TECTONIC GEOMORPHOLOGY AND EARTHQUAKE HAZARDS OF THE NICOYA PENINSULA SEISMIC GAP, COSTA RICA, CENTRAL AMERICA

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The Nicoya Peninsula, Costa Rica deforms in response to rapid subduction of the Cocos oceanic plate at the Middle America Trench (9 cm/yr). This emergent forearc peninsula lies ~60 km inboard of the trench axis along a locked segment of the seismogenic zone. The Nicoya segment is a high-potential seismic gap, with a slip deficit of ~5 m since the last megathrust earthquake (M7.7, 1950). That event produced widespread damage and >1 m of coseismic coastal uplift. Since then, the Nicoya coast has undergone gradual interseismic subsidence, reflecting strain accumulation toward the next earthquake. While elastic seismic-cycle strain produces decadal-scale shoreline fluctuations, net tectonic uplift results in long-term coastal emergence. This investigation examines both short-term seismic-cycle deformation and longer-term forearc uplift. The results provide new insights into the rupture behavior, paleoseismology, and earthquake hazards of the Nicoya Peninsula seismic gap.

Net coastal uplift is recorded by Quaternary marine terraces and incised valley fill alluvium. Terrace mapping, surveying, and isotopic dating reveal uplift variations that coincide with three contrasting domains of subducting seafloor offshore (EPR, CNS-1, CNS-2). Uplift rates vary between 0.1-0.2 mm/yr inboard of older EPR crust north of Punta Guiones, 0.2-0.3 mm/yr inboard of younger CNS-1 crust south of Punta Guiones, and >1.0 mm/yr inboard of CNS-2 seamounts at Cabo Blanco. Variable upper-plate uplift reflects along-strike differences in subducting-plate roughness, thermal structure, fluid flow, and seismogenic-zone locking. Local uplift anomalies reveal upper-plate faults that may accommodate significant forearc deformation (shortening and/or lateral sliver transport). In addition to ongoing terrace studies, new field research includes wetland sediment coring to extract paleoseismic records, and pre/post earthquake coastal surveying to constrain seismic-cycle deformation. The estimated recurrence interval for large Nicoya earthquakes is ~50 years. While these events produce meter-scale coseismic uplift, a large fraction is recovered during interseismic subsidence. The net result is gradual long-term emergence of the Nicoya coastline.