Study of Mongolian coals from different deposits by FTIR spectroscopy

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ABSTRACT

We have used FTIR for study of coals from different deposits of Mongolia. As a measurements result, IR spectra of all coals have organic and inorganic bands. Khushuut coal spectrum owns more C-C bands than other coals, which can be related to its high carbonization. Coals from Uvurchuluut, Aduunchuluu, Baganuur and Nalaikh have hydroxyl group bands more than others which may relate their high content of moisture.

Key words: *IR absorption, coal, Mongolia*

INTRODUCTION

Coal basically consists of two parts– crystalline, inorganic parts, and an amorphous, organic part [**1**]. Infrared spectroscopy is a convenient and informative method for studying coals structure. It makes possible to highly accurately determine the position of the absorption bands and to carry out semiquantitative analysis of the hydroxyl OH groups, aromatic and aliphatic CH groups, carboxyl COOH groups, mineral components, and other functional groups in coal and coal extracts [**2, 3**]. The degree of carbonization (the carbon atom content), which varies during the natural process of coal formation, and the reflection coefficient of light, depending on the molecular structure of coals, are usually used to characterize coals [**4**]. Study of the optical properties of coals with high carbon content (>70 at. %) is made difficult by low intensity of spectrally poorly resolved absorption bands in the IR region [**5-8**].

The aim of the current work was to use FTIR (Fourier transform infrared) spectroscopy to determine the functional groups of Mongolian coals.

EXPERIMENTAL

Samples and study procedure. Samples were collected from nine different coal deposits of Mongolia. Three of them (Khushuut, Maanit, Khurengol) are situated in Mongol-Altai basin in the western Mongolia, two (Tavantolgoi, Nariinsuhait) are situated in Umnu-Gobi basin in the southern Mongolia and other location is shown in Table 1.

Table 1. *Location of coal samples* [**9**]

№	Name of Deposit	Basin	Situation
1	Khushuut	Mongol-Altai	western Mongolia
2	Maanit		
3	Khurengol		
4	Tavantolgoi	South-Gobi basin	southern Mongolia
5	Nariinsuhait		
6	Baganuur	Choir-Nylga	central Mongolia
7	Nalaikh	Orkhon Selenge basins	central and north Mongolia
8	Uvurchuluut	Umnud khangai	north-western Mongolia
9	Aduunchuluun	Choibalsan	north-eastern Mongolia

The pieces of the coal samples were ground in an agate mortar into a powder of granule size to 2μm. The IR transmission spectra of the coal samples were recorded in the frequency range 400-4000 cm^{-1} on a Shimadzu FTIR spectrometer.

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Table 2. *Ultimate and proximate analysis of coal samples* [**10, 11**]

№	Deposit	Moist (dry.wt.%)	Ash (dry.wt.%)	S, %	C, %	H, %
1	Khushuut	1.1	14.8	1.0	90.0	4.2
2	Maanit	1.3	28.3	0.6	70.0	-
3	Khurengol	2.0	16.5	0.5	-	-
4	Tavantolgoi	0.6	19.9	0.7	83.97	4.4-5.4
5	Nariinsuhait	1.0	1.25	0.5	84.84	5.53
6	Baganuur	11.4	14.2	0.3	67.9	4.8
7	Nalaikh	-	-	-	-	-
8	Uvurchuluut	14.0	15.6	1.2	-	-
9	Aduunchuluun	10.1	17.9	0.2	66.75	4.88

RESULT AND DISCUSSION

Figure 1-3 had shown the transmission spectra for coal samples. In the spectrum of the coal samples, we can see following absorption bands: *3695.61-3427.51 cm^{-1}* due to intermolecular hydrogen bands and free OH groups[**1**,**12-16**], *3051.39-2852.72 cm^{-1}* are stretching alkanes/alkenes bonds of aliphatic groups and *1436.97-912.33cm^{-1}* are valence's mode of alkanes/alkenes bonds[**1,12-16**]. In figure 1-2, the peaks of hydroxyl groups have less intensity.

