovoo Deposit	J 2	homocline	NS	0-3° (max 5°)	1	2-2.4m	variable thickness, basalt lava	K,KJ-A	MV-A	C-A1	4.5-7.0	0.1-12.0	21.7	10.0-46.0	0.6	6,100	7,290-8,700
(7) Bayantsagaan Deposit	J 2	homocline	NE	30°	1	10m	partings	B3	SB (B)	F-E	7.3	2.6	25.5	39.8	0.6	5,600	7,500
(8) Uburchuluut Deposit	K1	gentle syncline	NE	0-5°	1	6-8m	few partings	B2	SB(B)-HV(C)	F	30-40	10.0	6-25	43.0	< 1.0	3,500	7,000
(9) Bayanteeg Deposit	J1-J2	asymmetrical syncline	EW	18-24° (north wing) 70-85° (south wing)	1	3-36m	variable thickness, splitting	B3-D	SB(B)-SB(A)	F-E	5.2	2.2	22.6	51.9	1.0	4,680	7,230
(10) Shinjinst Deposit	J1-J2	homocline	EW	30-40° S	1-3	42-49m (east) 8-18m (west)	splitting (west)	GJ	HV (B)	C	6.1	1.0	13.1	33.8	0.6	4,500	8,310
(11) Tevshiingovi Deposit	K1	gentle syncline with faulting	EW	10-15° (surface)	5	IV: 20m I - III: max 230m	much variable thickness,splitting	B2	SB (C)	F	30.5	11.0	20.9	45.5	0.7	3,370	6,450
(12) Tavantologoi Deposit	P2	gentle syncline	NW	0-30° 0-15° (north)	12	2-72m	splitting partially coking	G-KJ	HV(C)-LV	E-B	6.9	0.1-2.5	14.9	32.8	0.8	5,,100-5,500	7,700-8,400
(13) Sharyngol Deposit	J2-J3	homocline with faulting	N60° E	6-9° SE	2	30-40m	faulting splitting	B3-D	SB(B)-SB(A)	F-E	18.0	3.0	22.0	45.0	0.6	3,900-4,200	7,200
(14) Nalaykha Deposit	K1	homocline	NW	8-10° SW	5	8-20m	variable thickness	B3	SB (B)	F	21.0	5.0	16.5	45.0	0.7	3,900	6,620
(15) Baganuur Deposit	K1	basin with faulting	NE	8-20°	3	2-98m	splitting (Seam 3)	B2	SB (C)	F	33.0	9.2	18.0	44.6	0.4	3,200-3,500	7,070
(16) Shivee Ovoo Deposit	K1	gentle basin	NW	8°	4	2-23m	splitting max depth: 350m	B2	SB (C)	F	43.6 34.5	6.0 10.4	17.3 8.7	45.7 44.0	0.9 0.5	2,690 3,610	6,660 6,700
(17) Chandagantal Deposit	K1	homocline with faulting	WNW	5-8° S	1	30-50m	parting (0.1-3.4), intrusive rock	B2	SB (C)	F	30.6	12.3	11.7	46.5	0.9	3,000-3,400	6,580
(18) Talbulag Deposit	K1	gentle basin	NE	<10° 8-15° (area II)	3	2-30m	variable thickness	B1	L (A)	F	30.0	9.5	14.0	47.0	0.8	2,850	6,000
(19) Aduunchuluun Deposit	K1	gentle basin	ENE-WNW	6-8°	2	2-50m	much variable thickness	B1	L (A)	F	45.2	9.4	16.7	48.1	1.1	2,400	6,480
(20) Narynsohait Deposit	P2	homocline	EW	15-35° S(west) 35-55° (east)	1	West I :100m East V :100m	few partings, intrusive rock (East b.)	GJ-A	HV (C)-A	E-A	5.0	1.0-2.8	5.0-30.0	28-40	0.4		7,500
(21) Ulaan Ovoo Deposit	J	gentle basin	EW	15-20° N, 60-70° N (west)	1	24-63m	variable thickness, many partings	B3-D	SB (B)-SB (A)	F-E	13.4	7.3	11.2	46.0	0.3	4,270	7,370
(22) Khoot Deposit	J2-J3	homocline with faulting	ENE	5-12° S	5	V :8-10m	V : few partings Others: many partings	B3-D	SB (B)-SB (A)	F-E	13.8	7.5	14.5	43.0	0.7	4,100	7,030
(23) Tsaidamnuur Deposit	K1	elongate basin with faulting	NNE	0-5°	3 groups	5-50m	variable thickness, splitting	B2	SB (C)	F	30-34	9-11	12-18	42-45	0.4-0.7	3,600-3,800	6,800-7,100
(24) Ovdok Huduk Deposit	K1	plain-syncline	NE, EW	0-5°	1	30-60m	high sulphur	B1-B2	SB (C)	F	36.0	7-9	13.9	45.0	2.8	3,070	6,300
(25) Sainshand Deposit	J	fold and faulting	n.a.	60-85°	3	1-3m	steeply dipping	G-GJ	HV (B)	E-C	2.1-7.2		6.1-25.7	16.3-29.7		5,050-6,730 (base unknown)	
(26) Hulstnuur Deposit	K1	gentle basin	EW	8-15° (max 20°)	2	VI: 9.0-32.6m V : max 9.8m	variable thickness, splitting(V)	B2	SB (C)	F	30.1	10.2	12.7	47.5	0.7	4,430 (ad base)	6,470
(27) Tugrugnuur	K1	anticline syncline	dome shape	7	2	5m 15m	few partings	B2	SB(C)	F		7.3	14.9	50.6	0.8		6,240

(Note) Above coal quality data is not the coal quality standard of Mongolia (see Table 3.5)

Table 3.3 Main Coal Deposit in Mongolia (2/2)

Coal Deposit	Megablock	Province (Aimag)	Sotuation	Access	Topography	Size of Deposit Extent	Area	History of Exploration First Record	Prospecting	Detailed Exploration	Coal Reserves million t. Area	Depth	Mineable (A+B+C1)	Geological (A+B+C1 +C2+P)	Year of opening	Mining Results Method	Products (1,000t)
(1) Nuurstholgor Deposit	West	UVS	49° 40'N 90° 33'E	110km WNW of Ulaangon	Plain grassland	NS: 15.0km EW: 30.0km	450km²	1927	1941-1942 1990-1991	1960 (partially)	whole area	100m	142.3	166.6	1963	O/C	(1963-1993) 3,139.9
(2) Khartarvagatai Deposit	West	UVS	49° 35'N 91° 40'E	50km SW of Ulaangon (100km by vehicle)	mountain grassland	SWNE: 6.0Km NWSE: 2.5Km	30km²	1941	1941	1961 (partially)	NNE : 0.85km WSW : 0.4km	60-100m	19.7	25.7	1964	O/C	(1964-1993) 2,350.4
(3) Khusheet Deposit	West	HOVD	46° 40'N 93° 25'E	20km NE of Testseg, 60km SN of Darvi by vehicle	gentle hills	NS: 3.5km EW: 2.0km	7km²	1926	1967	1972(partially) 1978	NS : 0.8km EW : 0.7km	70-140m	14.7	24.3	1971	O/C	(1971-1993) 1,190.8
(4) Zeegt deposit	West	GOVAILTAI	45° 20'N 97° 50'E	9km SW of Changmani, 250km SE of Altay by vehicle	plain	NW: 2.5km NE: 1.0km	2.5km²	(ancient)	1969	1979	1.6 x 0.5km whole area	50m	2.57 4.58	6.87	1966	O/C	(1966-1993) 1,261.0
(5) Mogoingol Deposit	Middle-North	HOVSGOL	49° 20'N 97° 55'E	165km WSW of Moron	hills forest	NS: 1.0km EW: 0.4-0.6km	0.5km²	1955	1967-70	1976	NS : 1km	80-90m	4.0	15.0	1970	O/C	(1970-1993) 1,645.6
(6) Saihanm Ovoo Deposit	Middle-North	BULGAN	48° 48'N 102° 30'E	80km W of Bulgan (90km by Vehicle)	hills forest	NS: 5.0km EW: 3.5km	17.5km²	1960	1988-89	1961(West) 1977(East) 1993(North)	over 1.5m thick of coal seem	250m	23.95	34.66	1965	U/G	(1966-1993G) 521.1
(7) Bayantsagaan Deposit	Middle-North	ARHANGAY	47° 40'N 101° 18'E	25km NNW of Tsetserleg	hills grassland	SWNE: 2.5 Km NWSE: 0.5 Km	0.6 km²	1977	1986	1989	whole area	100m	1.2	5.5	1994	U/G	on preparing
(8) Uburchuluut Deposit	Middle-South	BAYANHONGOR	46° 20'N 101° 05'E	60km WNW of Bayanhongor	hills grassland	: 0.5km : 0.8km	0.4km²	1971	1978	1981	0.5 x 0.8 km	60-70m	3.7	3.7	1978	O/C	(1978) 1.2 interruption
(9) Bayanteeg Deposit	Middle-South	OVORHANGAY	45° 40'N 101° 35'E	134km SW of Arvayheer	plain grassland	NS: 1-2km EW: 7km	10km²	1961	1961 1973	1977	EW : 7km	100-110m	29.7	100	1962	O/C	(1962-1993) 4,047.3
(10) Shinjinst Deposit	Middle-South	BAYANHONGOR	44° 35'N 100° 13'E	7km NW of Shinjinst 250km SW of Bayanhongor	plain grassland	NS: 1km EW: 9km	9km²	1977	1977	1977-78 (partially)	North block	100-110m	2.4	4.1	1991	O/C	(1991-1993) 32.9
(11) Tevshiingovi Deposit	Middle-South	DUNDGOVI	46° 00'N 106° 07'E	30km N of Mandalgovi	gentle basin grassland	NS: 6km EW: 12km	72km²		1940-60	1981-82	whole area	300-350m 300-350m	587.7	960.0	1963	O/C	(1963-193) 1226.7
(12) Tavantologoi Deposit	Middle-South	OMNOGOVI	43° 35'N 106° 30'E	96km W of Dalanzadgad 540km S of Ulaanbaatar	plain grassland	NS: 6-15km EW: 60km	600km²	1890	1978-81 1984-87	1981-90	main area	300m 500m	3,500	6,500	1966	O/C	(1966-1993) 2,085.7
(13) Sharyngol Deposit	Middle-East	SELENGE	49° 12'N 106° 27'E	50km SE of Darhan by train	hills forest	NW: 1.5km NE: 3.0km	4.5km²	1957	1957-1960	1976-78	stripping ratio : 10m³/t	250m	32.0	O/C 37.0 U/C 45.0	1965	O/C	(1965-1993) 41989.4
(14) Nalaykha Deposit	Middle-East	TOV	47° 40'N 107° 18'E	37km SE of Ulaanbaatar by train & vehicle	gentle hills grassland	NS: 3.5km EW: 10km	35km²	1912	1925-26 1930	1931 1954-78	whole area	350m	59.0	76.0	1922	U/G	(1922-1993) 25,476.9
(15) Baganuur Deposit	Middle-East	TOV	47° 45'N 108° 23'E	120km ESE of Ulaanbaatar by vehicle	plain grassland	NNE: 12km WNW: 3.5km	42km²	1925	1964	1974-75	whole area	200m 350m	515.8	- 713.1	1978	O/C	(1978-1993) 34,536.3
(16) Shivee Ovoo Deposit	Middle-East	DORNOGOVI	46° 10'N 108° 33'E	20km SE of Choyr	rolling plain grassland	NW: 25km NE: 17km	425km²	1957	1986-88	1986-88 (partially)	Sincus whole area	350m	564.1	2,700	1992	O/C	(1992-1993) 748.4
(17) Chandagantal Deposit	East	HENTIY	47° 25'N 110° 05'E	280km E of Ulaanbaatar 160km ESE of Baganuur 40km W of Ondorhaan (by vehicle)	plain grassland	NS: 1.5km EW: 2.0km	3km²	1941	1941	1962-63 (partially)	1.2 x 0.8km	100m	122.9	213.0	1966	O/C	(1966-1993) 1,649.7
(18) Talbulag Deposit	East	SUHBAATAR	46° 55'N 112° 58'E	35km NW of Suhbaatar	plain grassland	NW: 5-6km NE: 12km	70km²	1939	1967	1980 (partially)	block II whole area	100m 300m	48.6	51.9 421.3	1976	O/C	(1976-1993) 1,532.2
(19) Aduunchuluun Deposit	East	DORNOD	48° 05'N 114° 28'E	6.5km N of Choybalsan	plain-hills grassland	NW: 6km NE: 7km	40km²	1951-1953	1962	1988-89 (partially)	south block whole area	60m 60m	230.0	400	1955	O/C	(1955-1993) 8,423.6
(20) Narynsohait Deposit	Middle-South	OMNOGOVI	42° 50'N 101° 40'E	300km SW of Dalanzadgad 30km N of border with china	plain desert	NS: 1.0Km EW: 11Km	30km²	1971	1971	1991 (partially)	2 blocks	100m 200m	40_50	200-250	1994	O/C	on preparing
(21) Ulaan Ovoo Deposit	Middle-East	SELENGE	50° 20'N 105° 00'E	5km W of Tushig 85km W of Suhbaatar	mountain forest	NS: 2km EW: 3km	6km²	1974	1979	1979-93	NS : 0.45km EW : 1.5km	150-160m 150-160m	23.6	42.1	_	O/C	on preparing
(22) Khoot Deposit	Middle-East	DUNDGOVI	45° 39'-45° 46'N 107° 39'-107° 46'E	90km SW of Choyr 120km ESE of Mandalgovi	plain grassland	NS: 5km EW: 5km	25km²	1964	1964	1964, 1992-94 (partially)	1 x 3km 3 x5km	100m 100m	82.3	190.9	1993	O/C	(1993) 3.8
(23) Tsaidamnuur Deposit	Middle-East	TOV	47° 22'N 108° 00'E	100km SE of Ulaanbaatar 10-20km S of railway	plain grassland	NE: 46km NW: 10-15km	500km²	1940s	1980s	no	whole area	300m	_	1700	_		
(24) Ovdok Huduk Deposit	Middle-East	DUNDGOVI	45° 32'N 108° 00'E	140km ESE of Mandalgovi 90km W of railway	plain grassland	NE: 16km NW: 3km	48km²	1964	1964, 1965	1968-72 (partially)	Middle b. WS b.	100m 100m	159.5	168.2	_		
(25) Sainshand Deposit	Middle-East	DORNOGOVI	44° 50'N 110° 08'E	18km SW of Sainshand	plain desert		10km²	1930s	1939-40		2.3km² 7.7km²	120m 300m	0.6	1053	1937		1937- (?) minced up to 35m from surface
(26) Hulstnuur Deposit	East	HENTIY	48° 20'N 112° 33'E	65km NE of Bayan-Ovoo (by vehicle)	rolling plain grassland, lake	NS: 5km EW: 10km	50km²	1944	1980-81	1980-81 (partially)	1.2 x 1.2km (1.44km²)	50m	11.2	190	_		
(27) Tugrugnuur	Middle-East	TOV	46° 55'N 104° 07E	110km S of Malaykh	plain grasslamd	10 x 10km	80km²	1952	1984		whole area	300m	_	695	_		

1974-75 : Sampling survey by the Bulgarian expedition
- sampled each 5 tons from 4 seams at the central area
- evaluated the Seam IV 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 Tavantolgoi deposit in a narrow sense
- 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 : 700-750 m

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

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

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

1990 : Feasibility study by the former Soviet Union
- study cost : 8 million Tugrug (7 Tg/US$)

1992 : Reconnaissance survey for the Baruun-Omno area

3) Coal geology

The Tavantolgoi 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 Tavantolgoi Formation of Late Permian age. The Tavantolgoi Formation is 1,500 m in thickness and the upper part of coal-bearing has 600-1,000 m thick.

The basic geological structure is formed of several gentle synclinal structures with faulting (Figure 3.4). 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 3-30 m in average thickness and 165 m 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 IX 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 are shown 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 3.5 shows the seam conditions at the central part of Tavantolgoi deposit.

4) Coal quality

The coals are classified as seen in Table 3.1. 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).

