The application of High-Definition Geological Expression workflows to improve the understanding of a carbonate reservoir, NW Australia

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The petroleum potential of NW Australia has led to the region becoming the fourth largest LNG producer in the world: currently accounting for more than 2% of the worlds' gas reserves, NW Australia has an excess of 6608 tcf in the Carnarvon Basin and associated sub-basins. Our understanding of the subsurface is often poor and the complex geological histories remain elusive. This paper shows how using data-driven interpreter-guided Geological Expression workflows can better reveal the stratigraphic component of geology and bring more comprehensive understanding to exploration and development targets.

The prospect is from the Exmouth Sub-Basin, NW Australia. It forms the most southern rift basin in the Carnarvon Basin. The carbonate reservoirs are typified by complex stratigraphic architecture, digenesis and lithology variations. The steady subsidence of the Exmouth Plateau from the late Cretaceous resulted in deposition of carbonate chalks, marls and oozes which were subjected to burial, compaction and digenesis. The varying mineralogical composition of the carbonates results in differential digenetic features; however, karstification remains prevalent. Identification of the reservoir characteristics and karst networks is essential in being able to define migration pathways and potential prospects.

We present examples of how Data Conditioning, attribute analysis, multi-attribute visualisation, Frequency Decomposition and seismically driven facies classifications can increase the likelihood of technical and economic success with regard to discovering hydrocarbon accumulations.

Volumetric noise cancellation attenuated noise whilst minimizing the loss of primary geological signal. We systematically applied edge preserving methods for attenuating both random noise and high-spatial frequency coherent noise that may be masking features such as karsts. The Spectral Enhancement brought a white spectrum to the data where all frequencies contribute equally and thin bed events are resolved (Figure 1).

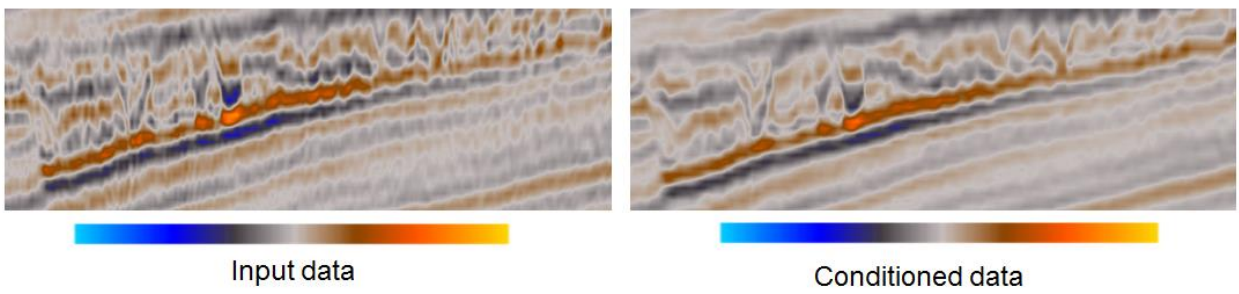

Figure 1. Noise Cancellation and Spectral Enhancement techniques were applied to the data, improving the imaging of the carbonate interval while preserving the edges and subtle details of the geological features.

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Tailored attribute analysis within the carbonate environment utilised both trace-based and multi-trace attributes to identify and extract the karst network and depositional geometries (Figure 2).

