# Investigating Marine Sediments of the Alaska-Aleutian Subduction Zone Through OBS-Enabled Seafloor Compliance Measurements

Mengjie Zheng[1,2], Anne F. Sheehan[1,2], Chuanming Liu[4], Mengyu Wu[3], Michael H. Ritzwoller[3]
mengjie.zheng@colorado.edu
1 CIRES, University of Colorado Boulder ; 2 Department of Geological Sciences, University of Colorado Boulder;
3 Department of Physics, University of Colorado Boulder; 4 University of Texas at Austin

## Introduction

Characterizing the sediment properties of subduction systems is essential for comprehensively understanding of subduction dynamics and geometry. The complexity and variability of the seafloor sediment used to be hypothesized to contribute to along-strike variations of seismicity in Aleutian-Alaska subduction zone[1]. The Alaska Amphibious Community Seismic Experiment (AACSE)[2], designed to sample the subduction zone at the Alaska Peninsula region including the incoming Pacific plate, accretionary wedge and forearc, offers a unique opportunity to test this hypothesis and investigate the role of seafloor sediment in subduction systems.

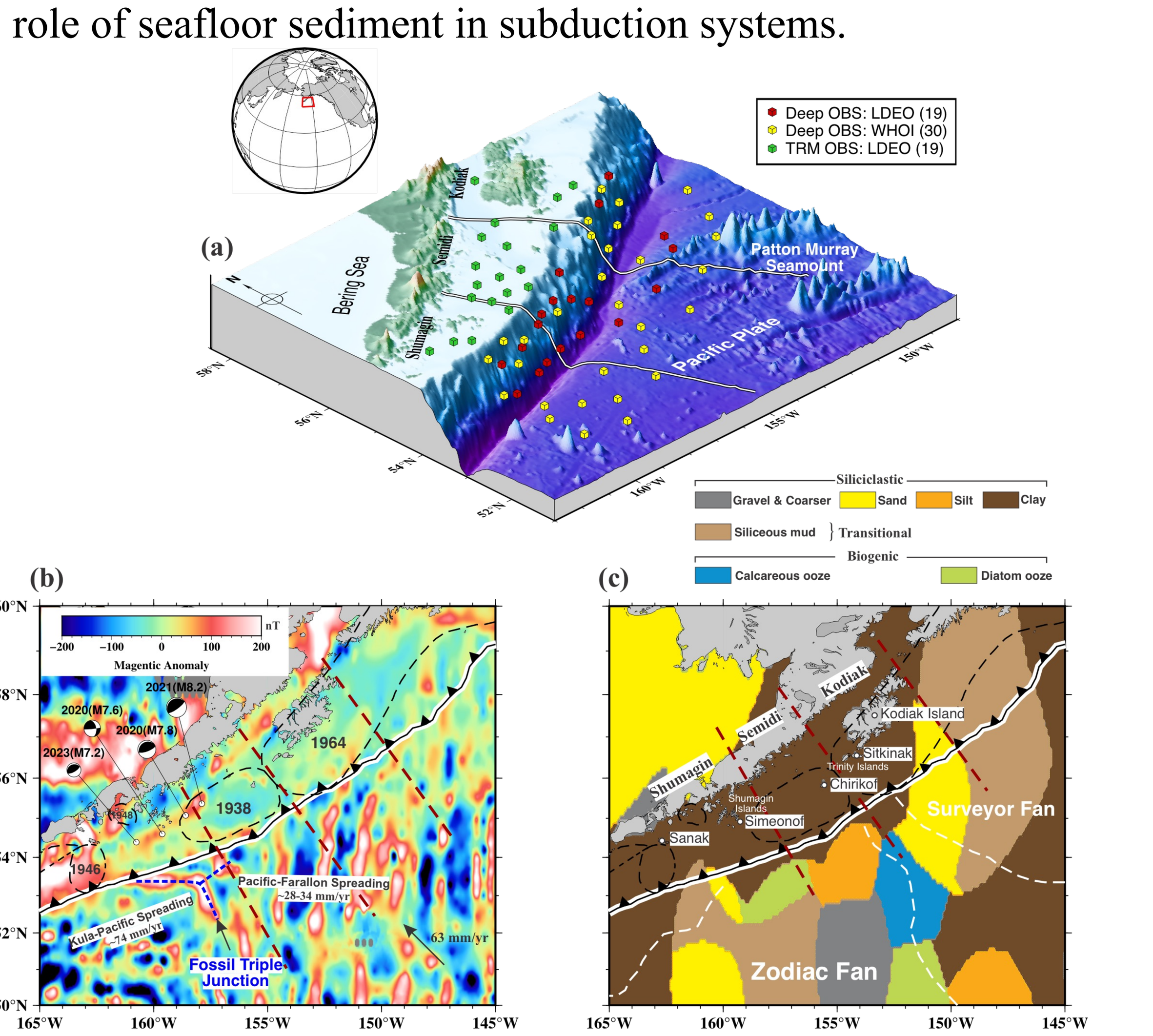


Figure 1 (a) Oblique view of the Alaska-Aleutian subduction zone at the Alaska Peninsula region, showing 68 ocean-bottom seismometers (OBS) used in this study. (b) Magnetic anomaly map at the Alaska Peninsula. (3) Seafloor lithology map of the Alaska Peninsula.

## Data and Methods

- **Seafloor Compliance**: A measure of seabed stiffness, i.e., how much the seafloor moves under pressure forcing from ocean waves.

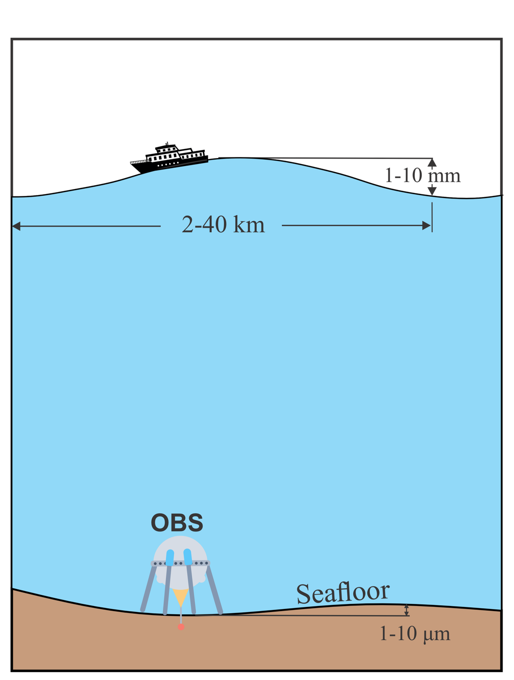


Figure 2 Illustration of ocean infragravity wave and the resulting seafloor compliance, which refers to seafloor's elastic response to the pressure induced by the ocean wave

