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Kinematics of the Guanacaste Volcanic Arc sliver boundary, Costa Rica, revealed by deformation during the 2016 Bijagua earthquake sequence.

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When convergence at a subduction zone is oblique, plate motion is partitioned with a trench parallel component accommodated within the continental plate. The result is a rigid micro-block called a tectonic sliver. The motion of the rigid sliver can be accommodated by a range of mechanisms including well- defined faults or diffuse fault systems that lie along the volcanic arc, or by block rotation around a vertical axis. In Costa Rica, the boundary of the Guanacaste Volcanic Arc Sliver is thought to be the Haciendas Chiripa Fault System (HCFS) which is located $\sim$10 km behind the volcanic arc. We investigate this atypical sliver boundary by studying the 2016 Bijagua earthquakes sequence of shallow events, including a Mw 5.4 right-lateral earthquake and a Mw 5.1 normal-faulting earthquake. We combine seismic data from the National Seismological Network, and Interferometric Synthetic Aperture Radar (InSAR) images from the ALOS-2 satellite of the Japanese Aerospace Exploration Agency (JAXA). The stack of three co-seismic interferograms show $\sim$7 cm of displacement in the line of sight of the satellite, indicating uplift or SE horizontal surface displacement. The deformation pattern is located between the Caño Negro fault and the Upala fault.

We initially compare the observed deformation with forward models based on the focal mechanisms and location of the two largest events using data from the local seismic network, but find a poor fit. Next we use a linear distributed slip inversion based on the geometry of the mapped fault network. The deformation could not be explained by slip on a single fault, but a model composed of two linked faults fits the data well. The best-fit model consists of 0.33 m of right lateral slip on the Caño Negro fault and 0.36 m of reverse slip on the Upala fault. The combined geodetic moment of 2.25x 10^{17} Nm is equivalent to seismological moment of the largest moment 1.58 x10^{17} Nm. However, the seismic data does not show any reverse focal mechanisms, so we infer that the slip on the Upala fault occurred aseismically. We propose the HCFS is transpressional with a positive flower structure between the two faults containing the deformation. The complexity of this boundary suggests the forearc is not yet mature, with a complex fault system boundary similar to the Northern Chile forearc, and contrary to mature forearcs with long, well defined boundaries. Although aseismic slip is common on mature strike-slip faults such as the San Andreas and North Anatolian Fault, this is the first study to find aseismic slip on an immature tectonic sliver boundary.