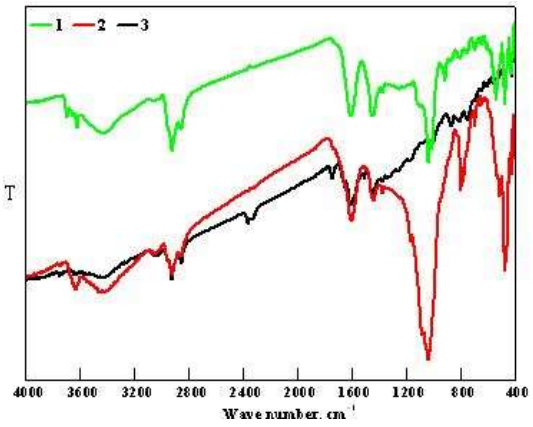

Figure 1. *IR spectra of 1- Maanit, 2-Khuren gol, 3-Khoshoot*

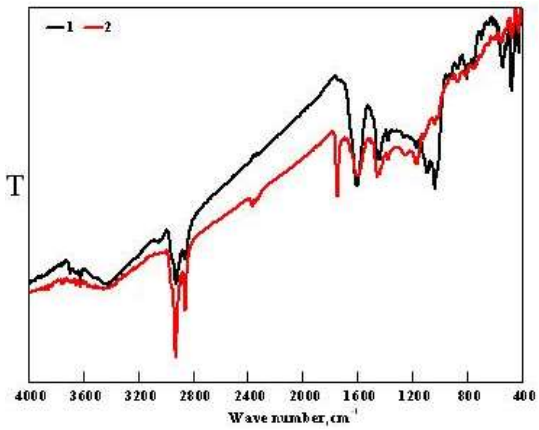

Figure 2. *IR spectra of 1- Tavantolgoi, 2-Nariinsukhait*

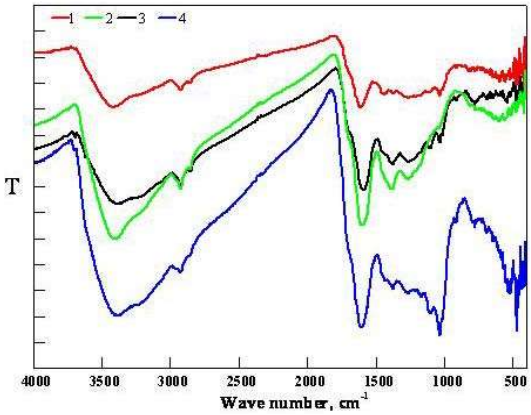

Figure 3. *IR spectra of 1- Ovorchuluut, 2-Aduunchuluu, 3-Baganuur, 4-Nalaikh*

The moisture content of these samples is from 1,1 to 2,0 [table 2]. In spectrum, *1653-1506.41cm^{-1}* are C=C- stretching bands of aromatic rings of alkyne group. Also, *1747.51cm^{-1}*, *1091.71cm^{-1}*, *1078.21cm^{-1}*, *1035.77cm^{-1}*, *1033.85cm^{-1}*, *1028.06cm^{-1}* stretching bonds of carbonyl group and *1008.77cm^{-1}*, *796.6-459.06cm^{-1}* were caused by Si-O bonds of quartz and aluminosilicates[**1,12-16**]. Figure 3 have shown the transmission spectra the coal samples from different basins. In the spectrum, intense absorption bands such as *3415.93-3410.15cm^{-1}* are due to intermolecular hydrogen and free OH

groups. It is to depend on moisture which is 10-14[table 2]. Peaks of *1436.97cm^{-1} , 910.40cm^{-1}* are bending C-H bands of *1031.92cm^{-1}* are stretching bonds of carbonyl group[**1,12-16**]. The peak at *1263.37cm^{-1}* may be due to C- N band of amines group[**1,12-16**].

CONCLUSION

IR spectra of all coals have organic (O-H, C-H, C-C, C-O) and inorganic (SiO_2) bands. Khushuut coal spectrum owns more C-C bands than other coals, which may due to its high carbonization. Coals from Uvurchuluut, Aduunchuluu, Baganuur and Nalaikh had hydroxyls groups (O-H) peaks more than others. It may relate their high content of moisture. The result have many interesting peaks in fingerprint region. It remains many open questions in this region.

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