- Spare parts expenses is paid by coal mine that use it

As an idea of the training center is in the conceptual stage, detail feasibility study should be carried out in future. Several manufacturers have been extending their business into Mongolia and establishing service centers for Mongolian coal mines. It is recommended to establish the training center, taking manufactures service for training, maintenance and spare parts supply into consideration. The training center will be open to the public, not only coal mining industry but other industries to meet various demand.

7.2 Coal utilization plan

7.2.1 Baganuur Mine Mouth Power Plant

From the study results, described in clause 4.1.2 (3), Baganuur mine mouth power plant was recommended as next new thermal power plant in line of power development plan.

(1) Coal supply scheme

1) Coal properties

Property of Baganuur coal is black lignite and calorific value is 3,250 kcal/kg (low heating value base). Distinguished feature is its high total moisture of 30%.

2) Coal consumption

The coal consumption at the rated evaporation of 450 t/h is 108 t/h and when the annual utilization rated is 65%, the calculations of the annual coal consumption of a thermal power plant of 100MW x 2 units electric power output, extraction steam of 30 t/h and hot water generating system of 100 Gcal/h are shown below.

- Daily coal consumption (ton) = 108 t/h.unit x 2units x 24 hr = 5,184 ton
- Annual coal consumption (ton)=108 t/h.unit x 2units x 8,760 hr x 0.65 =1,230 x 10^3 ton

3) Supply scheme of coal for new power plant

Similarly to the existing system, coal shall be transported by dump trucks to coal hopper from open cut mining spot and then hauled to the coal bunker located in front of the boilers by a belt conveyor through a vibrating screen. When 50 ton capacity dump trucks are used, the rate of daily haulage is 104 dump trucks per day (4.3 dump trucks per hour). Coal bunker storage capacity is such to allow 10 hours loading so that interruption of coal trucking by bad weather can be absorbed. It is desired that no coal storage yard is provided in the power station so that advantages of a mine mouth power plant can be fully utilized to minimize capital requirement.

(2) Water supply scheme

1) Water consumption

(a) Plant water consumption

Required water quantity for plant water consumption is as follows.

- Blow volume in boiler : 4.5 t/h.unit x 2units (1% of 450 t/h rated evaporation)
- Others : 2.5 t/h.unit x 2units

Total 14 t/h

(b) Make-up water for cooling tower

Cooling tower would have to be installed for the cooling of turbine condensate. Make-up water is the largest water consumption item. Make-up water volume is given as follows assuming steam inflow into condenser of 240 t/h, steam enthalpy of 544.5 kcal/kg (condenser vacuum : 690 mmHg, saturation temperature : 44.5°C), cooling water temperature difference between inlet and outlet of 10°C, and make-up rate of 3% of cooling water circulation volume.

$$\frac{240\ \text{t/h.unit} \times 2\text{units} \times (544.5 - 44.5) \times 10^3}{10} \times 0.03 = 720\ \text{t/h}$$

(c) Make-up water for losses of hot water and steam into the exterior of power station

3% of total hot water quantity is expected to be lost from the basis of the actual figures in Mongol. Steam sent to factories does not return to the power station and becomes a loss.

Hot water : Because hot water quantity corresponding to 50 Gcal/h is 690 t/h;

690 x 0.03 x 2units = 42 t/h

Steam : 15 x 2units 30 t/h

Total 72 t/h

(d) Total water consumption

Total water consumption is calculated as follows from the said (a), (b) and (c)with an addition of about 5% redundancy.

(14 t/h + 720 t/h + 72 t/h) x 1.05 = 850 t/h

General service water and living water would have to be added.

Therefore, total water consumption is expected to be:

Phase I (200 MW)	Final (700 MW)
Average:14,000 t/d	49,000 t/d
Peak: 20,000 t/d	70,000 t/d

2) Water supply scheme

70,000 t/d water supply is considerably enormous in quantity. Water source where this much water of volume can be secured is Kerlen River, several 10 km away from the plant site. Water wells would have to be bored within the vicinity of the river to make use of infiltration water during summer draught and frozen season in winter.

Although capacity of water storage tank for the power station is preferably such to hold at least one week water requirement, the size of tank shall be 40,000 m^3 to hold 3 days consumption in order to repress capital requirement.

(3) Environmental countermeasures

In view of the said current state and economic aspect involved, following countermeasures would have to be implemented at the time to construct a new power station. Countermeasures to prevent diffusion of smoke dust and waste water discharge are considered to be the major subjects.

Environmental countermeasure as seen from facility's point of view is as follows:

1) Air pollution

Electromagnetic precipitator or bag filter shall be installed as a means to prevent spread of smoke dust. Ulaanbaatar No. 4 power station which uses. Baganuur coal is equipped with an electromagnetic precipitator. Baganuur coal is low sulfur and low nitrogen content coal

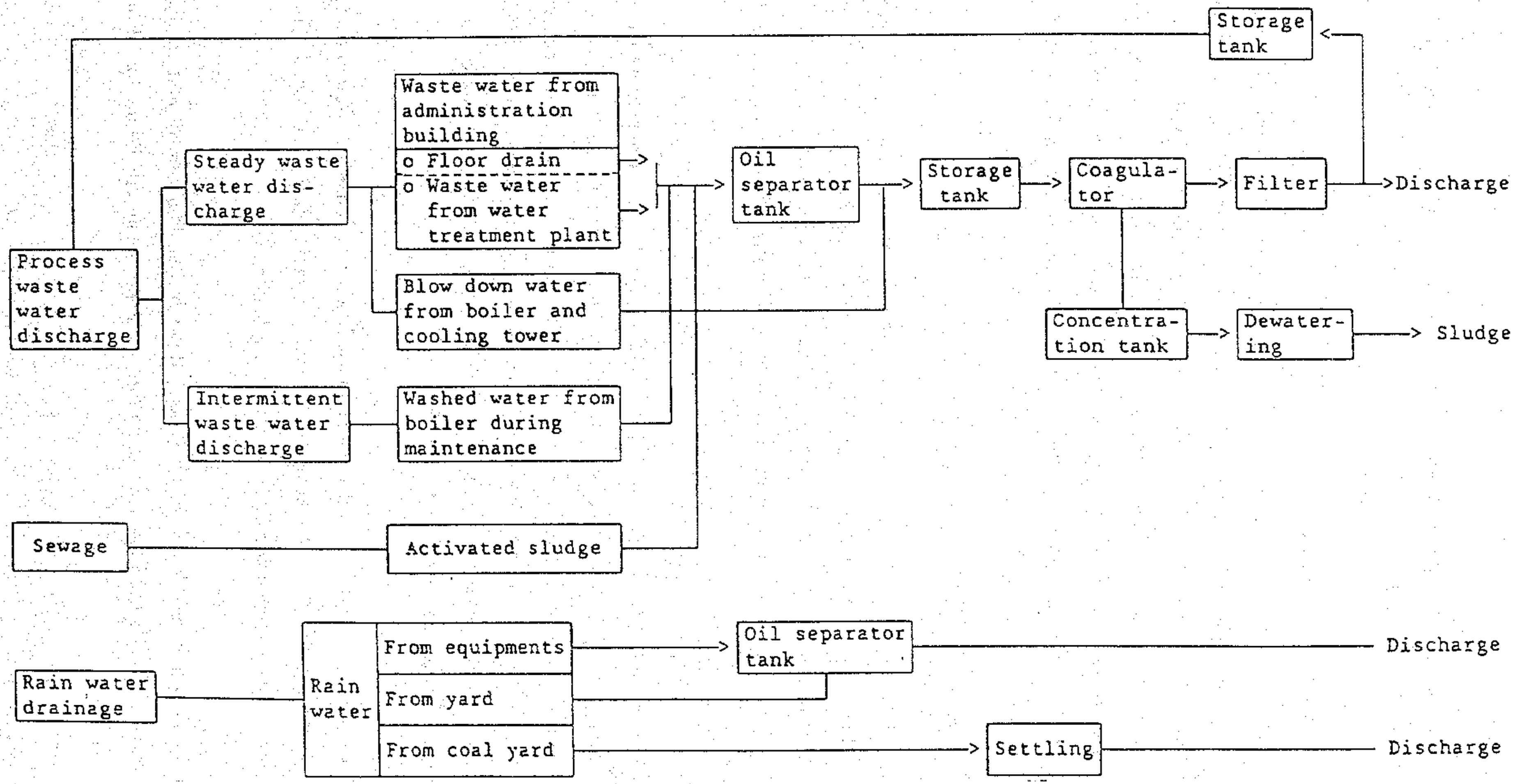


Figure 7.2 Waste Water Treatment Flow Sheet of Power Plant

and no special equipment needs to be installed from economical point of applicable environmental criteria.

2) Waste Water quality

There are two types of water discharge equipment in a coal burning thermal power station; one is to discharge waste water steadily and the other is to discharge only in certain period of time, such as when a station starts or stops its operation and when regular inspection and maintenance work are being done. Figure 7.2 shows waste water treatment flow sheet of a new thermal power station. Water of Kerlen River into which waste water is discharged will be recycled at downstream. Quality of waste water discharge must be stringently controlled to clear applicable water quality criteria.

(4) Basic design points

1) The contemplated thermal power plant herein is to be a representative power station in Mongolia to supply hot water and steam to the city of Baganuur and electric power to the Central Energy System. Construction of the power plant must be welcomed by the citizens and its existence should never be a disturbance to the Mongolian high land throughout the year.

2) Primary fuel fired in the power plant shall be the coal excavated from the Baganuur coal mine located in the suburb of the city of Baganuur. Fuel oil A shall be used as boiler starting fuel. Removal of impurities such as metal pieces or gravel,which are contained largely in Baganuur coal must be considered, since the Baganuur coal has behavior of spontaneous combustion. Direct pressure system shall be adopted in order to minimize the residence time of pulverized coal.

3) The power plant shall be operated at a base load. Care shall be taken to ensure operational reliability and safety and automatic operating system shall be adopted. Control range of boiler steam temperature is within 50 - 100% load range.

4) Steam conditions shall be decided as follows in consideration of unit capacity, fuel cost, construction cost, experience and so on. Although steam conditions for Ulaanbaatar No. 4

power station is 130 kg/cm^2, 555°C, steam conditions of the power plant shall be as follows which is close enough to Japan or US standard steam conditions.

- Steam pressure at the inlet of steam turbine 130 kg/cm^2
- Steam temperature at the inlet of steam turbine 540°C

Though ferritic system material can be used up to 540°C (1,000 °F) class,austenitic system material shall have to be used for use at higher temperatures.

5) Adoption of centralized control system

The power plant is coal firing unit and designed for cogeneration system. The control system of the power plant is somewhat complicated because of diverse types and a large number of auxiliary equipment. Because generation of electric power is the primary objective, 1 boiler - 1 turbine with interconnecting steam pipe system shall be adopted in order to simplify its operation. A central control room for 2 units shall be provided in the control building which shall be designed to centralize principal monitor instruments and operating switches to facilitate plant start-up and stop as well as emergency operation at the time of accident. Care shall be taken to ensure prevention of malfunction and to improve overall reliability. A command center which is capable of totalized operation and monitoring of all units shall be provided in the future.

6) Adoption of supervisory control system

The system enables plant start-up and stop, operation of equipment in accordance with volume of load and principal valves by remote controls from the centralized control in order to prevent malfunctions and to minimize manpower requirement.

7) Consideration of the environmental protection

The Mongolian plateau is susceptible to environmental pollution because of its cold and dry climate.some concrete countermeasures must be considered to the harmful effects of water intake, waste water discharge, exhaust gas emission on environment and any other harmful effects on the environment. flue gas desulfurization and NOx removal equipment are not planned to be used here.

Concentration of dust at the stack outlet: 200 mg/Nm^3

8) Capacity of fuel oil A firing equipment facility

Capacity of fuel oil A firing equipment facility shall be of 30% MCR in consideration of troubles in pulverized coal firing equipment and ash sluicing equipment.

9) Omission of coal storage yard

As it is a mine mouth power station, coal storage yard is to omitted to rationalize power station plan. "Kanban" system shall be adopted for the direct transport of coal from coal mine by trucks.

10) Future expansion scheme

For the time being, 200 MW will be commissioned in the year 2005, and 200MW and 300 MW will also be commissioned at an interval two years thereafter. Final capacity shall be 700 MW.

11) Effective ash utilization

Silo storage system which can be used as an effective ash utilization and ash disposal will be adopted.

12) Adoption of wet type cooling tower

The site is blessed with a river of a high flow rate in spite of dry climate. Consequently, mechanical draft cooling tower will be adopted instead of natural draft closed cycle cooling tower which require higher capital. The cooling water system will not be adopted for the purpose of water saving and environmental protection.

(5) Baganuur coal design conditions

1) Type Mongolian coal

Black lignite

2) Proximate analysis

Surface moisture (%) (As fired base)	5
Moisture fire base:	
Ash(wp%)	17.0

Volatile component(wp%)	31.8
Fixed carbon (wp%)	40.0
Inherent moisture(wp%)	11.2
	100%
Calorific value (kcal/kg)	3,250

(6) Design of power plant

1) Selection of unit capacity

Though the larger the unit capacity is the less is the cost of construction or cost of staff for operation and maintenance per unit output, if the impact of accident is considered, 6 - 8% of network maximum power supply capacity shall be selected, since the rated power supply capacity of the Central Energy System is 796 MW, maximum power capacity is assumed to be 20% plus and assuming maximum capacity of the transmission line interconnected with ex-RUSSIA network to be 180 MW,

Phase I :

(796 x 1.2 + 180) x 6 - 8% = 1135 x 6 - 8% = 68 - 91 MW

Phase III:

Assuming final capacity of 700 MW, 6 - 8% of which is 42 - 56 MW to be added,

= 110 - 147 MW

Accordingly, average unit capacity shall be 100 MW. Most of the parts would have to be import from the outside Mongolia in the future and commonness of parts is desired. Consequently, same system and same capacity to be 100 MW through Phase I - III will be adopted.

2) Adoption of indoor design

In view of cold climate, indoor design will be adopted. Independent buildings and main building are to be connected with each other by covered passageways, and equipment subject to preventive maintenance will be installed indoor.

3) Adoption of non-reheat system

Whether to adopt reheat design or non-reheat system depends upon the economics. In the case of the subject power station, no substantial difference exists between the two.

Majority of operation and maintenance personnel is expected to be trained by the staff from

Ulaanbaatar No. 4 power station. Accordingly, non-reheat system Ulaanbaatar No. 4 power station will be adopted to make operation and maintenance easier.

4) Generator rating

Generator rating will be adopted as follows.

Output :	100 MW (85% power factor : 117.64 MVA)
Terminal voltage :	13.8 kV
Revolution per minute/frequency :	3,000 rpm/50 Hz

5) Boiler type and capacity

The boiler of natural circulation which is easier to operate is considered more adequate than once-through boiler for Mongolia. Boilers of Ulaanbaatar No. 4 power station are of natural circulation type. Balanced draft system shall be adopted. Boilers of Ulaanbaatar No. 4 power station also employ balanced draft type. Maximum continuous rating (MCR) of the boiler shall be 470 t/h with 5% increment as the steam volume needed at the turbine inlet being 445 t/h at the rated conditions.

