Earthquake potential in Costa Rica estimated by the integration of the interseismic geodetic data with seismicity records and inland faulting traces

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The western border of the Panama Microplate (PM) is presented by the Central Costa Rica Deformed Belt, a diffuse predominant northwest dextral-strike and conjugated northeast sinistral-strike faulting area. This diffuse boundary crosses Central Costa Rica (CCR) from the Caribbean Coast, including the Metropolitan Area (most dense population area in Costa Rica) and the Central Pacific coastline to intersects the Meso American Trench along the subduction of the Cocos Plate (CO).

We use 139 GNSS observation sites located in Nicaragua, Costa Rica and Panama for inversion finding that the crustal deformation in Costa Rica is mainly arranged in three groups: 1). Northwestern Costa Rica is dominated by a northward deformation with rates up to 25 mm/yr, rotating and decreasing up to 12 mm/yr northwestward following the Central American Forearch. 2). Southeastern Costa Rica shows deformation to the North-eastward up to 40 mm/yr (opposite to northwestern Costa Rica). 3). Central Costa Rica is characterized by a diffuse deformation pattern oriented mainly to northward, with deformation rates up to a half of those observed in northwestern and southeastern Costa Rica.

By the integration of the interseismic geodetic data with seismicity records and inland faulting traces, we evaluated the crustal deformation in Costa Rica in 3 kinematic models with different spatial geometries of the tectonic configuration around Central Costa Rica, and determine the earthquake potential in Costa Rica using the best model. Crustal deformation in Costa Rica and surroundings is modeled as result: i) kinematic effects of rigid block motions, ii) elastic deformation due to the interaction on subduction and inland tectonic interfaces and iii) internal strain of each tectonic block. We adopted the Markov Chain –Monte Carlo method in order to estimate the Euler poles of each tectonic block, slip deficit rates (SRD) on block interfaces, and internal strain of each block.

Assuming that the seismic moment in the subduction and inland interfaces is accumulated only as elastic strain and is released co-seismically, the resulting seismic moment accumulated rates in the best model reflect capacity for producing Mw 8.2 earthquakes every 318 ±16 years in southwestern Costa Rica, Mw 7.3 earthquakes every 55 ±7 years beneath CCR, and Mw 8.5 earthquakes every 231 ±21 years in southeastern Costa Rica, as the upper limits of the earthquake potential produced by the Cocos Plate convergence.

Our assumption represents an upper limit of the earthquake potential since additional effects may contribute to the release of accumulated slips, such as the post-seismic deformation, plastic deformation, and the occurrence of slow slip events.

Keywords: Central Costa Rica, Earthquake potential Costa Rica, Crustal Deformation Costa Rica

