Llanos Basin, PSDM contribution to fault shadow zone effect mitigation – Case study

Alexander Negut[1], Goran Cotra[1], Carlos Duran Naffah[2], Jose Araujo Sanchez[2], Gabriel Alvarez[2], Trino Salinas[1], Dan Negut[1]

1:Z-Terra North, 2: Petroleos Sud Americanos

Summary

The Entrerríos Block is located in the Llanos Orientales Basin in Colombia, with an area of six thousand thirty-eight (6038) hectares. There are three producing formations in the field: Mirador, Gachetá and Ubaque.

The main one is the Mirador Formation, which corresponds to continental deposits of fluvial sands.

Geologically the field is part of the Llanos Orientales basin and structurally its configuration is a smooth NE-SW monocline. Entrapment is a combination of structural and stratigraphic factors.

The hydrocarbon produced in the Entrerríos field is 16 ° API.

Due to structural and stratigraphic settings and target spatial distribution along the fault shadow zone, the main challenges for a proper target imaging are the mitigation of the fault shadow zone effects at the reservoir level and optimum seismic calibration against the existing well tops (Fagin, 1996; Chermak et al. 2009). The fault shadow effect has been studied extensibility in the Llanos Basin through numerical modelling (Di Giulio et al. 2012).

While time domain processing could not solve these issues, anisotropic PSDM processing, as described in this paper, was successfully used to alleviate the fault shadow effects, even though the offsets were too short to accurately estimate the anisotropy parameters.

Methodology / Workflow

The Entrerrios-2007 and Entrerrios-2014 3D surveys were processed as a Merged 3D, through to PSTM. The acquisition parameters of the two surveys are different as shown on Table 1:

Survey	Receiver Interval	Rec. line separation	Source Interval	Source line interval	Source	Bin Inline	Bin Xline
Entrerrios-2007	40m	240m	80m	360m	dynamite	40m	20m
Entrerrios-2014	54m	764m	54m	972m	dynamite	40m	20m

Table 1 *Acquisition parameters for Entrerrios-2007 and Entrerrios-2014 3D surveys.*

Upon successful PSTM completion, the interpretation process identified 5 main target horizons (Leon, Carbonera 1, Mirador, Ubaque, Basement) and 7 wells (tops and VSP/Sonic for Entrerrios #1, #2, #3, #5, #6, #7, #8) which formed the “skeleton” of the PSDM initial velocity model.

The workflow from building the initial Interval Velocity Model to the final Interval Velocity Model is described in Table #2 below.

After each tomographic Interval Velocity Model update procedure, a detailed Quality Control process qualified the PSDM to the well tops mis-ties as well as the Fault shadow zone extent and structural behaviour.

The workflow included three tomographic isotropic Interval Velocity Model updates and three TTI anisotropic fault constraint.

Iteration/ Model	Description	Tomography Grid Size	Semblance Smoothing	Inversion Smoothing	Max Velocity Variation (%)
Initial Model (Model 0)	Isotropic				
Model 1	Isotropic (From surface to top of Leon shale)	150 x 150 m	800 x 2400 x 2400 m	500 x 1000 x 1000 m	10
Model 2	Isotropic (From surface to Basement reflector)	150 x 150 m	800 x 2400 x 2400 m	500 x 1000 x 1000 m	10
Model 3 (Initial anisotropic model)	TTI Anisotropic (Fault constrained)	150 x 150 m	800 x 2400 x 2400 m	500 x 1000 x 1000 m	10
Model 4	TTI Anisotropic (Fault constrained)	150 x 150 m	800 x 2400 x 2400 m	200 x 1000 x 1000 m	5
Model 5	TTI Anisotropic (Fault constrained)	150 x 150 m	800 x 2400 x 2400 m	200 x 1000 x 1000 m	2.5
Model 6 (Final Model)	Same as Model 5 with improved basement velocity				

Table 2 *Summary of tomographic update parameters.*

Results and Conclusions

To illustrate the improved image in the fault-shadow zone, Figure 1 shows a comparison between VTI-PSDM and VTI-PSTM converted to depth. The area enclosed by the rectangle shows that although the fault shadow effect has been mitigated to a point where a correct interpretation can be carried out.

Anisotropic PSDM proved to be a powerful tool to correct for the fault shadow effect in this dataset, even though the offsets were very short compared to the depth of the reflectors

The seismic well tie went from an average error of about 2 to 3% in the isotropic model to about 0.1% in the final anisotropic model.

The Results of the PSDM processing and its subsequent interpretation permitted correcting in a very good way the effect of the fault shadow, allowing to observe and interpret the field as a monocline compartmentalized by faults of preferential direction SW-NE of greater size and quite different configuration; this has brought a strong benefit in finding a larger area of the field, which is reflected in an increase in on-site reserves and the possibility of drilling new development and advanced wells in better structural positions that the well previously drilled in the field.

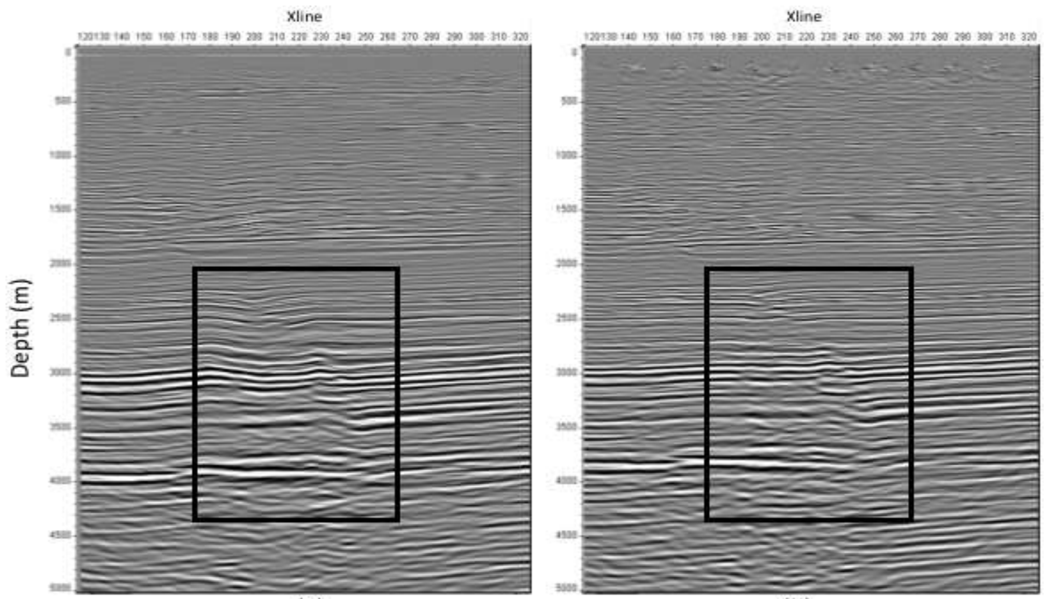

Figure 1 *Comparison of depth converted PSTM (a) with final PSDM section. Notice that the fault shadow effect (inside the rectangle) has been greatly reduced.*

Acknowledgements

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References

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