Upper Mantle Seismic Velocity Estimates around the St. Paul Transform System, Equatorial Atlantic

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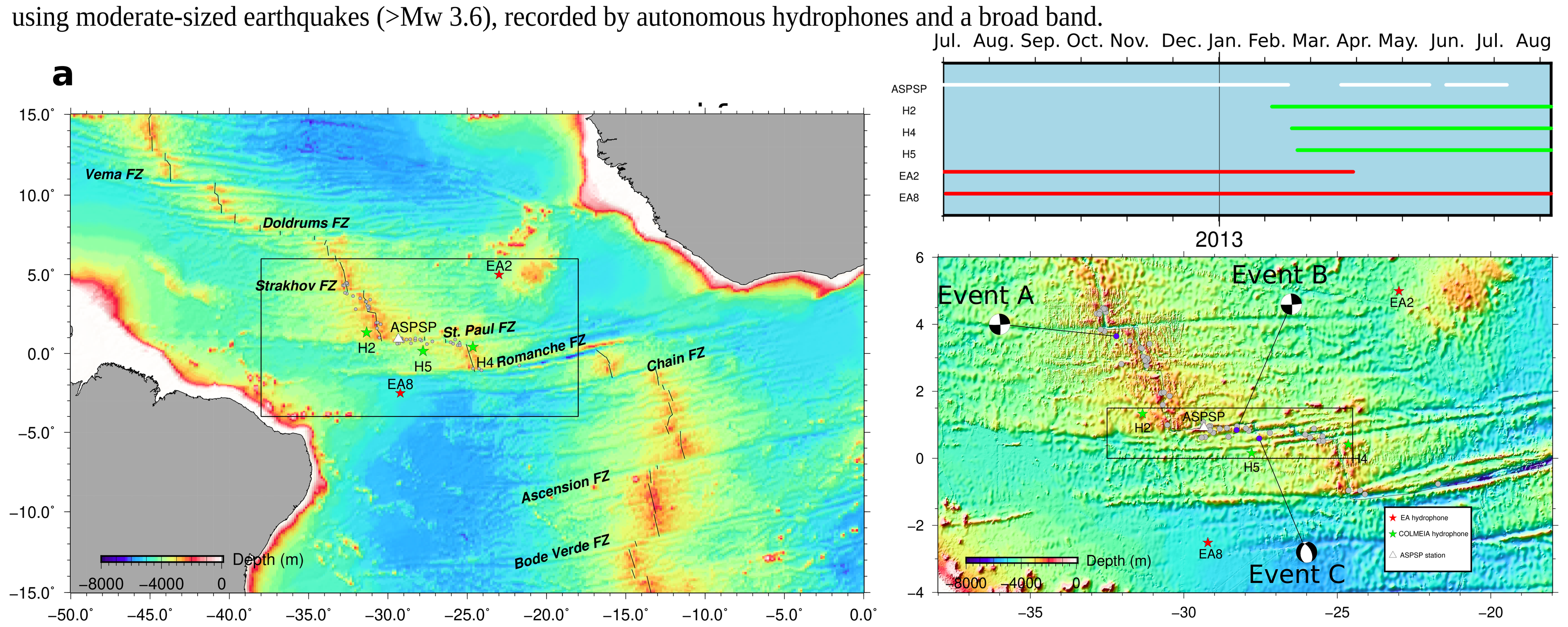
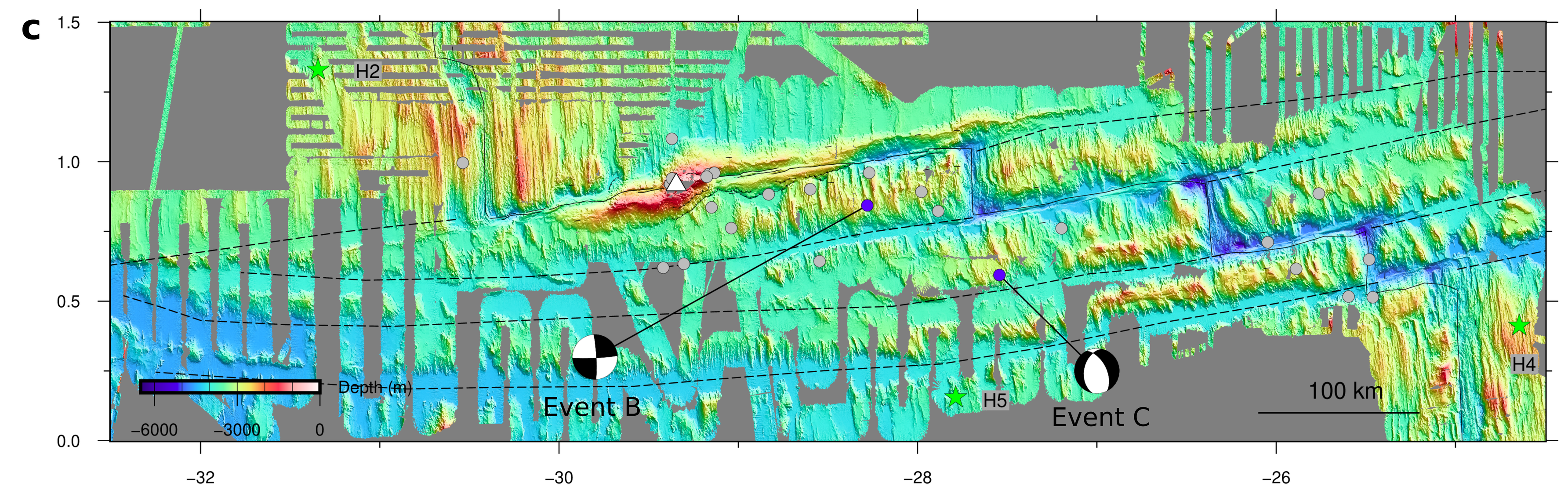
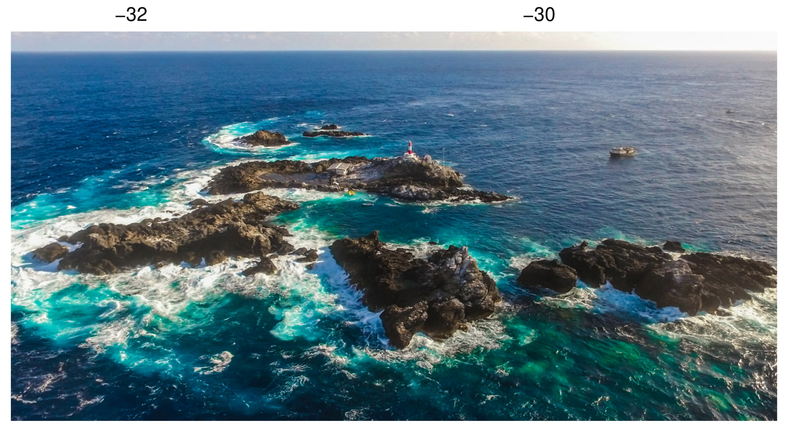
1 Introduction

