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Stress sensitivity of gypsum dehydration kinetics at constant uniaxial stress under dry conditions

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We recently showed that the dehydration of alabaster, natural gypsum rock with randomly oriented grains, can be accelerated by a factor of two through the application of an elastic differential pre-stress of ~ 5 MPa applied via a uniaxial constant-displacement boundary condition (https://doi.org/10.1038/s43246-021-00156-9). Here, we present a novel series of gypsum dehydration experiments using a new in-situ experimental cell monitored with fast synchrotron transmission small- and wide-angle X-ray scattering (SAXS/WAXS) to investigate if an acceleration of the kinetics also occurs at constant uniaxial stress. Prior to stressing and heating, the loaded sample chamber was flushed with nitrogen to remove atmospheric moisture and finally locked, filled with the nitrogen atmosphere pressurised to 1 bar. Six increasing uniaxial stresses in the interval [0;10] MPa were studied at a dehydration temperature of 142˚C. A strongly nonlinear acceleration of dehydration rate is observed over the studied stress interval. At 10 MPa, the reductions of induction and characteristic time amount to ~60% and ~50%, respectively. 2D SAXS patterns generally evolve from isotropic to highly anisotropic shapes, indicating preferential growth of nano-scatterers. Post-mortem scanning-electron imaging reveals that the phase transformation occurs via pseudomorph replacement. These results are largely consistent with our previous experiments and support the notion that tectonic stresses affect mineral transformation kinetics.