

“Central Kazakhstan Coal-fields Potential for Development of Coalbed Methane Production Projects”

N.S. Umarhajieva, OJSC Azimut Energy Services;
R.K. Mustafin, E.G. Alekseev, Methane Center

INTRODUCTION

The objective of the report is to introduce two coal basins and 36 coal deposits of carbonic age in Central Kazakhstan, which have certain potential for implementation of coal reserves commercial development projects. Coal methane resources of the Central Kazakhstan coal fields are estimated at more than 1 trillion cubic meters, and under appropriate projects development annual production may reach to 3-4 billion cubic meters. It may provide supply for gas consuming industry sectors for more than 100 years.

The figured data are called to evaluate potential investment opportunities in Central Kazakhstan.

Coal fields and basins' areas selection criteria:

Deposits, presented in the report were selected on the base of a geological data analysis conducted for carbonic age coal-fields.

The selected fields are meet the following criteria:

- certain reserves and estimated coal resources of the fields;
- reserves and resources of coalbed methane are available for calculation and evaluation, based on the coal quality and occurrence depth data;
- small deposits with scanty and problematic methane resources are included considering their adjacency to the main objects there they may be in demand.

Production of coal methane and its utilization as an environment-friendly energy resource for housing and communal services, heat-and-energy stations and transport sector will improve ecological conditions in abovementioned regions.

The potential of carbon dioxide emission reduction gained from 1 billion cubic meters methane utilization is 3.6 million ton per year.

In the regional and global scale the development of coal methane production projects may hypothetically provide the reduction of its emission to the atmosphere at 0.1-0.15 million ton, equivalent to 2-3 million ton of carbon dioxide, only in Karaganda basin.

Implementation of such projects in Kazakhstan would provide significant mitigation of greenhouse gas emission, and with introduction of the emission quota trading system, according to Kyoto Protocol, coal-gas production may be seen as a source of carbon credits.

COAL DEPOSITS OF CENTRAL KAZAKHSTAN

Considering the methane-bearing of all coal deposits of Central Kazakhstan only carbonate age deposits make an interest, and only coals of Karaganda and Ekibustuz basins as well as deposits of Kushoky and Borly are being used. Now only Karaganda and Ekibastuz basins have real perspectives of methane production. Other deposits of carbonate coals in Central Kazakhstan

(Fig. 1) by virtue of the sizes, quality of coals and methane-content do not represent a practical interest yet but in the future at active development of coal-gas industry and technological development perspectives of some of them may be reconsidered.

1. KARAGANDA COAL BASIN

Karaganda basin is located on the area of the same name and in the center of this region. Carbon coal-content area occupies the land of about 2000 km² at the total thickness 4000m. Four synclines are notable in the basin: Tentek, Sherubainur, Karaganda and Verkhnesokursk, first three of them make an industrial part of basin and are studied full enough up to the depths 700-1300m. Productive sediments are represented by Ashlyarik (? 1), Karaganda (? 1), Dolinsk (? 2) and Tentek (? 2-3) series which contain up to 30 coal seams with the total working thickness 40m, coal ash content varies within the limits of 10-35 % with the tendency of reduction upwards the section. The most-widely spread are coals of types from hvBb to mvb. Karaganda basin is considered as a high gas content and gas content seams intensively grow from the beginning of methane zone up to 400-500m reaching 15-20 m³/t, and are more stabilized on the depth within the limits of 22-27 m³/t. Gas weathering zone depth varies within the limits of 60-250 m.

Total coal resources of basin up to the depth of 1800m were estimated at 41.3 billion tons and are maintained by 11 mines 8 of which belong to "Ispat Karmet" OJSC.

Karaganda coal basin is the most perspective from the view of conformity to requirements of above-mentioned criteria.

The depth of methane zone surface in the basin varies over the range of 60-250m and depends on geologic-structural features on each definite site. Methane content of seams rises sharply with the deepening from the methane zone surface to 400-500m (from 0 to 15-20 m³/t) then the growth rate sharply decreases, and at the depth of 800-1800m it amounts 22-27 m³/t.

