Historically, migration of seismic data has been performed with either integral or wave-field extrapolation methods. These two methods can have significant limitations that prevent effective imaging in some instances. In 2005, ION commercially introduced reverse time migration (RTM), a depth migration technique that overcame the limitations of these existing techniques. Since introducing RTM, ION has used it effectively on dozens of projects spread throughout the world.

Standard shot-based one-way wavefield extrapolation (WE) preSDM techniques image the subsurface by continuing the source and receiver wave-fields for each shot downward in depth. An image is subsequently formed by cross correlating these two wave-fields at each depth level and each lateral position. Finally the partial images formed for all shots are summed to form the final image. One of the assumptions made in this technique is that the source and receiver wave fields only travel in one direction along the direction of extrapolation between the surface and the subsurface image point: forwards for the source wave-field, and backwards for the receiver or scattered wave-field. In practice, each of these wave-fields will generally travel both up and down if the velocity model is complex or exhibits strong velocity gradients. Such complexities will produce turning (or diving) rays, double bounces, and multiples. Furthermore, approximations in the one way wave equation extrapolation techniques usually limit the dips present in the final image to less than seventy degrees. Steep dips, and turning rays are usually imaged using Kirchhoff techniques, but this technique fails to deliver acceptable images when either the source or receiver wave fields become sufficiently complex for multi pathing of the wave fields to occur.

Advanced Anisotropic RTM Imaging

Complex salt geometries with intra-salt basins from deep-water West Africa are poorly resolved with conventional WEM imaging.

The image generated with ION’s groundbreaking RTM technology, shows significant improvement of the intra-salt basin and steep salt flanks, and sediment pinch-outs beneath the salt.
FULL AZIMUTH ANISOTROPIC CAPABILITY

Complex bodies such as salt domes are illuminated by many wave paths that cannot be imaged by conventional one-way propagators, and furthermore, are not captured with narrow-azimuth acquisition. Significant improvement can be achieved both in the model building and final migration by employing the two-way reverse time migration technique for full azimuth data.

The very nature of ION’s shot-based RTM inherently captures all azimuthal information present in the input data. ‘Wide’, ‘Multi’, ‘Full’ and ‘Rich’ azimuth geometries are readily handled by the algorithm, with full TTI anisotropic capabilities. Additionally, ION’s multi-azimuth TTI tomography is a natural precursor for determining the sediment overburden velocities for complex imaging projects.

It is the combination of model building and migration that is the key to successful imaging. Iterative application of RTM, using RTM angle gather tomography to update velocities, can be used to delineate salt geometries in areas where both Kirchhoff and one-way wave equation methods fail.

A North Sea sub-salt image generated with conventional anisotropic WEM technology, showing poor imaging of salt flanks and sub-salt chalk and pre-chalk structures.

Image generated with ION’s advanced anisotropic RTM technology, showing significant imaging improvement, especially beneath the salt at the top and base chalk levels.