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A Comparison Between Modeling and Field Observations of Off-Fault Strain around Pseudotachylyte Fault Veins, Norumbega Shear Zone, southern Maine

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Static stress changes caused by fault motion may be of significant magnitude around fault bends, ends, and intersections, and have been shown to partially explain aftershock distributions. In the brittle-ductile transition zone, these stress concentrations may be relaxed after earthquakes by ductile flow. Small-scale deformation features adjacent to pseudotachylyte faults may record deformation in response to static stress changes in the wallrock caused by slip on non-planar or intersecting fault surfaces.

Using an existing pseudotachylyte map of the Fort Foster Brittle Zone (Kittery, Maine) [1], we mapped details of same deformation structures at selected sites of the outcrop surface. High-resolution photographs and field measurements were taken where pseudotachylyte faults vein bend and there was associated near-fault small-scale deformation features. A ~ 0.5 m^2 area of outcrop was selected for Coulomb stress modeling, which is bound by 2 pseudotachylyte veins. Between these faults, when the one fault bends toward the other, the deformation in between the two is characterized by millimeter-to-centimeter-scale pseudotachylyte injection veins. Where the faults are furthest from each other, the deformation style is characterized by ductile features such as tight isoclinal folds (Fig. 1).

Figure 1 was then used as a basemap in Coulomb3 [2] software so as to build an idealized fault model indicating the fault geometries. The predicted stress orientation and magnitude distribution produced

Figure 1: Pseudotachylyte fault veins and off-fault deformation at Fort Foster upon which simplified model is based.

by Coulomb3. As the rake and slip of the earthquakes which formed the pseudotachylytes are not known, the shear zone is primarily dextral, and we will use the average scaling of normal earthquakes and low-frequency earthquakes to make estimates of appropriate slip. We will compare the Coulomb stress change magnitudes predicted by the model to the strength of the fault rocks at appropriate temperatures to constrain reasonable slip. We will compare the stress change distributions from the models to the distribution of small near-fault structures mapped in the field. If the distribution of stresses are similar to the distribution of shortening and extensional strain measured in the wallrock, we will conclude that static stress changes were accommodated plastically in the post-seismic time interval. If the patterns do not match, we will conclude that near-fault deformation in the wallrock may reflect inherited structures, or long-term plate motions unrelated to slip on the proximal pseudotachylyte faults.

References:

[1] Swanson M (2006) *Earthquakes: Radiated Energy and the Physics of Faulting*: 167-169

[2] Toda et al. (2011) *U.S. Geological Survey Open-File Report 2011-1060*: 1-63