Four transform faults and three intra-transform ridge segments make up the St Paul transform system (SPTS), located in the equatorial Atlantic ocean. Rocks on the St and St Paul Islets are brought to the surface by transpression, resulting in exposures of serpentinized and mylonitized peridotites. It is thought that the nature of the underlying mantle may explain this extraordinary uplift (Maia et al., 2016), however observations of lower crust and mantle seismic properties are difficult due to the remote location. Here, we present estimates of upper mantle Pn velocity, obtained using moderate-sized earthquakes (>Mw 3.6), recorded by autonomous hydrophones and a broad band.







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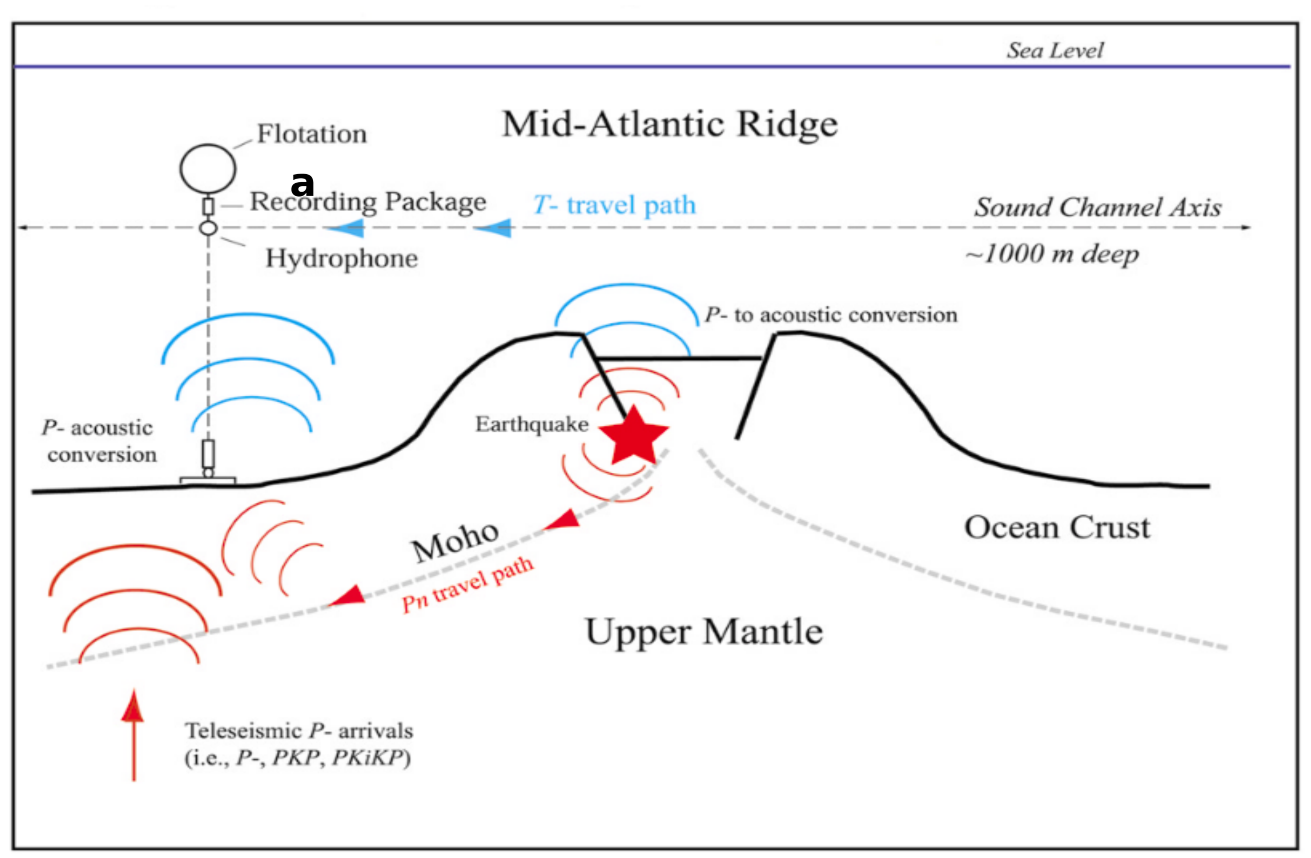
Objectives

