Geophysical Research Abstracts
Vol. 16, EGU2014-15386, 2014
EGU General Assembly 2014

Investigating the generation of Love waves in secondary microseisms using 3D numerical simulations

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Longuet-Higgins (1950) proposed that secondary microseismic noise can be attributed to oceanic disturbances by surface gravity wave interference causing non-linear, second-order pressure perturbations at the ocean bottom. As a first approximation, this source mechanism can be considered as a force acting normal to the ocean bottom. In an isotropic, layered, elastic Earth model with plain interfaces, vertical forces generate P-SV motions in the vertical plane of source and receiver. In turn, only Rayleigh waves are excited at the free surface. However, several authors report on significant Love wave contributions in the secondary microseismic frequency band of real data measurements. The reason is still insufficiently analysed and several hypothesis are under debate:

- The source mechanism has strongest influence on the excitation of shear motions, whereas the source direction dominates the effect of Love wave generation in case of point force sources. Darbyshire and Okeke (1969) proposed the topographic coupling effect of pressure loads acting on a sloping sea-floor to generate the shear tractions required for Love wave excitation.

- Rayleigh waves can be converted into Love waves by scattering. Therefore, geometric scattering at topographic features or internal scattering by heterogeneous material distributions can cause Love wave generation.

- Oceanic disturbances act on large regions of the ocean bottom, and extended sources have to be considered. In combination with topographic coupling and internal scattering, the extent of the source region and the timing of an extended source should effect Love wave excitation.

We try to elaborate the contribution of different source mechanisms and scattering effects on Love to Rayleigh wave energy ratios by 3D numerical simulations. In particular, we estimate the amount of Love wave energy generated by point and extended sources acting on the free surface. Simulated point forces are modified in their incident angle, whereas extended sources are adapted in their spatial extent, magnitude and timing. Further, the effect of variations in the correlation length and perturbation magnitude of a random free surface topography as well as an internal random material distribution are studied.