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Influence of the timing of HC injection on the preservation of petrophysical properties of carbonate reservoirs at great depth

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In the oil industry, the preservation of petrophysical properties at great depth may lead to the existence of a deeply buried reservoir (DBR), a favoured target in the field of petroleum exploration and exploitation. The accurate prediction of reservoir quality requires an understanding of the key controlling diagenetic processes. Pressure solution is one of the main processes happening during diagenesis and being responsible for the evolution of porosity and permeability in many reservoirs. However, others processes may potentially act upon carbonate rocks during diagenesis: the timing of oil arrival is one of these processes. The aim of this study is to investigate experimentally the influence of oil injection and timing of this injection on the pressure solution process and thus on carbonate petrophysical properties.

The experiments were performed using a subsurface consolidated carbonate rock and a specifically designed experimental apparatus, enabling the simulation of in situ conditions (pressure/stresses and temperature) of deeply buried reservoirs. Three experiments were realised with different fluids and injection conditions, namely meteoric fluid as the interstitial fluid, early saturation in oil of the sample followed by the injection of a meteoric fluid, late injection of oil in a sample initially saturated with a meteoric fluid.

The results obtained in this study showed that without oil in the interstitial fluid, the main diagenetic process is the pressure solution creep (PSC). This process reduces by three the initial porosity but don't have any significant influence on permeability. When the sample was initially saturated with oil before the injection of the meteoric fluid, the process of PSC was inhibited. In this case, the porosity showed a slight decrease and the permeability showed a strong decrease from 23 mD to 1 mD. When an initially saturated (with a meteoric fluid) sample undergone a late injection of oil, the porosity was not preserved and permeability decreased after oil injection.

The dataset obtained from these experiments showed the importance of the timing of oil arrival in the preservation of porosity at great depth by inhibiting diagenetic processes such as PSC. When petroleum arrival has occurred relatively early (i.e. prior to PSC), reservoir quality is preserved. When this arrival has occurred after burial cementation, reservoir quality is significantly deteriorated.