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A COMPARATIVE STUDY OF METHANE GAS COMPOSITION IN SOME COAL DEPOSITS OF MONGOLIA

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This study selected 14 samples from the Tavan Tolgoi coal deposit and 19 samples from the Naryin Suhait coal deposit, totaling 33 samples, and the amount of gas composition was determined. In 33 samples taken for research, gas chromatography determined gas composition in the "Green Crown" LLC laboratory. This study aimed to determine the correlation between the methane gas composition of the coal seams of Tavan Tolgoi and Naryn Sukhait deposits, the coal seams' depth and thickness, the coal's chemical and physical properties, and the cracks in the rocks. For the above 2 deposits, the findings revealed that the composition of coalbed methane gas (Methane) contains up to 95% of methane gas, the gas composition varies depending on the physical and chemical properties of the rocks containing the deposit, coal structure, age, pressure of the layer, hydrogeological and geological conditions, and gas sampling. Shortly, it is believed that the standard methodology needs to be improved.
Key words: coal seam methane gas, gas composition, physical and chemical properties

PURPOSE AND OBJECTIVES OF THE STUDY

Purpose of the study

The composition of methane gas in the Tavan Tolgoi and Naryn Suhait coal deposits of Mongolia was studied and the influence of geological and other factors affecting their composition was determined.

Objectives of the study

To achieve the purpose of the research, the following objectives were proposed.

- Analyze the composition of coal samples taken from coal deposits by gas chromatography;
- Process the results of laboratory analysis and observe the pattern of physical and chemical properties and geological parameters;
- Determine the factors affecting the composition of methane gas in coal seams.

Significance of the study

Analyzing the composition of methane gas in coal deposits and determining the correlation between the factors affecting it, it is of practical importance to create sources of information necessary for exploration, research, analysis, and use of deposits for current and future exploration and research.

Novelty of the study

An innovative aspect of the research is the comparative study of the methane composition of coal seams in Mongolian coal deposits. Moreover, in this research, using gas chromatography, the researchers studied the chemical composition of CBM and compared it with the geological conditions of the deposits.

GEOLOGICAL FORMATION OF TAVANTOLGOI DEPOSIT

Tavantolgoi coking coal deposit is located administratively in Ulaannuur Valley which belongs to the area of Tsagaan-Ovoo bag, Tsogttsy Sum (Figure 1).

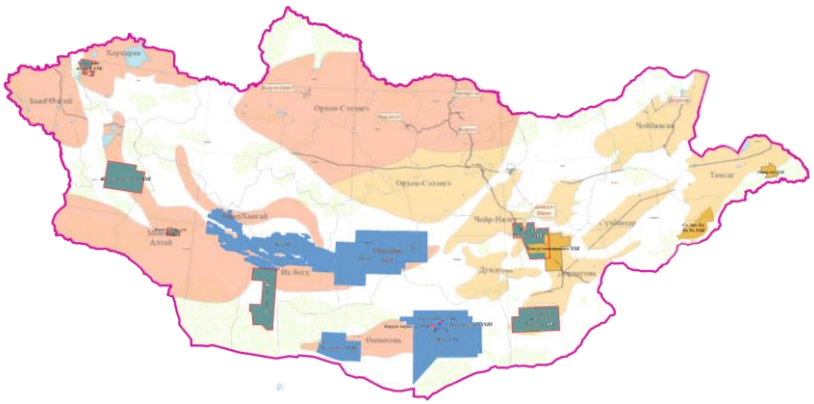

Figure 1. Location of Tavantolgoi deposit

The central part of the Tavantolgoi syncline is filled with Upper Permian coal-bearing sediments, and there are mounds where Middle-Upper Devonian, Lower Carboniferous, and Late Carboniferous-Early Permian volcanogenic sediments lie on top of the deposits. Cenozoic sediments are developed in a limited area[2, 3].

