Depth Imaging

Case Study: West Coast India
- 12,083 km of 2D marine data, acquired in 2002 by LARGE for DGH, India
- 6000m cable, 8.0s record length, 25m/12.5m shot / group interval
- Reprocessed through to PSTM & PSDM
- Overall objective was to improve the final migrated image, particularly sub-basalt in the Mesozoic basins.

Overview
To date, the main deepwater exploration efforts offshore India have concentrated on the East Coast. Now attention is turning to the deep offshore area of the West Coast of India where, outside the petrolierous shallow water province of the Mumbai High, exploration has been frontier in nature with very few wells drilled so far.
Spectrum recently re-processed a regional survey in this area using modern seismic techniques, including PSDM. The results of this processing have produced significantly improved imaging, particularly sub-basalt, and have led geologists to upgrade the petroleum potential of the area.

Model Building

Migration Results

Fig 1. Map of Regional Seismic Lines

Fig 2a. Smoothed interval velocity model
Fig 2b. Final interval velocity model showing smoothed RMS converted interval velocities from seabed to T.Basalt/Basement horizon and a flood velocity of 4500m/s below

In recent years Spectrum has made significant investment in our depth imaging services. Spectrum uses Tsunami and Paradigm software for 2D and 3D tomographic velocity analysis and also for Kirchhoff Pre-stack Depth Migration (PSDM). The velocity analyses and tomography is fast and easy to use, the benefits being:
- Grid-based and layer-based method eliminates the need for interpretation.
- Horizon-based velocity converter to convert from \( V_{\text{seabed}} \) to \( V_{\text{depth}} \)
- Automatic residual velocity analysis
- Multiple QC displays including delta-v maps and ray path displays.
- User can control the density of the tomography calculation.
- User may limit velocity changes, hold shallow velocities constant and restrict maximum velocity changes.

Spectrum uses Parallel Geoscience software when a multi-path 1-way based wave equation is required for the final migration or for base salt imaging in complex geologic environments.

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Pre-Stack Depth Migration at Spectrum
Spectrum has provided pre-stack depth migration services for over 15 years. Our experience is truly global, with many satisfied customers who continue to return with new business.

Capabilities:
- 2D and 3D pre-stack depth migration
- Anisotropic Kirchhoff and Wave-Equation migration algorithms
- Specialist 3rd party modelling tools
- Multi-node supercomputers and clusters for fast turn-around
- Client remote viewing of modelbuilding via Secure Global Desktop and the internet

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The axis of symmetry is also chosen and epsilon that flatten the gathers. Combining this with values of delta mis-tie of zero for all the wells and gradients to obtain an average depth of using vertical well velocities and the geology.

In principle, the model building consists of dividing the subsurface into layers; each layer represents a formation with common geophysical properties.

Spectrum understands that accurate velocity definition is one of the key factors in pre-stack depth migration. During processing, an initial depth interval velocity model is generated via one of several methods.

Building a depth-velocity model is an important step in the PSM workflow. The depth model reflects how you have decided to divide the subsurface into formations and indicates which part of the subsurface belongs to which formation. The model building consists of dividing the subsurface into layers; each layer represents a formation with common geophysical properties.

Anisotropic Model Building

Our Anisotropic models include the ability to vary values of vertical variation (delta \( \delta \)) and lateral variation (epsilon \( \epsilon \)) for each layer below a survey area, as well as describing the vertical velocity. The exact sequence for building an anisotropic model depends on the number of wells available, the quality of the seismic data, the offset range and the geology.

In principle, the model building consists of using vertical well velocities and gradients to obtain an average depth mis-tie of zero for all the wells and combining this with values of delta and epsilon that flatten the gathers. The axis of symmetry is also chosen by comparing well information to the input common image gathers and the updated velocity model. Typically, the seismic imaging inversion process involves several iterations of pre-stack depth migration, each iteration results in ever more complexity and model refinement.

The Spectrum workflow begins with the depth model reflecting how you have decided to divide the subsurface into layers; each layer represents a formation with common geophysical properties.

The initial velocity model is usually derived from an existing geologically driven time migration velocity field which can be converted to depth interval velocities via the Dix Equation. After depth migrating the pre-stack data the depth gathers can be analysed and the residual moveout picked for events within the gather followed by tomographic inversion. The degree of non-flatness of the common image gathers is a measurement of error in the velocity model; tomography will minimize the difference between the residual moveout (RMO) or non-flatness of the input common image gathers and the updated velocity model. Typically, the seismic imaging inversion process involves several iterations of pre-stack depth migration, each iteration results in ever more complexity and model refinement.

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