Linear Diffractor Imaging

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Abstract:

Detection of small scale local near-surface heterogeneities in a noninvasive manner is an important problem in a variety of fields such as engineering, archeology, site investigation, geology and security. Imaging methods that were developed in the last couple of decades that aim to detect such heterogeneities are mostly dependent on travel-time surfaces of point diffracted waves. In a case where the heterogeneity has a linear character, the use of an imaging method which is based the point-diffractor approximation may result in a poor image.

When an incident ray hits a corner, edge or vertices of boundary surfaces, diffraction rays are produced. In the case that the ray is diffracted on a point or a tip it is scattered radially, in a case that a ray hits an edge it is scattered in a more complex manner. Keller (1962) described Somerfeld's solution to a plane wave diffracted by a semi-infinite screen with a straight edge as follows: when an incident wave is propagating in the direction normal to the edge the wave is diffracted in a cylindrical manner with the edge as its axis. When an incident wave propagates in the direction oblique to the edge the solution is conical; thus, the wave fronts are diffracted as parallel cones with the edge as their common axis and

the diffracted ray makes equal angles with the incident wave at the edge. Another major difference between a point diffraction and an edge diffraction is that in the case of a point diffraction, for any given pair of sources and receivers the location of the scattering point will be in the same location. In the case of an edge diffraction, for any given pair of sources and receivers, the diffraction point will be located differently along the edge. Rays diffracted on a linear diffractor behave in the same manner as rays diffracted on an edge. In the case of a linear diffractor, the common axis of the wave fronts will be the linear diffractor itself.

In this study we propose a new approach for imaging linear-diffractors using 3D seismic data. Our approach suggests that the linear-diffractor may be situated at any location and angle in 3D space. Imaging is performed by stacking seismic energy along all suspected linear-diffractor travel-time surfaces.