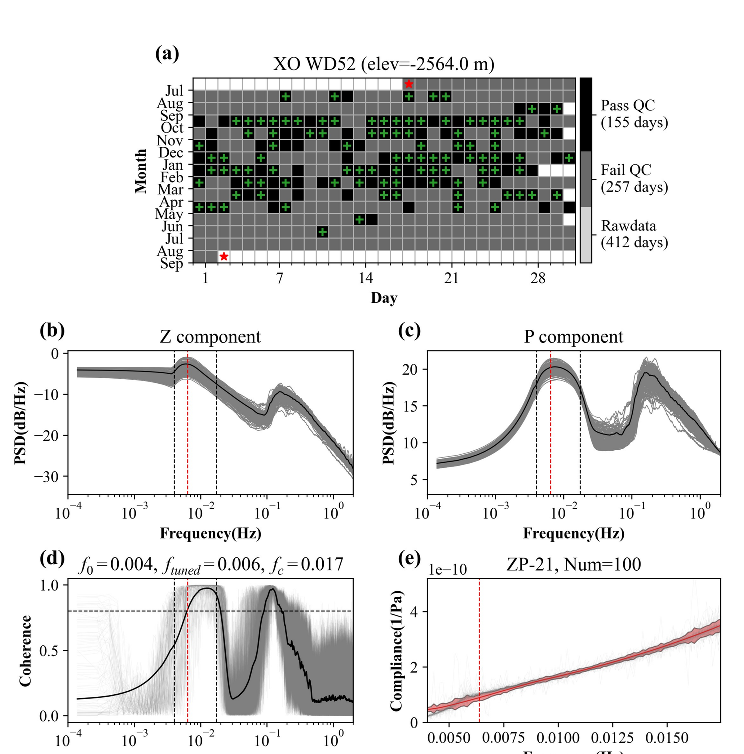


Figure 3 (a) Quality Control[3] statistics for daily noise seismograms. (b) Daily PSD functions and the averaged PSDs for the vertical component. (c) Similar to (b) but for the pressure component. (d) The Z-P coherence functions. (e) The retained and averaged compliance measurements.

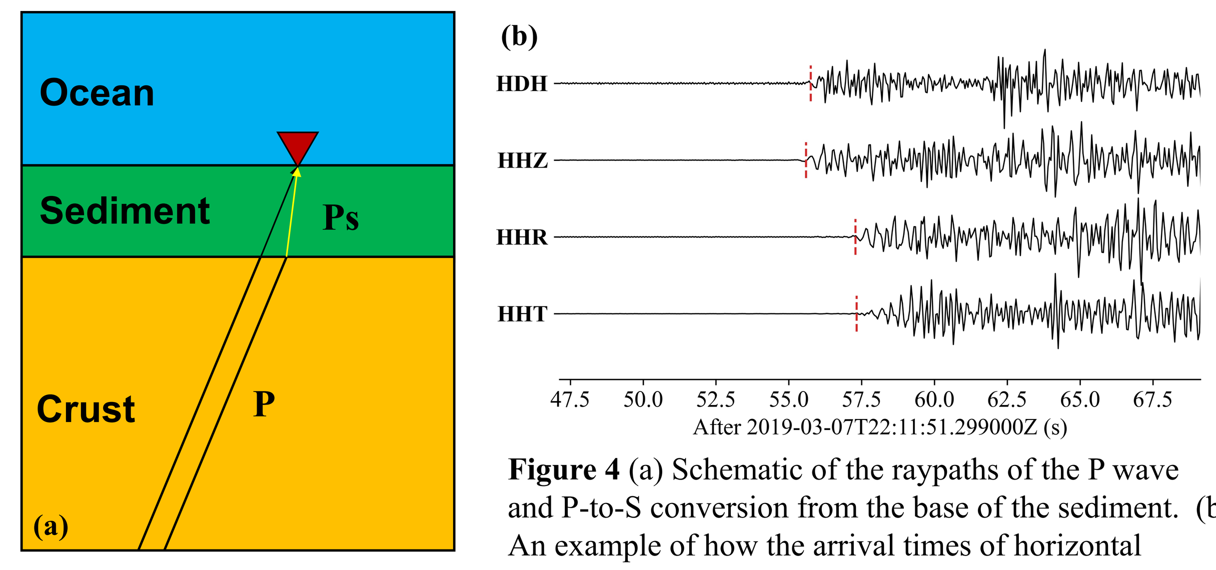


Figure 4 (a) Schematic of the raypaths of the P wave and P-to-S conversion from the base of the sediment. (b) An example of how the arrival times of horizontal components (HHR and HHT) are delayed compared to the vertical (HHZ) and pressure components (HDH).

- **Ps Converted Wave**: The sharp contrast in seismic properties between seafloor sediment and ocean crust results in the conversion of upward propagating P-waves to S-waves

