ANALYSIS OF BODY WAVE SPECTRA FOR EARTHQUAKE ENERGY DETERMINATION

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This study examines the body wave spectra of earthquake signals for the estimation of energy in the seismic waves by taking into account the radiation pattern of the source, the effect of geometrical spreading and absorption in the earth's mantle, the effect of crustal structure under the receiver and the response of the recording instruments.

The mechanism at the focus of an earthquake is an important factor in determining the energy radiated in different directions and its distribution into different wave types. As a first step towards energy determination the focal mechanism solutions of one intermediate and four deep focus earthquakes analyzed in this study have been determined using the P wave first motion directions and S wave polarization angles. All the mechanism solutions are well determined and conform to a double couple source model.

Frequency domain analysis provides a convenient means for compensating for the effects of various factors e.g. the mantle, the crust, the seismograph, which took part in modifying the waveform of the seismic signals during their travel from the source to the station. In all 155 P wave time signals and 224 S wave time signals were analyzed in this study. A Hamming data window described by Blackman and Tukey (1958) was used to taper the digitized seismic pulses. The data

window smooths out the spectrum and suppresses the high frequency components which may be largely due to the background noise. The instrumental response was obtained theoretically using the constants provided by the U. S. Coast and Geodetic Survey. The Thomson-Haskell matrix formulation was adopted for obtaining the crustal response for incident P and S waves, as a function of frequency and angle of incidence. The effects of geometrical spreading and absorption in the mantle were evaluated by the use of Jeffreys Bullen travel time tables, Bullen A earth model, and a Q(H) model calculated by Anderson and Archambeau (1964) and adapted in the form of a mathematical expression by Ben-Menahem _et al._ (1965).

The basic equations for estimating the energy in body waves from the spectra equalized to the source are discussed. The main uncertainties in the energy estimates are most likely due to the inadequate knowledge of the effect of absorption, which is quite significant at the high frequencies. At the high frequencies the effects of scattering and diffraction also become significant and the uncertainties of the effects of the crustal structure and of the recording instrument make the accurate recovery of the source spectra rather difficult. For this reason we compute the energy in the frequency band .005-.205 cps. The energy so obtained may be considered to be the lower limit of the seismic energy. Most of the energy is carried by the S waves. The ratio E_P/E_S varies between .008 to .106. The possibility of a small tensile component accompanying the shear faulting is indicated. The results of energy computation for any particular earthquake from the spectra at different stations are fairly consistent and should be considered quite reliable.

A method has been developed for the consideration of the effect of the radiation pattern on body wave magnitude determination. The application of the method to the data of the five earthquakes studied using the $\overline{Q}$ values of Duda (1969) reveals definite improvements in the magnitudes determined from the vertical component of P waves. The method, in general, does not improve the magnitude determination from the horizontal components of S waves and the need for a more accurate chart for $\overline{Q}$ values as a function of depth and epicentral distance is emphasized.