

Experiment Report

Rheology of enstatite aggregates at upper mantle pressures and temperatures

The aim of this project was to investigate the rheology of enstatite at upper mantle conditions. We have performed 4 test experiments at high pressures and temperatures in the Deformation-DIA at the ID06LVP beam line. These are very new types of experiments at ID06LVP, and they have necessitated a lot of effort in adapting the existing set-up and testing sample assemblies. We have managed to reach pressures of up to 9 GPa and temperatures up to 800°C, but all of our runs were accompanied by important technical difficulties (difficulty to keep temperature constant, sample columns getting off-center in the assemblies during the run, recurrent blow outs). At this stage, deforming mineral aggregates at both high pressures and temperatures to significant finite strains remains very challenging and a high risk endeavour in this apparatus. The beam scientists at ID06LVP should clearly be given more development time to work on technical improvements in order to increase the percentage of successful deformation runs in the future.

In addition, we have performed two successful deformation experiments at high pressures (up to 6 GPa) and room temperature. We are now in the process of analyzing a large data set that will allow us to determine the yield strength and the strain hardening of monomineralic olivine and enstatite aggregates as a function of pressure (Fig. 1). These result will provide important constraints on the low-temperature plasticity of these minerals and may have important implications on the high-stress deformation of the upper mantle at lithospheric conditions.

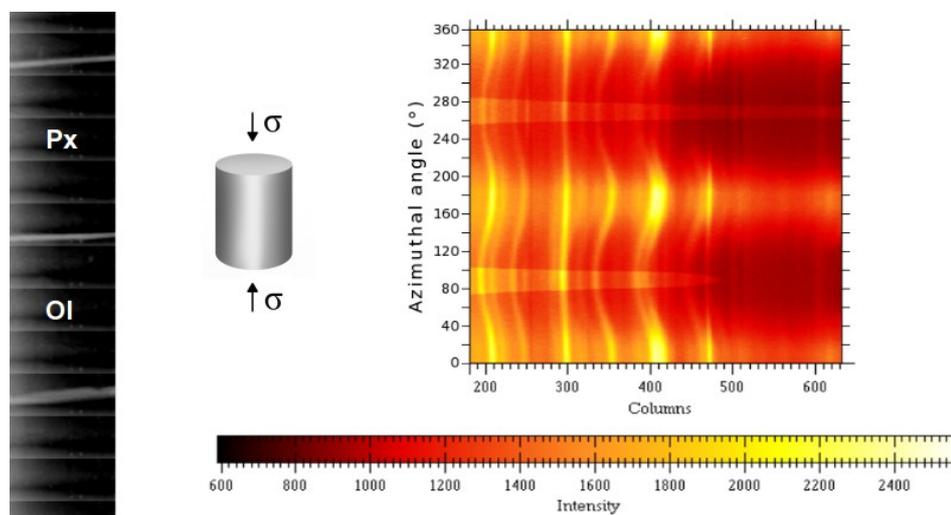


Figure 1 – Deformation data on olivine and pyroxene aggregates obtained at a pressure of ~5.5 GPa and room temperature. (Left) X-ray image of the deformation assembly showing the pyroxene (Px) and the olivine (Ol) samples. (Right) Diffraction data obtained on olivine at these conditions.