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LETTER

The structure of a super-aluminous version of the dense hydrous-magnesium silicate phase D

TIZIANA BOFFA BALLARAN,* DANIEL J. FROST, NOBUYOSHI MIYAJIMA, AND FLORIAN HEIDELBACH

Bayerisches Geoinstitut, Universität Bayreuth, D-95440 Bayreuth, Germany

ABSTRACT

The dense hydrous-magnesium silicate phase D, which has the ideal formula $MgSi_2H_2O_6$, may be an important link in a chain of hydrous phases that carry H_2O in the ultramafic portions of subducting lithosphere, into the Earth's lower mantle. We have synthesized a new Al-rich form of phase D, containing up to 50 wt% Al_2O_3, using a multi-anvil device at ~1300 °C and 25 GPa. The phase, with the formula $Mg_{0.2}Fe_{0.15}Al_{1.8}H_{1.8}SiO_6$, was initially produced in a bulk composition designed to synthesize Al- and Fe-rich magnesium silicate perovskite with a composition similar to that produced in experiments on mid-ocean ridge basalt bulk compositions at lower mantle conditions. Further experiments using a starting mixture based on the composition of this Al-rich phase resulted in the synthesis of 60–70 μm long single crystals at similar conditions. The recovered crystals were slightly richer in H_2O ($Mg_{0.2}Fe_{0.12}Al_{1.5}Si_{0.92}H_{3.1}O_6$) and their unit-cell parameters were similar to those of $MgSi_2H_2O_6$ phase D. A refinement of the crystal structure was carried out in the $P\bar{3}1m$ space group and revealed a more disordered cation distribution than magnesium silicate phase D. All cation-oxygen distances are similar, suggesting a high degree of Si/Al disorder. Although the stability field of this new variant of phase D is yet to be determined, this phase may be an important host for H_2O within portions of subducted oceanic crust in the lower mantle.

Keywords: Lower mantle, high pressure, subduction, single crystal, DHMS, deep water cycle