OBSERVATIONS AND SYNTHESIS OF SEISMIC WAVES IN ANISOTROPIC MEDIA

Batakrishna Mandal, B.Sc (Hons), M.Sc.

A Digest Presented to the Faculty of the Graduate
School of Saint Louis University in Partial
Fulfillment of the Requirements for the
Degree of Doctor of Philosophy

1987

DIGEST

The polarizations of three-component shear-wave trains carry information about the internal structure of the media through which they pass. Specifically, observed shear-wave splitting contains information on the orientation and magnitude of anisotropy which may be related to flow in the mantle. If data of sufficient quality are available it may be possible to delineate the orientation of the anisotropy and the depth range over which it occurs.

Algorithms for synthesizing seismic waveforms in transversely isotropic media are developed for use at both regional and teleseismic distances. The propagator matrix method and wavenumber integration are used to generate complete seismic waveforms, including all body and surface waves, for regional distances. Compound matrices and extended floating point notation are used to stabilize the computations for a wide range of frequencies. Numerical noise generated during integration, especially for the case of zero-order Bessel functions, is partially eliminated. This algorithm has been verified by comparing the results of computations with those generated by other methods for isotropic media. Comparisons of synthetic seismograms for anisotropic models having a small degree of anisotropy with similar, but isotropic models, show that significant differences in travel times, amplitudes and waveforms can be caused by the anisotropy.

The propagator matrix method for waves in near-surface homogeneous layers, the WKBJ approximation for a generalized ray in a vertically

inhomogeneous half-space, and wavenumber integration over a specific range of real wavenumbers are used to synthesize teleseismic body wave in transversely isotropic media. In this process, the "leaky mode" *PL* phase can be generated.

The polarizations of 272 direct shear waves are observed from three-component observations at stations of the Global-Digital-Seismic-Network (GDSN) at distances between 50^o and 80^o. The polarizations of the faster shear-waves are determined by rotating the horizontal component seismograms through 15^o increments and using a visual interpretation procedure. These polarizations indicate that the faster shear-wave velocities are oriented in a northeast-southwest direction in North America, a northwest-southeast direction in Europe, a mixed direction in Australia and Japan. The average differential arrival time between fast and slow direct shear waves is 1.04 ± 0.84 sec. These small values suggest that anisotropy is either largely restricted to the upper mantle or that fast directions of anisotropy at one depth are compensated by slow directions of anisotropy at other depths for each ray path.

The synthesis of seismic waveforms with different combinations of anisotropic media in the crust and mantle suggests that there is always some ambiguity to locating the depth range over which anisotropy occurs, if only differential times are used. Some observations are compared with possible synthetics in transversely isotropic media. A model which includes anisotropy in the low-velocity zone of the upper mantle, and where *SH* is faster than *SV*, satisfies several of the present observations.