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The influence of OH in coesite on the kinetics of the coesite-quartz phase transition

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ABSTRACT

Metastable coesite is an important pressure indicator for ultrahigh-pressure rocks. However, in many cases coesite does not survive exhumation, but reacts back to quartz. Although it was shown experimentally that incorporation of H in coesite increases with increasing pressure, most coesite relics found in nature are essentially dry (i.e., OH concentrations are below detection limit, <1 wt ppm H_2O). Thus, does the incorporation of H promote the back-reaction of coesite to quartz during exhumation? The influence of intrinsic OH on the kinetics of the coesite-quartz phase transition was determined using synthetic "dry" coesite with $\approx$ 10 wt ppm H_2O and "wet" coesite with $\approx$ 105 wt ppm H_2O. TEM analysis of the quenched samples proved the presence and absence of water in the "wet" and "dry" samples, respectively. The kinetics of the coesite-quartz transition was investigated in-situ using the multi-anvil apparatus MAX 80 at the Hamburger Synchrotron Radiation Laboratory (HASYLAB). The transition rates were measured by observing changes in selected diffraction line intensities as a function of time. The transformation and growth rates were derived using Cahn's model of nucleation and growth at grain boundaries. Under the same experimental conditions the transformation rate of the "wet" coesite is more than ten times higher than that of the "dry" coesite. This difference may explain why OH-bearing natural coesite is rare. This study reveals the importance of structurally bound OH for the kinetics of phase transitions of nominally anhydrous minerals.