On the dispersion of seismic waves

Arsen'yev S.A.

Schmidt's Institute of the Earth's Physics in the Russian Academy of Sciences, Moscow, Russia

e-mail: arrsenyev@yandex.ru

The earthquake wave zug recorded by seismographs usually consists of four waves of different genesis: P - waves of longitudinal compression and rarefaction, S - transverse waves, R - Rayleigh surface waves and L - Love waves. They arrive at the seismic station sequentially and all together form a packet of waves that cause an earthquake. All these waves are considered non-dispersive, with the exception of Love waves, which, due to dispersion, break up into harmonic components and fade out quite quickly. In this paper we study the dispersion of transverse S-waves. It appears due to friction, which acts differently on waves of different frequencies.

The initial one is the wave equation with friction (telegraphic equation). With its help, it is possible to obtain a dispersion relation linking frequency, phase velocity and wave number. In the case of the linear law of dispersion, the phase velocity does not depend on the wave number, the medium is non-dispersive, the waves in it propagate without distortion, the phase and group velocities coincide. This takes place in the absence of friction. If there is friction, dispersion appears, the wave packet is blurred, the law of dispersion is non-linear, the phase and group velocities are different. In general, the behavior of a seismic wave packet is determined by the tangent of the loss angle: the ratio of the friction frequency to the wave frequency. For weakly damped waves and low friction or for high frequency waves, the tangent of the loss angle is small and there is an acoustic analogy: there is no dispersion, but the dissipation is frequency-dependent. On the contrary, with strong attenuation or for low-frequency waves, we have an optical analogy: the magnitude of losses and phase velocity depend significantly on frequency, and it is possible that high-frequency (short) waves run faster than low-frequency (long) waves.