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# Rheology of olivine at mantle pressures and temperatures

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Our understanding of olivine rheology in the upper mantle was until recently mostly inferred from extrapolation of low to moderate pressure (<3 GPa) data to mantle high-pressure conditions. Such an extrapolation implies that the low–pressure deformation mechanisms and corresponding rheological laws extrapolate to mantle high-pressure condition. These assumptions are questionable in the case of olivine since, according to a number of studies, grain-boundary sliding is an active mechanism in olivine at low and/or moderate pressure, while reports from recent deformation experiments carried out at 8 GPa suggest that dislocation creep assisted by dynamic recrystallization controls olivine deformation at mantle pressures and temperatures [1]. It is thus critical to investigate olivine deformation microstructures and rheology at mantle condition in order to better interpret seismological data evidencing lattice preferred orientation (LPO) in the mantle, and constrain mantle dynamics. Owing to recent efforts in developing experimental techniques, investigation of materials rheology at high pressure is today possible.

We will report results from rheological experiments carried out at high pressure and temperature on olivine, on both single crystals and polycrystals with typically 5-µm average grain size. The single crystals were oriented in order to allow activation of either the [100](010) or the [001](010) dislocation slip system alone, to compare the relative activity of these systems, and to allow the TEM investigation of high-pressure dislocation microstructures in a well constrained stress field. These experiments were carried out at the NSLS (BNL, Upton, NY) beamline X17B2, in a Differential-DIA (D-DIA) apparatus [2] coupled with X-ray synchrotron radiation. The D-DIA apparatus allows controll specimen strain rate during the high pressure runs, while the applied stresses and specimen strain rates are monitored in situ (during the run) by time resolved -ray diffraction and radiography, respectively.

### References

[1] L. Li et al. (2003) *Phys. Earth Planet. Int.* **138**, 113-129.
[2] Wang et al. (2003) *Rev. of Scientific Instruments.*, **74** (6), 3002-3011.

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# In-situ study of the iron species in silicate melts

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The oxidation state of iron has a significant effect on physical properties of melts in magmatic systems, which is probably caused by the different structural role of $Fe^{2+}$ and $Fe^{3+}$ in the melt. In addition, the redox regime affects the stability of Fe-bearing phases and therefore influences the compositional evolution of magmas. Insight to the structural units of the melt is an important key to modeling properties of silicate melt or magmas. The structure found in glass is often used for such models. However, the speciation of an element in the glass may well differ from that found in the melt at higher temperatures as the glass represents the melt structure at the glass transformation temperature [1]. XANES and Mössbauer spectra taken on Fe in water-bearing glasses also show strong evidence that the quench process significantly affects the Fe species in the glass [2]. Here, we present results of an in-situ XAFS study of iron in silicate melts at reducing and oxidizing conditions. This study was conducted to reveal differences in the Fe speciation between glass and melt, and to provide better constrains on the speciation of Fe in melts.

In situ XAFS spectra of dry $Na_2Si_3O_7$, haplogranitic, and basaltic melts show that differences in the Fe species can exist between glass and melt, which agrees with previous studies, e.g. [3]. An increase in tetrahedrally co-ordinated Fe in molten $Na_2Si_3O_7$ and basalt is suggested by an increase of the pre-edge intensity in the XANES at high temperatures. Changes in the spectra are much more pronounced at oxidizing conditions, which indicates stronger changes in the structural environment of $Fe^{3+}$. At reducing conditions, the polymerized haplogranitic melt behaves similar to the other compositions. At oxidizing conditions, however, we observed a small decrease in the pre-edge intensity at high temperature, which is opposite to the trend displayed by the more depolymerized compositions. The EXAFS region of the spectra shows changes that support the interpretation of the XANES.

### References

[1] Farges et al. (1996) *Geochim. Cosmochim. Acta* **60,** 3055-3065
[2] Wilke et al. (2002) *Chem. Geol.*, **189,** 55-67.
[3] Jackson et al. (1993) *Science*, **262,** 229-233.