QUANTIFICATION OF EARTHQUAKES BASED ON IMPROVED ESTIMATES OF ENERGY USING REGIONAL WAVES

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INVESTIGATIONS UNDERTAKEN

We have completed our plan under this award to study source and wave propagation parameters for regional earthquakes, especially the development of methods to measure earthquake strength, using seismic energy as the underlying property. The study was accomplished by analyzing the strongest regional seismic waves at distances in the range 20 - 1000 km, using frequencies across a broad band. Because of the demonstrable stability of root-mean-square (RMS) Lg amplitudes and the relationship between RMS Lg and seismic energy, our study improved the accuracy of the traditional steps of correcting measured regional wave amplitudes for propagation effects, such as geometrical spreading and attenuation as a function of frequency. We also improved methods of measuring static stress drop and seismic energy from regional recordings of earthquakes in the Northeastern United States.

RESULTS

Following on the projects reported previously, we obtained in this final year a procedure for determining radiated seismic energy using Lg regional waves.

In particular, we used Boatwright's decelerating source model to investigate the energy radiated out into the far field, and used it to scale the Lg waves recorded at regional distances from earthquakes in the Northeastern United States. A paper on this subject has been submitted for publication in the Bulletin of the Seismological Society of America. The work necessitated a procedure for accurate calculation of far-field pulse shapes. To this end we found it useful to implement a method given by Jeffreys and Jeffreys (1972) for integrating functions that have a singular derivative -- caused, in this case, by radiation from near the rupture front, as seen in the S-wave using retarded time. (Such radiation can be strong if the rupture speed is not much smaller than the S-wave propagation speed.) Figure 1 shows that the calculated far-field displacement pulse shapes, from Boatwright's decelerating source, are sufficiently smooth to present no obstacle when computing the squared velocity pulse shapes needed for evaluating the radiated seismic energy.

The seismic data upon which our results are based are available in AH format. The contact person is

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NON-TECHNICAL SUMMARY

Most of the energy radiated by earthquakes appears as regional seismic waves such as Lg. We have studied the use of Lg waves to obtain measurements of earthquake strength, such as the stress drop and seismic energy release. We proved that a root-mean-square (RMS) measurement of Lg waves has physical significance in terms of seismic energy, and shows excellent consistency and stability even for measurements made with a single station. We have made estimates of the seismic energy radiated by earthquakes in the Northeastern United States.

REPORTS PUBLISHED

Shi, J., W.-Y. Kim, and P. G. Richards, The corner frequencies and stress drops of intraplate earthquakes in the northeastern United States, *Bulletin of Seismological Society of America*, **88**, 531-542, 1998.

Shi, J., P. G. Richards, and W.-Y. Kim, Determination of seismic energy from Lg waves, submitted February 1998 to the *Bulletin of Seismological Society of America.*

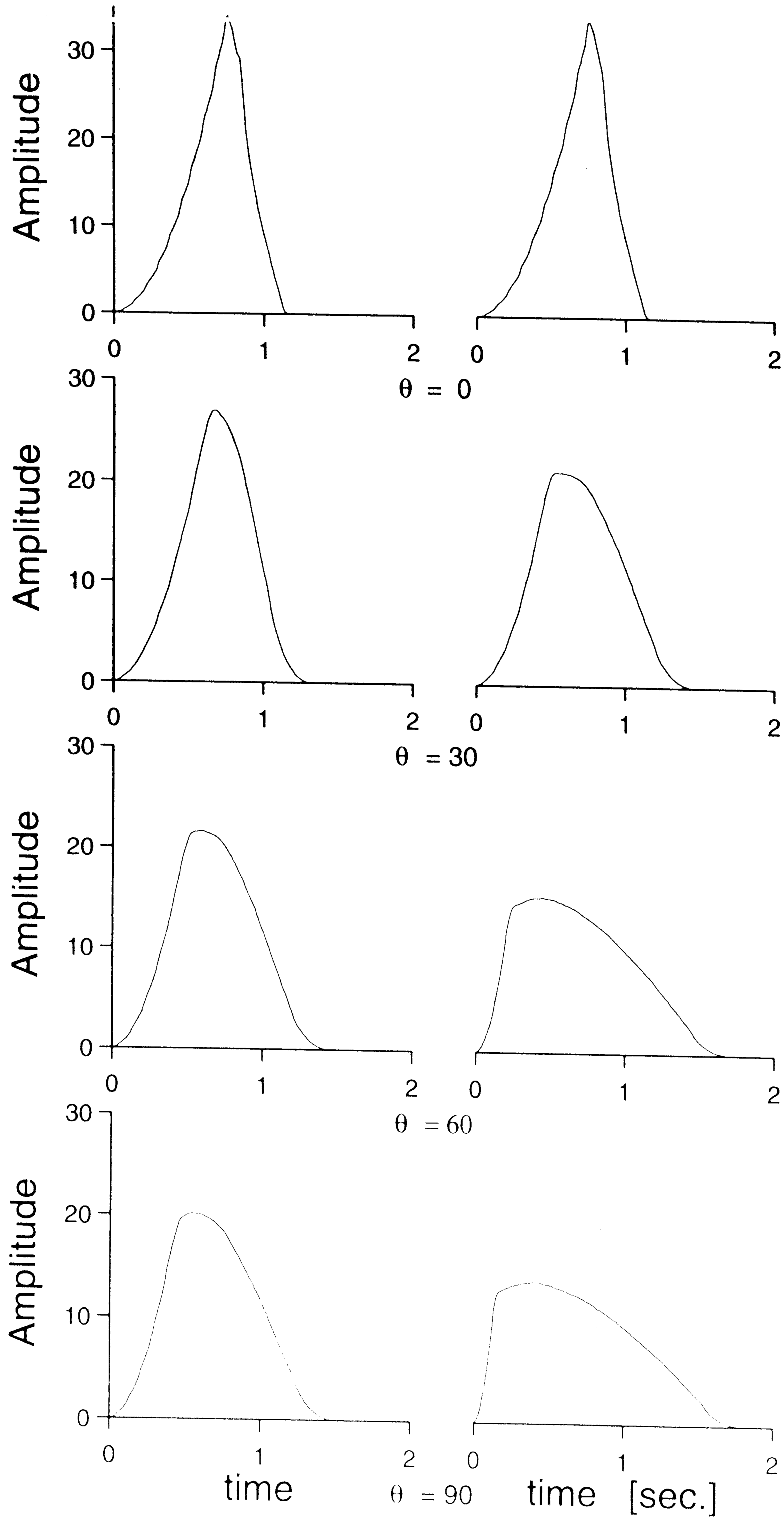

Figure 1: The far field pulse shapes of P and S waves are plotted at different take-off angles (thirty degree increments) from Boatwright's deceleration model. Jeffreys and Jeffreys' method (1972, section 9.092) is used in the integration to obtain smooth waveforms, suitable for computing the squared velocity pulse shapes needed for evaluating the radiated energy.