Silurian-Lower Devonian Nomgon Uul Formation (S-D1 nm)

Middle-Upper Devonian Tsetsgershand Formation (D2-3 cs)

Lower Carboniferous Ikhshankh Formation (C1 is)

Late Carboniferous-Early Permian Dush-Ovoo Formation (C3-P1 ds)

Lower Permian Tsogtsetsy Formation (P1 cc)

Upper Permian Jirem Formation (P2qr)

The coal-bearing sediments of the Tavantolgoi Formation of the Tavantolgoi deposit contain layers of coal 0-XIII with a thickness of 1-86 meters (86.2 m thick in well 1298 and 74 m in well 1295 with stone age from layer VIII). There are 10 seams of coal from 0 to IX in the area of Tsankh, and the area is limited by exploration line XII in the west, XIII in the east, and XI in the north.

GEOLOGICAL FORMATION OF COAL DEPOSIT OF NARYN SUHAIT

The Naryn Suhait coal mine is located in the southwestern part of Mongolia, in the Gurvantes sum, Umnugovi province, 57 km north of the Mongolian-Chinese border (Figure 2).

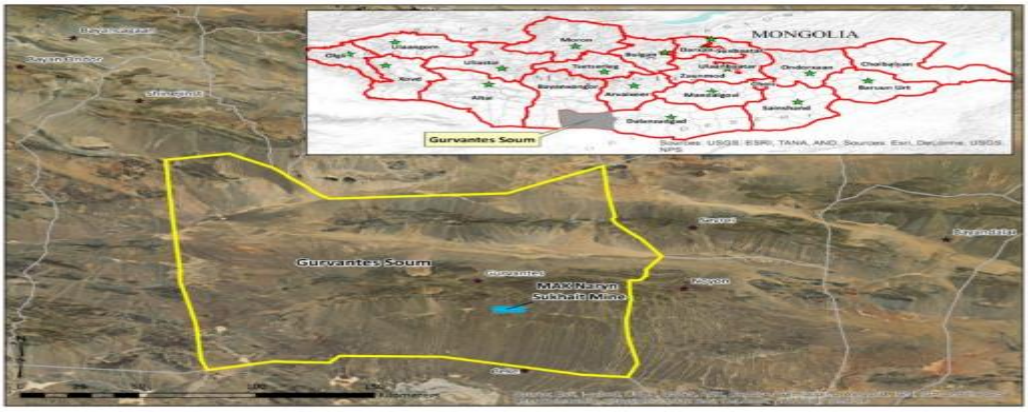

Figure 2. Location of the Naryn Suhait coal deposit

Coal in Naryn Sukhait and accompanying sedimentary sediments were deposited in promontory basins. Promontory basins are characteristically formed at continental extremities, on stable foundations. In such cases, the basin formed on the margin of a nascent basin during the Early Mesozoic, and during subsequent stages of widespread deformation, the basin was filled with sediments until it became highly rifted and disrupted. The sedimentary rock basin is filled with coal seams and branched layers of thick and fine-grained clustered rocks. Deformation of the basin-filling sediments occurred at least twice, the first during the Late Jurassic basin rifting and damage. The second deformation occurred in the late Cenozoic period, in connection with the distortion, rifting, and damage of the India-Asian sub-continent. The geological formations containing the mineable coal reserves of the Naryn Sukhait mine went from the Early Jurassic to the Middle Jurassic.

MATERIALS AND RESEARCH METHODS

Empirical data collection, observation, comparison, and experimental research methods have been used in this research work.

The sampling is primarily measured with the amount of methane gas in the coal drill bit sample – Q, and this method mostly follows the Australian standard AS 3980:2016 to determine gas content in coal and other carbon-bearing minerals. Methane gas is separated from the coal sample by pushing with helium and other inert gases.

RESEARCH RESULTS

19 Naryn Sukhait samples and 14 Tavan Tolgoi samples totaling 33 samples were analyzed for CBM gas composition. The samples were made at the customers' expense and have not been disclosed to the public, so at the customer's request, the

details of the customer and the geographic location of the samples taken from the deposits have been kept confidential.

Correlation between methane gas content and the depth of the borehole

When selecting the methane gas samples, the samples were randomly taken in steps of 4-5 meters. Figure 3 depicts that the methane composition of the samples has a linear correlation to the deposit depth. As for nitrogen, a decreasing phenomenon was also observed depending on the depth (Figure 4). This is because the air rate in the gas composition decreases as the coal layer gets deeper. However, there is a very weak correlation between carbon dioxide and deposit depth (Figure 5).

