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De-risking stratigraphic and combination traps with newly re-imaged depth data in the Orange Basin, Namibia

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Summary

The Namibian margin is one of the hottest exploration areas in Africa, with multiple multi-billion barrel discoveries in the Orange Basin since 2022 within a range of Upper and Lower Cretaceous reservoirs. As exploration progresses in the Orange Basin, more detailed seismic attribute mapping on depth migrated data is needed to capture subtle variations in structural dips across the basin, in particular, to accurately image structural dips beneath the gravitational system and de-risk trapping structures. Depth re-imaging of eight 2D surveys in the Orange Basin was completed in 2024, creating one contiguous dataset extending across the entire continental shelf into the deepwater domain. Many prospects mapped in the deepwater Orange Basin rely on some component of stratigraphic trapping (e.g. basin floor fans, slope fans), therefore imaging the reflector geometries correctly aids the evaluation of seismic attribute and AVO mapping, providing improved confidence in their conformance to both regional and local structural trends. We show examples of counter-regional dips observed in PSDM, and the impact on mapping prospects in depth versus time. Detailed play mapping on these integrated PSDM data highlights the potential for sizeable stratigraphic traps, which may appear smaller or be missed on time data alone.

Introduction

The Namibian margin is currently one of the hottest exploration areas in Africa, with multiple multi-billion barrel light oil discoveries in the Orange Basin since 2022 including Mopane, Venus and Graff within a range of Upper and Lower Cretaceous reservoirs. Further drilling campaigns were initiated in late 2024 by Chevron and Rhino Resources, testing the play extensions to the north, and inboard of the existing discoveries. The majority of these recent discoveries and undrilled prospects rely on a component of stratigraphic trapping, in particular, the greater Venus play also benefits from counter-regional dip in the outboard. In deepwater settings with much subtler depositional structures, depth migrated seismic is key to understanding the true reflector geometries and their impact on prospect mapping.

Geological Background

The Namibian margin is characterised by the presence of syn-rift half grabens along the inner part of the continental shelf, which pass into laterally extensive Seaward Dipping Reflector packages outboard. These are overlain by a series of post-rift basins with inner and outer depocentres initially separated by a NW-SE trending Outer High. The Orange and Lüderitz basins contain deepwater fold-and-thrust belts generated by gravitational collapse in the Upper Cretaceous. The distal extent of these gravitational systems is structurally controlled by the presence of the Outer High. The Venus discovery is an Aptian-Albian aged basin floor fan, directly overlying the Aptian source. The Graff discovery opened up the Upper Cretaceous play, finding oil in Cenomanian and Coniacian-Santonian slope fans down-dip of the gravitational toe-thrusts. The largest find to date, Mopane, extended these plays inboard and discovered oil at four reservoir levels, including both Lower and Upper Cretaceous targets.

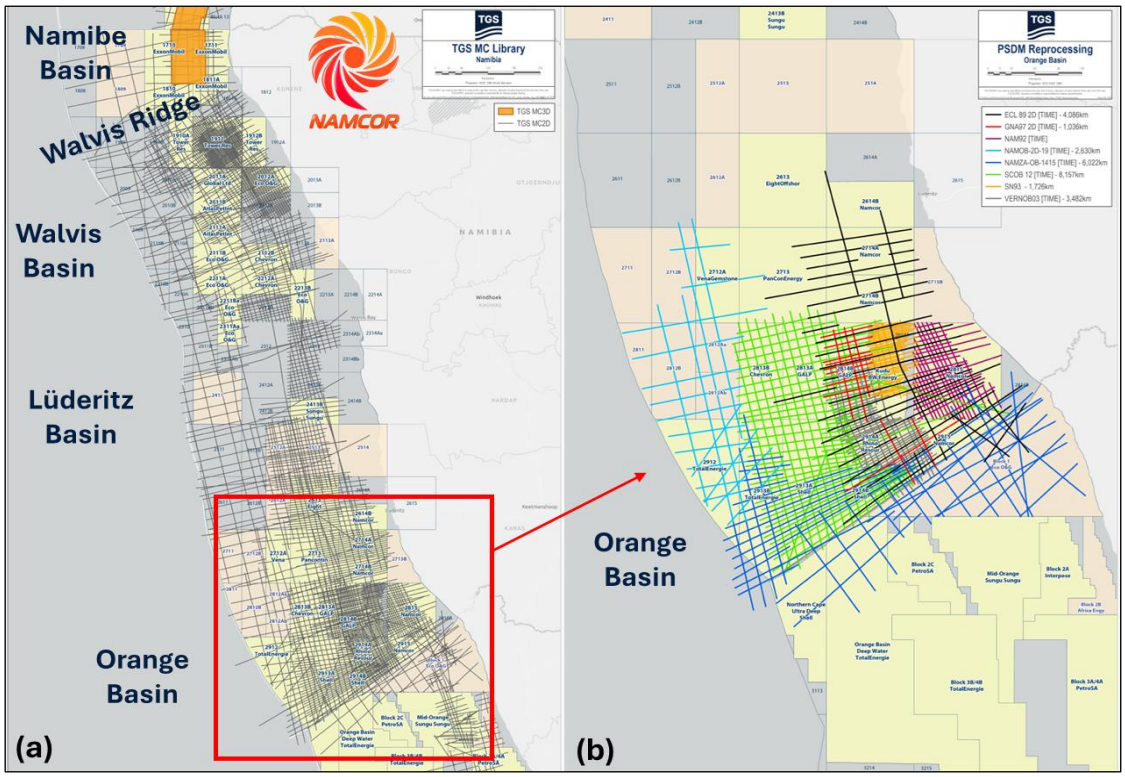

Figure 1(a) *2D & 3D seismic data library offshore Namibia;* ***1(b)*** *including a contiguous dataset of ~30,000 line km of Kirchhoff PSDM reprocessing across eight 2D surveys in the Orange Basin.*

