

IMAGING OF DIFFRACTORS USING PASSIVE SEISMIC DATA

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A seismic wave encountering a small subsurface heterogeneity scatters in many directions. Such heterogeneities are called diffractors. Examples of diffractors in the subsurface include terminations of sedimentary layers at faults and edges of objects such as a reservoir, as well as intrusions, lenses and fractures. Since all these geological features are important for better understanding of the subsurface, imaging and inferring properties of seismic diffractors is an active area of research.

Since Trorey's (1970) derivation of the theoretical response of a seismic diffractor, there were many authors that studied diffractions and their application to seismic imaging (e.g. Landa et al., 1987; Kanasewich and Phadke, 1988; Khaidukov et al., 2004; Fomel et al., 2007; Klem-Musatov, 2008; Moser and Howard 2008).

Imaging methods based on Kirchhoff type summation along diffraction hyperbolae usually assume global aperture. This means that the summation is performed along the entire diffraction travelttime surface, even though the energy is located only along the tangent of this surface to the travelttime surface of the actual reflection or diffractor. The extra aperture can introduce imaging artefacts and can increase noise in the resulting image (Sun, 1998). To reduce these effects, there were many suggestions how to reduce the aperture by finding the tangent point between the two surfaces and restricting the aperture around this point by the first Fresnel zone. Klovov and Fomel (2013) provide a brief summary of these works. Naturally, most of these methods result in enhancement of reflections and diminishment of the diffractors, whose migration aperture is greater than that of the reflectors. Herein we propose the opposite of the usual approach – limit the migration aperture to suppress reflections and enhance the diffractors while improving S/N by setting aperture appropriate to the diffractor type. We perform such analysis on passive pre-stack data.

We investigate the possibility to image and characterise the different types of diffractors – such as point, line, and edge – and separate them from reflections by limiting the aperture around the tangent point between the diffraction hyperbola and the reflection travelttime surface. To this end, we look at the tangents of the diffraction hyperbola with typical travelttime surfaces corresponding to the different diffractor types. We do this by studying the coherency of the recorded wavefield along the diffraction hyperbolae. The different types of diffractors show different energy distributions that can be used to characterise the diffractors and separate them from specular reflections.

Unlike point diffractors, edge and line diffractors possess both reflection and diffraction like characteristics. This dual nature of the diffracted signal means that imaging of these diffractor types using passive data is more challenging than passive imaging of point diffractors. However, the reflection characteristics can also provide an extra information about the passive source that is not available from point diffractors.

