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Constraining Reservoir Quality of Early Dolomites Using Clumped Isotopes Thermometry and Detailed XRD Analysis

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ABSTRACT

Reservoirs petrophysical properties are determined by depositional processes and subsequent diagenetic events. In carbonates, diagenetic processes are diverse and challenging to predict due to their reactive nature. Dolomitization is a common diagenetic process consisting of the addition of Mg in the calcite crystal lattice. Early dolomitization studies are made difficult by our poor understanding of the kinetics below 60C. It is therefore challenging to constrain reactive transport models with temperature fields or fluid chemistry, which leads to major uncertainties in the prediction of reservoirs heterogeneities. In order to address these problems, we use clumped isotopes thermometry coupled with advanced XRD analysis on dolomite samples of the Miocene Marion Plateau (NE Australia). Our goal is to demonstrate that by applying these methods to well data, even in sparsely sampled area, we can improve reservoir predictions. We measured clumped isotopes and record XRD patterns in 28 dolomite samples. Clumped isotope thermometry has the advantage over traditional isotope geochemistry that the temperature of dolomite growth can be inferred independently from the parent fluid (Ghosh et al., 2006a; Eiler, 2007; Dennis et al., 2011). XRD patterns are refined with the Rietveld method to extract the dolomite phases stoichiometry and ordering state. XRD refinements show that dolomites of the Marion Plateau are non-stochiometric, with up to 58% Ca. Clumped isotopes give temperatures between 15 and 37°C (mean= 22°C). These results show that the Marion Plateau has been dolomitized at low temperatures and low salinity. XRD highlights the precipitation of a stoichiometric cement below 600 m, coincident with the increase of dissolution of the non-stochiometric phase and an increase of porosity and permeability. Despite a very shallow-burial for the dolomite, the deepest samples show a relative increase of temperature, which coupled with thin section and XRD observations indicates the onset of dolomite recrystallization. This points out that early dolomite might equilibrate rapidly during early burial before reaching a stable mineralogical phase, a process that could be critical in determining final reservoir quality. It demonstrates that great care should be taken in the choice of the samples. A temperature measured in a recrystallized sample can lead to erroneous interpretation of the mechanism of dolomitization.