5) Coal reserves

The coal reserves at the exploration area up to 1,000 m above 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 within 300 m below the surface, the minable reserves($A + B + C_1$) is 3,500 million tons, of which 1,000 million tons is estimated for

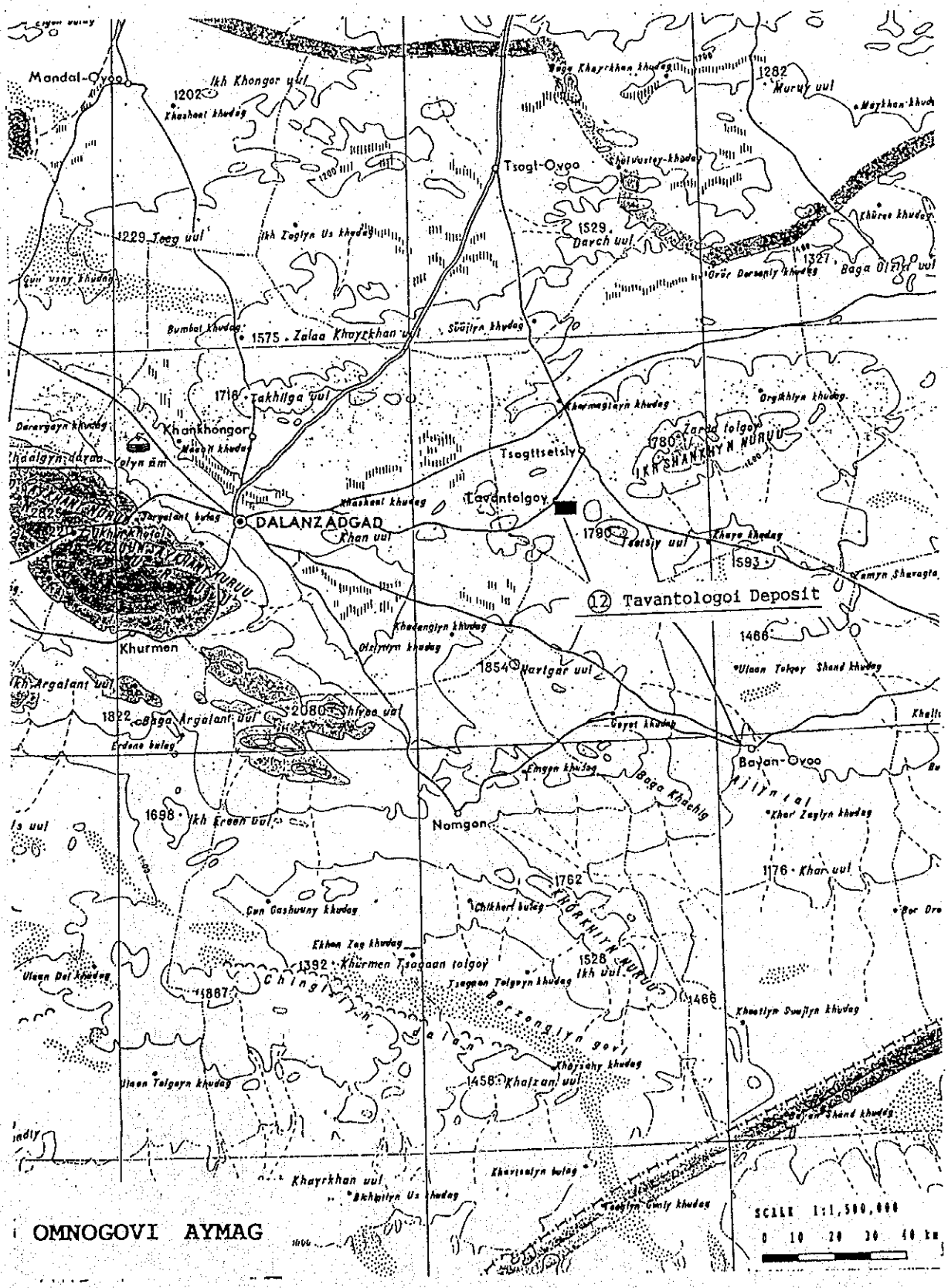


Figure 3.3 Deposit Locality Map in East of Omnogovi Province

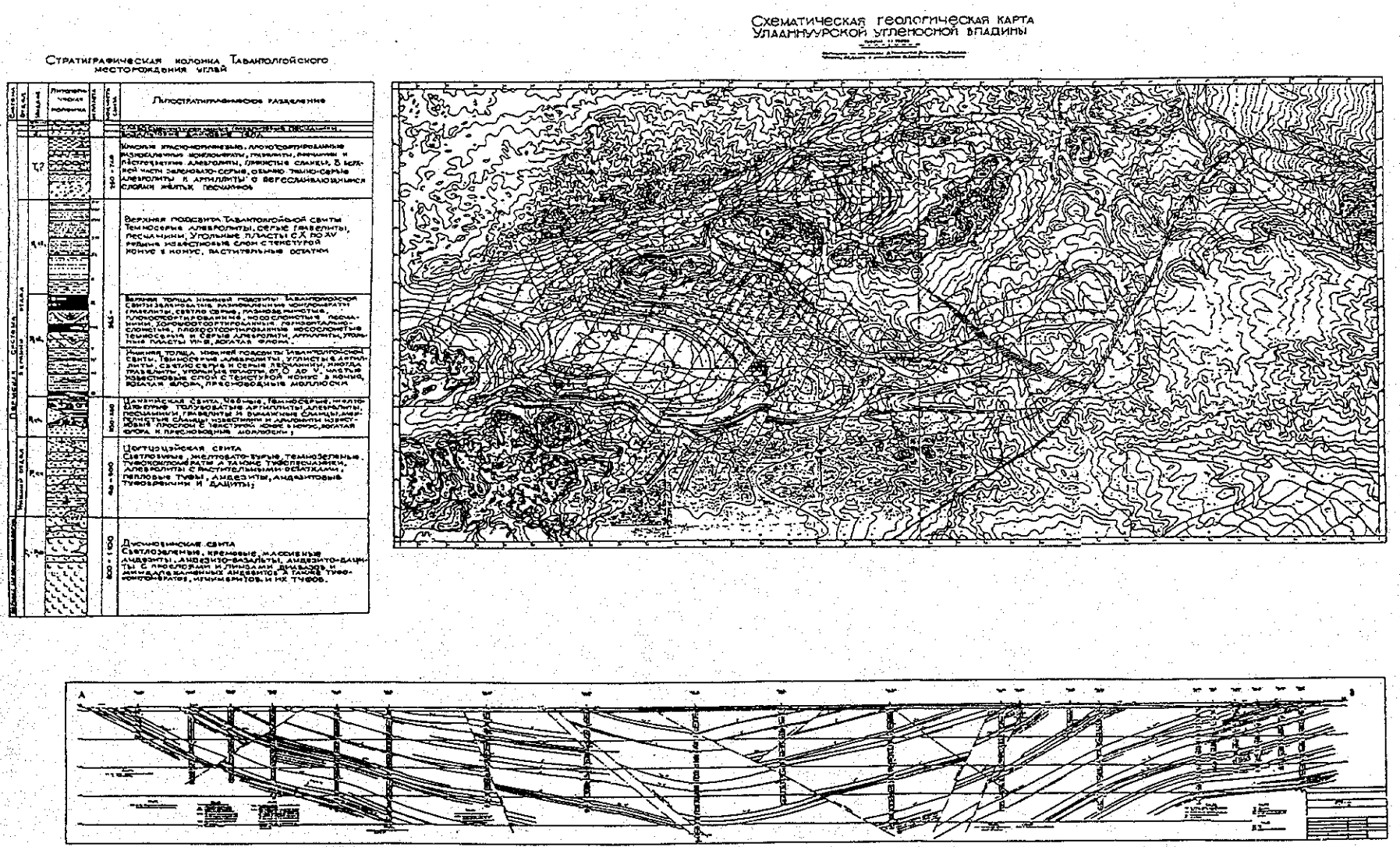
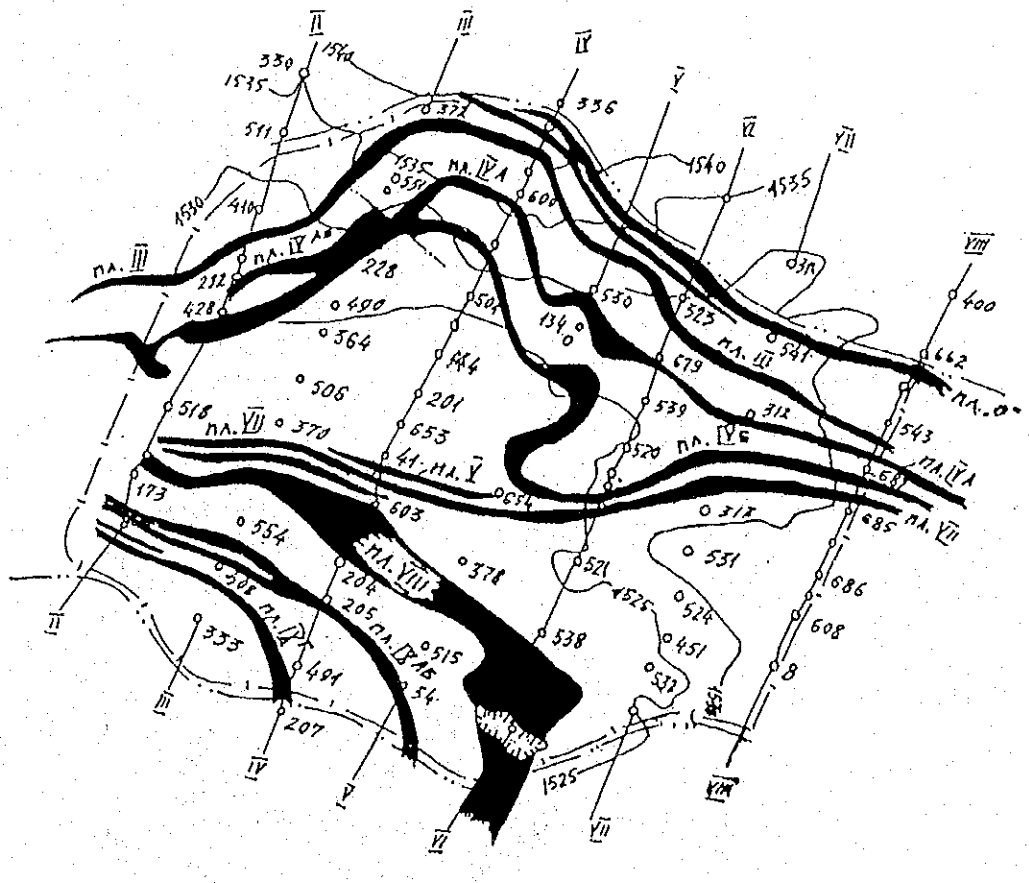


Figure 3.4 Geological Map of Tavantolgoi Deposit



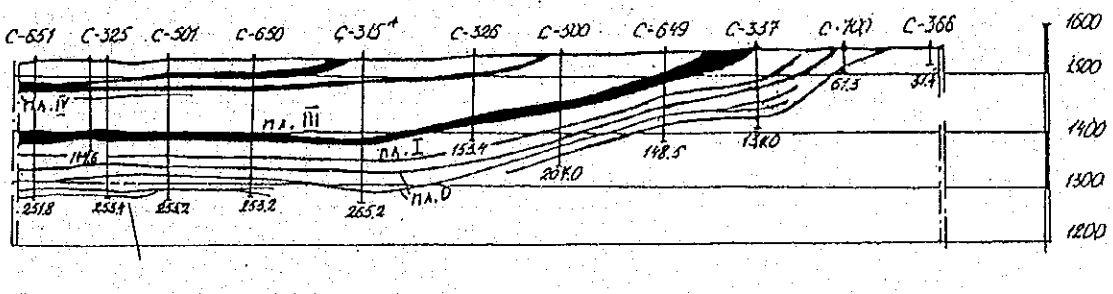


Figure 3.5 Seam Conditions of Tavantolgoi Mine

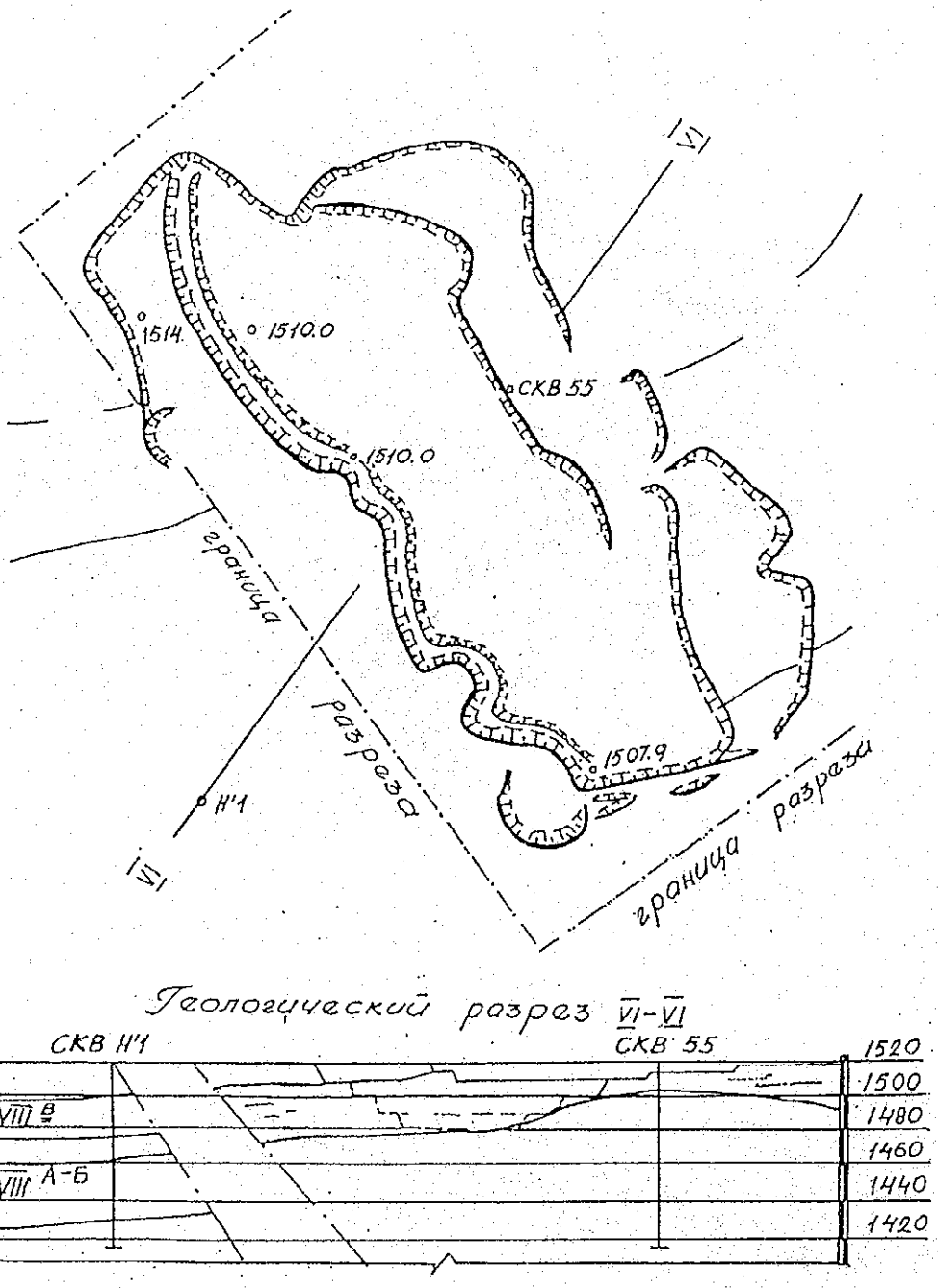


Figure 3.6 Schematic of Tavantolgoi Mine

coking coal reserves. According to the feasibility study carried out in 1990, the minable reserves within 300 m below the surface was calculated a total of 1,883.3 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 open cut in 1966. The total production until 1993 was 2.09 million tons with an average of 120 thousand tons/year and the coal was utilized by local consumers restricted in Omnogovi and Dornogovi Provinces. The schematic of mining site is shown in Figure 3.6.

