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Imaging the SE1 reflector near the Continental Deep Drilling Site (KTB, Germany) with coherence-based prestack-depth migration

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Kirchhoff prestack depth migration algorithms are widely used to image geological structures. There are a variety of Kirchhoff-type methods, such as Fresnel-Volume-Migration (FVM), that try to overcome the incapability of standard Kirchhoff migration to image steeply dipping reflectors or to produce clear and artifact-free seismic images if only a small number of seismic traces is available. All of these modified Kirchhoff migration algorithms employ additional weighting factors to confine the migration operator and to limit the seismic image to the actual position along the two-way travel time isochrone where diffractions and reflections originate.

Coherence-based prestack-depth migration (CBM) uses a weighting factor obtained directly from the input data by evaluating a normalized coherence measure defined over neighboring traces and a time window around the particular time sample to be imaged. This coherence measure and the corresponding weighting factor are high if the differences in the arrival times of a coherent event at nearby receivers can be explained by the differences in the travel times along the ray paths from the source position to a certain image point on the two-way travel time isochrone, and from there to the receiver group. In turn, a small weighting factor is obtained if the travel time differences cannot be explained by a certain combination of source, image point and the selected receiver group. Thereby it is possible to suppress random noise and to obtain artifact-free seismic images even with a small number of seismic traces.

This method is applied to a single shot from the Instruct-93 data recorded at the Continental Deep Drilling Site (KTB) near Windischeschenbach (Germany). This seismic experiment was designed to illuminate the steeply dipping SE1-reflector, that was known from earlier seismic investigations, at a target depth of about 8 to 9 km. For this purpose the shot point and the 120 receivers were placed approximately 10 km away from the KTB site.

Despite the limited aperture and the low number of seismic traces, CBM yields a clear image of the SE1 reflector similar to FVM if appropriate migration parameters such as time window length and choice of the traces to include in coherence computation are chosen. However, CBM does not involve ray tracing to reconstruct the ray paths and estimating the Fresnel volume unlike FVM. Therefore the computation effort of CBM is lower compared to FVM.