Title: Seismic interferometry, with applications in passive reflection imaging
Lecturer: Kees Wapenaar
Length of lecture: half a day or a full day

Course description

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. This amazing result implies that, when a natural noise source in the Earth's subsurface emits waves to the surface, passive measurements of the noise at the surface suffice to compute the reflection response of the Earth's subsurface. The seismic wavelet in this synthesized reflection response is the autocorrelation of the noise source in the subsurface. Later Claerbout conjectured for the 3-D situation that 'by crosscorrelating noise traces recorded at two locations on the surface, we can construct the wave field that would be recorded at one of the locations if there was a source at the other'. Schuster argued that a similar principle applies to crosscorrelations of traces in seismic shot records and introduced the principle of interferometric imaging, i.e., forming an image of the subsurface from crosscorrelated seismic traces.

In this course we first discuss the theory of seismic interferometry for 3-D inhomogeneous media. Starting with a correlation-type reciprocity theorem, we derive a number of relations that form the basis for seismic interferometry (amongst others these relations prove Claerbout's conjecture). Also we discuss the theory of interferometric imaging. Next we discuss a number of applications, like passive reflection seismics (useful for monitoring), improving sparse data sets (ideally a source can be created at each receiver position) and interferometric imaging for different geometries. Apart from applications in exploration, seismic interferometry has potential applications in deep seismics and global seismology, which will also be briefly discussed.

About the lecturer

Kees Wapenaar received his Ph.D. in Applied Sciences in 1986 at Delft University of Technology. From 1986 until 1999 he was one of the project leaders of the Delphi consortium (a project on seismic imaging and characterization) at the Department of Applied Physics. In 1999 he was appointed professor of Geophysics at the Department of Geotechnology in Delft. Since 2002 he heads the section of Applied Geophysics and Petrophysics at this department. His main research interest is wave theory and its applications in seismic imaging and characterization, multi-component seismics and, since recent, passive seismic reflection imaging. He published one book and 75 journal papers on these subjects.