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Research Advances

Isotopic Geochemistry of Evaporite-Carbonate Sediments in Majiagou Formation Euxinic Systems with Implications for Evaluating Ordovician Northern Shaanxi Epicontinental Sea, Ordos Basin

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Objective

The Ordovician Shaanxi salt basin is located in the junction of the North China Sea and the Qilian Sea.In this basin the Majiagou Formation accumulated more than 1000m thick evaporite-carbonate sediments, and this basin is divided into east and west saltern sags (ESS, WSS) according to the characteristics of geochemical analysis (Zhang Yongsheng et al., 2014). Isotope stratigraphy of evaporite sediments represents a fundamental tool in palaeoenvironmental and palaeoclimate reconstruction. This work first illustrates the stable isotope geochemistry of the Shaanxi evaporites, which represents the most significant example of detailed facies stratigraphy for the Majiagou Formation evaporite-carbonate (M5) in Ordos epicontinental sea (Liu Jingdong et al., 2017). These findings will be used to reconstruct Middle Ordovician palaeoenvironment in contrast with equivalents during the same geological time.

Methods

Thin sections and SEM analysis were used to describe the carbonate and evaporite composition in order to identify the evaporites and diagenetic characteristics of the restricted platform. The oxygen and carbonate isotopes of limestone/dolomite were used to compare with the coeval features. Ion chromatography and ICP-MS were utilized to quantify composition of secondary west and east depressions. Sr and S isotopes of carbonate and evaporites were used to determine the origin and sulfur cycle of ocean.Oxygen isotopes from conodont apatite were utilized to determine good geochemical constraints on the temperature history of the Middle Ordovician.These findings will be an

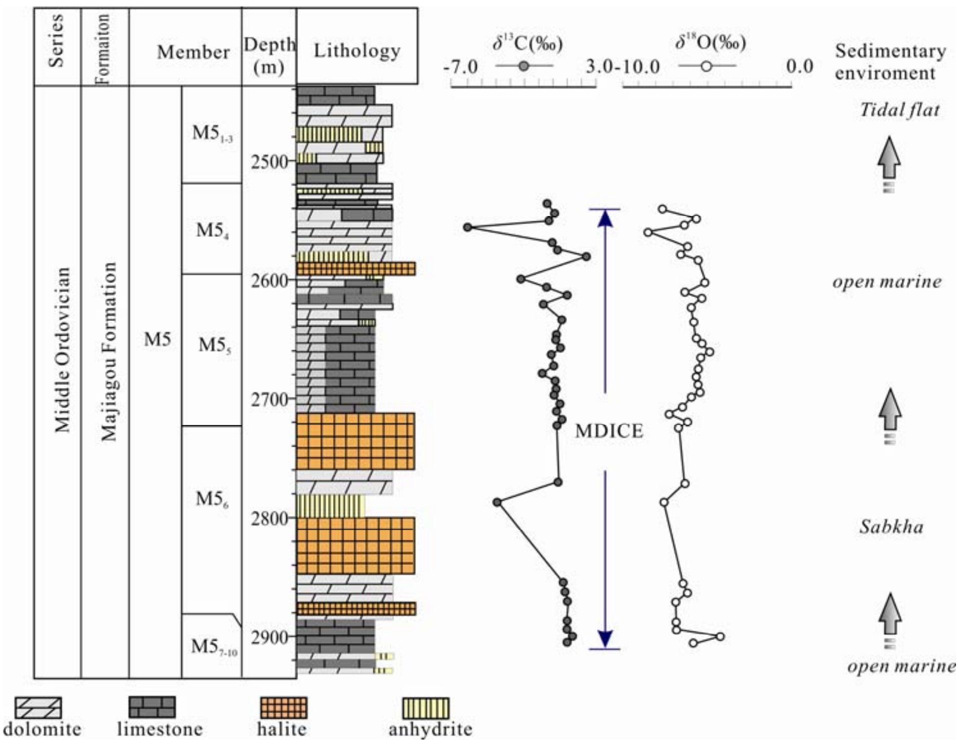

Fig.1. Isotope geochemistry and sedimentary environment of the 5th member of the Majiagou Formation in Shaanxi salt basin.

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indication of the GOBE during the Phanerozoic period.

