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Improved imaging below high-impedance sediments by the common reflection surface (CRS) stack

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Introduction

Target structures below high impedance sediments generally render a weak seismic reflection signal which is additionally obscured by multiples from the high impedance section. As a consequence, the seismic image of the target structure is often characterized by some discontinuous portions of the reflectors that are otherwise buried in the noise.

Both acquisition and processing techniques are used to increase the image quality. Common technical strategies are to increase the fold and aperture in acquisition, and to use more accurate prestack imaging techniques with more reliable background models in processing. However, both these strategies require a large effort.

As an alternative, the Common Reflection Surface (CRS) stacking technique combines some advantages of both strategies, and thus may add to obtain an improved image below high-impedance sediments. The strength of this time domain imaging method is demonstrated in case studies by comparison to conventional time and depth imaging.

Common Reflection Surface (CRS) method

The Common Reflection Surface (CRS) method belongs to the macro-model independent imaging techniques (e.g. Hubral, 1999), which do not require an imaging parameter field or velocity model as input to the imaging process. The method assumes local reflector segments in the subsurface, which are characterized by their location, dip, and curvature. The corresponding reflection time surfaces are described by a hyperbolic approximation, which, in contrast to the conventional NMO approximation, is not confined to a single CMP gather. This leads to a much larger stacking fold, and allows a more reliable fit of the stacking surface to the reflection response in case of noisy field data (Trappe et.al., 2001).

The CRS reflection time approximation for 2D seismic data is provided by three independent parameters, which comprise an emergence angle, and two radii of wavefield curvature. As in all macro-model imaging methods, the imaging parameters are directly measured from the prestack data.

Data example

A data example is selected from an exploration area where a folded target structure is situated below a largely flat overburden. The overburden is characterized by a high impedance formation, where the reflection strength is raised by about one magnitude above the remaining amplitude level. As a consequence, this formation produces a large number of internal multiples which strongly disturb the deeper target reflections.

In comparison to the conventional NMO/DMO processing, the CRS technique distinctively improves the signal-to-noise ratio and reflector continuity. The key structure of a central uplift is well resolved in the CRS stack, whereas conventional time processing delivers a rather vague image. Moreover, Poststack Depth Migration of the CRS stack provides a much better image, than Prestack Depth Migration (PreSDM). The CRS technique proves to be an alternative where PreSDM fails to enhance resolution.

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References

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