6) Heat balance

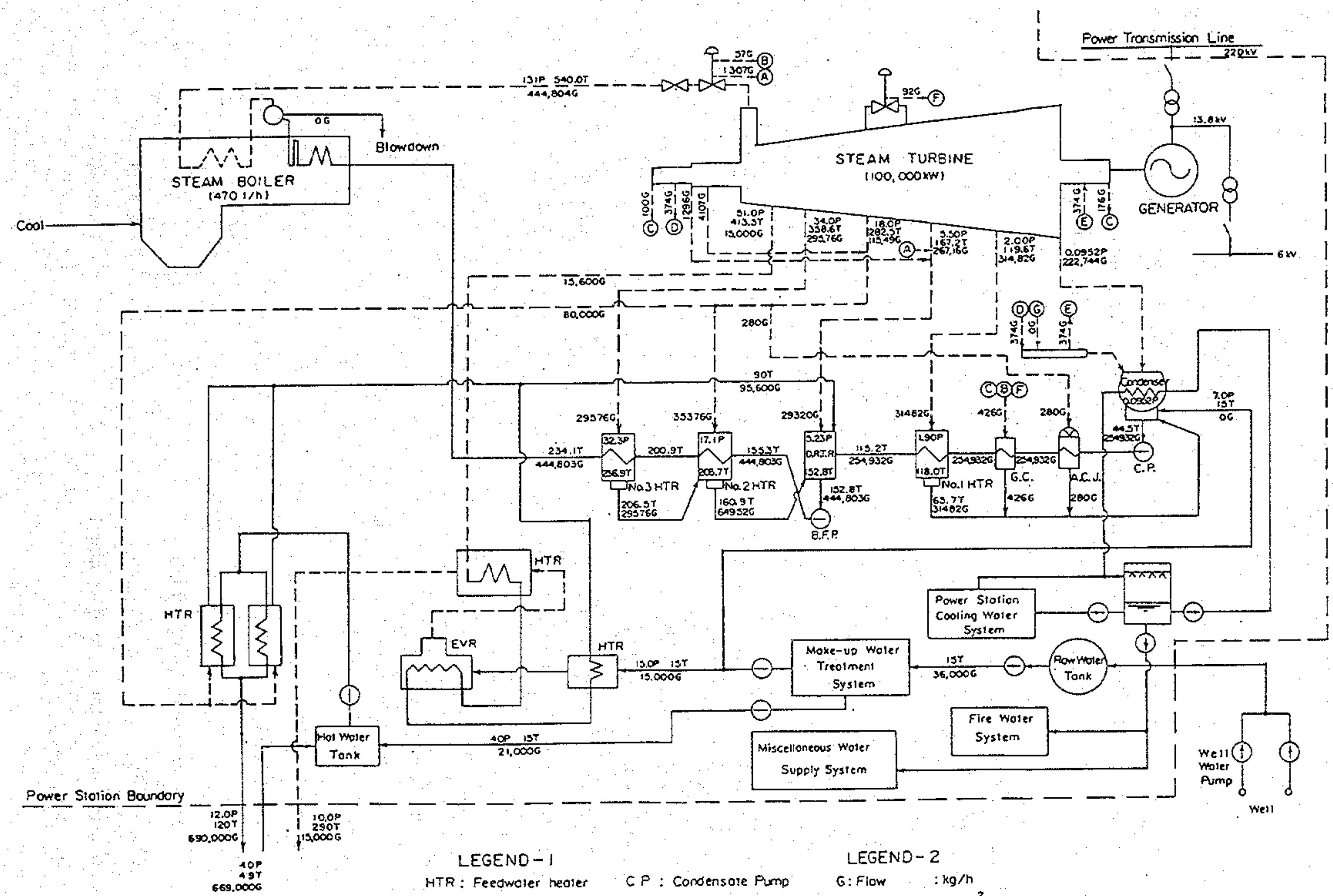
Figure 7.3 shows results of heat balance which was calculated as follows.

(a) Ordinarily continuous blow of boiler water from boiler and drum shall be executed to keep required boiler water quality. For this calculation of heat balance, the above blow water was taken as null and void.

(b) Though hot water and steam will be supplied to the city of Baganuur, only hot water will return to the power station with about 3% loss. Heating value is 50 Gcal/h for hot water and 15 t/h for steam.

Therefore, at the power station boundary;

Hot water :	Delivery	12.0 kg/cm^2 abs. 120°C
	Return	4.0 kg/cm^2 abs. 49°C



LEGEND-1

HTR : Feedwater heater
G C : Gland Condenser
AEJ : Air Ejector
C P : Condensate Pump
EVR : Evaporator

LEGEND-2

G: Flow : kg/h
P: Pressure : kg/cm^2 abs
T: Temperature : °C

Figure 7.3 Baganuur Thermal Power Station Heat Balance Diagram

Steam : Delivery 10.0 kg/cm^2 abs.
290°C
15 t/h

(c) The evaporation from cooling tower and hot water loss shall be covered by make up water. In reality, loss of general service water, boiler blow water, water loss of ash treatment system would have to be added, which however were taken as nul and void for this calculation. Temperature of make-up water was assumed to be 15°C.

(7) Electro-Mechanical Facilities

1) Boiler facility

(a) Boiler

a) Type

Natural circulation, single drum indoor type

b) Quantity	1 x 2 set
c) Evaporation (MCR)	470 t/h
d) Steam pressure (MCR)	
Superheater outlet (MCR)	135 kg/cm^2.g
e) Steam temperature (MCR)	
Superheater outlet (MCR)	543 °C
f) Feed water temperature (MCR)	234 °C

g) Draft system

Balanced draft system

h) Burner arrangement

Corner installation or front installation

2) Turbine facility

(a) Main turbine

a) Type

Extraction condensing turbine

b) Quantity	1 x 2 set
c) Rated output (generating terminal)	100 MW

d) Steam pressure

Main steam stop valve inlet	130 kg/cm^2.g
e) Steam temperature	540 °C
f) Number of bleed stage	5 stage
g) Degree of vacuum	690 mmHg vac

3) Generator

(a) Type: Horizontally mounted, revolving field type, totally enclosed, hydrogen-cooled, explosion proof

(b) Rating: Capacity	117,647 kVA
(Hydrogen pressure 2 kg/cm^2)	
Frequency	50 Hz
Voltage	13.8 kV

4) Exciter

Static exciter

5) Bus duct

(a) Type: Cylindrical aluminum casing

(b) Rating: Voltage	13.8 kV

6) Main transformer

(a) Type : Outdoor, 3 phase, forced oil air cooled

Primary voltage	13.8 kV
Secondary voltage	220kV± 5% kV
(b) Quantity:	1 x 2 set

(8) Project implementation schedule

Following are considerable construction schedule as turn-key project basis;

1) Definite design and preparation of tender documents	6 month
2) Tendering	4 month
3) Evaluation	3 month
4) Award of contract	3 month

5) Civil Work & EM installation	36 month
6) Test	3 month
Total	55 month

2nd unit will be commissioned 3 month after 1st unit.

(9) Project cost	(US$ 1,000)
1) Boiler facilities	142,000
2) Turbine facilities	45,000
3) Generator and other electrical facilities	68,000
4) Electrostatic precipitator	17,000
5) Steam piping and reheater	22,000
6) Cooling tower	24,000
7) Stack (one set)	3,000
8) Civil works	34,000
9) Supervisors	18,000
10) Transportation insurance	14,000
Total of equipment and others	387,000
11) Contingency	19,000
12) Engineering consultant	7,000
Grand total	413,000

7.2.2 Briquette

From the study result 4.6.1, the coal briquette supply project is recommended as the new type utilization system of coal in Mongolia. The preliminary study for the bio-coal briquette project as follows. As mentioned above, it is recommended to MEGM to proceed Feasibility Study for Bio-Coal Project.

(1) Project scheme

One model plant manufacturing bio-coal briquette will be built up and in operation, and testing to use in actual consumer in the gers or in the small boilers around Ulaanbaatar City will be made.

(2) Outline of plant

1) Plant capacity : 5 tons/hour(38,400 tons/year)

Operation hours : 24 hour/day x 320 days = 7,680 hours

Production : 5 x 7,680 = 38,400 tons

2) Raw materials and utilities

i) Raw material

Raw coal : Lignite(Baganuur coal, Shivee Ovoo coal, etc.)

Bio-mass : Wheat straw or animal dung

Desulphurizing agent : Lime

ii) Product

Shape : almond type

Size : 37 x 21 x 13 mm

Ii) Utilities

Power & LP steam

3) Process description

Raw materials, coal and bio-mass, dried and pulverized respectively and stored in the feed hoppers. Raw material coal and bio-mass are mixed-up with lime as desulphurizing agent and compressed at high pressure of 1 to 3 tons/cm^2, to make briquettes continuously. The product briquettes are transferred to storage area.

4) Major equipment

Major equipment consist of the plant are as follows:

Major equipment list

	No.	Type
Raw biomass feeder	1	3 t/h
Raw biomass crusher	1	3 t/h
Raw biomass dryer	1	
Raw biomass hopper	1	
Raw coal feeder	1	6 t/h
Raw coal dryer	1	

Raw coal crusher	1	
Bio-mass feeder	1	
Pulverized coal feeder	1	
Lime feeder	1	0-1 t/h
Mixer	1	
Roll press	1	3 t/cm^2
Air heater	2	
Air blower	1	

5) Unit consumption

Raw coal	0.75 ton/ton product
Biomass	0.25 ton/ton product
Lime	0.02 ton/ton product
Utilities	
Electric power	46 kwh/ton
LP steam	0.25 ton /ton

(3) Cost

1) Investment cost (US$ 1,000)

Machinery and equipment for 5 tons/hour plant	3,837
Building& Erection work	1,700
Engineering & Supervising work	1,023
Total	6,560

2) Operation cost

Operation cost 12.7 US$/ton

Note: Above cost is based on 10 $/ton of lignite and biomass.

3) Estimated approximate production cost (before tax)

Capital cost	8.5 US$/ton
Operation cost	12.7 US$/ton
Total	21.2 US/ton

Note: Above is approximately estimated cost and not including tax, royality and interest.

8 Conceptual study of Action Plan

8.1 Master plan for coal development

1) Priority among coal development projects

Increase in coal products in the future will be carried out by the proirity order, first with a plan of the highest priority given from the five positive development plans; among those coal production increase plans with two existing coal mines studied in Part I and three new coal mines selected from this study, "Part II". The priority order will be given taking consideration into overall economic view of each coal mine development plan, its influence on local development, suitable dispersion of a source of supply, and others.

Comparisions in technical characteristics, development plan outlines and results of preliminary economic evaluation of the five coal mines are shown on Table 8.1.

Expansion of Shivee Ovoo coal mine holds most likely the first priority as it occupies the first positions in both economic evaluation and approximate production cost.

Expansion of Baganuur and new establishment of Tsaidamnuur show hardly any comparative merits and demerits, and thus the priority order makes no difference between them. The expansion of Baganuur is said to be slightly superior in economic cost due to the existing ready-to-use infrastructure, but stability in supply at occurrence of any natural calamities remains insecure since the coal supply sources are concentrated in an area.

Although the proved coal reserves in Khoot is rather small in valume, its coal mining cost is possibly cheaper than that of Sharyngol. An immediate feasibility study of Khoot Coal mine is recommended as it seems that it is worth a prompt launch of a small-size production.

Table 8.1 Comparison of Technical and Economic Features

	Baganuur Expansion	ShiveeOvoo Expansion	Tsaidamnuur New Mine	Tugrugnuur New Mine	Khoot New Mine
Proved reserves (mil. ton)	567	550	864	288	85
Mining condition:					
Mining depth (m)	200	250	34	47	34
Seam thickness (m)	10,17,12	16,13	15,30,15	5,15	7,6,7
Strip ratio (BCM/t)	4.2	3.5	3.0	4.2	3.8
Coal type					
LHV(ar:kcal/k;g)	3250	3250	3250	3250	4350
Ash content (ad:%)	14.9	16.4	18	14.9	14.5
Total Sulfur content (daf:%)	0.73	0.75	0.4~0.7	0.8	0.7
Designed capacity (mil. t/y)	2.3	1.4	2	2	1
Capital expenditure (mil.US$)	51.6	36.5	70.8	84.5	51.7
Existence of infrastructure for Transportation	Yes	Yes	No	No	No
Total production volume (mil t/y)	47	25	40	40	20
Total sales amount (mil.US$)	510	259	444	555	296
Total investment (mil.US$)	130	80	157	186	110
Total operating cost(mil.US$)	336	138	217	286	132
Coal price at 10% EIRR (Tg/t)	4339	4070	4444	5547	5892
Approximate production cost (US$/t)[*1]	9.9	8.6	9.4	11.8	12.1
Apr.production cost (US$/1,000kcal-t)	3.05	2.65	2.89	3.63	2.78
Ranking of priority	2	1[*3]	2	4	[*2]

Note: 1) Appropriate production cost =
(total capital cost + total operating cost) / total production volume
2) Priority order was not decided due to industrial use
3) Expansion of Shivee Ovoo mine provides with advantages such as:
- Expansion of the infrastructure is easy technically and economically
- Required investment cost for the expansion is low
- Geological and mining conditions are comparatively favorable ect.

and in accordance with these advantages the order to expand this mine in priority is first.

2) Implementation schedule and capacity of each development project

In order to meet the requiered increment in coal production (capacity) discussed in Chapter 2.5.2, the time of operation commencement of the individual projects is settled as below in accordance with the said priority order. There is no difference in the timing of commencement between high and low cases. Only the timing with high case is introduced here in the master plan since it shows hardly any significances to study both cases in the master plan.

Table 8.2 Implementation Schedule of Coal development projects

(mil.ton)

	1996-	2001-	2006-	Not
Required amount of expansion eexpansion	1.3	1.7	2.5	n.a
Lignite mine for fuel				
Shivee Ovoo (expansion)	1.4	-	-	
Baganuur (expansion)		2 .3	-	
Tsaidamnuur (new mine)			2	
Tugrugnuur (new mine)				2
Lignite mine for industry				
Khoot mine				*1
Bituominous Coal mine for Export				
Tavantolgoi mine				*2

Note: 1) Timing of Khoot depends on the mining cost of Sharyngol coal mine.
2) Export contracts of coking coal and electricity are required to start Tavantolgoi caol mine development, though the timing is unpredictable.
3) In this implementation schedule it is foreseen that the Ulaan Ovoo mine will be opened by 2000 and have the capacity of 550,000 t/y.

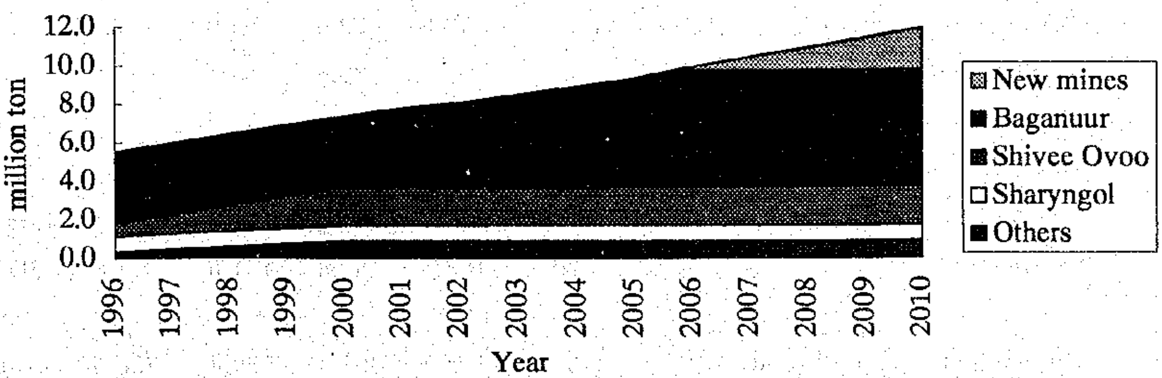


Figure 8.1 Master Plan for Coal Production Capacity in CES

3) Total capital and operating cost required for the Master Plan

Overall annual funds requiered for the master plan are calculated by adding annual development funds and operating cost of each individual project, starting from the time of operation commencement of the above mentioned each individual project. The below listed are funds and costs necessary in every five years and in the whole development period (details are shown in Attachment).

Further, the coal mining is currently a government undertaking, and it is a plan in which the national capital occupies more than half even in the future, and therefore loyalty, import tax and trade tax are excluded in these costs considering them as the government costs.

Table 8.3 Investment and Operating Cost for Coal Mine Development

	Total Project Cost	1996-2000	2001-2005	2006-2010	2011-2015	Total (1995-2015)	Not specified
Investment for coal mine development							
Shivee Ovoo (expansion)	80.0	36.5	12.4	7.8	13.4	70.1	
Baganuur (expansion)	130.0		52.0	36.9	2.1	91.0	
Tsaidamnuur (new mine)	156.5			70.8	22.9	93.7	
Tugrunuur (new mine)							186.0
Khoot (new mine)							109.5
Tavantolgoi (new mine)							817.4
Total (before tax)	367.5	36.5	64.4	115.5	38.4	254.8	1,112.9
Operating cost							
Shivee Ovoo (expansion)	138.0	20.7	34.5	34.5	34.5	124.2	
Baganuur (expansion)	336.0		73.8	82.0	82.0	237.8	
Tsaidamnuur (new mine)	217.1			35.3	54.5	89.8	
Tugrugnuur (new mine)							285.6
Khoot (new mine)							132.0
Tavantologoi (new mine)							1,634.0
Total (before tax)	649,7	20.7	108.3	151.8	171.0	451.8	2,051.6
Total required amount of fund	1,017.2	57,2	172.7	267.3	209.4	706.6	3,164.5

Note : 1) In 1996-2000 the total required fund for expansion of Shivee Ovoo mine is 57 mUS$. In 2001-2005 the total required fund for expansion of Baganuur mine is 126 mUS$. The loyalty and taxes are excluded in these costs.

2) In order to expand the capacity of existing coal mines, it is essential to renovate some equipments and improve the living conditions at the mine sites, costs for which are included in the above-mentioned investment.