Average concentration (density) of methane resources in Karaganda basin estimated at 275 million m³/km², and in the series of prospecting sites - 400-700 million m³/km².

Fragility of coals rises with increase of sparkling microcomponents content. With rise of vitrinit content in general case the hardness of coal is falling. As a whole Karaganda basin coals are classified as a fragile and semi-fragile.

Structural features of basin are characterized by simple sloping folds or monoclines with pitch angles 5-20°, only sometimes running up to 40°. The analysis of structures allows to estimate a geodynamic condition of various parts of basin at a slight pressing or stretching.

1.1. TENTEK TROUGH

Tentek trough is the deepest synclinal fold of the basin where Dolinsk and Tentek series can be found. Trough square is 150km², depth of Dolinsk seams is up to 1650m. Trough is asymmetric: seams in the northwest part lay steady but steeply (40-70°), and in southeast – flat (10-25°) but complicated with small folds and breaks. The steep part occupies no more than 20 % of the area and is not prospected, and three mines operate on the top horizons of the flat part.

Dolinsk series contains 11 coal seams of thickness from 1,0 to 6m, the majority of them keep working thickness throughout the area of trough. The most steady and thick (up to 7m) is a layer D6 where almost a half of Dolinsk series methane stocks are concentrated. Coals of seams have a medium ash content (18-22 %), pertain to the types hvBb-mvb (R° - 0,8-1,2%). Depth of methane zone surface depends on the angles of seams and varies from 120 to 330m, gas content of coal seams rises with the depth of seams from 14,5 to 27m³/t.

Tentek series includes 17 coal seams, but only two bottom ones have proper thickness (1,7-1,9m). Medium ash content coals (19-23 %) relate to the types 2GF and FC, gas content of coal seams varies from 12 to 24m³/t, maximal seams depth is 1000m.

Vitrinit content in coals is 54-77 % that conditioned on a high index of cracking – 20 and rather low firmness of coal – resistance to destruction is 100-90kg/cm², that in turn created preconditions for the high gas recovery and gas permeabilities. No direct definitions of these parameters were existing so far but gas-dynamic effects, high gas content of mining production, extraction up to 47 % of gas from m³ of coal at complex preliminary seams degassing allow to assume their high values.

1.2. DEEP HORIZONS OF SARANSKY FIELD

Deep horizons of Saransky field are located in the northwest part of Karaganda syncline. Sediments of Karaganda series are gas-bearing. Fields of operating mines “Saranskaya”, “Aktasskaya”, by the name of Kuzembayev can be found on the top horizons up to the 700? depth. Deep horizons of the field occupy 46 sq.m area and depths from 700 to 1300m.

Growth of the secondary folding and disjunction disrupt delineated by subwidth concordant ramps and less often concordant and not consent ramps extending up to 4-6km and displacement up to 80?, rarely 100-150m is observed up to the depth of 700-750m. These fractures break top horizons of Saransky field into small blocks where gas content is usually different. Deep horizons seams are mostly monoclyne, their angles flattening up to 20-5°, breaking disruptions are not numerous. However seams operating experience on the top horizons testifies the presence of numerous low amplitude disruptions (?-1-5m) revealing only at seismic survey and mining operations. Presence of such disruptions is inevitable and on the deep horizons.

The Karaganda series contains 29 coal seams and subseams at total thickness up to 33m. 11 of them are operational at thickness from 1 to 6,1m. Coals are mainly clarain-durain and less durain-clarain type and vitrinit content varies from 37 to 60 %, averaging 46 %. Coal ash content from ?18 to ?53 is equal to 22 % in average, seams ?4-?1 - 30 %. Methamorphism rate defines by types hvBb, hvBb-hbAb (R° =1-1,3%). Seams gas content is stabilizing at the depth of 700-1300m changing for the seams ?18-?7 from 22 to 25 m³/t, and for the seams ?5-?1 - within the limits of 23- m³/t.

