ESRF	**Experiment title:** The fate of subducted slabs: an x-ray diffraction study at high pressures and temperatures	**Experiment number**: HS1881
Beamline: ID30	**Date of experiment**: from: 30/01/2003 to: 04/02/2003	**Date of report**: 23/04/2003
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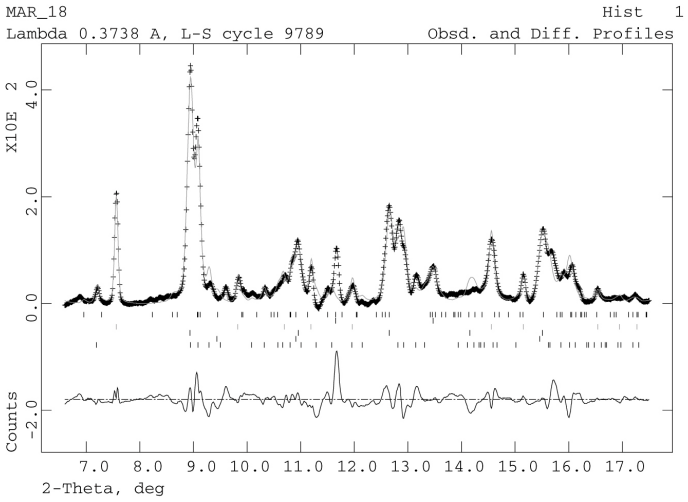
Report:

The fate of subducted slabs is controversial and the issue wether subducting slabs penetrate the 660 km discontinuity is crucial to the nature of the mantle convection. In that respect, the phase relationships of mid-oceanic ridge basalt (MORB) at high pressures and temperatures is of high interest since MORB is one component of the oceanic crust likely to be involved in the deep mantle circulation. The density profile of such material as a function of depth should obviously play an important role in the dynamics of subducted slabs in the lower mantle, a whole mantle convection regime indeed requiring that the oceanic lithosphere is denser than the surrounding mantle.

Several attempts have been previously reported in the literature to address that question but none of them could take into consideration possible variation of mineral compositions with depth nor measure the density evolution *in situ* at high pressure and high temperature of each single component of the complex mineralogical assemblage synthesized at these conditions.

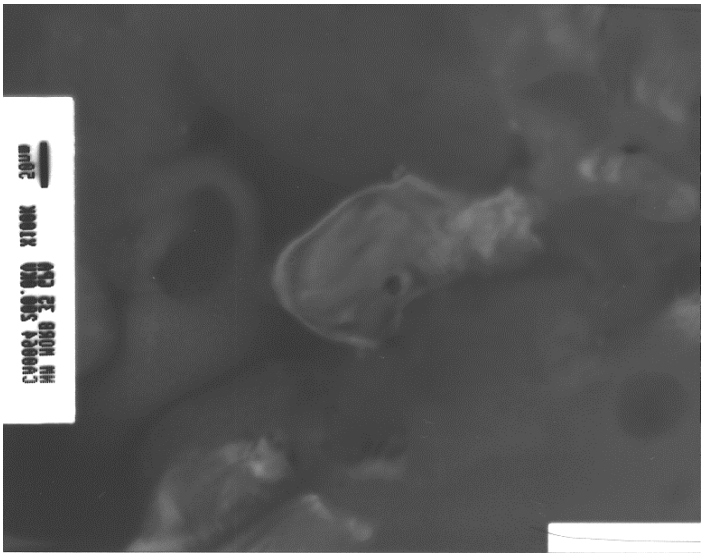
We report here preliminary experiments aiming at measuring the density of a MORB sample as a function of pressure along a temperature profile as close as possible from a deep Earth geotherm. The starting material is a natural glassy MORB sample from the East Pacific Rise, for which chemical as well as trace elements compositions are fully characterized. This sample was polished down to 20 μm thin sections from which discs 50 μm in diameter were cut and subsequently loaded in diamond-anvil cells using neon as pressure transmitting medium. These samples were then transformed and studied at high pressure and high temperature on high-pressure beamline ID30 at ESRF, using the *in situ* YAG laser heating system developed for this purpose. X-ray diffraction pattern were collected in different pressure conditions, namely 28, 36 and 40 GPa, and temperatures ranging from 1800 to almost 3000 K. An example of x-ray diffraction pattern collected at 300 K and 40 GPa is presented below. Powder Rietveld refinements yielded the following relative abundances for the five different phases clearly detected from such diffraction pattern:

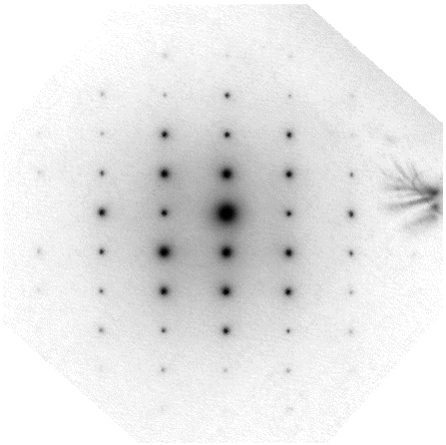
- a high-pressure phase of SiO_2 (stishovite)	9.1 (in wt%)
- a calcium silicate with perovskite structure	29.5
- an iron magnesium and aluminium silicate with perovskite structure	34.5
- an iron and magnesium oxide (magnesiowüstite)	1.5
- an aluminium bearing phase with calcium ferrite structure	16.1
- neon (pressure transmitting medium)	10.0



These results are in good agreement with results previously reported in literature by several groups using multi-anvil apparatus apparatus (Irifune and Ringwood, 1993; Hirose et al., 1999; Ono et al., 2001). In particular, the aluminous phase amounts to about 15-25 wt% in experiments carried out at lower mantle pressure and temperature conditions in samples having the MORB composition (Kesson et al., 1994; Ono et al., 2001).

It is also important to know the actual chemical composition of each individual phases for which x-ray diffraction pattern have been collected. Chemical compositions are likely to be quite different from those of simple systems studied so far and these compositions are required to evaluate the compositional effect on the physical properties as well as to calculate proper density for the mineralogical assemblages. Samples were thus recovered and prepared for SEM and TEM observations. With the FIB technique (focused ion beam), it is possible to cut in a well controlled manner a thin slice (20 µm x 5 µm, 100 nm in thickness) suited to TEM observations. A TEM image and one electron diffraction pattern collected for a sample transformed at 40 GPa are presented below. Chemical analyses as well as TEM observations are currently underway and should bring the complementary information needed to calculate density at each P,T conditions.





(K,Na,Mg,Fe)$AlSiO_4$ with the $CaFe_2O_4$ structure, zone axis [010], space group *Pnma*, a=10.154Å, b=8.664 Å, c=2.7385 Å

In this report, we show that it is possible to:

(1) identify the different phases present in natural MORB sample transformed along a lower mantle geotherm, measure molar volumes and phase fractions.

(2) recover these samples and analyse them by analytical transmission electron microscope.

(3) with such analysis in hand, we should be able to calculate the average density of the high pressure high-temperature mineralogical assemblage and the density differentials between a “normal” mantle and one subducting oceanic crust.

References

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