Table 8.4 Capital and Operating Cost Required for the Master Plan

(Unit : million US$)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
[Capital]										
Shivee Ovoo	16.2	20.3	0.0	0.0	0.0	4.1	0.0	0.3	0.0	8.0
Baganuur						51.6	0.0	0.0	0.0	0.4
Tsaidamnuur										
Sub total	16.2	20.3	0.0	0.0	0.0	55.7	0.0	0.3	0.0	8.4
[Operating]										
Shivee Ovoo	0.0	0.0	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Baganuur						8.2	16.4	16.4	16.4	16.4
Tsaidamnuur										
Sub total	0.0	0.0	6.9	6.9	6.9	15.1	23.3	23.3	23.3	23.3
Total	16.2	20.3	6.9	6.9	6.9	70.8	23.3	23.6	23.3	31.7

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
[Capital]										
Shivee Ovoo	4.8	2.7	0.0	0.3	0.0	4.7	0.4	8.0	0.0	0.3
Baganuur	0.0	0.3	0.0	36.6	0.0	1.4	0.0	0.7	0.0	0.0
Tsaidamnuur	12.8	36.0	22.0	0.0	0.0	0.0	4.0	0.3	0.0	18.6
Sub total	17.6	39.0	22.0	36.9	0.0	6.1	4.4	9.0	0.0	18.9
[Operating]										
Shivee Ovoo	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Baganuur	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4
Tsaidamnuur	0.0	5.4	8.1	10.9	10.9	10.9	10.9	10.9	10.9	10.9
Sub total	23.3	28.7	31.4	34.2	34.2	34.2	34.2	34.2	34.2	34.2
Total	40.9	67.7	53.4	71.1	34.2	40.3	38.6	43.2	34.2	53.1

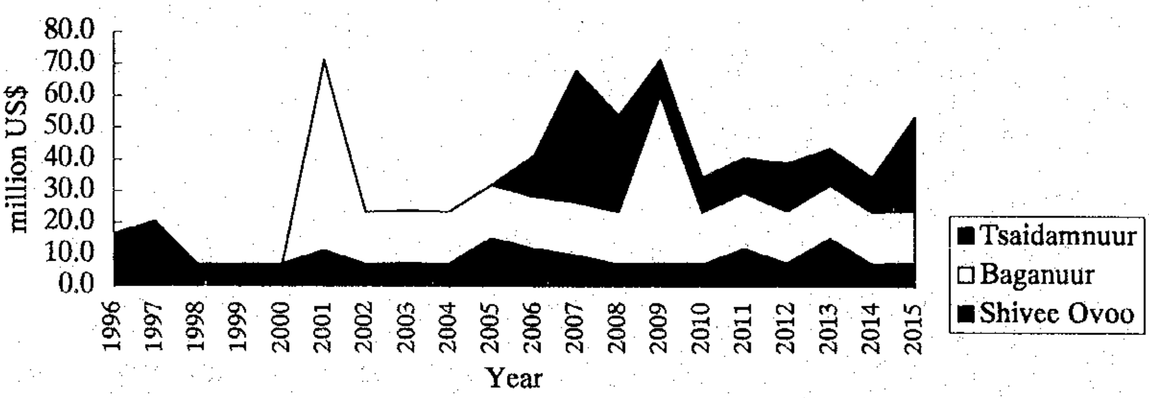


Figure 8.2 Capital and Operating Cost Required for the Master Plan

4) Cash flow and requiered fund raising amount

Calculations of cash flow and the requiered fund raising amount apply the government costs that exclude loyalty, import tax and trade tax.

The annual cash flow and the period of fund deficiency, and the requiered fund raising amount (debt) of the overall master plan are visualized by adding yearly cash flow, at the time coal is sold at the price when EIRR of each project reaches 10% after each project starts its operation as scheduled above, to the overall projects.

Table 8.5 Total Net Cash Flow in the Master Plan

(Unit : million US$)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Shivee Ovoo	-16	-20	6	6	6	2	6	6	6	-2
Baganuur	0	0	0	0	0	-47	9	9	9	8
Tsaidamnuur	0	0	0	0	0	0	0	0	0	0
Total	-16	-20	6	6	6	-45	15	15	15	6
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Shivee Ovoo	1	3	6	6	6	1	6	-2	6	6
Baganuur	9	8	9	-28	9	7	9	8	9	9
Tsaidamnuur	-13	-30	-13	11	11	11	7	11	11	-7
Total	-3	-19	2	-11	26	19	22	17	26	8

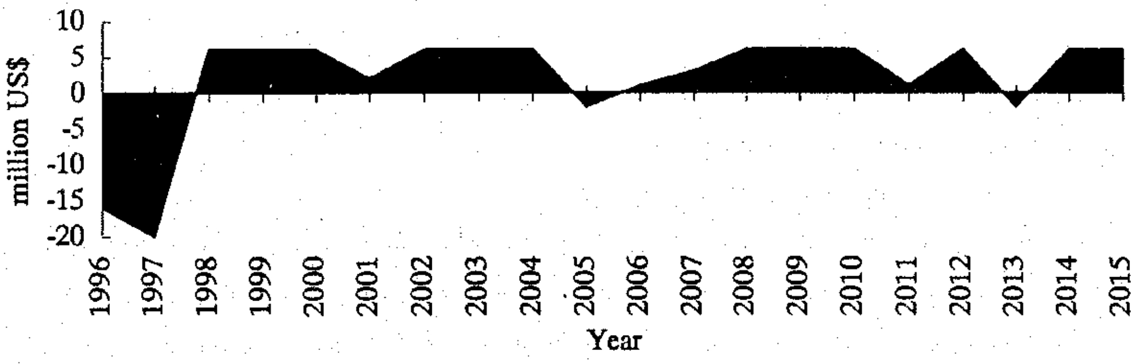


Figure 8.3 Net Cash Flow of Shivee Ovoo Mine

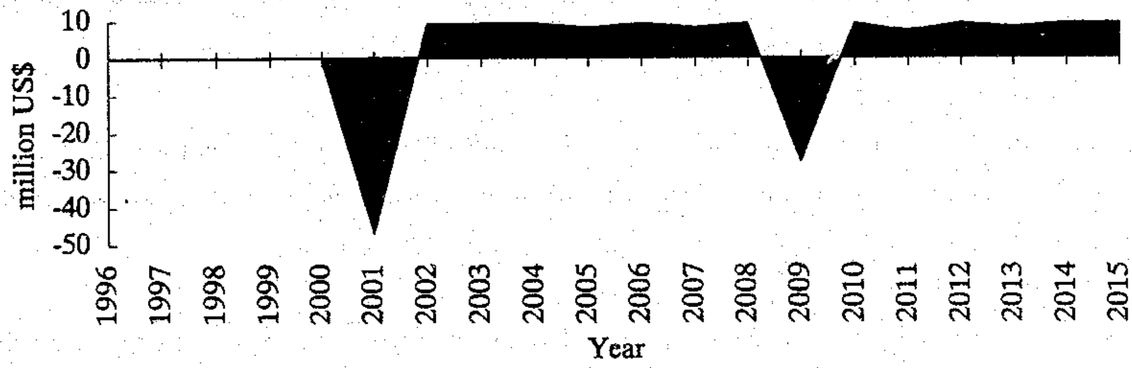


Figure 8.4 Net Cash Flow of Baganuur Coal Mine

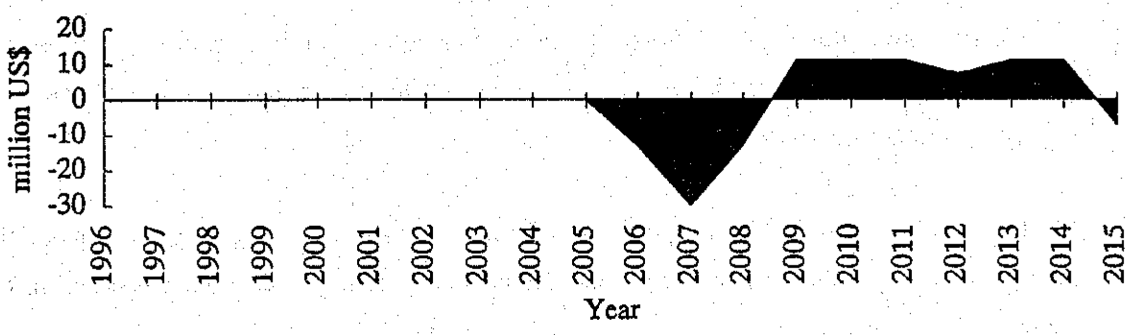


Figure 8.5 Net Cash Flow of Tsaidamnuur Coal Mine

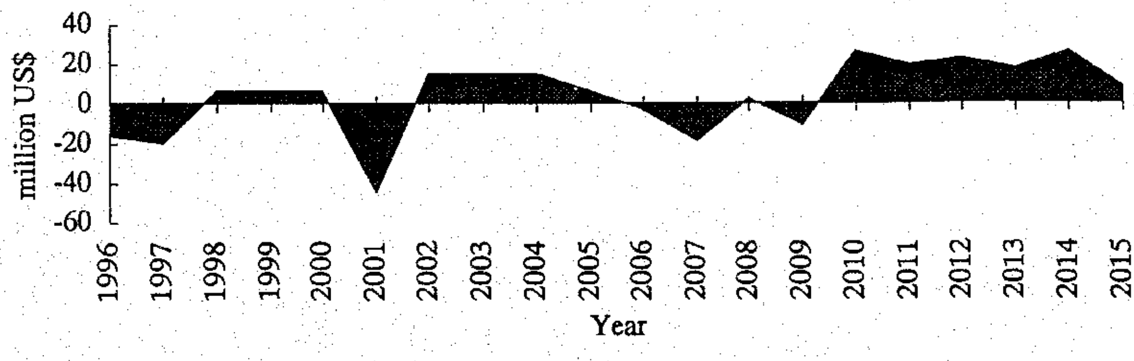


Figure 8.6 Total Net Cash Flow in the Master Plan

8.2 Master plan for coal utilization

(1) Electric power development plans

1) Development schedule and capacity

In the electric power plans included in the master plan, there are electric power development corresponds to the electric power demand in the CES areas as discussed in Chapter 4 and electric power development for export with an assumption of electric power export though its timing is not yet decided. Starting priority within the electric power plans is given as below considering mainly the financial conditions (generation cost), effects on the social development, relationship with characteristics of electric power demands and others.

- the first priority is given to Egiin Hydro Power Plant which is designed to generate the peak energy, and in accordance with MEGM development plan, generation is planed to start from 1999.

- the second priority is given to a mine-mouth coal fired power plant which is established in the coal production area that include Baganuur, Shivee Ovoo and Tsaidamnuur. Specific development spot will be decided after further detailed study in the future.

- Electric power development for export is to start after 2011 in this funds plan as it is difficult to give specific timing, but this development will be given the priority as soon as a contract for export is made.

Further, the data in this electric power development master plan are originated from the preliminary study on establishment of Baganuur Mine Mouth Power Plant discussed in the chapter 7.2.1.

Table 8.6 Electric Power Development Plan

	1993	2000	2005	2010	2011~
Electricity demand in CES (mil. MWh)	2.61	3.11	4.48	7.05	n,a
Electricity Peak Demand in CES *1(MW)	458	545	787	1,239	n,a
Required Generating Capacity in CES *2 (MW)	790	779	1,125	1,770	
Electric Power Development Program (MW)	-	0	345	990	n,a
Electricity Development Plan (MW)					
Egiin Hyeropower plant *3		(55)	(165)		
Mine site coal fired power plant (A)			200		
Mine site coal fired power plant (B)				200	
Mine site coal fired power plant (C)				200	
Mine site coal fired power plant (D)				200	500MWX8

Note *1: Demand in case load factor is assumed to be 65%.
*2: Power Generating Capacity in case plant factor is assumed to be 70%.
*3: Egiin Hydro Power Plant is out of the subject in this study, but it is listed here for reference. Further, the rate of its annual operation is predicted to be 30%.

2) Total capital and operating cost required for the master plan

Overall annual funds requiered are caluculated by adding annual development funds and operation cost of each individual project, starting from the time of operation commencement of the above mentioned each mine-mouth coal fired power plant. The below listed are funds and costs necessary in every five years and in the whole development period.

Further, the electric power supply is curretly a government undertaking, and it is a plan in which the national capital occupies more than half even in the future, and therefore, loyatly, import tax and trade tax are excluded in these costs considering them as the government costs.

Table 8.7 Required Costs

	1996-2000	2001-2005	2006-2010	After 2011
Capital cost (mil. US$)				
Mine mouth coal fired power plant (A)		320		
Mine mouth coal fired power plant (B - D)			320 x 3	
Operating cost (mil. $)				
Mine mouth coal fired power plant (A)			80	
Mine mouth coal fired power plant (B - D)				80 x 3
Total	0	320	1,040	240

Note: Loyalty, import tax and trade tax are excluded.

3) Requiered financing amount

It is meaningless to calculate cash low and requiered fund raising amount at this stage as the earliest development of mine-mouth coal fired power plant is expected to be in around 2005 as mentioned above. It is not necessary to raise funds for new coal fired power plants until 2000.

The rest is not yet studied.

(2) Coal briquett and other use

1) Briquette development plan

As discussedin Section 6.4.1 and 7.2.2, production of briquette and use in gers are advised in order to prevent air pollution and to promote energy conservations. Required total capacity of briquette plans will reach to about 100,000 t/y in the future.

Capital cost of a briquette plant of 40,000 t/y is about 6.5 million US$. Required total capical cost for 100,000 t/y is about 17 million US$, however, the steps and time schedule of development is hardly predictable, because "who will pay the cost" is the biggest issue of introduction of briquette use in gers.

2) Other use plans

Coal use plans in other uses are hardly estimated, and therefore, the fund raising for other coal uses cannot be included in the master plan.

8.3 Policies and incentives for coal development and utilization

(1) Pricing

Prices are decided by the government in the present Mongolia as both coal and electric power plants are owned by the government.

The taxation and pricing policies of these key energies form a base for economic policy. When the taxation and price policies are well-directed, steady supply of key energies, healthy management of energy industries, economization of energy, and income of tax and loyalty to the government will be increased and progressed.

The bottom limit of the price is the level to avoid financial load for the government and the price with which the related energy industries are able to gain reasonable profit for reinvestment, and the ceiling can be said the coal economic value in Mongolia (international price level).

The government to consider following rules when they study on the price policy.

- Coal and electricity, as basic energies for living and industries, are to be supplied as possibly as cheap
- On the other hand, when transference to the healthy market economy and promotion of economization of energy are taken into consideration, long-term maintenance of low price by support of the government is not preferable.
- It is impossible to operate with financial soundness under the present coal price given by the government. Immediate raise in coal price to match coal economic value in Mongolia, while protecting the nation's living, is preferred.
- The price which is lower than the coal economic value in Mongolia (about 6,000 Tg/t at 3,500 kcal/kg), and with which coal minings are able to make enough profit to reinvest is adequate. Such price may be realized by reallocating the huge profit given to the government by the severe taxation system to the coal minings as reduction of and exemption from taxes and low interest loan.

Having an example of the renovation plan of Baganuur coal mining discussed in this study in Chapter 1, Paragraph 1, reduction of and exemption from taxes, and effect on reduction in price by low interest loan and such are considered in search of the suitable price level below (in this chapter).

Firstly, as for the bottom price, from the government viewpoint, it is required to establish a sale price nccesarry to gain EIRR 10%, and not to cause any financial troubles as a bottom limit of the price. From the investors and coal mine managers' viewopint, it is required to establish a sale price necessary to gain FIRR 10%, as a reinvestable lowest coal price under the present taxation system. The price in the case of Baganuur coal is as listed below.

The coal price required to gain 10% EIRR: 4,743 Tg/t

The coal price required to gain 10% FIRR: 7,493 Tg/t

Secondly, as for the ceiling price, the import price will impose restrictions as coal is a necessary material for the nation.

Economic value of Baganuur coal (Lignite with about 3,560 kcal/kg GHV): 6,057 Tg/t

Under the present Mongolian taxation system, there are many taxation items and their taxation rates are high that the necessary sale price of coal from the view of investors and coal mine managers is understood to be higher than the international coal price. These facts indicate that it is necessary to reconsider its taxation system (reallocation of profit among the government, coal mine investors and consumers) in order to develop a healthy coal industry and to offer coal to the nation at as cheap as possible price.

(2) Tax exemption and low cost loan

As discussed above tax reduction and exemption is requiered to set a suitable coal price, and it seems that a tie-in support with low interest loan is necessary to lower FIRR. Effect on reducing price by tax reduction and exemption , and low interest loan is studied with a sample of Baganuur coal.

1) Effect of tax exemption

Tax reduction and exemption required to achieve the price equivalent to the economic value (6,057 Tg/t at 3,560 kcal/kg GHV) are as follows.

