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INVESTIGATING PETROLOGIC INDICATORS OF MAGMATIC PROCESSES IN VOLCANIC ROCKS

Petalite under pressure: Elastic behavior and phase stability†

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ABSTRACT

The lithium aluminosilicate mineral petalite ($LiAlSi_4O_{10}$) has been studied with high-pressure single-crystal X-ray diffraction (HP-XRD) up to 5 GPa. Petalite undergoes two fully reversible pressure-induced first-order phase transitions, not previously reported in the literature, at ca. 1.5 and 2.5 GPa. The first of these transforms the low-pressure α-phase of petalite ($P2/c$) to an intermediate β′-phase that then fully converts to the high-pressure β-phase at ca. 2.5 GPa. The α → β transition is isomorphic and is associated with tripling of the unit-cell volume. Analysis of the HP-XRD data show that although the fundamental features of the petalite structure are retained through this transition, there are subtle alterations in the internal structure of the silicate double-layers in the β-phase relative to the α-phase. Measurement of the unit-cell parameters of petalite as a function of pressure, and fitting of the data with third-order Birch-Murnaghan equation of state, has provided revised elastic constants for petalite. The bulk moduli of the α- and β-phases are 49(1) and 35(3) GPa, respectively. These values indicate that the compressibility of the α-phase of petalite lies between those of the alkali feldpsars and alkali feldspathoids, whereas the β-phase has a compressibility more comparable with layered silicates. Structure analysis has shown that the compression of the α-phase is facilitated by the rigid body movement of the Si_2O_7 units from which the silicate double-layers are constructed.

Keywords: Petalite, high-pressure, single-crystal X-ray diffraction, equation of state, phase transition