Introduction

The Thebe Discovery located on the Exmouth Plateau, North Carnarvon Basin, offshore Northwest Australia was discovered in 2007 with the successful drilling of the Thebe-1 well which penetrated a 73m gas column. The Thebe-2 appraisal well was drilled 18.75km NNE of discovery well in 2008, again encountered a significant gas column, leading to estimates of 2 to 3 Tcg of gas in place within the Thebe structures. To this day, the Thebe Discovery remains undeveloped. The gas accumulation encountered by the Thebe-1 and -2 wells is clearly visualised in the seismic, as a large scale "flat-spot", which crosses multiple reflections in the crest of a rotated fault block within the Triassic Mungaroo Formation. So, if the hydrocarbon filled fault block is so easily identified why is the discovery still undeveloped? In this paper, the results of a cognitive interpretation study are shown to identify potential geological risk to the Thebe Discovery and to highlight other future potential in the surrounding area.

Method

About 40% of the brain is devoted to visual cognition and as there are strong links between visual systems and memory, this enables the interpreter to linking current visual data with past experience and learnings in order to make sense of incomplete or ambiguous data. This method of interpretation allows for quick concise interpretation allowing an interpreter to spend more time understanding the geology rather than interpreting it.

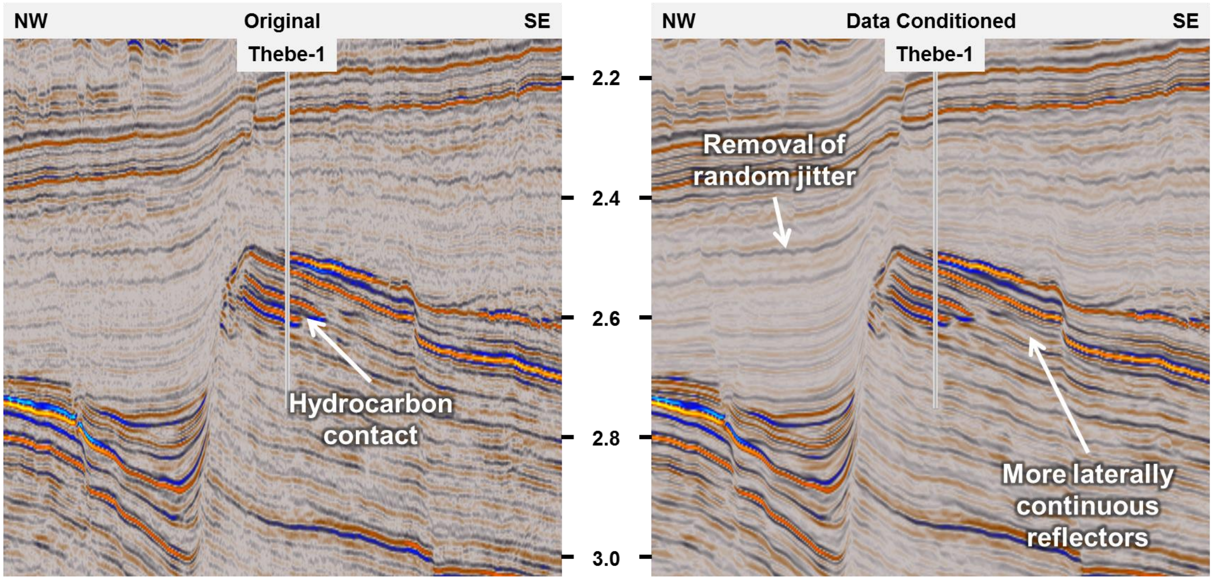

Figure 1 *Data conditioning is a crucial stage in the Cognitive Interpretation workflow. Noise cancellation and spectral enhancement help generate an optimised volume. Noise attenuation and spectral whitening allow for more laterally continuous, noise-reduced seismic reflectors.*

The first part of the workflow includes a two stage data conditioning process whereby noise cancellation and spectral enhancement are undertaken. This aims to remove as much random and coherent noise as possible and subsequently improve the signal to noise ratio whilst enhancing structural and stratigraphic edges and improving the vertical resolution of the seismic data (Figure 1). The optimized seismic volume is then used for a number of interpretation based processes all of which act as interpretation feedback loops to the next process. In this study a fluid "flat spot" is indicated, but Red-Green-Blue (RGB) frequency blends were used to accurately map the contacts limits. These blends also helped in identifying heterogeneities in the reservoir and surrounding areas. This information feedback process helps the interpreter understand the reservoir with much greater detail more quickly compared to conventional interpretation techniques (Figure 2). This process was applied to the key components of the petroleum system (reservoir, trap, seal and migration) to identify areas of risk and uncertainty of the Thebe Discovery. The same processes were applied to deeper sections of the rotated fault block to identify if further hydrocarbon potential exists in the Thebe fault block.

