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Carbonate Clumped-Isotope (D47): A New Tool to Understand Carbonate Diagenetic Processes

Isabel Millan Sanchez[1], Tanya Goldberg[1], Rader Abdul Fattah[1], Stefano Bernasconi[2]

[1]Petroleum Geoscience, TNO, Utrecht, NETHERLANDS
[2]Geologisches Institut, ETH , Zurich, SWITZERLAND

ABSTRACT

Carbonate reservoirs are strongly heterogeneous in terms of porosity and permeability from the time of their deposition owing to rapid changes in depositional facies, and hence sediment texture. Diagenetic alterations (cementation, compactation, dissolution, micritization, neomorphism, and dolomitization) impose further and profound impact on modification to depositional porosity and permeability, and hence on final quality of carbonate reservoirs. Elucidating the impact of diagenesis on the spatial and temporal distribution of reservoir quality is essential to define the hydraulic properties of a reservoir. This task can be achieved by applying different techniques such as petrographic examination (optical, scanning electron microscope, cathodoluminescence), fluid inclusion microthermometry and isotopic compositions of carbonates in the characterization of heterogenic carbonate reservoirs. However, fluid inclusion in carbonates are not always present or reliable due common stretching problems and therefore, new paleothermometer methods are very welcomed.

Carbonate clumped isotope is an innovative paleothermometer based on the abundance of 13C-18O bonds in the lattice of carbonate minerals. The excess abundance of 13C-18O bonds in carbonates above a theoretical random distribution has been shown to be temperature-dependent (Ghosh et al., 2006). Unlike the conventional carbonate- water isotopic thermometers this novel method allows to reconstruct the precipitation temperature of carbonate minerals independently of d18O of the fluids in which the mineral grew. In addition, in combination with the oxygen isotope composition of the carbonate, it is possible to reconstruct the d18O of these fluids. Therefore, this technique allow to help solve many of the remaining questions in carbonate diagenesis.

This innovative method has been already tested in two cases. 1) the Upper Devonian Nisku reef (west-central Alberta) which is a well-understood natural oil/gas play and 2) The Albian Ramales carbonate platform (northern Spain, western Pyrenees) which is a good analog of fracture-related hydrothermal dolomite reservoirs. Our objective is to extend the application of this innovative technique in the Middle East where carbonate reservoirs and their complex diagenetic histories play a crucial role in oil and gas exploration/production.

P. Ghosh et al., 2006. 13C-18O bonds in carbonate minerals: A new kind of paleothermometer. Geochimica et Cosmochimica Acta 70, 1439-1456.