Geophysical Research Abstracts, Vol. 9, 05213, 2007 SRef-ID: 1607-7962/gra/EGU2007-A-05213 © European Geosciences Union 2007



Modeling of the active vibroseismic monitoring of the lithosphere

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The paper devoted to the problem of the mathematical modeling of vibroseismic monitoring of changes in the elastic characteristics in the interior Earth's crust zone. The direct problem of modeling is the determination the changes in the characteristics of the stationary wave field recorded at the surface which are cause by the changes in the density and velocity of seismic waves in some inner area of the medium. Also, it is the determination of the relation between the quantitative changes in the amplitudes and phases of the oscillations recorded at the surface, the geometry and location of the zone of changes in the medium, and the magnitude of changes in the elastic characteristics. For modeling the model of the Earth's crust-mantle system in the form of a layer at a half-space with different velocity values of elastic waves is considered. The mathematical statement of the problem is made in the in the approximation of the wave equation. It is assumed that the vibrational source is a point and harmonic one, with a constant oscillation frequency, and that the zone of changes of the characteristics in the medium is spherical. The wave field in the medium is calculated in the ray approximation. Wave field variations in the medium and at the free surface are determined for the case of small velocity changes in the spherical region by calculating the beam pattern of a fictitious 3D source in diffraction approach. As a result of the modeling the estimation of sensitivity of active monitoring method with harmonic vibrational signals is done. It is determined the relation between the quantitative changes in the amplitudes and phases of the oscillations recorded at the surface, the geometry and location of the zone of changes in the medium, and the magnitude of changes in the elastic characteristics.