Diagenetic studies and its implication on reservoir character of the Anisian-Norian Kingriali Formation, Salt Range, Pakistan

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Abstract

Burial dolomitization of the late Triassic age shallow marine carbonates of Kingriali Formation resulted in the formation of medium to thick bedded dolostone with good reservoir characterization proved in different exploratory wells drilled in Potwar region. Petrographic observations and geochemical data interpretation suggests that replacement of limestone by dolomite is the most common process of dolomitization as observed during this study. The process of matrix selective dolomitization, crystal overgrowth as overdolomitization and dolomite cementation, development of moulds and vuggs, presence of calcium sulphate cement, occurrences of two dolomite populations and formation of saddle dolomite strongly support the process of replacive dolomitization within Kingriali Formation. Three major phases of dolomitization are observed: Matrix selective dolomitization with high porosity values is followed by closely packed mosaic of non-planar to planar low porous RD-1 replacive phase which is finally modified by neomorphism process and result in the formation of RD-2 replacive phase during progressive dolomitization. Field observations and petrographic studies revealed eight different phases of dolomites with distinct isotopic signatures. Stable isotope studies show less depleted 13C and coherent 18O for MZKD-2, MZKD-5, MZKD-6, whereas MZKD-3 exhibited relatively less depleted 18O values (-4.53 to -3.32), interpreted that this dolomitization is a result of slightly high temperature basinal brines and meteoric water. In contrast, 13C & 18O isotopic signatures of MZKD-1, MZKD-4 & MZKD-8 exhibit marine signatures. Stratigraphic positions of Kingriali Formation in support with stable isotope interpretation suggests that late Permian to middle Triassic age seawater derived brines were heated up and enriched in Fe, Mg and radiogenic Sr while circulating through clastic sediments, are responsible for the replacement of precursor limestone. Meteoric water are responsible for the modification of dolomitization phases and dissolution. Petrophysical interpretation shows considerably high values of porosity and permeability which is assumed to be as a result of different processes involved in the modification of shallow marine limestone to present day dolostone. Development of moulds and vuggs by dissolution of calcite at shallow depth, mole per mole replacement of high Mg unstable calcite and aragonite and fracturing due to active tectonism and burial compaction are the processes involved in porosity & permeability enhancement. 3D porosity values from plugs analysis ranges from 8.62 to 16.73% while values for 2D porosity calculations ranging from 2.16 to 30.37%, similarly values for air permeability ranges from 0.064 to 30md while Klinkenberg permeability values ranges from 0.037 to 27.2md which is in the range of a good hydrocarbon reservoir.