Evolution of Caribbean subduction from P-wave tomography and plate reconstruction

Background

- Caribbean subduction governed tectonic evolution, associated hazards and distribution natural resources.
- One of only two zones that subducts Atlantic seafloor, by slow spreading, a global end member of old oceanic lithosphere subducting at slow speeds.
- Poorly understood subduction history involving changes in length and shape of the trench and several generations of arcs.

Aims

- In our Volatile Recycling in the Lesser Antilles (VoIa) project, we installed the first ocean-bottom seismometer (OBS) network in the region (red triangles, Fig. 1). Using these data, we improve imaging of the eastern Caribbean upper mantle using teleseismic P-waves.
- We compare imaged fragments of subducted plate with subduction locations predicted from a recently published plate reconstruction.

Plate reconstruction

Reconstruction: Müller et al. (Tectonics, 2019) updated as follows: (1) improved geometry of Atlantic opening boundaries (2) Proto-Caribbean opening was reconstructed using an improved geometry of the ridge between North and South America and assuming symmetric spreading.

P-wave tomography

VoIa-P19: Joint inversion of data from regional seismic networks (VoIa experiment and additional land stations on Fig. 3) together with the highest quality data from the global EHB catalogue [Engdahl et al., BS&A 1998], using the method of Widyananto and van der Hilst (GiJ 1997) where a fine regional grid is embedded in a coarser global grid.

Conclusions

- In eastern Caribbean upper mantle, material subducted at different trenches from 70 Ma has accumulated in similar location due to westward movement of the Americas.
- 100-120 Ma slab in the shallow lower mantle below northeastern South America consistent with start of GAC subduction prior to the most significant phase of CLIP plume volcanism.
- Slab gaps found at the location of the Proto-Caribbean spreading ridge, detachment of the northern GAC slab after Cuba docked with North America, and a lateral tear below Grenada, likely along a Proto-Caribbean fracture zone.
- NAM-SAM plate boundary is yet to start subducting, but subducted anomalies (arrows Fig. 3b) may correspond to hydrated plate-domain boundary between lithosphere formed in Proto-Caribbean and that formed in Equatorial Atlantic.

Acknowledgements: Funded by HERC consortium grant (NE/J020382/1). Thanks to all who sailed on cruises RMS James Cook KC123 and JC149, our partners at the University of West Indies Seismic Research Centre (SRL), the German Instrument Pool for Amphibian Seismology (DEPAS), and USCS (Scirps) for providing ocean-bottom seismometers.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5