Impact of Wettability on Reservoir Quality Distribution and Preservation

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Reservoir quality can be defined as the measure of the level of porosity and permeability of a rock, reservoirs with good or excellent qualities have porosities and permeabilities between and above the range of 15-20% in porosities and 0.01mD in permeability. These properties of the reservoir and its distribution, is of utmost importance in subsurface energy and resources exploration. Micro-scale mechanisms such as cementation, compaction, grain texture, and sorting, have been proposed to explain the distribution of reservoir quality in the subsurface. The above-mentioned factors mainly describe the rock structure. Additionally, factors that link fluid/fluid/rock interactions such as wettability are found to play a key role in reservoir quality.

It is known that the inorganic reactions that cause cementation and result in porosity reduction are water-mediated processes, that can occur in the presence of hydrocarbons in the pores. In this process, organic matter adsorption on the mineral surfaces can cause hydrophobicity and also block the active sites available for cementation, these can then limit the level of cement precipitation and growth. Although the link between wettability and cementation inhibition has been known, however, this correlation has not been used to explain the evolution of porosity and permeability within geological system. This work is therefore, an attempt to quantify the impact of wettability on inorganic cement inhibition and to match varying degrees of wettability with their corresponding values of porosity and permeability evolution.

Here, we employ an experimental approach to demonstrate the impact of oil in altering the wettability of carbonate grains and by extension, inhibiting the extent of cementation. To achieve this, we have used an ageing technique, to alter the wettability of the carbonate grains, alongside gravimetric analysis, SEM, and XRDF with flow procedures in porous media. The cementation process is initiated from hypersaline solution supersaturated with calcite at room temperature and atmospheric pressure conditions to grow on carbonate ooids. The dynamics of the calcite cementation was investigated in both water and oil wet conditions using the aforementioned techniques

Our result shows epitaxial growth and development of calcite cement on the grains, and a significant change in their wettability, due to the effect of oil presence. There is also 50-60% reduction in the extent of cementation, compared to the precipitation levels that occur in the absence of oil or under water wet conditions.