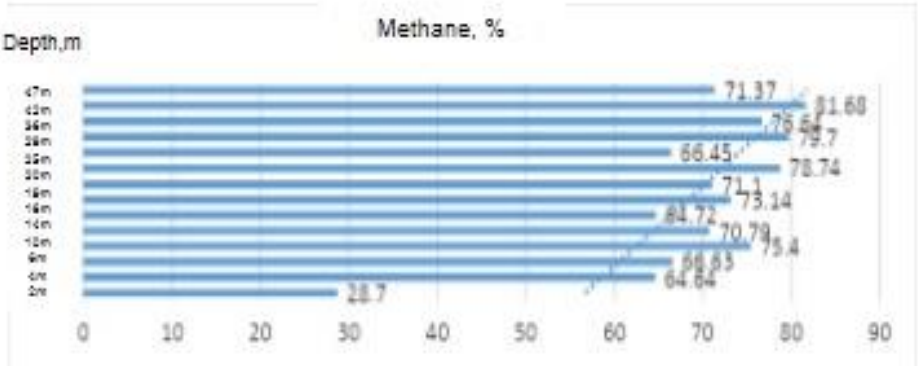

Figure 3. Correlation between methane content and borehole depth

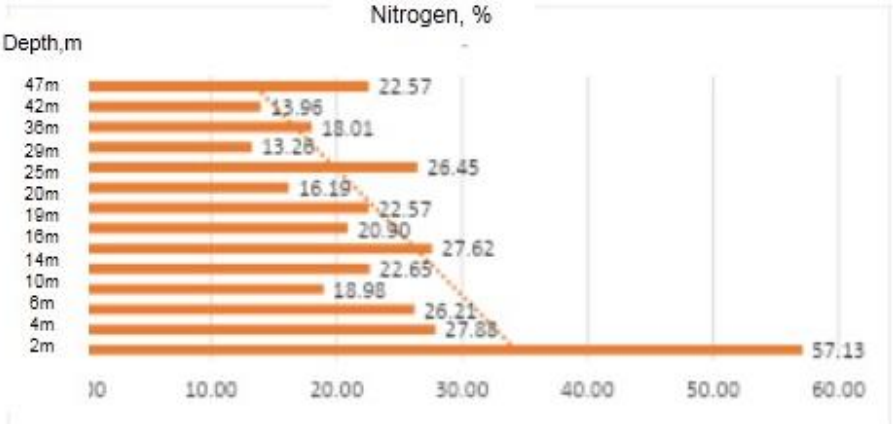

Figure 4. Correlation nitrogen gas content and borehole depth

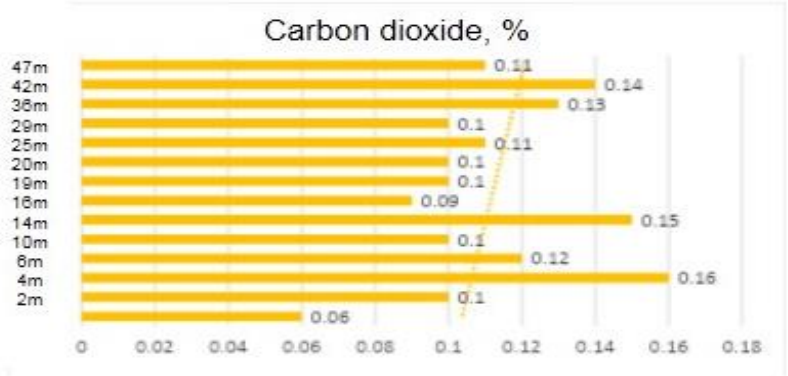

Figure 5. Correlation between carbon dioxide content and borehole depth

The gas composition of the samples taken from a depth of 10-180 meters at the borehole of the Naryn Sukhait coal deposit contains methane gas between 62.2-95.49% which constitutes the majority of gas composition, nitrogen 1.21-27.57%, oxygen 0.78-7.16%, carbon dioxide 0.01-3.31%, carbon monoxide 1.29- 4.54%, propane between 0.02 and 1.13% (Table 1), according to the estimation.

Table 1.

