Mapping sediment thickness in Minnesota with horizontal-to-vertical spectral ratios

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The horizontal-to-vertical spectral ratio (HVSR) is an empirical method that correlates the seismic noise spectral ratio to unconsolidated sediment thickness. The HVSR method takes advantage of lower energy in the vertical component, and in most stations an excess amount of energy in the horizontal components, at a characteristic resonance frequency (Figure 1). The characteristic frequency depends on sediment thickness. Increasing sediment thickness decreases the characteristic frequency.

This method has been validated empirically [*Parolai et al., 2002*] and explored theoretically [*Fah et al., 2001*]. Typically researchers use this method in a localized region with a single seismometer that they move between sites with good well control. We use the transportable array and the SPREE flex array experiment to test the effectiveness of the HVSR method in a larger area. The advantage of this approach is the massive amount of data available at no additional cost. With a single seismometer, it is typical to record 15 minutes of data several times at a site and then average the spectra from the 15-minute segments. We use 10 days of data broken up into 20-minute segments, which are then stacked to create robust average spectra. The HVSR show a consistent pattern throughout Minnesota (Figure 2). We correlated our HVSR peaks with depth to bedrock data from the Minnesota Geological Survey, which are interpolated from wells. We then fit a log-log linear regression to the correlated points, which has an R^2 of 0.72. Overall the method gives good estimates of sediment thickness at the given locations, and thus has the potential for reasonable estimates elsewhere.

Figure 1:

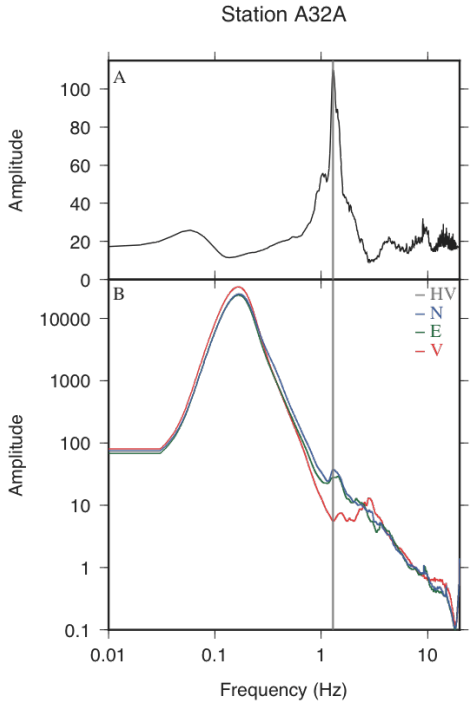
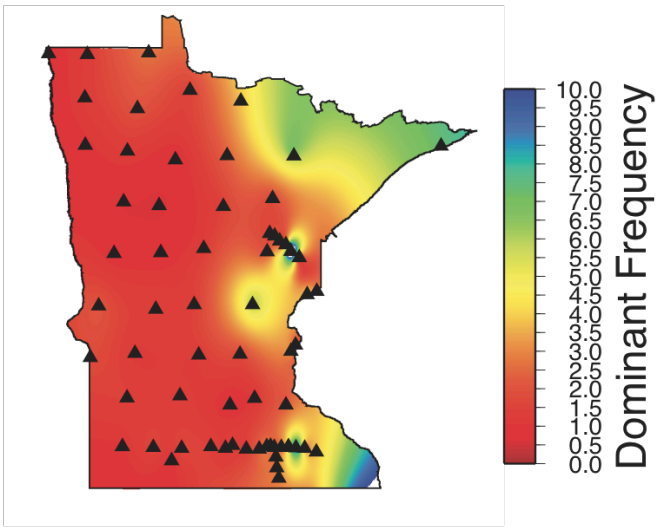


Figure 2:



Fah, D., F. Kind, and D. Giardini (2001), A theoretical investigation of average H/V ratios, *Geophysical Journal International*, 145(2), 545-549.

Parolai, S., P. Bormann, and C. Milkereit (2002), New relationships between Vs, thickness of sediments, and resonance frequency calculated by the H/V ratio of seismic noise for the Cologne area (Germany), *Bull. Seismol. Soc. Amer.*, 92(6), 2521-2521.