1.3. DUBOVSKY FIELD

Dubovkiy field is a continuation of Saranskiy field deep horizons' inclination and located at the depths of 1300-1500m.

Its study is at the exploration stage. According the data, seams retain the same thickness, ash content and petrographic composition as those of the

deep horizons of Saranskiy field. Its study is on the stage of survey according to which coal seams presenting here keep thickness, ash content, petrographic content same as on the deep horizons of Saranskiy field. Only metamorphism grade increases - hvBb-hbAb (R° - 1.15-1.5 %) and methane content of the seams rises for 1-1.5 m³/t a.f.b.

1.4. TALDYKUDUKSKY FIELD

Taldykuduksky field is allocated on a southern extension of Karaganda syncline and has rather complex tectonic pattern due to the adjacency to Zhalairstkiy thrust – higher rates folds are complicated by breaks. On the northern extension of Taldykuduk trough coal seams lay rather easy and the southern extension is divided by system of step ramps. It is supposed that significant complexity of geological structure of this field will provide high gas output and gas permeability of coal seams.

Coal-bearing deposition of the field represented by 20 seams, 17 of them are of working thickness (from 1 to 6,3m). Their total thickness is 47m and coal mass content – 36,3m. Ash content of coal does not exceed 21 %. Composition of coals is 47 % vitrinit, type composition comply with hvBb, mvb (R_0 -1.15-1.4 %). Methane content in the interval from 200 to 700 m rises from 10 to 23 m³/t a.f.b..

1.5. DEEP HORIZONS OF SHERUBAJNURINSKY AREA

Deep horizons of Churubainurinskiy area are marked out in the central part of northeast extension of the same-name syncline at the depths from 700 to 1500 m. They are represented by full section of Karaganda series. Complex geological structure is observed 700m above: fractures break coal-bearing sediments into huge blocks where the field of mine settles down. Number of disruptions and amplitudes is decreasing on the depth of 550-700m, seams are flattening. On the deep horizons seams lay easy, monoclinally, at the angles of 10-20° and very rare intersecting with low amplitude ramps at extensions perpendicular to the strike of seams.

Karaganda series here contains 20 seams, 15 reach the working thickness. Total thickness is 37,6m, coal mass – 30,6m. Vitrinit content in coal seams varies from 35 to 61 %, ash content of coal – 20-25 %, methamorphism rate comply with the type mvb (R_0 -1.5-1.75%). Gas content of seams is rather stable and varies with the depth from 24m³/t (700m) to 27m³/t (1500m).

2. EKIBASTUZ COAL BASIN

Ekibastuz coal basin is located in Pavlodar region on the northeast of Central Kazakhstan. Recovery area of coal content sediments is 63 km² at the total thickness approximately 1000m. Sediments of lower carbone Ekibastuz series that include four seams by total thickness of 146-170m at coal mass more than 100-142m are industrially coal-bearing.

Average seams ash content is high and varies over the range of 35-50 %, coal ash content mass - 29-35 %, and some prolayers - 15-30 %. By their coals parameters are noted as the types mvb and hvBb.

Gas content of coal seams below the gas weathering zone (70-225 m) grows quickly and at the depths of 500-700 m is equal to 18-20 m³/t. Gas content of holding rocks is no more than 3 m³/t of rocks.

All coals stocks of the basin are studied in details on the full depth

(700 m) and make 11,3 billion tons, production is carried out by three mines. The basin pertained to the same name graben syncline and represents an asymmetric trough extended from northwest to southeast. From northeast and southwest trough it is limited by fractures at 100 and 150m amplitudes. Extensions of trough are strongly destructed in places but the number of breaks is decreasing with the depth and in the central part of trough where seams lay almost horizontally, they completely disappear. Coal area extension is 63 sq.km, maximal depth of the main coal horizon – 700m. Coal-bearing layer contains 6 coal seams of working thickness and is submitted by 5 series of which only Ashlyarikskaya and Ekibastuz series contain seams of working thickness.