Table 8.8 Tax Exemption to Gain 10% FIRR

Tax reduction and exemption, and apply order	FIRR on total project	NPV at 10% discount rate
Current tax regimes (after assets revaluation)	0.9	-30,730
1.Assets revaluation & carry-over of loss	n.a	-29,630
2.After tax expenses into operation cost	2.3	-25,530
3.Reduction of tax rate for equipment. (Import tax 7.5% to 0, trade tax 10% to 5)	2.9	-22,080
4.Reduction of tax rate for spare part: (Import tax 15% to 0, trade tax 10% to 5)	6.1	-11,470
5.Tax exemption for equipment and spare parts: (trade tax 5% to 0)	7.8	- 6,680
6.Coal trade tax redistribution	10.0	+120

In the case of Baganuur coal mine, it is not enough by exempting import and trade taxes on equipment and spare parts (step 1-5) as above, and it is necessary to return a part of coal consumption tax to coal mines or to support them with low interest loans as discussed in the following section.

2) Effect of low cost loan with tax exemption

Effect of reduction and exemption of taxes discussed above shows the case of full self-funds. Multiplicative effects with reduction and exemption of taxes when a part of such self-funds is loaned with low interest are as follows (when interest of the loaned foreign currency is 2 % and coal price is 6,057 Tg/t).

Table 8.9 Effect of Low Interest Loan and Tax Reduction

Tax exemption steps	FIRR on equity for debt/equity of 50/50	80/20
Current tax regimes (after assets revaluation)	0.8	1.1
1.Assets revaluation & carry-over of loss	1.2	1.1
2.After tax expenses into operation cost	1.4	n,a
3.Reduction of tax rate for equipment. (Import tax 7.5% to 0, trade tax 10% to 5)	2.8	n,a
4.Reduction of tax rate for spare part: (Import tax 15% to 0, trade tax 10% to 5)	7.4	10.6
5.Tax exemption for equipment and spare parts: (trade tax 5% to 0)	9.7	(16.1)
6. Coal trade tax redistribution	13.7	(32.2)

Note: Tax redistribution is financially unnecessary for ( ) as its FIRR marks high.

With the above case, when low interest of 2% is loaned up to 80% of the total required funds, necessary reduction and exemption of taxes to gain 10% FIRR will be up to Step 4. In this way, the price with which enables to establish a healthy coal mine management can be reduced to economic coal value (the ceiling price), and further, it becomes possible to bring the coal price close to 4,743 Tg/t at EIRR 10%.

As for the more specific conditions of reduction and exemption of taxes and low interest loan will be decided considering the coal price policy by the government and conditions for possible fund raise.

It is necessary to control the loyalty in order to provide a fair business competition since coal mining cost at each coal mine differs depending on coal quality and coal mining conditions.

8.4 Institutional arrangement

The energy industries that include coal mining and the central electric power system in Mongolia are the state-own company. Since the settlement of "Mongolian privatization program" introduced in May, 1991, privatization of the national indutries have been rapidly progressed. The energy industries, however, that include coal mining and the central electric power system are planned to avoid rapid privatization by continuing full (or majority of) undertaking by the government as the public utilities that will provide, most importantly, stable operations and cheap energy supplies.

The rationalization of following organizations will be requiered in order to extend energy supply and realize cheaper price through activated energy industries under the national policy.

- Transfer the competence of the central government office to each coal mine and electric power plant, define management responsibilities at each organization and provide an organization which can promote rapid and high-rate actions with one's self-responsibility.

- Establish a financial control system within each organization and strengthen authority by financial control systems in order to change from the operation control under the planned economy to the control with the principles of competition under the market economy.

- Establish better organizations for sales and after services in order to meet the market needs rapidly.

- Establish a training center for human resources development and better maintenance services for whole coal mines in Mongolia.

- Establish a total energy information system as well as an organization that will enable to offer information on production, demand and coal quality in the manner that each organization can access freely.

It seems, however, preferable to change these state-own companies into private companies in the long-run in order to activate them.

In Poland where its privatization is said to be relatively successful among East European countries the privatization was carried out after the organization reform of the national undertakings was planned. The privatization of the basic industries in Mongolia should be carried out after establishment of organization reform that will promise a stable and continuous industry activities, settlement of price policy, and definition of responsibility and authority between the government and enterprises.

To privatize such basic industries, it is necessary to have enough preparations to learn know-how of the management in the market economy, establish an ability to settle bank accounts, security of cooperation with related business such as raw material suppliers and transport industries.

8.5 Human resources development

It is important to educate manpower in administrative officials, business managers, engineers and technicians to promote rational production and use of energy, and energy conservation.

The first thing to be done is to educate engineers and technicians who are able to repair machines and handle overall technical matters. Lack of such technicians and skilled laborers is the today's major problem in the coal mines. In respect to this countermeasure, establishment of a training center is advised in Section 7.1.5. Positive use of ODA from the developed countries is recommended to hire instructors from the developed countries and to purchase training machines. This training center is expected to have effects on effective promotion of technical transfer from overseas, and technical exchange between the same and different industries.

Secondly important matter is to educate administrative officials and business managers who are in charge of production and utilization of coal and electric power. Being in the transition from the planned economy to the market economy, it is necessary to educate manpower who has leadership and the power of execution with well understanding of the market economy in the antithetical fields of administrative officials and private sectors, central administration and job sight, and production and consumption. Educating, in particular, the administrative officials and the personnel of organizations in the countries about transition to the market economy and new technology must be done.

It is said that chances to study in overseas have greatly reduced since the introduction of the market economy policy in 1990 despite of the fact that the Mongolian government has supported ten-years-education system even in the middle of national financial trouble and sent many students to the old COMECON.

When human resources development is considered as an investment in the future, people from the fields of students, research workers, technicians, administrative officials, business managers should be given chances to study, with positive use of ODA from the developed countries, in universities, postgraduate courses, governments, and institutes and plants of machine makers of overseas. ODA should be also positively used to invite instructors from the developed countries and to purchase necessary machines for research and development as well as training.

8.6. Coal quality control plan

It is reported that off-specification coal and a fluctuation of coal quality cause troubles and difficulties to the operation of power plant, including power failure in the worst case. In this Section, due to keep the coal quality within the range of the standard, overall coal quality control plans from coal mines to coal use plants are studied.

8.6.1 Issues of coal quality

(1) Current issues of coal quality

At present, coal supplied to the power plant in Ulaanbaatar has the problems of coal quality such as high total moisture contents, low calorific value, the lump of coal, and contamination with rock and metal materials. Coal often frozen during transportation in the winter season due to high total moisture contents. Users have been requesting to minimize the fluctuations of coal quality, particularly in total moisture because high moisture contents cause freezing of coal in the railway wagons and plugging of the pipelines at the power stations. High total moisture of coal has been delivered to the power station due to delays in dewatering of the groundwater. Low calorific value of coal has been caused by mining of the oxidized coal and dilution of partings and interburden. In the case of Shivee Ovoo coal mine which does not have the crushing and screening plant, bulldozer crushes run of mine coal by push dozing prior to loading coal into the wagons of a unite train. Therefore, the size of coal supplied to the power station is not uniformed. Spontaneous combustion of coal occurs in the windy season is another problem on control of coal quality.

The causes to lower the coal quality can be itemized as follows:

(1) High moisture content

(2) High ash content caused by contamination with rock

(3) Oxidized coal

(4) Lump of coal

(5) Contamination with parts of mining machine

Baganuur coal mine and Shivee Ovoo coal mine are required the following quality from consumers, however, off-specification product coal is sometimes delivered to consumers.

Table 8.10 Typical Coal Quality Required by Consumers

		Baganuur			Shivee Ovoo
		Power Station	Industry	Other User	Power Station
T.M. (a.r.)	%	35	36	35	under 36
Ash (d.b.)	%	18	15	12	-
V.M. (d.a.f.)	%	45	45	45	-
T.S. (d.b.)	%	0.5	0.5	0.5	under 1.5
C.V. (a.r.,net)	kcal/kg	3,250	3,360	3,500	over 3,000
Size	mm	0-300	0-300	50-500	0-300

The coals delivered from Baganuur and Shivee Ovoo coal mine are sampled at the each power station and analyzed by the Mining Institute of Mongolia. Actual coal quality received by the No.4 power station is shown in Table 8.11 .

Table 8.11 Actual coal quality received by the NO.4 power station

	<Baganuur coal>					<Shivee Ovoo coal>				
	T.M. (ar)	ash (db)	V.M. (daf)	T.S. (db)	C.V. (ar, low)	T.M. (ar)	ash (db)	V.M. (daf)	T.S. (db)	C.V. (ar, low)
93-1	32.3	27.2	40.1	0.42	2,559	42.8	14.2	42.3	0.38	2,468
2	32.6	13.2	42.1	0.43	3,440	44.9	14.2	40.9	0.52	2,293
3	30.6	15.4	43.5	0.48	3,404	37.2	16.7	49.7	0.51	2,603
4	33.5	11.1	43.5	0.60	3,493	38.7	10.0	44.1	1.25	3,070
5	32.0	10.7	43.5	0.54	3,599	35.2	13.9	43.9	1.04	3,069
6	33.1	9.7	42.6	0.62	3,632	36.6	14.2	43.7	0.95	2,938
7	34.8	8.3	42.3	0.55	3,538	42.5	9.4	43.4	0.70	2,779
8	34.8	9.2	43.1	0.67	3,524	44.6	7.8	43.5	0.74	2,728
9	34.1	11.7	43.5	0.51	3,380	41.8	10.1	44.4	0.95	2,761
10	31.6	13.2	43.3	0.48	3,499	41.1	11.7	45.7	0.96	2,668
11	32.7	15.4	43.8	0.54	3,205	42.8	12.9	47.8	1.06	2,305
12	32.2	14.3	44.5	0.54	3,375	43.7	8.7	45.1	1.04	2,768
Ave.	32.9	12.5	43.1	0.54	3,433	41.0	11.2	44.6	0.93	2,750
94-1	30.5	15.0	44.8	0.40	3,481					
2	32.3	16.5	43.0	0.47	3,266					
3	32.4	11.7	44.3	0.51	3,555					
4	32.3	12.2	42.9	0.50	3,532					
5	33.0	14.6	41.6	0.83	3,407					
6	37.6	7.4	43.9	0.40	3,472					
7	29.5	18.1	42.2	0.50	3,364	37.2	11.6	46.3	0.78	3,044
8	34.6	9.7	46.0	0.48	3,390	44.6	7.9	49.4	0.95	2,492
Ave.	32.5	12.9	43.8	0.51	3,471	40.7	9.8	47.8	0.86	2,780

Baganuur coal is almost satisfied the quality required by power station, although there is fluctuation of total moisture content, ash content and calorific value. Shivee Ovoo coal is high total moisture content and low calorific value and there is fluctuation of total moisture content, ash content, total sulfur content and calorific value.

(2) Issues at the coal mine

As the thought for coal quality control is not understood completely, the quality of the product coal is not managed properly. Therefore, off-specification coal in terms of high total moisture content, low calorific value, lump sized coal and contamination such as rock, wood, metal, etc. is delivered.

(3) Issues caused by low coal quality at the power station

Although low calorific value coal is burned with heavy oil at the power station because Sharyngol coal is design coal, if calorific value is lowered widely, the boiler can not cope this situation. The high total moisture content coal causes handling troubles and the plant is stopped due to be clogged in worst case. As low calorific value coal is burned, amount of heavy oil consumption increases due to keep the temperature of inside of boiler and also cost for generation of electricity is increasing.

8.6.2 Approach to coal quality modification

(1) Causes of lowering quality

As mentioned before, the causes to lower the coal quality are high moisture content and ash content, and mixing of oxidized coal, lump of coal and parts of mining equipment.

High moisture content is caused by groundwater level, flowing of surface water and wetting of rain water. Therefore, proper dewatering of groundwater and draining at the pit will be required.

Increasing ash content is caused by mixing or contamination of waste from upper seam, lower seam, partings, spoil pile and near fault.

Mixing of oxidized or low quality coal is caused by mining the coal near surface and delivering or blending due to economic problem and shortage of stock.

Mixing of lump of coal is caused by no crushing and screen plant. Mining of parts of mining equipment is caused by imperfect daily inspection and maintenance.

(2) Countermeasures for quality modification

Due to prevent to lowering quality, the following countermeasures might be considered at the mine site and the power station.

1) Countermeasure at the mine site

- Introduction of quality control management system and installation of coal quality control facilities into each coal mine are inevitable. This method requires the improvement of the mining technology of each coal mine and skills of each labor and the ability of each engineer and the management. This method is the fundamental and effective countermeasures to solve any kind of cause of lowering coal quality.

2) Countermeasure at the power station

- In addition to the abovementived countermeasures at the mine site, the power plant as coal user should take the following countermeasures.
- Modification and reinforcemeng of the coal drying facilities in the coal treating process of the power station are required to use the low quality caol. This method will be effective to solve the moisture content problem.

- Introduction of metal detector and magnetic catcher is effective for separating contamination such as piece of iron and other metal.
- It is important to redesign and modify the existing coal-fired boilers to fire the coal with quality of lignite, which are being extracted currently and will be extracted from designed deposits.

Power plants in Ulaanbaatar should modify the coal feeding system (drying and crushing) and the modification of boilers would be considered on the basis of Mongolian coal standard of Baganuur coal and Shivee Ovoo coal because their calorific values are 20-30 % lower than the design value.

In the countermeasures, drying coal at the mine site and blending high quality coal are not recommendable for the following reason.

- Drying coal at the mine site is difficult due to increased fragility and spontaneous problems during the transportation and stock. This could meet the only moisture trouble.
- Blending imported high quality coal requires foreign currency to be paid for importing high quality coal and transporting it to power plant and blending facilities and process. This will result in high production cost and could meet the increased ash content and mixing of low quality coal problem only. Therefore, this method will be never fundamental solvent.

8.6.3 Recommended coal quality control plan

(1) Management

Due to satisfy required coal quality by customers and deliver the product coal with secure quality, a new thought for quality control of coal must be introduced at the mine site. The principle of coal quality control is as follows:

- Making the product coal specification clear
- Realization of geological and mining condition
- Optimum design of mining plan and work face
- Selection of effective mining machines
- Establishment of procedure and standard
- Improvement of ability of employees
- Installation of sampling and analysis equipment
- Precise operation of each production process or stage according to the procedure and standard.

- Sampling and analyzing coal quality periodically
- Feeding back analysis data to product process promptly
- Investigation of causes to produce the off-specification coal immediately
- Correction of the production activity into standardized process
- Keeping product coal quality within the range of specification
- Improvement of coal quality control system, if necessary

(2) Technical countermeasures

1) Moisture control

Methods to control moisture content are lowering the groundwater level, preventing surface water from flowing into mining pit and keeping rain water from wetting coal.

(a) Lowering the groundwater level

In the large scale coal mine to supply fuel coal for power plant such as Baganuur and Shivee Ovoo, the most effective method to lower the groundwater level is constructing dewatering wells and pumping and pipe line system. The dewatered should be used as industrial water or conveyed outside influence range.

The procedure to perform this method is as follows:

a) Survey of groundwater condition in exploration stage

b) Design the adequate number of well and the capacity of pump and pipe line system.

c) Construction of dewatering system according to the design.

d) Consistent operation of dewatering system.

e) Monitoring groundwater condition and dewatering record.

f) Comparison of dewatering record with analysis result of moisture content.

g) Maintenance and improvement of dewatering system.

(b) Preventing surface water from flowing into mining pit

In Mongolia most coal mines are operated in the flat plain terrain and under the surface water flowing level. The moisture content control requires preventing surface water from flowing into mining pit.

a) Changing the flow route of surface water current.

b) Building bank surrounding mining pit.

c) Digging ditch surrounding mining pit to convey surface water outside.

d) Pond, pump and pipe line system might be installed in some case.

e) Improvement and maintenance of the system.

(c) Keeping rain water from wetting coal

a) Digging ditch and pond to drain rain water from working place.

b) Installation of pump and pipe line to convey water outside the pit promptly.

c) Improvement and maintenance of the system.

2) Ash control

The cause of increasing ash content should be the mixing or contamination of waste from upper seam, lower seam, partings, near fault and spoil pile.

a) Realization of geological, mining condition in the exploration stage.

b) Optimum design of mining plan and working face to minimize mixing of waste.

c) Selection of most effective mining equipment for precise selective mining, for example, wheel loader and backhoe type hydraulic shovel, etc.

d) Selection of most effective support machine for cleaning before mining coal seam, for example, bulldozer and grader, etc.

e) Establishment of procedure and standard of mining works.

f) Instructing operators and other labors in skills, procedure and standard.

g) Securing the uncovered coal enough to clean coal seam by supporting equipment.

h) Precise mining works according to the procedure and standard.

i) Review and improvement of mining works.

3) Countermeasure for increasing mixing oxidized coal or low quality coal

The coal near the surface is usually oxidized and turns low calorific value coal. When the oxidized coal is mined, it should be regarded as mere overburden or be blended with produced coal under precise quality control standard. This means that more stripping machine capacity should be required. The outline of this countermeasure is as follows:

a) Realization of geological, mining condition, that is, the range of existence of oxidized coal.

b) Optimum design of mining plan and working face to produce the specified coal under the quality control standard.

c) Establishment of the procedure and standard of mining works.

d) Daily mining work and each working process should be controlled under the procedure and the working standard.

