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In situ coseismic stiffness of fault rocks calculated using pseudotachylyte injection veins

W. Ashley Griffith (1), Tom M. Mitchell (2), Giulio Di Toro (3,4)

(1) Department of Geology and Environmental Science, University of Akron, Akron, Ohio, United States (wag8@uakron.edu), (2) Experimental Geophysics Laboratory, Ruhr-University Bochum, Bochum, Germany (tom.m.mitchell@btinternet.com), (3) Dipartimento di Geoscienze, Università di Padova, Padova, Italy (giulio.ditoro@unipd.it), (4) Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy

Elastic stiffness of fault zone rocks is expected to be highly variable during the seismic cycle due to complicated damage and healing processes. In addition to longer-term alteration which may take place during exhumation, it is impossible to assess how well rock stiffness as measured in the laboratory represents *in situ*, coseismic rock stiffness at seismogenic (5-15 km) depths. Here we calculate the *in situ*, coseismic rock stiffness of fault rocks from the pseudotachylyte-bearing Gole Larghe Fault Zone of the Adamello Batholith, Italian Southern Alps, using aspect ratio measurements of pseudotachylyte injection veins and numerical Displacement Discontinuity Method simulations. Aspect ratios of over 100 pseudotachylyte injection veins which cut across tonalite, cataclasite, or aplite show that maximum vein thickness is linearly related to vein length. For modeling of vein opening, the fault and the injection vein are assumed to be filled with melt that has a fluid pressure P. Consistent with recent results from modeling of melt lubrication we assume that the magnitude of the fluid pressure P is exactly the same as the normal stress (σ_{yy}^{R}) such that the fault vein approximately maintains constant thickness (i.e. melt extrusion exactly balances melt production). This model assumes that an array of tensile cracks orthogonal to the fault vein have been left in the wake of the earthquake rupture tip, allowing fluid to inject into the sidewall without significant fluid overpressures. These assumptions are in contrast to previous models of injection vein development which assume that vein opening is driven by melt fluid overpressure. Numerical simulations of injection vein opening due to fluid pressure of frictional melt indicate that *in situ* coseismic stiffness of the fault rocks ranged from 5-50 GPa, about a factor of two less than typical laboratory measurements of the same rocks, and the coseismic stiffness of tonalite, cataclasite, and aplite are markedly different.