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Density of carbonated peridotite magma at high pressure using an X-ray absorption method

Tatsuya Sakamaki,[1,*] Eiji Ohtani,[1] Satoru Urakawa,[2] Hidenori Terasaki,[1] and Yoshinori Katayama[3]

[1]Department of Earth and Planetary Materials Science, Tohoku University, Sendai 980-8578, Japan
[2]Department of Earth Sciences, Okayama University, Okayama 700-8530, Japan
[3]Japan Atomic Energy Agency, Hyogo 679-5143, Japan

Abstract

The density of carbonated peridotite magma was measured up to 3.8 GPa and 2100 K using an X-ray absorption method. A fit of the pressure-density-temperature data to the high-temperature Birch-Murnaghan equation of state yielded the isothermal bulk modulus, K_{T0} = 22.9 ± 1.4 GPa, its pressure derivative, K_0' = 7.4 ± 1.4, and the temperature derivative of the bulk modulus $(\partial K_T/\partial T)_P$ = –0.006 ± 0.002 GPa/K at 1800 K. The bulk modulus of carbonated peridotite magma is larger than that of hydrous peridotite magma. The partial molar volume of CO_2 in magma under high pressure and temperature conditions was calculated and fit using the Vinet equation of state. The isothermal bulk modulus was K_{T0} = 8.1 ± 1.7GPa, and its pressure derivative was K_0' = 7.2 ± 2.0 at 2000 K. Our results show that the partial molar volume of CO_2 is less compressible than that of H_2O, suggesting that, on an equal molar basis, CO_2 is more effective than H_2O in reducing peridotite melt density at high pressure.

Keywords: X-ray absorption method, carbonated peridotite magma, density, high pressure, equation of state, partial molar volume of CO_2