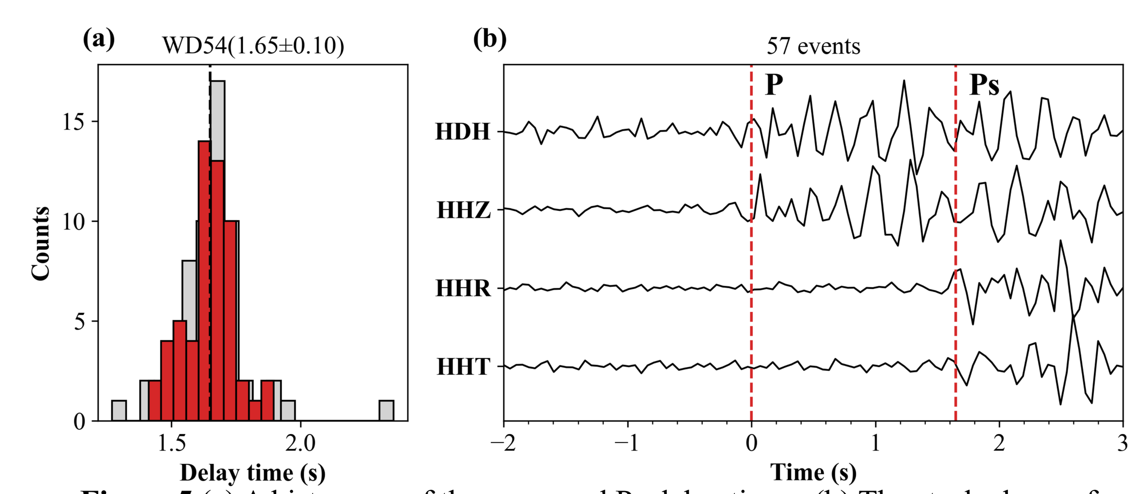


Figure 5 (a) A histogram of the measured Ps delay times. (b) The stacked waveforms from different earthquakes.

- **Monte Carlo Joint Inversion**

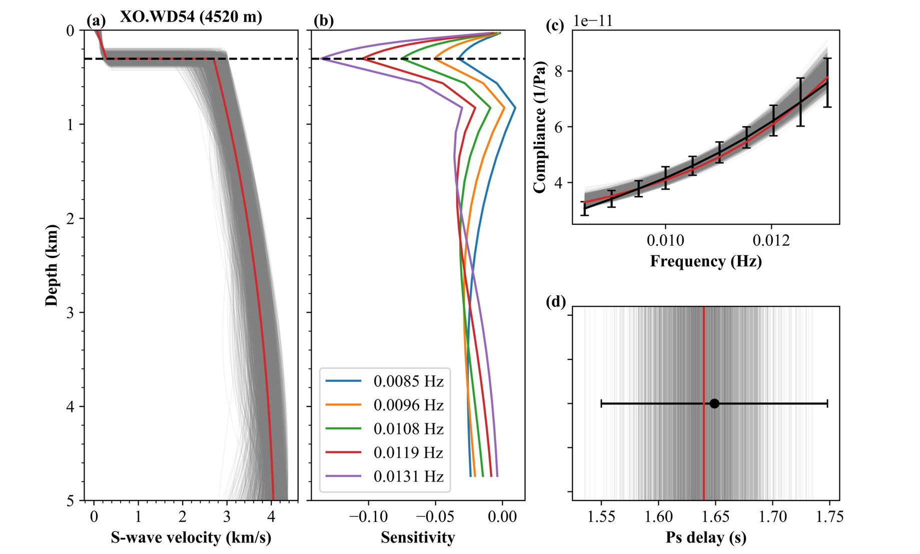


Figure 6 (a) 2,000 randomly picked models (gray lines) and misfit-weighted average model (red line). (b) The associated sensitivity kernel curves. (c) Compliance functions as calculated and measured, with the red line representing the calculated compliance of the averaged model. (c) Similar to (b), but for Ps delay.

