Seismic Attenuation Across the Juan de Fuca Plate from Ridge to Trench to Arc

1. BACKGROUND AND MOTIVATION

- The Canada Basin offers an unprecedented opportunity to study the thermal evolution of an oceanic plate from “hot to cold”. Seismic attenuation provides a means to complement the accurate depth estimates of the physical characteristics of the plate. The asthenosphere is in a strong function of temperature and the presence of water. Measurements of attenuation are critical in understanding the presence of water in the asthenosphere.
- The fate of the basaltic–asthenosphere highly depends on the presence of water. Theoretical studies suggest that the thermal structure of the oceanic plate is relatively well understood. By comparing oceanic plate temperature with plate cooling models, we can test experimentally derived anelastic scaling relationships and their implications on the thermal trend. These studies explain how hot spots correlate with lower surface wave amplitudes, with implications for the frequency dependence of anelastic processes.

2. PREDICTIONS FROM PLATE COOLING + ANELASTIC SCALING RELATIONSHIPS

- Seismic attenuation in the Earth is described by the quality factor, Q, which is related to the functional energy loss per cycle by a propagating seismic wave. It is given by the equation: \( Q = \frac{\Delta \omega}{\Delta \Phi} \) (1), where \( \Delta \omega \) is the frequency change due to attenuation and \( \Delta \Phi \) is the phase change.
- The observed spectrum of a body wave arrival, \( S(t) \), is related to the theoretical spectrum, \( \hat{S}(\omega) \), by the attenuation operator, \( \hat{S}(\omega) = \hat{S}_0(\omega) e^{-\gamma \omega} \), where \( \gamma = 2\pi Q/\omega \). Therefore, the observed spectrum is a convolution of the theoretical spectrum and the transfer function of the attenuation.

3. BODY WAVE ATTENUATION

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4. A SIGNATURE OF COOLING + SEDIMENTS, MELT?

- The effect of lateral temperature variations may help to distinguish between oceanic and continental lithosphere. In this case, the effect may be temperature dependent, thereby altering the slope of the thermal trend. These studies explore how melt is present. Certain factors, such as major-element composition and hydration states, can influence the thermal trend from left to right (or up and down). Other factors include the role of water on diffusion creep, dislocation creep, and grain-boundary viscosity reduction.

5. STATION-AVERAGED T-STAR

- To test whether attenuation is frequency dependent (i.e., \( \omega \Delta S = \omega \Delta S_0 e^{-\gamma \omega} \)), we can test if body waves vary at different frequencies. The observed spectrum is a convolution of the theoretical spectrum and the transfer function of the attenuation.

6. DIFFERENTIAL TRAVEL TIMES

- By calculating the first-order signal of plate cooling from spectral ratios of body wave arrivals recorded at OBS stations, we can measure the first-order signal of plate cooling from spectral ratios of body wave arrivals recorded at OBS stations. This study explores how melt is present. Certain factors, such as major-element composition and hydration states, can influence the thermal trend from left to right (or up and down). Other factors include the role of water on diffusion creep, dislocation creep, and grain-boundary viscosity reduction.

7. CONCLUSIONS AND FUTURE WORK

- We can measure the first-order signal of plate cooling from spectral ratios of body wave arrivals recorded at OBS stations. Theoretical studies suggest that the thermal structure of the oceanic plate is relatively well understood. By comparing oceanic plate temperature with plate cooling models, we can test experimentally derived anelastic scaling relationships and their implications on the thermal trend.
- However, more work is required to characterize the effects of shortening and compliance or measurements of anelastic properties, and whether these corrections improve data without introducing artifacts. A variety of factors, such as the resolution of the observations and the geodynamic setting, influence the interpretation of the results.

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REFERENCES

- C. M. Romanowicz and co-workers have interpreted agreement between observed a strong spherical-harmonic degree-2 pattern in global seismologically observed attenuation and velocity in terms of a highly heterogeneous asthenosphere–mantle interface. This study explores how melt is present. Certain factors, such as major-element composition and hydration states, can influence the thermal trend from left to right (or up and down). Other factors include the role of water on diffusion creep, dislocation creep, and grain-boundary viscosity reduction.