AN INTRODUCTION TO MACRO-MODEL-INDEPENDENT SEISMIC REFLECTION IMAGING

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A classical processing step in seismic reflection imaging is the simulation of a zero-offset (ZO) stack section from multi-coverage seismic reflection data. This reduces the amount of data and enhances the signal-to-noise ratio. In general, imaging methods imply a particular representation of the underlying earth model. We present a new imaging method called *common-reflection-surface (CRS) stack* which is based on ray theory and a subsurface model description that is more general than for conventional methods like, e. g., Kirchhoff-type methods or a migration to zero-offset (MZO). Thus, our approach is better suited to approximate the kinematic reflection response of curved interfaces in laterally inhomogeneous layered media. Furthermore, our new approach can be applied without explicit knowledge of the subsurface model. The near surface velocity is sufficient to determine the corresponding stacking operators and a set of three useful kinematic wavefield attributes. These attributes can be used for various applications, e. g., the calculation of Fresnel zones and geometrical spreading factors, or the inversion of the model.

We elaborate the different model assumptions and stacking operators of Kirchhoff-type migration, MZO, and the CRS stack. Due to the more general approach of the CRS stack, its stacking operator fits better the actual reflection events in multi-coverage data, i. e., the region of tangency of an event and the stacking operator is significantly larger than for conventional methods. This immediately leads to an increased signal-to-noise ratio.

For 2-D data, the kinematic wavefield attributes defining the CRS stacking operator are associated with two hypothetical *eigenwave* experiments: we consider a ZO ray from a normal incidence point (NIP) on an interface to a point P at the surface. A point source located at the NIP yields a wavefront emerging at the surface point P with a well-defined curvature and a specific emergence angle. Analogously, an exploding reflector experiment provides the same emergence angle and an additional curvature at P. An emerging wavefront stemming from an arbitrarily curved interface can be described as a superposition of these eigenwaves.

Instead of calculating the attributes and the associated stacking operator by forward modeling, we use coherency analyses to derive the operator directly from the input data. Thus, the CRS stack can be performed without knowledge of the actual model.

We applied the common-reflection-surface stack to various synthetic and real 2-D data sets. The comparison of CRS stack and conventional results reveals significant improvements with respect to the signal-to-noise ratio and the continuity of the events. Let us emphasize once more that the CRS stack does not require a macro-velocity model, but even provides the kinematic wavefield attributes suitable to derive the model.

The CRS stack approach can also be extended to 3-D data. Then, the scalar wavefront curvatures turn into curvature tensors and a second angle is required to describe the emergence of the normal ray. As a consequence, the stacking operator in 3-D depends on eight independent parameters. The implementation of the CRS stack in 3-D is a subject of our current research.

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