The main productive horizon of basin including seams 3, 2 and 1 has 130-210m thickness. The layer 3 is of the highest thickness (86-102m) and has a complex structure and contains 140-160 sand-and-clay prolayers at 1-15cm thickness. Thickness of coal bands mostly varies from 0,1 up to 1,5m, less often up to 6,5m. The share of the coal mass is 76 % of average working thickness or 92m. Layer 2 is the most sustained; its total thickness is 38-45m, coal mass – 31-40m, coal density – 87 %. Layer 1 consist of 4-20 coal bands, its average thickness is 21-25m, and coal mass - 19-23m, coal density – 93 %. In the upper part of layer 1 there is small ash content (1?-19%) band at 1,2-2,3m thickness.

Coals of seams 3, 2 and bottom part of layer 1 are mostly half- lustreless (45 %) and half-bright (26-39 %). The content of mat differences – 10-22 %. Vitritin content prevails (53 %) only in the layer 1, in other seams it is same (41-46 %) as fusinit (40-43 %). Coal of all three seams pertains to the types hvBb-mvb. Coal ash content increases downwards the section and complies: layer 1 – 35 %, 2 – 33 %, 3 – 40 %, 4 – 46 %.

Total coal reserves in basin are 11301million tons, and 1, 2, 3, 4 seams reserves – 8847 million tons. Gas content of seams 1, 2, 3 was studied in three blocks I, II and III marked under conditions of allocation.

Seams in block I are situated at the angles of 60-90°, they are degassed up to the depth of 300m, and lower their gas content does not exceed 8m³/t that allows to exclude the block from the area of prospected methane extraction. In the block II seams are degassed up to the depths 245-315m, and their gas content varies from 9 to 20 m³/t. In the block III depth of degassing is 73-126m and gas content - 11-19 m³/t. There is a dependence established for the basin which contradicts the standard: depths of degassing zone increasing with the stratigraphic depth, i.e. in all blocks the third layer is degassed deeply than the second, and the second is deeper than the first. In the same direction there is a reduction of coal gas content in the seams. This regularity is explained by increase coal ash content with the depth and free migration of methane to the surface due to the half open type of basin.

3. KUSHOKY (KUUCHEK) DEPOSIT

Deposit Kushoky is in 55 kms to the north of Karaganda. The area of the coal-bearing sediments recovery is about 40 km², and thickness is about 800 m. Karaganda series with five coal seams at the total average thickness of 47m, coal mass thickness 32m and maximal depth 400m is the only industrial coal-bearing area. Coals ash content is 37-44 %, and coal mass - 32-40 %. Genetic and technical characteristics of coals are of mvb type.

Coal seams are gas-bearing, weathering zone reaches the depths 140-180m, and on the depth of 200m methane content is exceeding 3m³/t. Total coal reserves of deposit are estimated at 623 million tons. Deposit is exploiting since 1963 by large coal section.

4. PRINURINSKAYA GROUP OF DEPOSITS

Prinurinskaya group of deposits includes Samarskoye, Zavyalovskoye and Nurinskoye deposits located in 15-90km to the north and west from Karaganda basin, and first two are studied and are of coking coals interest of F type. Gas content in these deposits are Ashlyarikskaya, Karaganda, Dolinskaya and Tentekskaya series in which 56, 43 and 18 coal seams are totaled, but only 5-8 seams reach the working thickness. Total coal mass thickness does not exceed 10m.

Coals are gas-bearing, weathering zone is on the depths 160-200m, and on the depths 300-500m methane content reaches 20m³/t.

Total resources of coal are estimated for Samara deposit as 1305million tons up to the depth of 1800m, Zavyalovsk – 529 million tons up to the depth of 1200m, Nurinsk – 491million tons up to the depth of 1200m.

