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Petrophysical and Geochemical Variations Related to Stromatolite Dissolution

Alcantara, J.V.[1], Silva, T.G.[1], Luz Junior, L.F [1], Cury, L. F, França, R.M [1] Bahniuk, A.M [1]

[1]Universidade Federal do Paraná, Centro Politécnico, jp.alcantara@uol.com.br

The parameters that control dissolution and precipitations of carbonate minerals are pH, CO_2 pressure, temperature and microbiological activity. However, it is difficult to quantify which parameter dominated during the dissolution process. The petrophysical changes that occur on a micro scale need to be assessed because these are the most relevant properties for oil recovery in CO_2 saturated reservoirs and for Enhanced Oil Recovery (EOR) processes with matrix acidification in carbonate reservoirs. In addition, studying the impact of increased CO_2 concentrations on porosity generation, which can also be a result of microbial activity, has general implications for distinguishing between primary and secondary porosity development in ancient stromatolites.

A lagoon, Lagoa Salgada, located in Rio de Janeiro, Brazil, where stromatolites occur, represents a potential modern analogue to study porosity formation in oil reservoir. For our study, we performed an experiment involving the dissolution of stromatolite samples by submergence in an aquarium containing deionized water saturated with CO2 under low energy flow at surface conditions.

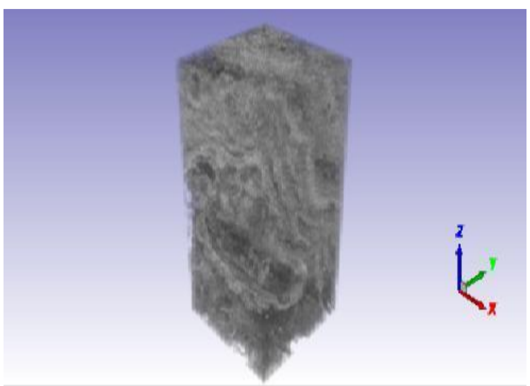

Figure 1: 3D model of sample from MCT scan

Micro tomography scans were performed to analyze the initial petrophysical properties, such as porosity, connectivity and mean pore size.

X- Ray Diffractometry (XRD) analysis was performed to identify the initial mineral composition and subsequent changes and/or crystal lattice modifications. The analyses performed after 3 and 6 months showed a heterogeneous porosity ranging from 48% to 24% (base to top). XRD analyses indicate that high-Mg calcite was the primary mineral phase with subordinate amounts of quartz and aragonite. Unexpectedly, the porosity of the samples decreased within 3 months in the dissolution experiment. As the aim of this work was to characterize and quantify the range of the petrophysical properties and the geochemical alterations associated with precipitation and dissolution processes within carbonate reservoirs, the observed decrease in porosity suggests that process is more complicated than simple dissolution with the injection of CO_2. Indeed, the diagenetic processes related to CO_2 availability in pores spaces can increase microbial metabolisms that influence the petrophysical properties of ancient carbonate microbialites. Furthermore, these results have potential to be applied in the oil industry to contribute to enhanced production and oil recovery processes.