WS09 D04

From RWI to JFWI: including diving waves in reflection-based velocity model building

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Summary

In this presentation, we will review the main limitations of classical FWI for imaging at depth, and the main concepts behind RWI and JFWI. Based on synthetic and real data applications on a 2D OBC datasets collected across a gas cloud, we will show the added value of such schemes and also their limitations mainly associated with the misfit function definition (cycle-skipping and amplitude dependency).

For the past few years, Reflection Waveform Inversion (RWI) has been proposed to build velocity macro-models by focusing on reflected waves and by restricting the sensitivity kernel of full waveform inversion (FWI) along the two-way transmission paths of short-spread reflections. RWI is classically alternated with impedance inversion or migration that produces short-scale impedance/reflectivity model, used as an input to build the RWI sensitivity kernel. Relying on scale separation, RWI allows to increase the sensitivity of FWI below the penetration depth of early transmitted arrivals, and significantly reduce the cycle-skipping issue in short offset ranges. The approach is, however, not immune to cycle-skipping at intermediate to large offsets when used with classical difference-based misfit, and is also unable to handle transmitted waves.

With the development of super long offset and wide azimuth acquisition geometry, increasing amount of early arrivals data are recorded. In order to overcome the limitation of RWI associated with transmitted/diving waves, we proposed the Joint Full Waveform Inversion as a natural combination of RWI and classical FWI applied to early arrivals, for building macro velocity model. The JFWI misfit function relies on an explicit separation between early arrivals and short-spread reflections and also relies on an alternate estimation of short-scale impedance model. The combined use of reflections and diving waves allows to significantly improve the near-surface reconstruction, generally weakly constrained by reflections, improving the overall velocity model building at depth.

In this presentation, we will review the main limitations of classical FWI for imaging at depth, and the main concepts behind RWI and JFWI. Based on synthetic and real data applications on a 2D OBC datasets collected across a gas cloud, we will show the added value of such schemes and also their limitations mainly associated with the misfit function definition (cycle-skipping and amplitude dependency).