Our first objective is to estimate upper mantle Pn velocity in the St Paul transform system and surrounding mid-Atlantic Ridge segments. We aim to use these estimates to examine how variations in upper mantle velocity might influence uplift of the SPTS, and the relationship between Pn, transform fault processes and crustal structure.

2 Data Acquisition

Data were recorded by a single seismographic station (ASPSP) on St. Peter and St. Paul Islet (de Melo & do Nasciemento., 2018); two autonomous hydrophones (EA2 and EA8) were deployed in 2011-2015 as part of the EA array (Smith et al., 2012), and three more (H2, H4 and H5) were deployed during COLMEIA experiment in 2013 (Maia et al., 2013).

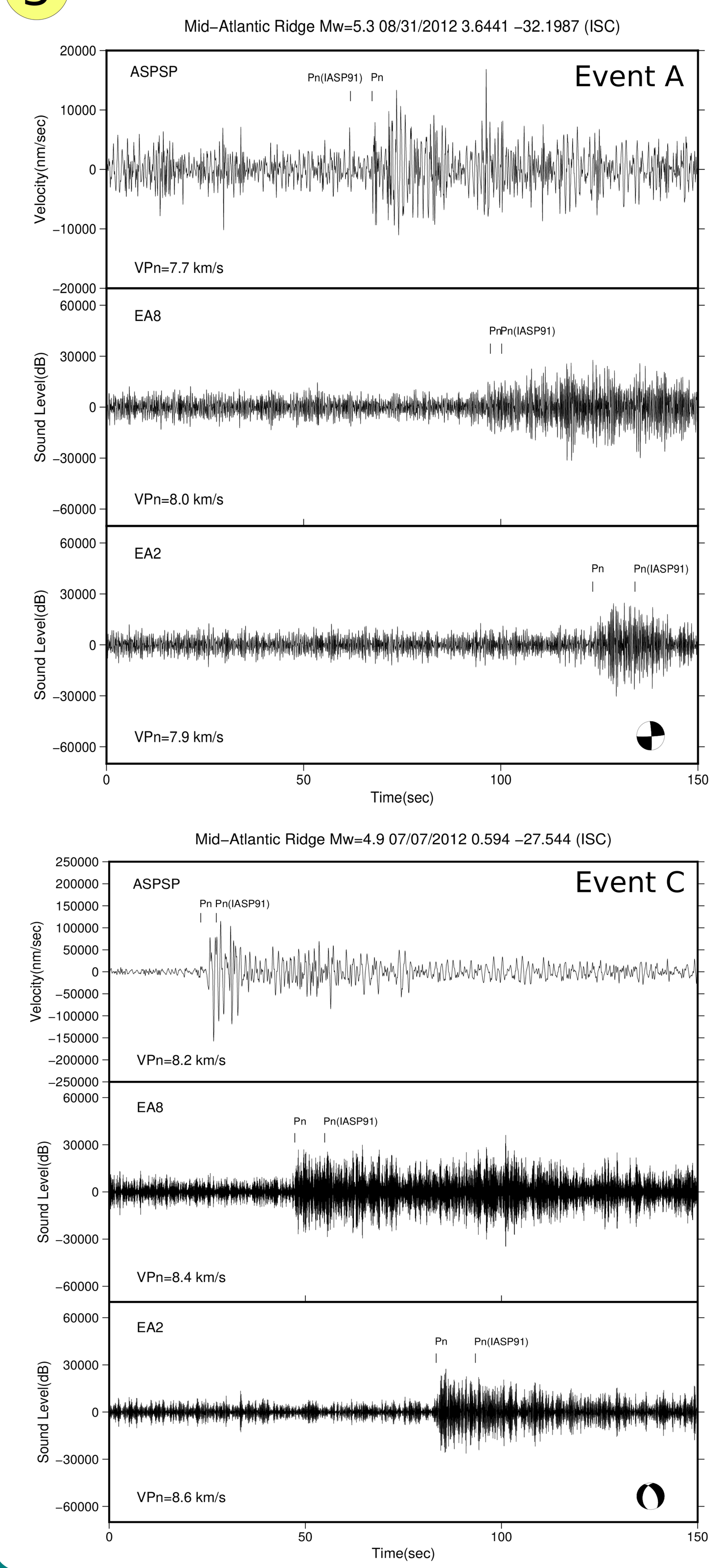


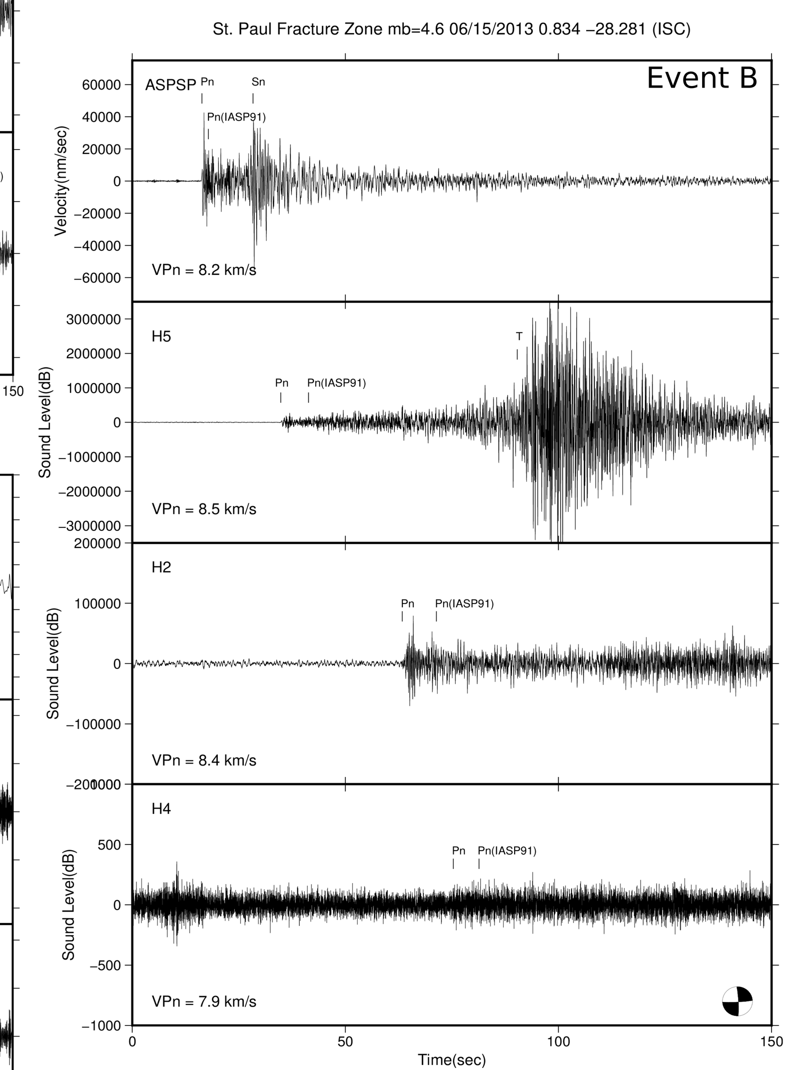
Analysis

Waveform data were bandpass filtered at 6-20 Hz, and Pn arrivals were identified with the aid of predicted arrival times from the IASP91 global model. Pn arrivals were then then picked manually for each station. Event origin times and locations were taken from the ISC catalog, giving a travel time to each station. An additional delay was added to account for the length of the mooring cable, using a constant water velocity from the global ocean sound speed model (GDEM). **(a)** The diagram present a scheme of seismic/ acoustic propagation paths of the P waves (obtained in Dziak et al., 2004).

