

## Improvement of SPAC method by taking the ratio of power spectra between two sites

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Since Aki proposed a new approach to estimate phase velocities of surface waves, spatial auto-correlation (SPAC) method has been a very useful tool to estimate ground structure because of its simple post-process. After that, many researchers both in and out of Japan continued to publish papers on practical adaption of Aki's theory to microtremor exploration. However, in all those improved methods, the layers under surface can only be assumed to be horizontal through the SPAC method while in fact, the layers are likely to be inclined slightly with certain angle. Hence, it is expected to obtain more detailed information of ground structure such as inclination by making better use of the records.

In recent years, the seismic interferometry theory has also been widely used to estimate ground structure. It is proved that 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 sites. Hence, it becomes possible to calculate the ratio of imaginary part of different Green's function by taking the ratio of corresponding cross correlation to analyze ground

structure more particularly because Green's function indicates intrinsic property of the medium. Actually, seismic interferometry is conditionally consistent with the SPAC method which offers the base of introducing seismic interferometry to SPAC method.

SPAC method requires the multiplication calculation of Fourier transformation of records at two sites of center of an array and a one site on the circular array. By taking the ratio of power spectral between two different sites, it is hoped to obtain the ratio of imaginary part of Green's function according to seismic interferometry theory correspondingly and analyze the difference of ground structure through the ratio. More information such as the inclination of layers could be obtained.

Since this new concept has been proposed, some problems has been pointed out and the availability of the combination remains to be proved. Firstly, the ratio of power spectra is used to calculate the ratio of imaginary

part of Green's function which means the wavefield is supposed to consist of mainly body wave. However, the SPAC method requires the wavefield to be dominated by microtremors. It seems to be paradox but it is believed

that seismic interferometry theory itself satisfies wavefield of full wave. It is hoped that by taking the ratio of power spectra between two sites, the surface wave content will be extinguished and the body wave content remains.

Secondly, under the assumption of body wave being dominating, it is said that power spectra itself of each site could be used to analyze out the peak frequency of the ground structure (in simple case, the first layer) which tend to say that there is no need to take the ratio of them. Nevertheless, in wavefield dominated by microtremor and with the inclination of layers small enough, it is hard to extract useful information from each power spectra alone and to compare between them.

In this paper, the concept of SPAC method, interferometry and the combination of them are firstly proposed comprehensively. Then, in order to solve the two problems mentioned above, we use finite-difference method to

simulate some 2-layered simple layered medium under the wavefield dominated by microtremors. Next, SPAC method is applied to certain array of observation sites to examine if this wavefield is effective for SPAC method. Finally, the availability of seismic interferometry would be analyzed and the need to take the ratio of power spectra will be shown.

Keywords: Power spectra, seismic interferometry, SPAC method, Green's function, layered medium