Instantaneous stress state of the lithosphere of S. California: A synthesis of geophysical and compositional products of SCEC

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Seismic observations are now able to reveal detailed basin geometries, Moho topography, wave speed variations that constrain temperature models and, as described in this proposal, SiO2 content variations that control rheological flow laws. In this presentation, we summarize an effort in using these implications from seismic (and other geophysical) data collected over the past 2 decades to build a geodynamic framework that quantifies the instantaneous stress state of the lithosphere of S. California. Particularly, by utilizing the seismic waveform data, we analyzed receiver functions at over 300 stations using a 2-layer H-k stacking method, and constructed a new crustal architecture (discontinuity depth and Poisson's ratio) across the southern California region. The new maps of Poisson's ratio are then combined with the high-resolution seismic model (e.g., the SCEC community model) to constrain the crustal composition based on petrophysical measurements of crustal rocks. The resulting compositional model provides important constraints to the rheological properties of the crust (such as the thickness of the felsic upper crust, Fig.1), thus helping develop a new geodynamic framework that is based on the UWGeodynamics modeling tools. This framework will incorporate the influences of a free surface with topography, kinematic boundary conditions defined by the strain-rate measurements, detailed 3-D geometry of fault system, and most importantly, by synthesizing the latest thermal, seismic, compositional and rheological constraints and products SCEC has fostered (Williams et al., 2011; Tape et al., 2009; Shaw et al., 2015; Montesi and Leete, 2018). Based on the initial geodynamic computation, the instantaneous stress state of the lithosphere in this region is quantified and visualized.

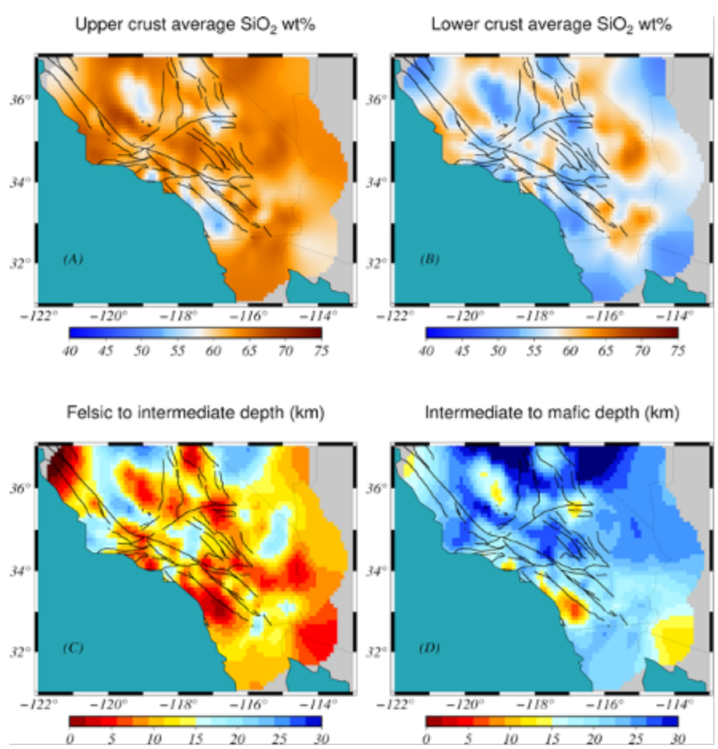

Figure 1. Crustal composition of the S. California. (A) the average silica content of the upper ⅓ of the crust, showing a granitic composition for most areas. (B) similar to (A), but for the lower ⅓ of the crust, showing a more mafic composition except for regions like the western Basin and Range Province. (C) We define the depth at which the composition decreases to 63 wt% for SiO_2, the threshold from granitic to intermediate in composition. (D) similar to (C), but for the threshold of 53 wt% for SiO_2, marking the boundary that transitions from intermediate to mafic, below which the crust may be represented by wet diorite or dry diabase, depending on tectonic setting.