Further comments on oblique reflectors

John C. Bancroft

ABSTRACT

In a constant velocity environment, oblique reflectors can be successfully imaged with a special prestack Kirchhoff migration or by including dip moveout processing with a poststack migration that uses modified velocities.

When the velocities vary with depth, the moveout correction portion of the dip moveout may be in error, and the constant velocity assumption of dip moveout is violated. Prestack time migration, that is based on the RMS velocity assumption, does not have these limitation.

COMMENTS

The kinematics of a scatterpoint that is displaced to the side of a 2-D seismic line has kinematic properties that are similar to those of an inline scatterpoint that is below the 2-D line and at the same depth. The raypaths from the displaced scatterpoint lie on a single radial plane that passes through the surface of the 2-D line and through the scatterpoint and may not be distinguishable from an inline scatterpoint. The traveltimes are computed using the velocity at the depth of the scatterpoints, even though the diffracted energy lies below the scatterpoint on the recorded time traces. The traveltimes to the displaced and inline scatterpoints are defined by the double-square-root (DSR) equation and have a shape in the prestack volume of (x, h, t) that is referred to as Cheops pyramid. The depth of the displaced Cheops pyramid will be deeper in the volume than that of the inline scatterpoint.

In a constant velocity medium, normal moveout (NMO) correction, dip moveout (DMO), and stacking will collapse the energy from both Cheops pyramids from the displaced and inline scatterpoints to their corresponding zero-offset hyperbola.

An oblique reflector may be considered to be an oblique line of scatterpoints. The energy from each scatterpoint can be collapsed to its corresponding zero offset hyperbola. The envelope of these hyperbola reconstruct a new hyperbola whose shape is defined by the migration velocity that is a product of the RMS velocity and the cosine of the angle of obliquity.

When the velocity increases with depth, the velocities on the recorded tracers also increase with increasing time. Consider again the two scatterpoints at the same depth, one displaced and the other in line. Both will have Cheops pyramids defined by the same velocity, but their apex will be at different time levels. Energy from the displaced scatterpoint will be deeper in time and appear to have a velocity defined at a lower time, and the NMO correction, prior to DMO, will be in error.

A prestack migration that is designed for the specific angle of obliquity could reduce this error.