American Mineralogist, Volume 91, pages 802–808, 2006

Compressibility of synthetic potassium-rich clinopyroxene: In-situ high-pressure single-crystal X-ray study

Luca Bindi,[1,*] Robert T. Downs,[2] George E. Harlow,[3] Oleg G. Safonov,[4] Yuriy A. Litvin,[4] Leonid L. Perchuk,[5] Hinako Uchida,[2] and Silvio Menchetti[1]

[1]Dipartimento di Scienze della Terra, Università di Firenze, Via La Pira 4, I-50121, Firenze, Italy
[2]Department of Geosciences, University of Arizona, Tucson, Arizona 85721-0077, U.S.A.
[3]Department of Earth and Planetary Sciences, American Museum of Natural History, New York, New York 10024-5192, U.S.A.
[4]Institute of Experimental Mineralogy, Moscow district, 142432, Chernogolovka, Russia
[5]Department of Geology, Moscow State University, Vorobievy Gory, 119899, Moscow, Russia

Abstract

The crystal structure of a synthetic potassium-rich clinopyroxene, $(Ca_{0.88}K_{0.12})(Mg_{0.83}Al_{0.17})(Si_{1.98}Al_{0.02})O_6$, was studied using high-pressure single-crystal X-ray diffraction methods. A four-pin diamond anvil cell with 4:1 methanol:ethanol pressure medium was used to achieve pressures to 9.72 GPa. Unit-cell data were measured at 17 pressures, and intensity data were collected at 6 pressures. Fitting the *P-V* data to the third-order Birch-Murnaghan equation of state yields $V_0 = 435.49(3)$ Å^3, $K_0 = 129(1)$ GPa, $K' = 2.7(3)$. Anisotropic compression was observed with unit strain axial ratios of 1:1.94:1.90. Unit-cell parameters decrease gradually as a function of pressure with axial compressibilities $\beta_b > \beta_c \sim \beta_a$. They match those found for kosmochlor but are stiffer than those observed for synthetic diopside and hedenbergite. Compressibilities of the bond distances within the M2, M1, and T polyhedra show significant anisotropy. The incorporation of K into the clinopyroxene structure has little effect on its compressibility, although the concomitant substitution of Al in M1 from the K-Jd component reduces its compressibility. The K atom is softer than the M2 polyhedron and thus shrinks enough at high pressure to fit into the pyroxene structure.

Keywords: High-pressure studies, clinopyroxene, crystal structure, XRD data, chemical mineral analysis