

Formation of metastable seifertite

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Seifertite is a polymorph of silica with alpha-PbO₂ type structure that was found in the heavily shocked Martian meteorite (e.g., El Goresy et al., EJM2008). This phase is thermodynamically stable at more than 90 GPa corresponding to the base of Earth's mantle (Murakami et al., GRL2003). However it has also been known that this phase metastably appears from cristobalite at around more than 40 GPa and room temperature (Dubrovinsky et al., CPL2001). In this study, we focus on the kinetics of metastable formation of seifertite as important constraints on shock conditions of meteorites containing silica phase.

We have carried out high-pressure and high-temperature in-situ XRD experiments of quartz and cristobalite using a Kawai-type apparatus (SPEED-1500) at BL04B1 of SPring-8. Diffraction peaks of both quartz and cristobalite became very broad with pressures during cold compression, suggesting that the partial amorphization occurred. In the experiments of quartz, we observed sharpening of diffraction peaks and complete amorphization when heating at around 19 and 23 GPa, respectively. In both cases, stishovite appeared at more than 500-600C without formation of seifertite. Whereas in cristobalite, we observed formation of seifertite before appearance of stishovite when heating at 11-23 GPa. In the time scales of tens of minutes, the formation temperatures decrease from 500C to 200C for seifertite and increase from 600C to 800C for stishovite with pressures. As a result, the metastable field of seifertite can be kinetically defined, which expands to much lower pressures than previously thought. Further analyses of kinetic data obtained enable to estimate the P-T-t conditions for the presence of seifertite in shocked meteorites quantitatively.