Abstract ID: 248

Title: SUBCONTINENTAL-SCALE STRESS TRANSFER VIA ASEISMIC STICK-SLIP BENEATH OROGENIC PLATEAUS

Student: No
Topic: IGCP-Paleoproterozoic
Medium: Invited Oral Presentation

Author 1 (CONTACT AUTHOR)
Name: Brian Wernicke
Org: California Institute of Technology
Country: USA
Author 2
Name: Davis, James L.
Org: Harvard Smithsonian Astrophysical Observatory
Country: USA

Keywords: Continental crust, orogenic plateau, geodesy, rheology, Basin and Range, seismology

Abstract: Continuous GPS geodesy demonstrates that tectonic velocity fields are not constant, but instead tend to be transient. The most conspicuous transients are the ~14 month oscillation of the Cascadian forearc region (amplitude ~5 mm), and similar but slower motions in a number of other active forearcs that reflect episodic, aseismic strain release on a deep portion of the subduction megathrust. Large-scale transient deformation is also evident in the orogenic plateau setting of the northern Basin and Range province. Temporal variations in site velocity define two geodetic domains between Reno and Salt Lake City, with an abrupt NNW-trending boundary between them in easternmost Nevada. Relative to the Colorado Plateau, sites west of the boundary slowed by ~1 mm/yr in 2000, while those in easternmost Nevada and Utah maintained relatively constant tectonic velocity (Davis et al., 2006, Nature, 441, p. 1131-1134). This "en bloc" slowing of Nevada resulted in local contraction along geodetic baselines near the Nevada-Utah border from 2000-2004. After 2004 the Nevada sites returned to velocities near their pre-2000 levels. Unlike most Nevada sites, a site near Lake Tahoe did not slow down in 2000, but owing to rapid transient motion (~20 mm/yr) in 2003, it "caught up" with the eastward position deviations of the other sites from their original trajectories (~5-8 mm total motion). The origin of this oscillation is most likely slip along or near the Moho, based on the temporal and spatial correlation of the Tahoe site's rapid motion with a deep crustal earthquake swarm. The characteristics of the swarm and associated geodetic motion indicate the injection of magma along a 50ºENE-dipping plane in the lowermost crust (Smith et al., 2004, Science 305, 1277-1280), suggesting the orientation of the maximum shear stress near the base of the crust is subhorizontal, top-to-the-ENE shear. The dike injection, its implied stress orientation, and the contraction of eastern baselines suggest the westward relative motion reflects strain release of the system via top-to-the-east shear. By analogy with the transients associated with subduction megathrusts, an episodically creeping, subhorizontal "megaoscillator" ~500 km wide near the base of the crust explains the motions, and explains why the strong

seismic reflectivity of the Moho in Nevada does not persist into Utah. “Shuttling” of Nevada with a period of ~8 yr implies that a relatively simple structure of subcontinental scale aseismically transfers stresses across 100s of kilometers of diffusely deforming lithosphere, perhaps controlling fault interactions at length scales well beyond those of elastic or viscoelastic effects associated with earthquakes. The lack of seismicity (except the Tahoe swarm) associated with these motions, and the likely high Moho temperatures in the Basin and Range suggests stick-slip behavior is occurring in rocks deforming via dislocational or diffusional flow.