

What Drives Micro-Plate Motion and Deformation in the Northeastern Caribbean Plate Boundary Region?

Rob Govers, Steven van Benthem, and Rinus Wortel

Earth Sciences Department, Utrecht University, The Netherlands

Abstract

The north Caribbean plate boundary zone is a broad deformation zone with several fault systems and tectonic blocks that move with different velocities. The indentation by the Bahamas Platform (the "Bahamas collision") is generally invoked as a cause of this fragmentation. We propose that a second driver of deformation is the western edge of the south-dipping Puerto Rico slab moving sideways with the North America plate. This proposal derives from our recently imaged tomographic structure of the Lesser Antilles - Puerto Rico slab. The westward motion of the slab edge results in a push on the Caribbean plate further west. We refer to this second mechanism for deformation as "slab edge push". The motion of the North American plate relative to the Caribbean plate causes both drivers to migrate from east to west. The Bahamas collision and slab edge push have been operating simultaneously since the Miocene. The question is the relative importance of the two mechanisms. We use mechanical finite element models that represent the two mechanisms from the Late Oligocene (30 Ma) to the Present. For the Present, both models successfully reproduce observed deformation, implying that both models are viable. Back in time the slab edge push mechanism better reproduces observations. Neither mechanism successfully reproduces the observed Miocene counter-clockwise rotation of Puerto Rico. We use this rotation to tune a final model that includes fractional contributions of both mechanisms. Both mechanisms contribute equally to the motion of the Caribbean plate. We find that slab edge push was the dominant driver of deformation in the north Caribbean plate boundary zone since 30 Ma.