4) Size control

Lump coal will cause the choking or the blocking at the shoot and the feeder in the conveying process in the mine site and the transportation and the power station. Under the mining condition, for example, the characteristic of coal seam that lump coals are apt to occur, some countermeasures should be adopted. Blasting coal seam and/or installation of breaker at the pit and/or installation of grizzly, etc. will be considered. In the large scale coal mines which supply coal to power plants, such as Baganuur and Shivee Ovoo, the building of screen and crushing facilities is the most effective method to produce the product coal with the specified size.

5) Contamination control

When machine parts which come off from mining machines mix in product coal, the breakdown of equipments of screen and crushing facilities and power plant might occur. For example, when a tooth of a bucket of shovel is mixed, the true causes and their countermeasures should be investigated as follows:

a) The coal seam is so hard that blasting is required

b) Retaining or welding method of teeth to the bucket is inadequate, and requires to be improved.

c) Digging method of shovel or work face design or procedure is inadequate and requires to be reconsidered or improved.

d) Sort or size of mining machine is inadequate or far small.

e) Skills of operators need to be reconsidered and trained or instructed again.

f) Preventive maintenance and daily check should be conducted precisely.

In any case, to prevent iron pieces from being mixed into product coal completely, the installation of the magnet catcher and/or the iron detector should be necessary at both mine site and user site.

(3) Recommended equipment for coal quality control

The following equipment and plants must be introduced and reinforced for improved control of quality:

Quality control equipment (on line analyzers)

Quality control equipment (off line analyzers)

Magnetic catcher

Metal detector

Crushing and sizing plant

Supporting equipment such as bulldozer and FEL for thin parting removal

Dewatering system

8.6.4 Expected product coal quality

The expected coal quality of Baganuur and Shivee Ovoo is estimated as based the following conditions. In new coal mines, the same level of product coal quality as Baganuur and Shivee Ovoo coal will be expected by carrying out the recommended coal quality control plan.

(1) The total thickness of dilution from the upper and lower interburden of each coal seam is assumed to be 10 cm. In order to minimize this dilution, it is necessary to clean up the surface of exposed coal seam by small equipment and to leave about 30 cm of coal at the bottom of seam on the excavation of coal.

(2) Average percentage of dilution from the partings of Baganuur coal is assumed to be 2% and that of Shivee Ovoo coal is assumed to be 6%.

(3) Total moisture is assumed to be 35%.

(4) The quality of interburden and parting is assumed as follows:

Ash : 70% (a.d.)

Calorific value : 1,000 kcal/kg (a.d.)

The results of calculation are shown on Table 8.12.

Table 8.12 Expected product quality

[Baganuur]

		AR	AD	D	DAF
Total Moisture	%	35.0			
Surface Moisture	%	26.8			
Inherent moisture	%		11.2		
Ash	%		17.0	19.1	
Volatile Matter	%		31.8	35.8	44.3
Fixed Carbon	%		40.0	45.1	55.7
Total Surfur	%		0.63	0.71	0.88
Calorific Value (HCV)	kcal/kg	3,563	4,868	5,780	6,780
Calorific Value (LCV)	kcal/kg	3,221	4,620		
Size	mm	0-300			

[Shivee Ovoo]

		AR	AD	D	DAF
Total Moisture	%	35.0			
Surface Moisture	%	28.8			
Inherent Moisture	%	-	8.7		
Ash	%	-	16.5	18.1	
Volatile Matter	%	-	32.7	35.8	43.7
Fixed Carbon	%	-	42.1	46.1	56.3
Calorific Value (HCV)	kcal/kg	3,580	5,030	5,509	6,725
Calorific Value (LCV)	kcal/kg	3,212	4,756		
Size		0-300 mm			

(Note) AR : As received basis, AD :Air dry basis, D : Dry basis
DAF : Dry ash free basis

Appendix-Master Plan Study

Coal Resources in Mongolia

Coal Resources in Mongolia

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Coal Resources in Mongolia

1 Outline of coal resources

Mongolia is one of the prominent countries having large resources of coal in the world. Coal is found in a total of 15 large-scale coal-bearing basins/regions as shown at Figure 1. These distributed limits of basins are presumed based on the similarities of each coal deposits and/or coal occurrences in terms of geological peculiarities such as major geotectonic structures, stratigraphical and paleogeographical features, degree of coalification. In the basins, about two hundred ore deposits and occurrences are known from the whole country. According to the last report by the Department of Geology in 1993, the total geological coal reserves is estimated at 152.2 billion tons in the whole country.

Generation of coal accumulations on the territory of Mongolia occurred during the Carboniferous, Permian, Jurassic and Cretaceous ages, which differ from each other in conditions of coal-bearing deposit, degree of coalification and coal quality. In the process of their formation, the coal-bearing deposits migrated from west to east in ascending order. The most intensive accumulation of coal took place during the Middle-Upper Carboniferous, Upper Permian and Lower Cretaceous times.

All the coal deposits formed under continental environment in areas of intramontane troughs of varying sizes. In terms of geotectonic structure, these deposits are subdivided into two major groups : orogenic and young platform areas. The first group includes all Carboniferous, Permian and Jurassic deposits, and shows usually a rather complex folded pattern representing frequently graben-synclines broken into blocks. The second group comprises the Cretaceous deposits of eastern Mongolia, and are found at low grounds in present geographical features.

With regard to the degree of coalification, the Carboniferous and Permian coals belong to bituminous to subbituminous coals of the medium grade. The Jurassic coals are subbituminous or transitional (to lignites) coals. The Cretaceous ones mostly belong to lignites of the low degree in coalification and partially to transitional (to subbituminous) coals. The classification of coal vanks in Mongolia, U. S. A. and Japan is summarized at Table 1.

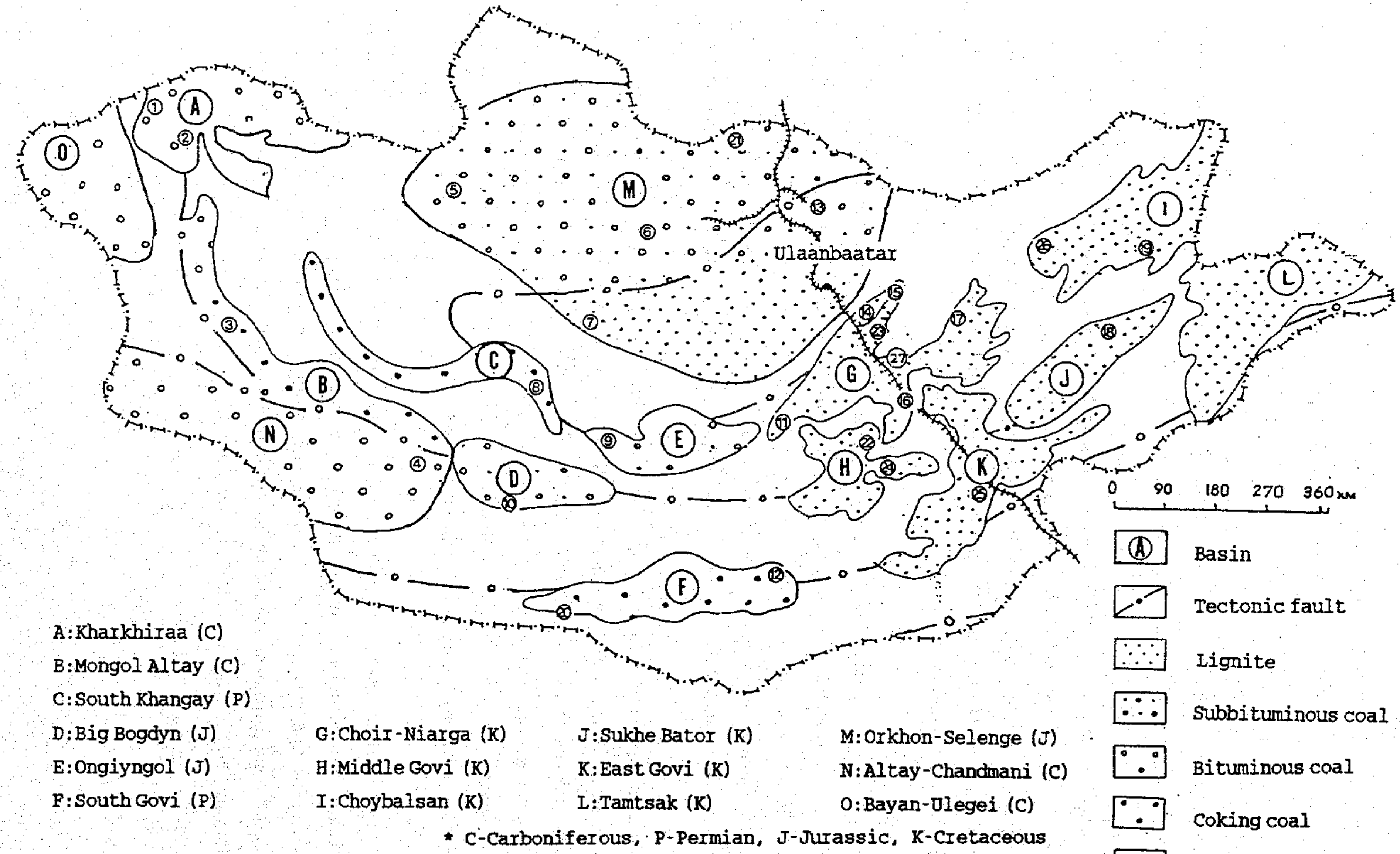


Figure 1 Distribution on Map of Large-scale Coal-bearing Basins

Table 1 Classification of Coal Ranks

Rank: Mongolia	Rank: U.S.A (ASTM)	Rank: Japan (JIS)	Ro %	Vol.M. (daf) %	Carbon (daf) %	Bed Moiture %	Cal.Value kcal/kg (Btu/kg)	Applicability of Different Rank Parameters
	Peat		0.2	68, 64	60	75		bed moisture (af); calorific value (daf)
B 1	Lignite	Lignite F	0.3	60, 56		35	4,000 (7,200)	bed moisture (af); calorific value (daf)
B 2	SB C		0.4	52				bed moisture (af); calorific value (daf)
B 3～D	SB B	E		48	71	25	5,500 (9,900)	bed moisture (af); calorific value (daf); carbon (daf); Ro
D～G	HV C / SB A	SB	0.5, 0.6	44	77	8-10	7,000 (12,600)	bed moisture (af); calorific value (daf); carbon (daf); Ro
G J	HV B	D	0.7	40				bed moisture (af); calorific value (daf); carbon (daf); Ro
J	HV A	C	0.8, 0.9, 1.0	36, 32				bed moisture (af); calorific value (daf); carbon (daf); Ro
K～K J	MV	Bit. B	1.2, 1.4	28, 24	87		8,650 (15,500)	carbon (daf); Ro; volatile matter (daf)
O C	LV	Anth.	1.6, 1.8	20, 16				carbon (daf); Ro; volatile matter (daf)
T	Semi Anthracite	A 2	2.0	12				carbon (daf); Ro; volatile matter (daf)
A	Anthracite / Meta-A	A 1	3.0, 4.0	8, 4	91		8,650 (15,500)	hydrogen (daf); volatile matter (daf); carbon (daf); Ro

2 Main coal deposits

In order to contribute to investigation works of 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 future. Figure of Attachment shows main coal mines and its supplying area.

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 Table 2 and Figure 2. All the boundaries of megablocks, without a part of west boundary of Middle-East Megablock, are overlapped on boundaries of province.

Summary of properties for appreciating above-mentioned main coal deposits is shown at Table 3. The outline and coal geology on each deposit are reported below. The following item number of 27 deposits is conveniently attached the same as the deposit number at Table 2, Table 3, Figure 1, Figure 2 and locality maps.

(1) Nuursthotgor Deposit

1) Locality and topography

The Nuursthotgor Deposit is present within the West Megablock and at the west of Uvs Province. The center of the deposit is in latitude 49° 40' N and in longitude 90° 33' E, 50 km southeast of the border with Russia and 110 km west-southwest of Ulaangom which is the capital town of Uvs Province (Figure 3). The land surface of the deposit forms a flat steppe surrounded by mountains and is covered with permafrost partially.

2) History of exploration

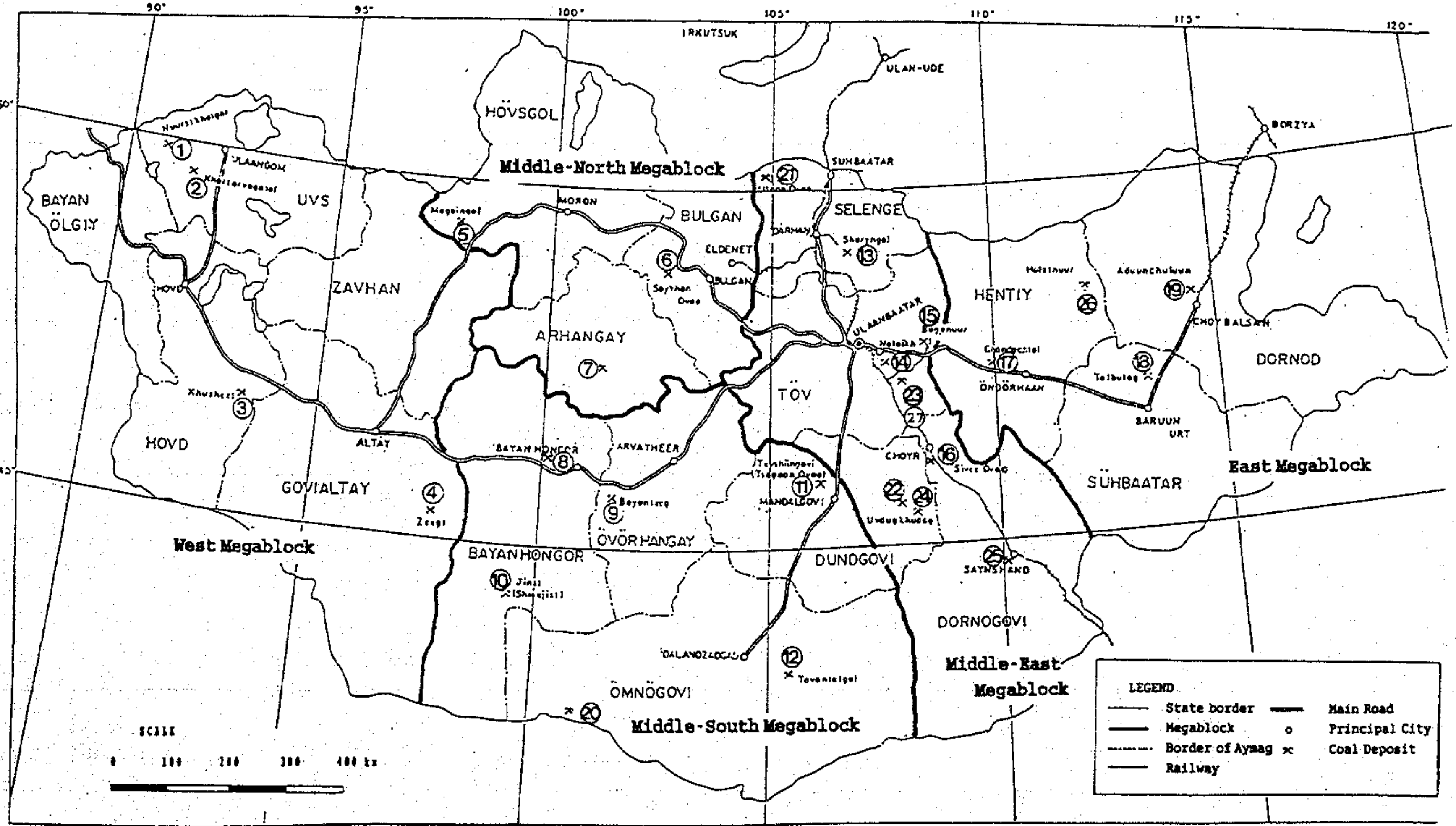
1927 : Firstly recorded by Russian geologists

1941-42 : Exploration
- evaluated as a minable deposit

1960 : Detailed exploration for the northeast area by a geological expedition of former Soviet
- area : 1.0 km × 0.6 km

Table 2 Megablocks of Coal Deposit

Megablock	West	Middle-North	Middle-South	Middle-East	East
Coal Deposit	①②③④	⑤⑥⑦	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 2 Main Coal Deposits in Mongolia

Table 3　Main Coal Deposit in Mongolia (1/2)

Coal Deposit	Age	Geological Structure Basics	Strike	Dip	Mineable Coal Seams Number	Thickness	Characteristic	Classification of Coal Mongolia (Russia)	ASTM (U.S.A.)	JIS (Japan)	Moisture (arc) %	(ad) %	Ash (d) %	Vol. (daf) %	S (d) %	Calorific Value (arc) 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	C3	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	J2	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	J2	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 patrtings, 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	VII: 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

