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Characteristics of hydrothermal fluids and their influence on the Lower Paleozoic carbonate reservoirs in the Tarim Basin, China

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The Tarim Basin is one of the main hydrocarbon producing basins in China with oil and gas production mostly from the Ordovician karst carbonate reservoirs. Recent explorations show that the carbonate reservoirs associated with hydrothermal activities also have an important place. Integrated petrography, trace element, isotopic geochemistry (C, O, Sr and Mg isotope) and fluid inclusion microthermometry indicate that the hydrothermal fluids in the Tarim Basin are characteristic of CO₂-rich but Mg²⁺-poor. The components of hydrothermal fluids have significant effects on the development of deep carbonate reservoirs.

Firstly, the scale of hydrothermal dolomitization is limited due to the small amounts of Mg ions in the hydrothermal fluids. The Mg ions available for the hydrothermal dolomitization primarily derived from the dissolution of matrix dolomites rather than the hydrothermal fluids themselves because of the similar the $\delta^{26}\text{Mg}_{\text{DSM3}}$ values between matrix dolomite and saddle dolomite cement. Thus, the content of Mg ions in hydrothermal fluids is limited and hard to form large scale hydrothermal dolomite. Meanwhile, the hydrothermal dolomitization often led to porosity reduction due to the formation of void-filling saddle dolomite and coarse-crystalline, non-planar anhedral dolomite by recrystallization of early-formed matrix dolomite near the faults.

Secondly, the test of probe in-situ by laser Raman spectroscopy shows that the main composition of fluid inclusions in hydrothermal minerals are CO₂, some contains small amounts of H₂S, which indicates that the hydrothermal fluids are acidic and have strong ability of dissolution. These hydrothermal fluids migrated along the faults, causing dissolution and forming plenty of vugs in adjacent carbonate rocks. Although the scale of these reservoirs associated with the hydrothermal alteration is small, the reservoir quality is perfect.

