Data Pre-processing for Advanced Surface and Internal Multiple Attenuation

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Abstract

The conventional surface-related or internal multiple elimination (SRME or IME) methods only kinematically predict multiples followed by an amplitude-correction. This simultaneously (1) enables the processor to compensate non-physical pre-processing via the adaptive subtraction, and (2) carries the risk of damaging the primaries or leaving behind multiples. These methods are mainly suitable in deep water with an overburden featuring very few strong reflectors. Novel purely data- and physics-driven algorithms, such as the Robust Estimation of Primaries by Sparse Inversion (R-EPSI) and Marchenko methods, are capable of predicting dynamically accurate multiples. In contrast to conventional methods, they still work very well in shallow water, or with very strong and numerous reflectors. To fully benefit from these algorithms, greater attention needs to be paid to physics-driven pre-processing. We outline the latest research in embedding these tools in a wider seismic data processing workflow.

The R-EPSI and Marchenko methods rely on similar quality data pre-processing as the conventional methods. We show that, when analyzed in the right domain, the novel methods offer little-known advantages of additional physics-based quantitative quality checks which can be used to guide the pre-processing. Moreover, we show that with clever filtering, we are able to relax some stringent sampling conditions and reduce the computational cost, without impacting the final result. Since the pre-processing parameters are often fine-tuned using individual 2D lines, we show that for such 2D tests to produce physical and reliable outcomes, the recorded 3D wavefield needs to be correctly converted to a hypothetical 2D-medium measurement. We showcase how the conventional correction by square-root of time combined with phase- and amplitude-dependent scaling is actually incorrect and propose a true-amplitude alternative.

The advanced de-multiple algorithms were first proposed about 8-10 years ago and have undergone continuous theoretical developments to date. Due to the practical pre-processing barriers addressed in this talk, they have not been widely adapted in the industry and their full value has not yet been unlocked.