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Seismic and thermal evidences for subduction of exhumed mantle oceanic crust beneath the seismically quiet Antigua-St Martin Margin segment in the Northern Lesser Antilles

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Wide-angle, multichannel reflection seismic data and heat-flow measurements from the Lesser Antilles subduction zone depict a large patch of atypical oceanic basement in the trench and beneath the outer fore-arc offshore of the Antigua-Saint Martin active margin segment. This segment triggers a very low number of earthquakes compared to the seismicity beneath the Virgin Island Platform to the north or in the Central Antilles (Martinique-Guadeloupe) to the south.

Seven along-dip and two along-strike multichannel seismic lines acquired in this region show high amplitude steep reflectors that extend downward to 15-km depth in the downgoing slab. These lines also substantiate the absence of any reflections at Moho depth. Based on the wide-angle velocity model, the oceanic basement consists of a 5-km-thick unique layer with p-wave velocities ranging from 5.2 to 7.4 km/s, which is atypical for an oceanic crust. Heat-flow measurements along a transect perpendicular to the margin indicate a "flat" heat-flow trend from the trench to the fore-arc at 40 ± 15 mW.m-2 (Biari et al., same session). This heat flow profile contrasts with the expected trench-to-forearc decreasing heat-flow and the 50% higher heat-flow values measured in the trench offshore off the central Antilles. Calculated heat-flow for an incoming oceanic plate with a depressed geothermal gradient in the trench and heat source at depth in the subduction zone corresponding with temperatures of 200-250°C fit the measurements.

We propose that a large patch of exhumed and serpentinized mantle rocks solidified at the slow-spreading mid-Atlantic Ridge is currently subducting beneath the studied margin segment. The fact that the crust here consists of one single layer and comprises velocities higher than found in igneous rocks (> 7.2 km/s) are consistent with this hypothesis. The plate bending possibly triggers long and deep delamination planes that extend into the mantle beneath the serpentinization front, which has been identified as a reflector in the wide-angle seismic data. These delamination planes outcrop at the interplate contact creating weak zones that focus the tectonic deformation in the upper plate. An incoming oceanic crust made of serpentinized mantle rocks is consistent with a depressed geothermal gradient in the trench due to water alteration and heat generation at depth due to serpentinite dehydration. This fluid-rich altered and weak oceanic crust likely reduces the seismic activity along this margin segment.