3 Regional Earthquakes

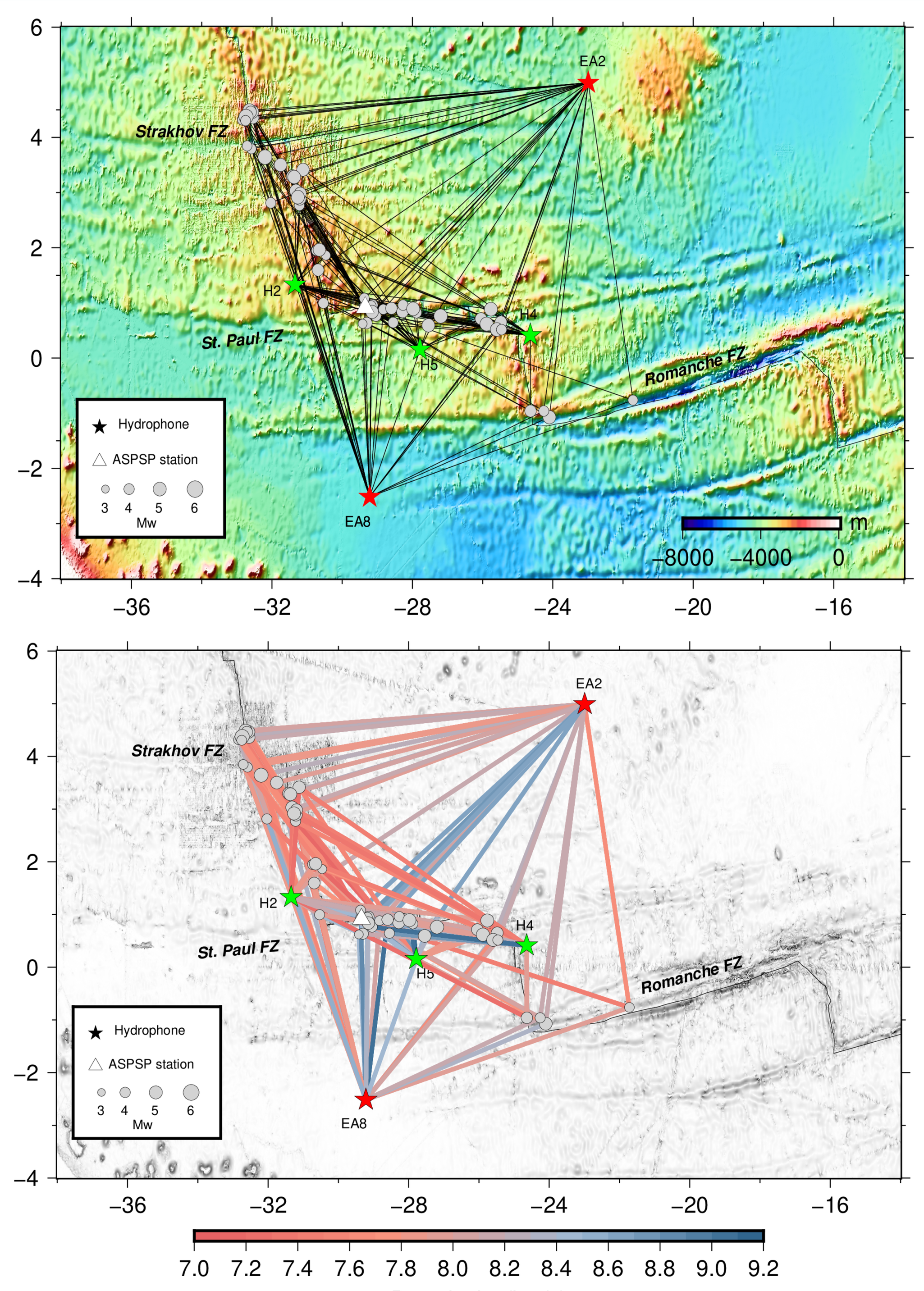
Waveforms from 54 regional earthquakes were used, (Mw 3.5-5.4) over the time interval shown in 1a. Plots below and right show predicted Pn arrivals (IASP91), observed Pn arrivals, moment tensors (ISC), and resulting Pn velocity estimates for three example events in **(a)**, **(b)** and **(c)** records.