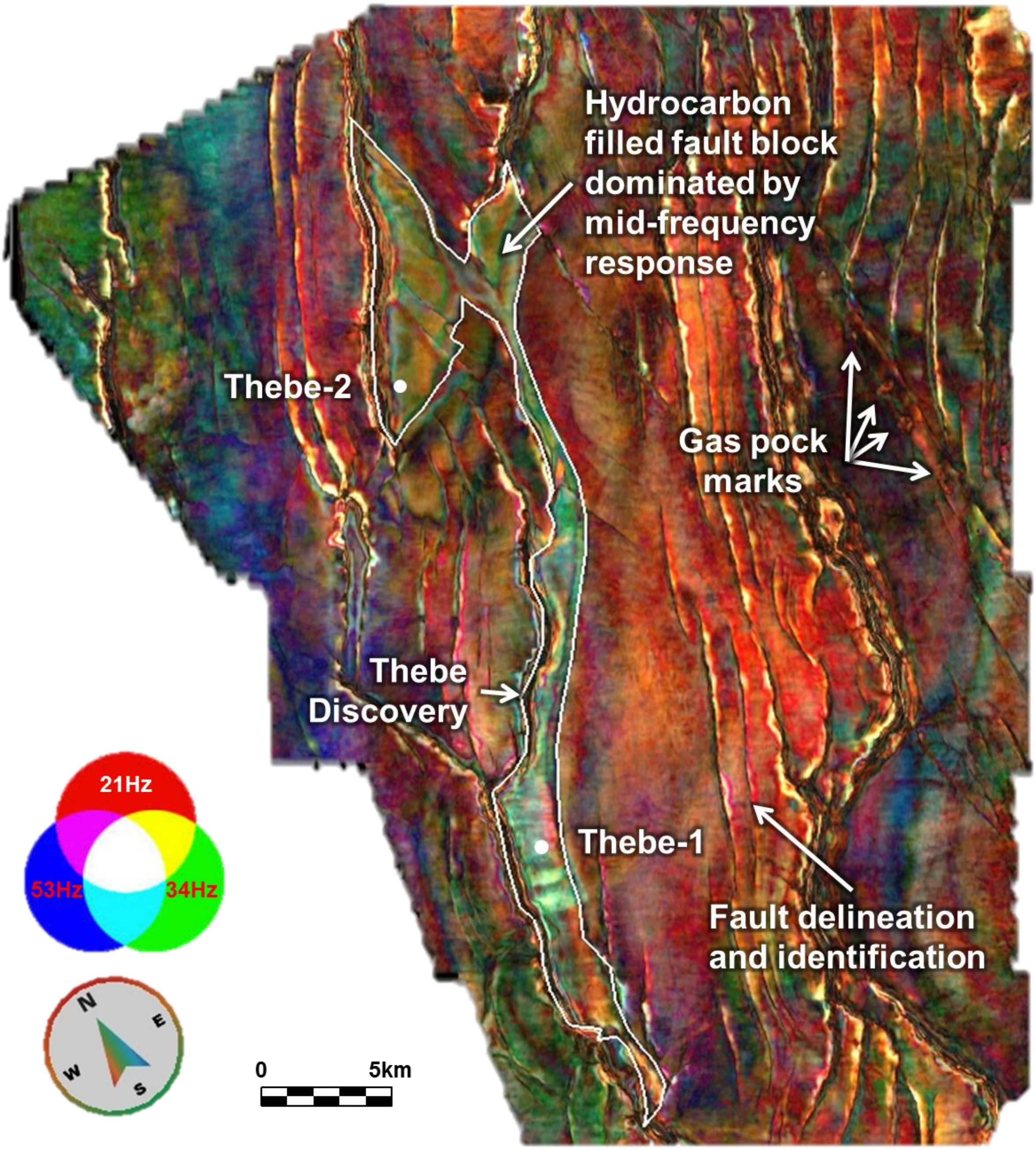

Figure 2 *RGB blending of frequencies allows for large amounts of structural and stratigraphic information to be revealed. When the blend results are draped along a horizon of interest it is possible to identify subtle features that may otherwise be masked in the amplitude or envelope volumes.*

