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Application of Controlled Beam Migration to Sub – Subsalt Imaging : A Case History from the Kerala – Konkan Basin, West Coast of India

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Summary

Within deep water offshore acreage, west coast India, large areas remain unexplored due to difficulties in imaging below basalt flows. In this paper, we present a reprocessing case study that applies the latest processing technologies in seismic migration to improve the images below the basalt layers. The highlight of this effort is the application of the Controlled Beam Migration (CBM) and associated velocity depth model building.

Introduction

This case study is located in the Kerala-Konkan (KK) basin, on the west coast of India. Mesozoic sediments have been recognized as potential source and reservoir rocks but, to date, remain largely unexplored due to the presence of overlying basalt flows. Imaging of sub-basalt geology is difficult because of the disruptive nature of basalt to seismic energy and the inability of the conventional processing techniques to attenuate the noise that obscures the sub-basalt reflections.

The main objective of this reprocessing was to image between the two basalt layers (Paleocene and Santonian traps) while preserving the integrity of the data above the basalt. Two of the main challenges are the poor signalto-noise ratio and complex ray paths due to multi-pathing associated with the basalt layers. Earlier processing, using pre-stack Kirchhoff time and depth migration, failed to image the Mesozoic sequence below the Paleocene basalt trap (Figure 1) where basalt thickness ranges from a few 100 m to over 500 m. Kirchhoff depth migration employing its single arrival assumption, is unable to deal with complex geology in presence of basalt. As a result, the primary reflections beneath the basalt are often masked by migration artifacts, such as excessive migration swings and characterized by low signal/noise appearance.

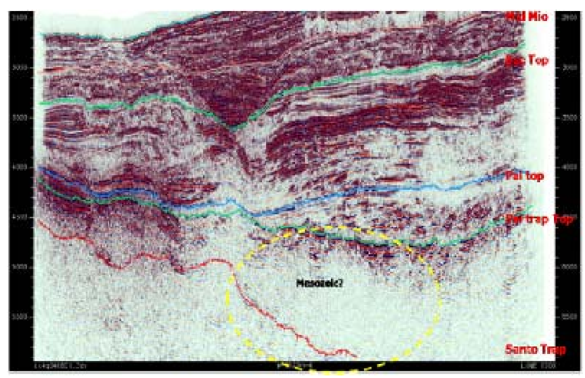

Figure 1: Pre-Stack Time Migration

Controlled Beam migration

Beam Migration is a multi-arrival alternative to Kirchhoff migration. The process migrates "beams" of data centered on modeled ray paths. For a given surface point and starting angle, the recorded energy is propagated along the beam to give a small part of the migrated image. Repeating this for beams over a number of starting directions, and summing the results from all surface locations, defines the fully migrated section. Because a number of raypaths are modeled from the same starting point, the possibility of multiple arrivals is explicitly included. (Hill, 2001; Gray, 2005)

Controlled Beam Migration (CBM) is a specialized version of Beam Migration designed to achieve improved signal-to-noise ratios and enhanced steep dip imaging in complex geological settings. The benefits of CBM have been described in a number of different situations (Vinje and al., 2008) and its application to subbasalt imaging is described in this paper.

Application of the CBM in the KK basin

Iterations of 3D tomographic inversion were used to derive the velocity-depth model. The high S/N characteristics of data output from CBM makes its utilization a particular advantage at the model building stage (Figure 2).

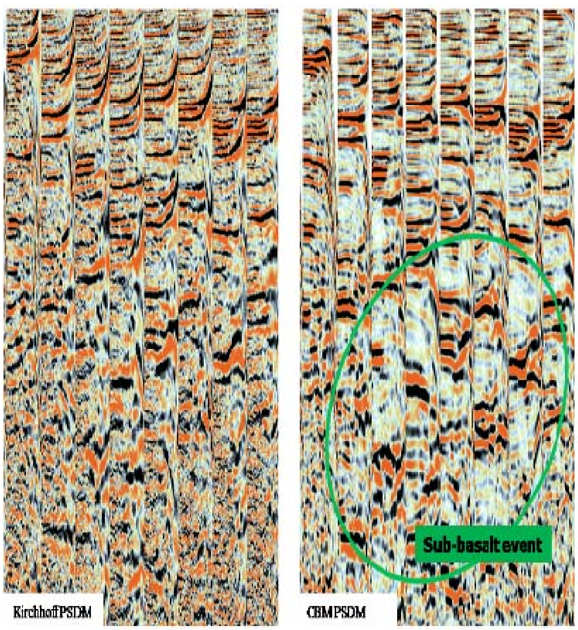

Figure 2: Comparison of migrated gathers using Kirchhoff and CBM depth migration.

