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Characteristics of fluid-rock interaction in the Sha-3 Member of Paleogene Dongpu Depression, Eastern China

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In the Eastern China region, particularly in the Sha-3 Member of Paleogene Dongpu Depression, extensive oil and gas resources are present within a geologically complex stratum characterized by multiple phases. This study employs field observation, thin sections, and whole-rock X-ray diffraction (XRD) quantitative analysis to discern rock types and mineral paragenesis. Additionally, LA-ICP-MS, cathodoluminescence (CL) analysis, scanning electron microscope (SEM), carbon and oxygen isotopes, major elements analysis, and water-rock reaction experiments were conducted to elucidate diagenetic characteristics, stages, and interactions with external factors. The lithology in the study area primarily consists of fine, gray siltstone, encompassing mudstone, silty mudstone, and sandstone, with abundant evaporites containing gypsum. Predictably, the sediment and porewater chemistry has undergone continuous changes from the initial sedimentary conditions, involving fluctuations in temperature, pressure, and fluid properties. Presently, the Sha-3 Member reservoir is in a mid-diagenetic evolution stage, marked by compaction, cementation (carbonate, clay, siliceous, anhydrite, and ferric), and dissolution. In the study area, regions within the vadose zone exhibit strong dissolution (e.g., feldspar), while with lower phreatic zone shows significant cementation by gypsum and calcium carbonate. Few dissolution pores are observed in local oil-gas filling layers. The evolution of diagenetic fluids in the mudstone also affect the diagenesis of adjacent sandstone, especially when the mudstone contains abundant carbonate particles.−The precipitation of gypsum and carbonates leads to overpressure which, on the one hand, inhibits compaction, while on the other hand, the internal fluid which are retained promotes dissolution and the formation of secondary porosity.─This research provides insights into the geochemical processes underpinning hydrocarbon distribution in a major Chinese sedimentary deposit.

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