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# The Study of Negative Carbon and Oxygen Isotope Excursion of Carbonate Rock in Ordovician Majiagou Formation, Ordos Basin

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**Abstracts:** Carbonate rock in Ordovician Majiagou Formation is the primary natural gas reservoir of Ordos Basin and therefore the key target formation of natural gas at present. However, the source of natural gas has not been identified yet, which seriously restricts the further research and exploration. Carbon and oxygen isotope of marine carbonate rock can indicate the tectonic movements, paleoenvironment evolution and types of diagenesis, and it can also be used to study the origin of rock and mineral. Therefore, it helps to evaluate whether the source rock can generate hydrocarbon effectively. Carbon isotope value of carbonate rock generally reflects the variation of sea level, and the transformation of oxidation/reducing environment (Li et al., 2019). Moreover, since the oxygen isotope value is mainly dominated by the fluid salinity and environment temperature during diagenesis process, it can indicate the salinity and depth of the sedimentary environment. Generally, the generation and preservation of hydrocarbon precursor are dominated by the above characters.

Systematically carbon and oxygen isotope analysis was carried out on drill core samples, which were selected from Ordovician Majiagou Formation in the north of Ordos Basin. In order to reflect the origin sedimentary characteristic, we selected rocks that did not experience secondary alteration. The standard deviations of carbon and oxygen data are both under 0.08‰. The carbon and oxygen isotope compositions of $Ma_4$ Formation show a narrow range between –1.5‰ and 1.4‰ (averaging 0.4‰, median 0.5‰, VPDB)，between –9.8‰ and –3.9‰ (averaging –7.0‰, median –7.1‰, VPDB), respectively. These carbon and oxygen values are consistent with that of Ordovician seawater and the transgressive characteristics of $Ma_4$ Formation. The carbon and oxygen isotope compositions of $Ma_5$ Formation display a wide range between –10.9‰ and 1.8‰ (averaging –0.5‰, median –0.1‰), between –11.5‰ and –5.4‰ (averaging –7.9‰, median –7.9‰), respectively. In $Ma_5^6$ Formation, the $\delta^{13}C$ and $\delta^{18}O$ mainly range between –7.3‰ and -1.3‰, between –9.6‰ and –7.4‰, respectively, which show a negative excursion. Our data coincide with that proposed by Shields through the analysis of the middle Ordovician brachiopods carbonate rock ($\delta^{13}C$, –3.0‰—1.8‰; $\delta^{18}O$, –9.0‰— –5.4‰) (Graham et al., 2003). The previous studies show that $\delta^{13}C$ ranges from –8.2‰ to 1.0‰ and $\delta^{18}O$ ranges from –15.9‰ to –6.4‰ in $Ma_5$ Formation, which show an obvious negative excursion from other formations. Most researchers attributed the negative excursion of $\delta^{13}C$ and $\delta^{18}O$ values to microbial dolomite formed in an evaporative setting with sufficient leaching of meteoric fresh water. However, systematical analysis of the negative carbon and oxygen isotope in this formation were not carried out yet (Wang et al., 2013). In-situ $\delta^{13}C$ and $\delta^{18}O$ analysis of the algal laminar dolomite with light and dark layers show that the $\delta^{13}C$ and $\delta^{18}O$ valuesof the light layer are more negative than those of the dark layer. In addition, the light layer is richer in calcium element but poorer in iron element by X-ray fluorescence spectrograph analysis.

The Z value of $Ma_5^6$ Formation is generally less than 120 according to the calculation formula of ancient salinity. Besides, the dissolved pores, gypsum and salt crystal on the surface of rocks all indicate an evaporative environment, which is coincident with the paleogeographic characteristics proposed by previous researchers that the sea level descended during $Ma_5$ depositional stage (Shi et al., 2009). In this regressive environment, the burial rate of organic matter became lower. The organic carbon enriched in $^{12}C$ was oxidized to $CO_2$ and dissolved in the ocean. Therefore, the marine carbonate formed in this stage is more depleted in $^{13}C$, leading to a negative excursion of $\delta^{13}C$. The enhanced salinity can bring about negative excursion of $\delta^{18}O$ values. Moreover, the $\delta^{13}C$ and $\delta^{18}O$ value of light layer in algal laminar dolomite are more negative than that of the dark layer, which may be attributed to the influence of organic acid salt. Further research of infrared spectroscopic analysis and fluorescence slice observation of the laminated area of dolomite (Liu et al., 2013) are on the way in order to explore the influence of organic acid salt on carbon and oxygen isotope. In general, this work is of significant importance in studying the mechanism of negative excursion ofcarbon and oxygen in carbonate rock. It can also provide effective geochemistry reference on the study of deposition, diagenetic environment, source rock and hydrocarbon-generation in lower Paleozoic strata of Ordos Basin.

**Key words:** Ordos Basin, Majiagou Formation, carbonate rock, $\delta^{13}C$, $\delta^{18}O$

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