4.1. SAMARA DEPOSIT

Samara deposit represents a narrow graben-syncline of 210sq.km with flat southern (5-20°) and other steeply extensions. Syncline is composed of all four productive series sediments, but only Karaganda and Dolinsk series contain seams of working thickness (4 seams each).

Thickness of Karaganda series working seams varies from 1,3 to 3,0m making in total 6,4m. Coal ash content is 14-30 %, the metamorphism range corresponds to the type F. Productives seams of Dolinsk series at total thickness of 4,3m are less ash contented (13-25 %) and less metamorphized (type GF). The surface of methane zone seams of Karaganda series is on the depth of 125m, Dolinsk – 160m. From it up to 550m methane content grows accordingly to 20 and 11m³/t. For industrial methane extraction only Karaganda series seams will be apparently profitable.

4.2. ZAVYALOVSK DEPOSIT

Zavyalovsk deposit on the fullness of coal-bearing carbon is similar to Karaganda basin and represents a narrow graben-syncline of 440sq.km limited from both ends by fractures. Seams ?3 (2,4m), ?7 (1,9m), ?9 (1,9m), ?13 (2,1m), D1(1m), D11 (1,2m), ?1 (2,3m) and ?3 (1m) have the working thickness and are characterized by comparative consistency. Total thickness of seams coal mass is 11,6m and ash content 21-28 %. On metamorphism rate they pertain to the types hvBb-mvb. Vitrit content in seams is close to 50 %. Methane content of seams from the surface of methane zone (190-200m) up to 400m is growing to 14-16m³/t, and from 700m exceeding to 20m³/t, in the center of syncline (on the depth 1200-1500m) it reaches 25-26m³/t.

5. AKZHAR GROUP OF DEPOSITS

Akzhar group of deposits includes Akzhar, Borly, Samaisor, Koitas, Tumensor, Bayet and a number of coal occurrences located on the territory of Karaganda, Akmmola and Pavlodar areas. Significant Coal content in these

deposits is concentrated in the bottom part of Karaganda series. Three horizons are noted on Borly deposit at their total thickness of 75 m and coal mass thickness 38m, and the Akzhar deposit the thickness of industrially significant horizon 7m and coal mass – 5m. Coal ash content of these deposits varies within the limits of 39-55 %, and coal mass 27-47 %.

Coals resources on the Borly deposit are estimated at 443million tons, Akzhar – 421million tons. Borly deposit is surveyed and exploited by “Molodejny” section.

Deposits of this group are on the depths up to 200m and are in the zone of degassing that is noted by Borly deposit gas content where methane content on the depth of 200 m makes 0,1? 3/?. Only Akzhar deposit contains seams on the depth of 300-600m and its methane content may exceed 10-12m³/t.

6. TENYZ-KORZHUNKOLSKY BASIN

Tenyz-Korzhunkolsky basin is located in Akmola region and includes deposits Kosmurun, Kyzylsor, Bosshasor and Saryadyr.

Coal-bearing are the analogues of Ashlyarik and Karaganda series. Total thickness of the coal horizon decreases in the northern direction from 80m to 20m at coal mass accordingly 50-15m. In the north and west of basin seams are complicated by numerous sills and dikes of the Permian granite - porphyries. Coal ash content in basin varies in limits of 22-45 %. Gas content of coals is not high, methane appears on the depth of 150-250m, and on depth of 60m its content reaches 8-12m³/t. Total coals resources in the basin are estimated at 2504million tons.

7. ZHAMANTUZ GROUP

Zhamantuz group includes deposits Zhamantuz, Ayakmalaysor, Aibike, Batyrshasor, Kyzyltau and number of coal occurrences in southern part of Pavlodar area. Coal content is related to the tops of Ashlyarik and bottoms of Karaganda series. Thickness of the coal horizon is 10-30m, coal mass - 5-15m. Ash content is 30-50 %. Resources of these deposits are estimated within the limits of 100-300 million tons, and totally at 1309 million tons.

There is no direct information about methane content, but from the depth of 200-250m it can reach 10-12m³/t.

