Solid Earth Physics Seminar, Harvard University

Tuesday, 1 July 2014, 1:15 pm
Faculty Lounge, 4th Floor, Hoffman Lab, 20 Oxford Street

Brittle faults are weak, yet the ductile middle crust is strong: implications for lithospheric mechanics

Whitney Behr
Department of Geological Sciences, Jackson School of Geosciences, University of Texas at Austin

Abstract:

A global compilation of shear stress magnitude from mylonites developed along major fault zones suggests that maximum stresses between 80 and 120 MPa are reached at temperatures between 300 and 350ºC on normal, thrust, and strike-slip faults. These shear stresses are consistent with estimates of brittle rock strengths based on Coulomb friction (e.g., Byerlee's law), and with in-situ measurements of crustal stress measured in boreholes. This confirms previous suggestions that parts of the continental crust are stressed close to failure down to the brittle-ductile transition. Many major active faults in all tectonic regimes are considered to be relatively weak, however; peak static shear stresses for brittle faults estimated by a variety of techniques lie in the range 1-50 MPa. The sharp contrast between static shear stresses estimated on the seismogenic parts of major faults and those estimated from ductile rocks immediately below the seismogenic zone suggests that there is an abrupt downward termination, probably controlled by temperature, of the weakening processes that govern fault behavior in the upper crust. These data also imply that seismogenic parts of major fault zones contribute little to lithospheric strength, and are unlikely to have much influence on either the slip rate or the location of the faults. Conversely, ductile middle crust immediately below the brittle-ductile transition deforms at high stresses, and forms a significant load-bearing element within the lithosphere.