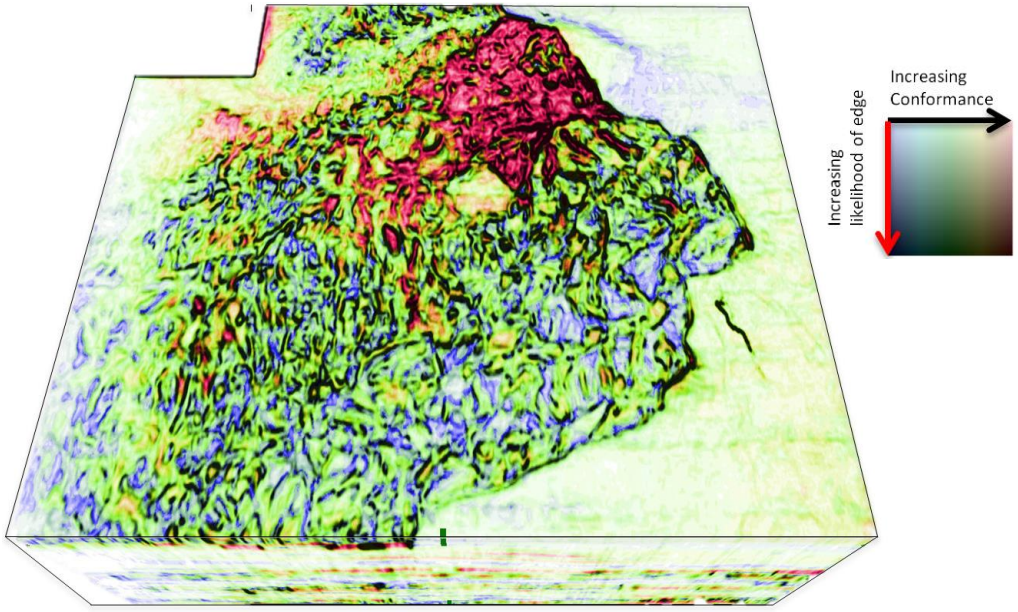

Figure 2. The TensorEnvelope combo volume shows stratigraphic and structural information combined in a single display. The tensor attribute highlights the edges of the karsts, and the envelope highlights high-amplitude stable areas.

Frequency Decomposition using a method analogous to a Fast Fourier Transformation and an algorithm based on matching pursuit aided the identification of dissolution features (Figure 3). The ability to extract these features was made possible by the Adaptive Geobodies which allow for extractions on non-sequential data and from multiple sources.

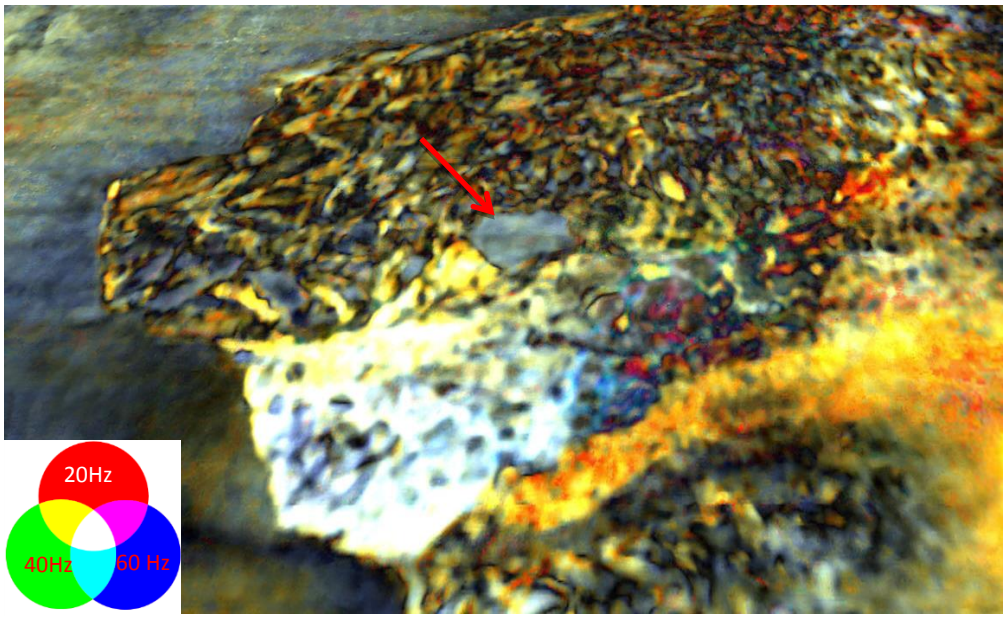

Figure 3. HD Frequency Decomposition and RGB blending identified the dissolution features as areas of high-frequency response.

Geological Expression workflows encompassing data-driven interpreted guided methods allowed for faster expression of the geology, rapid delineation of deposition geometries and extraction of geological entities. This reduces risk in high-stake, low-return assets.

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