Table 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)	Mining Results Year of opening	Method	Products (1,000t)
(1) Nuursthotgor 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 (pantially)	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)	Sineus 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- (?) mined 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° 07'E	110km S of Malaykh	plain grasslamd	10 x 10km	80km²	1952	1984		whole area	300m	–	695	–		

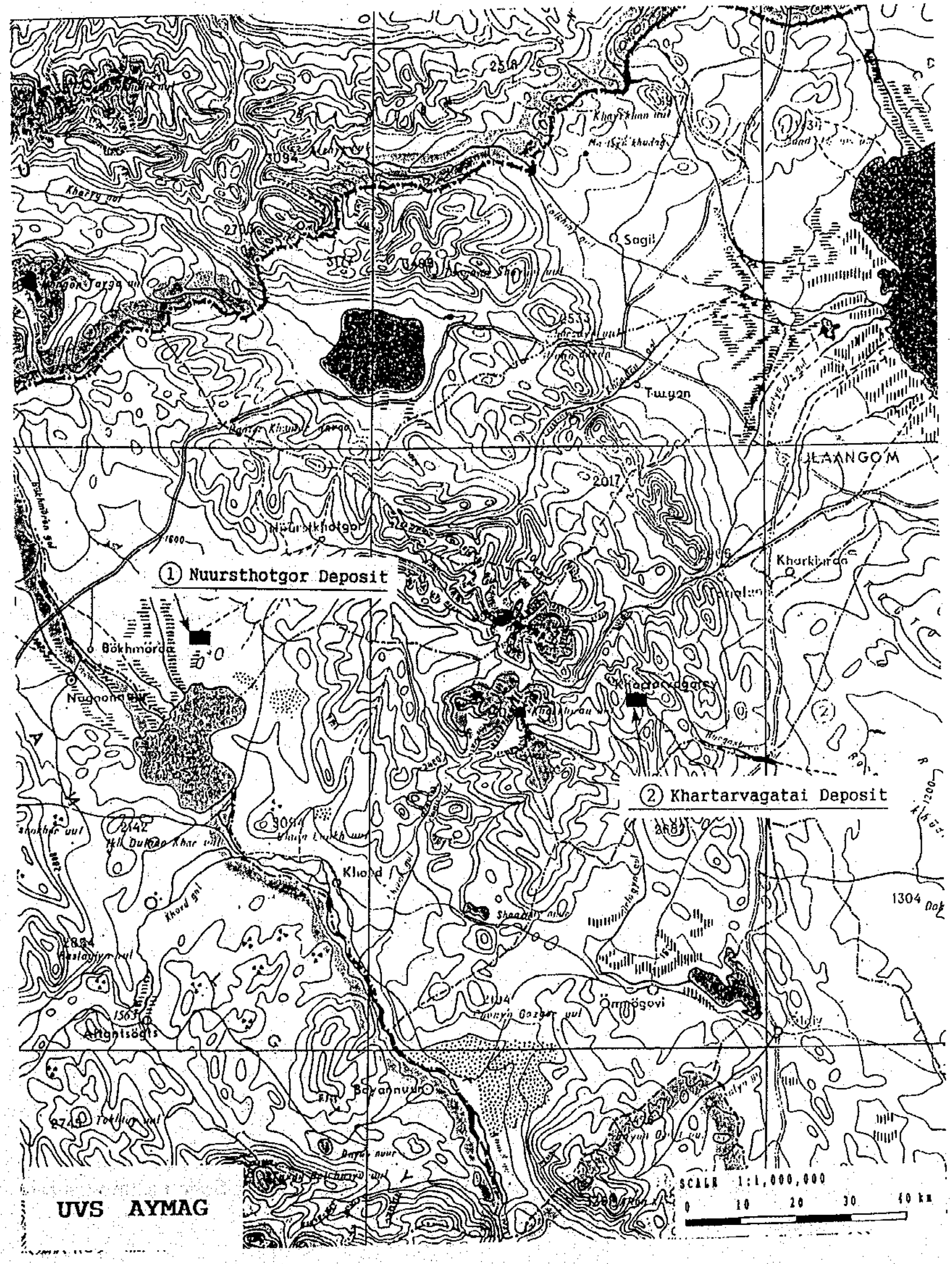


Figure 3 Deposit locality amap in Uvs Aymag

1964 : Start of opencut mining

1990-91 : Exploration for the whole deposit by Mongolia

- drilling : about 10 holes
- discovered the western deposit
- revealed the general geologic structure of the deposit

3) Coal geology

The Nuursthotgor Deposit belongs to the Kharkhiraa Coal-bearing Basin. The deposit shows a large basin extending for 30 km east-west and 15 km north-south with an area exceeding 450 km^2. Coal seams are embedded in the Uliastai Formation which was formed during Middle to Late Carboniferous time. The basic geologic structure is formed of a synclinal basin structure with an east-west axis (Figure 4). The coal seams near the surface dip 45° east at the west area and 11-25° west at the east area.

There are a total of eight named coal seams : the Seam I to VIII in ascending order. In the distribution of coal seams, the Seam I and II are restricted within the west area and the others, the Seam III to VIII restrictively occur at the east area (Figure 5). All the coal seams are characterized by a variable thickness and splitting. Particularly the seams of the east part have a tendency of thinning out toward the south. The thickness of eight seams ranges as follows:

Seam	Thickness	
VIII	2.6 - 5.7 m	
VII	1.1 - 6.2 m	
VI	0.8 - 3.6 m	East part
V	0.2 - 4.0 m	
IV	1.1 - 24.5 m	
III	1.6 - 7.4 m	
II	12 - 13 m	
I	30 - 50 m	West part

In the present mining area, only the Seam VIII has being mined. The Seam I at the west part is regarded to be available for future mining.

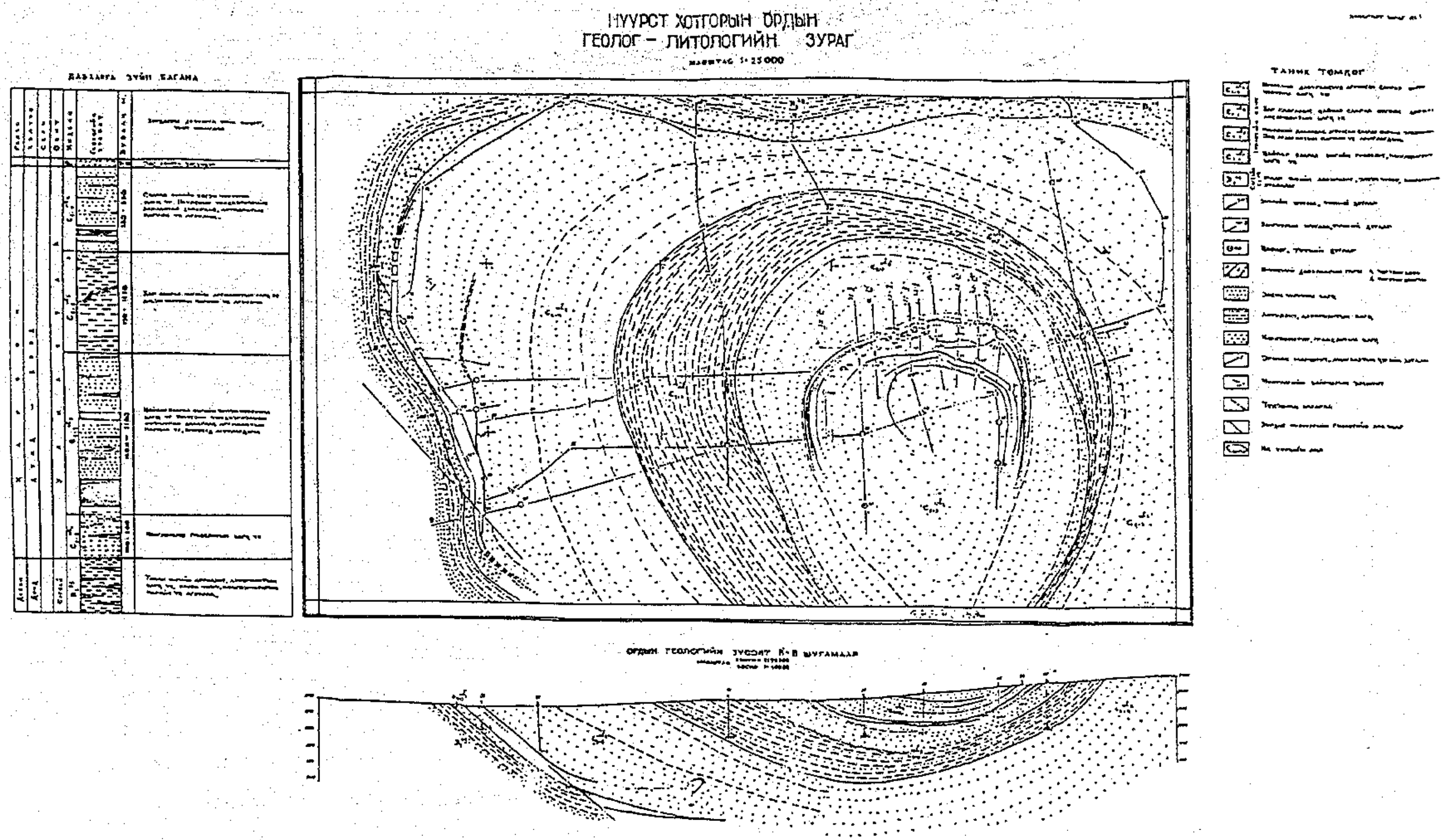


Figure 4 Geological map of Nuurthotgor Deposit

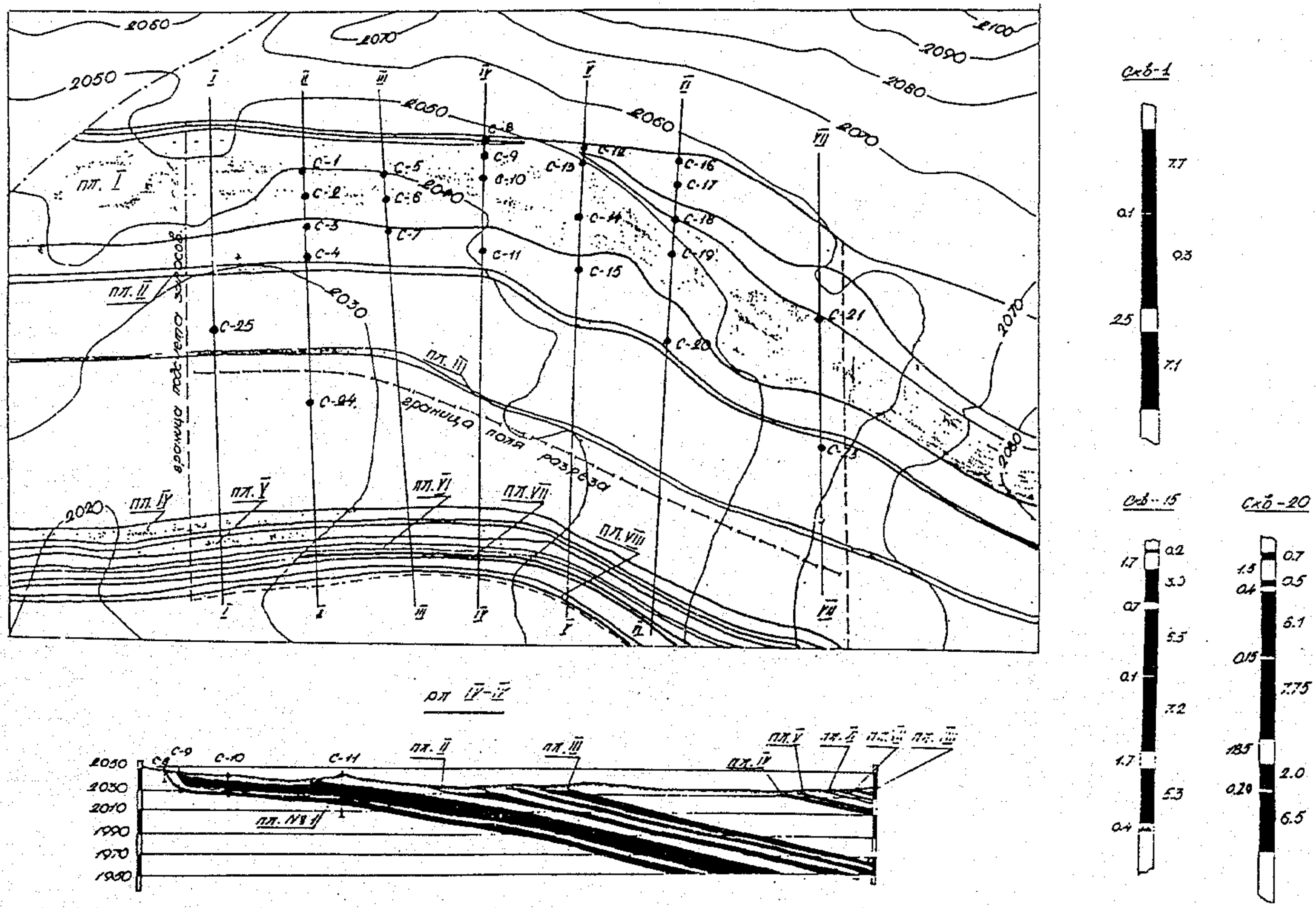


Figure 5 Seam conditions of Nuurthotgor Mine

4) Coal quality

The coals are classified into D-G (Mongolia, Russia), Subbituminous B-High volatile bituminous C (U.S.A) or Subbituminous E-Bituminous C (Japan -JIS). The general coals contain 1.4-2.1% total moisture (as received), 19-36% ash (dry), 31-44% volatile matter (dry, ash free), 0.3-0.5% total sulfur (dry). The calorific value is 5,400-6,100 kcal/kg (as received) and 7,560-8,430 kcal/kg (dry, ash free). Most of Nuursthotgor coals are regarded as a high quality bituminous coal with high calorific value and low sulfur contents.

5) Coal reserves

The reserves within 100 m in below the surface is estimated at 142.3 million tons for minable ones($A + B + C_1$) and 166.6 million tons for geological ones($A + B + C_1 + C_2$). According to the report in 1993, the geological reserves($A + B + C_1 + P_1$) above 300 m in depth is estimated at 1,918.3 million tons for the whole deposit.

6) State of mining

The Nuursthotgor Coal Mine began as an opencut mine in 1963 and has produced a total of 3.1 million tons until 1993, with an average of 150,000 tons/y. The coal has been utilized by local consumers restricted in Bayanolgiy and Uvs Provinces.

(2) Khartarvagatai Deposit

1) Locality and topography

The Khartarvagatai Deposit is present within the West Megablock and at the west of Uvs Province. The center of the deposit is in latitude 49° 35' and in longitude 91° 40', 50 km southeast (100 km by road) of Ulaangom which is the capital town of Uvs Province (Figure 3). The land surface of the deposit forms a mountainous steppe. The Outcrops of coal seams occur at 2,450-2,520 m above the sea level.

2) History of exploration

1941 : Firstly recorded by Russian geologists

1961 : Detailed exploration by a geological expedition of former Soviet Union

- drilling : 22 holes, 363.3 m in total
- trenching : 433.7 m^3

1964 : Start of opencut mining

3) Coal geology

The Khartarvagatai Deposit belongs to the Kharkhiraa Coal-bearing Basin. The deposit has an area of about 30 km^2 and is bordered by three faults. A coal seam is embedded in the Uliastai Formation of 200 m thick in Middle to Late Carboniferous time, the same as the Nuursthotgor Deposit. The geologic structure is characterized by synclinal and anticlinal folding with northeastward axes. The coal seam steeply dips 30-40° on the west flank and 50-70° on the east flank.

There is only one thick coal seam in the deposit, showing 80 to 85 m thick with two or four partings of 0.1-0.2 m thick respectively (Figure 6).

4) Coal quality

The coal is classified into the same rank as the Nuursthotgor coal: D-G (Mongolia, Russian), Subbituminous B-High volatile bituminous C (U.S.A) or Subbituminous E (Japan -JIS). The average coal contains 3.0-5.0% moisture (air dried), 15-25% ash (dry), 40-45% volatile matter (dry, ash free) and 0.5% sulfur (dry). The calorific value is 5,500 kcal/kg (air dried) and 7,450 kcal/kg (dry, ash free).

