Fault type identification and characterization in the Lesser Antilles using high resolution bathymetry and reflection seismic data

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Résumé

The volcanic island chain of the Lesser Antilles marks the eastern boundary of the Caribbean Sea and is a product of the subduction of the old Atlantic Plate (80 – 100 Ma) underneath the Caribbean. The subduction zone produces a moderate seismicity with strong earthquakes at comparably long recurrence times. Magnitude, recurrence time and location of earthquakes depend on temporal and spatial variations in the intraplate seismic coupling and faults and frictional properties, in which fluid migration plays an important role. Faults are known to be preferential fluid migration pathways, thus influencing seismicity. Furthermore, studies have shown, that many intraslab earthquakes do not only occur along the planes of maximum shear of the subducting slab but that intermediate-depth seismicity (30 – 70 km) occurs by reactivation of faults. Thus, understanding, identifying and characterizing faults within subduction zones can help to better understand overall seismic activity and subduction zone's dynamics.

Early hydration and faulting occur at mid-ocean ridges where ridge-parallel, steeply dipping normal faults are incorporated in the spreading fabric. Along the mid-Atlantic ridge, tectonic accretion occurs at some places through mantle exhumationa along shallow dipping detachment faults . Eventually, bending (normal) faults develop which are associated with the bending of the incoming oceanic plate along the subduction trench. Multibeam bathymetry studies have shown, that bending-related faulting forms patterns made of sets of faults with near parallel orientations to one another that could either be neofomed or reactivated structures.

Using bathymetric and reflection seismic data, acquired during three research cruises (Sismantilles, Antithesis and Manta-Ray), we categorize and identify three main classes of fault systems entering the subduction zone: normal faults in the spreading fabric, detachment faults and bending faults. Further categorization incorporates the evaluation of penetration depths, dipping angle and the comparison of strike directions of faults and nodal planes of (intermediate-depth) earthquakes.

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Mots-Clés: Antilles, seismic methods, subduction