
Abstract

This report describes: a) verification and its rationale; b) the basic tasks of seismic verification; c) the physical basis for earthquake/explosion source discrimination and explosion yield determination; d) the technical problems pertaining to seismic monitoring of underground nuclear tests; e) the basic problem solving strategy deployed by the forensic seismology research team at the University of Toronto; and f) the scientific significance of the team's research.

Seismology provides the primary means for monitoring nuclear explosions that take place underground. Improved seismographic hardware, Canadian research expertise, and the availability of a vast "proving ground" (the Canadian land mass which bears close resemblance with other regions of nuclear test ban verification interest), are all helping Canada become an increasingly notable contributor to this highly specialized branch of forensic seismology.

The research carried out at the University of Toronto since November 1985 has two components: a) teleseismic verification using P wave recordings from both the old and the recently refurbished Yellowknife Seismic Array (YKA); and b) regional (close-in) verification using high-frequency L_g and P_n recordings from the Eastern Canada Telemetered Network, a group of stations installed to record earthquakes.

Analysis of more than 600 explosion-generated teleseismic records from the YKA has shown major differences in P wave attenuation among the propagation paths connecting this quiescent listening post with seven active nuclear explosion testing areas in the world. By taking advantage of the YKA's voluminous body of archived nuclear explosion data and of newly available signal analysis techniques, we have been able to make significant revisions to previously published P wave attenuation results for the same paths.

To appreciate the magnitude of these revisions, we have shown that explosion yield estimates inferred from the YKA data using previous and our revised attenuation values differ by a factor as large as 2, depending on the nuclear test site location. To understand the significance of the revisions from yet another perspective, we have performed analysis of YKA explosion data using our new attenuation values. The study has resulted in instances in which a seismic source depth indicator (a seismic phase known as pP) is successfully unmasked in the signals from underground nuclear explosions.

To improve the accuracy of rapid teleseismic locations of distant seismic events, we have carried out an in-depth study of systematic biases between the array-derived locations and those determined using global seismic network