WAVEFORM MODELING OF EASTERN NORTH AMERICAN EARTHQUAKES USING SHORT-DISTANCE RECORDINGS

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An approach for determining the focal mechanism of small earthquakes by waveform modeling of short-distance recordings is developed and is applied to model the digital data, obtained by the U.S. Geological Survey, of four aftershocks of the 1982 Miramichi earthquake (Canada), four earthquakes near Monticello, South Carolina, and three earthquakes of the 1982 Arkansas swarm activity. The signals contain very high frequencies and, therefore, waveforms are very sensitive to the earth structure, depth and focal mechanism of the earthquakes.

An initial earth model is assumed and the earthquake is located. Green's functions due to step-shear dislocation are computed using Cagniard-de Hoop theory and are convolved with source-time functions for ground velocities. Instrument response is added. Finally, the ground motion is predicted for a fault of arbitrary orientation. For optimization purposes this is done for direct P, SV and SH waves. The amplitudes of these phases and their ratios are compared with the observed data to isolate the possible source mechanism before synthesizing the entire waveform. The earth structure is iteratively improved until a good correlation, as measured by the amplitude ratios between the observed and the predicted waveforms, is obtained.

In order to minimize the need for a detailed earth structure the digital data of four aftershocks of the 1982 Miramichi earthquake were filtered using a third order lowpass Butterworth filter at 10 Hz. The synthetic data were also identically filtered. The frequency content of the Arkansas earthquakes was low, but the P- and S-wave durations were

different. Therefore, these data were filtered at 15 Hz to reduce this difference. The seismograms of the Monticello area contained very high frequencies (upto 30 Hz) and were modeled without any filtering.

A least-squares inversion of the moment-tensor elements is also performed using the amplitude data of the direct P, SV, and SH waves. The inversion is constrained to have $M_{xx} + M_{yy} + M_{zz} = 0$, meaning the source is a pure double couple. The intermediate eigenvalue, therefore, must vanish. If the intermediate eigenvalue does not vanish, the solution is decomposed into major and minor double-couple mechanisms. The compensated linear dipole vector is also estimated.

Spectral analysis is performed on the New-Brunswick aftershocks. The stress drops associated with these events are found to be generally high. For the other earthquakes considered in this dissertation the results of the spectral analysis done by other authors are accepted. Generally, the seismic moment estimated from the spectral analysis was found to differ from the estimate obtained by time-domain modeling.