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Changes in rock physical properties of gypsum samples dehydrated in air

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This study aims at contributing to the experimental database of changes in rock physical properties, particularly permeability, induced by devolatilization reactions. Cylindrical samples of natural gypsum were dehydrated in air for up to 180 h at ambient pressure and temperatures between 378 and 423 K. Subsequently, the transformation kinetics, reaction induced microstructural changes and the concurrent evolution of the sample permeability, P-wave velocity, and thermal conductivity were constrained. Weighing the heated samples in predefined time intervals yielded the reaction progress where the stoichiometric mass balance indicated an ultimate dehydration to anhydrite regardless of temperature. The kinetic data was fitted with an Avrami-Arrhenius approach and the apparent activation energy obtained was 73 kJ/mol. Porosity measurements were performed with a He-pycnometer. Porosity was observed to continuously increase with reaction progress from approximately 2 % for fully hydrated samples to 30 % for completely dehydrated ones, whilst the initial bulk volume was preserved. Permeability measurements were performed on selected samples in a gas permeameter with argon used as the pore fluid. Confining pressure was kept at 3 MPa to minimize the risk of sample compaction. To measure permeability, four differential pore pressure steps of 0.5, 1, 1.5, and 2 MPa were applied and the Klinkenberg correction was performed. Permeability increased with reaction progress and thus porosity by three orders of magnitude from approximately 7•10E-19 m2 to 5•10E-16 m2. P-wave velocity was measured at ambient conditions with ultrasonic transducers indicating a linear decrease with porosity from 5.2 km/s at 2 % to 1.0 km/s at 30 %. In our contribution we will also report on the evolution of thermal conductivity and the sample microstructure as a function of reaction progress.