The gas composition of samples taken from Naryn Sukhait coal deposit

#	Sample depth in meters	O_2	N_2	CO	CH_4	CO_2	C_3H_8
1	10	3.93	14.28	2.33	77.20	2.22	0.05
2	16	2.82	9.85	2.22	81.47	3.17	0.46
3	25	1.98	7.65	4.45	85.38	0.10	0.45
4	30	2.42	8.71	2.47	83.76	2.62	0.02
5	47	4.85	18.00	2.38	73.74	0.22	0.82
6	58	2.14	8.33	2.31	85.85	0.27	1.10
7	75	-	8.88	2.29	86.44	2.12	0.27
8	85	7.16	27.57	1.65	62.20	0.83	0.59
9	95	0.78	6.53	2.28	86.80	3.19	0.43
10	105	3.30	12.53	4.54	78.35	0.32	0.96
11	113	-	2.59	2.55	91.37	3.03	0.46
12	120	2.92	10.77	2.41	82.79	0.27	0.84
13	128	-	1.85	1.29	95.49	0.38	0.99
14	136	2.46	8.37	2.18	84.44	2.50	0.04
15	144	-	1.21	2.60	93.41	2.76	0.03
16	150	3.06	11.16	2.37	81.81	0.24	1.36
17	156	3.05	11.31	2.25	81.99	0.27	1.13
18	163	-	9.83	2.44	84.07	3.31	0.34
19	180	-	7.83	2.69	86.57	2.53	0.39

Figures 6, 7, and 8 show how methane gas content, nitrogen gas content, and carbon dioxide content depend on the depth of the fine coal deposit.

When comparing the composition of methane gas at the same depth in the Tavan Tolgoi and Naryn Sukhait coal deposits, the Naryn Sukhait deposit has a relatively high methane gas content of 62.2-95.49%, low nitrogen content of 1.21-27.57%, low oxygen content of 0.78-7.16%, carbon dioxide of 0.01-3.31%, propane of 0.02-1.13% that is called the residue, a relatively heavy gas, due to estimates (Figure 9).

