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Petrophysical and transport parameters evolution during acid percolation through structurally different limestones

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Processes affecting geological media often show complex and unpredictable behavior due to the presence of heterogeneities. This remains problematic when facing contaminant transport problems, in the CO_2 storage industry or dealing with the mechanisms underneath natural processes where chemical reactions can be observed during the percolation of rock non-equilibrated fluid (e.g. karst formation, seawater intrusion). To understand the mechanisms taking place in a porous medium as a result of this water-rock interaction, we need to know the flow parameters that control them, and how they evolve with time as a result of that concurrence. This is fundamental to ensure realistic predictions of the behavior of natural systems in response of reactive transport processes. We investigate the coupled influence of structural and hydrodynamic heterogeneities in limestone rock samples tracking its variations during chemical reactions. To do so we use laboratory petrophysical techniques such as helium porosimetry, gas permeability, centrifugue, electrical resistivity and sonic waves measurements to obtain the parameters that characterize flow within rock matrix (porosity, permeability, retention curve and pore size distribution, electrical conductivity, formation factor, cementation index and tortuosity) before and after percolation experiments. We built an experimental setup that allows injection of acid brine into core samples under well controlled conditions, monitor changes in hydrodynamic properties and obtain the chemical composition of the injected solution at different stages. 3D rock images were also acquired before and after the experiments using a micro-CT to locate the alteration processes and perform an acurate analysis of the structural changes. Two limestones with distinct textural classification and thus contrasting transport properties have been used in the laboratory experiments: a crinoid limestone and an oolithic limestone. Core samples dimensions were 1 inch in diameter and varied from 0.5 to 2 inches in length. Experiments were performed at room temperature, 8 bar of total pressure and 3 bar of PCO_2. The acidic fluid has been injected at constant flow rate ranging from 0.4 mL/min to 6.7 mL/min depending of the rock typology and sample length. As expected, limestone dissolution occurred during the different percolation experiments, porosity and permeability augmented and sonic waves speed propagation decreased, showing an increase in the degree of heterogeneity of the rocks. The integration of all these parameters measured at different stages of dissolution provides contrasted and realistic geochemical, hydrodynamic and structural parameters to improve numerical simulations.