2024_85_JC: Structure and tsunamigenic potential of the Lesser Antilles fore-arc

Supervisors: Prof Jenny Collier (mailto:jenny.collier@imperial.ac.uk); Prof Saskia Goes

Department: Department of Earth Science and Engineering

Subduction zones are the sites of the world's largest earthquakes, which sometimes generate devastating tsunamis. However, the conditions under which a large earthquake propagates to the surface and disrupts the seafloor in a manner that generates a tsunami (or not) is unclear. The earthquake/tsunamigenic potential of the Lesser Antilles Arc (LAA) is particularly poorly known, largely because of the challenge of obtaining data along this chain of small islands and through the thick sediments accumulating at the fore-arc. However, at least two historic earthquakes are thought to have been classical subduction thrust events, and possibly generated tsunami. Despite this, the extent of megathrust seismic coupling remains debated and the potential risk to large, poorly-protected communities in the Caribbean region is significant.

Rationale:

In a recent large NERC consortium grant, VoiLA, we collected new seismic data, including active source, in and around the LAA. Data from our experiment has been used to image the subduction zone in unprecedented detail. We have estimated incoming fluid distributions and compiled a preliminary catalogue of earthquakes detected during our seismometer deployment and developed a new moment tensor method to characterise faulting styles. We have been able to track how regions of more extensively hydrated incoming plate correlate with concentrations of small earthquakes and enhanced volcanic productivity along the arc.

This PhD project will quantify the pattern of hydration of the incoming plate and determine the structure of the fore-arc where the two tectonic plates scrape past each other. This will involve advanced travel-time and waveform tomography, including the study of converted S-waves which are most sensitive to fluids. These results will be combined with earthquake catalogues being generated within the group, and predictions of the thermal structure and subducting plate stresses from numerical models that are tailored from our detailed imaging of the subduction zone. Results will be shared with partners in the Caribbean responsible for hazard management. Given the LAA is an important end-member, where slow-convergence of old, highly hydrated Atlantic lithosphere happens, the project will contribute to a better understanding of global subduction.