DISTRIBUTION OF METHANE CARBON ISOTOPE AND ITS SIGNIFICANCE ON
CBM ACCUMULATION OF NO.2 COAL SEAM IN YAN'CHUANNAN CBM BLOCK,
ORDOS BASIN, CHINA

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Introduction (Use of sections is optional)

Distribution and origins of methane isotope ($\delta^{13}$C(CH$_4$)) in coalbed methane (CBM) block of southeast-Ordos Basin are related to the accumulation and distribution of CBM in Yanchuannan CBM block, which is of great significance for the evaluation of CBM resources. In this paper, the stable isotope ratios of coalbed gases ($\delta^{13}$C(CH$_4$), $\delta$D(CH$_4$) and $\delta^{13}$C(CO$_2$)) of the No.2 coal seam associated with water samples collected from Permian Shanxi Formation in southeast of Ordos Basin were investigated.

Results (Use of sections is optional)

The data set reveals that stable isotope ratios vary within the following ranges: $\delta^{13}$C(CH$_4$) from -54.1 ‰ to -29.6 ‰ with an average of -37.73 ‰, $\delta$D(CH$_4$) from -230 ‰ to -158 ‰ with an average of -188.39 ‰, and $\delta^{13}$C(CO$_2$) from -20.6 ‰ to +2.2 ‰ with an average of -14.47 ‰. There are four dominant factors that decide the distribution of methane carbon isotope, including burial depth, $R_{o,max}$, hydrodynamic conditions and biogenic gases. The values of $\delta^{13}$C(CH$_4$) naturally desorbed from No.2 coal seam increase with an increase with burial depth, $R_{o,max}$ and reservoir pressure, which indicates that $\delta^{13}$C(CH$_4$) of almost the whole studied area is controlled by the thermodynamic equilibrium fractionation, except the Xibaigou gentle slope belt (A4). The stable isotope compositions in Xibaigou gentle slope belt (A4) characterized by shallow and up-dip areas suggest that late-stage biogenic methane was generated via CO$_2$-reduction associated with meteoric water recharge, which significantly contributes to $\delta^{13}$C(CH$_4$) stripping and higher gas saturation than expected. Furthermore, it is summarized a variation model of gas-bearing properties and $\delta^{13}$C(CH$_4$) values in Yanchuannan CBM block, which shows that the geological controls on gas-bearing properties are consistent with that on stable carbon isotope of methane, and normally lighter $\delta^{13}$C(CH$_4$) ratios corresponds to lower gas-bearing properties domain. Significantly, this result can be used to evaluate and instruct the enrichment law of CBM and benefit its exploration and development in research area.

Conclusions (Use of sections is optional)

(1) $\delta^{13}$C(CH$_4$) from desorbed gas in Yanchuannan CBM block of No.2 coal seam ranges from -54.1 ‰ to -29.6 ‰ with an average of -37.73 ‰, and is heavier than other surrounding
blocks in the east margin of Ordos Basin. The distribution of $\delta^{13}\text{C}(\text{CH}_4)$ is heterogeneous horizontally, increasing from east to west.

(2) $\delta^{13}\text{C}(\text{CH}_4)$ values of the No.2 coal seam increases with the increase of $R_o,\text{max}$ and burial depths by logarithmic functions, which demonstrate that fractionation of carbon isotope in this field is controlled by thermodynamics equilibrium mechanism during the formation of coalbed gases and the desorption-diffusion-migration process.

(3) Central faults divided this CBM block into two different hydrodynamic units, tectonic A1 (relatively closed zone) without hydrodynamic exchange, where there are perfect adsorption capacity existing higher gas-bearing properties and heavier methane carbon isotope; in runoff zone (open groundwater environment), flowing water breaks the balance of adsorption/desorption of CBM, which lead to lower gas content and lighter $\delta^{13}\text{C}(\text{CH}_4)$.

(4) Methane in this block mainly comes from thermogenic origins except the wells in tectonic A4 affected by secondary biogenic gases. And the influencing of microbic gases contributed to the lighter $\delta^{13}\text{C}(\text{CH}_4)$ ($<-50\,\%$), but it provided a supplement to gas content, which led to higher gas saturation.

(5) A variation model for gas-bearing properties and $\delta^{13}\text{C}(\text{CH}_4)$ indicate that controls on the accumulation of CBM are nearly similar with that on the distribution of methane carbon isotope in Yanchuannan CBM block, which is helpful to CBM exploration and development.