RGB blending highlighted a number of features that are associated to the petroleum system. To the east of the Thebe Discovery a number of "pock marks" can be identified (Figure 3). These pock marks can be traced in the seismic to a fault trending North-South. In an adjacent seismic cube these pock marks are also present at the Top Mungaroo Formation at faults with the same orientation. This would suggest that the North-South have a lower sealing potential and could act as a leakage point in the Thebe Discovery.

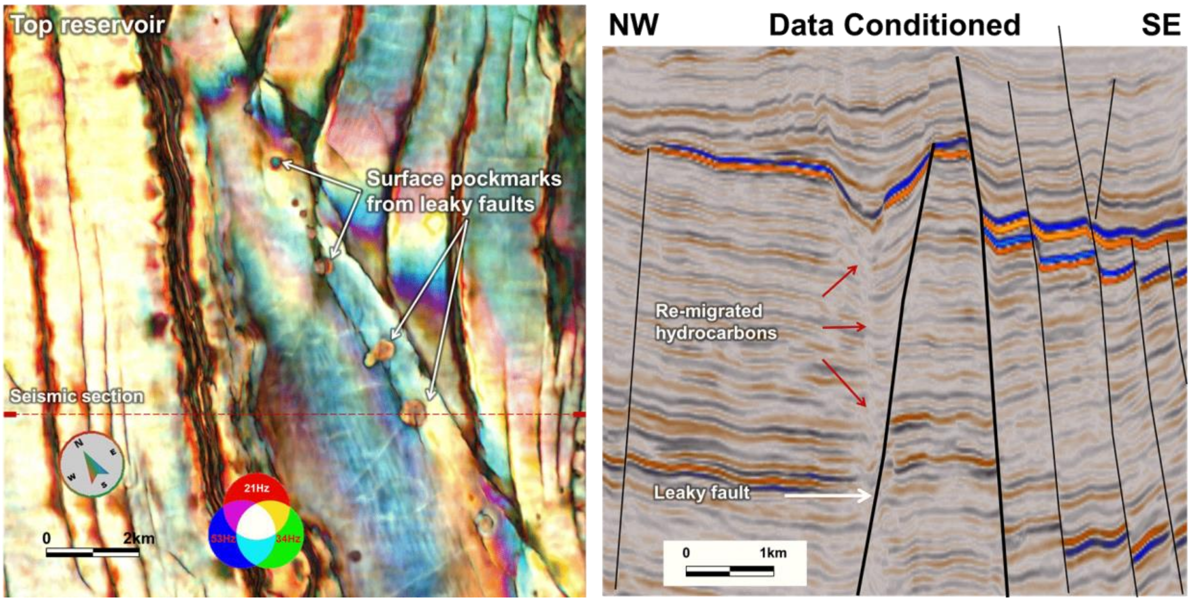

Figure 3 *The RGB blend draped over the Top Mungaroo Formation allows for the identification of surface pock marks from re-migrating gas. Highlighting the lack of sealing potential along faults and highlighting further risk in the Thebe Discovery.*

To better understand the fault distribution a cyan-magenta-yellow (CMY) Blend was generated using three different edge defining attributes. The combination of attributes that define geological edges by amplitude (tensor), phase (structurally oriented semblance) and structural dip allows for better vertical and lateral delineation of the structural event. When draped on the top reservoir horizon a number of structural elements can be clearly defined and its 3D distribution can be better understood.

These processes were undertaken on the full-stack volume; however, three angle stack volumes were also available for this study. Envelope (reflector strength) volumes for the Near, (6°-20°), Mid (20°-34°) and Far (34°-48°) angle stacks were subsequently generated and blended together with a RGB palate (Figure 4). This "AVO" blend can assist in defining features with more clarity than the reflectivity data and in some cases the frequency blend. The advantage of this blend over the frequency based blend is the AVO blend identifies potential changes in fluid or lithology.

