Geophysical Research Abstracts,
Vol. 10, EGU2008-A-07481, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-07481
EGU General Assembly 2008

Geological evidence for velocity-weakening behaviour within phyllosilicate-rich fault cores?

J. Imber, R.E. Holdsworth and S.A.F. Smith

Reactivation Research Group, Department of Earth Sciences, Durham University, Durham, DH1 3LE, UK (jonathan.imber@durham.ac.uk / Fax: +44 191 334 2301)

Studies of ancient faults exhumed from depths of $>$ 3 km suggest that many large-displacement crustal-scale faults contain foliated phyllosilicate-rich fault rocks (e.g. phyllonites and foliated cataclasites) within their cores. The metamorphic conditions required to produce foliated phyllosilicate-rich fault rocks at seismogenic depths are likely to be met in many (perhaps most) large-displacement faults that cut continental basement rocks. This prediction is consistent with the recovery of foliated rocks from the core of the Parkfield segment of the San Andreas Fault in the SAFOD borehole. A key question is to what extent do large-displacement faults with foliated phyllosilicate-rich cores deform by seismic slip or aseismic creep?

High-strain experiments using analogue materials indicate that such faults should be weak, deforming by frictional-viscous flow at low strain rates. At higher strain rates, a switch to pervasive granular flow – which is characterised by velocity-weakening behaviour – is predicted. Previous field studies of large-displacement faults have reported interlaced, mutually overprinting pseudotachylyte veins and phyllosilicate-rich fault rocks within the cores of large-displacement faults (e.g. Wasatch Fault, Utah; Siberia Fault, New Zealand), an observation that is consistent with periods of aseismic creep punctuated by seismic slip. Nevertheless, pseudotachylyte is relatively uncommon in nature – and may be particularly uncommon in direct association with phyllosilicate rich fault rocks..

In this talk, we present field observations from a segment of the Outer Hebrides Fault Zone (OHFZ) exposed on the island of North Uist, NW Scotland. The OHFZ is an ancient, long-lived, large-displacement fault exhumed from > 3 km depth. On North Uist, it contains multiple phyllosilicate-rich cores (shear zones) that were reactivated during late Caledonian (c. 400 Ma) extensional deformation. The shear zones display a well-developed phyllonitic foliation, which is locally cut by foliation-parallel extensional detachments that contain veins of quartz, albite, calcite and chlorite. The veins attest to the cyclic build-up and release of pore-fluid pressure within the low permeability fault cores, a process that has previously been invoked to explain microseismicity along low-angle normal faults. In addition, the phyllonitic rocks contain numerous bands of coarse, angular to sub-rounded quartz-albite-calcite-chlorite "porphyroclasts", some of which appear to truncate the foliation. These bands are most likely to have been derived from cataclastically-deformed detachment-related veins, which were subsequently reworked by ongoing macroscopically ductile shear. We speculate that transient strain localisation along extensional detachments, together with the increase in modal abundance of quartz, calcite and feldspar may have given rise to granular flow, hence velocity weakening behaviour within the phyllonitic fault cores.