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FK-filtering vs. Predictive Deconvolution in the Multiple Reflection Removal Approach

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Multiple reflection removal is one of the most important topic in seismic reflection processing, especially in the marine seismic data, where seabed multiple reflections can often severely mask the primary events. It is thus necessary to remove or to attenuate them prior to stack the data. In shallow water, the most common type of multiples is water reverberation.

In this study two different pre-stack attenuation techniques have been tested and compared by using the Focus PARADIGM software package: namely, the FK-filtering and the Predictive deconvolution. We performed this comparison on a multichannel seismic profile acquired offshore W-Calabria (SE Tyrrhenian Sea; Loreto et al., 2012), and characterized by the presence of remarkable multiple reflections.

Coherent linear events within the t-x domain can be separated as dip events within the F-K domain. This allows to remove some undesired energy (such as multiples) from the data. F-K filtering works based on the following strategy. NMO (Normal Move Out) correction is first applied to the Common Mid Point sorted data by using velocity lower than water velocity up to the first seabed multiple occurrence; a velocity close to sea water velocity (or slightly higher) will instead be applied from the first multiple up to the end of the record.

This will result in an overcorrection of the primary events in the t-x domain that consequently will fall within the positive sector of the F-K spectrum. The multiple reflections, conversely, will be either flattened or slightly under corrected, and thus will be positioned in the proximity of the F-K spectrum vertical axes or in its negative sector.

By applying the F-K filter on either the corrected (vertical axis) or undercorrected (negative sector) events, the multiples will be removed leaving untouched the primary events.

Deconvolution is a process whose purpose is to improve the temporal resolution by compressing signals to very short duration wavelets (spiking deconvolution) or to remove, if present, periodic events present in the data (peg lag multiples, bubble effect etc.). In the latter case, we refer to predictive deconvolution that can also be used to suppress seafloor multiple reflection. To perform predictive deconvolution, first the seafloor reflector has been picked on the brute stacked section, and the corresponding time stored within the water depth data header. Later, a dedicated velocity analysis was performed in order to flatten both the seafloor and the related multiple reflections of the first and secondary order. Finally, the deconvolution was applied with by adopting a gap parameter retrieved by the picked water depth, representing in this specific case the predictable occurrence of the first multiple. Compared to the conventional predictive deconvolution, where the gap parameter is kept constant, in the applied deconvolution the water depth changes continuously because it refers to the seafloor depths. Operator length is chosen so as to carefully remove only the multiple reflections and possibly leave untouched the primaries.

The results of F-K filtering and Predictive deconvolution indicate that the predictive deconvolution is more successful both to remove the multiples and to increase the resolution in the shallow part of the section.

References

Loreto, M. F., et al., 2012. In search of new imaging for historical earthquakes: a new geophysical survey offshore western Calabria (southern Tyrrhenian Sea, Italy). Bollettino di Geofisica Teorica ed Applicata, 53(4), 385-401.

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