

Event extraction from seismic data including frequency-dependent noise

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Extraction of seismic phases from the data contaminated by noise is an essential problem in seismic data analysis. Either natural or artificial noise may not be white noise, but has frequency dependence in general. We have extended the method proposed by Hasada et al. (2001) to analyze data including frequency-dependent noise.

This method, named the Sompi event analysis, has been developed as a basic analysis method of the data acquired by ACROSS (Accurately Controlled Routinely Operated Signal System), which is a subsurface exploring and monitoring methodology using continuous deterministic signal of seismic or electromagnetic waves. The observable in ACROSS is a band-limited Green's function in frequency domain with estimated error for each frequency component. In order to extract maximum information from such ACROSS data with estimated errors, the extension of the Sompi event analysis dealing with frequency-dependent error is essentially needed. This method is expected to improve the precision of determined travel times in analysis of general seismograms including frequency-dependent noises.

The Sompi event analysis is based on autoregressive (AR) modeling in frequency domain. The travel times of the time-domain events are derived by AR coefficients, which are estimated in order the power of output from the AR filter to be minimized. In extended version proposed in this study, we minimize weighted sum of the power of output from the AR filter, where the weights are calculated from moving averages of the estimated errors. For analysis of time-domain seismograms, estimated errors can be calculated by the power spectrum of the noise at the time without events.

First, we have carried out numerical tests using synthetic data with frequency-dependent noises, and confirmed the advantage of this extension compared with the previous procedure. Then we have applied this method to ACROSS data and records of local earthquakes, and determined the travel times of several wave arrivals. According to the data, the results did not clearly show the advantage because of the frequency dependence in data themselves and so on. However, this new procedure provides us with theoretically better estimation of travel times.