Seismicity and Mantle Pn Velocity Estimates at the St Paul Transform System

Report for the InterRidge Graduate Student Fellowship

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Support from an InterRidge Student Fellowship allowed me to carry out research at Scripps Institution of Oceanography (SIO), University of California San Diego (UCSD) in November of 2019, in collaboration with Dr. Ross Parnell-Turner. Seismic Pn velocities for the oceanic upper mantle are rarely measured, due to the difficulty in deploying instruments for extended time periods in remote regions such as the Equatorial Atlantic ocean. The focus of this project was to estimate upper mantle seismic velocity along the St. Paul, Strakhov and Romanche transform fault systems, and also the Mid-Atlantic Ridge using earthquakes recorded between July 2012 and July 2013. We used waveforms from 54 regional earthquakes with magnitude greater than Mw 3.6, recorded by six autonomous hydrophone instruments deployed in the region (Smith et al., 2012; Maia et al., 2016). We combined these records with data from the broadband seismograph station installed on St. Peter and St. Paul Island (de Melo and do Nascimento., 2018). Figure.1 shows the catalog earthquakes selected for analysis, with their raypaths from source to the instrument.

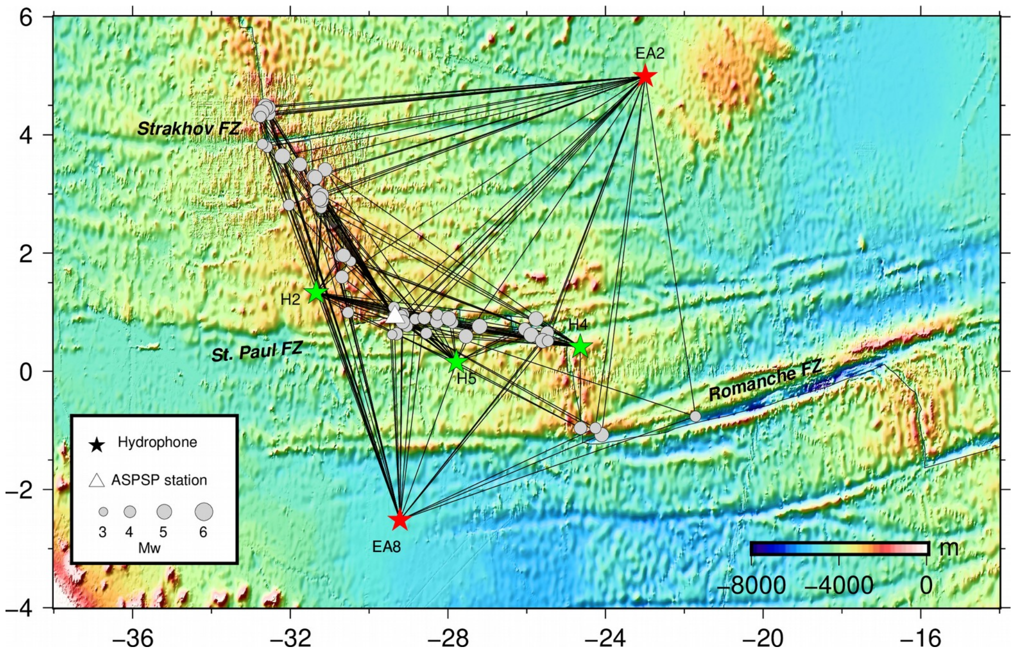

Figure 1. Bathymetric map showing earthquakes (gray circles, scaled by Mw), hydrophones , (red/ green stars; Smith et al., 2012 and Maia et al., 2016, respectively), and ray paths (black lines). ASPSP station located on St Paul Island marked with white triangle.

Waveform data recorded by the hydrophones and ASPSP seismograph station were analyzed using SAC (Seismic Analysis Code) software. A 6–20 Hz bandpass filter was applied to the waveform data to remove noise, then Pn arrivals were picked manually. Predicted Pn arrivals were calculated using the IASP90 global 1D velocity model, and used to aid identification of observed Pn arrival times. The observed arrival time was combined with the origin time and hypocenter location from the ISC catalog to calculate Pn velocity for each raypath, yielding a total of 186 separate Pn estimates. Pn estimates from individual ray paths range from 7.2 to 9.2 km/s (Figure 2). A comparison of Pn velocity with oceanic crustal age shows that there is only a weak dependence of velocity and age, with slightly elevated velocities on crust >30 Ma in age. Relatively slow Pn velocities of 7–8 km/s were identified along several segments of the Mid-Atlantic Ridge located between the boundary of transform faults. Highest velocities (8.6–9.2 km/s) were observed with rays that travelled approximately along the St Paul transform system. We also found no correlation between Pn and estimates of shear wave velocities at depths >150 km (i.e. beneath the lithospheric plate) from a global tomographic model (Schaeffer & Lebedev, 2013). This result suggests that upper mantle Pn variations do not simply reflect processes deeper in the mantle.

