Rotation and Plate Locking along the Central Cascadia Subduction Zone - An Update

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McCaffrey et al (2000) use Global Positioning System and surface tilt measurements to simultaneously invert for both secular plate motion relative to stable North America and elastic plate locking on the central Cascadia subduction interface. GPS measurements are from campaign and continuous measurements made between 1996 and 1999 by RPI and OSU, and incorporate campaign measurements between 1992 and 1998 by the US Geological Survey, Cascades Volcano Observatory, and the National Geodetic Survey.

McCaffrey et al. (2000) calculate a rotation pole for stations east of the Cascades, which approximate a rigid body rotation, and where plate locking is assumed to be negligible. The simultaneous inversion calculates the rotation pole and best-fitting coupling model through many iterations to minimize misfit. The rotation is then applied to all of Oregon. McCaffrey et al. (2000) infer that clockwise rotation of a relatively rigid Oregon block may be driven by collapse of the Basin and Range, the northward migration of the Sierra Nevada block, and resisted by shortening in NW Washington State. The rotation pole lies along the Olympic–Wallowa lineament and explains the predominance of extension south of the pole and contraction north of it. The rotation pole is in good agreement with that proposed by Wells et al. (1998) based on geologic and paleomagnetic evidence. The collision with a weaker western Washington is supported by both seismicity and observed contractional structures in the Puget Willamette lowland. The rotation about a pole in eastern Oregon can also explain the "fanning" of the fold axes of the Yakima fold belt. These active folds are responding to north-south compression, but also fan westward in map view. The fold axes project to a convergence at the computed Oregon rotation pole, consistent with the predicted strain field.

Plate locking at the Cascadia thrust is anomalous in that the model resolves two coupled zones, one offshore, and a second deep zone beneath the western Cascades. While the existence of deeper coupling may not be real, the model tries to resolve anomalous east velocities observed in the western Cascades in this way. In the Puget-Willamette lowland, little east component is observed. The anomalous western Cascades vectors could represent dextral shear along the Cascade Arc (not incorporated in the model) or other crustal deformation superimposed on a deep viscous coupling signal. More observations are needed in the Western Cascades to verify and characterize the velocity field in this area.