Diffraction Imaging: An Example from Saudi Arabia

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ABSTRACT

One of the objectives of seismic imaging is to obtain the maximum possible resolution of the subsurface structures. This resolution comes from defining boundaries between layers and often discontinuous features. One challenge to achieving this goal is that conventional images are produced using seismic data processing flows designed to image reflected energy that comes from specular reflectors. An alternative approach for locating small discontinuities in the subsurface is to analyze diffracted energy. Diffracted energy comes from small objects (on the order of a wavelength) that scatter seismic energy. Diffracted energy response, naturally describes geological discontinuities such as small-scale faults, pinch-outs, and fracture terminations which are often the aim of interpreters. Diffraction imaging gives higher resolution than conventional post-stack fault enhancement attributes and conventional seismic reflectivity volumes. Diffraction imaging is commonly done by separating diffracted energy from reflected energy in the data space domain. Plane-Wave Destruction (PWD) filters, which use a description of seismic reflection data based on the local plane-wave reflection model, is one convenient approach for extracting diffractions from seismic reflection data. The key concept is that plane-wave destruction filters effectively predict the smooth continuous events in the seismic data, which correspond to reflected energy in the offset plane of seismic CMP gathers. Therefore, plane-wave destruction filters, naturally predict and suppress this specular reflection energy. The remaining data should contain diffracted energy, coherent hyperbolas, and other kinds of energy such as random noise. The diffraction imaging workflow applied to this dataset demonstrates the effectiveness of this technique in imaging small scale heterogeneities. Even though PWD separates diffractions in the data space, there exist areas where diffraction-like responses will appear. Consequently, one needs to look at both conventional and diffraction images. The extracted diffraction image reveals subtle details about the geology of the subsurface which are hidden in the conventional image. Both the extracted diffraction and conventional images enable interpreters to characterize the subtle details of subsurface geology.