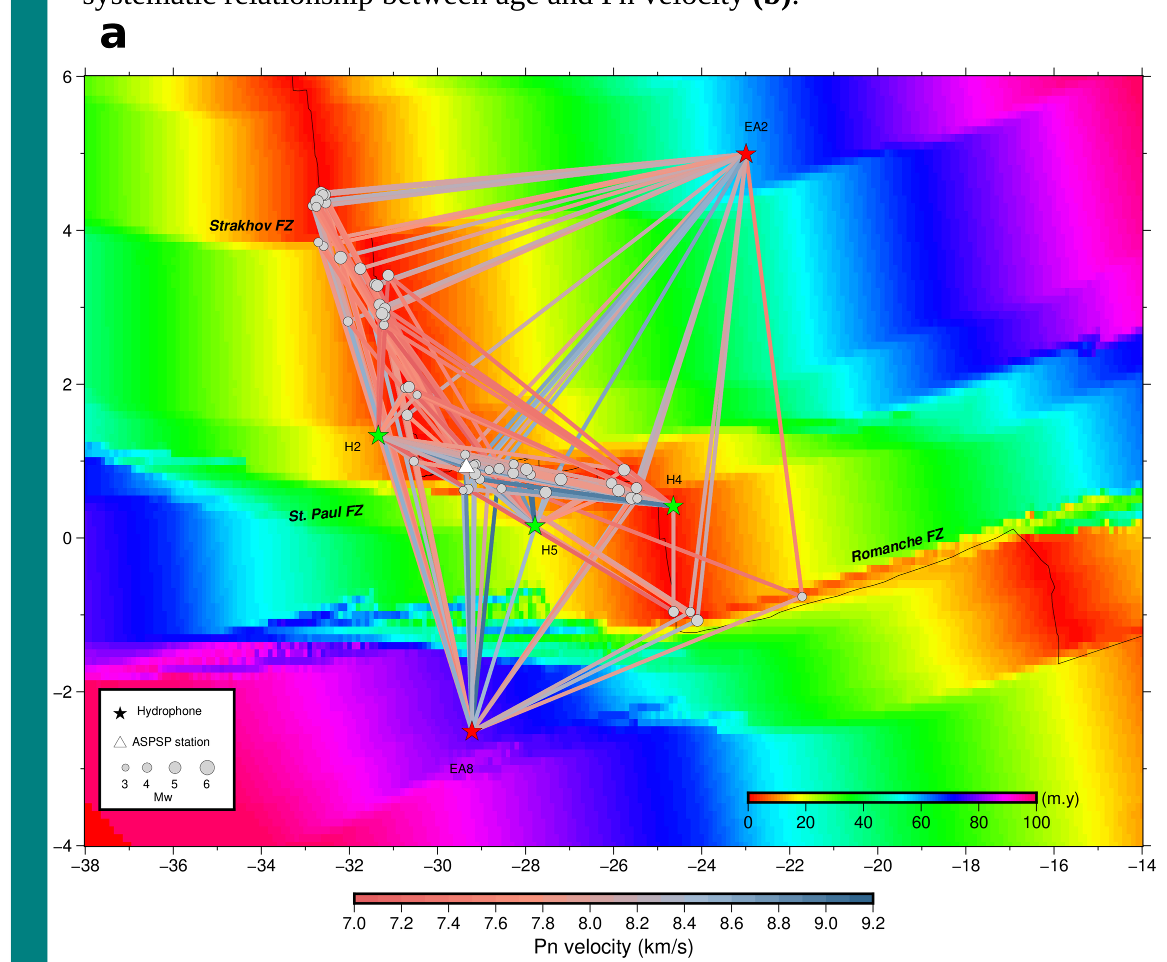
4 Raypaths and Pn velocity

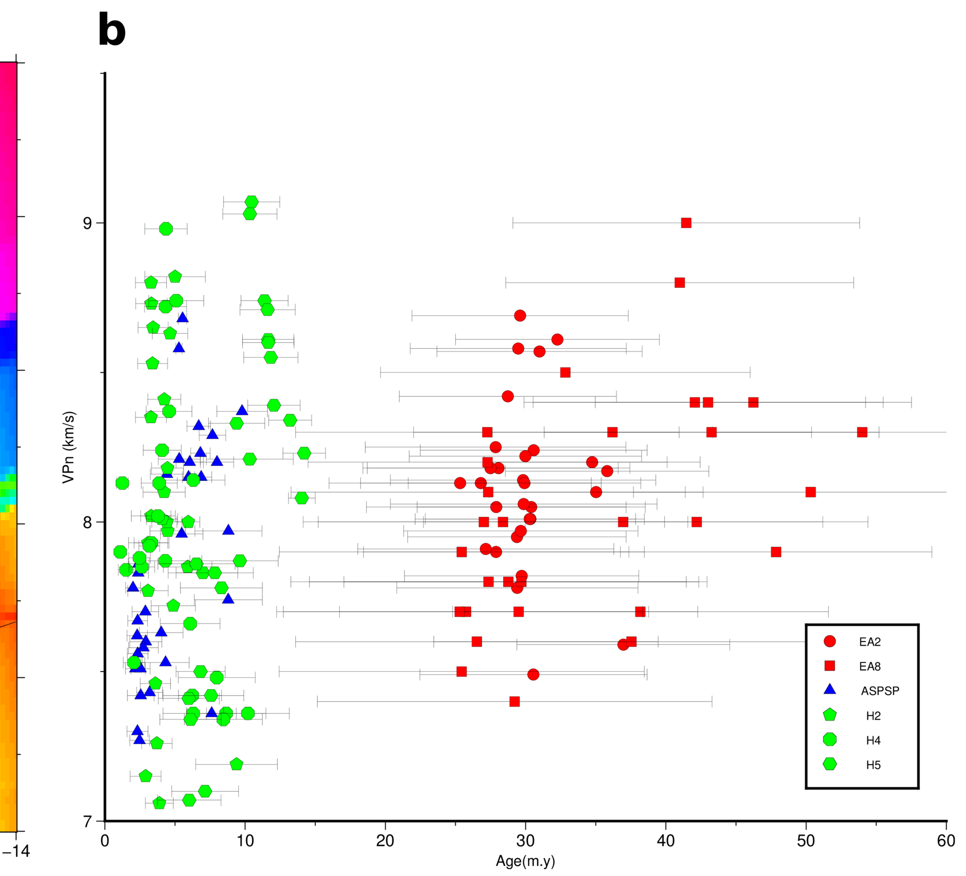
A total of 186 raypaths were analysed along the work. 90 of them belong to the 30 earthquakes occurred in 2012, being it from EA2 and EA8 hydrophone together ASPSP station. We obtained the total of 96 raypaths in 2013, which they were from the three COLMEIA hydrophone together of the ASPSP station records. The epicentral distances shown a range from 60.5 km until 1094.9 km, and arrival times range between 14 and 139.5 seconds. It was calculated using the epicenter coordinates of ISC catalogue to events with magnitude above 4.0. In 2013 events list, four of them with magnitudes 3.5-3.6 ML occurred in St. Paul Transform System were add to ISC catalogue to events using the ASPSP station (de Melo et al., 2019, submitted).



