Aftershock Study of the Subduction to Strike-Slip Transition of the North American-Caribbean Plate Boundary in the Dominican Republic

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The Northern Caribbean Plate Boundary Zone is a complex region that has been modified extensively by the relative eastward movement of the Caribbean Plate and the plate’s impact with the buoyant Bahama carbonate platform. This movement has produced extensive subduction of oceanic crust belonging to the North American Plate, a broad zone of deformation to accommodate strain, the development of several new transform and normal faults to relieve stress after collisions, the formation and rotation of microplates, and the rearrangement and aggregation of crustal fragments into new islands.

On 22 September 2003, a large (Mw = 6.5) earthquake struck the Dominican Republic, causing widespread damage that included partially collapsed buildings and bridges in the cities of Santiago and Puerto Plata and landslides in the mountainous outlying areas. Aftershocks reaching Mw = 5.1 followed for months afterward. This earthquake sequence is the strongest to affect the Dominican Republic since a series of powerful thrust events, which included five earthquakes ranging in magnitude from 7.1 to 8.1, occurred between 1943 and 1953. Prior to 1943, significant earthquakes occurred in 1564 (in which the city of Santiago was destroyed), 1783, 1842, 1887, and 1897.

Following the 2003 Puerto Plata main shock we deployed 10 IRIS PASSCAL broadband seismographs through IRIS’s Rapid Aftershock Mobilization Program in and around the aftershock zone for a period of two months and are analyzing the data jointly with data from two permanent seismic networks in the DR. Analyses include producing a new 1D model of earth structure, relocating more than 400 aftershocks, producing a 3D tomographic model of the fault zone from phase arrivals, and computing focal mechanisms. These will help elucidate the strain partitioning between strike-slip and thrust faults and form the basis for a longer-term study of the deep structure and tectonics beneath Hispaniola, which includes a pocket of unusually deep earthquakes, subduction of the Caribbean lithosphere northward—opposing the southwestward subduction of the North American Plate—and a long historical record of devastating, and tsunamigenic, earthquakes.