Abyssal hills, ocean infragravity waves, and background Love and Rayleigh waves

Yoshio Fukao[1]; Kiwamu Nishida[2]; Naoki Kobayashi[3]

[1] IFREE/JAMSTEC; [2] ERI, Univ. Tokyo; [3] Earth and Planetary Sci, Tokyo Tech

http://www.jamstec.go.jp

We propose that background Love and Rayleigh waves in a frequency range from 5 to 20 mHz are generated by infragravity waves in the same frequency range through a linear coupling process with the seafloor topography. Wavelengths of ocean infragravity waves in this frequency range are on the order of 10 to 40 km in the deep ocean. The seafloor topography with the wavelengths of this order is dominated by abyssal hills, which are the most widespread physiographic forms on the face of the Earth, covering as much as 85 % of the Pacific floor. Individual hills range in size up to a lateral extent of some 40 km and a height of some 300 or 400 m. Interaction of infragravity waves in the deep ocean with these abyssal hills generates a random distribution of point-like tangential forces on the seafloor which may be large enough to excite Love and Rayleigh waves simultaneously. We quantify this idea by noting that abyssal hills are at most 300-400 m high, an order of magnitude smaller than water depth of the deep ocean, 4000-5000 m, so that the topography-related phase velocity change and the associated wave scattering of infragravity wave can be neglected. The model we constructed is fully consistent with the known statistical properties of the abyssal hill geometry and the size distribution. The model, given the known amplitudes of infragravity waves in the deep ocean, can explain the reported amplitudes of background Love and Rayleigh waves in a frequency range 5-20 mHz, including their characteristic spectral shape and their amplitude ratio. Surface wave excitation by this mechanism is too inefficient and the associated Love to Rayleigh wave amplitude ratio is too large at frequencies below 5 mHz and above 20 mHz, where other excitation mechanism(s) should be more important.