Recent developments in microtremor surveys

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Microseisms and microtremors (hereafter called microtremors) are considered to be caused by ocean swells and human activities, respectively. Though they are recognized as noise to seismic observations, they can be turned into useful signal in other point of view. The nature of microtremors has been long studied. And the utilization of microtremors for engineering applications have been actively made in Japan such as the classification of site conditions based on the predominant periods, and the estimation of subsurface velocity structures by means of the spatial auto-correlation (SPAC) method and the horizontal-to-vertical (H/V) spectral ratio. These methods are now widely used all over the world in order to estimate shallow subsurface structures in terms of the prediction of strong ground motions. And in the last decade, studies on microtremors have been revitalized, mainly because seismic interferometry was developed and seismic observations became more efficient. For example, the H/V method was reinterpreted based on the theory of diffuse waves. And the centerless circular array (CCA) method was newly developed. Moreover, temporal changes in shallow subsurface structures caused by the nonlinear site effect can be detected by analyzing long-term continuous records of microtremors. In this session, we widely invite contributions on the nature of microtremors and their applications to exploration in order to understand the present status and discuss future directions of the subjects.

3:05 PM - 3:20 PM

Estimation of inter-station Green's functions using microtremor array data

3-min talk in an oral session

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The seismic interferometry technique is used to evaluate seismic velocity structure beneath two observation sites [e.g., Ma et al. (2008); Yamanaka et al. (2010); Asano et al. (2012); Hayashida et al. (2014)]. The technique can be applied under the assumptions of non-stationary and uniform distribution of microtremor (ambient noise) sources and it is important to investigate whether the data satisfy the conditions. The array observations of microtremor [Yoshimi et al. (2012)] were conducted at 13 sites in Niigata prefecture, Japan. The surveys were carried out for more than 10 days per site and each array consists of three equilateral triangular arrays whose radii range from several hundred meters to several kilometers. Here we used the data to estimate inter-station Green's functions with the seismic interferometry technique. The stacked cross-correlation functions (CCFs) of microtremor showed coherent and dispersive wave trains in frequency ranges between 0.4 and 1.0 Hz for the small array, 0.2 and 0.7 Hz for the middle array and 0.1 and 0.6 Hz for the large array. The wave trains derived for each array correspond well to each other regardless of azimuth angles, showing the effect from the abnormal microtremor source can be negligible in this study. We also calculated theoretical Green's functions from the estimated S wave velocity structures with the spatial autocorrelation (SPAC) method for each site,
assuming 1D velocity structure. The agreements between the calculated Green's functions and the derived CCFs from the seismic interferometry are generally good, especially at lower frequencies. Our results suggest that a combination of velocity structure estimation with surface-wave phase velocity (conventional array methods) and velocity structure validation with Green's function (seismic interferometry technique) provides better estimations for S wave velocity structures. Acknowledgements: We used the microtremor array data observed in a research project funded and supported by Japan Nuclear Energy Safety Organization (JNES).