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Sulfur Isotope Composition of Evaporites in Different Strata in the Tarim Basin

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Evaporite series is both an important target area looking for high-quality large potash deposits, but also one of the main types of hydrocarbon cap. Outcrops and drilling results indicate that five sets of evaporites were developed in Early-Middle Cambrian, Carboniferous, Late Cretaceous, Tertiary and Quaternary in Tarim Basin, respectively. The distribution, origin and sulfur isotope composition are distinctly different from each other.

Early - Middle Cambrian evaporites mainly distribute in west part of northern Tarim Basin, central Tarim and Bachu area, an area of up to 230,000 km², thickness up to 200m. Carboniferous evaporites locate in northern, central and southwest Tarim Basin, thickness up to 220m in Tahe Oilfield. Cretaceous evaporites mainly distribute in Yarkand subbasin, while Tertiary gypsum rock is mainly distributed in the Kuqa Depression, with an area of nearly 20,000 km² and maximum cumulative thickness up to 1500 m. Quaternary evaporites distribute in Lop Nur in eastern Tarim Basin, with potash resources greater than 250 million tons. In addition, Thin layers of gypsum, with thickness of 0.5mm ~ 3mm, were found among shale layers and cracks in Yuertusi Formation in Shenairike section in Keping area.

Sulfur isotopes of gypsum, anhydrite or glauberite can be used to reflect oxidation-reduction properties, distinguish the sedimentary facies of marine or continent and determine sulfur sources.

Sulfur isotopes of Middle Cambrian gypsum of Fang 1 Well are 33.7‰ to 34.0‰. It is very similar to that of Cambrian seawater (Strauss, 1997). It indicates that Middle Cambrian gypsum was deposited from Cambrian seawater. Middle Cambrian gypsum was deeply buried in central Tarim Basin, and the strata temperature can be up to 160°C. H₂S content of natural gas can be greater than

10‰ and the $\delta^{34}\text{S}$ value of H₂S is very close to that of Middle Cambrian gypsum, with a value of 33.6‰ of ZS1 well. It indicates that the high concentration of H₂S is originated from thermochemical sulfate reaction (TSR).

The $\delta^{34}\text{S}$ values of gypsum in Carboniferous System in northern Tarim Basin are from 15.6‰ to 15.9‰ (Hal Well), and it's similar to that of Carboniferous seawater (Strauss, 1997). This means Carboniferous evaporites were deposited from Carboniferous seawater.

Gypsum sulfur isotopes of the late Cretaceous Tuilok Formation and Paleocene Aertash Formation in Yarkand subbasin were 18.40‰ to 20.01‰ (Tan et al., 2005) and 16.59‰ to 20.59‰ ($\delta^{34}\text{S}_{\text{mean}}=19.9\%$) (Zhang et al., 2013) respectively. They are very similar to that of contemporary seawater (Strauss, 1997), indicating that the gypsums were from ancient seawater.

In Kuqa Depression, huge thick of evaporites were developed in Kumugeliemu Group and Jidike Formation. The $\delta^{34}\text{S}$ values of gypsum in middle to lower Talake Formation and in middle to lower Xiaokuzhibai Formation are from 17‰ to 20‰ ($\delta^{34}\text{S}_{\text{mean}}=18.66\%$) and from 18.4‰ to 18.5‰ ($\delta^{34}\text{S}_{\text{mean}}=18.45\%$) (Tan et al., 2005) respectively. They are also very similar to that of contemporary seawater (Strauss, 1997), indicating that the Kumugeliemu Group experienced two times of marine transgression and the gypsum was originated from ancient seawater. As the $\delta^{34}\text{S}$ values of other formation gypsums are among 9.30‰–12.62‰ (Tan et al., 2005), distinctly lower than that of contemporary seawater, it indicates that the gypsum was obviously influenced by terrigenous sources.

The Quaternary salt lake of Lop Nur is a world-class potash deposit. The $\delta^{34}\text{S}$ values of evaporites and brines distribute in the range of 7.4‰–12.5‰, indicating terrigenous sources (Jiao et al., 2006; Wang et al., 2001).

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