Multiphase Dolomitization in the Samana Suk Formation (Middle Jurassic), Himalayan Foreland Basin, Northwest Pakistan: Impact on Reservoir Characteristics

Mumtaz Shah[1], Hammad Rahim[2]
[1]Quaid-i-Azam University,; [2]Pakistan Museum of Natural History

9.29.2020 - 10.1.2020 – AAPG Annual Convention and Exhibition 2020, Online/Virtual

Abstract

The Samana Suk Formation (middle Jurassic) consisted of thick carbonate sequence, extensively dolomitized in the Himalayan foreland Basin, Pakistan. In order to understand the possible mechanism of multiphase dolomitization, integrated field/petrographic studies, geochemical and isotope analyses and microthermomtery was performed. Field observations show (i) bedding parallel, strata bound; and (ii) patchy hydrothermal dolostone geobodies. Based on petrographic studies (conventional, CL and SEM), seven phases of dolomite and three phases of calcite were recognized, which include; matrix dolomite (MD-I & MD-II), repalcive dolomite (RD-I to RD-III), saddle dolomite cement (SD and CD) and calcite (CC-I to CC-III). Matrix dolomites are nearly stoichiometric (i.e., 51.08-51.87 mole% $CaCO_3$), whereas replacive and saddle dolomites are non-stoichiometric (i.e., 52.09- 55.08 mole% $CaCO_3$). Geochemical analysis (EPMA) showed that Mn, Fe, Na concentration in matrix dolomite is relatively less than replacive/saddle dolomite, suggesting hydrothermal source of replacive/saddle dolomite in reducing conditions. Furthermore, stable isotope studies of matrix dolomite showed non-depleted $\delta^{18}O$ values (-0.99‰ to -2.94‰ V-PDB), which represents coeval sea-water signatures of Jurassic carbonates. Replacive and saddle dolomite shows depleted $\delta^{18}O$ values (-4.68‰ to -6.88‰ V-PDB), indicating burial/elevated temperature of dolomitization. In contrast, $\delta^{13}C$ values of the host limestone (0.11‰ to 2.01‰ V-PDB), matrix dolomite (0.47‰ to 3.19‰

V-PDB), and replacive/saddle dolomite (-0.3‰ 2.34‰ V-PDB) exhibited non-depleted signatures, hence consistent with the Jurassic sea water. Last phase of diagenetic sequence is marked by fracture-filled calcite cementation, which showed more depleted $\delta^{18}O$ values (i.e., -8.87 to -12.32‰ V-PDB) and $\delta^{13}C$(1.12‰ to 2.13‰ V-PDB), indicative of relatively high temperature. 87Sr/86Sr ratios of dolomite, calcite ranges between 0.70770 to 0.71074 showing late diagenetic alteration of limestone and the fluids coming from more radiogenic source. Fluid inclusion studies of replacive/saddle dolomite showed TH ranging from 108-130°C, suggesting basin related dolomitizing fluids for dolomite formation. In conclusion, above-mentioned studies indicate two distinct processes of dolomitization involved in the formation of matrix and replacive/saddle type dolomites. Matrix dolomitization may have resulted in mixing zone that has positive impact on reservoir properties, whereas replacive/saddle dolomite may have formed due to interaction of hydrothermal fluid and resulted in occludation of pore spaces.