8. KOKSHETAU AND TENIZ GROUPS

Kokshetau group includes deposits Yablonovskoye, Danilovskoye, Koksengir, Bogdanovskoye, Zholdybai, Priozeroye, Bogembai, Tamsor, Uhsor located in Kokshetau and Akmola regions.

Teniz group includes deposits Pervomaiskoye, Akmolinskoye, Maksimovskoye, Rozhdestvenskoye, Pavlogradskoye, Kypshak, Tasmola located in Akmola and Karaganda regions.

In deposits of these groups even a little significance coal content is related to the bottoms of Karaganda series where is noted a horizon at the thickness from 10 to 30m with the layer of 1-5m thickness. Coal ash content varies within the limits of 14-50 %, and types of coals are hvBb-mvb. These deposits coal resources are estimated at 10-147 million tons, and totally at 1302 million tons.

Yet there is no information on the coal methane content but very likely that majority of them are in a zone of degassing and do not represent any interest on methane.

Thus, the characteristic of carbonate coals deposits in Central Kazakhstan testifies the suitability for the coalbed methane production organization of only Karaganda and Ekibastuz basins, and in the long term, probably, Samara and Zavyalovsk deposits.

POTENTIAL COALBED METHANE RESOURCES

Initial parameters for methane predictable resources definition in coal seams are the balance and below-line stocks and resources of coal and coal seams gas content.

OJSC "Azimut" calculated stocks and resources of methane in Tentek trough, deep horizons of Saransky field, Ekibastuz basin, deep horizons of Sherubajnurinsky area, Dubovsky and Taldykumsky fields. On the other objects including Karaganda basin as a whole, forecasting estimation of resources is made proceeding from information on the coals quality and depth of occurrence (Table 1). The table contain shallow coal deposits with rather decent and problematic methane resources but in view of their close location to the main objects they may be required in the future.

VALUE OF COAL METHANE FOR CENTRAL KAZAKHSTAN

Commercial production and utilization of methane will render positive influence on Kazakhstan economics. Development of coalbed methane extraction and utilization projects in framework of the complex program will allow obtaining the following results:

- non-traditional, pure ecologic energy carrier which in part will replace traditionally used in power engineering, industrially developed Central and East Kazakhstan coal will be mastered;
- the volume of methane emissions, the second on the importance "hotbed gas", to the atmosphere by coal-mining industries of the Central Kazakhstan will decrease;
- economic expenses for a coal mining will decrease, safe conduction of mining operations will be raised at underground mining coal deposits.

Coal methane deposits resources of Central Kazakhstan are more than 1 billion cubic meters, and at sufficient development of projects its annual extraction can be increased to 3-4 billion cubic meters that will provide industrial sectors based on its use more than for 100 years.

Small distances of transportation (100-200km) will allow avoiding expenses on gas compression and high-pressure pipelines construction that raises competitiveness in comparison with imported liquefied natural gas.