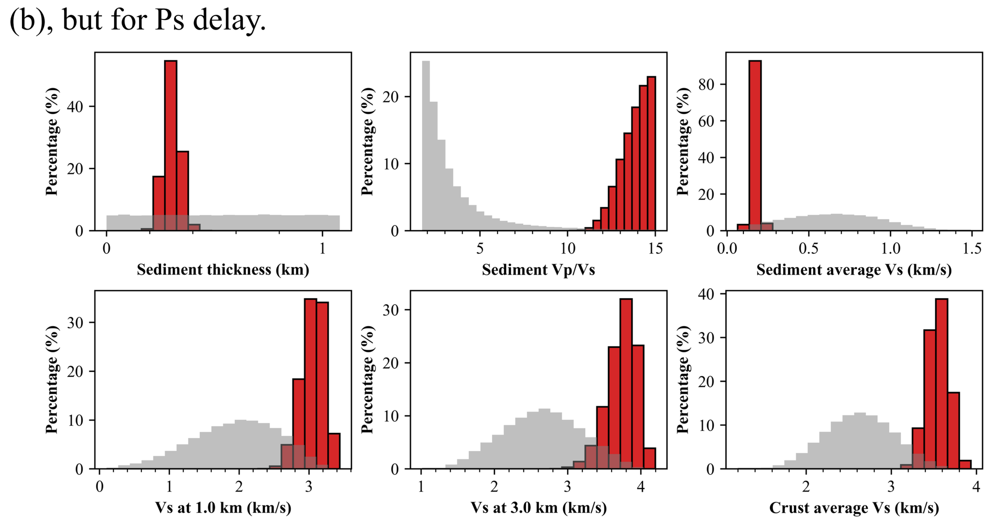


Figure 7 The prior (gray) and posterior (red) distributions of model parameters.