(2) 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′ in longitude 106° 27′, 50 km southeast of Darkhan which is one of main stations along the Trans-Mongolian Railway (Figure 3.7). The land surface of the deposit forms a forestation 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
- drilling : 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 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 3.8). 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 as seen in Table 3.1. The general coals contain 15.0% moisture(as received), 17.5% ash(dry), 41.0% volatile matter(dry,ash free), and 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 open cut 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 open cut.

6) State of mining

The Sharyngol Coal Mine began to mine by open cut in 1965. The total produce until 1993 was 42 million tons with an average of 150 thousand tons/year and the coal was mainly utilized by power plants at Ulaanbaatar, Darkhan and Erdenet. The schematic of mining site is shown in Figure 3.9. The recent annual production 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 depends on the shortage of mining materials and increasing of stripping volume.

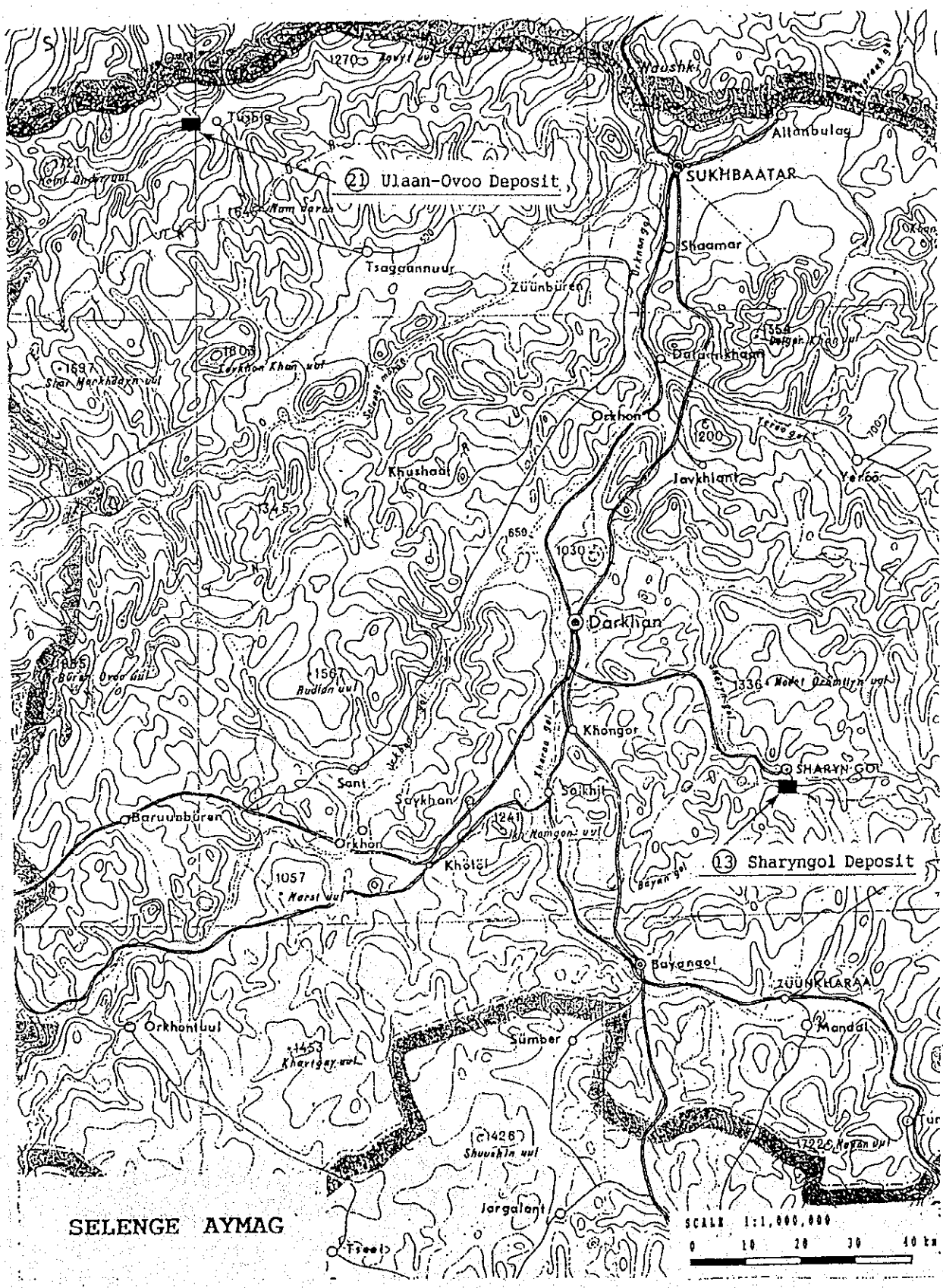


Figure 3.7 Deposit Locality Map in Selenge Province

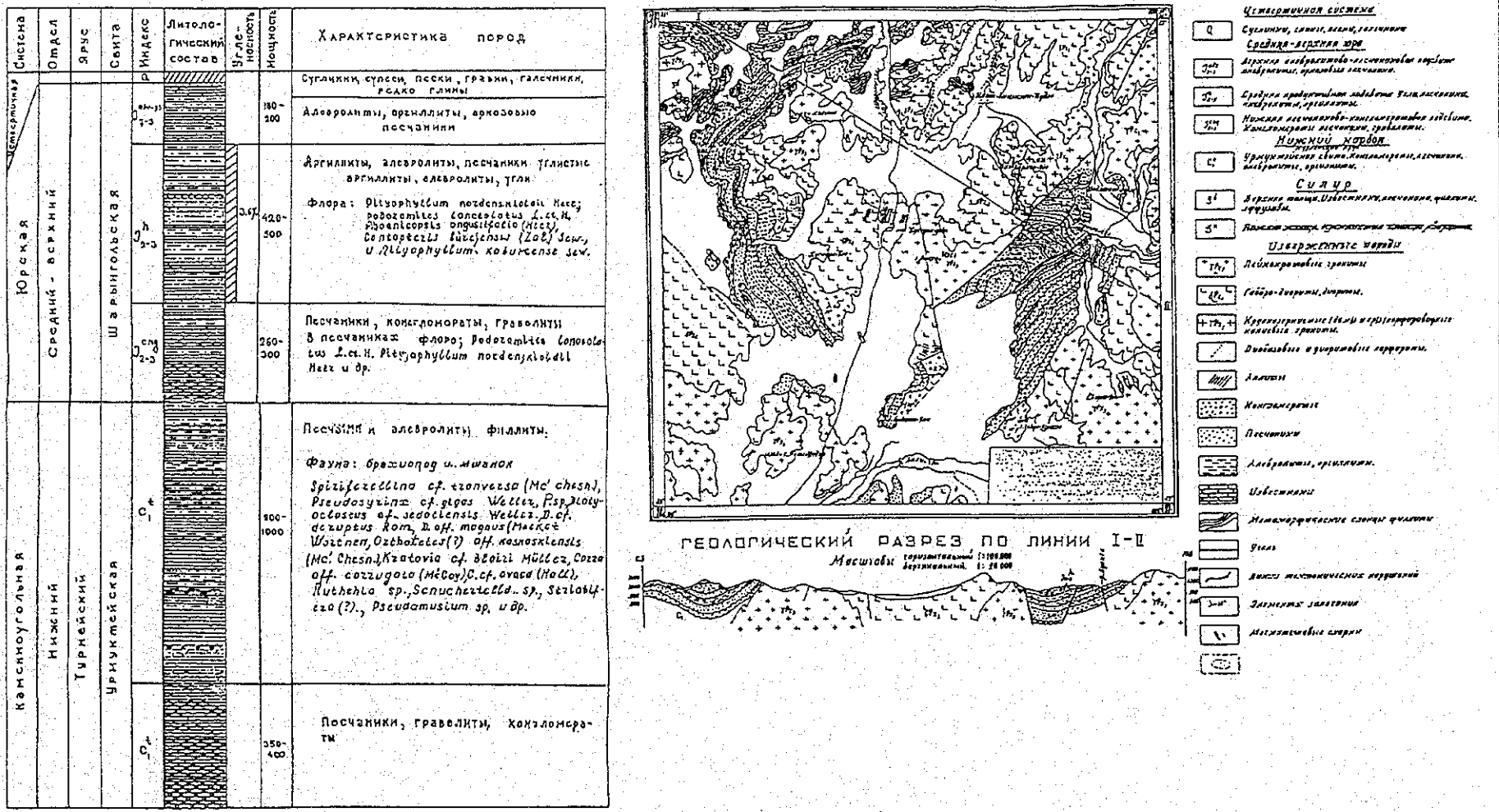


Figure 3.8 Geological Map of Sharyngol Deposit

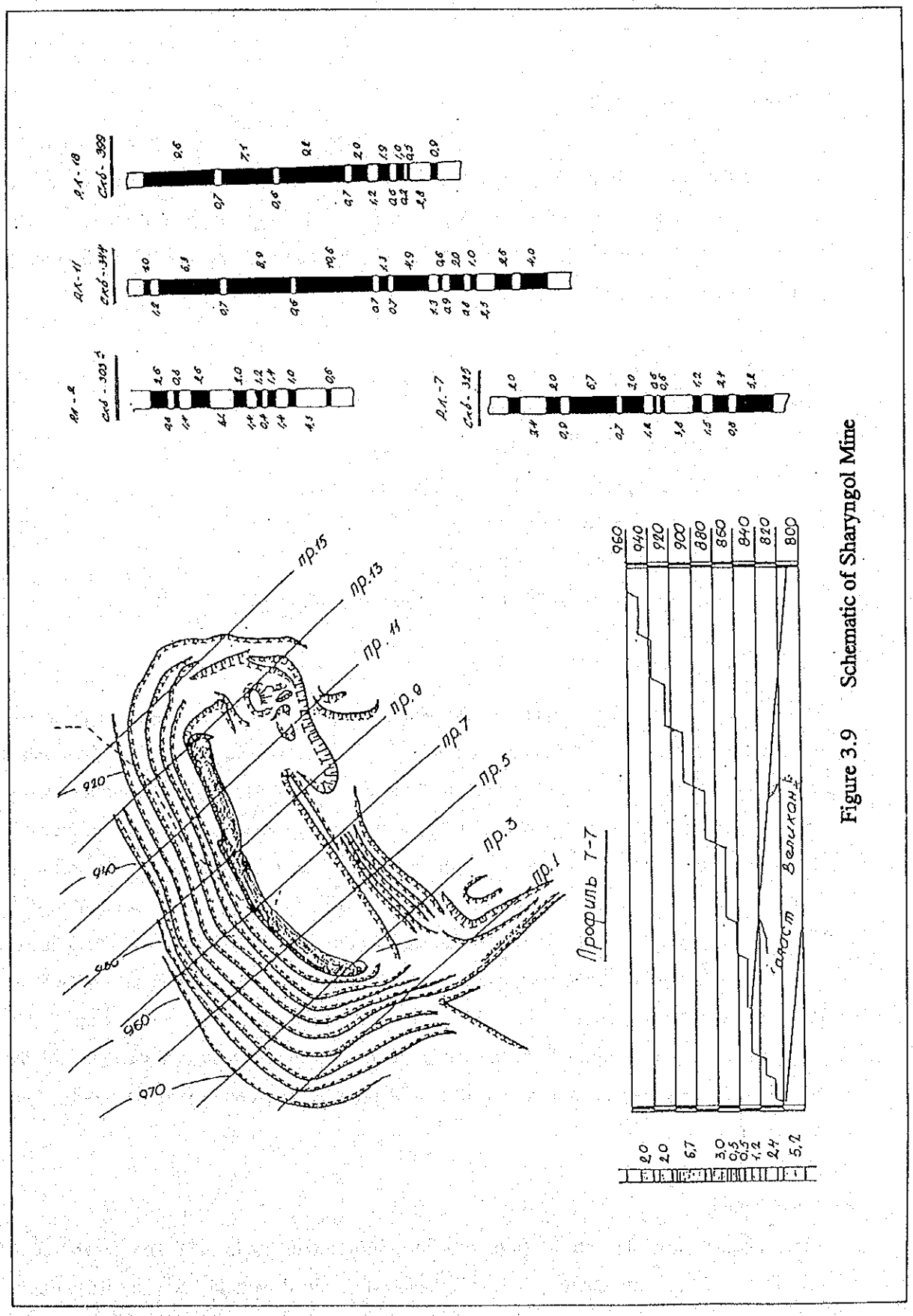


Figure 3.9 Schematic of Sharyngol Mine

(3) Chandgantal Deposit

1) Locality and topography

The Chandgantal Deposit is located, within the East Megablock and in Hentiy province. The center of the deposit is in latitude 47° 25′ N and in longitude 110° 25′, 280 km east of Ulaanbaatar, 160 km east-southeast of Baganuur and 40 km west of Ondorhaan which is the capital town of Hentiy province (Figure 3.10). The land surface of the deposit forms a flat steppe at 1,150 m above the sea level.

3) History of exploration

1941 : Discover of the coal deposit
- two seams of 1.5 m thick

1962-63 : Detailed exploration by the former Soviet Union
- trenching : 116 points
- drilling : 21 holes, 30-110 m/hole
interval of 150-400 m (with geophysical logging)

3) Coal geology

The Chandgantal Deposit belongs to the Choir-Niarga Coal-bearing Basin. The deposit extends for 1.5 km north-south and 2 km east-west with an area of about 3 km. Coal seams are embedded the same as the Baganuur Deposit in the Tevshiingovi Formation of the Dsunbayan Group in the Early Cretaceous time. The basic geological structure is formed of a homoclinal structure with a reverse fault (Figure 3.11). The coal seams trend west-northwest and gently dip 5-8° south. At the northeast part, the seams are cut by the reverse fault tending northwest and dipping 70° south with a displacement of over 20 m. There are a total of five coal seams ranging in thickness from 0.10 to 49.95 m. The minable seam is named the Seam II, which ranges in thickness from 30.45 to 49.95 m with two to five partings. The thickness of partings ranges from 0.10 to 3.40 m. The remarkable characteristics of the deposit are a thick coal seam of nearly 50 m and a thin overburden of 0 to 30 m only at the wide area.

