Geophysical Research Abstracts
Vol. 16, EGU2014-12900, 2014
EGU General Assembly 2014

Frictional properties of fault rocks along the shallow part of the Japan Trench décollement: insights from samples recovered during the Integrated Ocean Drilling Project Expedition 343 (the JFAST project)

Francesca Remitti (1), Steven Smith (2), Alessandro Gualtieri (1), Giulio Di Toro (3), and Stefan Nielsen (4)

(1) Dipartimento di Scienze Chimiche e Geologiche, Università di Modena e Reggio Emilia, Modena, Italy (francesca.remitti@unimore.it), (2) Department of Geology , University of Otago, Dunedin, New Zealand, (3) Dipartimento di Geoscienze, Università di Padova, Padova, Italy, (4) Department of Earth Sciences, Durham University, Durham, United Kingdom

The Japan Trench Fast Drilling Project (JFAST), Integrated Ocean Drilling Program (IODP) Expedition 343, successfully located and sampled the shallow slip zone of the Mw =9.0 Tohoku-Oki earthquake where the largest coseismic slip occurred (c. 50 m). Logging-while-drilling, core-sample observations and the analysis of temperature data recovered from a third borehole show that a thin (<5 m), smectite rich plate-boundary fault accommodated the large slip of the Tohoku-Oki Earthquake rupture, as well as most of the interplate motion at the drill site. Effective normal stress along the shallow plate-boundary fault is estimated to be c. 7 MPa.

Single-velocity and velocity-stepping rotary-shear friction experiments on fault material were performed with the Slow to HIgh Velocity Apparatus (SHIVA) installed at INGV in Rome. Quantitative phase analysis using the combined Rietveld and R.I.R. method indicates that the starting material is mainly composed of smectite (56 wt%) and illite/mica (21 wt%) and minor quartz, kaolinite, plagioclase and K-feldspar. The amount of amorphous fraction has also been calculated and it is close to the detection limit. Each experiment used 3.5 g of loosely disaggregated gouge, following sieving to a particle size fraction <1 mm. Experiments were performed either 1) “room-dry” (40-60% humidity) at 8.5 MPa normal stress (one test at 12.5 MPa), or 2) “water-dampened” (0.5 ml distilled water added to the gouge layers) at 3.5 MPa normal stress. Slip velocities ranged over nearly seven orders of magnitude (10-5 – 3 m s-1). Total displacement is always less than 1 m.

The peak and steady-state frictional strengths of the gouges are significantly lower under water-dampened conditions, with mean steady-state friction coefficients (μ, shear stress/normal stress) at all investigated velocities of $0.04<\mu<0.1$. This is consistent with the small measured frictional heat anomaly along the plate boundary fault $\sim$1.5 years after the Tohoku-Oki earthquake.

Under room-dry conditions the gouge material is velocity-strengthening at intermediate velocities (0.001 – 0.1 m s-1), but strongly velocity-weakening at > 0.1 m s-1. Instead, under water-dampened conditions, the gouge is velocity-neutral to velocity-weakening at all investigated velocities. In other words, the intermediate-velocity strengthening, which would probably act as a "barrier" to rupture propagation in the dry gouges, disappears in water-dampened gouges. This result is compatible with propagation of the Tohoku rupture to the trench, and also with large coseismic slip at shallow depths.

Quantitative phase analysis using the combined Rietveld and R.I.R. method has been performed also on six post-experiment gouges for the determination of both the crystalline and amorphous fractions. Preliminary results show that the mineralogical assemblage is basically the same after the experiments, with both smectite and illite phases preserved, this suggests that the weakening mechanism operating in this material is active at low temperature.