Crustal structure along the Costa Rican volcanic arc from the TICO-CAVA experiment

Awards: 06-25178 (April 2006)

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The TICO-CAVA seismic experiment acquired wide-angle and multi-channel seismic data along and across the Costa Rican arc, both onshore and offshore, along with additional seismic lines on the Pacific and Caribbean plates offshore Costa Rica. The land component of this experiment involved the recording of 40 explosive shots by over 700 seismographs along two principle transects across (Line 1) and along (Line 2) the active arc (Figure). These lines (along with the offshore extensions of Line 1) were designed to image the basic crustal architecture of the Costa Rican arc, with primary scientific goals of gaining an understanding of arc magmatic emplacement processes and estimating the bulk composition and growth rates of arc crust. Here we describe very preliminary results for Line 2, which was designed to image crustal structure beneath the volcanic arc itself and so to assess along-arc variability.

We find that crustal structure is markedly different beneath the Guanacaste volcanic province and the Central Costa Rica volcanoes. The entire arc has a 3- to 4-km-thick surface carapace of low velocity material (2.0-4.5 km/s) that is most likely a volcaniclastic layer. Upper crustal velocities transition to values characteristic of granitic and andesitic composition (5.8-6.4 km/s) just beneath this carapace in Guanacaste. Beneath the Central Costa Rican arc, however, a ~7-km-thick zone of low seismic velocities (4.5-5.8 km/s) underlies the carapace, with a large region of low velocities centered beneath Irazú volcano. We interpret these low upper-crustal velocities as due to high temperatures and possibly the presence of melt beneath Irazú.

The boundary between the Guanacaste and Central Costa Rica arc segments has a distinct seismic expression that suggests only minor magmatic emplacement here since the abandonment of the Tilaran arc. Note that these preliminary results do not include deep crustal reflection phases and so only constrain crustal structure to a depth of ~15 km. Analyses of this data set are ongoing.

Figure: (top) Map of Costa Rica with receiver locations (blue dots) and shot points along Line 1 (turquoise) and Line 2 (yellow) indicated. Named volcanoes indicated. (bottom) Very preliminary velocity model for Line 2 based on tomographic inversion of first-arrival traveltimes, valid for the upper 15 km. Numbers indicate velocity in km/s, with contours at 0.5 km/s increments.