A Theory for *H/V* Spectral Ratio based on the Diffuse Field Assumption

Francisco J. Sánchez-Sesma[(1)], Michel Campillo[(2)], Ursula Iturrarán-Viveros[(3)], Mathieu Perton[(1)], José Piña-Flores[(1)], Juan Camilo Molina-Villegas[(1)], Juan J. Perez-Gavilán[(1)], Hiroshi Kawase[(4)] and Shinichi Matsushima[(4)]

(1) *Instituto de Ingeniería, Universidad Nacional Autónoma de México; C.U., Coyoacán 04510 D.F.; Mexico*
(2) *Facultad de Ciencias, Universidad Nacional Autónoma de México; C.U., Coyoacán 04510 D.F.; Mexico*
(3) *Observatoire de Grenoble, Université Joseph Fourier, B.P. 53, 38041 Grenoble Cedex ; France*
(4) *DisasterPrevention Research Institute, Kyoto University; Gokasho, Uji, Kyoto 611-0011 ; Japan.*

It is not difficult to accept that both microtremors and coda of earthquakes have in common the multiple scattering produced by the heterogeneous lithosphere and can be conceived as the effect of multiple random sources, most likely close to the surface of the Earth. We assume that multiple scattering makes the process diffusive. In this circumstance the average autocorrelation at a given receiver, in the frequency domain, measures average energy density and it is proportional to the imaginary part of Green's function when both source and receiver are the same.

Under very general circumstances, we show here that the imaginary part of Green's function at the loading point is also proportional to the power injected into the medium by a unit harmonic load precisely at that point. Such quantity accounts to waves that are reflected back to the source location. Therefore, it also represents reflection events. In fact, the average autocorrelations in time domain are called pseudo-reflection seismograms. These properties of diffuse fields can be used to imaging the mechanical and geometrical characteristics of an elastic domain.

Horizontal-to-vertical (H/V) spectral ratios of microtremors have been traditionally interpreted as representing either directly the S wave amplification or the Rayleigh wave ellipticity for a horizontally layered structure. Under the diffuse seismic field assumption, we compute the H/V ratio for a horizontally layered medium overlaying a half space in terms of the imaginary part the Green's function tensor components at the surface.

This 3D approach naturally allows for the inversion of the well known H/V Nakamura's ratio. Therefore, if we observe microtremors, we can invert the underground structure below that site by using the theoretical point source solution. Some examples of noise records and distant earthquakes that display strong scattering are interpreted using the theoretical results herein presented. On the other hand, for relatively deep earthquake sources, with no surface waves, the H/V spectral ratio can be interpreted in terms of a couple of 1D Green's functions for the site structure. These 1D Green's functions are constructed only with body waves.

On the other hand, for a laterally heterogeneous underground structure, the horizontal reflection responses are different and in order to interpret microtremor H/V spectral ratios, a numerical approach is needed. We can use methods like 3D Spectral Element or Boundary Element Methods to study a model of laterally heterogeneous elastic layers over a half-space. We present observational evidence of 3D microtremor H/V spectral ratios and show significant directional dependency that can be considered to be the result of 3D surface geology.