In figure 3, the same line has been migrated with the same input data and velocity model using the Kirchhoff PSTM (stretched to depth for comparison), Kirchhoff PSDM and the CBM. The Kirchhoff PSDM is already showing an uplift in the general image but the CBM provides already a much cleaner image in the pre-basalt sediments, enhancing the steep dips and faults, but mostly provides a clear image of the sub-basalt horizons while the Kirchhoff presents characteristic artifacts ('smiles') that obscure all events.

Results and discussion

The CBM results are a major improvement over the previous studies. A comparison of the Kirchhoff PSTM and the CBM is shown in Figures 4 to 5. The sub-basalt events that were barely visible in Kirchhoff migration are clearly imaged with the CBM. The new volume provides clear image of the Mesozoic sequence below the first basalt trap as well as the first useful information about the horizons below the second trap.

Conclusions

In this paper, we presented a case study using Controlled Beam Migration (CBM) to image below the basalt. This method enables migration of multi-arrival energy, and is able to deliver images with better S/N ratio as well as cleaner gathers for velocity update. The image quality of CBM is superior to that of Kirchhoff migration.

References

Gray, S.H., 2005, Gaussian beam migration of commonshot records: Geophysics, S71-S77

Hill, N.R., 2001, Prestack Gaussian-beam depth migration: Geophysics, 22, 1240-1250

Vinje, and al., 2008, Controlled beam migration: a versatile structural imaging tool: First Break, 26, 109113

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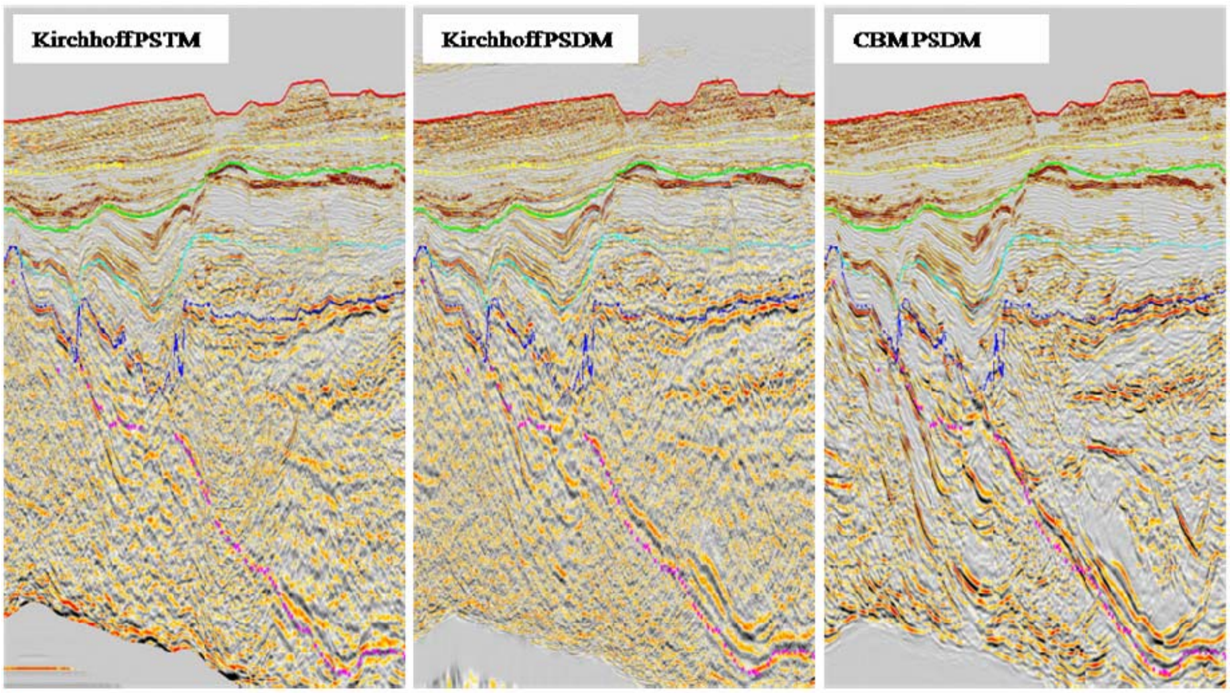

