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Re-Defining the Active Fault Boundaries and Kinematics of the Puerto Rico-Virgin Islands Microplate

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Abstract

Since the Puerto Rico-Virgin Islands microplane was first proposed, there have been controversies over its existence, its boundaries and its kinematics. In the original model, the microplate is envisioned as a sub-circular microplane rotating counter-clockwise, with extensional features along its southeastern edge in southern Puerto Rico at and the Virgin Islands basin, its northwestern edge in the Mona Passage, and compressional features along its northern edge in the Puerto Rico trench and its southern edge in the Muertos trench. We use 830 km of seismic reflection lines and 94,000 km^2 of high-resolution multibeam bathymetry to identify a 460-km-long and semi-arcuate strike-slip fault that can be traced to the southwest from the Mona rift west of Puerto, across the onland area of south-central Puerto Rico (Cerro Goden and Great Southern Puerto Rico fault zones), across the Whiting basin southeast of Puerto Rico, across the Virgin Islands basin and to the northeast along the Anegada Passage and Tortola ridge. On multibeam and seismic reflection data the fault is active based on a continuous seafloor scarp ranging in height from 10 to 40 m. Seismic profiles show that the fault is alternatively downthrown to the north and south, typical of strike-slip faults. The sense of most recent strike-slip offset on the fault is right-lateral based on offsets at 4 localities that range from 1.5 to 3.5 km. Shallow earthquake swarms are associated with the fault trace in the Virgin Islands area but large segments of the fault are aseismic and appear locked. We propose that this fault system forms the southern boundary of an actively CCW-rotating Puerto Rico microplate that is driven by oblique, left-lateral shear of the North America-Caribbean plate boundary. The northern edge of the microplate is inferred to follow left-lateral faults known in the Puerto Rico trench (Bunce and Bowin fault zones) that close the loop around the crudely circular microplate in the area of the Mona rift. We have modelled these boundaries of the rotating block using the Defnode method of finite elements constrained by GPS and earthquake slip vectors.