Fracturing and Carbonate Mineralization in Tertiary Carbonate Rocks from United Arab Emirates: Origin and Evolution of Basinal Fluids

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ABSTRACT

Fracture measurements, field observations, petrographic examination, fracture and geochemical analyses, and fluid-inclusion microthermometry of vein calcite and dolomite helped to unravel the origin of the fracture systems and geochemical evolution of diagenetic fluids, which circulated in Eocene marine carbonates of Jabal Hafit anticline, United Arab Emirates. The vein carbonates consist of coarse-crystalline calcite (mm to 7 cm in diameter) with diverse crystal shapes (equant blocky, bladed and fibrous) and saddle dolomite embedded in limestone and dolostone host rocks.

Two fracture systems have been identified with relatively different time of origin; each of which comprises an extensional set and two conjugate shear sets, wherein the flux of the fluids occurred during tectonic activities of compression and shear related to the Zagros orogeny (Eocene-present). Fractures kinematics and analysis revealed that a gradual counter clock wise rotation of the compressive causative stress from E–W to NE–SW to N–S has led to the development and reactivation of these fracture systems.

The $\delta^{18}O_{V\text{-}PDB}$ values of vein calcite (–20.2‰ to –2.9‰) coupled with fluid-inclusion microthermometry (homogenization temperatures 100ºC to 190ºC and salinity of 3-29 wt.% equivalent NaCl) suggest precipitation from hydrothermal fluids of variable salinities and probably origins. In contrast, $\delta^{18}O_{V\text{-}PDB}$

values of saddle dolomite in fractures and fossil molds (–7.16 to –6.22 ‰) show less depleted values than their calcitic counterparts but their fluid-inclusion microthermometry (homogenization temperatures 91.3 to 97˚ C and salinity of 20.5 to 22.0 wt. % NaCl) show more saline fluids than the ones precipitated fracture-filling calcite cements. The correlation between the $\delta^{18}O_{V\text{-}PDB}$ and $\delta^{13}C_{V\text{-}PDB}$ values in calcite and dolomite reflects two trends; a temperature fractionation dependent trend and a mixing fluid trend. In the latter the possibility of input of dissolved carbon derived from the host carbonate rocks and from meteoric waters may have occurred during tectonic uplift. Many of the strontium isotope ratios of vein calcite (0.70779-0.70875) and saddle dolomite (average 0.70782) are similar to Palaeogene seawater, and thus are suggested to be derived from the interaction of fluids with the host carbonate rocks. Howerer, radiogenic Sr ratios of some vein calcite and dolomite suggest influx of basinal fluids at high temperature and elevated salinity.

Key words: fracture-filling carbonates, fluid flow, Eocene, Tectonic evolution, United Arab Emirates