Geophysical Research Abstracts
Vol. 13, EGU2011-1093, 2011
EGU General Assembly 2011
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Evolution of kink-band microstructures and rheology during torsion deformation of muscovite

Santanu Misra and Jean-Pierre Burg

ETH, Zurich, Structural Geology and Tectonics Group, Geological Institute, Zurich, Switzerland
(santanu.misra@erdw.ethz.ch)

Kink-band formation is one of the frequent types of deformation-driven instabilities commonly observed in layer- and fiber-composites. Natural kink-bands are reported from strongly anisotropic, layered and/or foliated rocks principally deformed under compression and shearing. Yet, there is a lack of detailed experimental investigations on the rheology, deformation mechanism and evolution of kink microstructures during shear deformation of rocks. Therefore, we investigated the development of kink bands in synthetic muscovite aggregates during layer (001)-parallel torsion experiments with emphasis on microstructure and rheology at different temperatures (400-600^{o}C), pressures (100-300 MPa) and finite shear strains (γ = 0.2-5). The kink-instabilities developed during elastic to plastic transition (yield) at finite shear strain $<$ 0.2. The shear stress required to form the instabilities is a function of pressure and temperature and can range from 30 to 120 MPa within the experimental conditions. Scanning Electron Microscopy of the deformed samples on both longitudinal and transverse sections revealed that the kink bands are strongly asymmetric and spaced at shear strain γg $<$ g.5. The samples showed gentle work hardening at strains $>$2. . With progressive shearing the bands were packed and became narrowly spaced either by widening of early-formed kink bands or nucleation of new kink bands. The orientation of the kink band axes with respect to the shear direction asymptotically decreases from $\sim$ 60^{o} to $\sim$45^{o} with increasing strain. The rate of rotation of the kink band axes is more sensitive to confining pressure than to temperature. A two dimensional analytical model considering elastic-plastic rheology, inter-layer friction, confining pressure and bending energy of a transverse anisotropic body is proposed to justify the experimental observation.