4) Coal quality

The coals are classified into B2(mongolia, Russia-refer to Table 3.1) The general coals contain 30.6% moisture (as received), 12.3% moisture (air dried), 11.7% ash (dry), 46.5%

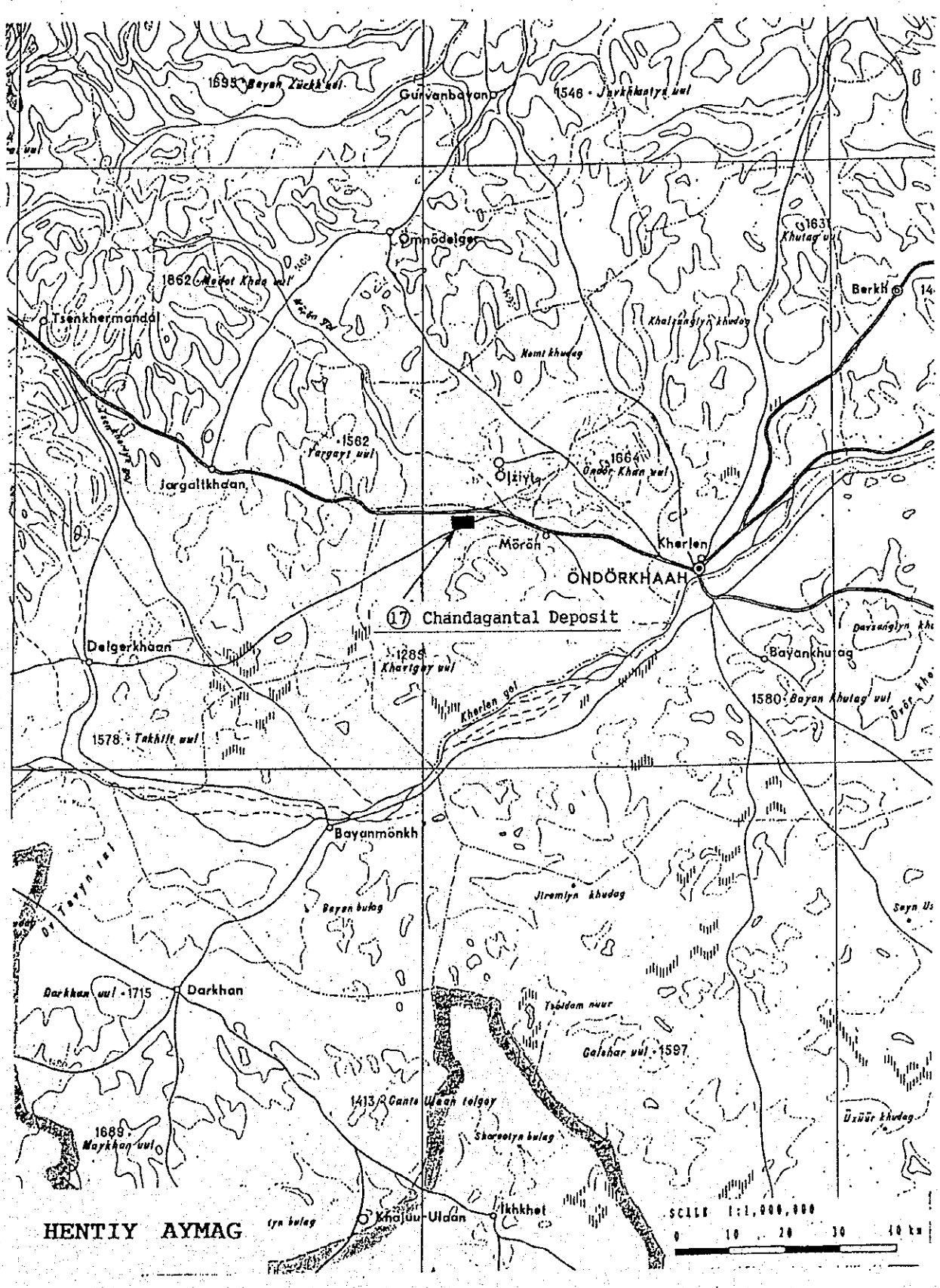


Figure 3.10 Deposit Locality Map in Middle of Hentiy Province

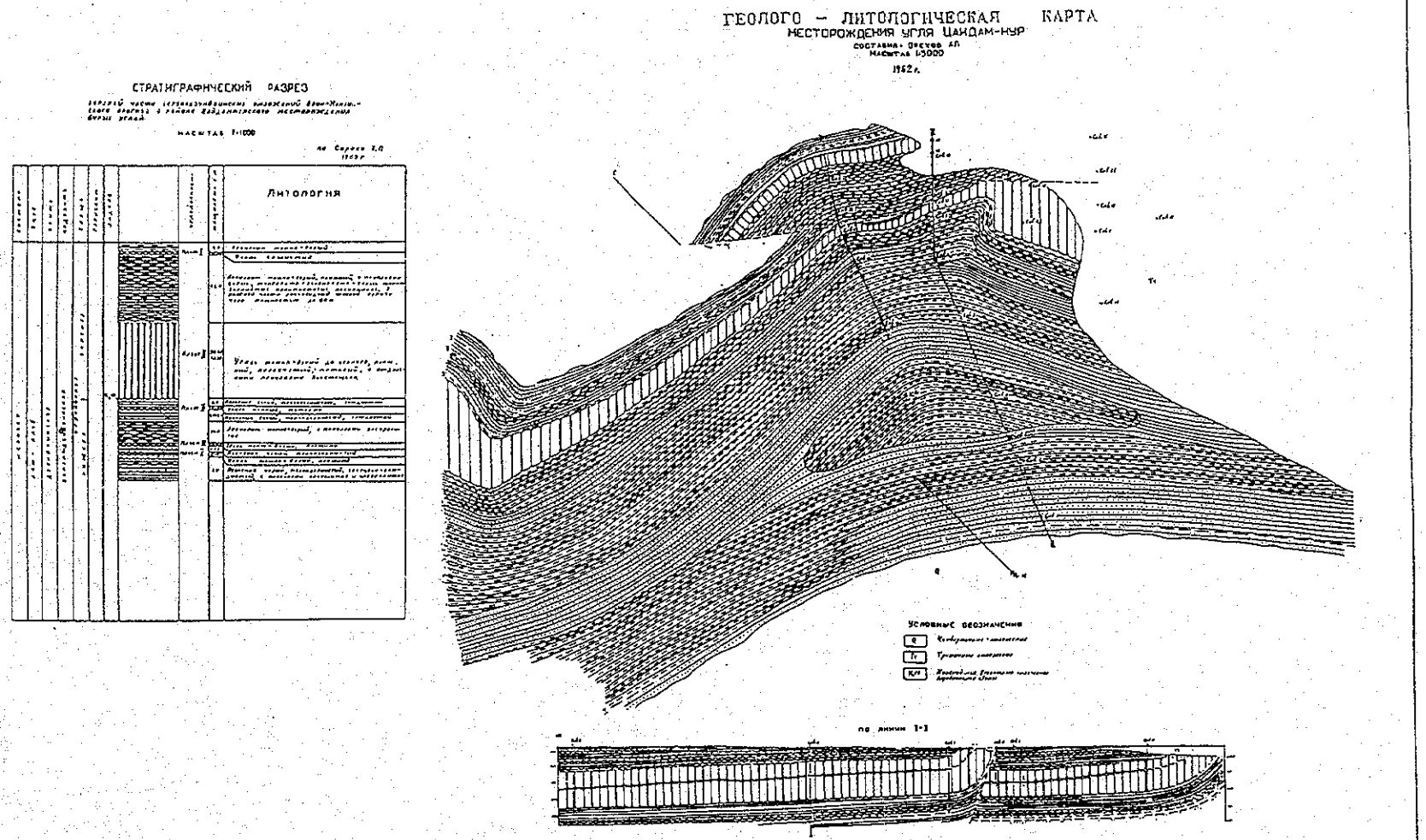


Figure 3.11 Geological Map of Chandagantal Deposit

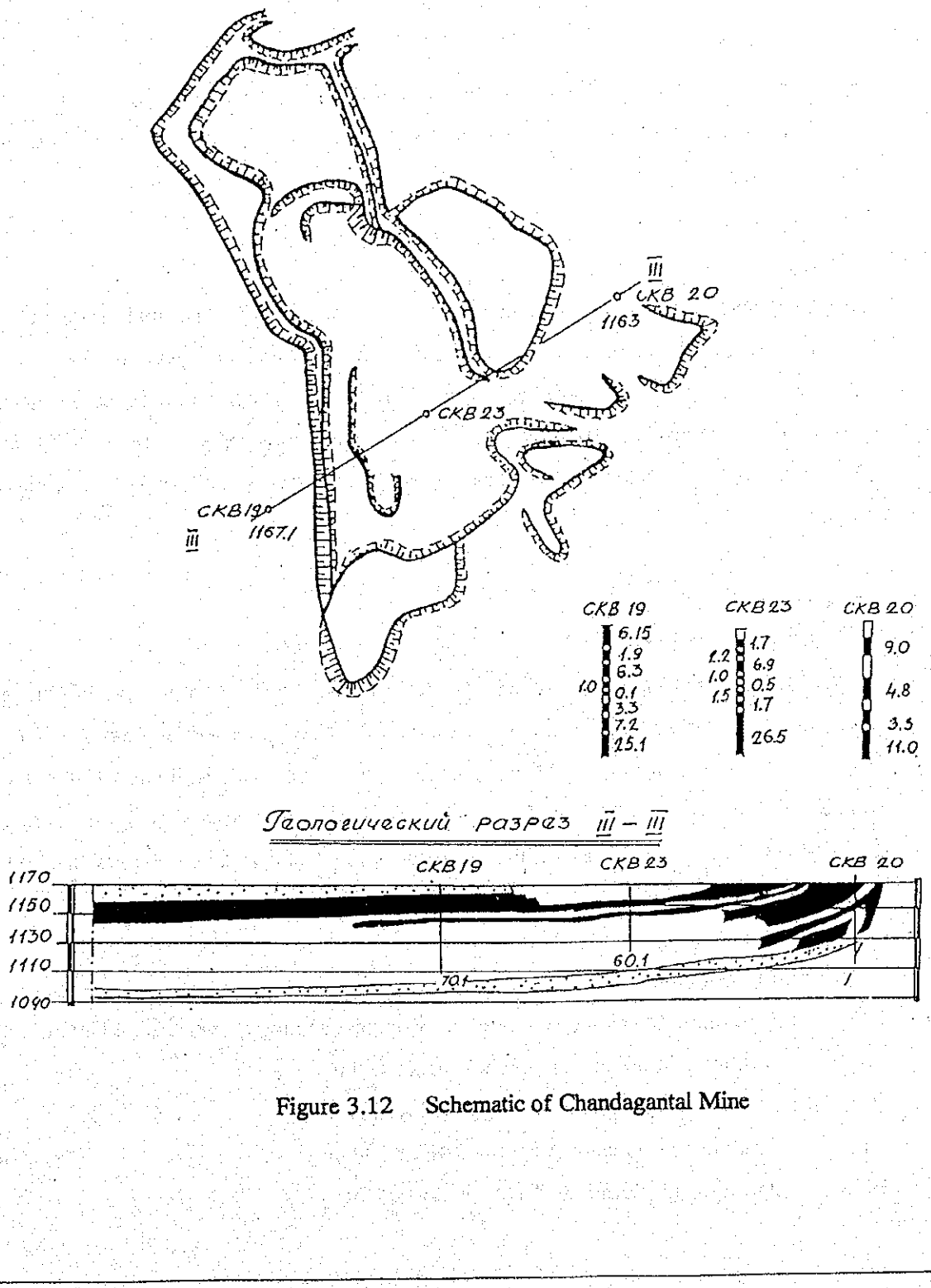


Figure 3.12 Schematic of Chandagantal Mine

volatile matter(dry, ash free), and 0.9% sulfur(dry). The calorific value is 3,000-3,400 kcal/kg(as received) and 6,580 kcal/kg(dry, ash free).

5) Coal reserves

For the area of 1.2 km x 0.8 km within 100 m below the surface, the coal reserves is estimated at 122.85 million tons of minable reserves($A + B + C_1$) and 212.99 million tons of total geological ones($A + B + C_1 + C_2$).

6) State of mining

The Chandgantal Coal Mine began to mine by open cut in 1966. The total production until 1993 was 1.65 million tons with an average of 120 thousand tons/year and the coal was utilized by local consumers restricted in Hentiy Province. The mine produced 55 thousand tons in 1993. The level of groundwater is 15 m in depth. This deposit is regarded as having a large potential of development because of plenty of reserves and a small stripping ratio (Figure 3.12).

(4) Khoot Deposit

1) Locality and topography

The Khoot Deposit is located within the Middle-East Megablock and at the east of Dundgovi province. The center of the deposit is in latitude 45° 39′ to 46′ N and in longitude 107° 39′ to 46′ E, 90 km southwest of Choir on the Trans-Mongolian Railway, 120 km east-southeast of Mandalgovi which is the capital town of Dundgovi province (Figure 3.13). The land surface of the deposit forms a flat steppe at 1,220-1,200 m above the sea level on the north of the Govi Desert.

2) History of exploration

1964 : Exploration by a joint expedition of Mongolia and the former Soviet Union
- drilling : 24 holes, maximum depth of 130 m

1992-94 : Exploration by a private sector (Mr. Munkhtogoo)
- drilling : 51 holes, maximum depth of 100 m

1993 : Start of open cut mining by the private sector

3) Coal geology

The Khoot Deposit belongs to the Middle Govi Coal-bearing Basin. The deposit confirmed by exploration extends for 5 km north-south and 5 km east-west with an area of about 25 km^2. Coal seams are embedded in the coal-bearing formation of Jurassic age. The basic geological structure is formed of a homoclinal structure with faults (Figure 3.14). The coal seams strike east-northeast and gently dip 5 - 12° south. There are a total of five coal seams: the Seam I to the Seam V in ascending order. The average of thickness and intervals is below:

Seam	Seam Thickness (coal thick.)	Interval
V	8.0 (8.0)m 10 m at the west	
		18 m
IV	6.4 (4.1)m	
		70 m
III	13.2 (5.5)m	
		70 m
II	14.1 (7.3)m	
		60-70 m
I	29.3 (13.1)m	

The existing mine shown as "A" at Figure 3.14 is working only the Seam V. Figure 3.15 shows the geological conditions of the mining site.

4) Coal quality

The coals are classified as seen in Table 3.1. The typical coal contains 13.8% total moisture (as received), 7.5% moisture (air dried), 14.5% ash (dry), 43.0% volatile matter (dry, ash free), 0.7% total sulfur (dry) and show a calorific value of 4,800 kcal/kg (as received) and 7,030 kcal/kg (dry, ash free). The coals produced at the existing mine contain 23% total moisture (as received), 13.4-35.0% ash (dry), 45.0% volatile matter (dry, ash free), less than 1.0% total sulfur (dry) and show a calorific value of over 3,000 kcal/kg (as received) and 6,600 kcal/kg (dry, ash free). Deep coals are estimated as of higher than present coals in quality.

5) Coal reserves

The coal reserves within 100 m below the surface is estimated as a total of 190.9 millon tons as follows:

Seam	Reserves (million tons)	Rank
V	82.3	(C_1)
IV	9.3	(C_2)
III	26.4	(C_2)
II	65.8	(C_2)
I	7.1	(C_2)
	190.9	

6) State of mining

The Khoot Mine has began as a small scale open cut mine by Mr. Munkhtogoo in July, 1993. The production in 1993 was a total of 3,800 tons and utilized by local consumers, of which 100 tons of coal was sent to Mandalgovi City.

7) Oil shale resources

In the deposit, it is noteworthy that a oil shale bed conformably overlies the coal bearing bed with a interval of 10-20 m above the Seam V. The oil shale bed has a maximum thickness of 100 m. According to the report by Mr. Munkhtogoo in 1994, owner of the Khoot Mine, the oil yield of oil shale samples, about 370 samples, generally ranges from 4 to 15%, 22% in maximum. On the project "Research on exploration and development of mineral resources in Mongolia" conducted by Institute of Geology and Mineral Resources in Mongolia and Geological Survey of Japan and financed by Agency of Industrial Science and Technology, Ministry of International Trade and Industry of Japan in 1991-92, a total of 10 oil shale samples were analyzed to show that the oil yield ranges from 2.89 to 11.82%, 7.88% on average. One sample collected during our study in 1994 was analyzed in Japan to show such results as oil yield of 5.3%, moisture of 4.9%, ash(shale) of 83.8%. Based on a general opinion that the value of 10 US gallon per ton (about 4.7%) is frequently used as the lowest limit of oil yield for oil shale. The Khoot oil shale can be regarded as having the potential of utilization. The oil yield of the Fushun oil shale in China, which is being mined and utilizing, is only less than 4%. If the coal below the oil shale bed is mined by open cut, mining cost for the oil shale can be estimated so low that the development plan of the Khoot mine should be considered with the utilization of oil shale.

