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Seismic interferometry in exploration geophysics: a review from practical aspect

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This is a brief review of the seismic interferometry (SI) in an exploration geophysics. The SI has highly developed and become multifunctional in this decade. Many theoretical and application researches have been published. In a view point of the exploration, an interferometric redatuming from a controlled-source seismic observation is one of the most important use. For example, a walkaway VSP survey can be changed to a reflection survey with sources and receivers on a well, which could image vertical structures clearer than a conventional surface reflection survey. Additionally, extracting signals from a passive seismic data is also useful to estimate subsurface structures or rock properties. The ambient noise surface wave tomography is based on the SI technique to generating Green functions from passive seismic data. A pseudo reflection survey from local earthquakes has capability to profile regional subsurface structures using not only S-wave coda but also P-wave coda.

The basis of the SI is an amplitude summation at stationary points after phase shift by crosscorrelating the seismic traces of the data with many sources or of the long passive seismic data. I summarize key terms at four practical aspects for effective use.

[1] Seismic source
(a) Controlled-source (air-gun, vibrator, dynamite, and so on)
(b) Natural earthquake
(c) Natural/artifitial ambient seismic noise
[2] Method
(a) Cross-correlation
(b) Deconvolution
(c) Multi-dimensional deconvolution
(d) Cross-coherency
(e) Convolution
[3] Function
(a) Redatuming
(b) Data interpolation/extrapolation
(c) Signal extraction
[4] Objective
(a) Reflection seismic imaging
(c) Surface wave tomography / inversion
(d) Rock property estimation
(b) Data processing; signal enhancement, noise elimination

Keywords: seismic interferometry, exploration geophysics, controlled-source, redatuming, passive seismic, signal extraction