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Anomalous Accretionary Margin Topography Formed By Repeated Earthquakes

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It has long been recognized that accretionary margins of major subduction zones undergo substantial deformation. However even with the large amounts of shortening accommodated within the margin, for most subduction zones, there is an extended submarine portion to the accretionary, highly-deformed upper-plate between the trench and the coast. This is a vexing situation since this submarine section typically overlies the actual locked or coupled patch of the plate interface. The result of this is added difficulty in directly observing processes related to the plate interface coupling - such processes as micro-seismicity and the actual patterns of plate coupling. There are a few locations globally in which there are sub-aerially exposed terranes that lie closer to the trench and overlie the inferred coupled or seismogenic portion of the plate interface. Such regions have taken on significance in subduction zone studies as they provide locations to observe the plate interface coupling effects in the near-field. In particular the Pacific coast of Costa Rica provides such a location, and there has been substantial geologic, geophysical, and geodetic research exploiting the positions of these near-trench peninsulas (Nicoya, Osa, and Burica). These sites provide near-field access to plate-interface processes, but whether they represent typical subduction zone behavior remains an open question as the deformational processes or inherited structures that have produced this anomalous topography are not well constrained. Simply put, if the existence of these sub-aerial, near-trench terranes is a result of anomalous behavior on the plate interface (as has been suggested), then their utility in providing high-fidelity near-field insight into the plate interface properties and processes is substantially reduced. Here we propose a new mechanism that could be responsible for the formation of both the Nicoya and Osa Peninsulas in the past, and is currently producing a third peninsula - the Burica Peninsula at the intersection of the Panama fracture zone and the margin.

Specifically we propose that the anomalous topography along the Pacific coast of Costa Rica has been produced by repeated, great subduction earthquakes that have ruptured across the boundary separating the Cocos and Nazca plates - the subducted continuation of the Panama fracture zone. The pattern of upper-plate shortening generated by such a process (documented in the 2007 Mw 8.1 Solomon Islands earthquake, which produced co-seismic localized uplift above the subducted transform plate boundary) convolved with the migration history of the Panama triple junction (PTJ) is proposed as the mechanism to produce substantial along-margin, long-lived accretionary margin topography. Specifically we argue that repeated great subduction earthquakes that rupture across fundamental plate boundary structures can produce substantial, long-lived upper plate deformation above the inter-seismically coupled plate interface.