Geophysical Research Abstracts
Vol. 16, EGU2014-5474, 2014
EGU General Assembly 2014

Do fluids control locking and seismic slip on the subduction fault? – evidence from the Chilean plate boundary

Onno Oncken (1), Marcos Moreno (1), Christian Haberland (1), Andreas Rietbrock (2), Samuel Angiboust (1), and Jon Bedford (1)

(1) GeoForschungsZentrum, Potsdam, Germany (oncken@gfz-potsdam.de, 0331-28813), (2) University of Liverpool, UK (a.rietbrock@liverpool.ac.uk)

A number of recent studies have suggested that the interseismic locking degree inverted from geodetic data at convergent plate boundaries may be closely related to slip distribution of subsequent megathrust earthquakes as found recently for the Maule 2010 and Tohoku 2011 earthquakes. The physical nature of locking, however, remains a matter of debate. We explore seismic, seismological and geodetic data collected from the southern part of the Maule 2010 earthquake rupture zone – overlapping with the northern termination of the Valdivia 1960 earthquake – in the decade before the event to identify the spatial variability of pore fluid pressure and effective stress along the plate interface zone.

The reflection seismic and the seismological data exhibit well defined changes of reflectivity and Vp/Vs ratio along the plate interface that can be correlated with different parts of the coupling zone as well as with changes during the seismic cycle. High Vp/Vs domains, interpreted as zones of elevated pore fluid pressure, spatially correlate with lower locking degree, and exhibit higher background seismicity as expected for partly creeping domains. In turn, unstable slip associated to a higher degree of locking is promoted in lower pore fluid pressure domains. This relationship is particularly well expressed in the upper two thirds of the seismic coupling zone down to a depth of some 25 km at an estimated 250°C. In the gradient zone towards deeper domains locking gradually decreases to very low values, and the elevated Vp/Vs-ratio returns to standard values. At the same time seismic reflectivity remains high to some 35 km and then disappears with only minor S-wave reflectivity persisting down to the zone of intermediate depth seismicity at some 60 km depth that is again highlighted by bright reflections. This transition zone, at temperatures > 250°C is also largely coincident with aftershock clusters and a concentration of geodetically recorded afterslip following the Maule earthquake. From their spatial interrelationship, we suggest similar, but less strongly expressed activity of an overpressured fluid. We demonstrate that variations of pore pressure at the plate interface control locking degree variations and therefore coseismic slip distribution of large earthquakes. Lateral variations of pore fluid pressure may be related to the subduction of a transform zone (Maule fracture zone) responsible for part of the fluid input. Finally, we speculate that pore pressure increase during the terminal stage of a seismic cycle to close to lithostatic pressure with an equivalent reduction of effective strength may be as relevant for earthquake triggering as stress loading from long-term plate convergence.