- **Sediment thickness & Vp/Vs ratio**

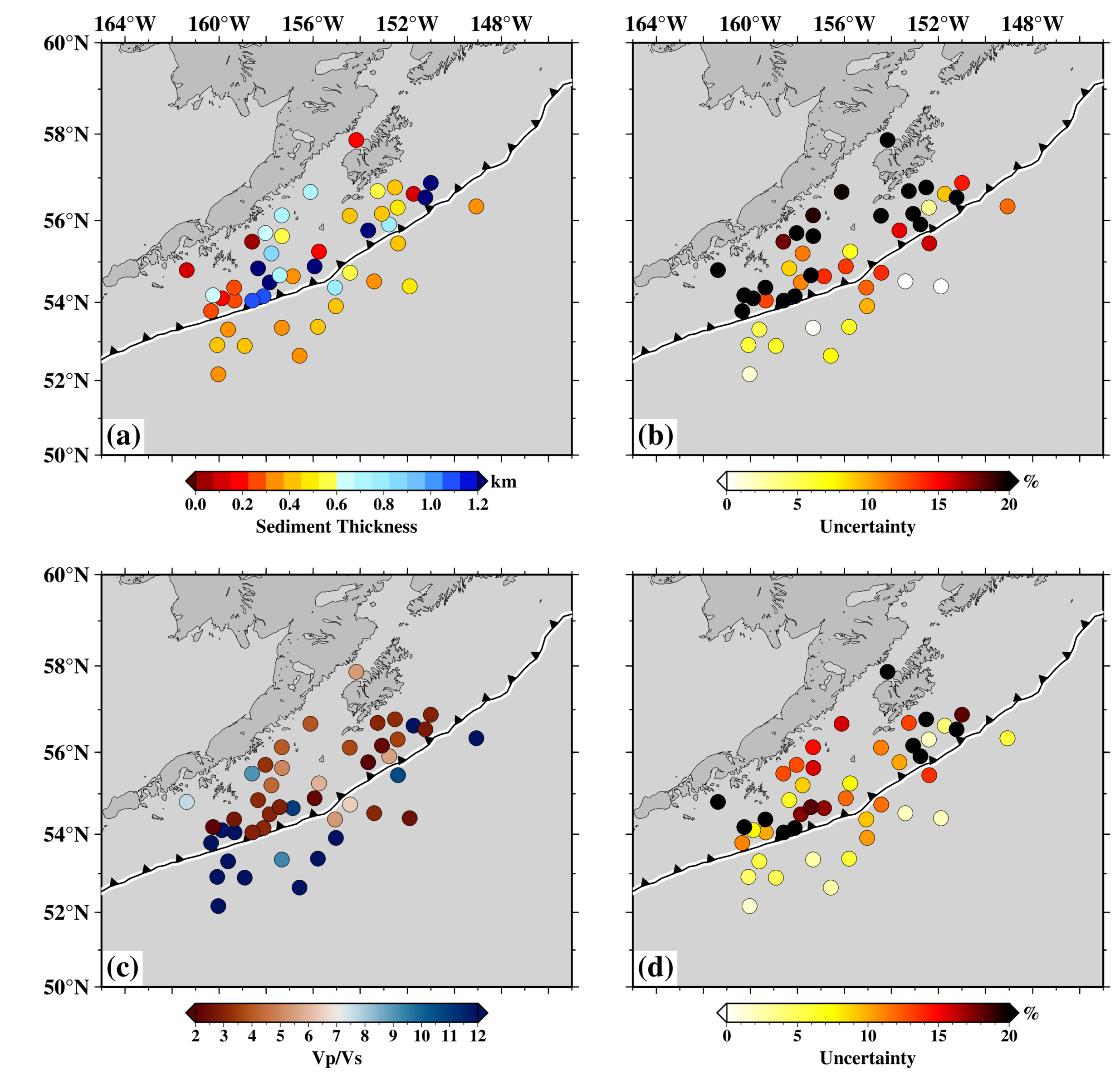


Figure 12 (a) Map of resolved sediment thickness and (b) associated uncertainties. (c) Map of derived Vp/Vs of seafloor sediment and (d) associated uncertainties.

## Results and Discussion

- **Compliance measurements**

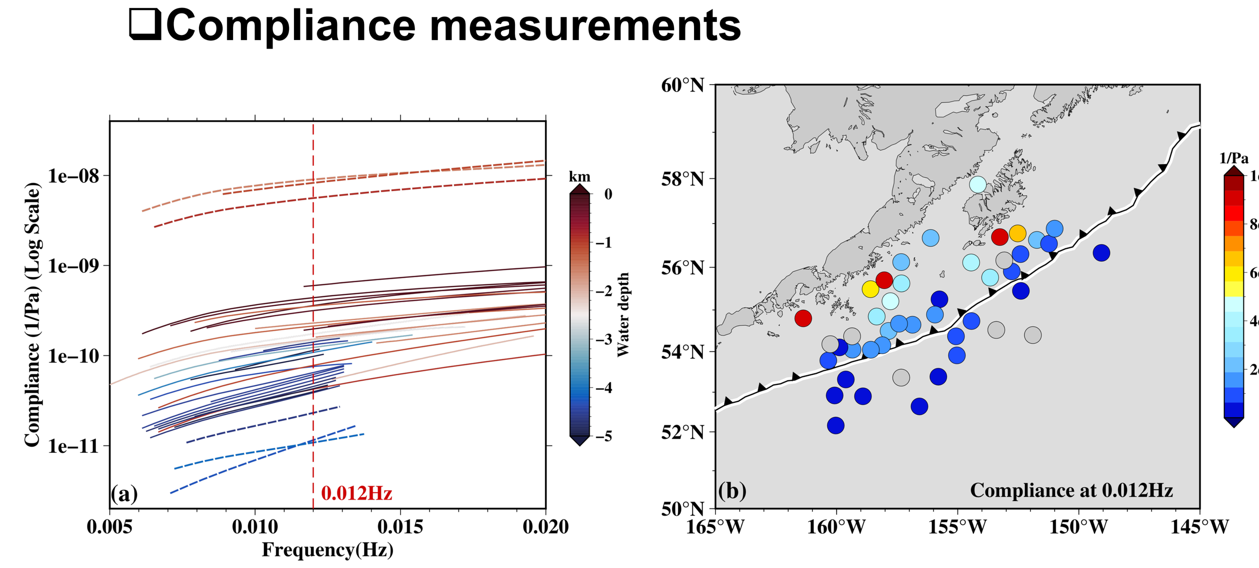


Figure 8 (a) The measured seafloor compliance, colors indicate different water depths. (b) The map of measured compliance at the frequency of 0.012 Hz.

