Amundsen inversion - an alternative for surface related multiple elimination?

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Abstract

In seismic data acquisition a signal is emitted by a source and recorded at a multitude of receivers. In the recorded reflection data one distinguishes between primaries, waves which have reflected once in the subsurface and multiples, waves which have reflected more than once in the subsurface. The most important multiples are surface related, namely those which have bounced against the surface of the earth at least once. Multiples cause a serious problem for the imaging of seismic data, as present day seismic imaging algorithms are based on linearized theory and therefore correct for primaries only. Therefore, one needs to remove or rather attenuate multiple reflections in the data before constructing an image of the subsurface.

There are many methods to attenuate surface related multiples in seismic data. Among them there is a class of methods which is purely data driven. It goes by the acronym of SRME, Surface Related Multiple Elimination. Starting from the Rayleigh reciprocity theorem, one derives an algorithm to predict multiples from (deghosted) reflection data. The predicted multiples are subsequently subtracted from the data by an adaptive procedure based on minimizing energy in the residual. The latter step is the weak link: the minimum energy criterion is known to be wrong in case of interference between primaries and multiples and it is quite easy to damage primary reflection information by being too aggressive in the adaptive subtraction.

Starting from the Rayleigh reciprocity relation again, L. Amundsen formulated a different way to extract primaries from seismic data. His algorithm is assuming that one has independent measurements of pressure and vertical particle velocity and takes the form of an inverse problem: one extracts primaries by multiplying upgoing waves by the inverse of downgoing waves.

This presentation will explain the theory behind these two approaches for multiple elimination and highlight their strengths and weaknesses. We will illustrate the new Amundsen method by examples on ocean bottom cable data and sketch a way towards application on towed streamer data.