The oil shale reserves at the area within 100 m below the surface, containing over 5.5% of oil yield, is estimated as 612.36 million tons: 18,900 km^2 (area) x 16.2 m (thickness) x 2.0 (specific gravity). Regarding as 7.0% of oil yield on average, the total oil yield is estimated

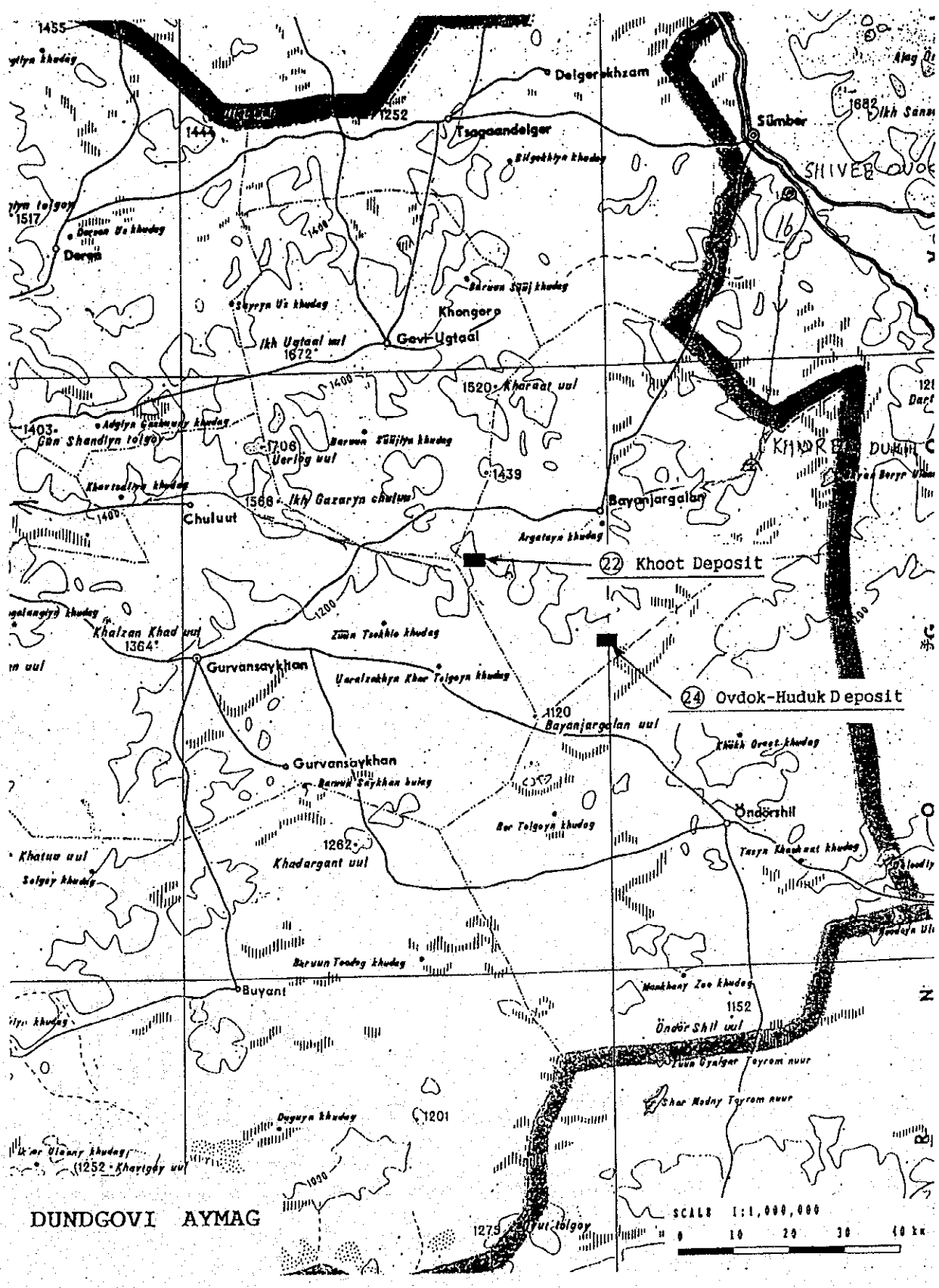


Figure 3.13 Deposit Locality Map in East of Dundgovi Province

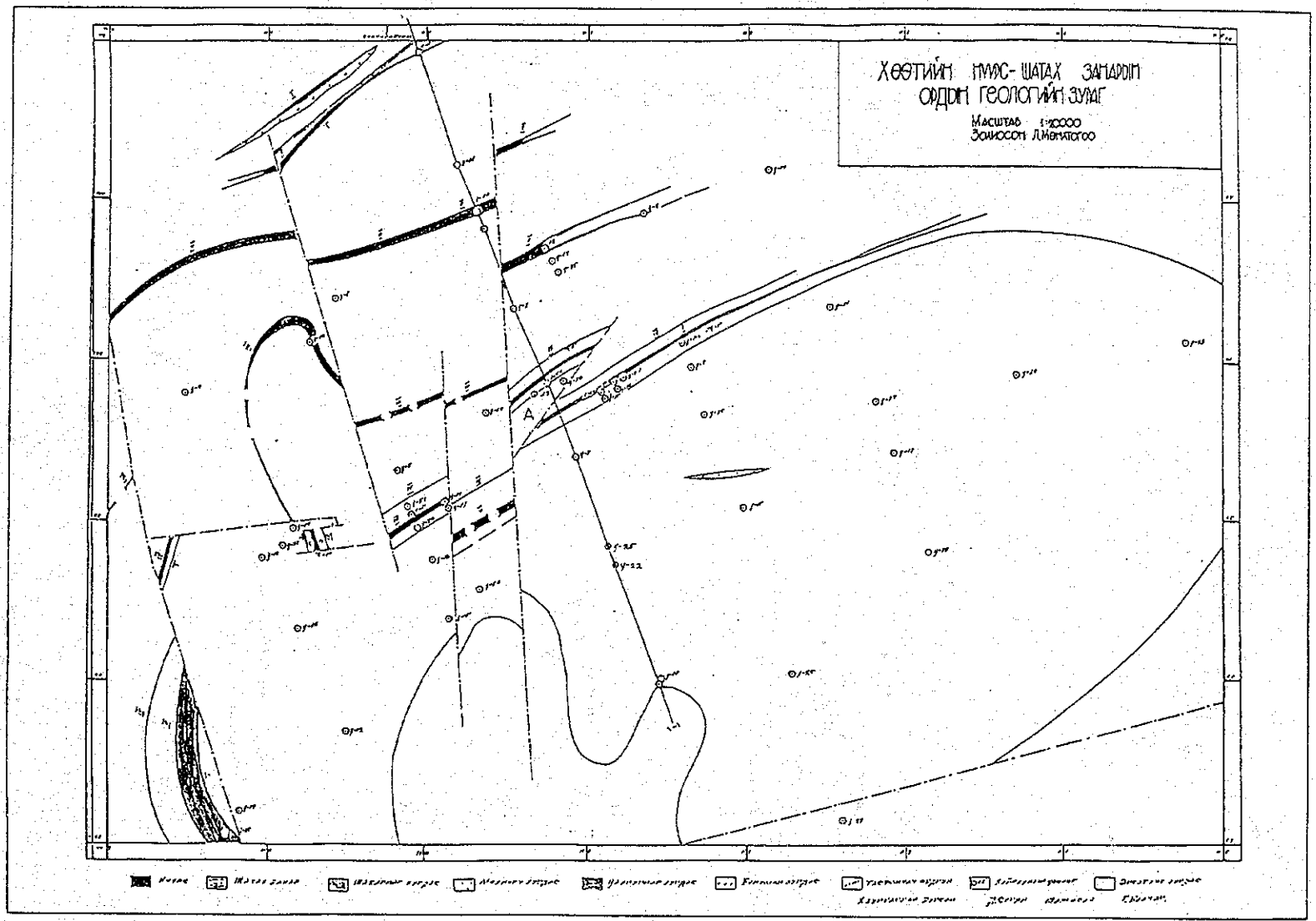


Figure 3.14 Geological Map of Khoot Deposit

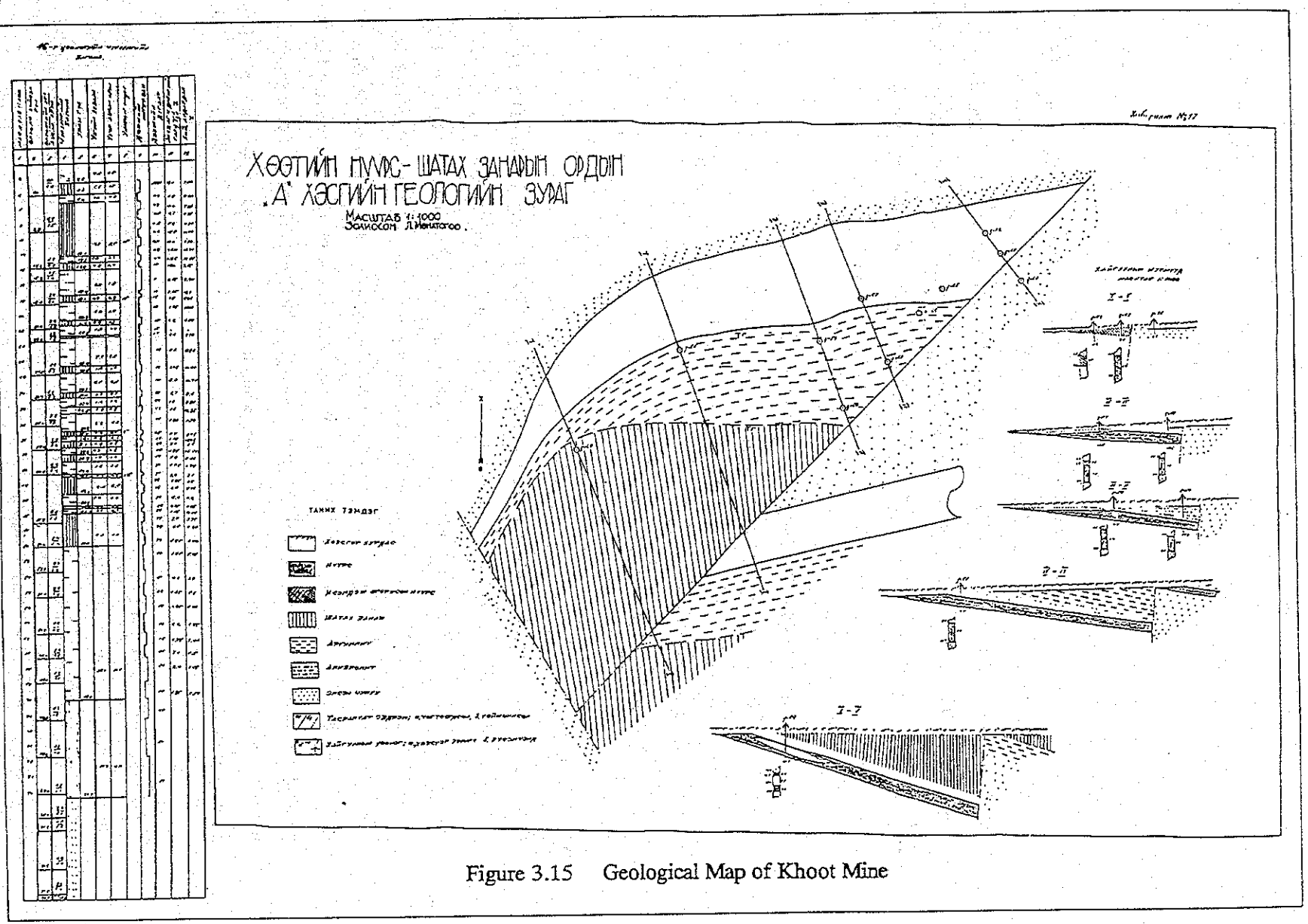


Figure 3.15 Geological Map of Khoot Mine

as 42.9 million tons.

(5) Tsaidamnuur Deposit

1) Locality and topography

The Tsaidamnuur Deposit is within the Middle-East Megablock and at the southeast of Tov Province. The center of the deposit is in latitude 47° 22′ N and in longitude 108° 00′ E, 100 km southeast of Ulaanbaatar, 20 km south from the railway connecting Baganuur and Ulaanbaatar, also 20 km east from the Trans-Railway (Figure 3.16). The land surface of the deposit is at 1,400 m above the sea level and forms a flat to gently undulating steppe.

2) History of exploration

1940s : Firstly recorded by Russian geologists

1980s : Exploration (roughly) by Mongolia

- prospecting line : 12 lines, interval of 4 km
- additional line : 2 lines
- drilling : about 80 holes, interval of 1-2 km

3) Coal geology

The Tsaidamnuur Deposit belongs to the Choir-Niarga Coal-bearing Basin. The deposit shows a elongated basin extending for 40 km northeast and 10-15 km wide, with an area exceeding 500 km^2. Coal seams are embedded, the same as the Baganuur and Shivee Ovoo Deposits, in the Tevshiingovi Formation of the Dsunbayan Group in Early Cretaceous time. The basic geological structure is formed of a elongated synclinal basin structure with an axis tending northeast. It is presumed that the basin structure is cut by three transverse faults tending northwest, being subdivided into four blocks (Figure 3.17). The dip of coal seams is regarded as less than 10° in general. The lowest seam level in the deposit is estimated at 400-500 m below the surface.

There are, a total of seven to eight coal seams 'observed in the deposit', showing a variable thickness with partings and splitting. The maximum seam thickness is confirmed to reach to 70 m by drilling. The detailed geological conditions of coal seams have not yet been clarified owing to the low degree of exploration.

