Paradigm®

Velocity Modeling and Depth Imaging in Onshore Pakistan

The Challenge

The Zamzama gas field, located within the Indus Valley in onshore Southern Pakistan, is a producing field. Before drilling an additional well, the client wished to improve the imaging of the data, especially the footwall reflectors in the main fault, in order to enable more accurate volumetric calculation and precise positioning of the fault. A previous pre-stack time migration had not been successful in imaging the footwall reflectors, as lateral and vertical variation in the velocities had led to substantial non-hyperbolic moveout within the footwall, distorting the conventional time image.

The Solution

The first step was to pre-process the data using the Paradigm™ Echos™ seismic processing system, in order to resolve some uncertainty about the original time processing, as well as to improve the pre-processing, and thus the quality of the final product. In addition, velocity depth model building and migration were undertaken using the GeoDepth® solution.

The pre-stack depth imaging was performed in three stages:

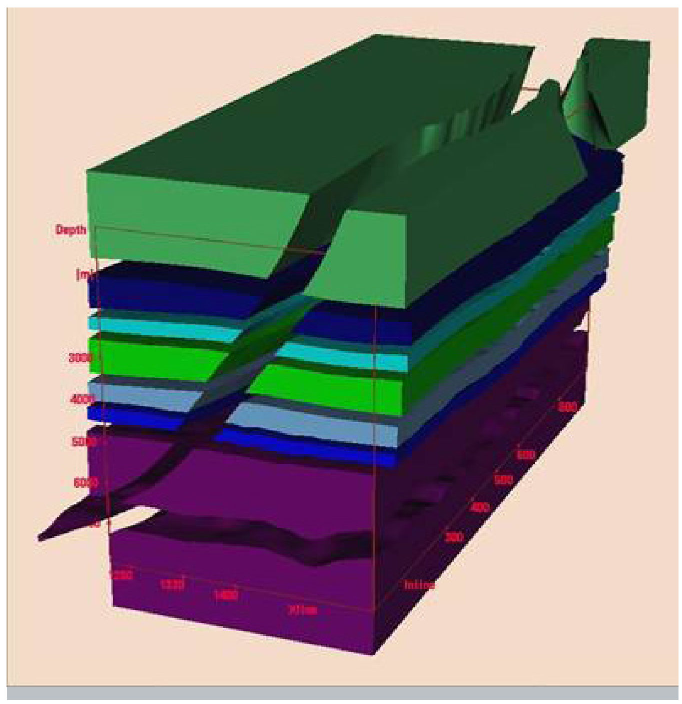
Initial velocity modeling

An initial layered velocity model was established, incorporating all the available geological information while honoring the seismic data. In order to achieve a more reliable velocity model, the initial model was updated without incorporating the fault. This model was used to depth convert the time interpretation into the depth domain. The depth maps and the interval velocity maps were then used to generate a smooth interval velocity depth cube for the initial pass of 3D pre-stack depth migration.

Velocity model update

GeoDepth's advanced tomography technology was used to update the velocity model. Each update iteration was carried out in three steps:

- 3D target-oriented pre-stack depth migration along velocity lines
- Horizon-based residual moveout analysis and interpretation
- Tomographic update of the layer velocity and structure



▲ Solid model

Fault modeling
Once the final smooth velocity model was considered correct in terms of layer velocities, the corresponding depth image was used to interpret the main fault plane.

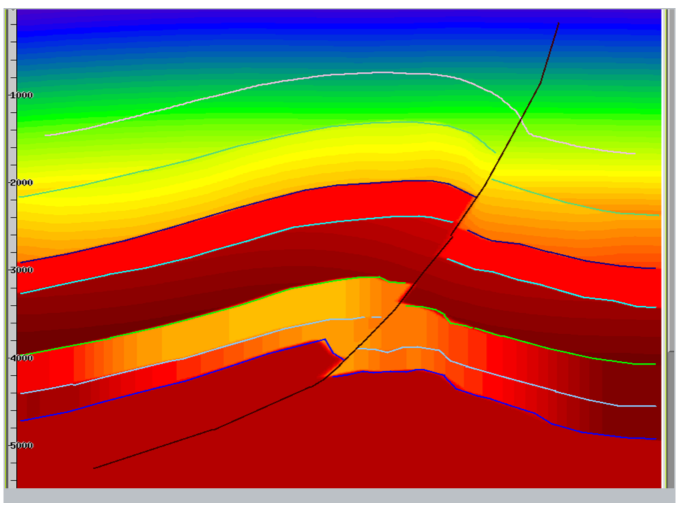
Fault positioning sensitivity
Two additional positions of the main fault were interpreted, with as much lateral displacement as the seismic data would allow. The images obtained were compared to establish which changes might result from variations in the fault position. The deterioration that was noted in the extreme fault interpretations as compared to that of the optimal fault position, confirmed the accuracy of the interpretation.

Full volume migration
Full volume pre-stack depth migration was performed using a Kirchhoff algorithm. This was followed by post-migration processing and calibration of the final depth imaged volume to the well data.

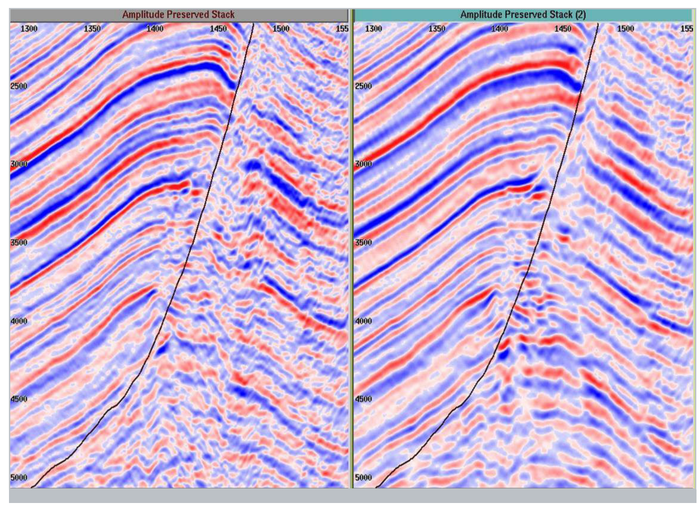
The Benefit

Compared to the previous pre-stack time migration, the final depth migrated cube showed a significantly enhanced definition of the main fault, as well as improved continuity of the footwall reflectors.

The final velocity model, constrained by seismic data, also enabled a more accurate estimation of the gross rock volume of structural closures in the footwall part of the reservoir. This information enabled the client to make a more accurate economic assessment of the reservoir, and to precisely place the next well.



Final velocity model



Pre-stack time (left) and pre-stack depth (right) cross-section

The final depth migrated cube showed a significantly enhanced definition of the main fault, as well as improved interpretability of the foot.

Paradigm thanks BHP Billiton Petroleum Ltd. for its permission to use its data.