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Discussion on the significance of seismic interferometry to estimate inclined layered medium

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In a case where the spatial auto-correlation (SPAC) method (Aki, 1957) is used to estimate phase velocity, the underground structure is assumed to be horizontal layers, which confine the estimation accuracy. On the other hand, according to seismic interferometry theory, in an elastic medium the Fourier transform of azimuthal average of the cross correlation of motion between two sites is proportional to the imaginary part of the exact Green's function between these site (SanchezSesma, 2006). It means that it is possible to introduce the concept of Green's function to SPAC method because we calculate out many Fourier transform of cross correlation as intermediate results. Actually, there was a successful example combining the H/V method and seismic interferometry by Sanchez-Sesma before. Hence, we propose a method combining the conventional SPAC method and the concept of Green's function, which is known as the seismic interferometry in frequency domain. It is expected to obtain more accurate model of ground structure like inclined layered medium.

Afterwards, we take the ratio of power spectra of center of the array and one site on the circular array to calculate the ratio of imaginary part of Green's functions of these sites. Therefore, in practical observations, we calculate the ratio of power spectra of center of the array and one site on the circular array to obtain the ratio of imaginary part of Green's function of these sites. The ratio of Green's function can be obtained without any additional calculation, because the power spectra are just intermediate results in the process of the SPAC method. Then, we can modify the structure, such as the thickness of each layer, to satisfy the ratio of the imaginary part of Green's function. Therefore, more detailed information of ground structure such as inclination can be obtained from the combination of the SPAC method and seismic interferometry. The condition to satisfy this method is the diffusive wavefield.

In order to examine the validity of the proposed method, we do the sensitivity analysis and numerical simulation. In sensitivity analysis, we calculated the ratio of imaginary part of Green's function between varieties of 2-layered models with different thicknesses and see how the ratio varies with the thickness. Through 36 comparisons between 36 pairs of models, it is found that the shallower ground structure is, the more sensitive the ratio is with respect to the thickness. In numerical simulation, we use certain finite difference method-based program to simulate the diffusive wavefield by random sources and see how the ratio of power spectra matches the ratio of imaginary part of Green's function. Through 12 comparisons, it is found that the critical frequency which gives the peak value of ratio matches quite well. Through error analysis, it is found that the shallower structure is, the smaller error is.

In conclusion, the validity of proposed method is primarily confirmed. It has best accuracy in estimating shallow structure.

Keywords: Seismic Interferometry, Green's function, Cross spectrum, layered medium, SPAC method