Geophysical Research Abstracts
Vol. 20, EGU2018-5022, 2018
EGU General Assembly 2018

Monitoring diagenetic alteration of coral and bivalve samples in a multi-permeameter

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To understand replacement of biogenic aragonite by calcite during carbonate diagenesis in nature and to specifically constrain transformation kinetics in natural samples saturated with aqueous solutions, we mimic the in-situ alteration by hydraulic experiments in a multi-permeameter on samples of a coral (Porites sp.) and a bivalve (Arctica islandica). Relying on the oscillatory pore-pressure method we continuously determine permeability and specific storage capacity of samples while at elevated pressure and temperature corresponding to diagenetic conditions. These two parameters are strongly linked to the pore-space characteristics that in turn evolve owing to dissolution and precipitation processes and the volume change involved in the ar-cc transformation. Albeit indirect, this hydraulic approach constitutes a continuous monitoring of reaction progress. Alteration experiments were performed with distilled water for durations between 1 and 3 weeks at temperatures from 125 to 200 °C, hydrostatic confining pressures between 20 and 30 MPa, and a pore pressure of 10 MPa. The coral samples with a porosity between 30 and 40 % exhibited a steady increase in permeability by one order of magnitude (10^{-14} to 10^{-13} m^2) at 150 °C and 200 °C over a time span of 10 days. The shell samples exhibited a rapid increase in permeability directly after the heating; at a temperature of 125 °C no further changes were observed but permeability continuously decreased at 150 °C and 175 °C over a time span of 120 and 50 hours, respectively. By performing X-ray tomographic analysis as well as X-ray diffraction analysis before and after the alteration experiments we verified the transformation for two coral samples tested with an effective pressure of 10 MPa at 150 °C and 200 °C. Yet, the relation between transformation-related changes in pore-space geometry and effective permeability and storage capacity still has to be further analyzed for the two types of sample material with significantly different initial porosity. The amount of the aragonite replaced by calcite will be quantified by linking the X-ray diffraction analysis with the tomographic results. To match natural situations more closely an artificial burial fluid will be used in future experiments.