Geophysical Research Abstracts
Vol. 17, EGU2015-6981, 2015
EGU General Assembly 2015

Widening of normal fault zones due to the inhibition of vertical propagation

Vincent Roche (1), Catherine Homberg (2,3), Mirko van der Baan (1), and Muriel Rocher (4)

(1) Dept. of Physics, CCIS, University of Alberta, Edmonton, AB, T6G 2E1, Canada, (2) Sorbonne Universités, UPMC Univ Paris 06, UMR 7193, ISTeP, 4 place jussieu, F-75005, Paris, France, (3) CNRS, UMR 7193, ISTeP, F-75005, Paris, France, (4) IRSN, Institut de Radioprotection et de Sureté Nucléaire, Fontenay-aux-Roses, France

Fault zones structures are the result of a progressive development and are largely controlled by fault geometry inherited from the early stage of faulting. In this paper, we document this early stage, based on detailed observations on mesocale faults in layered rocks in two outcrops. Study includes analyses of fault structures, along-planes displacement profiles, and far-field displacement profiles. This last profile take into account the total strain induced by fault zones including folding and segmentation.
The vertical propagation of the studied faults is stopped by layer-parallel faults. This restriction involves a flat-topped displacement profile along the fault plane. Far from the restricted tip, fault structures correspond to simple planar slip surfaces exhibiting dip refraction due to layering. Near the restricted tips, their structures range from planar structures to complex fault zone characterized by abundant parallel fault segment. In one site, fault-related folding also occurs at the fault tips. Unlike the segmentation, fault-related folding is not restricted by the layer-parallel fault. Far-field displacement profiles have therefore flat topped shape along the restricted faults exhibiting segmentation, whereas profiles become more triangular when folding take place.
Based on the observations, we developed a model of fault zone evolution in which the complexities and the width of fault zone are inherited during the fault restriction period. In this model fault propagation alternates between periods of vertical restriction and vertical propagation. In the course of restriction, faults form first as simple isolated planar structures, then, fault zone complexity, specifically the number of sub parallel segments, increases to accommodate increasing strain. Eventually the fault should finally propagate through the layer-parallel faults with a complex geometry.
This model implies that fault widening is controlled by the fault capacity to propagate vertically in the layered section and also the capacity to form fault segment by brittle failure. Among several parameters, our observations indicate that the nature of the restrictor and the occurrence of fault related faulting at the fault tip are critical. Wide fault zones are expected in layered rocks with strong mechanical heterogeneities and with preexisting joints and layer-parallel faults. However, fault related faulting may reduce the segmentation occurring during the restriction period. Likewise, fault growth occurs with non-linear increasing in maximum displacement, length, and thickness, due to restriction. Also, such a model of fault likely impacts on the vertical permeability and the seismic behavior of the rock.