Geophysical Research Abstracts
Vol. 20, EGU2018-10637, 2018
EGU General Assembly 2018

Adapting controlled-source coherence analysis to dense array data in earthquake seismology

Benjamin Schwarz, Karin Sigloch, and Tarje Nissen-Meyer
Department of Earth Sciences, University of Oxford, Oxford, United Kingdom (benjamin.schwarz@earth.ox.ac.uk)

Exploration seismology deals with highly coherent wave fields generated by repeatable controlled sources and recorded by dense receiver arrays, whose geometry is tailored to backscattered energy normally neglected in earthquake seismology. Owing to these favorable conditions, stacking and coherence analysis are routinely employed to suppress incoherent noise and regularize the data, thereby strongly contributing to the success of subsequent processing steps, including migration for the imaging of backscattering interfaces or waveform tomography for the inversion of velocity structure. Attempts have been made to utilize wave field coherence on the length scales of passive-source seismology, e.g. for the imaging of transition-zone discontinuities or the core-mantle-boundary using reflected precursors. Results are however often deteriorated due to the sparse station coverage and interference of faint backscattered with transmitted phases. USArray sampled wave fields generated by earthquake sources at an unprecedented density and similar array deployments are ongoing or planned in Alaska, the Alps and Canada. This makes the local coherence of earthquake data an increasingly valuable resource to exploit.

Building on the experience in controlled-source surveys, we aim to extend the well-established concept of beamforming to the richer toolbox that is nowadays used in seismic exploration. We suggest adapted strategies for local data coherence analysis, where summation is performed with operators that extract the local slope and curvature of wavefronts emerging at the receiver array. Besides estimating wavefront properties, we demonstrate that the inherent data summation can also be used to generate virtual station responses at intermediate locations where no actual deployment was performed. Owing to the fact that stacking acts as a directional filter, interfering coherent wave fields can be efficiently separated from each other by means of coherent subtraction. We propose to construct exploration-type trace gathers, systematically investigate the potential to improve the quality and regularity of realistic synthetic earthquake data and present attempts at separating transmitted and backscattered wave fields for the improved imaging of Earth's large-scale discontinuities.