Nuclear Explosion Monitoring Research and Engineering (NEMR&E) Program
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Research Title: "Advanced Waveform Simulation for Seismic Monitoring Events"

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Technical Progress:

A. Description of Activities

This quarter involved efforts in testing the Cut-and-Paste (CAP) code on a large data set. In particular, extraordinary amounts of seismic recordings are presently being produced by the many arms of EarthScope and the world community. These data are being used both in traditional event-station analysis as well as station-to-station ambient noise measurements to generate short-period spectral models. The latter methods produce upper crustal shear-velocity models which can be related directly to short-period source studies such as the CAP method. The possibility of locating small events using sparse but entire 3-component records is becoming increasingly attractive where these various methodologies are combined. We are addressing such a synergy with a special study of the best recorded regional event to date (Wells event) in Nevada recorded by over 500 stations (U.S. Army).

Some important issues are (1) How reliable is the CAP methodology in retrieving source information at larger ranges in complex tectonic regions, western U. S., and (2) Can we now determine self-consistent source parameters at all ranges by developing better 3D models and/or special path calibration? (*see Abstract*)

Regional wave propagation beneath western U.S.

Abstract

The recent Nevada Earthquake (M=6) produced an extraordinary set of crustal guided waves. In this study, we examine the three-component data at all the USArray

stations in terms of how well existing models perform in predicting the various phases, Rayleigh waves, Love waves, and Pnl waves. To establish the source parameters, we applied the Cut and Paste Code up to distance of 5° for an average local crustal model which produced a normal mechanism (strike=35°,dip=41°,rake=-85°) at a depth of 9 km and Mw=5.9. Assuming this mechanism, we generated synthetics at all distances for a number of 1D and 3D models. The Pnl observations fit the synthetics for the simple models well both in timing (V_{Pn}=7.9km/s) and waveform fits out to a distance of about 5°. Beyond this distance a great deal of complexity can be seen to the northwest apparently caused by shallow subducted slab material. These paths require considerable crustal thinning and higher P-velocities. Small delays and advances outline the various tectonic province to the south, Colorado Plateau, etc. with velocities compatible with that reported on by Song et al.(1996). Five-second Rayleigh waves (Airy Phase) can be observed throughout the whole array and show a great deal of variation (up to 30s). In general, the Love waves are better behaved than the Rayleigh waves. We are presently adding higher frequency to the source description by including source complexity. Preliminary inversions suggest rupture to northeast with a shallow asperity. We are, also, inverting the aftershocks to extend the frequencies to 2 Hz and beyond following the calibration method outlined in Tan and Helmberger (2007). This will allow accurate directivity measurements for events with magnitude larger than 3.5. Thus, we will address the energy decay with distance as s function of frequency band for the various source types.

B. <u>Progress</u> - on track.

C. <u>Progress is following the stated Work Statement</u>.