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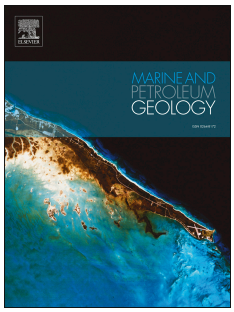

Diagenesis and reservoir quality of sandstones with ancient “deep” incursion of meteoric freshwater——An example in the Nanpu Sag, Bohai Bay Basin, East China

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Diagenesis and reservoir quality of sandstones with ancient "deep" incursion of meteoric freshwater——An example in the Nanpu Sag, Bohai Bay Basin, East China

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Abstract: An example of diagenesis and reservoir quality of buried sandstones with ancient incursion of meteoric freshwater is presented in this study. The interpretation is based on information including porosity and permeability, petrography, stable isotopic composition of authigenic minerals, homogenization temperatures (T_h) of aqueous fluid inclusions (AFIs), and pore water chemistry. These sandstones, closely beneath or far from the regional unconformity formed during the late Paleogene period, are located in the thick Shahejie Formation in the Gaoliu area of Nanpu Sag, Bohaibay Basin, East China. Early-diagenetic calcite cements were leached to form intergranular secondary pores without precipitation of late-diagenetic calcite cements in most sandstones. Feldspars were leached to form abundant intragranular secondary pores, but with small amounts of concomitant secondary minerals including authigenic quartz and kaolinite. The mass imbalance between the amount of leached minerals and associated secondary minerals suggests that mineral leaching reactions occurred most likely in an open geochemical system, and diagenetic petrography textures suggest that advective flow dominated the transfer of solutes from leached feldspars and calcites. Low salinity and ion concentrations of present pore waters, and extensive water rock interactions suggest significant incursion of meteoric freshwater flux in the sandstones. Distances of the sandstones to the regional unconformity can reach up to 1800 m, while with significant uplift in the Gaoliu area, the burial depth of such sandstones (below sea level) can be less than 800-1000 m during the uplift and initial reburial stage. Significant uplift during the Oligocene period provided substantial hydraulic drive and widely developed faults served as favorable conduits for downward penetration of meteoric freshwater from the earth's surface (unconformity) to these sandstone beds. Extensive feldspar leaching has been occurring since the uplift period. Coupled high T_h (95～115 °C) of AFI and low $\delta^{18}O_{(SMOW)}$ values (+17～+20‰) within the quartz overgrowths show that quartz cementation occurred in the presence of diagenetic modified meteoric freshwater with $\delta^{18}O_{(SMOW)}$ values of -7～-2‰, indicating that authigenic quartz only have been formed during the late reburial stage when meteoric fresh water penetration slowed down. Secondary pores in thin sections and tested porosity suggest that meteoric freshwater leaching of feldspars and calcite minerals generated approximately 7-10% enhanced secondary porosity in these sandstones. Meteoric freshwater leaching reactions cannot be ignored in similar sandstones that located deep beneath the unconformity, with great uplift moving these sandstones above or close to sea level and with faults connecting the earth's surface with the sandstone beds.

Key Words: meteoric-water diagenesis, freshwater leaching, enhanced secondary pores, open geochemical