

Geochemical Characteristics of the Upper Paleozoic Source Rocks in Marsel Area, Chu-Sarysu basin, Southern Kazakhstan

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Introduction

The Marsel area is located in the north of the Chu-Sarysu, the second largest depositional basin in Kazakhstan. The study area were discovered in the 1980s with total initial gas in-place of $137.9 \times 10^8 \text{ m}^3$ (Pang et al., 2014). In 2008, gas-recoverable reserves of $60.7 \times 10^8 \text{ m}^3$ were discovered (Pang et al., 2014). Huang and Fu (2008) believe that the source rocks of Lower Carboniferous Visean (C_{1v}) and Serpukhovian (C_{1sr}) are favorable prospecting targets with great potential because of their large thickness, good kerogen types, and high maturity. However, their geochemical and geological characteristics have not been studied systematically (Zhao et al., 2017). This study is aimed at assess the source rocks and reveal the hydrocarbon generation potential, the source of material of C_{1v} and C_{1sr} rocks.

Results

To define the exploration areas and to evaluate the hydrocarbon generation potential, deposition characteristics of the C_{1sr} and C_{1v} source rocks, we examined data from several sources such as the total organic carbon content, rock pyrolysis, vitrinite reflectance, stable carbon isotopes, gas chromatography, and gas chromatography-mass spectrometry (Table 1).

Table 1. Prime biomarker parameters in Marsel area

Well	Depth m	Strata	n-alkanes and isoprenoids				Hopance		steranes					
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
ASSA2	2167.0	C _{1sr}	0.20	1.29	1.29	0.25	0.48	0.24	28.13	29.02	42.85	1.52	0.49	0.45
ASSA2	2326.7	C _{1sr}	0.87	1.09	1.11	0.21	0.71	0.22	16.15	38.30	45.54	2.82	0.48	0.44
KNDK6	1526.9	C _{1sr}	1.99	1.00	1.07	1.73	0.38	0.30	25.01	31.20	43.79	1.75	0.46	0.41
KNDK6	1529.6	C _{1sr}	0.83	1.06	1.08	0.21	0.42	0.25	26.86	29.37	43.77	1.63	0.47	0.42
KNDK6	1533.6	C _{1sr}	2.00	0.99	1.04	1.87	0.37	0.27	15.96	37.54	46.49	2.91	0.49	0.46
KNDK6	1534.7	C _{1sr}	1.28	1.02	1.04	0.94	0.43	0.21	20.89	33.99	45.11	2.16	0.46	0.42
KNDK6	1535.8	C _{1sr}	1.31	1.02	1.04	0.76	0.43	0.27	21.67	33.38	44.95	2.07	0.50	0.53
KNDK6	1536.9	C _{1sr}	1.81	1.00	1.05	1.33	0.45	0.24	22.08	33.39	44.54	2.02	0.50	0.49
TGTR6	2602.0	C _{1sr}	0.80	1.07	1.09	0.33	0.34	0.24	16.87	35.98	47.16	2.80	0.52	0.49
TGTR6	2604.5	C _{1sr}	0.75	1.05	1.09	0.22	0.32	0.21	22.14	36.62	41.24	1.86	0.51	0.41
ASSA2	2499.1	C _{1v}	0.86	1.08	1.13	0.24	0.36	0.23	21.87	31.46	46.67	2.13	0.46	0.42
ASSA2	2604.4	C _{1v}	0.69	1.07	1.09	0.32	0.36	0.23	18.21	34.55	47.24	2.59	0.45	0.42
KNDK6	1721.1	C _{1v}	1.14	1.06	1.09	0.40	0.40	0.25	20.92	33.03	46.05	2.20	0.47	0.45

KNDK6	1723.5	C _{1v}	0.84	1.07	1.08	0.27	0.39	0.22	25.49	31.24	43.27	1.70	0.48	0.41
KNDK6	1726.7	C _{1v}	1.37	0.98	1.09	0.83	0.40	0.25	26.50	30.72	42.78	1.61	0.47	0.41
KNDK6	1727.8	C _{1v}	0.50	1.07	1.10	0.10	0.41	0.22	23.85	31.99	44.16	1.85	0.46	0.43
KNDK6	1797.7	C _{1v}	1.19	1.07	1.11	0.44	0.27	0.24	14.74	37.42	47.85	3.25	0.51	0.47
KNDK6	1798.8	C _{1v}	1.11	1.05	1.07	1.01	0.39	0.24	25.62	30.12	44.26	1.73	0.54	0.46
TMSK1	3163.4	C _{1v}	0.50	1.10	1.13	0.24	0.32	0.16	8.83	44.24	46.94	5.32	0.50	0.46
TMSK1	3164.3	C _{1v}	0.71	1.13	1.14	0.37	0.37	0.24	16.75	36.54	46.71	2.79	0.49	0.46
TMSK1	3165.0	C _{1v}	0.85	0.89	1.09	0.95	0.40	0.27	20.69	32.14	47.17	2.28	0.50	0.54
TMSK1	3165.6	C _{1v}	0.71	1.13	1.14	0.27	0.36	0.20	10.48	39.39	50.13	4.78	0.46	0.52

In the table, I: Pr/Ph; II: OEP; III: CPI; IV: $\sum C_{21}^-/\sum C_{22}^+$; V: Ts/(Ts+Tm); VI: C₃₁-22R-hopane/C₃₀-hopane; VII: $\alpha\alpha C_{27}$ -20R (%); VIII: $\alpha\alpha C_{28}$ -20R (%); IX: $\alpha\alpha\alpha C_{29}$ -20R (%); X: C₂₉/C₂₇ regular sterane ratios; XI: 20S/(20S+20R)-C₂₉; XII: $\beta\beta/(\alpha\alpha+\beta\beta)$ -C₂₉

Conclusions

1. The Lower Carboniferous carbonates in the Marsel area are potential source rocks, with the TOC content of C_{1v} and C_{1sr} in the range of 0.19–1.91% (mean 0.79%) and 0.15–1.24% (mean 0.50%), respectively, higher than that in typical carbonate source rocks. The carbonate source rocks mainly contain type-III kerogen.
2. The Ro of C_{1sr} source rocks is between 1.12% and 1.39%, whereas C_{1v} has a slightly higher Ro between 1.48% and 1.55%. The thermal maturity parameters T_{max}, OEP, CPI, Ts/(Ts+Tm), 20S/(20S+20R)-C₂₉, and $\beta\beta/(\alpha\alpha+\beta\beta)$ -C₂₉ suggest mature to highly mature rocks.
3. The source rocks are characterized by pre-peaks, post-peaks, and double peaks in the n-alkanes. Moreover, kerogen $\delta^{13}C$, C₂₉/C₂₇ regular sterane ratios, and C₃₁-22R-hopane/C₃₀-hopane ratios are -28.53‰ – -23.69‰ , 1.52 – 4.78, and 0.16 – 0.30, respectively. All parameters suggest terrigenous organic matter with small amounts of aquatic algae and bacteria. In general, the Pr/Ph value of C_{1sr} shows a greater scatter than that of C_{1v}, suggesting a change from strongly reducing to weakly oxidizing conditions, and this is consistent with the drop in sea level from C_{1v} to C_{1sr}.

References

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