

## Characterization and Modeling of Hydroxyapatite Growth on Calcite Surfaces for Improved Oil Recovery

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**Abstract.** The geochemical interactions between gas/liquid/rock systems involve an interplay between different phenomena, including dissolution, precipitation, aqueous complexation, and surface reactions. In the case of carbonate formations, the rock is reactive and significantly alters the bulk solution chemistry. These effects have major implications for improved oil recovery when solutions of phosphates interact with calcium carbonate minerals. In this work, we have modeled the geochemical reactions between calcite and high salinity injection water with 1000 ppm of dihydrogen phosphate ( $\text{H}_2\text{PO}_4^-$ ) while considering the fugacity of  $\text{CO}_2$  at atmospheric condition. The results show a shift of hydroxyapatite ( $\text{Ca}_5(\text{PO}_4)_3\text{OH}$ ) saturation index from negative to positive before and after the addition of calcite into solution as dissolution increases the activity of  $\text{Ca}^{2+}$  and  $\text{CO}_3^{2-}$  ions; calcium directly affects the ion activity product (IAP) of hydroxyapatite formation reaction while carbonate anions indirectly affect the reaction IAP by lowering the activity of protons. Therefore, the precipitation of hydroxyapatite becomes thermodynamically favourable. It was found that hydroxyapatite grow on the surface of calcite through characterizing the surface of calcite particles using scanning transmission electron microscope (STEM) with energy disperse x-ray spectroscopy (EDX).