Results

The Ordovician period is most of the time in a super greenhouse state (Trotter et al., 2008), and the rise of sea levels has led to the expansion of marine ecosystems and the eustacy was related to the isotatic adjustment of the intracrationic(NBC) basins.The Majiagou Fm successions in the north Shaanxi salt basin accumulate within a saltern (dominantly subaqueous evaporate water body) that was subject to recurrent desiccation, freshening and exposure of other periods.

The carbonate and oxygen isotope show a variable excursions ($-6.0‰<\delta^{13}C<2.16‰;-9.71‰<\delta^{18}O<-4.75‰$), implying a shallow water to ephemeral hypersaline environment typified by increasing salinity and shallow evaporate coastal lagoon conditions,in accordance with the global carbon isotope event MDICE (Middle Darriwilian Isotope Carbon Excursion)(Fig.1.). With regard to the $^{87}Sr/^{86}Sr$ of carbonate sediments, most samples yield a non -oceanic origin, which is insensitive to salinity change and evaporation conditions, but is directly controlled by simple mixing of ocean and continental water. Typical values of the coeval global ocean represent the same pulses of direct ingression of oceanic water brines deriving from oceanic water mix with continental waters. The results indicate that the Shaanxi marginal evaporite platform was dominated by marine water-derived brines.

Conclusion

This is the first detailed isotope geochemistry characterizations of evaporite-carbonate sediments in Shaanxi salt basin that indicates the palaeoclimate and palaeoenvironmental reconstruction by several periods of transgression-regression, suggesting desiccation stages, hottest and dry climate, a feature of marginal and central evaporite platforms.The results indicate that the Shaanxi marginal basin was dominated by oceanic water and received repeated pulses of continental water-derived brines.

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Appendix 1 Lithology and isotope data of the 5th member of the Majiagou Formation in Shaanxi salt basin

Sample	Lithology	Depth(m)	$\delta^{13}C_{V-PDB}$(‰)	$\delta^{18}O_{V-PDB}$(‰)
ZJ-1	Micrite limestones	2535.68	−0.5	−8.7
ZJ-2	Calcirudite	2543.71	0.0	−6.4
ZJ-3	Calcitic dolomite	2549.47	−0.4	−7.2
ZJ-4	Muddy dolomite	2554.62	−6.0	−9.7
ZJ-5	Dolorudite	2567.73	−0.2	−7.0
ZJ-6	Argillaceous dolomite	2574.06	0.2	−7.5
ZJ-7	Argillaceous dolomite	2579.85	2.2	−6.2
ZJ-8	Calcirudite	2598.94	−2.3	−5.8
ZJ-9	Micrite limestones	2606.42	−0.6	−7.2
ZJ-10	Dolomite limestone	2612.15	0.8	−6.0
ZJ-11	Calcirudite	2619.88	−0.8	−6.8
ZJ-12	Micrite limestones	2632.91	0.5	−6.6
ZJ-13	Micrite limestones	2646.37	0.1	−6.4
ZJ-14	Dolomitic limestone	2651.31	0.0	−6.0
ZJ-15	Dolomitic limestone	2657.72	0.4	−5.5
ZJ-16	Dolomitic limestone	2663.24	−0.3	−6.2
ZJ-17	Micrite limestones	2673.01	−0.1	−6.3
ZJ-18	Micrite limestones	2678.85	−0.9	−6.5
ZJ-19	Micrite limestones	2685.08	0.0	−6.3
ZJ-20	Micrite limestones	2692.02	0.1	−6.2
ZJ-21	Micrite limestones	2696.91	−0.1	−6.8
ZJ-22	Micrite limestones	2704.66	0.3	−7.4
ZJ-23	Limestone	2711.26	0.1	−8.3
ZJ-24	Limestone	2717.67	0.5	−7.0
ZJ-25	Limestone	2723.19	0.1	−7.7
ZJ-26	Lime mudstone	2769.73	0.3	−7.2
ZJ-27	Dolomite	2786.73	−3.9	−8.7
ZJ-28	Dolomite	2856.2	0.5	−7.4
ZJ-29	Dolomite	2863.22	0.7	−7.0
ZJ-30	Dolomite	2871.91	0.8	−7.8
ZJ-31	Limestone	2889.21	0.8	−7.8
ZJ-32	Dolomite	2895.24	0.8	−7.8
ZJ-33	Dolomite	2901.67	1.2	−4.7
ZJ-34	Limestone	2907.21	0.8	−6.7