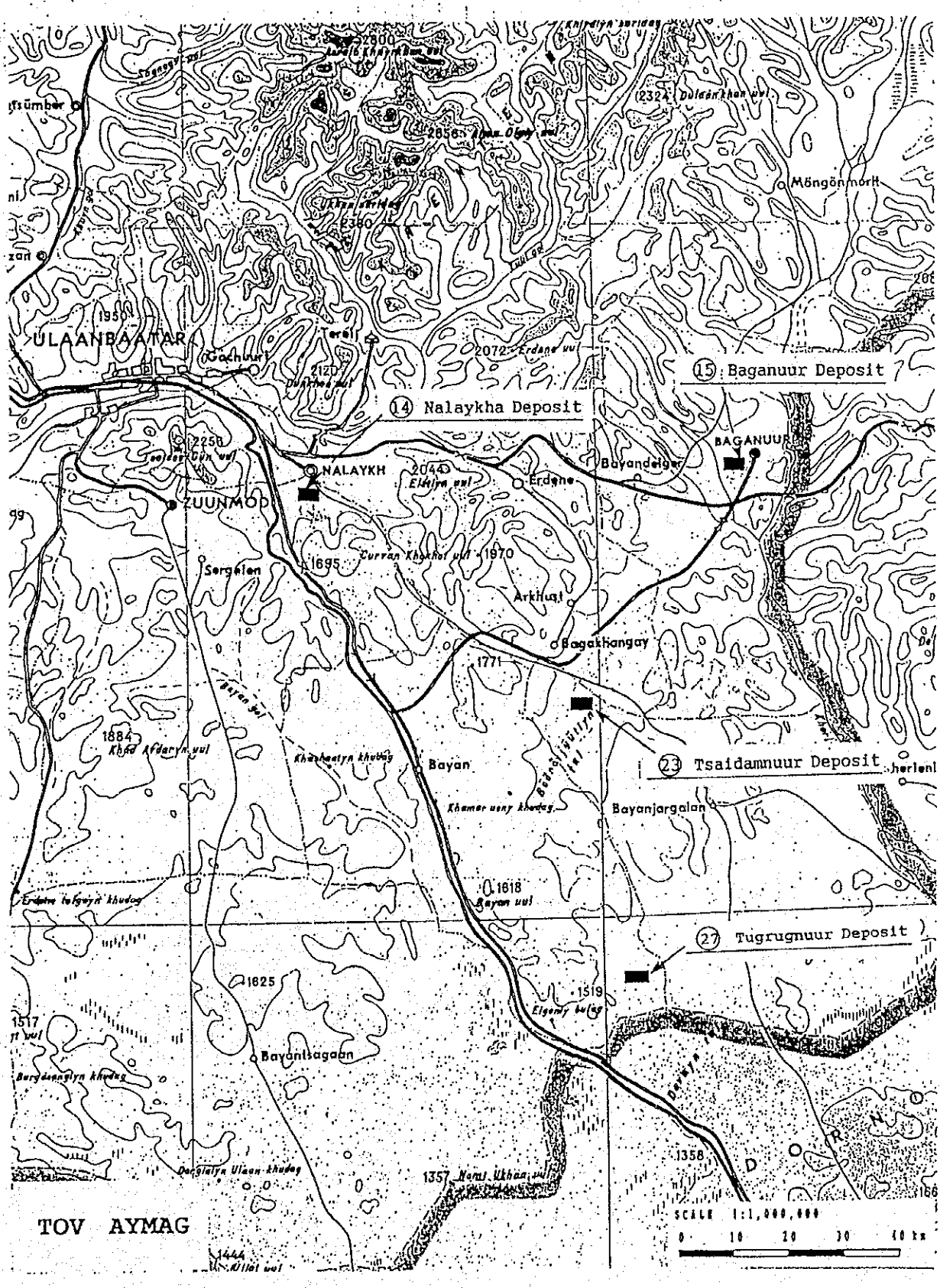


Figure 3.16 Deposit Locality Map in Tov Province

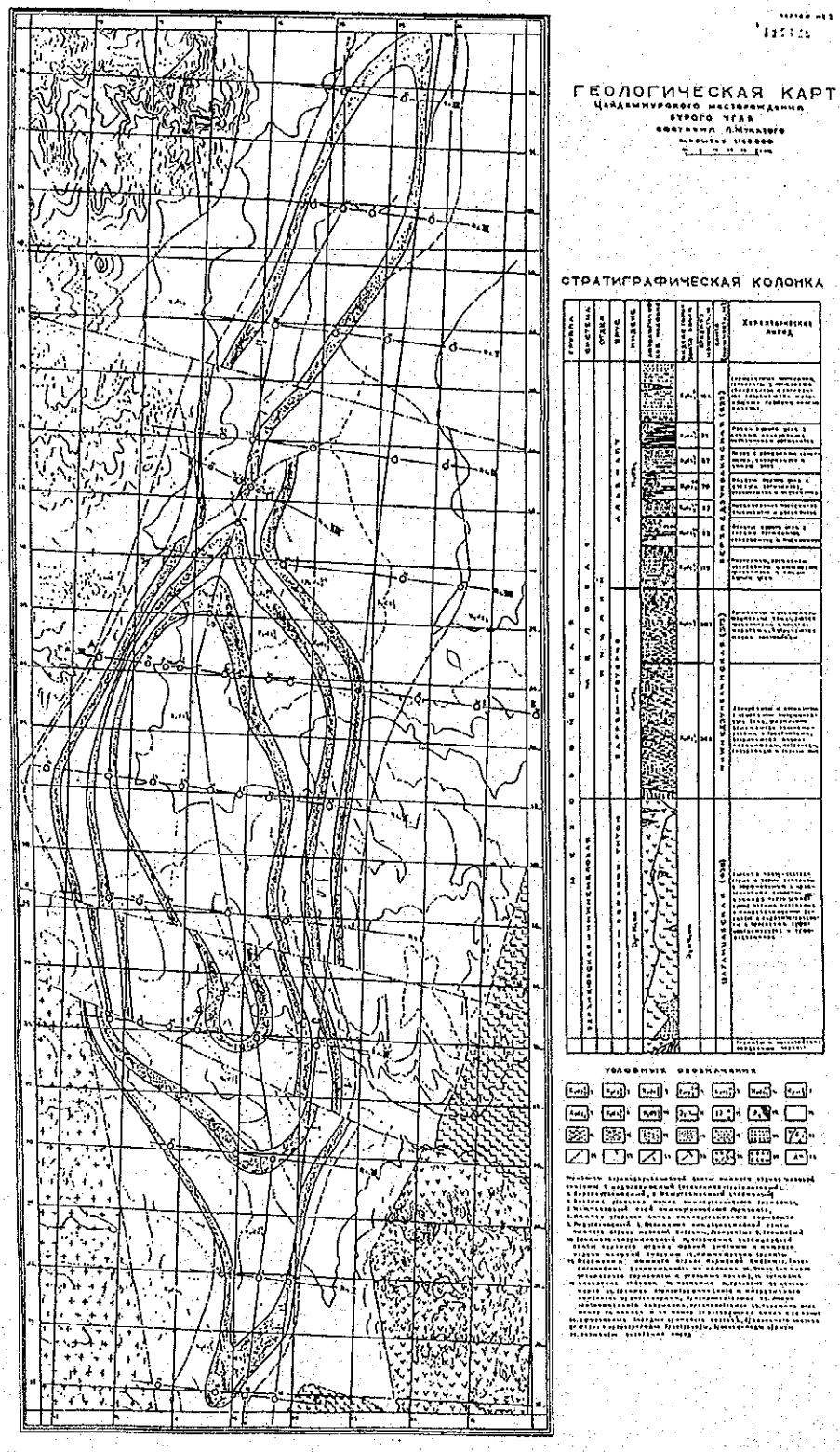


Figure 3.17 Geological Map of Tsaidamnuur Deposit

4) Coal quality

The coals are classified as seen in Table 3.1. It is reported that the general coals show the same quality as the Baganuur's.

5) Coal reserves

The total geological reserves for the whole deposit within 500 m below the surface is roughly estimated as 4,000 million tons (C_2+P). The reserves within 300 m below the surface is a total of 1,700 million tons (C_2), of which 500 million tons is estimated at the central area where thick coal seams are regarded as being favorably distributed for open cut mining. Since the detailed exploration has not yet been conducted, the minable reserves is not estimated.

6) State of mining

There is no activities for mining and/or exploration.

(6) Tugrugnuur Deposit

1) Locality and topography

The Tugrugnuur Deposit is located within the Middle-East Megablock and at the southeast of Tov Province. The center of the deposit is in latitude 46° 55′ N and in longitude 108° 07′ E, 150 km southeast of Ulaanbaatar, 110 km south of Nalaikh, 20 km southeast of the south end of the Tsaidamnuur Deposit, 20 km east from the Trans-Railway connecting with Ulaanbaatar (Figure 3.16). The land surface of the deposit is at 1,300 m above the sea level and forms a flat to gently undulating steppe.

2) History of exploration

1952 : Firstly recorded

1984 : Exploration (roughly) by Mongolia

- drilling : 6 holes
- trenching

3) Coal geology

The Tugrugnuur Deposit belongs to the Choir-Niarga Coal-bearing Basin. The deposit is regarded as extending 10 km x 10 km with an area of about 80 km^2. The extension of coal

seams is not clarified because the exploration has not yet been conducted sufficiently. Coal seams are embedded, the same as the Baganuur, Shivee Ovoo and Tsaidamnuur Deposits, in the Tevshiingovi Formation of the Dsunbayan Group in Early Cretaceous time. The geological structure is characterized by a dome structure accompanied with a synclinal fold around it (Figure 3.18). The coal-bearing formation occurs at the synclinal structure around the dome. The dip of coal seams appears to be gentle less than 10°.

There are two groups of coal seams the same as the seam conditions of the Shivee Ovoo Deposit, the upper and lower groups. A total of three drill holes encountered coal seams. One coal seam was observed at the Hole C-2 from 5.2 to 50.5 m in depth with a seam thickness of 45.3 m (Figure 3.19). Although the details on geological conditions, in particular coal seam conditions, have not yet been clarified, it is expected that the occurrence of coal is the same as one of the other deposits of Early Cretaceous age, such as the Shivee Ovoo and Tsaidamnuur Deposits.

4) Coal quality

The coals are estimated to be classified as seen in Table 3.1. Although it can not be regarded as showing the typical quality because of restricted data, one coal sample contained 7.31% moisture (air dried), 14.89% ash (dry), 50.63% volatile matter (dry, ash free) and 0.81% sulfur (dry). The calorific value was 6,242 kcal/kg (dry, ash free).

5) Coal reserves

The total geological reserves for the whole deposit within 300 m below the surface is roughly estimated as 695 million tons, although the reliability is of scarcity because the extremely low degree of exploration.

6) State of mining

There is not any activities for mining and prospecting.

3.1.3 Mining conditions and capacity of existing coal mines

(1) General information on existing coal mines

There are many coal deposits in Mongolia. Coal reserves are tremendous, and geological structure is simple and moderate. Coal seams lie near surface. The mining method of coal mines

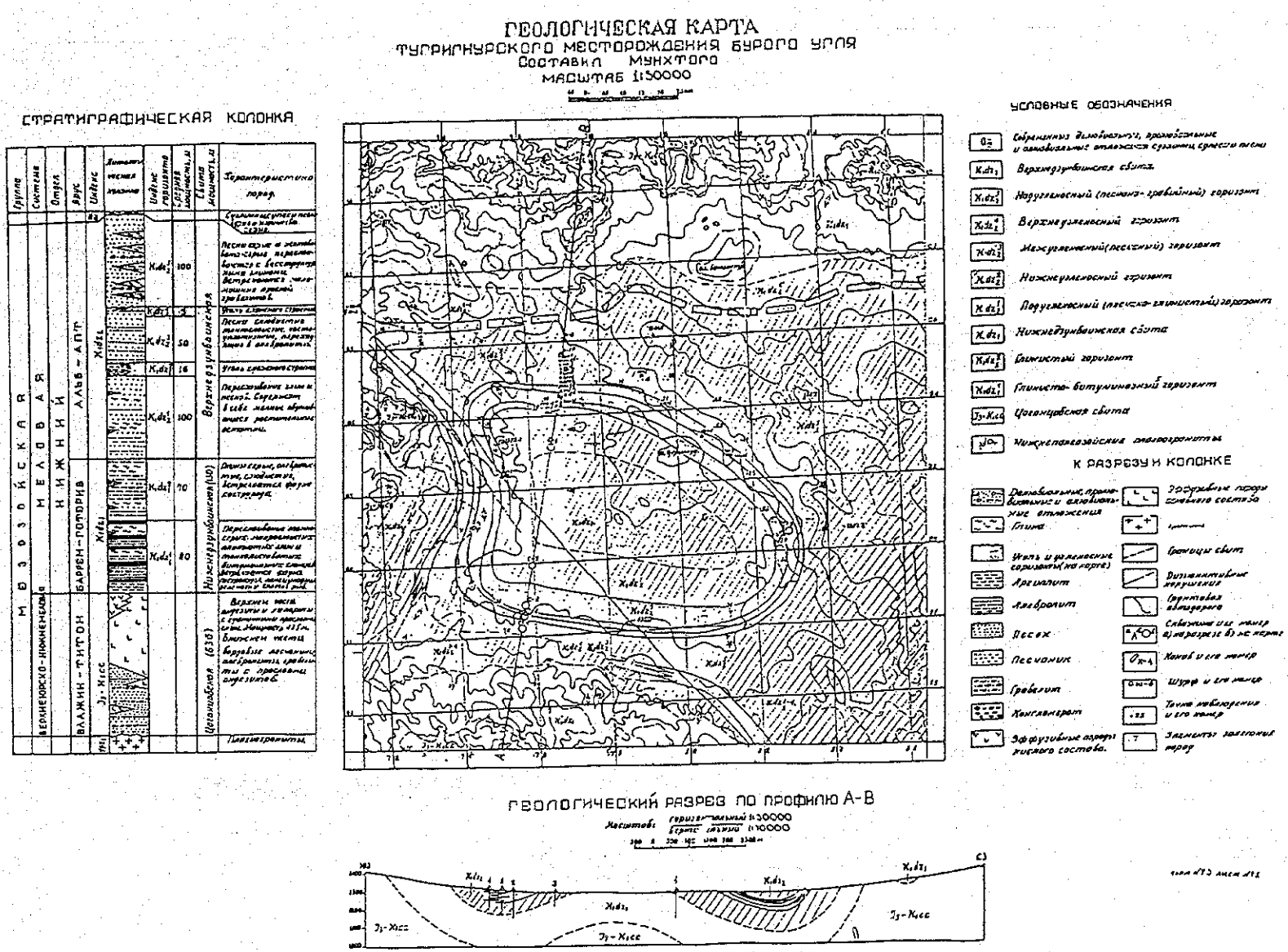


Figure 3.18 Geological Map of Tugrugnuur Deposit

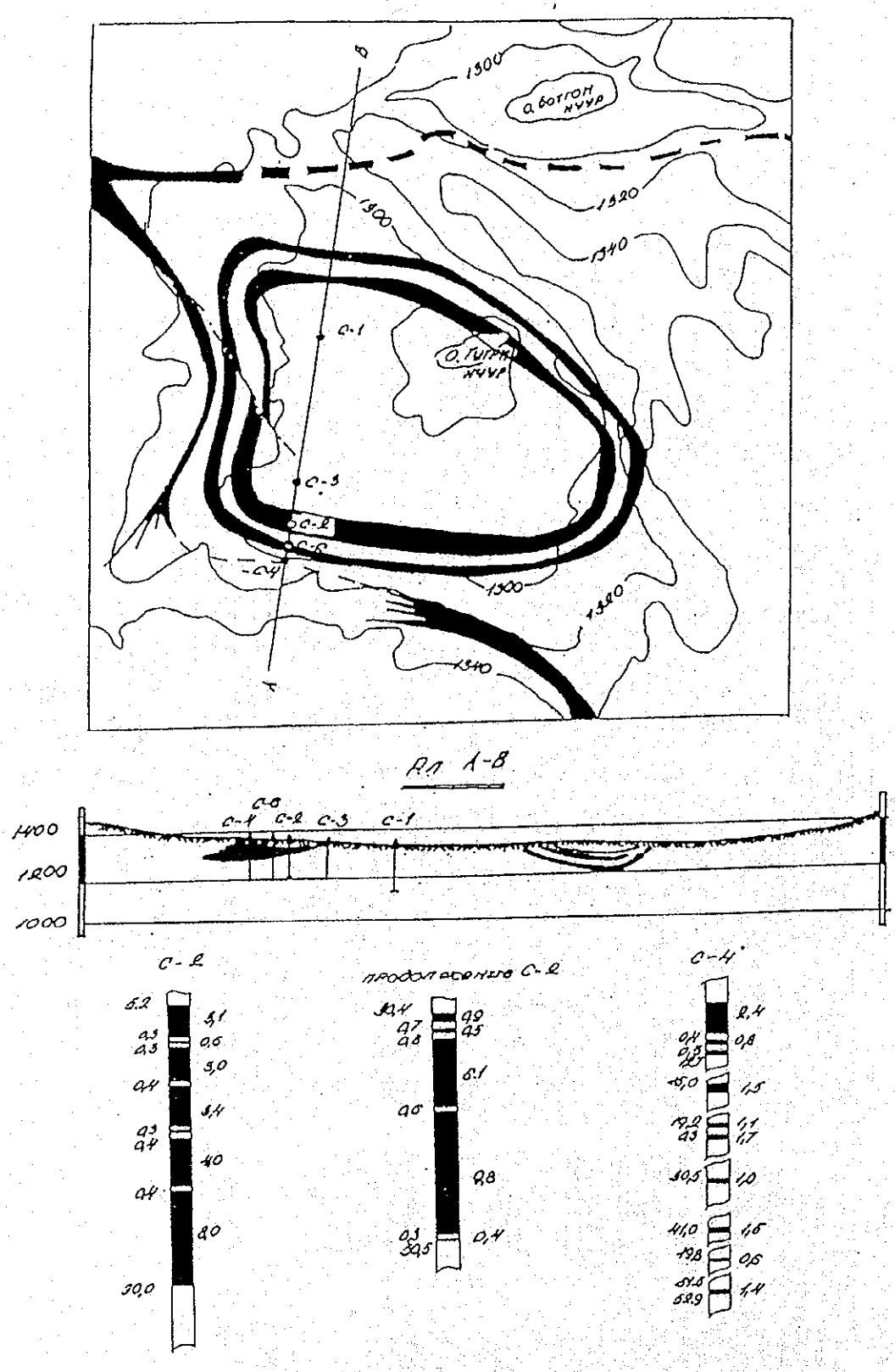


Figure 3.19 Seam Conditions of Tugrugnuur Deposit

in Mongolia is open pit except two coal mines as the coal mining condition is suitable for open pit. In making a plan to expand existing coal mines or to develop new coal mines, only the open pit mining method would be adopted from the economic and technical point of view. The existing coal mines in Mongolia are found in four regions, the western, central, eastern and southern regions.

The western region is characterized by its mountainous topography, complicated geological structure, hard rock seams, small scale coal mine due to small coal demand, and relatively high coal quality. The central region is characterized by its topography of plain, steady geological condition, large scale coal mine due to large coal demand, and low coal quality. The eastern region is characterized its topography of plain, steady geological condition, large amount of ground water, small scale coal mine due to small coal demand, and low coal quality. The southern region is characterized by its semi-desert climate, shortage of water supply, small scale coal mine due to small coal demand, and good coal quality.

The coal mines in Mongolia can be also categorized into two groups by the amount of annual coal production. One is the local small coal mines, and the other is major coal mines with the large capacity. The local small coal mines are characterized by their small amount of production, seasonal mining operation (only during winter), mining machine maintenance system which is not done by their own machine shop but by Nuurs company **, and their small scaled mining machine (diesel rope shovel with $1m^3$ bucket).

(Note**) : General information on the mobile maintenance and repair team of Nuurs Company

a) The team is based at Ulaanbaatar
b) The team consists of one mechanical engineer and six mechanics, who have abundant experience and ability to guarantee.
c) It used to receive order of small-scaled coal mine made by a person in charge of machine maintenance.
d) Recently it is called only in the occurrence of breakdown or failure of mining machines instead of scheduled maintenance because of shortage of spare parts and funds.

