

8. IDENTIFICATION OF EARTHQUAKES AND EXPLOSIONS

8.1 Identification Criteria

The state-of-the-art in seismological discrimination between natural earthquakes and underground explosions to the year 1968 is presented in excellent summary form in the SIPRI (1968) document. A table in that document (p.62) lists ten discrimination criteria, three of which are described as "positive identifiers" above a certain threshold magnitude, and seven of which (including the positive identifiers) are described as "diagnostic aids" to identification.

A great deal of research has been published on these ten and other discrimination criteria since 1968. The basic conclusions concerning discrimination, however, have not changed significantly from those presented in the SIPRI document: the same three "positive identifier" criteria are considered of most value in identifying underground explosions. The three criteria are listed by SIPRI as surface wave:body wave magnitude, Rayleigh wave spectra, and P wave spectra. The concept of these three criteria in total or in combination can be considered as discriminating between earthquakes and explosions on the basis of the total spectrum of seismic energy released by the two types of sources. Although some of the less useful criteria will be considered in various ways in this chapter, the majority of the discussion will be confined to these three criteria and this concept of differences in the total seismic wave spectrum between earthquakes and explosions.

The entire discussion can be confined to consideration of only shallow focus (say $h < 50$ km) earthquakes by assuming the capability exists, either by least-square hypocentral determination or by observation of pP phases, of accurately defining focal depths greater than 50 km and thereby positively identifying such deep events as earthquakes. Section 4.7 explains why, in the low magnitude range, all shallow focus earthquakes are potential explosions in terms of the accuracy achievable in depth of focus.

Differences in the total seismic spectra of earthquakes and explosions appear over a wide range of frequencies, and are apparent in a wide variety of both body wave and surface wave phases. They are most distinct, or most easily measured, within the short period P waves, in the relative excitation of Rayleigh and P waves and within the Rayleigh waves. These three criteria are the major topics for discussion in the next three sections.

8.2 P Wave Spectral Ratio

The P wave spectral ratio criterion often uses a measure of the ratio of energy in two frequency bands in the P wave. The results have shown that shallow earthquakes tend to have relatively more low frequency energy in the P wave than do explosions. Results using this type of method are available from studies in the U.S.S.R. (see SIPRI, 1968), Japan (see SIPRI, 1968), United States (see Lacoss, 1969b) and