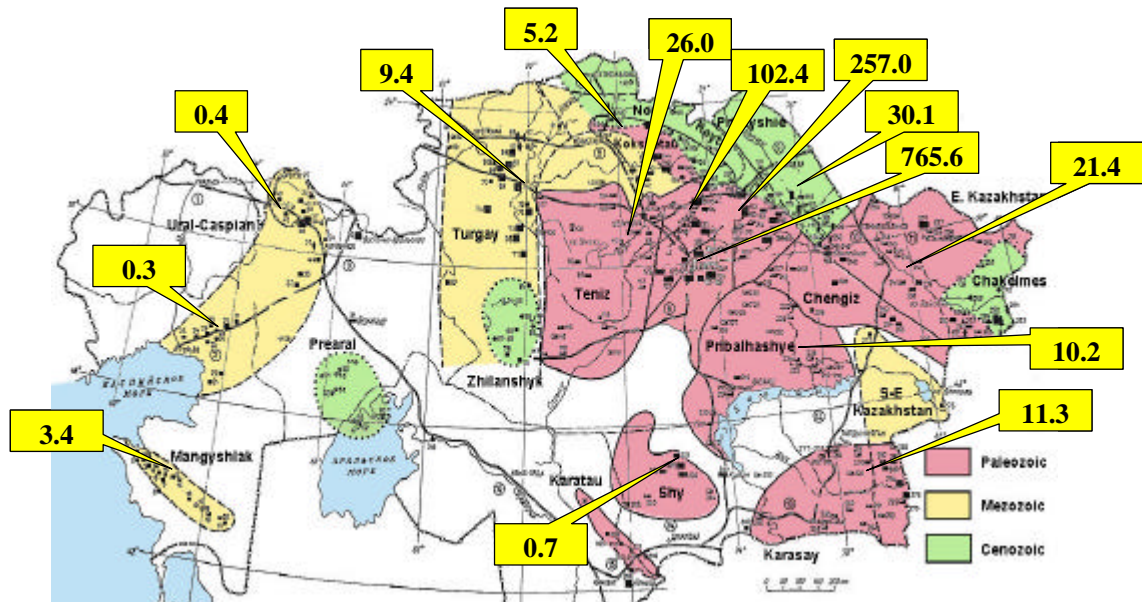
Table 1

METHANE RESERVES OF CENTRAL KAZAKHSTAN COAL DEPOSITS

Basin, deposit, field	Coal reserves, million ton	Methane capacity m³/t	Methane reserves , billion m	Density of methane reserves, billion m³/km

1	2	3	4	5
Karaganda basin		10-27	550	
First-priority objects				
Tentekskaya mold	1200,4	14,5-27	20,7	0,5
Deep horizons of Saranskiy field	1891	22-27	31	0,7
Second- priority objects				
Dubovkiy field	600	24-28	10,2	0,5
Deep horizons of Churubainurinskiy area	2327	24-27	55,4	0,4
Taldykudukskiy field	1520	10-23	28,5	0,4
First-priority objects				
Ekibastuz coal basin (seams 1,2,3)	6900	11-20	75	1,3-3,1
Other objects				
Zavyalovskoye	529	17	14,6	0,03
Samarskoye	732	15	11,0	0,05
Nurinskoye	491	12	5,9	0,17
Akzhar	421	8	3,4	0,08
Teniz-Korzhunkolskiy basin	2085	12	28,4	0,26
Koitas	452	12	5,4	0,08
	Total:		713,7	

Fig.1. COAL METHANE RESERVES OF KAZAKHSTAN



Coal Methane Reserves (billion.cub.m)

REFERENCES

- 1 Time methodical requirements to a geologic-economical estimation and calculation of methane stocks in coal seams. ? ., USSR, 1987.
- 2 Geology of Karaganda coal basin. M, Bowels, 1972, p. 415
- 3 Geology of coal deposits and combustible slates of USSR, volume5, book 1. Coal basins and deposits of Kazakhstan M., Bowels, 1973, p.720
- 4 Coal basins and deposits gas content. USSR, v.2, – Coal basins and deposits of Siberia, Kazakhstan and Far East, pages 7-107.
- 5 Geology of the USSR, v. XX, Central Kazakhstan, minerals. ? ., Bowels, 1989, pages 9-259.
- 6 Geological prospects of methane production in Kuznetsk basin. "Goeinformmark" ? ., 1992.
- 7 Instruction on determination and prognosis of coalbed gas content and holding rocks at geological survey. ? ., Bowels, 1977.
- 8 Methodical manual on resources estimation of hydrocarbonic gases of coal deposits as useful mineral. ? ., USSR MinGeo, 1988.
- 9 Alma Raisova, Aliya Sartbayeva, « Prevention of a climate change: from discussions to practical steps », Almaty, 1999.
- 10 Shvets I.A., Shipulin A.A., Report at the 1-st Workshop on Coal Methane of Kazakhstan, Almaty, 12.09.2002.