Estimating Amplitude, Delay, Attenuation and its Frequency Dependence of Seismic Waves Simultaneously with Applications to Alaska

Levi Borevitz[1] , William Menke[1]

[1]*Lamont-Doherty Earth Observatory of Columbia University*

Seismic waves are dependent on four parameters: travel time, ray focusing, attenuation, and alpha. These parameters reflect the asthenosphere's structure and are used to better understand it. In this study, we design a procedure to estimate the four parameters simultaneously, ensuring that no one parameter is biased by changes to the waveform caused by another. We define the error as the squared difference between the observed and predicted wave. We then use a linearized least squares procedure to estimate the parameters by minimize the error (Newton's method). We add weighted prior information so as not to let the parameter values vary too much. With synthetic data, Newton's method gave good alignments of waveforms and low errors, and a solution similar to the results of a grid search. Applying Newton's method with weights to data from two events in Alaska, we achieved significant error reduction and reasonable parameter values. Delay times correlated with estimates derived from cross-correlation, with about 0.1 s scatter. T-star and alpha also correlated with a parabola-like trend. Maps of the parameter values show spatial coherence and some correlation with one another. However, there were some instances where DT and T-star's anti-correlated which is not expected when both delay and attenuation arise from a thermal mechanism. Our results show that the four parameters can be reliably measured simultaneously, but that the relationship between them and its geological significance might not be fully understood.