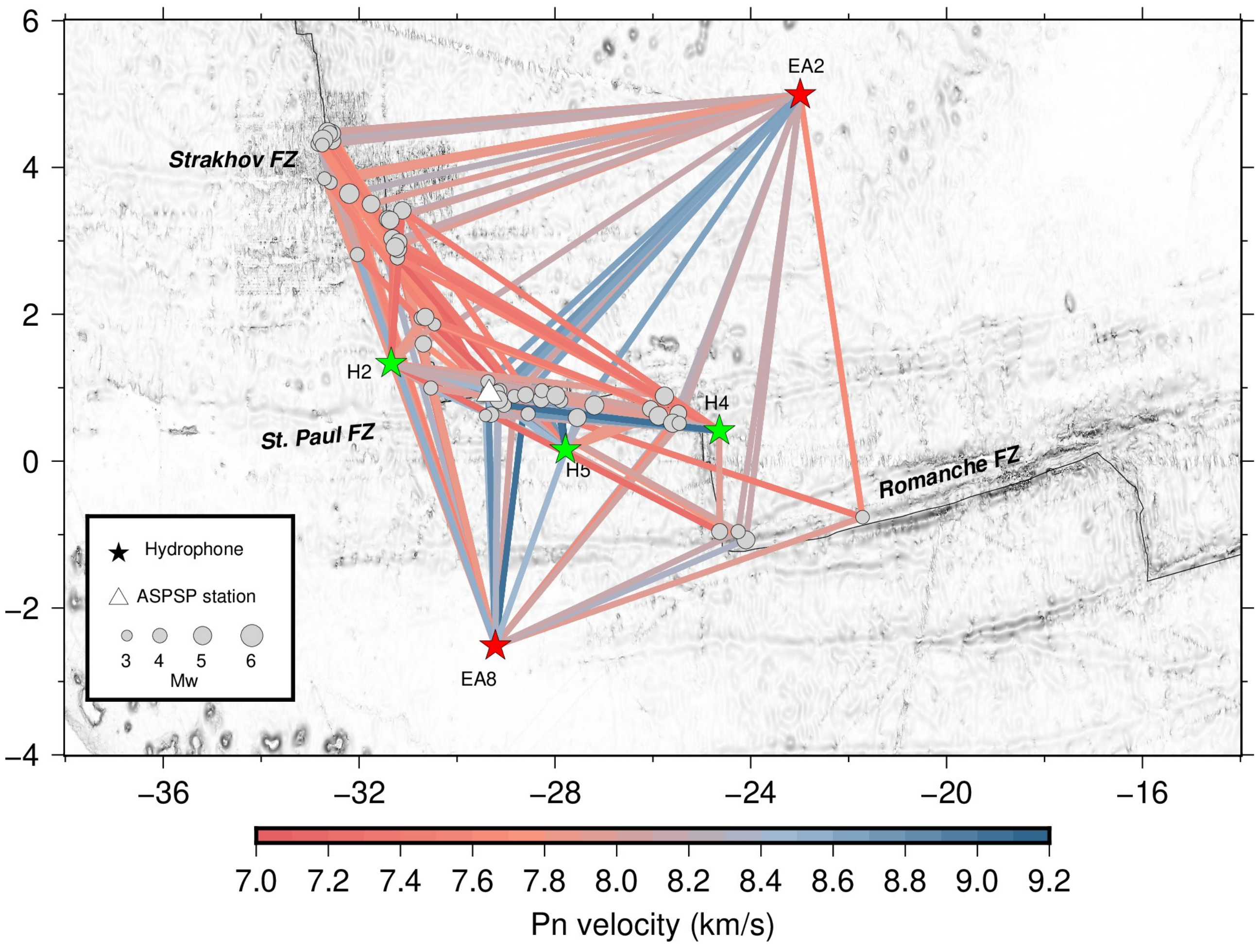

Figure 2. May showing earthquakes, stations, with raypaths colored by estimated Pn velocity.

Conclusion

The InterRidge Graduate Student Fellowship allowed us to make rare estimates of upper mantle Pn velocity variations in the Equatorial Atlantic ocean. We used autonomous hydrophones to estimate Pn velocity of earthquakes that occur along the ocean faults and spreading ridges, and found relatively fast mantle velocities beneath the the St. Paul Transform System, compared with other transform faults in Equatorial Atlantic. The results were presented at the AGU Fall Meeting in 2019 (de Melo et al., 2019), and will be submitted to a peer-reviewed journal.

References

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