Figure 3: Comparison between Kirchhoff PSTM stretched to depth, Kirchhoff PSDM and CBM

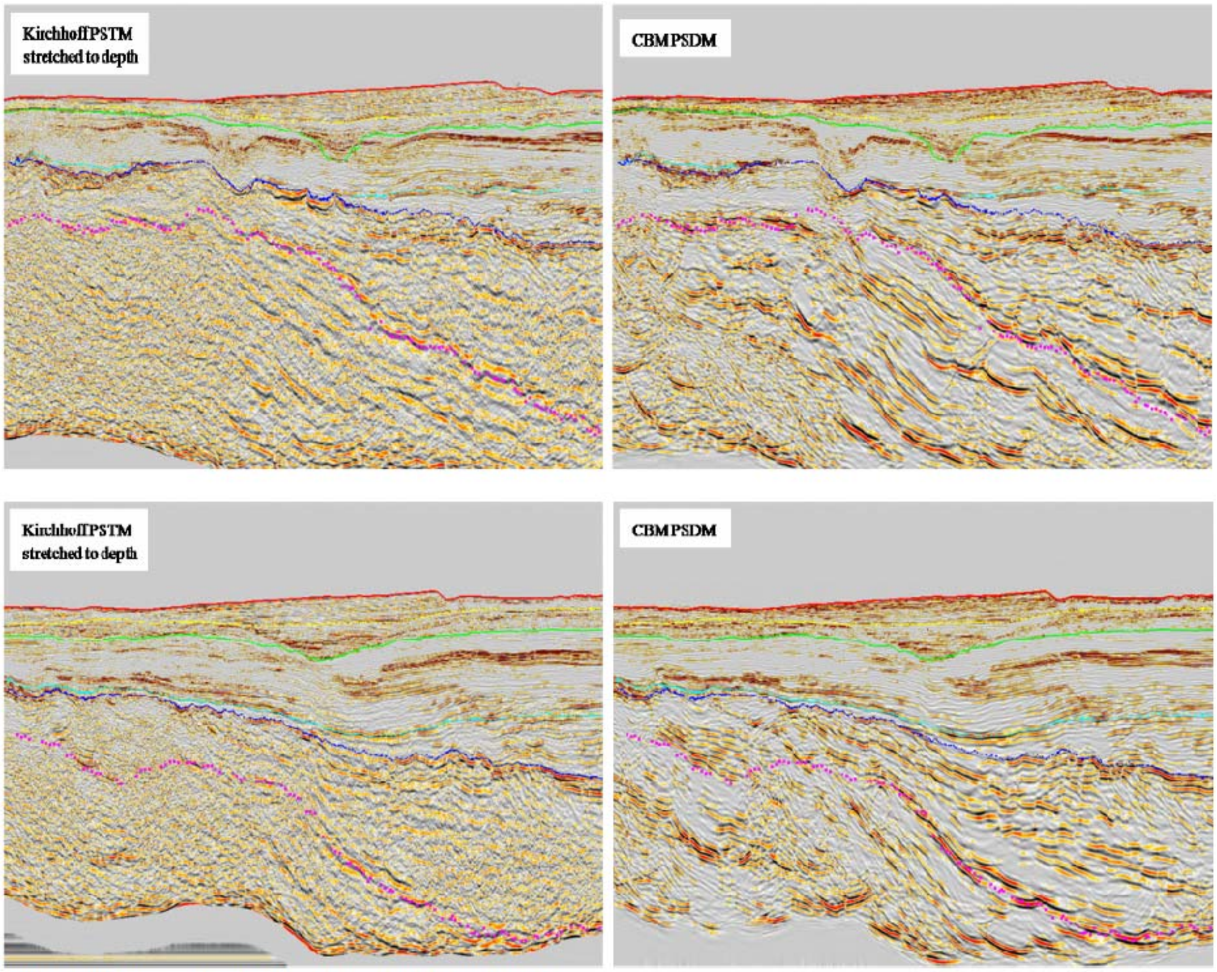

Figure 4 and 5: Comparison between Kirchhoff PSTM and CBM