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Comparative high-pressure crystal chemistry of wadsleyite, β-$(Mg_{1-x}Fe_x)_2SiO_4$, with $x = 0$ and 0.25

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ABSTRACT

High-pressure crystal structures are reported for two synthetic wadsleyite crystals, β-Mg_2SiO_4 (Fe00) and β-$(Mg_{0.75}Fe_{0.25})_2SiO_4$ (Fe25), at six pressures to 10.12 GPa. In both compositions, bulk compressibilities are equal to the average compressibility of divalent cation octahedra. Individual silicate tetrahedra, by contrast, are relatively rigid, though the Si-O-Si angle between tetrahedra in Si_2O_7 dimers decreases systematically with pressure. Wadsleyites display anisotropic compression, with the *c* axis approximately 40% more compressible than *a* or *b*. This behavior results from differential compression of (Mg,Fe)-O bonds; in each of the structure's three symmetrically independent octahedra, the longest and most compressible bonds are roughly parallel to the *b* axis. Although the linear compressibilities of Fe00 and Fe25 are similar, details of structural changes with pressure differ. Iron-enriched M1 and M3 octahedral sites in Fe25 are significantly less compressible than analogous Mg sites in Fe00.