Initial Wavelet Estimate of EPSI in Shallow Water

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Abstract

Objectives
Shallow water presents a very difficult environment for surface demultiple due to the interference of the very high number of different orders of free-surface multiples with primaries (and internal multiples). An inversion approach, such as Estimation of Primaries by Sparse Inversion (EPSI), is one of the few methodologies capable of handling these complex situations. However, the standard way of estimating an initial wavelet for the inversion proved to be insufficient when the method was tested on a very shallow OBN dataset. An alternative method with good and consistent results is introduced and discussed.

Procedures
The commonly used Surface Related Multiple Elimination (SRME) method uses a relation between input data and that data without surface multiples to generate an estimate of the surface multiples, which are subsequently adaptively subtracted to obtain data without those multiples. This approach works fine for deep water, but becomes more and more challenging with decreasing water depth. EPSI inverts for the data without surface multiples and a wavelet in an alternating fashion by minimizing a misfit derived from the same relation. Initially, the wavelet used to kickstart the inversion was derived indirectly from first break times picked for a range of near-offset traces. Unfortunately, the signal-to-noise ratio of those traces is relatively low. Hence, the chances for mis-picks is high with observable effects on the estimated initial wavelet and subsequent inversion result. We implemented an alternative method to derive the initial wavelet, which applies NMO using water velocity on the same range of near offset traces and then stacks them, before using part of the resulting trace across its first break event as the initial wavelet. Results We tested EPSI with both wavelet methods on a very shallow OBN dataset with water depths ranging between 25 and 40 meters. We noticed that two very similar looking input gathers with identical depths could give very different results when the initial wavelet was estimated for each gather separately with the original method. Furthermore, the results along the test line appeared to be inconsistent. This lack of robustness, probably due to the wavelet, was investigated and confirmed by various tests using synthetic data modelled for different water depths. Hence, a new wavelet estimation method was required. The results of EPSI with the alternative wavelet estimation method proved to be robust for the synthetics and more consistent for the OBN data.

Conclusions
Free-surface demultiple in very shallow water is challenging due to the interference between primaries and the various orders of multiples. The EPSI method is capable of handling this complex situation provided its inversion is started with a good initial wavelet. A new and more robust method to derive this wavelet from the data is presented and tested on synthetics and field data.