

Reconstructing Jurassic Dolomitization: Insights from Mg Isotopes, In-Situ U-Pb Dating, and Geochemical Signatures

XIAOLAN JIA¹, WEIQIANG LI², **DR. MOHAMMAD
ALSUWAIDI**¹, CAMERON MANCHE³, MASSIMO
TIEPOLO⁴, ZHIGUANG XIA^{2,5}, GIANLUCA SESSA⁴,
HOWRI MANSURBEG⁶, JUAN DIEGO MARTIN-MARTIN⁷
AND DR. HAMED GAMALELDIEN, PHD^{8,9}

¹Khalifa University

²Nanjing University

³Texas A&M University

⁴Università degli Studi di Milano

⁵Chengdu University of Technology

⁶Palacky University Olomouc

⁷University of Barcelona

⁸Khalifa university

⁹Polar Research Center, Khalifa University

Understanding the dolomitization process and subsequent diagenetic alterations is crucial for reconstructing ancient geochemical environments of the carbonate reservoirs. This study integrates petrography, mineralogy (XRD), geochemical, C-O-Sr-Mg isotopes, and in-situ U-Pb dating to investigate the Upper Jurassic Arab dolostones. The results suggest dolomitization occurred via evaporative Kimmeridgian-Tithonian seawater infiltration in a fluid-buffered open system, as indicated by C-Mg isotope alignment with seawater signatures and early closure of the U-Pb system. However, post-depositional diagenesis significantly modified the original records, evidenced by depleted $\delta^{18}\text{O}$ values, low Sr concentrations, coarse dolomite crystals with mottled cathodoluminescence, and elevated cation ordering. The depletion of $\delta^{26}\text{MgDol-DSM3}$ values suggests minimal interaction with non-carbonate phases, while heavier $^{87}\text{Sr}/^{86}\text{Sr}$ ratios in some crystalline dolostones imply potential burial dolomite cementation. The stratigraphic $\delta^{26}\text{Mg}$ variations reflect different diagenetic systems, with a fluid-buffered system dominating the lower Arab interval and a semi-closed system in the upper interval, linked to seepage reflux dolomitization. In-situ U-Pb dating results confirm early dolomitization ages (~154.8–145 Ma), reinforcing seawater-driven dolomitization under near-surface conditions. This study demonstrates the utility of Mg isotopes in reconstructing paleo-seawater signatures and highlights the necessity of integrating sedimentological and isotopic approaches to decode pristine dolomitization signals from overprinted geochemical records. The findings provide valuable insights into carbonate diagenesis, with implications for hydrocarbon reservoir characterization and basin evolution.