This group supplies their produced coal to small cities, for example, center of province as fuel of boiler and local metal or nonmetal mines and domestic use. On the other hand major coal mines are characterized by their large amount of annual production, full season mining operation, mining machine maintenance system which is carried out at their own machine shop, and large size mining machines (electric rope shovels with the bucket size of 5 m^3 and 8 m^3). This group of coal mines supplies their produced coal to power plants in Central Energy System to factries in the majer cities. The present situation of two types of coal mines are shown on Table 3.4. From this table following matters would be recommended to improve existing coal mines in Mongolia.

1) Selection of the suitable equipment for mining conditions of each coal mine.
2) Establishment of appropriate machine operation system.
3) Introduction of the most modern diesel mining machines.
4) Establishment of machine maintenance system.
5) Introduction of machine manufacturer's support system.
6) Establishment of training and instruction system and facilities for operator and maintenance work force.
7) Education of middle class management.

(2) Mining operation factors of each coal mine

The key factors to realize the mining condition of each coal mine and estimate the capacity of each coal mine, are coal quality, mining condition, geological condition, mining machines, operating hours and drainage system. They are shown in Table 3.5. The present situation of each coal mine could be evaluated from these factors. The future rough production plan could be made by using simple formulae and these factors.

Among these factors, coal quality, mining condition, geological condition are providential. In planning mining activity, it is needed to say that the selection of the most appropriate mining method to given mining condition is essential. The shape of working face and the procedure of mining operation are decided by mining machines which are adopted to stripping and coal mining. Therefore, the selection of mining machine is most important.

Among various type of mining machine in open pit mines, the shovel and truck system is the

Table 3.4 General Information on Coal Mines in Mongolia

		Local small coal mines	Major coal mines (supplier to CES, etc.)
1	Operation System	(1) Operated according to demand. During summer only stripping is conducted. (2) Stock of coal is conducted by only supplies (boiler, etc.) in autumn. Stock of coal in mine site is not conducted. (3) If large amount of overburden is stripped and large area of coal is exposed, spontaneous combustion is apt to occur. (4) Ordinary operation system is one shift.	(1) Operations of Baganuur, Shivee Ovoo and Sharyn Gol are conducted by 3 shifts system. (2) Operation of Aduunchuluun is conducted by 2 shifts (Aduunchuluun coal mine supplies to near by power plant.)
2	Transportation to users	Users transports coal from mining site to their destination by their own trucks (Only loading coal is conducted by excavator of coal mine)	(1) Each coal mine loads coal into wagons and transports by rail. (2) Aduunchuluun coal mine transports coal to near by power plant directly by trucks (distance of one way is about 2.5km)
3	Coal stock and drying	Drying coal by stock is not conducted.	(1) Coal is dried during being stocked. (2) There is scarecely problem of spontaneous combustion during stock. (There was an example in Baganuur.)
4	Crushing and Sizing installation	Even sizing equipment is not installed	Only Baganuur and Sharyn Gol have Crushing and Sizing installation (In Nalaikh coal mine, hand piching and sizing used to be conducted.)
5	Road	(1) Roads of each coal mine are not constructed by particular finishing. (2) Road inclination is 7 or 8 %.	(1) Roads are not constructed by particular finishing. (Road maintenance is done by graders) (In Bananuur roads without pit are finished by as plait.) (2) Road inclination is 7 or 8%.
6	Communication	Nothing inside pit. (ex. in Tevshiin Govi, there is a radio in only manager's room.)	Radio and telephone are installed.
7	Water supply system	Utilization of ground water.	In Sharyn Gol, both coal mine and town are supplied from Sharyn Gol River. In Baganuur, both coal mine and town are supplied from Herlen Rive
8	Boiler device	Small boiler device is installed. (also shower device)	Ex: In Sharyn Gol, both coal mine and town are supplied hot water from common boiler.
9	Magazine storage, fuel depot, parts warehouse	(1) Small scale facilities are built. (Every facilities is planned by common specification in each feasibility study) (2) Storage is only one in each coal mine for common use.	All facilities are built and managed according to requlations.
10	Implementation of overhaul	Repair and maintenance party of Nuurs Company comes to each mining site and overhauls mining machine. (During 2 or 3 years overhaul has not been implemented because of shortage of funds)	In Baganuur and Sharyn Gol, overhaul is implemented by their own maintenance shop.
11	Repair shop	Repair shop is poorly equipped with only lathe, fraise and welder.	Bagannur, Sharyn Gol and Aduumchuluun (small scale) are well equipped.
12	Parts supply system	All coal mines purchase necessary parts from their own sources.	
13	Basic combination of mining machines	Excavator (1m³ rope shovel) + 12t of trucks, Bulldozer (110 to 120H), Drill (160～200mm φ) (Each coal mine is planned by using the same machines in feasibility study.)	Excavator (5m³ rope shovel) + 27 to 32t of trucks (Belaz) Excavator (8m³ rope shovel) + 40 to 42t of trucks (Belaz) Bulldozer (250H), Drill (160～250 mmφ)
14	Blasting	(1) Explosives are ANFO and AMMONITE and detonating fuse system is adopted (as countermeasure against thunder and lighting and stray current) (2) All of explosives, primers and detonators are imported from Russia. (In Baganuur, Sharyngol ANFO is used by site mixing) (3) Only hard rock seams are blasted during all year around. (4) Frozen rock seams are blasted during winter season (from December to May)	
15	Maintenance criterion of mining machine	Each sort of machine is overhauled by its own maintenance criterion according to operating hours. (Repair and maintenance are thought to be implemented according to each machine's schedule.) Ex. (1) Trucks (Belaz) : in 200,000km of traveling distance (or 3 years) (2) Excavator(5 m³) : monthly inspection, seasonal repairment (spring, autumn), annual repairment and overhaul by every 4 years (5 million BCM). (3) Huge mining machine: Overhaul by every 6 years.	
16	Diagnosis system of mining machines	(1) Up-to-date diagnosis system, for example oil analysis system is not adopted. (2) Every diagnosis is done by skilled workers by generation of heat and unusual sound, etc.	
17	Basic conncept of machine life	(1) Truck (Belaz) ----Overhaul is conducted in 3 years, and is scrapped in more 2 years (Total 5 years) (2) Excavator --------Overhaul is conducted once in every 4 years, at the time of third overhaul it is judged to be done or not. (In the longest case overhaul is done three times and machine life is 16 years.) (3) Huge machine -----Over haul is conducted once in every 6 years. (Machine life is 15 to 18 years.) (4) Drill ----------Machine life is ten and several years. (because of its light load and lower frequency of operation) (5) Buildozer --------Managed according to operating hours because its light load. Ordinary life is 3 years. (with no supper) (in small coal mine machine life is 5 to 6 years).	
18	Causes of break downs of machines	(1) Abrasion by dust (2) Larger fuel consumption because of high altitude (3) Great extremes of temperature. (4) Deterioration of rubber and chemicals caused by severe solar radiation. (5) Lower operating skill level of operators. (6) Freezing outdoors during winter.	
19	Measures	(1) Measures against dust ---------- pressuring inside of machines (but not enough) (2) Measures against freezing -------- i) fitting a electric heater to the door of excavator ii) using an antifreezing solution iii) stoppage of operation on the occasion of lower temperature than -35 ℃ (Average temperature is -20℃ around) (3) Measures against winter season --- seasonal repairment in autumn is conducted. (Other particular measured without above mentioned ones are not adopted.)	
20	Control of tire life and fuel consumption	(1) The basic control method of tire life is one depending or traveling distance. (2) The control system is based on the norm. A bonus system is adopted, the longer in case of tire and the less in case of fuel are rewarded. (3) To the contrary there is a penalty system in case of fuel. In case of more fuel consumption than criterion the operator should be fined.	
21	Education system	(1) Education for skilled workers ---- Nalaikh technical school (It has 2 year course from basic theory to practical skill for operators of excavator, bulldozer, truck and electrician and mechanic. After passing examination license could be given.) (Education for huge mining machine used to be conducted in Russia) (Only licensee can operate machine) (2) Education for middle class management ---- Darhan technical college. (There are electrical, mechanical and mining course) (3) Education for engineer ----- Ulaanbaatar technical university. (There are electrical, mechanical, mining, survey and geological course) (4) There is no particular facility like a kind of training room in mine site. (5) Only periodic safety training is being done. (When new type machine is purchased, special training should be done) (6) The number of skilled worker in major coal mines is enough but is not in local small coal mines.	

Notes: Shivee Ovoo coal mine is regarded as the one being progressed from a local small coal mine to a major coal mine. (source; Mining Institute)

Table 3.5 Mining Operation Factors of Each Coal Mine (1/2)

No	Coal Mine	Aimag	Location (Distance from major city)	Start Year (Operating Years)	Coal Quality Standard (as of 1995)						Mining Condition																	
					Moisture (Wr, %) (as received) *1)	Ash (Ar, %) (as received) *1)	Volatile matter (Vdaf, %) (dry ash free)	Total Sulphur (Sdf, %) *1)	Net Calorific Value (as received) *2)		Overburden Soil				Overburden Rock				Coal					Bench Angle	Overall Slope Angle	Stripping ratio	Mine Site	
									MJ/kg	kcal/kg	Name	Density (g/cm³)	Swell Factor	Bucket Fill Factor	Name	Density (g/cm³)	Swell Factor	Bucket Fill Factor	Dencity (g/cm³)	Swell Factor	Bucket Fill Factor				Width (m)	Length (m)
1	BAGANUUR	TOV	120km from Ulaanbatar	(17) 1978	33.0	18.0	45.0	0.5	13.6	3,250	quaternary sandstone	1.2	1.35	0.95	Middle and big grain siltsone	2.3	1.25	1.05	1.2	1.25	1.05	70 ∫ 80	37	design 2.7 chosen 3.4	6,000	14,000
2	SHARYN GOL	SELENGE	62km from Darkhan	(30) 1965	18.0	22.0	45.0	0.6	17.2	4,100	quaternary sandstone	1.2	1.35	0.95	Sandstone, Siltsone and hard claystone	2.3	1.35 ∫ 1.25	0.95 ∫ 1.05	1.32	1.25	1.05	70 ∫ 80	35	~8.4	700	2,000
3	SHIVEE OVOO *3)	DORNOGOVI	260km from Ulaanbaatar	(3) 1992	40.0	15.0	45.0	1.5 *4)	11.3	2,700	quaternary sandstone	1.2	1.35	0.95	sandstone, siltstone	1.9	1.35 ∫ 1.25	0.95 ∫ 1.05	1.21	1.25	1.05	70 ∫ 80	37	(<35m) 1.89 (>35m) 3.15	5,000	7,000
4	ADUUNCHULUUN	DORNOD	7km from Choibalsan	(26) 1969	46.6	9.0	45.0	0.8	9.8~10.3	2,340 ~ 2,460	quaternary sandstone	1.2	1.35	0.95	sandstone	2.2	1.35	0.95	1.25	1.25	1.05	70 ∫ 80	37	1.2	750	2,010
5	CHANDGANTAL	HENTIY	55km from Undurkhaan	(28) 1967	30.0	13.0	46.0	0.6	12.2~21.8	2,925 ~ 3,075	quaternary sandstone	1.2	1.35	0.95	sandstone, claystone siltstone	2.2	1.35 ∫ 1.25	0.95 ∫ 1.05	1.3	1.25	1.05	70 ∫ 80	37	(48m) 1.2 (56m) 2.72	780	1,110
6	TALBULAG	SUHBAATAR	40km from Baruun Urt	(19) 1976	30.0	20.0	47.0	0.8	9.8~10.3	2,340 ~ 2,460	quaternary sandstone	1.2	1.35	0.95	sandstone, conglomerate, siltstone	—	1.35 ∫ 1.25	0.95 ∫ 1.05	1.3	1.25	1.05	70 ∫ 80	36	3.0	1,000	7,000
7	TEVSHIIN GOVI	DUNDGOVI	30km from Mandalgovi	(11) 1984	33.0	22.0	45.0	0.95	12.6	3,010	—	—	—	—	———	—	—	—	1.3	1.25	1.05	70 ∫ 80	36	0.5	—	—
8	TAVANTOLGOI	OMNOGOVI	100km from Dalanzadgad	(29) 1966	8.5	20.0	32.5	0.5	21.4	5,110	quaternary sandstone and sand	1.2	1.35	0.95	little grain Sandstone Siltstone, conglomerate	2.4 ∫ 2.5	1.35 ∫ 1.25	0.95 ∫ 1.05	1.3	1.25	1.05	70 ∫ 80	37	1.1	7,000	15,000
9	NUURSTKHOTGOR	OVS	133km from Bayanulgii	(32) 1963	5.0	30.0	27.0	0.4	17.1	4,085	quaternary sandstone	1.2	1.35	0.95	sandstone, hard shale	2.6	1.35	0.95	1.4	1.35	0.95	70 ∫ 80	37	(90m) 1.1 (190m) 3.2	365	1,882
10	KHARTARVAGATAI	UVS	94km from Ulaangom	(31) 1964	16.0	24.0	35.0	0.4	16.3	3,895	quaternary sandstone	1.2	1.35	0.95	hard sandstone	1.4 ∫ 2.6	1.35	0.95	1.4	1.35	0.95	70 ∫ 80	39	(100m) 0.14	500	1,000
11	KHUSHEET	HOVD	197km from khovd	(24) 1971	7.0	19.0	20.0	0.5	20.4~21.4	4,875 ~ 5,110	—	—	—	—	sandstone	2.6 ∫ 2.7	1.35	0.95	1.36	1.35	0.95	70 ∫ 80	38 ∫ 45	(100m) 1.3	570	1,600
12	ZEEGT	GOVIALTAY	98km from Altai	(30) 1965	15.0	18.0	35.0	0.5	16.7	3,990	quaternary sandstone	1.2	1.35	0.95	claystone, siltstone sandstone	2.4	1.25 ∫ 1.35	1.05 ∫ 0.95	1.4	1.35	0.95	70 ∫ 80	37	(40m) 1.56 (>40m) 3.83	500	4,200
13	MOGOINGOL	HOVSGOL	228km from Murun	(25) 1970	14.0	17.0	26.0	0.8	22.1	5,300	quaternary sandstone and sand	1.2	1.35	0.95	siltstone, hard sandstone freezed granite	2.35	1.25 ∫ 1.6	1.05 ∫ 0.90	1.3	1.25	1.05	70 ∫ 80	37	6 ~ 8	400	1,150
14	BAYANTEEG	OVORHANGAY	123km from Arvaikheer	(33) 1962	11.0	22.0	46.0	0.8	19.6	4,680	quaternary sandstone	1.2	1.35	0.95	basalt, oilsahle	2.3	1.35 ∫ 1.6	0.95 ∫ 0.90	1.3	1.25	1.05	70 ∫ 80	39	(<100m) 1.69 (100m) 2.56 (300m) 4.00	1,750	7,000
15	JINST	Bayankhongor	263km from Bayankhongor	(1) 1993	—	—	—	—	—	—	quaternary sandstone	2.4	—	—	weathered gravel, siltstone, claystone	2.5	1.22	1.05	1.34	1.35	0.95	—	—	0.93	—	—

Note: 1) less than
2) more than
3) Coal quality standard is valid in 1995 only
4) expected value is 0.5~0.9

(Source; Mining Institute)

Table 3.5 Mining Operation Factors of Each Caoal Mine (2/2)

