Geophysical Research Abstracts
Vol. 12, EGU2010-4890, 2010
EGU General Assembly 2010

Fault Behaviour During the Seismic Cycle from Observation and Modeling

Jean Chery
(jean.chery@gm.univ-montp2.fr)

Fault behaviour can be studied over a wide range of time scale thanks to geodetic and geologic methods. We review in this paper the relation between the rheological properties of the fault zone and of the lithosphere (friction and viscosity) and the fault motion. We address this point starting from the long term behaviour (geological motion) to the short term deformation (geodetic strain).

Based on the agreement between geodetic and geological plate velocities, interplate fault slip rates are usually considered constant over long periods of time. However, measurements made at different time scales on intracontinental faults suggest that slip rate evolves with time. To understand the physical cause of such variation, we examine the slip evolution of a fault embedded in an elastic lithosphere loaded by plate motion. Assuming that the effective fault friction varies due to climatic or internal causes, we show that high average fault stress and low lithospheric stiffness favour large variations of slip rate. In the case where fault weakening is controlled by slip rate, we find that a high loading velocity leads to a low stress and constant slip rate, while low loading velocity drives the fault slip rate to cycle between high and low values. If correct, this suggests that paleoseismic slip rate could overpass the loading velocity but also fall to zero for some period of time.

At a shorter time scale (10-100 yrs), it is possible to link the stress interaction between earthquakes and the occurrence of temporal clustering. Coseismic static stress change in the vicinity (50 km) of large earthquakes suggests that perturbations of 0.01 to 0.1 MPa may affect the occurrence of other earthquakes. At larger distances, interactions also seem to exist: four M 8 earthquakes have occurred in Mongolia on distant faults (400 km) during the last century. Also, paleoseismic observations documenting much longer time periods display a time clustering of major events. We demonstrate with simple mechanical concepts that postseismic stress relaxation magnifies the coseismic stress change and has a major effect on fault interaction during the seismic cycle. In the simple case where two distant faults are coupled, the probabilistic occurrence of triggered earthquakes may increase dramatically due to long range postseismic coupling.

At small time scale (<10 yrs), the use of interseismic strain to infer fault dynamics is now paramount due to the high density geodetic measurements onland. The geodetic velocity field is generally interpreted in the framework of a thick elastic lithosphere with a slipping fault at depth (block model). Because lateral variations of lithospheric rheology play a key role in determining the geological strain distribution, we examine if interseismic strain rate variations could also occur in response to lateral variations of the lithosphere effective rigidity. We discuss the impact of the choice of the physical model (block model vs variable rigidity) on fault slip rate determination.