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Finite difference model of seismic wave propagation in an anisotropic elastic body -orthorhombic system-

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In the previous study (Japan Geoscience Union Meeting ABSTRACTS, S149-001) a transversely isotropic elastic body was modeled by the use of two dimensional finite difference method and elastic waves were simulated. The problem whether the discrepancy of quasi-body wave velocities between qSH-waves and qSV-waves can be detected or not was investigated. The model consists of isotropic and vertical transversely isotropic elastic bodies which are vertically adjacent to each other. In this model shear-wave splitting (Crampin, 1986; Kaneshima et al., 1987) was successfully observed when elastic waves propagate in the anisotropic elastic body of hexagonal system. A Ricker wavelet was used as a wave source pulse in that study and the pulse was also used in the present study. The anisotropic material of orthorhombic system, whose physical property is symmetric with respect to xy, yz, and zx plains, was modeled by HDM (Hidaka Dunite Model) (Kawasaki and Kon'no, 1984) which represents the constituent olivine in the uppermost mantle in the Pacific Ocean. The wave propagation in the anisotropic elastic body was modeled by the use of three dimensional finite difference method. The basic equation used in the calculation is the equation of wave motion associated with stress and displacement and the one of stress-strain relation in the anisotropic elastic body. The model has 24 receivers around a wave source with a radius of 125 km and a central degree of 15 deg. The source and receivers are located on the free surface. In the present study the azimuthal dependence of propagation velocity of qP-waves is investigated. The velocities of qP-waves recorded at each station were compared with theoretical ones (Crampin, 1977) determined from elastic constants of HDM. The velocity characteristics of simulated qP-waves of three components for x-, y-, and z-axes were finely accordant with those of theoretical ones within a horizontal A-B plane that includes x- (a-) and y- (b-)axes, indicating the maximum and minimum velocity directions, respectively. The study of anisotropy of seismic wave velocity has been developed from observations and analyses of seismic body waves and surface waves (e.x., Kasahara et al., 1968; Kawasaki, 1989; Kaneshima and Silver, 1995). Three dimensional finite difference model investiated corresponds to a near-field wave propagation and the application of the present method will be usefull to the study of anisotropy associated with azimuthal dependence of seismic waves in local or regional stress fields.