Synthesis of Seismicity, 3D velocity and Q models for southern California

Egill Hauksson, Caltech

Abstract

We synthesize relocated regional seismicity, 3D velocity and Qp models to infer structure and deformation in the transpressive zone of southern California. These models provide a comprehensive synthesis of the tectonic fabric of the crust.

The regional seismicity patterns in southern California are brought into focus when the hypocenters are relocated using the double difference method. In detail, often the spatial correlation between background seismicity and late Quaternary faults is improved as the hypocenters become more clustered, and the spatial patterns are more sharply defined. Along some of the strike-slip faults the seismicity clusters decrease in width and form alignments implying that in many cases the clusters are associated with a single fault. In contrast, the Los Angeles Basin seismicity remains mostly scattered, reflecting 3D distribution of the tectonic compression. We present the results of relocating 327,000 southern California earthquakes that occurred between 1984 and 2002. In particular, the depth distribution is improved and less affected by layer boundaries in velocity models or other similar artifacts, and thus improves the definition of the brittle ductile transition zone.

The 3D V_P and V_P/V_S models confirm existing tectonic interpretations and provide new insights into configuration of the geological structures in southern California. The models extend from the US-Mexico border in the south to the Coast Ranges and Sierra Nevada in the north, and have 15 km horizontal grid spacing and an average vertical grid spacing of 4 km, down to 22 km depth. The heterogeneity of the crustal structure as imaged in both the V_P and V_P/V_S models is larger within the Pacific than the North America plate reflecting regional asymmetric variations in the crustal composition and past tectonic processes. Similarly, the relocated seismicity is deeper and shows more complex 3-D distribution in areas exhibiting compressional tectonics within the Pacific plate. The V_P values are 0.2 to 0.4 km/s too high to support an abundant occurrence of schist beneath the Mojave Desert and the San Gabriel Mountains. The models reflect mapped changes, from east to west, in the lithology of the Peninsular Ranges. The interface between the shallow Moho of the Continental Borderland and the deep Moho of the continent forms a broad zone to the north beneath the western Transverse Ranges, Ventura basin and the Los Angles Basin and a narrow zone to the south, along the Peninsular Ranges.

Similarly, the 3D Qp model includes several features that correspond to regional tectonic features and possibly the thermal structure of the southern California crust. A clear low Qp zone extends from the San Bernardino Basin, across the Chino Basin, San Gabriel Valley, into the Los Angeles Basin. This zone is consistent with the geology and decreases with depth from east to west. The Peninsular Ranges have a high Qp zone consistent with the high velocities in the 3-D Vp model. There are also zones of high Qp in the southern Mojave and southern Sierras. Several clear transition zones of rapidly varying Qp, extend across major late Quaternary faults and connect regions of high and low Qp. The strongest low Qp zone coincides with the Salton Trough where near-surface low Qp is associated with the sediments and the deeper low Qp may be associated with elevated mid-crustal temperatures.