Geophysical Research Abstracts
Vol. 14, EGU2012-3374, 2012
EGU General Assembly 2012


# Evolution of microstructure and elastic wave velocities in dehydrated gypsum samples

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This study aims at contributing to the experimental database of changes in rock physical properties, particularly elastic wave velocities, induced by devolatilization reactions. Cylindrical samples of natural gypsum were dehydrated in air for up to 800 h at ambient pressure and temperatures between 378 and 423 K. Subsequently, the transformation kinetics, reaction induced changes in microstructure and porosity and the concurrent evolution of the sample P and S-wave velocities 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. 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. In a first set, 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 %. Results of a second set of ultrasonic measurements for both P and S-waves will be presented as well aiming at a spatially resolved wave velocity dependence on microstructure.
For P-waves three different effective medium models - Voigt, Wyllie (Reuss), and Nur - were compared to the data. The linear dependence of P-wave velocity on porosity observed is best represented by the Voigt bound. The Voigt bound, however, overestimates the measured values significantly. The Wyllie-Equation (the Reuss bound) does not replicate the linear decrease in P-wave velocity with porosity and generally underestimates the data. However, at porosities above approximately 25 % the agreement with measured values is excellent. The Nur-Model yields a nonlinear dependence but replicates the data best for model-inherent critical porosities between 0.25 and 0.3.
Thin section micrographs taken on selected samples reveal a sharp reaction front progressively migrating sample inwards. SEM imaging confirmed this observation, additionally showing (1) that the cylindrical outer rim consists of a highly porous network within an anhydrite matrix and (2) that the remaining inner cylinder appears unaltered at 388 K whereas bassanite needles progressively turning into anhydrite can be found at 398 K.