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Porosity evolution during experimental diagenesis of carbonates: influence of salinity

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The existence of high quality (high porosity – high permeability) reservoirs in carbonated rocks at great depth highlights a paradox. Indeed, classical modeling of rock evolution during burial forecasts a strong decrease of porosity with depth, thus predicting a lack of economically interesting reservoirs under 4000 m. So how these reservoirs come to exist? The understanding of the way porosity is altered at great depth may indicate potential reservoir rocks. By which processes is porosity modified?
To answer these questions, an experimental approach has been conducted, using a specifically designed apparatus that enable, in laboratory, the simulation of deeply buried reservoirs in situ conditions (high pressures and temperature as well as the circulation of fluids). The nature of carbonated rocks (bioclastic and oolitic) has been investigated as well as the nature of the percolating fluid (with and without NaCl). To characterize the evolution of the porosity and of the porous network, analysis via nanotomography, mercury intrusion porosimetry and specific surface area were used.
The results obtained in this study show that the main diagenetic process of porosity loss is the pressure solution creep (PSC), reducing by at least three the initial porosity. PSC results in both dissolution and precipitation, processes that lead to a great modification of the rock porous network. This modification is more pronounced in the oolitic limestone than in the bioclastic one. The presence of NaCl in the fluid leads to a greater dissolution of carbonate matter but also to a precipitation of salt minerals partially blocking the porous network.
The dataset obtained from these experiments shows the importance of the nature of the deposit rock but also of the nature of the percolating fluid. It can be concluded that pore fluid chemistry and, by consequence, its origin is of great importance in the study of porosity modification with depth.