

Abstract

An X-Ray Diffraction Study of the High Pressure Behavior of Gaspéite (NiCO₃)

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As part of our understanding of Earth's carbon cycle, we need to understand the stability and mechanical properties of carbonates at conditions of planetary interiors. Previous high pressure experiments have studied a variety of carbonates such as siderite (FeCO₃), calcite (CaCO₃), and magnesite (MgCO₃). However, the nickel carbonate gaspéite (NiCO₃) has not been thoroughly studied under high pressure. A single previous study has measured the phase stability and compressibility of gaspéite up to 8 GPa (Zhang and Reeder, 1999). Here we present new measurements of the phase stability and lattice compressibility of gaspéite to 40 GPa. One set of powder X-ray diffraction measurements were made at beamline 12.2.2 at the Advanced Light Source (ALS) and two sets at beamline 13 IDD at the Advanced Photon Source (APS). Natural samples of gaspéite were ground into a powder and loaded into a diamond anvil cell with a Ne pressure medium. The samples were pressurized to 40 GPa in ~3-5 GPa pressure steps and decompressed in steps of ~5-10 GPa. Gaspéite maintains its calcite structure up to 40 GPa, and reverts to its zero-pressure volume on decompression with some hysteresis. A fit to the Birch-Murnaghan equation of state yields an isothermal bulk modulus for gaspéite to be 132.45 ± 20 GPa and its pressure derivative to be 7.9 ± 1.9 . The c/a ratio decreases as a function of pressure by 3.5% over 40 GPa and can be described with the equation: $\frac{c}{a} = 3.22 - 0.0032 \cdot P + 2.22 \cdot P^2$. We present these results in the context of the transition metal calcite-structured carbonates, showing systematics in the compressibility and c/a ratio as a function of volume, allowing predictions of mixing energetics amongst the calcite-structured carbonates.