

## **A study of ambient seismic noise as the source for body-wave interferometry**

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In seismic exploration, one is particularly interested in body-wave reflections, as they provide the highest resolution images of potentially hydrocarbon bearing structures. However, the extraction of body-wave reflections using ambient-noise interferometry has turned out to be much more challenging than the extraction of surface waves from noise. This is in part due to the longer propagation paths between the receivers (and the higher rate of geometric spreading), the more severe restrictions on the distribution of sources for the retrieval of body waves (as pointed out by Wapenaar, PRL, 2004, for the retrieval of reflections, sources should be located in the subsurface) and the fact that omnipresent surface-wave noise dominates the generally weaker body-wave noise. In fact, for body waves it is less clear whether any (continuous) noise sources contribute to the synthesis of Green's functions and if any, what are the source mechanisms and distributions.

Most studies on noise observations agree that the bulk of the noise recorded at the surface of the Earth consists of fundamental- and higher-mode surface (Rayleigh) waves. Nevertheless, comparisons of spectra measured at the surface and in boreholes also permit the alternative explanation of (standing) body waves (Gupta, Geophys., 1965, Seriff et al., Geophys., 1965, Douze, BSSA, 1967). Only very few studies have observed directly and with confidence the presence of body waves in noise. If any, they appeared to be relatively low-frequency body waves, probably excited by oceanic microseisms (Toksöz and Lacos, Science, 1968). In the frequency band of interest for seismic exploration (> 1 Hz), these observations are particularly rare.

We investigated some properties of seismic noise recorded for 11 hours in the eastern part of the Sirte basin in Libya. The bulk of the energy in the noise is composed of surface waves at frequencies below 5 Hz. Using this part of the noise for interferometry results in the extraction of surface waves with velocities that match well with the velocities extracted from the active dispersion curve. Correlating 11 hours of filtered noise records results in the extraction of shot records containing body-wave reflections that coincide with reflections in an active shot record. From a more detailed analysis of the noise, we identified several records containing coherent energy traveling nearly vertically. FK analysis of these events show that they have very high apparent velocities, corresponding to upcoming body (P-) waves. Current work is focused on further characterizing these events. We will also selectively correlate the noise using only the 'events' (see Draganov et al, in this workshop). We expect this will enhance the body-wave reflections in the virtual-shot records. Characterization of the events will allow us to evaluate the effects of their distribution on the resulting virtual-shot records.