Mapping stratigraphic traps

Regional horizons, sediment depocentres and play fairways have been mapped out across the Namibian margin, utilising an extensive 2D PSTM seismic library (Figure 1a). As exploration progresses in the

Orange Basin, there is a requirement for more detailed seismic attribute mapping on depth migrated data to capture subtle variations in structural dips and trends across the basin. This is of particular importance in order to accurately image structural dips beneath the gravitational system and de-risk trapping structures. PSDM re-imaging of eight 2D surveys in the Orange Basin was completed in 2024, creating one contiguous dataset extending across the entire continental shelf into the deepwater domain (Figure 1b). In addition, a 2Dcubed dataset was generated using dip and coherency parameters to guide a structurally conformable 2D interpolation into a 3D dataset (O'Keefe et al, 2017).

These data allow for a more robust assessment of trapping geometries, migration pathways and charging points. Additionally, lines within the re-imaged dataset have been depth matched in a 3D model to minimise misties between individual surveys, improving confidence in the regional tie of surfaces and seismic attribute interpretation within the fairways (Figure 2a). With the 2Dcubed dataset we can image the reservoir fairways and investigate seismic attributes from a 3D perspective (Figure 2b). In this study we show the results of PSDM re-processing and examples of how this dataset is vital to draw the correct conclusions for basinwide prospect screening based on the recently proven hydrocarbon play trends.

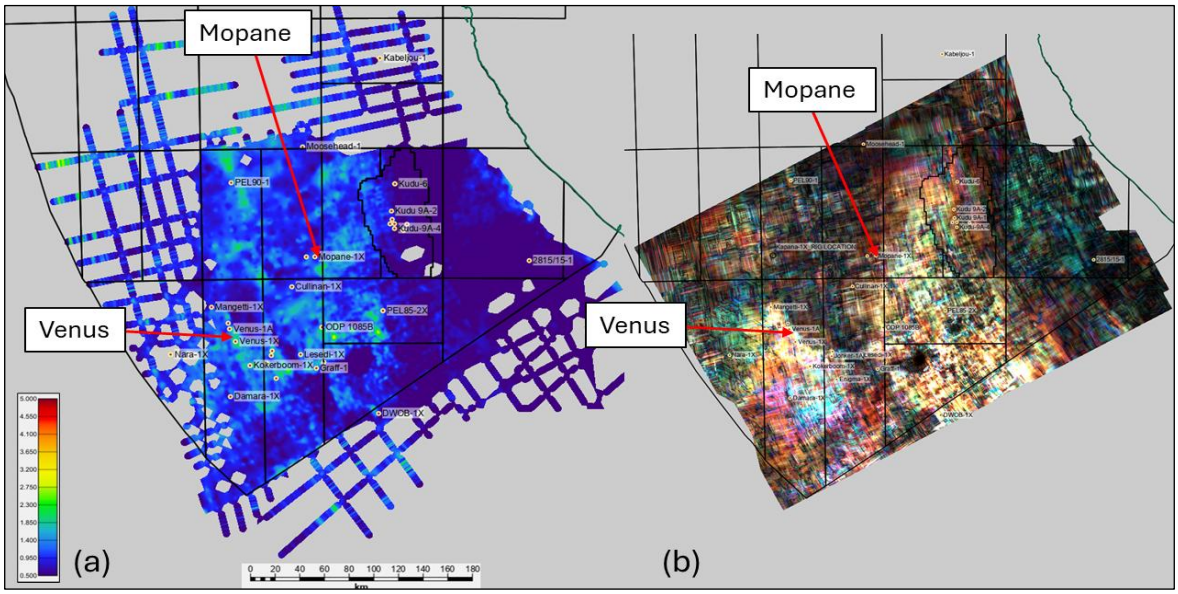

Figure 2(a) *RMS amplitude extraction at approximately Top Aptian level* ***2(b)*** *Spectral decomposition (8-16-32 hz RGB) flattened on the Top Aptian. The RMS amplitude anomalies correspond with bright zones of spectral decomposition associated with basin floor fans outboard of Outer High.*

Conclusions

Many prospects mapped in the Orange Basin rely on some component of stratigraphic trapping (e.g. basin floor fans, slope fans), therefore imaging the reflector geometries correctly aids the evaluation of seismic attribute and Amplitude Versus Offset (AVO) mapping, providing improved confidence in their conformance to both regional and local structural trends during prospect mapping. Modern PSDM datasets such as these are essential to successfully image and de-risk stratigraphic and combination traps in the deepwater domain of the Orange Basin. We show examples of counter-regional dips observed in PSDM, and the effect this has made on mapping prospects in depth versus time. Detailed play mapping on these integrated PSDM data highlights the potential for sizeable stratigraphic traps, which may appear smaller or be missed on time data alone.

Acknowledgments

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References

O'Keefe, S., Ratnett, N., Woodburn, N., Pedersen, C., Bradbury, W., Guo, M. and Whiteside, W. (2017), The development and applicability of structurally conformable 2D to 3D interpolation, SEG International Exposition and 87th Annual Meeting