Target-oriented retrieval of subsurface wave fields – Pushing the resolution limits in seismic imaging

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Travelling wide-bandwidth seismic waves have long been used as a primary tool in exploration seismology because they can probe the subsurface over large distances, while retaining relatively high spatial resolution. The well-known Born resolution limit often seems to be the lower bound on spatial imaging resolution in real life examples. In practice, data acquisition cost, time constraints and other factors can worsen the resolution achieved by wavefield imaging. Could we obtain images whose resolution beats the Born limits? Would it be practical to achieve it, and what are we missing today to achieve this? In this talk, we will cover aspects of linear and nonlinear seismic imaging to understand elements that play a role in obtaining "super-resolved" seismic images. New redatuming techniques, such as the Marchenko method, enable the retrieval of subsurface fields that include multiple scattering interactions, while requiring relatively little knowledge of model parameters. Together with new concepts in imaging, such as Target-Enclosing Extended Images, these new redatuming methods enable new targeted imaging frameworks. We will make a case as to why target-oriented approaches to reconstructing subsurface-domain wavefields from surface data may help in increasing the resolving power of seismic imaging, and in pushing the limits on parameter estimation. We will illustrate this using a field data example. Finally, we will draw connections between seismic and other imaging modalities, and discuss how this framework could be put to use in other applications