The Fate of Subducted Basaltic Crust in the Earth's Lower Mantle: an Experimental Petrological Study

A. RICOLLEAU[1], G. FIQUET[1], JP. PERRILLAT[2], I. DANIEL[2], A. ADDAD[3], N. MENGUY[1], H. CARDON[2], C. VANNI[4], N. GUIGNOT[5]

[1] Laboratoire de Minéralogie-Cristallographie, Paris, France
[2] Laboratoire de Sciences de la Terre, ENS-Lyon, 46 allée d'Italie, Lyon, 69364 France
[3] Centre Commun de Microscopie, Université des Sciences et Technologies de Lille 1, Villeneuve d'Ascq, France
[4] Centre pluridisciplinaire de microscopie électronique et de microanalyses, Faculté St Jérôme, Marseille, France
[5] ESRF, BP 220, Grenoble, France

The fate of the subducted oceanic lithosphere in the Earth's lower mantle is an important issue to understand the dynamics of the Earth's interior. Several geodynamical models have attempted to reconcile observed geochemical data with a whole mantle convection. In order to be in an agreement with geochemical constraints, these models require that subducted lithospheric slabs are denser than the surrounding mantle so that they can reach the base of the mantle.

In this study, we describe some experimental observations to model the behaviour of an oceanic crust under Earth's lower mantle pressure and temperature conditions. A natural MORB glass has been loaded in a Diamond Anvil cell and studied with in situ X-ray diffraction at pressures from 28 GPa to 85 GPa and temperatures ranging from 1800K to 2600K. Samples were recovered and studied by ATEM (Analytical Transmission Electronic Microscopy) to obtain the chemical composition of the recovered phases. The chemical compositions of individual phases were subsequently taken into account in the Rietveld refinements made to the X-ray diffraction patterns, from which phase relative abundances, molar volumes, hence densities could be extracted from high-pressure high-temperature X-ray diffraction patterns.

Five phases were observed from 28 GPa to 45 GPa, namely stishovite, the calcium perovskite, the aluminium bearing magnesium perovskite and two Al-rich phases, the CF type phase and the NAL phase. After 45 GPa, The NAL phase disappears and the assemblage remains in the same proportions from 50 GPa to 85 GPa. When compared to the average mantle density profile of PREM, our measurements indicate that the oceanic crust may become buoyant at a depth of about 2000 km for slabs equilibrated along a high temperature geotherm.