

# Estimation of lithospheric-scale velocity models using body-wave seismic interferometry

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Active source surveys are widely used for the delineation of hydrocarbon accumulations. Most source and receiver configurations are designed to illuminate the first 5 km of the earth. For a solid understanding of the evolution of the crust, and therewith the hydrocarbon potential, much larger depths need to be illuminated. The use of large-scale active surveys is feasible, but rather costly. As an alternative, we propose to use passive acquisition configurations in combination with seismic interferometry (SI).

Passive acquisition configurations are arrays of receivers that listen (semi-)continuously to detect uncontrolled seismicity. Only since recently passive seismic arrays are used in exploration geophysics, e.g., for monitoring hydraulic fracturing jobs. Another application is emerging to use (natural) seismicity not only for source localization and tomography, but also for reflector imaging. The transmission responses caused by local seismicity can be turned into reflection responses using SI. Subsequently, these reflection responses can be processed to a reflectivity image, as was shown by Draganov et al. (2009) for an exploration-scale passive dataset. Using a similar approach, global-scale seismicity can be used to obtain lithospheric-scale images. In this case, a broadband array of receivers is required, preferably inline with an earthquake belt. It needs to be deployed for a time long enough to collect a proper selection of earthquake responses. Subsequently, by applying SI, responses can be obtained as if there was a source at each receiver position. These responses contain reflections and multiples and internal multiples from the prominent features in the crust.

In this work, we focus on the estimation of a lithospheric-scale velocity model before imaging. We use a semblance analysis to estimate velocities from retrieved reflections. The analysis differs somewhat from a conventional semblance analysis. Naturally, the limiting velocity-functions between which the velocities are picked are rather different from the exploration scale. Another difference is that the near-offset is not used in the estimation. This is because, for the existing distribution of earthquakes, it is hard to retrieve good-quality reflections at near offset. We show with modeling examples and with actual data from the Laramie array (2000-2001) that realistic velocities can be estimated using reflections retrieved with SI. The estimated velocity model has a much higher resolution than would be obtained from tomography and is considerably cheaper than a large-scale refraction survey.

## Reference

Draganov, D., X. Campman, J. Thorbecke, A. Verdel and K. Wapenaar, 2009, Reflection images from seismic noise: Geophysics, in press.