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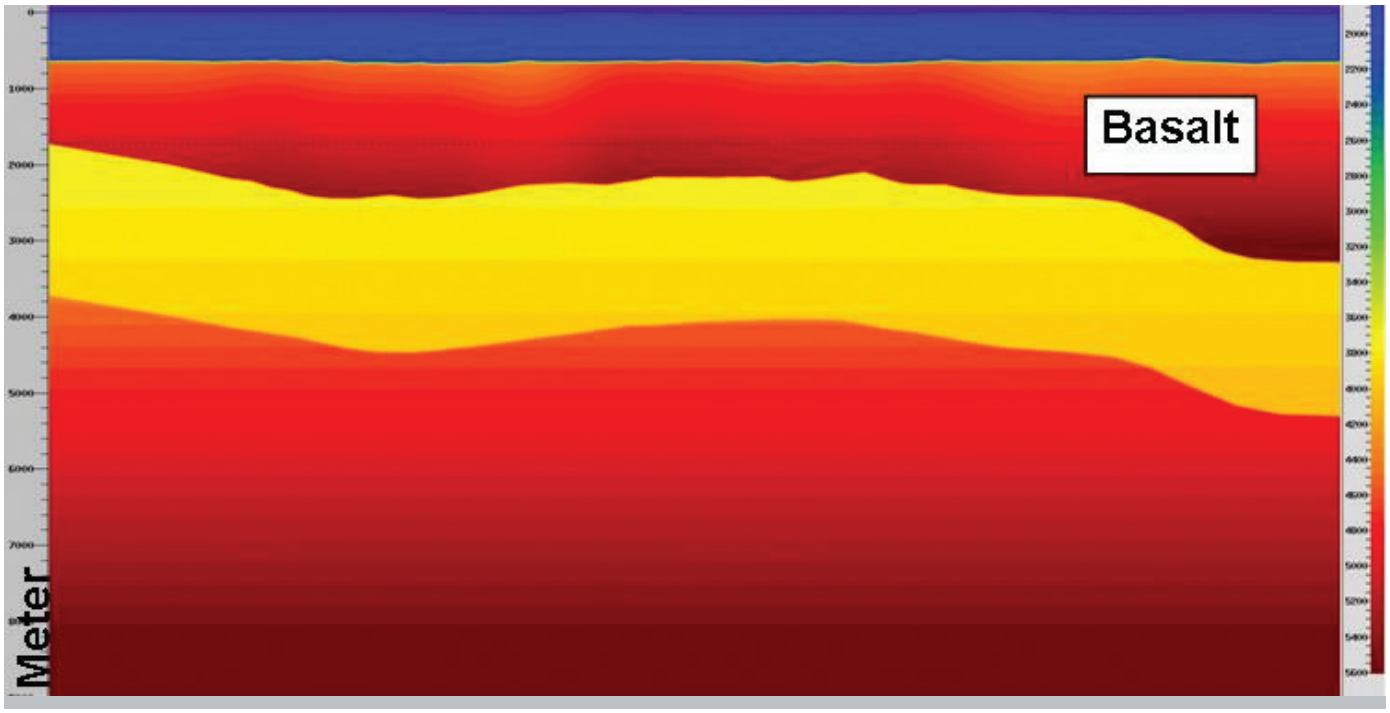
Sub-basalt Imaging through Anisotropic Pre-Stack Depth Migration

The Challenge

In the Cambay Basin, Oil and Natural Gas Company Ltd. ("ONGC"), the national oil corporation of India, wanted to image the Mesozoic sediments below a basalt layer of varying thickness. The basalt layer is a highly reflective trap that caused problems with multiples, preferential absorption of high frequencies within basalt, and large velocity gradients.

The Assessment

The existing seismic data was of a conventional land acquisition configuration and did not permit imaging of either the base basalt reflector or the target Mesozoic sediments beneath, despite several attempts of reprocessing and imaging. This determined that new data was required to enable sub-basalt imaging with a new technique to image the data.



▲ Interval velocity model used for the synthetic full-wave elastic.

The Solution

ONGC acquired new data with an offset of twelve kilometers to enable sub-basalt imaging. A model-based noise attenuation technique was applied to suppress the different kinds of noise, After accounting for the Kirchhoff pre-stack depth migration imaging, vertical transverse anisotropy (VTI) was modeled.

The wave field consisted of a number of wave types, including:

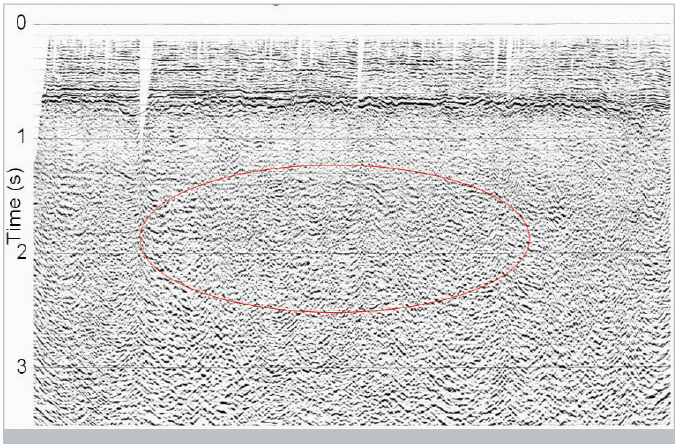
- Conventional offsets
- Converted waves
- Diving waves
- Head waves

It was essential that the workflow include elastic wave equation modeling to fully understand these different wave types. The data were carefully treated to suppress the nose cone, to eliminate multiples generated from the top of the basalt, and to suppress mode-converted waves. The long offset data were affected by VTI, which was handled by velocity modeling with coherence inversion and Kirchhoff pre-stack depth migration. To account for the long offset affect, the pre-stack depth migration (PSDM) gathers were used to scan for optimal epsilon values until the gathers were flat. These values were refined by residual update.

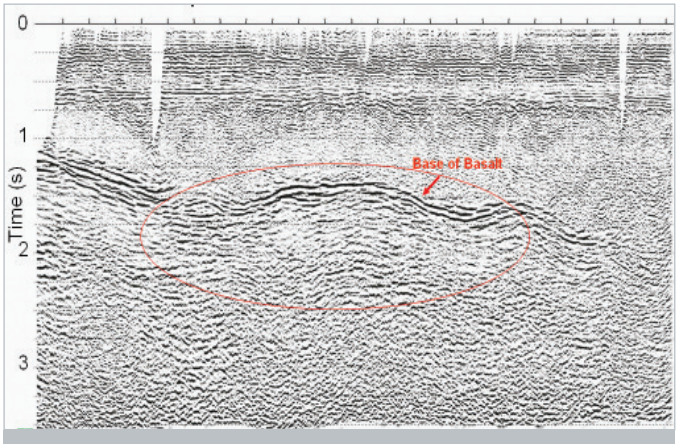
Comparison between the conventional time domain processing result and the anisotropic Kirchhoff PSDM result were converted to time domain. The sub-basalt image, especially the base of the basalt, was clearly visible and could be mapped confidently.

The Results

ONGC obtained improved imaging of the base basalt reflector which helped to increase their understanding of the target sediments beneath. This enhanced knowledge of their play is generating new prospects and reducing risk in well planning.



▲ Conventional time domain processing result



▲ Anisotropic Kirchhoff PSDM result