Geophysical Research Abstracts
Vol. 15, EGU2013-12387, 2013
EGU General Assembly 2013


# 3D microstructural and microchemical characteristics of SAFOD fault gouge: implications for understanding fault creep

Laurence Warr (1), Jasmaria Wojatschke (1), Brett Carpenter (2), Chris Marone (3), Anja Schleicher (4), and Ben van der Pluijm (4)

(1) Institut für Geographie und Geologie, Ernst-Moritz-Arndt Universität Greifswald, 17487 Greifswald, Germany (warr@uni-greifswald.de), (2) INGV, Rome 1 Section, Via di Vigna Murata 605, Rome, 00143, Italy, (3) Department of Geosciences and Center for Geomechanics, Geofluids, and Geohazards, The Pennsylvania State University, PA 16802, USA., (4) Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, MI 48109, USA

Fault creep on the SAFOD section of the San Andreas Fault occurs along mechanically weak fault gouge characterized by high proportions of hydrous clay minerals, namely smectite, illite-smectite and chlorite-smectite phases. These minerals are concentrated along closely spaced, interconnected polished slip surfaces that give the gouge its characteristic scaly fabric. Although it is generally accepted that the creep behavior of the gouge relates to the concentration of these minerals, the precise mechanisms by which clay minerals weaken rock is currently a topic of debate. In this contribution we present the first results from a “slice-and-view” study of SAFOD gouge material by focused ion beam – scanning electron microscopy (Zeiss Auriga FIB/SEM), which allows the reconstruction of the microstructure and microchemistry of mineralized slip surfaces in 3D. The core and cuttings samples studied were selected from ca. 3297 m measured depth and represent some of the weakest materials yet recovered from the borehole, with a frictional coefficient of ca. 0.10 and a healing rate close to zero. This gouge contains abundant serpentine and smectite minerals, the latter of which was identified by X-ray diffraction to be saponite, after Mg- and glycol intercalation. Imaging and chemical analyses reveal nanometer scale thin alteration seams of saponite clay distributed throughout the ca. 50 micron thick sheared serpentinite layer that coats the slip surfaces. The base of this layer is defined by cataclastically deformed iron oxide minerals. The 3D fabric implies the orientation of the hydrated smectite minerals, which are interconnected and lie commonly sub parallel to the slip surface, are responsible for the gouge creep behavior in the laboratory. These minerals, and related interlayered varieties, are particularly weak due to their thin particle size and large quantities of adsorbed water, properties that are expected to persist down to mid-crustal depth (ca. 10 km). Creep of the San Andres Fault at Parkfield can therefore be adequately explained by the nature and abundance of smectite lattice layers that provide a nanometer-scale control on the mechanisms of fault behavior.