The 15th Global-COE International Frontier Seminar

January 14th, 2010, from 17:00, at the room#486 meeting room 4F

Let's creep! – Part II

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I would like to continue with the theme I discussed in Nov 2008, during my last visit to GRC, and report progress on investigations on high pressure rheological properties of mantle minerals conducted at GSECARS, using both the D-DIA and the high-pressure x-ray tomography microscope (HPXTM). I will use four examples to demonstrate the importance of continuing developments addressing four critical aspects of rheological studies. (1) In the study of polycrystalline "rocks" of olivine, I will show the importance of using monochromatic diffraction and elasto-plastic self-consistent (EPSC) modeling to examine changes in deformation mechanisms at various experimental conditions. One of the major issues in diffraction-based rheology studies is how to link stresses derived from lattice planes to the macroscopic stress in the bulk sample. EPSC modeling, based on the assumption that crystals deform by dislocation glide only and with small total strain, provides great insights into deformation mechanisms, but cannot provide a satisfactory solution to the stress issue. (2) Quasi-Laue diffraction on deformed single-crystals is being developed to determine uniquely the full stress tensor. This is a new development and I will show our preliminary results on garnets. Single crystal creep studies at ambient pressure have been a critical part of rheolgoical studies, the quasi-Laue technique has the potential to provide single-crystal deformation information at high pressures. (3) Since the mantle is made of multiple phases, it is important to understand rheological behavior of individual phases in a deforming composite. I will show some preliminary results on an analog lower mantle composite, which is produced by experimentally breaking down $CaMgGeO_4$ (in olivine structure) into $CaGeO_3$ perovskite and MgO. By comparing the behaviors of the two phases in the composite with those in single-phase samples (pure $CaGeO_3$ perovskite and pure MgO), some physical insights can be gained as to how the composite should behave under modest axial strains (up to about 20 – 30% in the D-DIA). (4) Large-strain deformation in composite is the norm in considering mantle rheology, but quantitative studies in this area have been virtually non-existent. I will show some results on analog materials obtained in the HPXTM, which provides an unique opportunity to directly view textural evolution during large-strain deformation. From these observations, some important conclusions, although qualitative, can be drawn regardinh composite rheological behavior and anisotropy due to the development of shape preferred orientation. Finally, I will discuss the development of a large D-DIA, namely DDIA-30. A similar instrument (MADONNA) is already operating at GRC. Many of the exciting developments for MADONNA can be directly applied to DDIA-30, which is operated at an insertion-device beamline. With this new instrumentation and collaboration with GRC colleagues, more significant progresses are expected in the near future.

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Room486, meeting room 4F
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