ORGANIC GEOCHEMISTRY OF THE DEVONIAN BITUMINOUS SHALES AND LIPTOBIOLITHE COALS OF THE KUZNETSK BASIN

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Introduction

The paper is devoted to comparative study of the Dmitrievka-Pereboy Formation bituminous shales from the Dmitriyevskoye field and the Barzas Formation liptobiolithe coals from the Barzasskoye field in Kuzbass. To determine the type, catagenesis, and hydrocarbon generation potential, concentration and pyrolytic characteristics of organic matter (OM), and total organic carbon (TOC) isotopic composition of samples from these fields have been identified (Table) using conventional techniques [1-4].

Results

The liptobiolithe coals of the Barzasskoye field are significantly more enriched in TOC (48.2-73.3 %) than the bituminous shales of the Dmitriyevskoye field (2.7-16.6 %). S2 values ("kerogen" component) in the Dmitrievskoye shales comprise 17-123 mg HC / g rock and 197-450 mg HC / g rock the Barzas coals. Fluctuations in the S2 values precisely replicate the profile of TOC, and similar variations are marked for S1 values ("bitumoid" component). In the Dmitriyevskoye shales, very high values of the hydrogen index (HI) have been recorded (488-879 mg HC / g TOC), and OM falls in the region of lake sapropel (type I kerogen), with the exception of four samples, which belong to sapropelic marine OM (type II kerogen). In the Barzas coals, HI is slightly lower, though is very high for coals only (343-654 mg HC / g TOC). A third of the Barzas samples can be attributed to type I kerogen and the rest to type II kerogen. Carbon isotope composition of the Dmitriyevskoye shales OM match pyrolysis data. $\delta^{13}C$ values [(−37.7 ‰) – (−32.0 ‰)] indicate marine (or lake) OM and Barzas coals are isotopically notable for heavier carbon – $\delta^{13}C$ values [(−21.4 ‰) – (−17.8 ‰)], which is peculiar to terrestrial OM. The Barzas coals consist of residues of higher plants – Lycopodiaceae Barsassia ornate Zal. [5], as well as Orestovia and Petzia plants, that Z.V. Yergolskaya [6] defined as the higher terrestrial plants (psilophytes) and proposed to refer the Barzas coals not to sapromixite, but to cuticle liptobiolithes. Perhaps the presence of both terrestrial and sapropelic marine (or lake) OM signs just due to the specifics of these ancient plants preserved features of the aquatic life with hydrogen compounds predominance. The presence of type I and II kerogens in the Devonian shales and coals suggests an existence of marine and large lakes facies with sapropel accumulation along with running-water peatlands and lagoon environments [7, 8] in the Middle Devonian of the studied area. Both in the Dmitrievskoye shales and Barzas coals catagenesis by pyrolysis analysis (T_{max} ranges 439-448°C and 430-449°C respectively) corresponds to protocatagenesis (immature) and early mesocatagenesis (early oil window). The vitrinite reflectance data confirm by Dmitrievskoye shales pyrolysis data (R^o_{vt} = 0.46-0.60 %). In the Barzas coals, R^o_{vt} values range from 0.48% to 0.49%, i.e. OM is immature and completely preserved its hydrocarbon generation potential.

Conclusions

Therefore, based on pyrolysis data, the Middle Devonian OM of the Dmitrievskoye bituminous shales and Barzas liptobiolithe coals refer to type I (lake) and II (marine) kerogens, altered within protocatagenesis (immature) and early mesocatagenesis (early oil window), and largely or completely saved its high generation potential. The organic carbon isotopic composition of the Dmitrievskoye bituminous shales corresponds to type I and II kerogens. In the Barzas coals, discordance in the organic carbon isotopic composition (terrestrial, with high $\delta^{13}C$ values) and pyrolytic characteristics (type II and I kerogens) probably due to the specificity of the original biota – the oldest higher plants in the Earth's history.

Table. Concentrations, pyrolysis characteristics, isotope composition and vitrinite reflectance of the Devonian organic matter in the Kuznetsk Basin

Characteristics		Liptobiolithe coals of the Barzasskoye field (22 samples)		Bituminous shales of the Dmitriyevskoye field (67 samples)	
		spread of values	mean value	spread of values	mean value
TOC, %		48.2-73.3	60.1	2.7-16.6	10.4
Pyrolysis	S1, m HC / g rock	0.2-8.5	2.3	0.1-2.5	1.0
	S2, mg HC / g rock	197-450	292	17-123	76
	HI, mg HC / g TOC	343-654	484	488-879	725
	T_{max}, °C	430-449	443	439-448	445
$\delta^{13}C$, ‰		(−21.4) – (−17.8)	−19.5	(−37.7) – (−32.0)	−33.8
R^o_{vt}, %		0.45-0.50	0.48	0.46-0.60	0.52

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