Contribution ID: **49** Type: **Oral Presentation**

Nanoscale visualization of dissolution and precipitation at calcite-oil-brine interfaces upon aging at variable salinity

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While wettability alteration is arguably the dominant factor controlling low salinity IOR in sandstones, the relative importance of mineral dissolution and wettability alteration through modified organic-mineral interaction for carbonate reservoirs is still under debate. In this study, we present a new method to directly visualize local dissolution/precipitation in model systems upon aging crude oil drops in brines of varying composition.

Calcite samples covered in crude oil droplets were aged for up to two weeks at room temperature in brines of varying salinity, ranging from high-salinity formation brine to various low-salinity smart brines. After aging, the oil droplets were removed by toluene washing and the samples were dried. Subsequently, the calcite surface was scanned with Atomic Force Microscopy (AFM), characterizing the topographical differences between locations previously covered by oil and the immediate surrounding area that was directly exposed to the brine.

During aging, optical microscopy showed no change in the location or shape of the droplets (as seen from above), hinting at pinning of the three-phase contact line for each droplet. Height maps taken by AFM at droplet locations, show the locations of the original oil-calcite interfaces as mesas above the ambient substrate level for samples aged in undersaturated ambient brines of low salinity, whereas holes below the ambient substrate level are seen for supersaturated ambient brines. At the same time, the surface underneath the original droplet resembles the freshly cleaved calcite. This suggests that the oil protects calcite from being accessed and altered by the surrounding brine, while calcite is either dissolved or precipitated from the brine next to drop leading to the altered substrate levels. In accordance with their Saturation Index, high-salinity formation brine caused precipitation whereas low-salinity smart brines caused dissolution. Precipitation was limited to tens of nanometers observed at all timepoints (2 days –2 weeks), whereas dissolution continued over time up to of hundreds of nanometers. Addition of SO4(2-) had little effect on the dissolution; increasing the Mg(2+) content slightly inhibited mineral dissolution.

Our results provide a direct microscopic demonstration of mineral dissolution and precipitation upon aging calcite in various brines in the presence of crude oil. The method is easily adapted to elevated temperatures and possibly natural rock samples. Our observations contribute to the understanding of the relevance of mineral dissolution for smart water IOR in carbonate reservoirs.

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References

Time Block Preference

Time Block B (14:00-17:00 CET)

Participation

Unsure

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