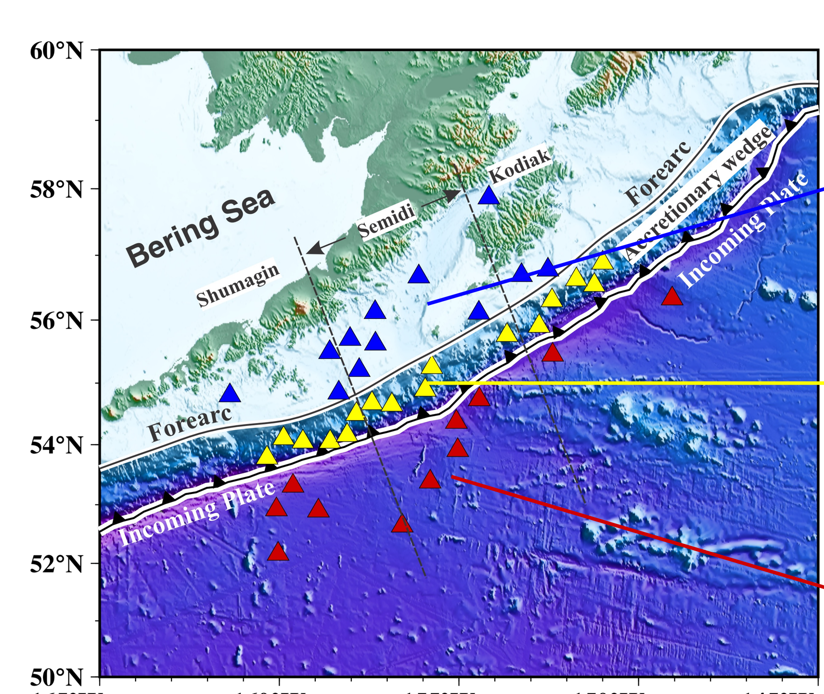


Figure 10 Map of the Alaska-Aleutian subduction zone at the Alaska Peninsula region, marked the range of the Kodiak, Semidi, and Shumagin segments. The blue, yellow and red triangles denote the OBS station with compliance measurements within the incoming Pacific plate, accretionary wedge and forearc.