No	Coal Mine	Geological Condition									Mining Machines																Operating hours				Dewater and Drainage System	Production (×1,000)			
											Stripping										Common Machine		Coal Mining				Stripping		Coal Mining						
											Main Excavator (Electric Shovel)						Truck										Excavator (E/S)										
		Total thickness of seams (m)	Quantity of coal seam (Quantity of mining coal seam)	Thickness of mining coal seam (m)	Average Thikness of mining coal seam (m)	Thickness of interseam rock (m)	Average thickness of interseam rock (m)	Thickness of overburden (m)	Depth (m)	Dip (°)	8 m³	5 m³	4.6 m³	3 m³	2.5 m³	1 m³	40 t	32 t	27 t	12 t	3 t	Bulldozer	Drill	5 m³	1 m³	8 m³	Annual days	Shifts per day	Annual days	Shifts per day		Design	Plan ('93)	Actual ('93)	Cumurative Coal Production ('22~'93) (t)
																																Stripping (m³)			
																																Coal Mining (t)			
1	BAGANUUR	77	3 (3)	6.95 ~ 80	35	5.9 ~ 120	70	0 ~ 250	150	8 ~ 20																						Well and pump System	—	—	—	34,536
2	SHARYN GOL	32.0	2 (1)	3.7 ~ 49.6	27.8	1.9 ~ 29	8	100	0 ~ 300	8 ~ 12	(4) (3)	(1)	(2) (1)				(43)					8	9	2 (3)		1	305	3	305	3	Tunnel, Shaft and pump system	4,000	3,500 1,300	2,307 1,205	41,989
3	SHIVEE OVOO	40.7	8 (2)	6 ~ 15.5	14	0.6 ~ 10.9	510	0 ~ 60	0 ~ 60	6 ~ 8																						Well and pump system	—	—	—	748
4	ADUUNCHULUUN	75.0	1 (1)	0 ~ 75.0	17.7	—	—	10 ~ 30	20	10 ~ 20		3					7		10			5	3	1			305	2	305	2	Bench floor back and pump system	800	765 405	558 351	8,424
5	CHANDGANTAL	50.0	1 (1)	50.00	40.2	—	—	1 ~ 30	34	4 ~ 6						2			4		2	1		2		226	1	226	1	Bench floor back and pump system	103 100	150 110	51	1,650
6	TALBULAG	39.0	2 (1)	4 ~ 49.5	30.5	5 ~ 37	19	0 ~ 200	0 ~ 200	5 ~ 8				1	2		3	3		2	2		1						Bench floor back and pump system	—	—	—	1,532
7	TEVSHIIN GOVI	150	5 (1)	55 ~ 64	44	3.5 ~ 66	40	0 ~ 150	0 ~ 250	3 ~ 8					1			5		1	1		1		305	1	305	1	Bench floor back and pump system	50	30('94) 25	23	1,227
8	TAVANTOLGOI	153	14 (1)	0.8 ~ 600	10	15 ~ 110	100	0 ~ 500	500	10 ~ 40					2			3		2	1		1		305	1	305	1	Bench floor back and pump system	150	75 50	43	2,086
9	NUURSTKHOTGOR	30.1	8 (1)	17.65 ~ 25.15	21.4	0.15 ~ 50	10	0 ~ 50	0 ~ 70	14 ~ 18					5			10		2	4		1		305	1	305	1	No drainage	116 100	200 135	93 95	3,140
10	KHARTARVAGATAI	85	1 (1)	80~85	80	—	—	0 ~ 300	0 ~ 300	30 ~ 60					1			2	1	2	2		1		305	1	305	1	No drainage	100	20 80	52	2,350
11	KHUSHEET	60.7	5 (1)	0.87 ~ 34.9	15.15	0.5 ~ 130	70	0 ~ 100	0 ~ 70	10 ~ 45					2			5		2	3		1		300	1	300	1	No drainage	50	50 45	35 31	1,191
12	ZEEGT	18.2	2 (1)	9.0 ~ 16.0	14.0	42 ~ 60	51	0 ~ 100	0 ~ 100	25 ~ 40					2			7		2	1		1		305	1	305	1	Bench floor back and pump system	50	35 25	25	1,261
13	MOGOINGOL	20.2	1 (1)	3.1 ~ 20.2	7.8	—	—	0 ~ 60	0 ~ 60	8 ~ 10		1			3	3		12		3	3		1		298	1	298	1	Bench floor back and pump system	100	420 60	112 27	1,646
14	BAYANTEEG	36	1 (1)	14~36	25	—	—	0 ~ 100	100	18 ~ 85				2	3		7	2		3	2		2		187	2	189	1	Bench floor back and pump system	200	300 160	164 108	4,047
15	JINST		7 (1)	42.65 ~ 49.7	45	0.24 ~ 2.87	1.5	0 ~ 200	0 ~ 200	35					1			3		1	1		1						——	—	—	—	33

(Source; Mining Institute)

best recommended to mining conditions of coal mines in Mongolia. Though the dragline, the shovel and railway system, and the shovel and truck system are adopted for stripping in large-scale coal mines in Mongolia, the shovel and truck system is the most suitable system for stripping even in large-scale coal mines. The shovel and truck system has a flexibility for changes of geological and mining condition and the fluctuation of production capacity due to machine failure or breakdown could be avoided.

(3) Estimation of the production capacity of existing coal mine

The major factors to decide the production capacity of open pit coal mine are the capacity of mining machine for stripping and the stripping ratio of the coal mine. Therefore, in order to estimate production capacity of existing coal mines, the stripping capacity of existing mining machines must be estimated. At first, from the total number of shovels and trucks for stripping of each coal mine, the number of trucks per one shovel and the number of fleets are calculated. Then, from the transportation distance of stripped overburden and the number of truck per one shovel, transportation capacity per one fleet could be estimated by Figure 3.20 (for $5m^3$ of shovel and 40t of trucks) and Figure 3.21 (for 1 m^3 of shovel and 12t of trucks). The annual stripping capacity could be calculated by the following formula.

The annual stripping capacity =

transportation capacity per one fleet (per hour) × number of fleets

× annual scheduled hours × net utilization

The annual coal production capacity limited by stripping capacity could be calculated by following formula.

The annual coal production capacity limited by stripping capacity =

the annual stripping capacity ÷ stripping ratio

Table 3.6 shows the estimation of production capacity of existing coal mines which are calculated on Figure 3.20 and Figure 3.21.

Figure 3.20 and Figure 3.21 are very useful to study the measures against increasing coal production and increasing overburden and lengthening transportation distance. The fact that limit of number of trucks per one shovel changes according to the transportation distance must be taken into consideration at that time.

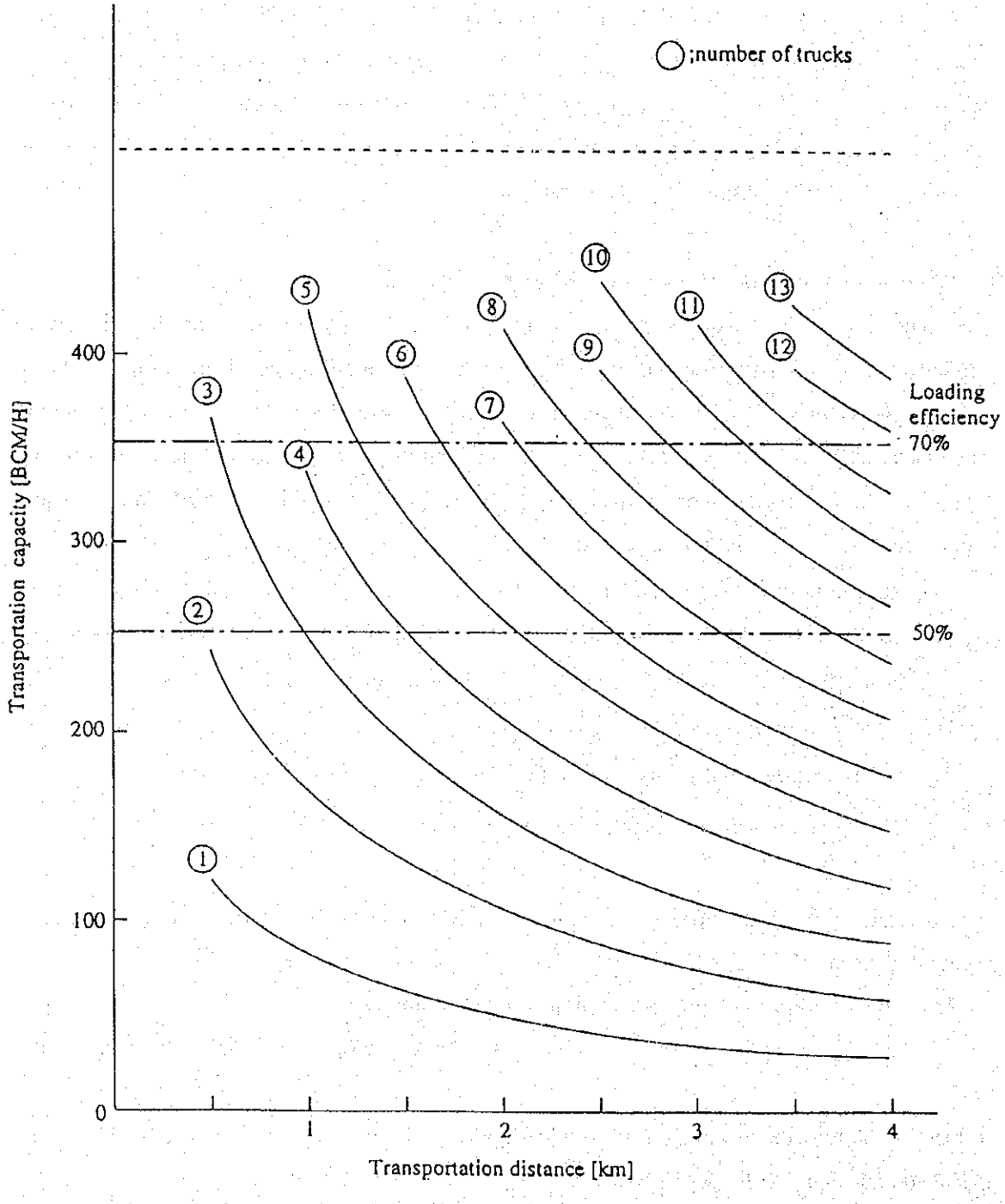


Figure 3.20 Relation among the Transportation Distance and the Necessary Number of Trucks and the Transportation Capacity (EKG5a + Belaz548)

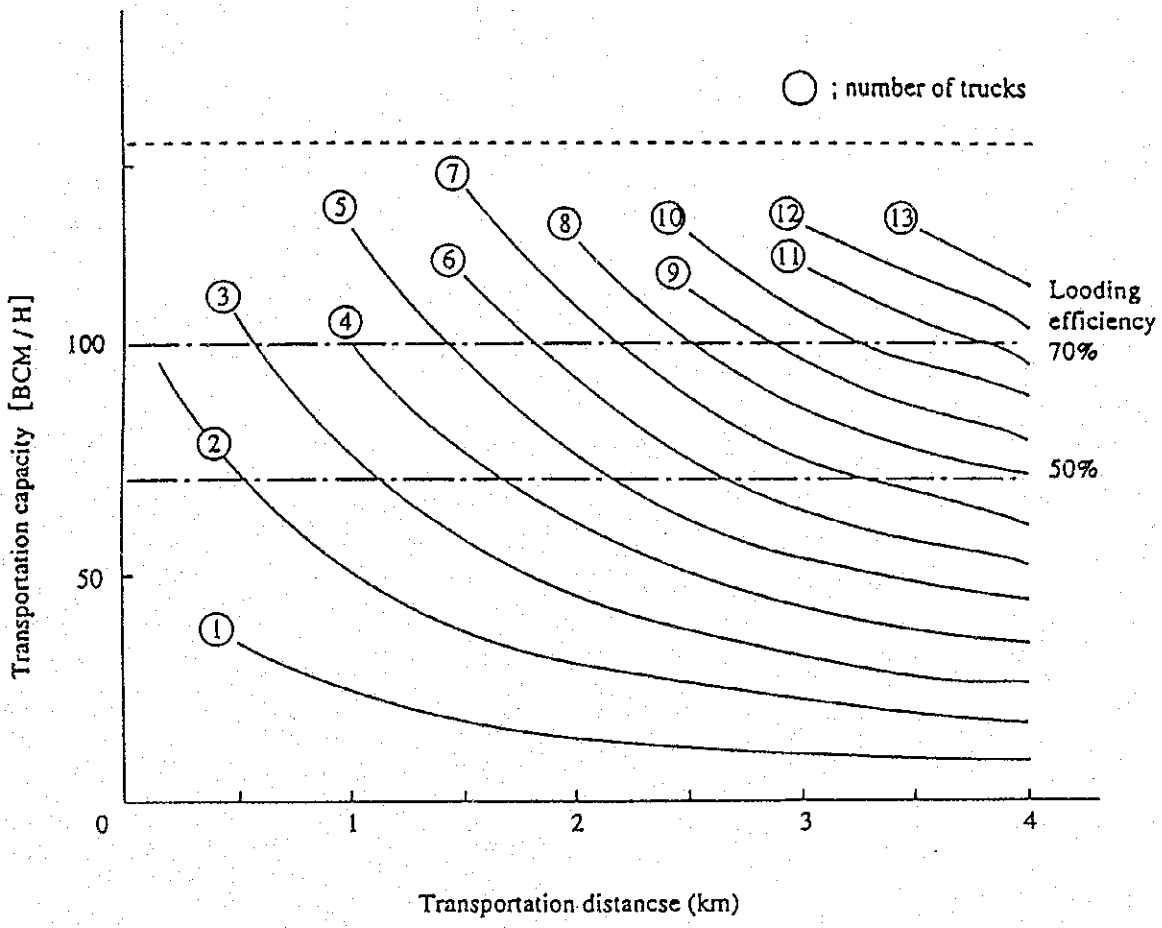


Figure 3.21 Relation among the Transportation Distance and the Necessary Number of Trucks and the Transportation Capacity (1m³ shovel+12 ton truck)

Table 3.6 Estimation of Production Capacity of Existing Coal Mines

No	Coal Mine	Stripping ratio	Overburden Transport-ation distance	Stripping machine							Coal mining machine		Estimate Capacity			Forecasted Coal demand of each coal mine in 2010	Measures for production increase						Remarks
				Large scale					Small scale								Large scale		Small Scale		Adding capacity		
				Shovel	Shovel	Shovel	Truck	Truck	Shovel	Truck	Shovel	Shovel	Stripping	Coal mining	Coal loading capacity		Shovel	Truck	Shovel	Truck	Stripping	Coal mining	
				5 m³	3.0m³	2.5m³	40t	27t	1 m³	12t	5 m³	1 m³	[×10³ BCM/Y]	[×10³ t/y]	[×10³ t/y]	[×10³ t/y]	5 m³	40t	1 m³	12t	[×10³ BCM/Y]	[t/y]	
1	BAGANUUR	—	——	—	—	—	—	—	—	—	—	—	——	——	——	6,000	—	—	—	—	——	——	
2	SHARYN GOL	—	——	—	—	—	—	—	—	—	—	—	——	——	——	1,000	—	—	—	—	——	——	
3	SHIVEE OVOO	—	——	—	—	—	—	—	—	—	—	—	——	——	——	2,000	—	—	—	—	——	——	
4	ADUUNCHULUUN	1.2	1.0～1.5 AV. 1.2	3	—	—	7	10	—	—	1 (4.6)	—	1,627	1,356	1,810	1,000							
5	CHANDGANTAL	1.2	1.0～1.2	—	—	—	—	—	2	4	—	2	131～148	109～123	532	80							
6	TALBULAG	3.0	2.0	—	—	1	—	3	2	3	—	1	216	72	266	160	1	4			297	99	
7	TEVSHIIN GOVI	0.5	1.0	—	—	—	—	—	1	5	—	1	154	308	266	100							
8	TAVANTOLGOI	1.1	1.5	—	—	—	—	—	2	3	—	1	83	75	266	250			1	9	259	236	
9	NUURSTKHOTGOR	1.1	1.2～1.8	—	—	—	—	—	5	10	—	1	243～328	221～339	266	200							
10	KHARTARVAGATAI	0.14	0.2～0.3	—	—	—	—	—	1	2	—	1	124～139	886～993	266	200							
11	KHUSHEET	1.3	——	—	—	—	—	—	2	5	—	1	——	——	266	50							
12	ZEEGT	1.56 3.83	1.0	—	—	—	—	—	2	7	—	1	260	68～167	266	160							
13	MOGOINGOL	6～8	1.5	1	—	—	3	—	3	12	—	1	618	77～103	266	200	2	9			826	104～137	
14	BAYANTEEG	2.56	1.1～1.5	—	2	—	—	7	3	2	—	2	489～603	191～236	532	220	1	2			183～226	72～88	
15	JINST	0.9	0.5～1.0	—	—	—	—	—	1	3	—	1	111～159	123～177	266								