

MARCHENKO IMAGING

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Traditionally, the Marchenko equation forms a basis for 1-D inverse scattering problems. A 3-D extension of the Marchenko equation enables the retrieval of the Green's response to a virtual source in the subsurface from reflection measurements at the Earth's surface. This constitutes an important step beyond seismic interferometry. Whereas seismic interferometry requires a receiver at the position of the virtual source, for the Marchenko scheme it suffices to have sources and receivers at the surface only. The underlying assumptions are that the medium is lossless and that an estimate of the direct arrivals of the Green's function is available. The Green's function retrieved with the 3-D Marchenko scheme contains accurate internal multiples of the inhomogeneous subsurface.

Using source-receiver reciprocity, the retrieved Green's function can be interpreted as the response to sources at the surface, observed by a virtual receiver in the subsurface. By decomposing the 3-D Marchenko equation, the response at the virtual receiver can be decomposed into a downgoing and an upgoing field. Next, by deconvolving the retrieved upgoing field with the downgoing field, a reflection response is obtained, with virtual sources and virtual receivers in the subsurface. This redatumed reflection response is free of spurious events related to internal multiples in the overburden. The redatumed reflection response forms the basis for obtaining an image of a target zone. An important feature is that spurious reflections in the target zone are suppressed, without the need to resolve first the reflection properties of the overburden (Figure 1).

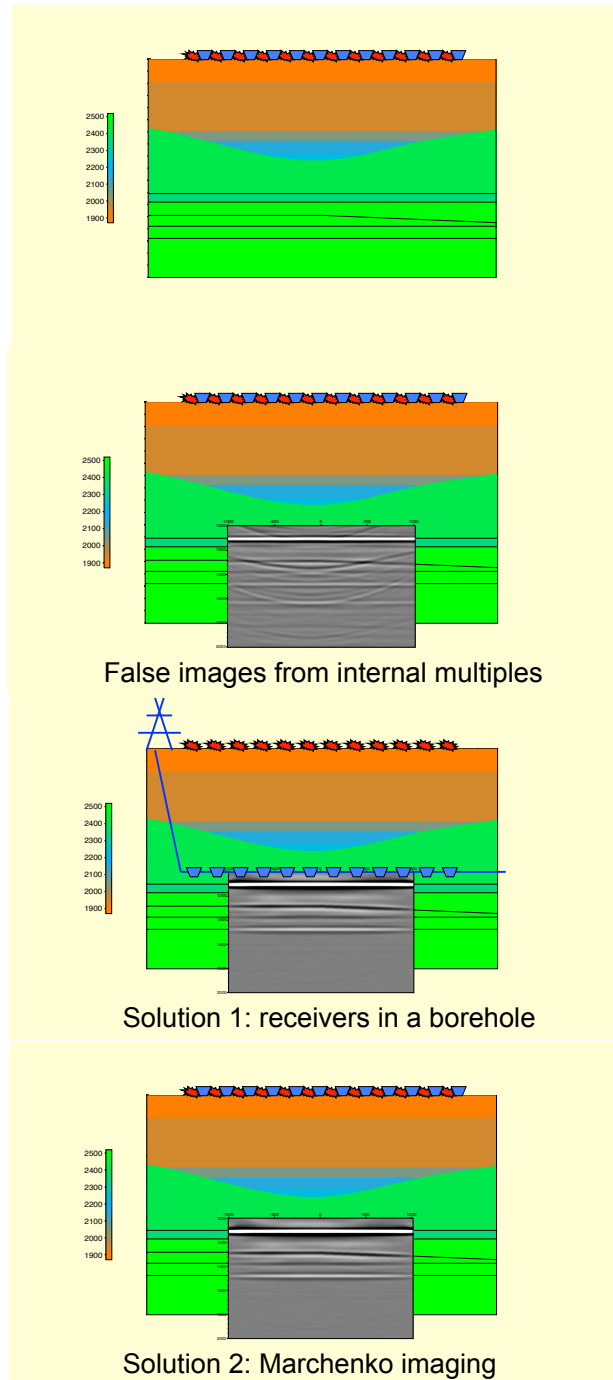


Figure 1. Example of imaging of a target zone in a simple 2D configuration. Standard imaging does not account for internal multiples, which leads to false images. When receivers are present in a borehole, “interferometric imaging” leads to a much clearer image. Marchenko imaging, also called “beyond interferometry”, achieves the same result when sources and receivers are available at the surface only.