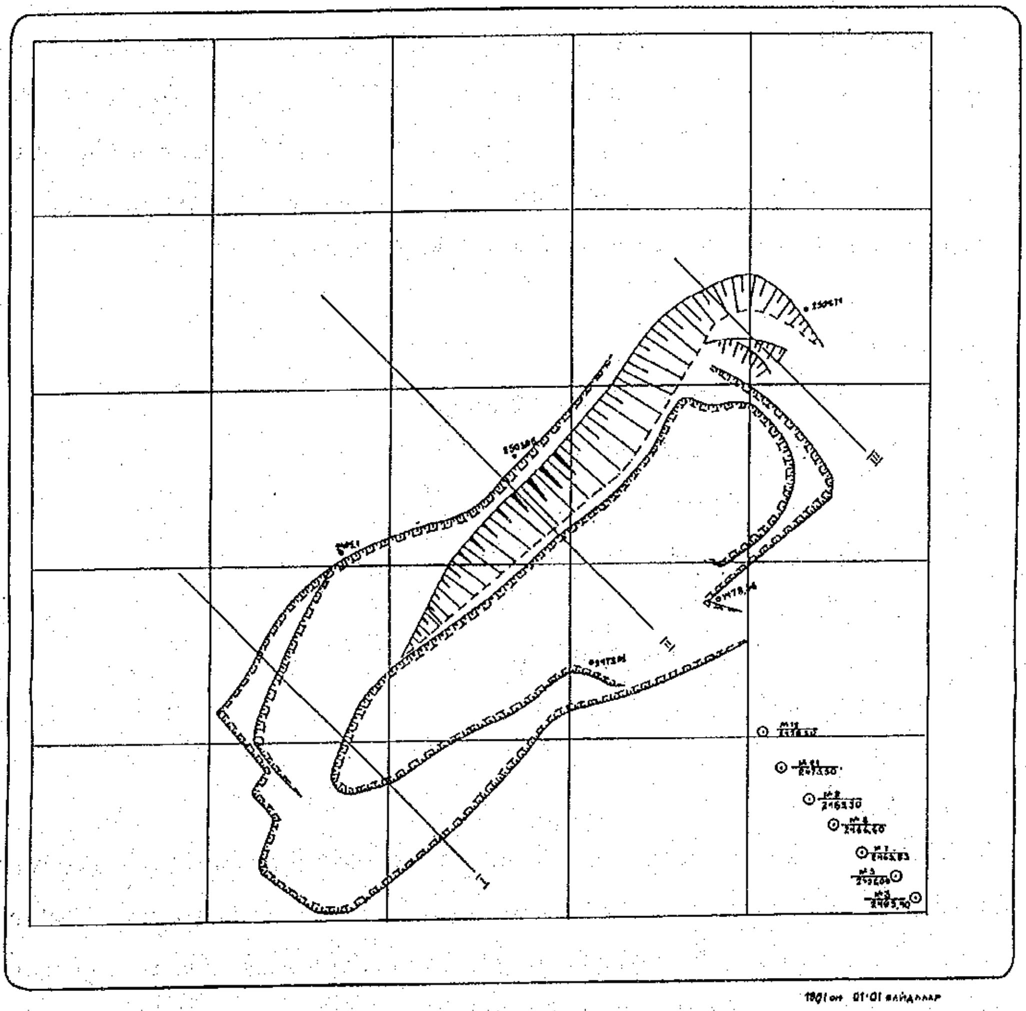
5) Coal reserves

The reserves of the detailed exploration area, a block of 0.85 km x 0.4 km within 60-100 m below the surface, is estimated at 19.7 million tons for minable reserves($A + B + C_1$) and 25.7 million tons for geological reserves($A + B + C_1 + C_2$). According to the report is 1993, the geological reserves for the whole deposit is estimated at 283.1 million tons.

6) State of mining

The Khartarvagatai Coal Mine began as an opencut mine in 1964 and has produced a total of 2.4 million tons until 1993, with an average of 110,000 tons/y. The coal has been utilized by local consumers in Uvs, Hovd and Zavhan Provinces.

Хартарвагатайн уурхай



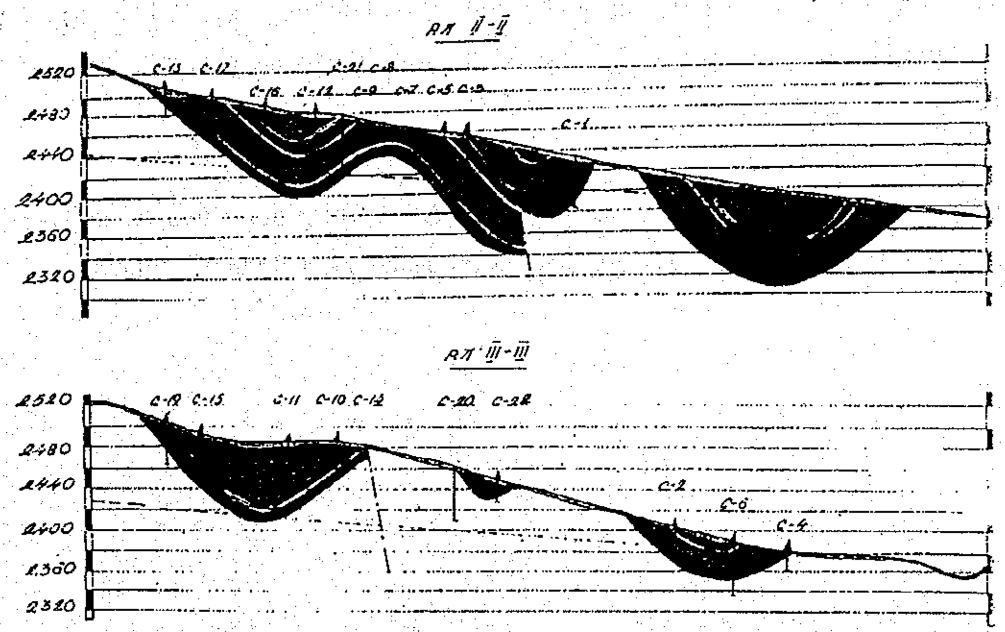


Figure 6 Schematic of Khartarvagatai Mine

(3) Khusheet Deposit

1) Locality and topography

The Khusheet Deposit is present within the West Megablock and at the Middle east of Hovd Province. The center of the deposit is in latitude 46° 40' and in longitude 93° 25', 20 km northeast of Testseg and 30 km southwest (60 km by road) of Darvi on the highway (Figure 7). The land surface of the deposit forms a hilly steppe at the southern foot of Mt.Altay. The outcrops of coal seams occur at 2,000-2,080 m above the sea level.

2) History of exploration

1926 : Firstly recorded by Russian geologists

1967 : Exploration by Mongolia

- drilling : 14 holes

1972 : Detailed exploration (south area)

- drilling : 8 holes

1978 : Detailed exploration (south area)

- additional drilling : 12 holes

3) Coal geology

The Khuseet Deposit belongs to the Mongol Altay Coal-bearing Basin. The deposit extends for 3.5 km north-south and 2.0 km east-west with an area exceeding 7 km^2. Coal seams are embedded in the sediments of Middle to Late Carboniferous age. The geologic structure is characterized by synclinal and anticlinal folding with northward axis (Figure 8). The coal-bearing formation steeply dips 45° east on the west flank and 40 to 65° west on the east flank.

In the whole deposit, there are a total of 5 seams, of which upper two seams(C and B) are minable seams (Figure 9). The average thickness and intervals are the following.

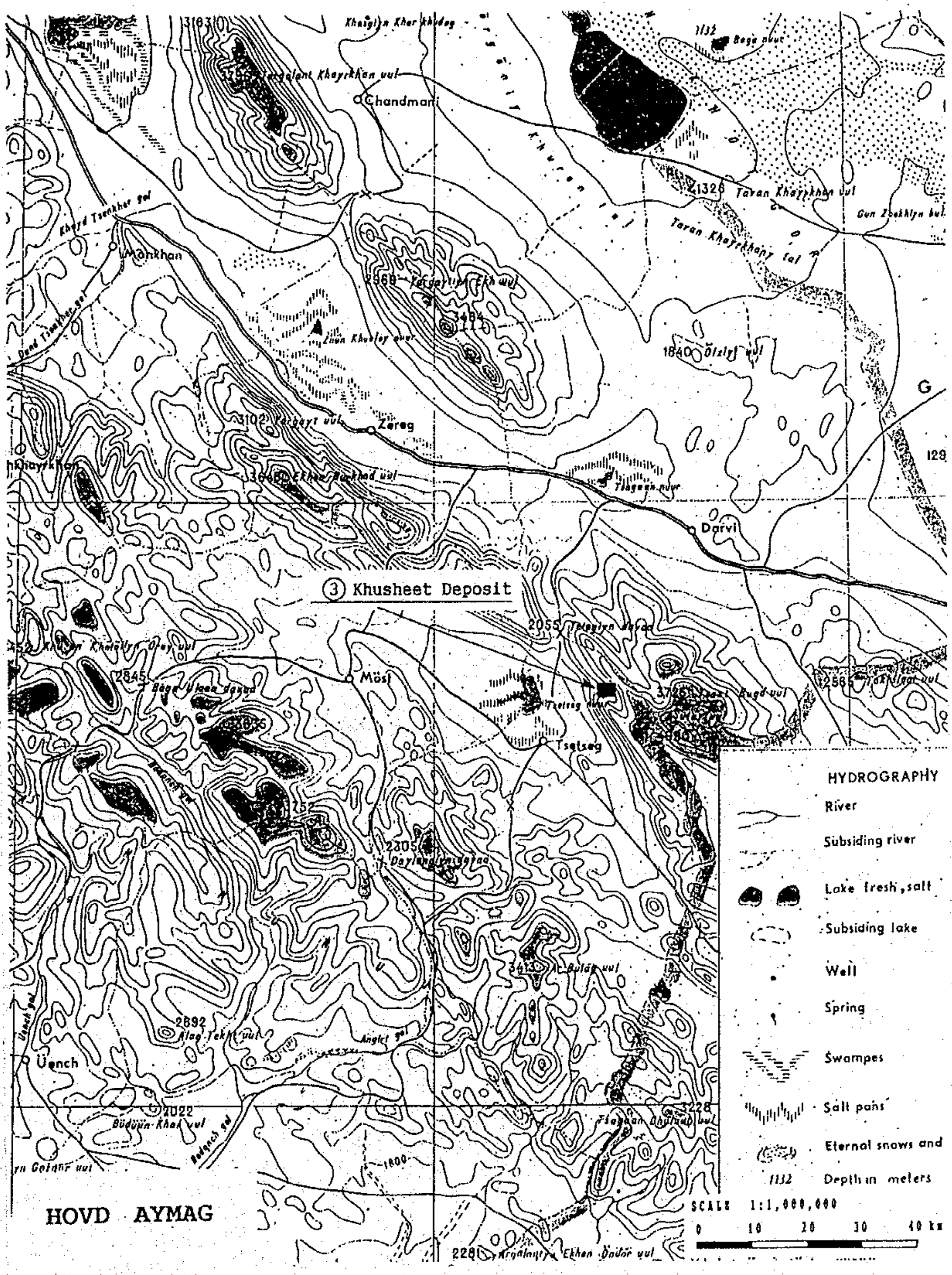


Figure 7 Deposit locality map in Hovd Aymag

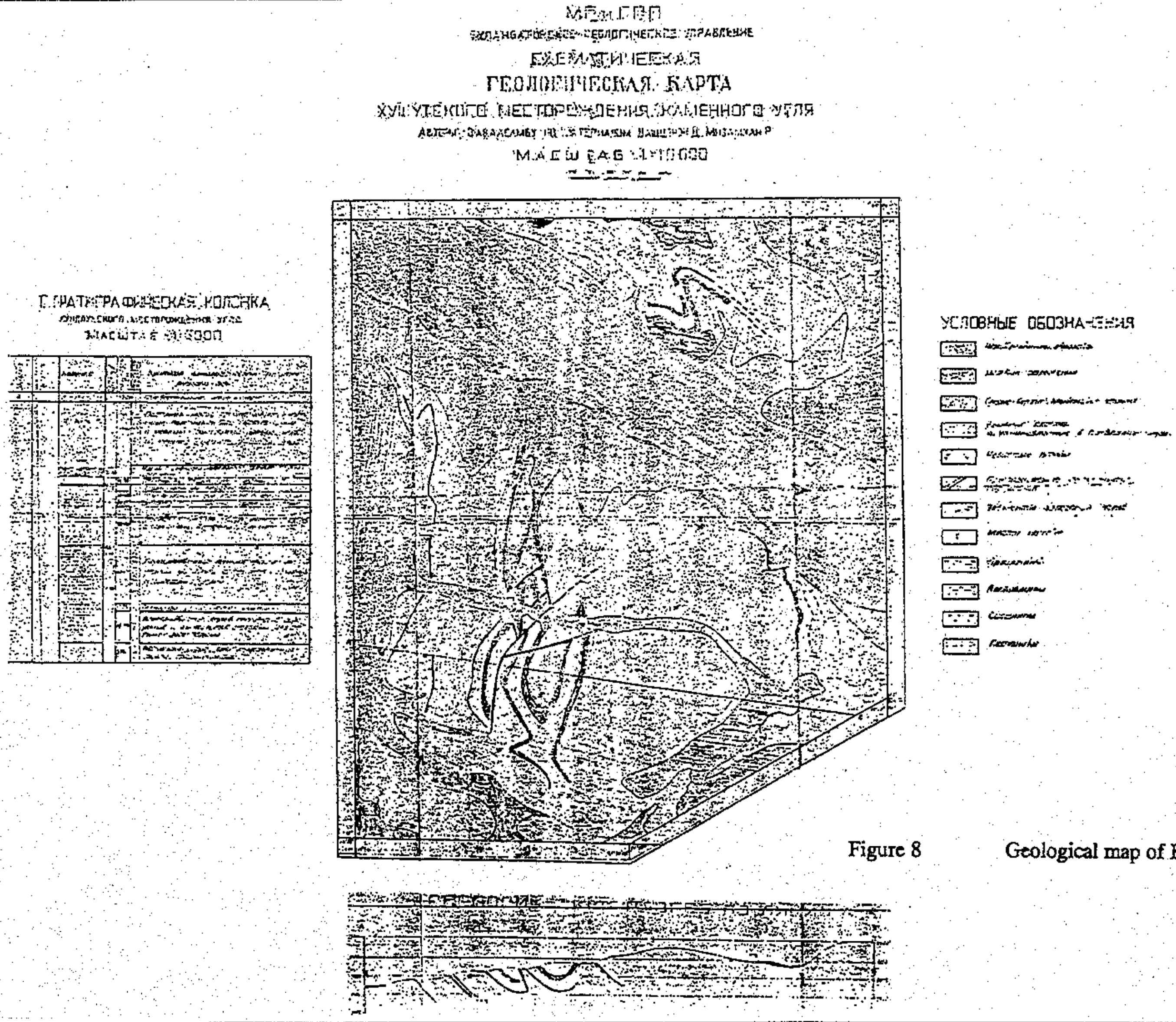


Figure 8 Geological map of Khuseet Deposit

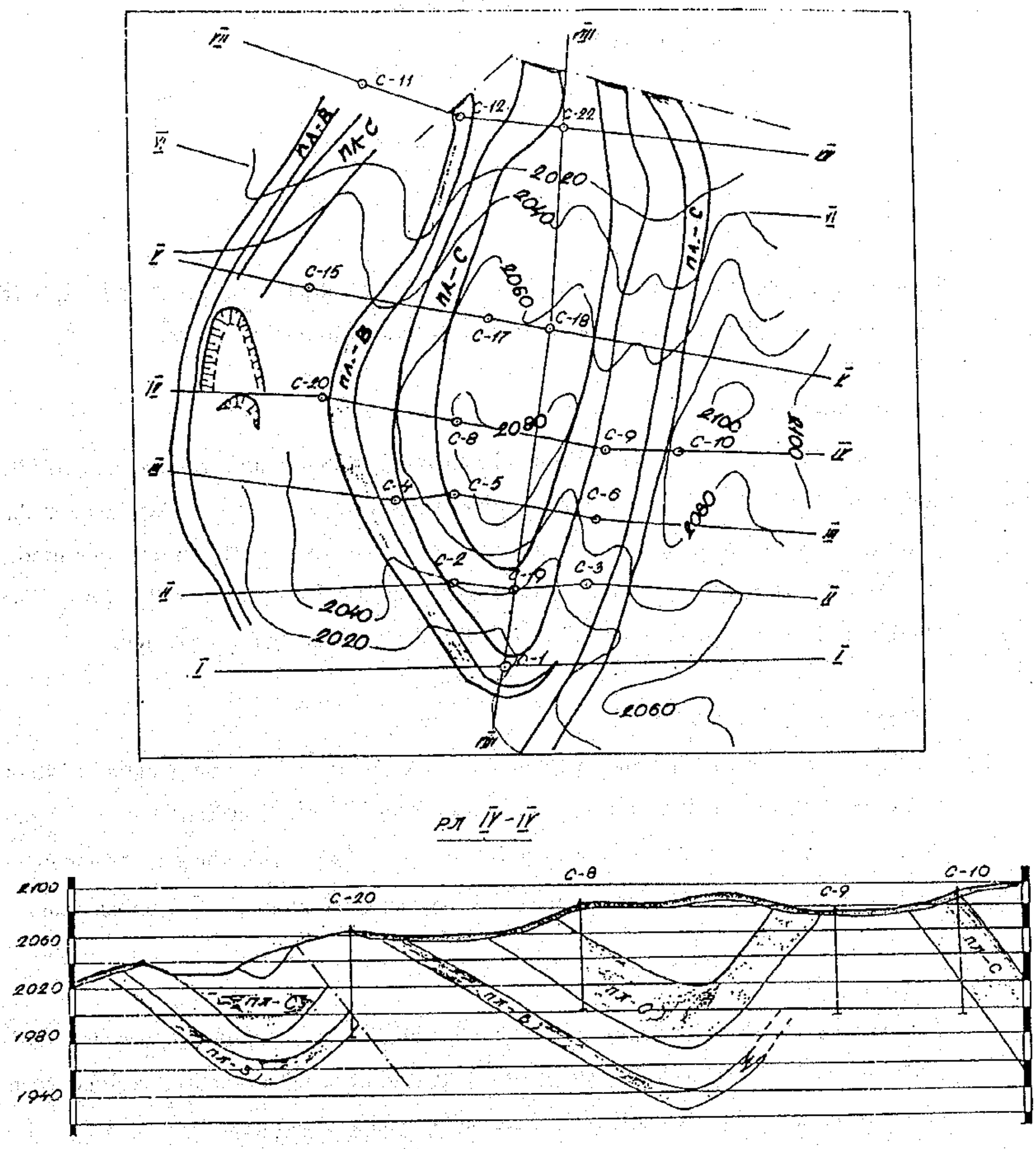


Figure 9 Seam conditions of Khuseet Mine

Seam	Thickness	Interval
C	34.9 m minable	
		20-30 m
B	15.5 m minable	
		120-130 m
A_1	0.8 m	
		0.5-3.5 m
A	2.5 m	
		130 m
D	6.9 m	

In the northern area of the deposit, which is covered by Quaternary sediments, it is expected for the extension of coal seams to be confirmed by future exploration works.

