Report on experiment HS-2926 performed at the ID27 beamline

The aim of this study was to determine the melting relations for deep Earth mantle material in the pressure and temperature range representative of the lower mantle. For pressures between 25 and up to more than 100 GPa, the material consisted of a mixture of (Mg,Fe)SiO_3 perovskite (Mg-Pv), MgO periclase and $CaSiO_3$ perovskite. We investigated melting up to more than 4000K using the laser-heated diamond anvil cell coupled with angle dispersive X-ray diffraction at the ID27 beamline of the ESRF. Melting was evidenced from: (a) disappearance of sets of diffraction rings representative of the different minerals on the 2D diffraction images; (b) Clear changes in diffraction intensities for the integrated patterns; (c) appearance of a broad band of diffuse X-ray scattering associated with the presence of a liquid silicate phase.

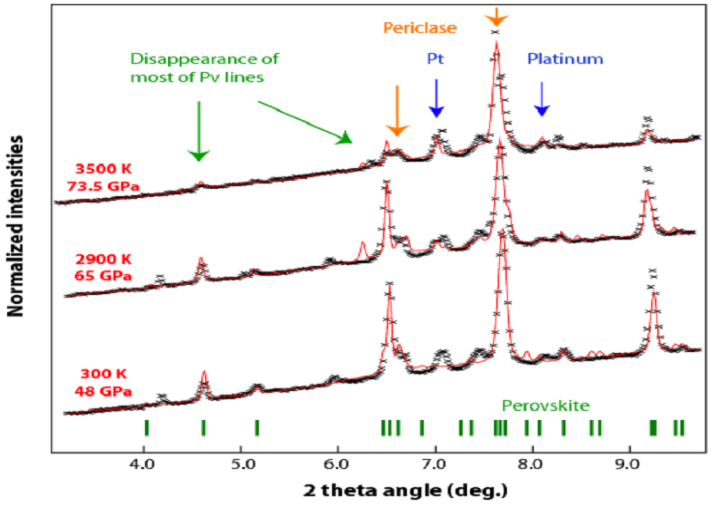

Figure 1: Diffraction patterns recorded with increasing temperature at a nominal pressure of ~48 GPa. Melting of the Mg_Pv phase is observed below 3500K

We then recorded X-ray fluorescence spectra at various positions in the melted zone of the sample, using an energy dispersive solid-state Si(Li) detector (Vortex) set at ~30° to the incident beam in the horizontal plane.

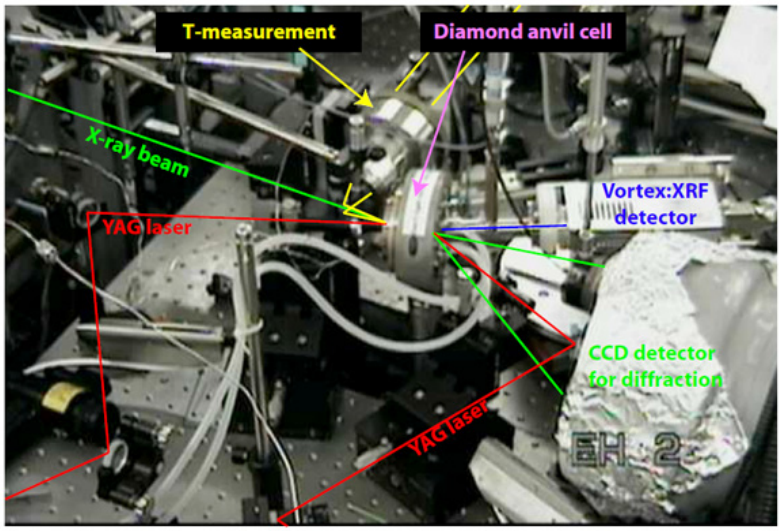

Figure 2: Experimental set up for tandem XRF (blue) and XRD (green) measurements in the laser-heated diamond anvil cell at the ID27 beamline.

Using an incident beam energy of ~33 keV, with a spatial resolution of about 3x3µm, we could detect the K-fluorescences of Fe and Ni transition elements as well as those of the Rb, Y, and Zr elements that were used to dope the starting material prior to the experiment. Typical acquisition time was about 500 sec. Quantitative element contents were derived using the PyMCA program.

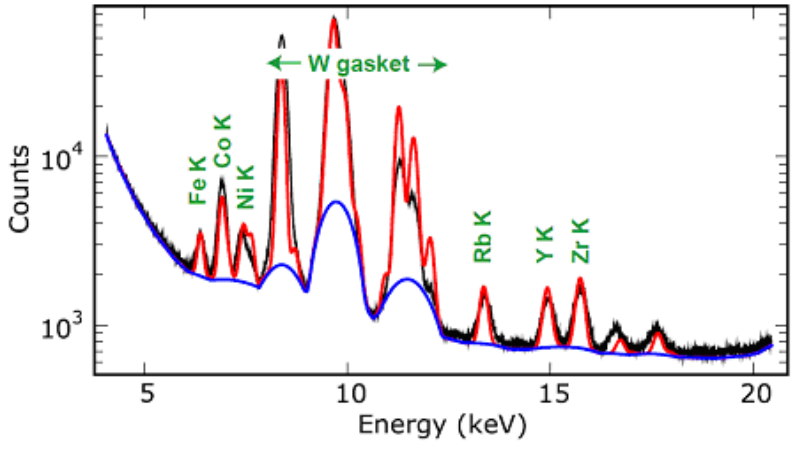

Figure 3: Fluorescence spectra measured in the DAC. We calculate weight-contents of Fe, Ni, Rb, Y and K to be 12 %, 1 %, 120 ppm, 80 ppm and 100 ppm, respectively.