Geophysical Research Abstracts
Vol. 16, EGU2014-6165, 2014
EGU General Assembly 2014

Virtual Patterson Experiment - A Way to Access the Rheology of Aggregates and Melanges

Thomas Delannoy (1,2), Evgueni Burov (1,2), Sylvie Wolf (1,2)

(1) Sorbonne Universités, UPMC Univ Paris 06, UMR 7193, Institut des Sciences de la Terre de Paris (ISTeP), F-75005 Paris, France, (2) CNRS, UMR 7193, Institut des Sciences de la Terre Paris (iSTeP), F-75005 Paris, France

Understanding the mechanisms of lithospheric deformation requires bridging the gap between human-scale laboratory experiments and the huge geological objects they represent. Those experiments are limited in spatial and time scale as well as in choice of materials (e.g., mono-phase minerals, exaggerated temperatures and strain rates), which means that the resulting constitutive laws may not fully represent real rocks at geological spatial and temporal scales.
We use the thermo-mechanical numerical modelling approach as a tool to link both experiments and nature and hence better understand the rheology of the lithosphere, by enabling us to study the behavior of polymineralic aggregates and their impact on the localization of the deformation. We have adapted the large strain visco-elasto-plastic Flamar code to allow it to operate at all spatial and temporal scales, from sub-grain to geodynamic scale, and from seismic time scales to millions of years.
Our first goal was to reproduce real rock mechanics experiments on deformation of mono and polymineralic aggregates in Patterson's load machine in order to deepen our understanding of the rheology of polymineralic rocks. In particular, we studied in detail the deformation of a 15x15 mm mica-quartz sample at 750 °C and 300 MPa. This mixture includes a molten phase and a solid phase in which shear bands develop as a result of interactions between ductile and brittle deformation and stress concentration at the boundaries between weak and strong phases. We used digitized x-ray scans of real samples as initial configuration for the numerical models so the model-predicted deformation and stress-strain behavior can match those observed in the laboratory experiment. Analyzing the numerical experiments providing the best match with the press experiments and making other complementary models by changing different parameters in the initial state (strength contrast between the phases, proportions, microstructure, etc.) provides a number of new elements of understanding of the mechanisms governing the localization of the deformation across the aggregates. We next used stress-strain curves derived from the numerical experiments to study in detail the evolution of the rheological behavior of each mineral phase as well as that of the mixtures in order to formulate constitutive relations for mélanges and polymineralic aggregates.
The next step of our approach would be to link the constitutive laws obtained at small scale (laws that govern the rheology of a polymineralic aggregate, the effect of the presence of a molten phase, etc.) to the large-scale behavior of the Earth by implementing them in lithosphere-scale models.