An Analogue Approach to Understand the Effect of Oil Emplacement on Pressure Solution in Reservoir Rocks

Sathar, Shanavas [1]; Worden, Richard H.[1]; Faulkner, Daniel R.[1]; Smalley, Craig [2] (1) Earth & Ocean Sciences, University of Liverpool, Liverpool, United Kingdom. (2) BP Exploration, BP, Sunbury on Thames, United Kingdom.

Pressure solution, also referred to as chemical compaction, is a ubiquitous diagenetic process occurring as a result of elevated temperature and effective stress during burial in reservoir rocks. This process results in minerals preferentially dissolving into the fluid phase at grain contacts and consequent diffusive transfer of the dissolved particles to zones of low effective stress such as pore spaces where they re-precipitate as mineral cements. Pressure solution is a major cause of porosity-loss and so has a big impact on reservoir quality. The effect of oil emplacement on pressure solution is not well understood and remains controversial.

Two contrasting hypotheses have been proposed to explain the effect of oil emplacement on pressure solution. The first hypothesis advocates that emplacement of oil inhibits pressure solution. This is supported by: for e.g. the apparent preservation of porosity in oil-bearing sandstone reservoirs. Conversely, the second hypothesis argues that pressure solution is not at all affected by oil emplacement. This is supported by: for e.g. no variations in quartz cement volumes between water and oil legs in certain reservoir sandstones.

However, pressure solution is a complex process involving mineral dissolution, aqueous transport and mineral precipitation and all of these steps may have their rates influenced by oil emplacement. Attempted simulation of pressure solution under realistic conditions using typical reservoir minerals like quartz (sand) has been unsuccessful. Rather than using largely insoluble (over laboratory timescales) reservoir minerals such as quartz, we use halite (NaCl) as an analogue. Initially, hydrostatic compaction experiments were conducted on halite mineral aggregates in the presence of saturated NaCl solution as pore fluid to ascertain its suitability as an analogue for simulating pressure solution experiments in reservoir rocks. The results from those experiments imply that halite can be used as an analogue in understanding the effect of oil emplacement on pressure solution. Finally, the oil emplacement scenario is simulated in the laboratory by systematically varying the ratio of brine and oil starting from 100% brine through 50-50% brine-oil to 100% oil. We present here our observations and inferences from these reservoir analogue experiments.