Marchenko redatuming and imaging of seismic wavefields

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ABSTRACT

The novel technique of Marchenko redatuming can retrieve waves in the earth's subsurface, including primaries and multiples, where no real observations are available. We interpret the Marchenko scheme as an approach to overcome "incomplete time reversal": the method can be thought of as exciting focusing fields from one-sided "secondary sources", that yield subsurface-redatumed waves as if a complete two-sided experiment were available. These secondary focusing fields are retrieved directly from one-sided reflection data by means of an iterative autofocusing scheme. Here, we discuss the key components of the Marchenko scheme and their underlying assumptions, these being: knowledge of the medium's reflection response, and the choice of an initial focusing function and a data separation filter necessary for the iterative procedure. Using a complex subsalt benchmark model, we show that the current implementation of Marchenko redatuming outperforms conventional methods in estimating the desired subsurface fields. More importantly, we demonstrate that the fields resulting from the Marchenko scheme enable new imaging applications from one-sided reflection data, including imaging of transmitted waves and nonlinear, high-resolution imaging of target subsurface areas.