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Implementation of a receiver carpet geometry in a challenging environment in the Middle Magdalena Valley, Colombia.

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Summary

In cases with shallow targets and steep dips, dense surface sampling is required to mitigate aliasing issues. However, when compounded by environmental restrictions that limit the number of source points below the theoretical design requirements, the acquisition geometry can be highly affected. In this case in a field in the Middle Magdalena Basin in Colombia, the exclusion zones (see Fig. 1) associated with sensitive environmental features would significantly reduce short-offset coverage, hampering the imaging of the shallowest section. I addition, the seismic response near the crest of the structure was known to be dominated by chaotic reflectivity and high noise levels, further increasing the challenge.

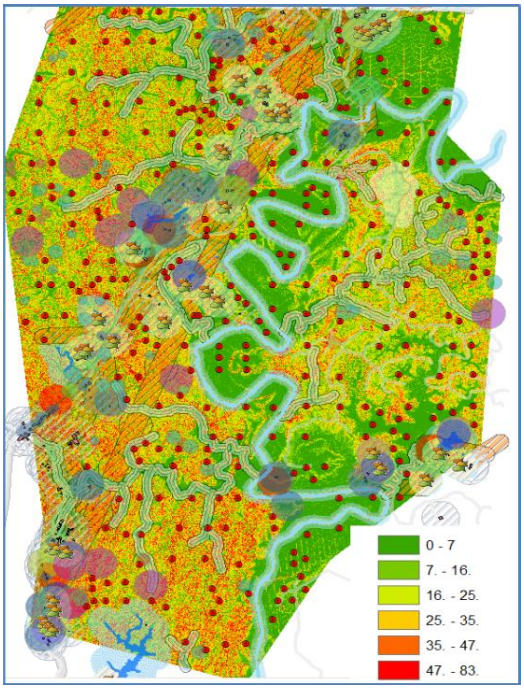

Figure 1. Slope map and exclusion zones. Red dots correspond to all feasible shot point locations. No regular pattern can be recognized. Superposition of exclusion zones associated with rivers and sensitive elements results in big gaps that in turn hurt the population of short offsets, a big concern given the shallow nature of the exploration target. In this case, a regular grid of receivers helped to compensate for the low source density.

This paper illustrates the use of a carpet receiver geometry on a 40 m x 40 m grid and a very low source density that allowed the acquisition of a 3D volume that contributed to the understanding of a reservoir whose seismic coverage was limited to a few 2D lines. Despite the irregularities of the geometry and the relatively coarse spacing of the receiver carpet, the main elements configuring the accumulation were successfully imaged.

Method

The field is an asymmetric monocline structure with a North-South trend and closure in three directions, to the west of a back thrust fault. The terrain conditions were characterized by rough topography with an overwhelming number of restrictions and difficulties related to social and environmental issues.

A fixed patch of 6600 cableless Unite receiver units was used, arranged in a regular grid 40 m x 40 m, while only 269 shot point locations were found feasible for drilling. The operations were completed in 49 days and required constant attention to multiple non-technical situations.

A 2D test line with 600 Stryde units with 4 m separation was also recordered in parallel with the normal layout.

The seismic processing work contemplated the integration of this survey with other existing 3D volumes with very different geometries. The final product was a Gaussian Beam Depth Migration which required a significant amount of processor-interpreter interaction.

Results and observations

As seen in previous 2D vintage data acquired in the area, the quality of individual shot records was marginal. However, the combined power of stack and 3D migration after a dedicated effort in processing yielded good results with a final image (See Figure 2) that provided a much better understanding of the geometry of the structure. Within the very shallow structure (less than 800 m deep), at least 8 compartments separated by vertical faults that generally have two directions (NNE-SSW and NNW-SSE) were identified.

A decimation analysis of the 2D test with Stryde nodes provided valuable insight into the potential for improved sampling of noise and signal with shorter station intervals in this type of environment. The field procedures to deploy the nimble nodes were efficiently implemented by the local crew.

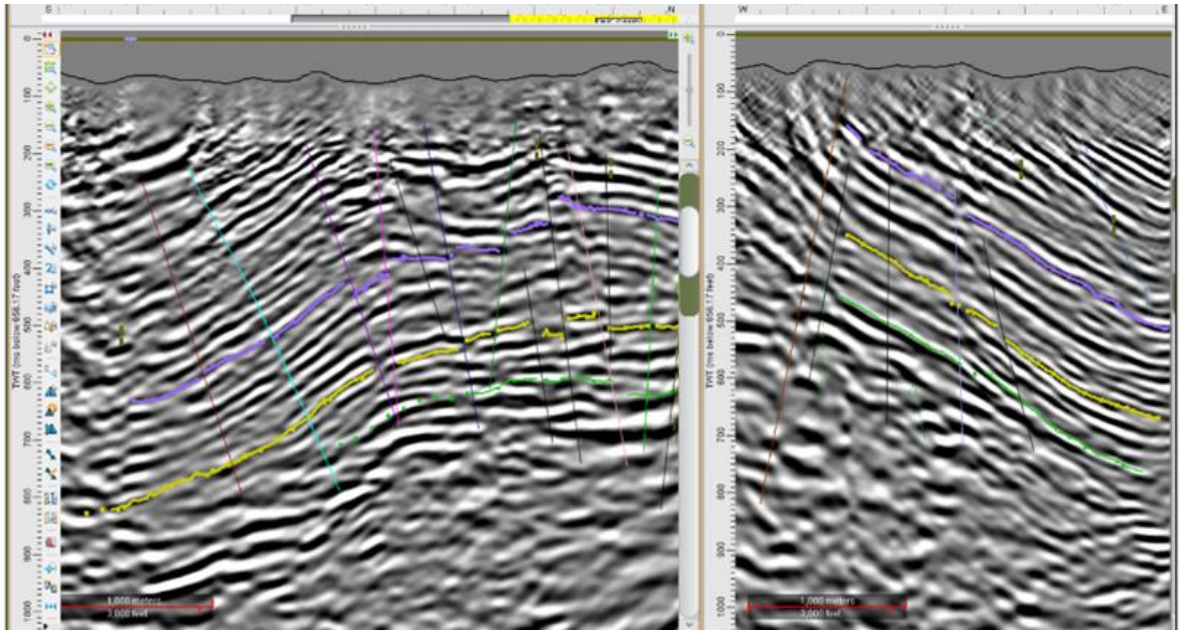

Figure 2. *Interpreted strike and dip seismic sections obtained after Gaussian Beam depth migration. The whole section is contained in 1.0 s TWT. Multiple compartments were identified and the general understanding of the geometry of the structure was improved.*

Novel/Additive Information

Carpet geometries are seldom used in Colombia. This could be the first documented example of this type of seismic acquisition in Colombia aiming to optimize the number of explosive sources in areas where drilling is the most significant component of the cost and/or environmental restrictions prevent the use of denser source patterns.

Every seismic program is a great opportunity for testing the actual response of the earth at local scale. The information obtained in testing can translate into more efficient operations when difficult conditions impose challenges (Regone, 2015).

Acknowledgements

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References

Carl Regone*, Michael Fry, and John Etgen, (2015), "Dense sources vs. dense receivers in the presence of coherent noise: a land modeling study," *SEG Technical Program Expanded Abstracts* : 12-16.