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The high-pressure behavior of orthorhombic amphiboles

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Abstract

The high-pressure behavior of a natural Mg-rich anthophyllite (space group *Pnma*) from Talcville, New York, U.S.A., with empirical formula $^{A}Na_{0.04}{}^{B}(Mg_{1.30}Mn_{0.57}Ca_{0.09}Na_{0.04})^{C}(Mg_{4.96}Fe_{0.02}Al_{0.02})^{T}(Si_{7.99}Al_{0.01})O_{22}{}^{W}(OH)_2$ has been studied to 7 GPa. Bulk and axial moduli determined by fitting a third-order Birch-Murnaghan equation-of-state to lattice parameters are: $K_{T0} = 66(2)$ GPa, $K' = 11(1)$, $K_{T0}(a) = 41(3)$ GPa, $K'(a) = 11(2)$, $K_{T0}(b) = 97(5)$ GPa, $K'(b) = 6(2)$, $K_{T0}(c) = 83(7)$ GPa, and $K'(c) = 12(4)$. Structure refinements were also obtained at 0.0001, 1.98(2), 4.57(2), and 6.13(4) GPa. A comparison with the recent study of Fe-rich proto-amphibole, space group *Pnmn*, by Zanazzi et al. (2010) allows the effects of symmetry and composition upon high-*P* behavior of amphibole to be evaluated. The effects of composition have been identified and the central role of the ribbon of M1,2,3 octahedra in the compression of amphibole is discussed. The only significant differences between the elastic properties of anthophyllite and proto-amphibole are the greater stiffness of anthophyllite along [100] and the much higher-pressure derivatives $K'(b)$ and $K'(c)$ of anthophyllite. It is proposed that a high Mg content of the M1,2,3 ribbon stiffens the amphibole structure considerably on compression, compared with an Fe-rich ribbon. This result indicates the importance of determining K', as the zero-pressure moduli can be very similar but change significantly with *P*.

Keywords: Anthophyllite, high pressure, equation of state, proto-anthophyllite