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Effect of hydration on the single-crystal elasticity of Fe-bearing wadsleyite to 12 GPa

Zhu Mao,[1,*] Steven D. Jacobsen,[2] Daniel J. Frost,[3] Catherine A. McCammon,[3] Erik H. Hauri,[4] and Thomas S. Duffy[1]

[1]Department of Geosciences, Princeton University, Princeton, New Jersey 08544, U.S.A.
[2]Department of Earth and Planetary Sciences, Northwestern University, Evanston, Illinois 60208, U.S.A.
[3]Bayerisches Geoinstitut, Universität Bayreuth, D-95440 Bayreuth, Germany
[4]Department of Terrestrial Magnetism, Carnegie Institution of Washington, 5241 Broad Branch Road NW, Washington, D.C. 20015, U.S.A.

Abstract

The single-crystal elastic properties of Fe-bearing wadsleyite with 1.93 wt% H_2O ($Mg_{1.634}Fe_{0.202}H_{0.305}SiO_4$) have been determined by Brillouin scattering. At ambient conditions, the aggregate bulk and shear moduli (K_{S0}, G_0) of this wadsleyite are 156.2(5) and 98.0(3) GPa, respectively. Compared to the corresponding anhydrous wadsleyite, 1.93 wt% H_2O lowers K_{S0} and G_0 by 8.1% and 9.3%, respectively. High-pressure measurements up to 12 GPa show that the pressure derivative of the bulk modulus, K'_{S0} = 4.8(1), is similar to that of the anhydrous Fe-wadsleyite with reported values of 4.6–4.74, but the addition of H_2O increases the pressure derivative of the shear modulus, G'_0 from 1.5(1) to 1.9(1). This contrasts with the G'_0 of Fe-free wadsleyite, which is the same within uncertainty for the hydrous and anhydrous phases. As a result, both the compressional- and shear-wave velocities (v_P, v_S) of hydrous Fe-bearing wadsleyite are about 200(±24) m/s slower than anhydrous Fe-bearing wadsleyite at transition zone pressures.

Keywords: Fe-bearing hydrous wadsleyite, elasticity, Brillouin scattering, transition zone, high pressure