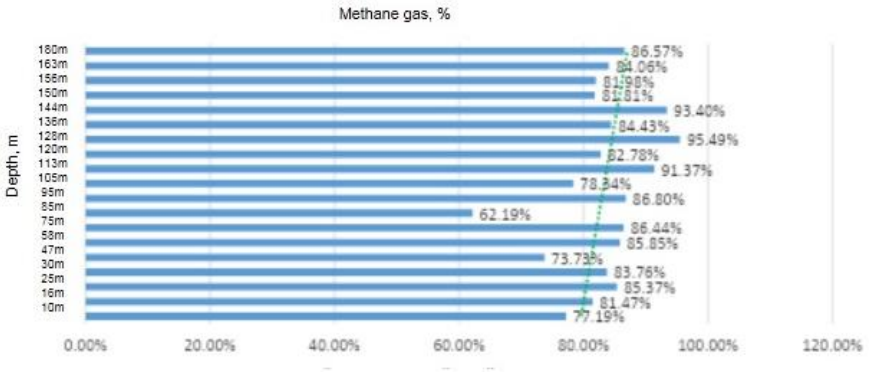

Figure 6. Correlation between methane content and borehole depth

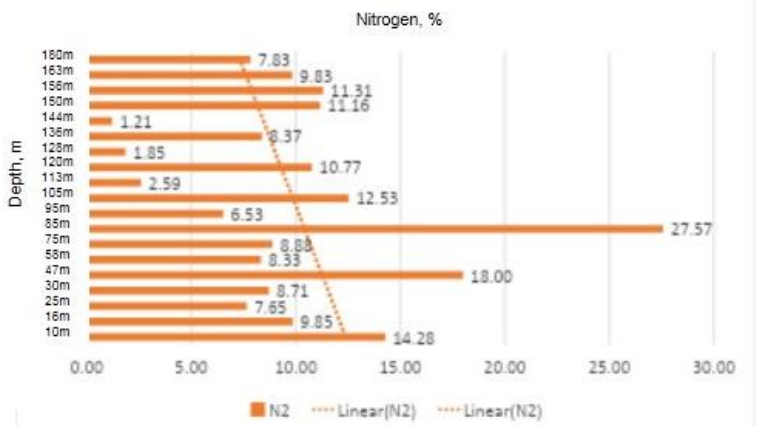

Figure 7. Correlation between nitrogen gas content and borehole depth

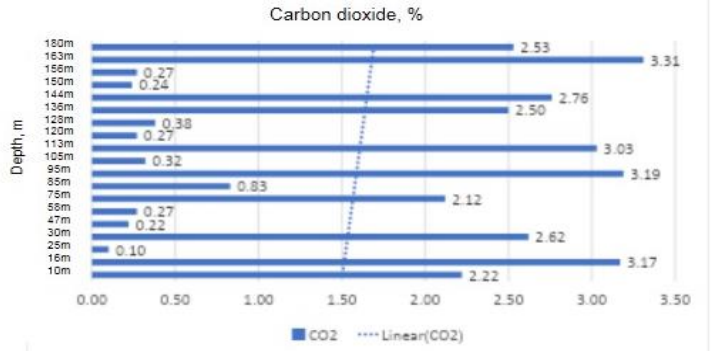

Figure 8. Correlation between carbon dioxide content and borehole depth

A comparative study of gas composition at the Tavan Tolgoi and Narij Sukhait coal deposits

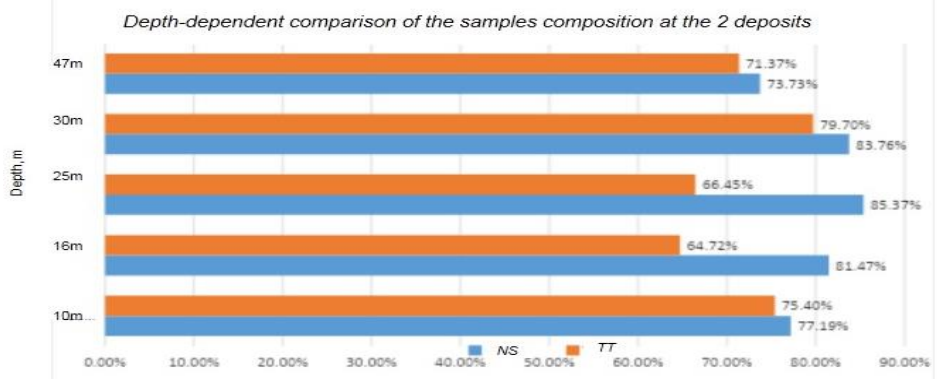

Figure 9. Depth-dependent comparison of the samples composition at the 2 deposits
TT – Tavan Tolgoi coal deposit gas; NS-Naryn Sukhait coal deposit gas

As shown in Table 2, it is obvious that the Naryn Sukhait deposit has a higher amount of ash but a relatively lower amount of moisture and sulfur compared to the Tavan Tolgoi deposit.

As moisture and sulfur content at the Naryn Sukhait deposit is relatively low, it is possible to use a relatively simple technology to purify its coal seam gas. Findings reveal that the relatively different content of chemical properties of the 2 deposits' coal depends on certain factors such as the geological parameters, age, and properties of the coal. Moreover, the gas composition is affected by external factors: gas sampling and transportation methods, etc.

Table 2.

Chemical characteristics of coal at the Tavan Tolgoi and Naryn Sukhait coal deposits

#	Indicators	Tavan Tolgoi deposit	Naryn Sukhait deposit
1	Ash content, (%)	14.9%	5-30%
2	Moisture content,%	6.9%	5%
3	Moist and air-dried	0.1-2.5%	1.0-2.8%
4	Volatility Daf,%	32.8	20-40
5	Age	P2	P2
6	Classification	HV(C)-LV	HV(C)-A
7	Sulphur, %	0.8%	0.4%

CONCLUSIONS

The laboratory analysis of methane gas samples at the Tavan Tolgoi and Naryn Sukhait deposits by gas chromatography revealed that the variation of methane gas content is medium to high, from 60 to 96%, which means that CBM does not require deep purification technology, as well as gas can be served for energy, automobiles, and domestic use [1].

The pattern of changes in the composition of methane gas in the coal seam depending on the depth was observed for both deposits, and the content of methane gas increases with the depth of the coal seam, according to previous geological exploration reports.

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