The Physical Basis for the L_g/P Discriminant

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Abstract

Recent interest in a Comprehensive Test Ban Treaty (CTBT) has stimulated a desire to detect and identify much smaller seismic events. Furthermore, concern for possible proliferation of nuclear weapons into countries where nuclear weapons testing was not previously at issue requires extending seismic capabilities into new geographic regions. To reach these goals at magnitude levels of interest will require utilization of regional seismic signals. Unfortunately, implementation of effective regional discriminants has proven to be elusive due to the complexity of regional signals and incomplete physical understanding of their dependence on regional propagation and excitation. The objective of this research program is to improve fundamental understanding of the L_g/P ratio regional discriminant, which over the years has proven to be one of the most promising and enduring measures at regional stations for distinguishing between explosions and earthquakes. This investigation includes an empirical element to review and formalize the salient features of the L_g/P measure for distinct tectonic environments and different source types and a theoretical element to explain the observed features in terms of source mechanism, source size, depth, and propagation path influences on the regional signals.

The empirical element of this research program utilizes a traditional analytic approach including time-domain measurements and spectral analyses of L_g and regional P signals from large, high-quality databases representative of different source types and geographic regions. We are performing time-domain, bandpass filter, and spectral analyses on these regional signals recorded from underground nuclear explosions, earthquakes, non-nuclear blasts, and rockbursts using the digital seismic data collected over the years and currently being collected for the western U.S., eastern North America, central Asia, and central Europe. The theoretical part of this research program draws upon published information on the velocity and attenuation structures for each of the regions considered to generate ensembles of propagation models. Synthetic seismograms determined for the various models can then be used to predict the behavior of the L_g/P ratios and their variations for suites of source mechanism, size, and taking into account model uncertainties. Comparisons of the predicted behavior with the empirical results will be used to modify the regional models and refine predictive capability for the L_g/P discriminants. Finally, the results of these comparisons will be used to document and codify the procedures needed to define a more general predictive capability for the L_g/P ratio and to perform sensitivity analyses which will help determine which methodologies are most useful for transporting an L_g/P ratio into uncalibrated regions.

Key Words: Seismic, Discrimination, Regional, Explosion, Earthquake, Mechanism