A Novel Technique for Measuring L_g Wave Attenuation

Consider a great-circle path passing through two seismic sources and two seismic stations (Figure 12)[13]. It turns out that the L_g attenuation between the two seismic stations so positioned can be neatly extracted even in the presence of unknown site effects, unknown recording instrument errors and unknown seismic source complications.

The method, referred to as RTSM (Reversed Two-Station Method), is in fact based on two simple observations. First, for a given seismic source, the source effects on the observed L_g ground motions are the same at the two stations, and they therefore can be cancelled out using a well-known spectral ratio technique. The spectral ratio technique does not remove the site effects and instrument errors associated with the two stations, however. It was then discovered that the combined station site effects and the unknown instrument errors at the two recording stations can be cancelled by "sending" the L_g signals back and forth — once in each direction — along a fixed waveguide containing the inter-station path segment, the signal emitters being the pair of seismic sources positioned as shown in Figure 12. The RTSM method has since been extensively tested in the Eastern Canadian proving ground using natural earthquakes and industrial mineblasts from Ontario, Quebec and New Brunswick as seismic sources. The results have shown that L_g amplitude reduction due to attenuation of as low as 10% or less can be reliably measured even though the individual station site amplifications alone are found to differ by a few tens to a few hundred percent. As demonstrated by Chun *et al.*[14], the reliability of the RTSM method for measuring L_g wave attenuation is unaffected at high frequencies (>5 Hz) where site effects are particularly strong.

Towards Understanding P_n Propagation and Attenuation

In the above, a novel technique for extracting subtle L_g attenuation effects in the presence of strong contaminating factors was discussed. Achieving similar results for the equally important companion regional phase P_n proved to be a difficult task because of the added uncertainty concerning the manner in which the P_n energy spreads out geometrically, a phenomenon unrelated to anelastic seismic attenuation. This uncertainty is rather unique to the P_n wave and, as far as we are aware, there have never been published methods for experimental determination of the geometrical spreading of the P_n wave. It has recently been pointed out[15] that the disagreements among the P_n practitioners regarding the P_n geometrical assumption have been the main cause of disparity among the published P_n attenuation for any given region. This is rather unfortunate in light of new research results implicating great importance of high-frequency P waves in detecting and identifying decoupled underground nuclear explosions[16].