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Signal Apparition – A seismic shift for imaging the Earth’s interior

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The concept of signal apparition, introduced by Robertsson et al. (2016), offers a new perspective on the sampling of seismic wavefields. Signal apparition has range of applications in seismic data processing and imaging. In particular, for simultaneous source data acquisition, and through the use of periodic source modulation functions to encode sources during simultaneous shooting, energy can be partially injected or “apparated” along the wavenumber axis in the frequency-wavenumber (f - k) domain that would otherwise not be occupied by any signal. In the non-overlapping regions of the f - k domain, the individual sources can be exactly recovered by using linear combinations of weighted versions of the apparated data. In this fashion, the cost of acquiring a seismic survey can be reduced proportionally to the number of sources that can be activated simultaneously – thus enabling very significant cost reductions and/or increased image quality.

We present results from an exploration scale simultaneous source field test carried out over a producing hydrocarbon reservoir in the North Sea in 2016. The test demonstrates excellent results with unprecedented low-noise separated results fit for time-lapse reservoir analysis. We expect that signal apparition will also transform the way that imaging of the Earth’s deeper structure in the crust and mantle is carried out during refraction and reflection seismic experiments. In particular our acquisition approach will allow for 3D imaging using 2D-like acquisition geometries and will also allow for a significant increase in data quality in the low-frequency band below 5Hz. We will discuss specific seismic data acquisition configurations that will allow for a step-change in imaging of crustal-scale Earth structures without significantly increasing acquisition cost compared to current practice for academic seismic data experimentation.

Robertsson, J. O. A., Amundsen, L. and Pedersen, Å. S. [2016]. Express Letter: Signal apparition for simultaneous source wavefield separation. *Geophys. J. Int.*, 206(2), pp:1301-1305.