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Nathan Bangs (Nov 25, 2020 13:04 CST)

Abstract

Kinematic Restoration of the Costa Rican Convergent Margin: Exploring the Effects of a Rough Subducting Seafloor

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The University of Texas at Austin, 2020

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The Costa Rican convergent margin has been a primary site for studies of subduction erosion because it is a documented example of an end-member type of erosional subduction zones with tectonic erosion by seamount, plateau, and ridge collision. Previous work has explored both modern-day and historical evidence for ongoing subduction of a rough seafloor at Costa Rica that has left erosional scars on seafloor bathymetry, but the mechanisms that alter slope sedimentation processes, tectonic removal of pieces of the upper plate, and the long-term sub seafloor geologic record left behind from these events is not known. To further explore the effects of subducting seafloor features on the long-term structural and stratigraphic record, this study used three-dimensional kinematic restoration to examine trends in uplift and subsidence over time and potentially identify periods of seamount subduction. This study utilized a 3D seismic-reflection volume along with interpreted well log data to create a finite element model of major structural and stratigraphic features within the study region. The 3D model was then kinematically restored using Paradigm's SKUA-Gocad Kine3D, providing a 2.2Ma history of three-dimensional motion for the modeled area. Results start at 2.2Ma when subaerial uplift elevated the margin 1.2km corresponding to a regional unconformity established from drilling. This event was followed by a period of subsidence before a short pulse of uplift occurred in a ~9 km wide circular area on the shelf. Recent (1.3Ma – 0Ma) enhanced subsidence in the same region has led to the formation of a circular bathymetric depression on the seafloor that resemble similar features farther north interpreted as seamount impacts. This leads us to conclude that a subducted seamount (~9km at the base, 1.5 km height) passed through the study region ~1.8Ma leaving behind a weakened region of underplated sediments. Over time, basal erosion of this area has removed 180 km^3 of material. The models reveal that seamount subduction causes erosion both by transfer of material from the upper plate in front of the seamount, and by weakening the upper plate to promote erosion in the wake of the seamount, resulting in distinctive seafloor indentations.

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Final Audit Report 2020-11-25

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