Crystal chemistry of calcium-ferrite type aluminous phase

Fei Qin[1,6], Ye Wu[2], Xiang Wu[3], Dongzhou Zhang[4], Oliver Lord[1], Shan Qin[5], Steven D. Jacobsen[6]

[1]School of Earth Sciences, University of Bristol, Bristol, United Kingdom
[2]School of Science, Wuhan University of Technology, Wuhan, China
[3]State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Wuhan, China
[4]School of Ocean and Earth Science and Technology, Hawai'i Institute of Geophysics and Planetology, University of Hawaii at Manoa, Honolulu, Hawaii, USA
[5]Key Laboratory of Orogenic Belts and Crustal Evolution, MOE, Peking University and School of Earth and Space Sciences, Peking University, Beijing, China
[6]Department of Earth and Planetary Sciences, Northwestern University, Evanston, Illinois, USA

The behavior of high-pressure phases in mid-oceanic ridge basalt (MORB) has been extensively studied since the subduction of MORB may give rise to the chemical heterogeneity observed in the deep mantle. Experimental studies have shown that aluminum-rich phases coexist with bridgmanite, Ca-perovskite and a silica polymorph in rocks with MORB composition at lower mantle conditions. Up to 50 GPa, the new hexagonal aluminous (NAL) phase and orthorhombic calcium-ferrite (CF) type phases coexist. At higher pressures, only the CF phase is stable, constituting ~ 15 vol % of MORB throughout the remainder of the Earth's lower mantle. It has been proposed that the NAL and CF phases contain approximately 12 mol % Fe, which has been shown to undergo a high-spin to low-spin transition between 25 and 40 GPa on the basis of powder X-ray diffraction data. Here, we present the results of single-crystal synchrotron-based X-ray diffraction measurements on Fe-free and Fe-bearing samples of the CF phase in the diamond-anvil cell up to 42 GPa at room temperature. We will describe the effect of Fe on the structural evolution of the CF phase, including the effects of the spin transition. We will present an updated model of the density of MORB composition rocks in the lower mantle on the basis of our experimentally determined equation of state. These models have implications for our understanding of the seismic signatures of chemical heterogeneity caused by the presence of subducted slabs in the lower mantle.