Geophysical Research Abstracts
Vol. 21, EGU2019-17227-2, 2019
EGU General Assembly 2019

Rayleigh Wave Imaging of the Lesser Antilles

Nicholas Harmon (1), Catherine Rychert (1), Stephen Hicks (1), David Schlaphorst (2), Lidong Bie (3), Ben Maunder (4), Jenny Collier (4), Andreas Rietbrock (5), Frank Krüger (6), Saskia Goes (4), J Michael Kendall (2), and Jeroen Van Hunen (7)

(1) University of Southampton, Southampton, United Kingdom, (2) University of Bristol, Bristol, United Kingdom, (3) University of Liverpool, Liverpool, United Kingdom, (4) Imperial College, London, United Kingdom, (5) Karlsruhe Institute of Technology, Karlsruhe, Germany, (6) GFZ Postdam, Potsdam, Germany, (7) Durham University, Durham, United Kindgdom

The Lesser Antilles Arc is an important global end member in subduction, where slow spread, potentially more hydrated, Mid-Atlantic Ridge lithosphere of the North and South American Plates is slowly converging with the Caribbean Plate. From March 2016-Jan 2018, we performed an onshore-offshore experiment across the entire forearc and backarc of the Lesser Antilles as part of of the Volatiles in the Lesser Antilles (VOILA) Project. The experiment used 34 broadband ocean bottom seismometers, 8 temporary stations in the Grenadines and the publicly available data from the networks across the region. We performed Rayleigh wave tomography from the onshore-offshore deployment We use a combination of ambient noise tomography and teleseismic surface wave tomography using the two-plane wave method to construct a 3-D shear velocity model across the region. We image the incoming plate and subducting slab as a tabular high velocity region (> 4.5 km/s) down to 200 km depth throughout the region. We find good agreement between our interpreted slab feature and local seismicity recorded during our deployment. In the mantle wedge we image low seismic velocities in the upper 100 km of the arc/back arc in the region, primarily focused in the northern and central parts of the backarc and extending up to 200 km westward from the arc. The lowest velocities ($\sim$4.2 km/s) are found in the mantle wedge near Dominica. We image a high velocity seismic lid (> 4.5 km/s) in the back arc region which is $\sim$60 km thick, but a thin to non-existent high velocity lid beneath the arc. We also image an $\sim$80 km thick incoming oceanic lithosphere of the North and South American Plates.

Velocity models are compared to 2-D geodynamic models and predictions for seismic velocities to constrain the amount of water and/or melt that is required to explain the back arc low velocities. The low velocities in the back arc can be attributed to a hydrated mantle wedge and/or possibly a small degree or partial melt (nominally $\sim$3000 H/Si). In order to hydrate the back arc, the fluids must be released from the deeper parts of the slab, as the corner flow is sluggish, and fluid ascent is expected to be vertical. This requires dehydration reactions to occur in the mantle part of the down going plate, where colder temperatures are maintained to greater depth of subduction. The deep release of fluids suggests Mid-Atlantic Ridge generated lithosphere has been significantly serpentinized to 10's of kilometres below the Moho, which is consistent with relatively deep seismicity observed at long offset fracture zones at the Mid-Atlantic Ridge. Indeed, we find good agreement between the projection of the Marathon, Mercurius and Vema Fracture zones onto the downgoing slab with our seismically slow back arc anomalies focused beneath Dominca. This suggests that the fracture zones enable deep slab hydration, which strongly impacts fluid release, transport and dynamics of the wedge.