COMMON-REFLECTION-SURFACE STACK – A MACRO-MODEL-INDEPENDENT SEISMIC IMAGING METHOD

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The recently introduced common-reflection-surface (CRS) stack offers a new method to obtain a well-simulated zero-offset (ZO) section from multi-coverage seismic reflection data. The CRS stack can be seen as a generalization of the classical migration to zero-offset (MZO) method which is usually approximated as a sequence of normal moveout (NMO) and constant-velocity dip moveout (DMO) corrections. Due to the more general parameterization of the CRS stacking operator, it fits better to the kinematic seismic reflection responses of arbitrarily curved interfaces in laterally inhomogeneous layered media.

In contrast to the conventional NMO/DMO/stack approach which only provides one stacking parameter (namely, the stacking velocity), the CRS stacking operator for 2-D media depends on three independent kinematic wavefield attributes. Obviously, they can provide more information about the subsurface model than a single stacking parameter. Moreover, these attributes can be derived directly from the multi-coverage input data by means of coherency analysis. In other words, the desired ZO section as well as the additional wavefield attributes are obtained in a self-consistent, macro-model-independent way. An introduction to the underlying concepts is given during this workshop by Peter Hubral et al. in the talk "*An introduction to macro-model-independent seismic reflection imaging*".

The present contribution is dedicated to the implementation strategies and the application on 2-D multi-coverage data. To illustrate the ability of the CRS stack to determine the correct wavefield attributes and, thus, the related stacking operators, we compare the model-derived (forward calculated) attributes to the data-derived results of the CRS stack. As this requires the detailed knowledge of the model, we restrict this presentation to a synthetic seismic data example.

A pragmatic and efficient algorithm for the estimation of initial attribute values is discussed. We propose a search method based on three one-parametric searches that are applied in different subsets of the multi-coverage data. These initial attributes are already sufficient to obtain a high-quality simulated ZO section. If, in addition, the wavefield attributes are used for further calculations, e. g., the inversion of the layered model, a subsequent optional three-parametric local optimization step serves to improve them.

The results reveal a wide agreement of the model-derived versus the data-derived wavefield attributes. Accordingly, the simulated ZO section obtained from the CRS stack provides kinematically correct reflection events with a high signal-to-noise ratio. Furthermore, the continuity of the events is superior to the conventional results.

The synthetic data example also exposes the relationship between the kinematic wavefield attributes (i. e., the emergence angle of a specific normal ZO ray, and two curvatures of hypothetical wavefronts) and the geometrical properties of the arbitrarily curved interfaces in the subsurface. In this context, the interfaces can be seen as a superposition of reflector segments with well-defined locations, orientations, and curvatures.

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