Geophysical Research Abstracts
Vol. 21, EGU2019-5308, 2019
EGU General Assembly 2019

In situ TEM nanomechanical testing of antigorite plasticity and faulting

Hosni Idrissi (1,2), Thomas van der Werf (1,2), Vahid Samaee (2), Gunnar Lumbeeck (2), Thomas Pardoen (1), Dominique Schryvers (2), and Patrick Cordier (3)

(1) Université Catholique de Louvain, Institute of Mechanics, Materials and Civil Engineering (iMMC), Belgium (hosni.idrissi@uclouvain.be), (2) Electron Microscopy for Materials Science, University of Antwerp, Antwerp, Belgium, (3) Unité Matériaux et Transformations, UMR 8207 CNRS/Université Lille, Lille France

It is now recognized that large earthquakes are preceded and followed by a wide range of events, $e.g.$ bursts of low-frequency earthquakes (LFEs), tremors, which can release as much strain as megathrust earthquakes. These events are related to creeping parts of the fault interface for which some recent models have inferred the possibility of viscosities of the order of some 10^{17} Pa.s. However, the detailed mechanisms associated with these events are poorly known. In this study we adopt the mineral physics point of view and address the issue of the mechanical properties of antigorite which, among serpentines, is an important component of fault rheology. Given its particular crystal structure and its complex microstructure, the rheology of antigorite is still poorly understood. Standard ductile processes involving dislocation glide have been reported, but other mechanisms like kinking, delamination, which can lead to a semi-brittle behaviour are likely to contribute as well. Consequently, the type of rheological law that is adapted to this mineral is still a matter of debate.

Recently, the development of a new generation of advanced instruments for quantitative *in situ* TEM nanomechanical testing has open a new field of investigation of mechanical properties in the transmission electron microscope (TEM). The major advantage of this technique is to provide a direct, visual access, to the deformation mechanisms as they operate while recording the mechanical response *in-situ* inside the microscope. In the present work, small beams ($4\times1\times0.1$ μm^3) of antigorite are prepared by Focused Ion Beam and deformed in tension in the TEM. Cyclic deformation is applied in the load control mode using the PI-95 TEM picoindenter holder and the Push-to-Pull (PTP) device (Bruker.Inc). Automated crystal orientation mapping in TEM (ACOM-TEM) was used prior to the *in-situ* tensile TEM tests in order to obtain statistical information regarding the local orientation of the grains and the nature of the interfaces.

Despite applied stresses close to 1 GPa, no dislocation activity could be observed. In contrast, significant plasticity, largely recoverable, resulted from the development of damage at interfaces. We propose that due to the crystal structure of antigorite, the interfaces represent a key factor in controlling its mechanical properties.