- **Ps delay measurements**

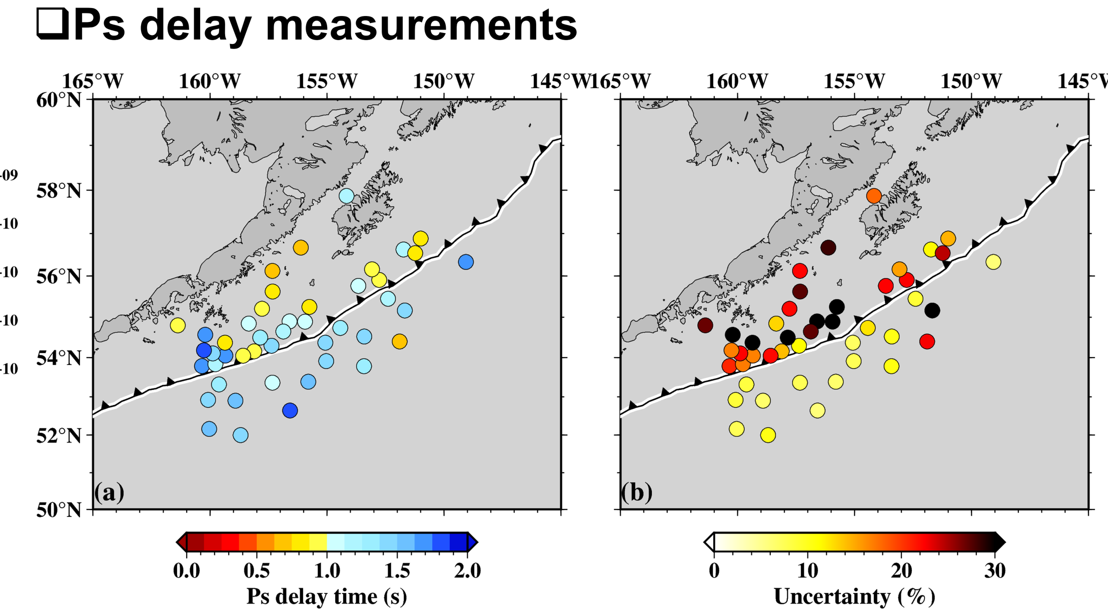


Figure 9 (a) The measured Ps delay times and (b) their associated uncertainties

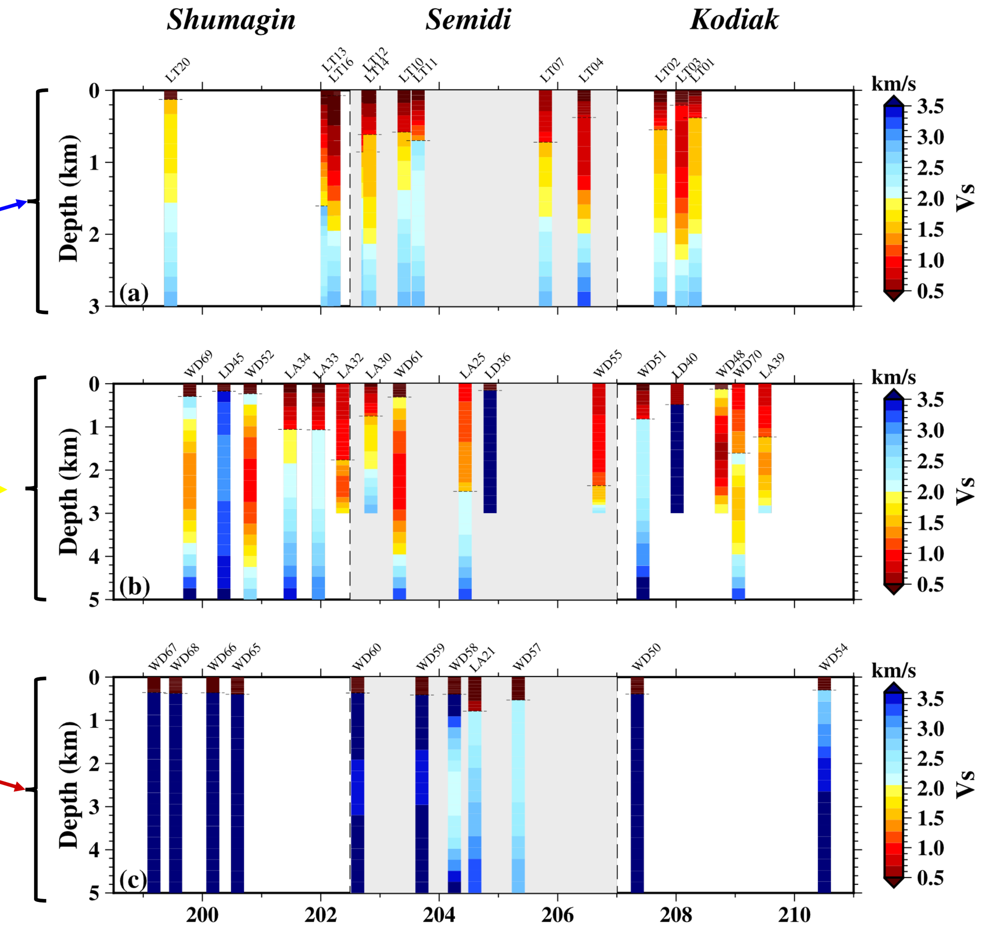


Figure 11 S-wave velocities along the trench within (a) forearc (b) accretionary wedge, and (c) incoming plate.

## Conclusion

We use seafloor compliance and Ps delay times measured from Alaska Amphibious Community Seismic Experiment Ocean Bottom Seismometer (OBS) data to image the marine sediment and shallow crust across the Alaska-Aleutian subduction zone offshore the Alaska Peninsula.

- The sediment thickness varies from approximately 0.1 to 2.5 km across the array, with the thickest sediment in the accretionary wedge. High Vp/Vs ratios characterize the clay-poor sediments of the incoming plate, contrasting with the reduced Vp/Vs observed in the clay-dominated sediments of the forearc and accretionary wedge.
- The upper crustal S-wave velocities of the incoming plate in Semidi are much lower than those in the Shumagin segment, which we attribute to differences in how crust forms at fast and intermediate seafloor spreading rates .

## References

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