5 Crustal Age and Pn velocity

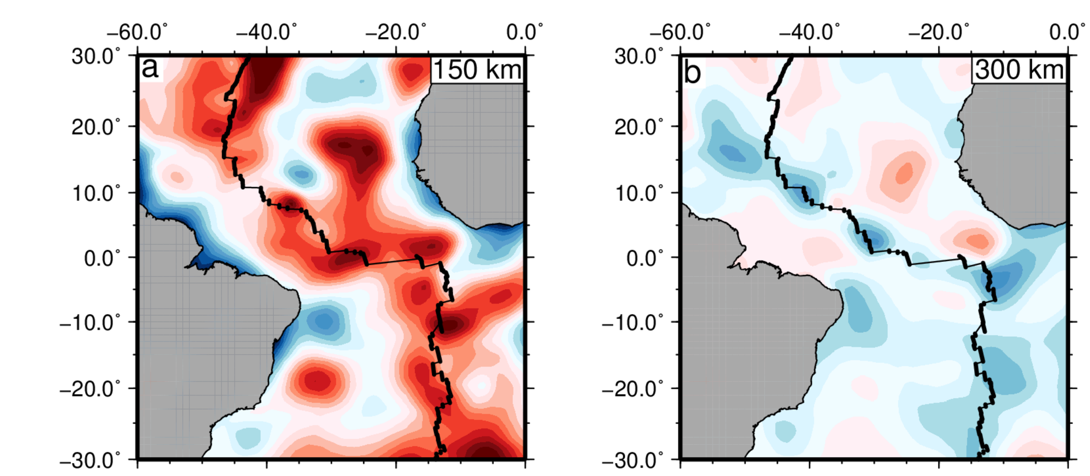
We explore the relationship between Pn velocity and oceanic crustal age. Our raypaths cross a range of crustal ages until 15 m.y with Pn values reaching since 7.2 until 9.2 km/s, and crustal ages 25-55 m.y shown a Pn velocity range of 7.4-8.7 km/s **(a)**. However, there is weak evidence for a systematic relationship between age and Pn velocity **(b)**.