4) Coal quality

The coals are classified into D-G (Mongolia, Russia), Subbituminous B-Medium volatile bituminous (U.S.A) or Subbituminous E-Bituminous C (Japan -JIS). According to the report by the government in 1979, the average coal contains 3.0-5.0% moisture (air dried), 10-16% ash (dry), 20-27% volatile matter (dry, ash free) and 0.5% sulfur (dry). The calorific value is 5,400-6,300 kcal/kg (air dried) and 8,590 kcal/kg (dry, ash free).

5) Coal reserves

The coal reserves restricted at the south area, a block of 1.0 km x 0.5 km within 70-140 m below the surface, is estimated at 14.7 million tons for minable reserves(A + B + C_1) and 24.3 million tons for geological reserves(A + B + C_1 +C_2). According to the report in 1993, the total geological reserves for the whole deposit is estimated at 383.7 million tons.

6) State of mining

The Khusheet Coal Mine began as an opencut mine in 1971 and has produced a total of 1.19 million tons until 1993, with an average of 100,000 tons/y. The produced coal has been utilized by local consumers restricted in Hovd and Govialtay Provinces.

(4) Zeegt Deposit

1) Locality and topography

The Zeegt Deposit is present within the West Megablock and at the middle east of Govialtay Province. The center of the deposit is in latitude 45° 20' N and in longitude 97° 50', 9 km southwest of Chandmani and 170 km southeast (250 km by road) of Altay which is the capital town of Govialtay Province (Figure 10). The land surface of the deposit forms a flat steppe gently dipping northeast. Coal seams crop out about 2,400 m above the sea level.

2) History of exploration

1969 : Exploration by a geological expedition of Mongolia

1979 : Detail exploration with drilling

This coal deposit had been known since old times and utilized by native residents.

3) Coal geology

The Zeegt Deposit belongs to the Altay Chandmani Coal-bearing Basin. The defined deposit extends for 2.5 km northwest and 1.0 km northeast with an area of about 2.5 km^2. The extension to the east, north and west of the deposit is not clarified owing to overlying Quaternary sediments. Coal seams are embedded in the formation of 380-400 m thick in Middle to Late Carboniferous time on the basement of Pre-cambrian metamorphic rocks.

The geologic structure is characterized by synclinal and anticlinal folds with northeastward axes and two faults extending in parallel with the axis of folds (Figure 11). The dip of formation ranges from 0 to 40°.

The deposit has minable two coal seams: the Seam I and II. The Seam I ranges in thickness from 9 to 16 m, 14 m in average. The Seam II stably shows 4.2 m thick. Both coal seams are characterized by containing many thin partings. The Zeegt Coal Mine has been mining the Seam II which occurs at the anticlinal part of the northeast block (Figure 12).

4) Coal quality

The coals are classified into G-J(Mongolia, Russia), High volatile bituminous A(U.S.A.) or Subbituminous E-Bituminous C(Japan-JIS). The general coals contain 0.2-13.3% moisture (air dried), 18.4% ash(dry), 30-34% volatile matter(dry,ash free) and 0.43% sulfur(dry). The calorific value is 4,880 kcal/kg(as received) and 8,200 kcal/kg(dry, ash free). In regard to coking property, there is no analytic data. It has been, however, reported that coals had shown such a property as congealing after combustion.

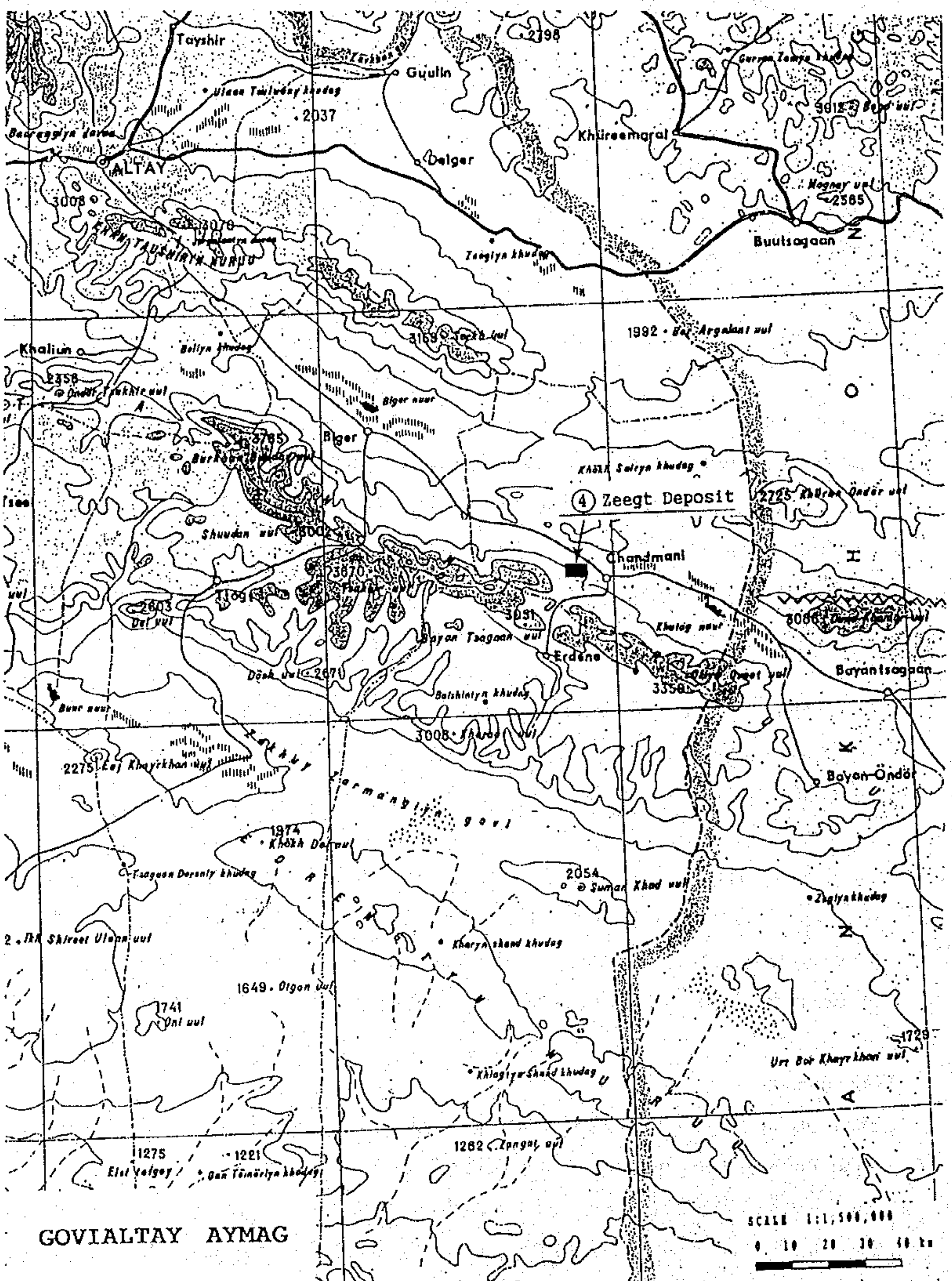


Figure 10 Deposit locality map in Govialtay Aymag

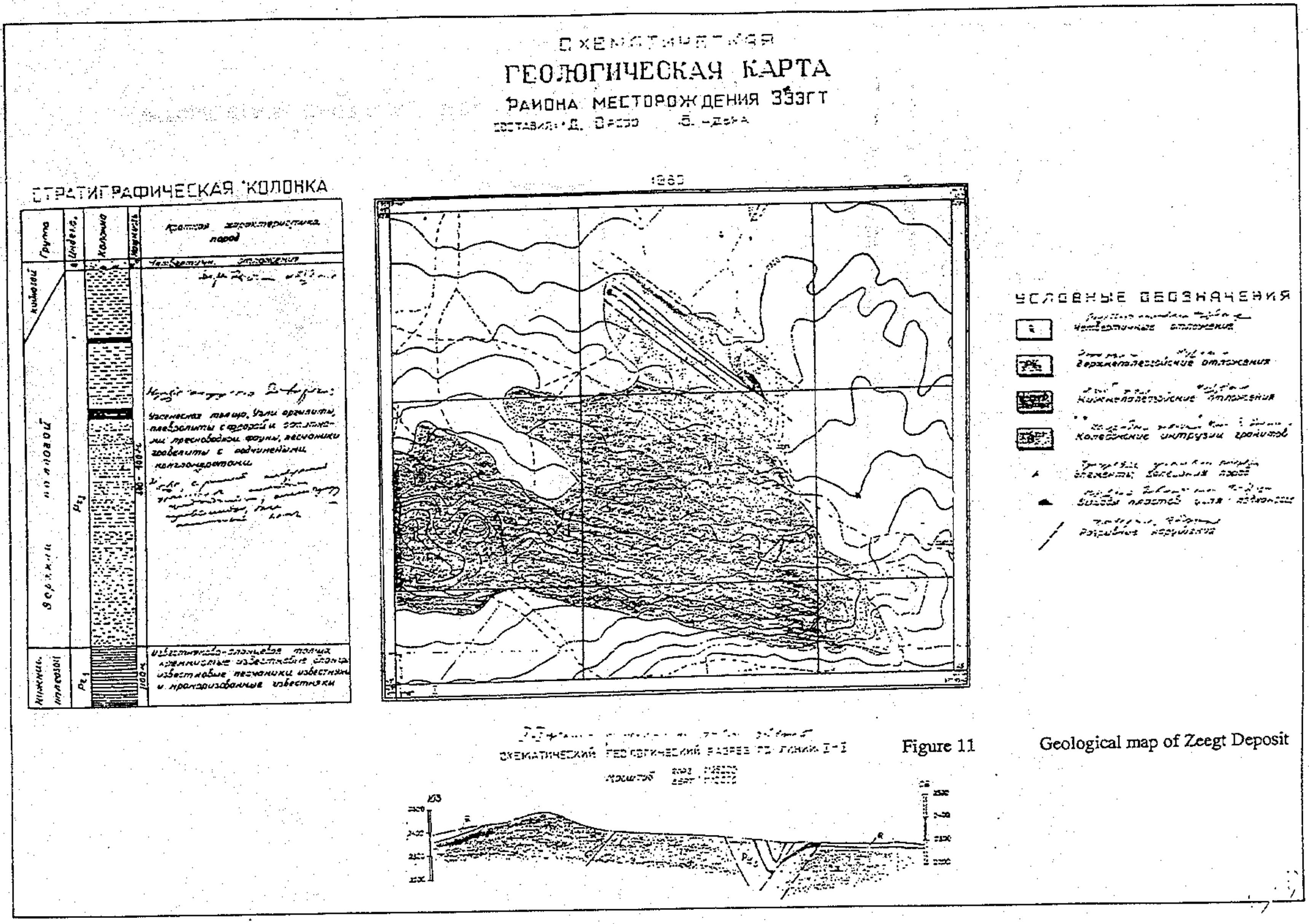


Figure 11 Geological map of Zeegt Deposit

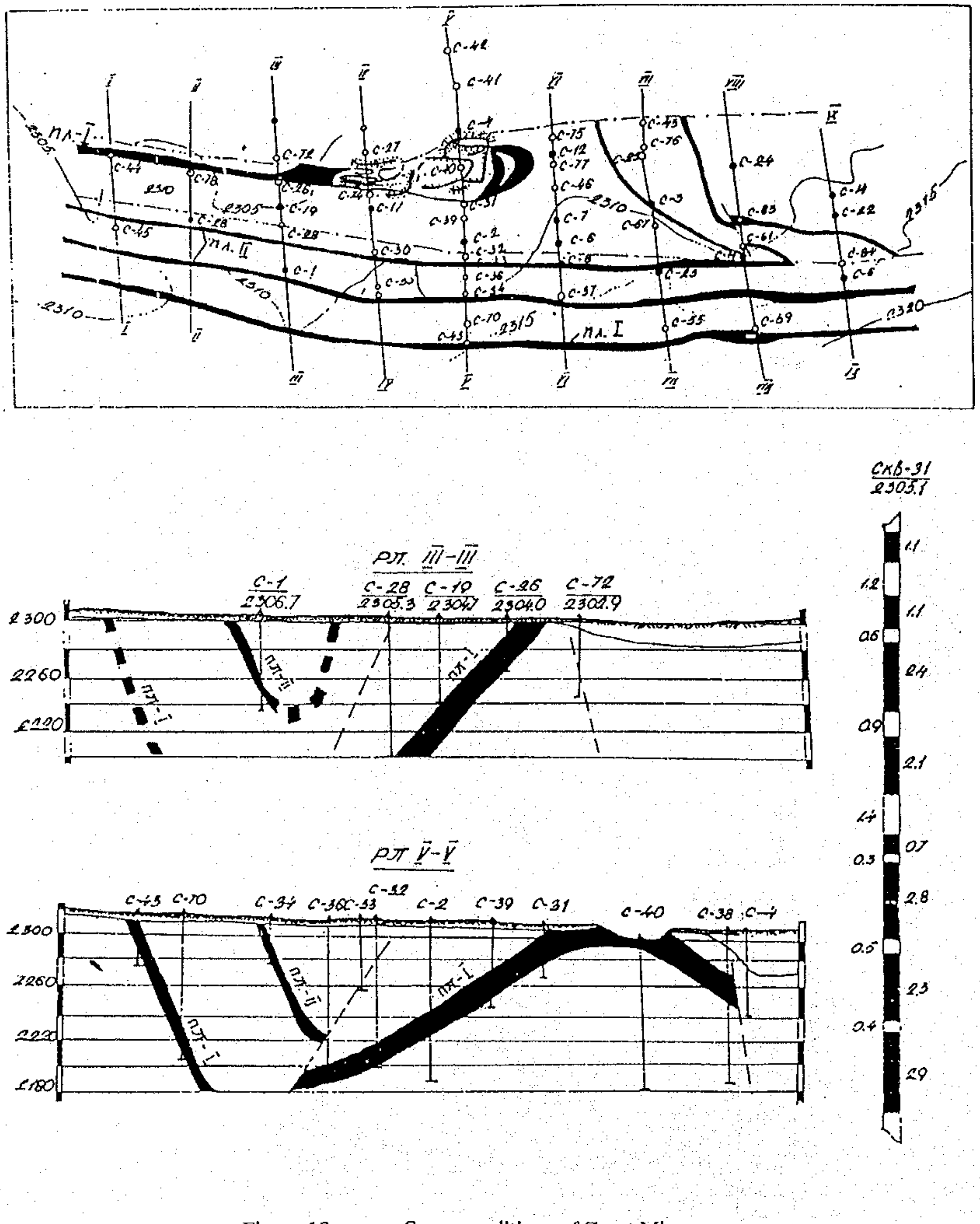


Figure 12 Seam conditions of Zeegt Mine