Seismic interferometry, with applications in passive reflection imaging (invited)

Kees Wapenaar and Deyan Draganov

Seismic interferometry is the process of generating new seismic responses by crosscorrelating seismic observations at different receiver locations. A first version of this principle was derived in 1968 by Claerbout, who showed that the reflection response of a horizontally layered medium can be synthesized from the autocorrelation of its transmission response. Later he conjectured a similar principle for crosscorrelations of 3-D wave fields. In a similar fashion, Schuster (2001) introduced the principle of interferometric imaging, i.e., forming an image of the subsurface from crosscorrelated seismic traces.

In this paper we first discuss the theory of seismic interferometry for arbitrary 3-D inhomogeneous media (deterministic or random). Starting with the Rayleigh-Betti reciprocity theorem and the principle of time-reversal, we derive a number of relations that form the basis for seismic interferometry (amongst others these relations prove Claerbout’s conjecture). Despite the difference in assumptions, these relations show a close resemblance with those of Weaver and Lobkis (2001) for the retrieval of the Green’s function from diffuse wave field correlations. Next we discuss a number of applications, like passive seismic reflection imaging, surface wave reconstruction, improving sparse data sets and interferometric imaging for different geometries.