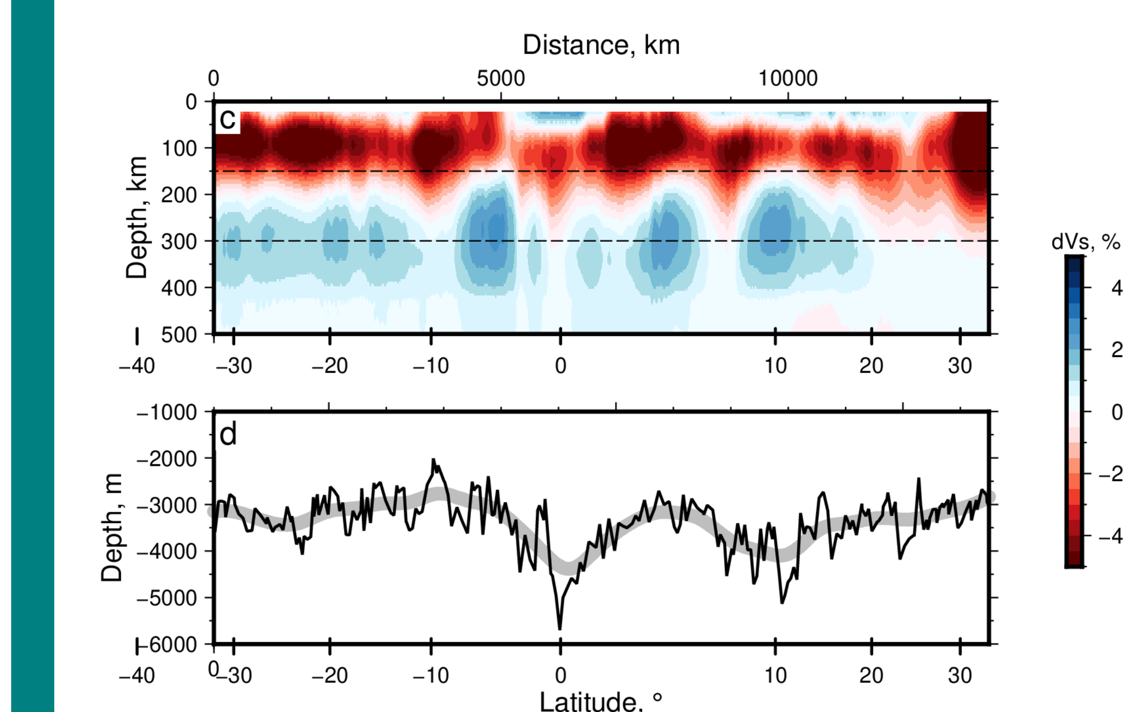


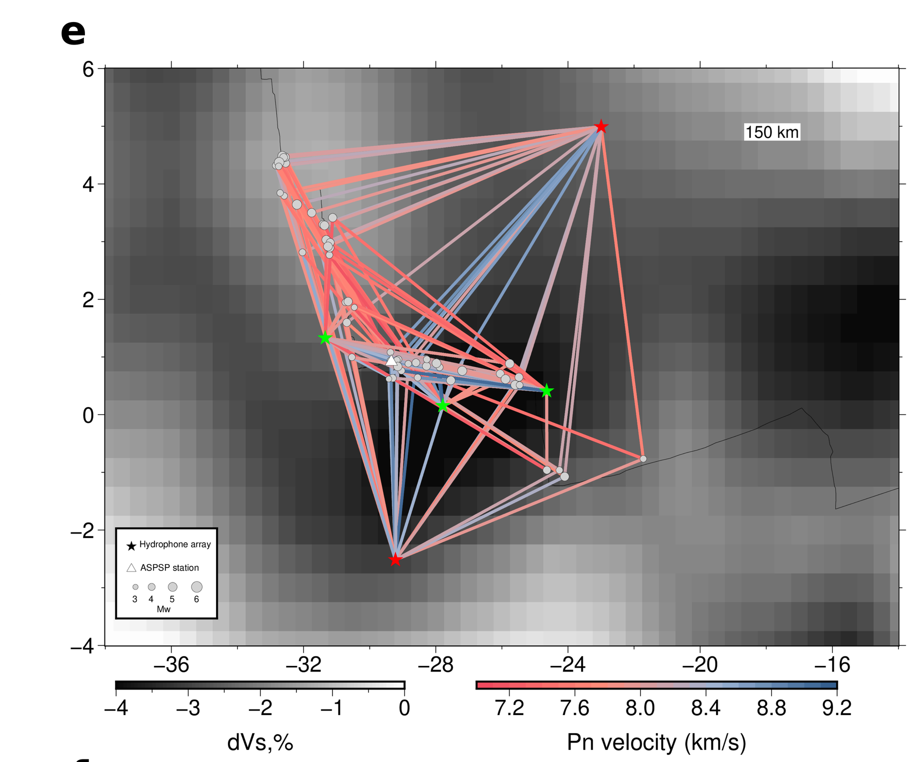


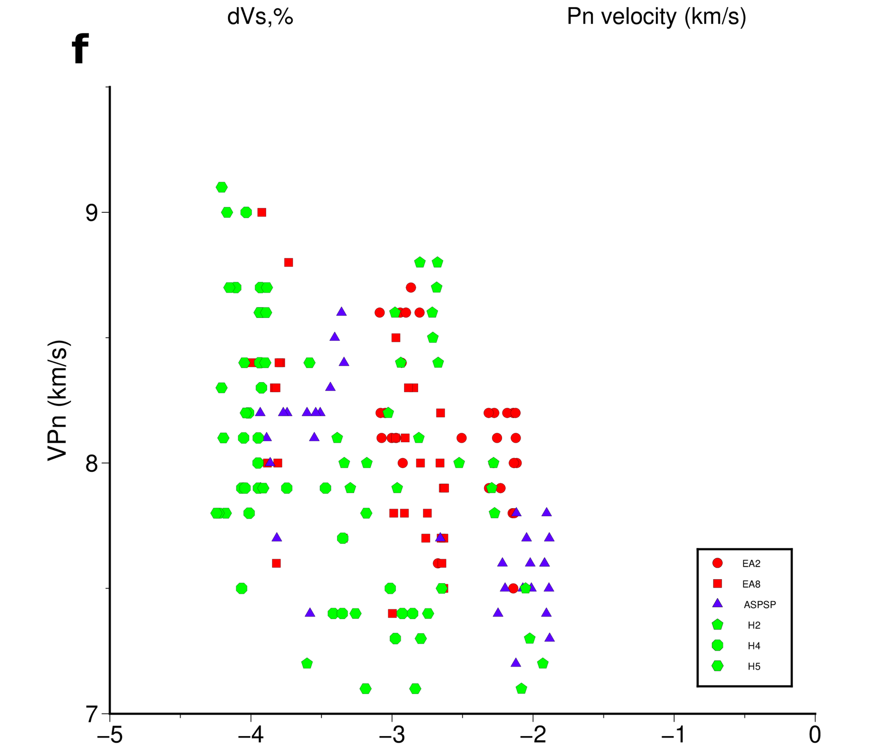
6 Sub-Plate Velocities

We compare our Pn velocity estimates with a global shear wave velocity model (Schaeffer & Lebedev, 2013), to investigate whether our high Pn velocity estimates have any relation to deeper mantle properties. However, we find that the Pn velocities measured there is no clear relationship with dVs **(f)**.









7 Conclusions

- Autonomous hydrophones can be used to measure Pn velocity of earthquakes occurred along the ocean faults and spreading ridges
- Pn wave present high velocities along the St. Paul Transform System, Equatorial Atlantic
- Crustal age shown weak relationship with Pn velocities and dVs of global tomography are not correlated

Selected References

de Melo and do Nascimento. (2018), *Pure and Applied Geophysics*. **178**, 741-756

Dziak et al. (2004), *Bulletin of Seismological Society of America*, **94**, 665-677

Maia et al. (2016), *Nature Geoscience* **9**, 619-624

Schaeffer and Lebedev. (2013), *Geophysical Journal International*, **194**, 417-449

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