Subsurface monitoring using virtual sources and receivers (invited)

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There are many ways to monitor the propagation of waves in the subsurface, and for this purpose, often detailed models of the subsurface are employed to model the wavefields in the subsurface. An alternative for such models would be the use of the Marchenko method, which employs reflection data at the surface of the Earth and a smooth velocity model to create virtual sources and receivers in the subsurface. The method is capable of retrieving accurate wavefields that account for the full scattering of the medium at the location of interest in the subsurface. The advantages of the Marchenko method are that no detailed velocity model is required, that the method is target-oriented; i.e. the overburden above the target does not need to be resolved; and that the virtual receiver or source can be created at any location in the subsurface. The virtual wavefields that are obtained using the Marchenko method can be used to retrieve the response between any two locations in the subsurface, thereby forecasting the wavefield in the subsurface. Alternatively, the virtual wavefields can be combined with a real wavefield, that was measured in the field, to monitor the propagation of this real wavefield in the subsurface. In both cases, various source mechanisms and setups can be incorporated. To demonstrate the capabilities of this type of retrieval, numerical examples in 2D and 3D will be shown, as well as 2D field data examples.

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