The AVO blend is very useful at identifying areas of potential in either deeper or shallower sections. As shown in Figure 4C a large number of channel-like features are located in the Triassic section below the Thebe Discovery. As neither of the wells penetrated into this section, the play remains untested but a better geological understanding can be achieved. With a richer understanding of the geological environment and depositional system it may be possible to more accurately risk new potential prospects.

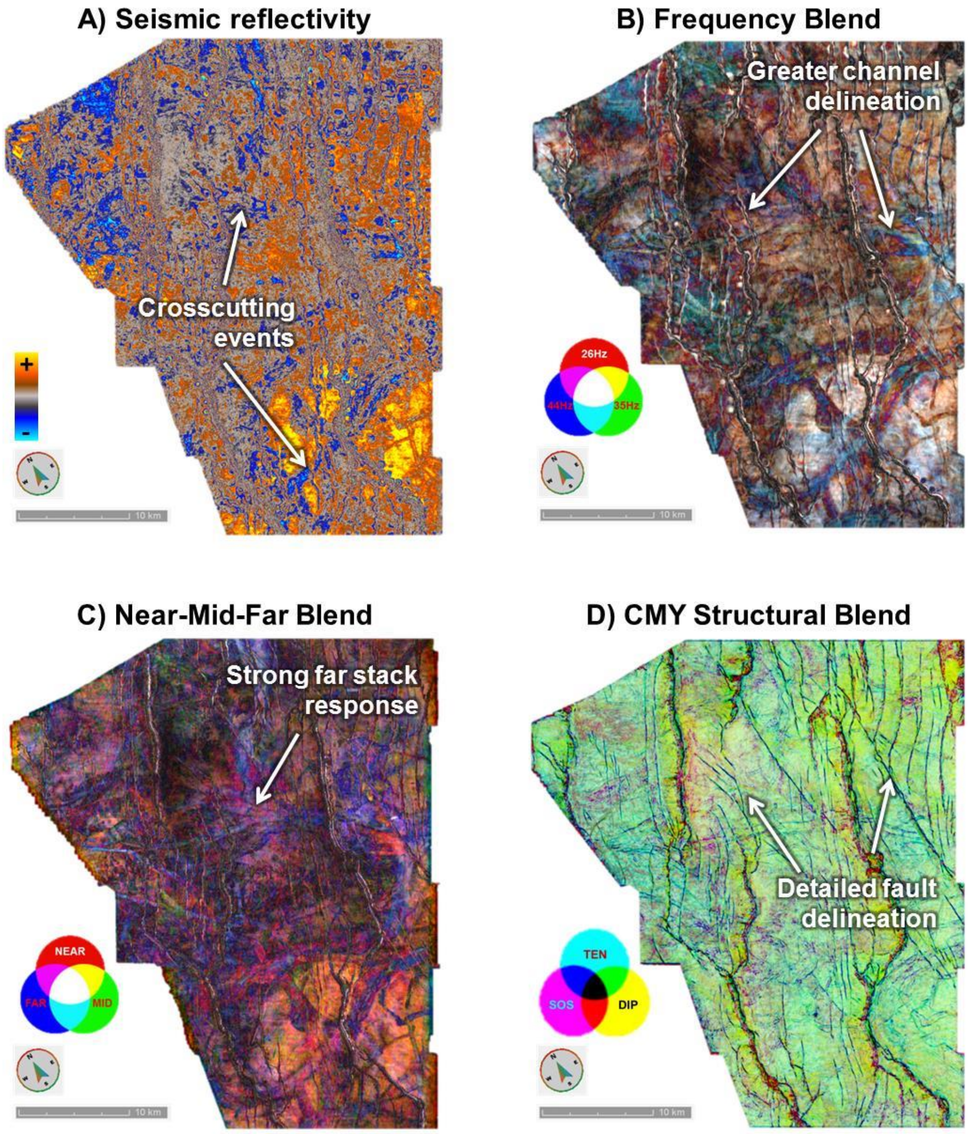

Figure 4 *A) seismic reflectivity highlights a number of the large scale features and large fault zones. B) RGB Frequency blending highlights the features but with much more clarity. C) Blending of the Near-Mid-Far angle stacks brings out even more information and detail regarding the laterally continuous channel –like events. D) Blending of 3 differing edge defining attributes further helps delineate and identify structural patterns within specific target areas.*

Conclusions

The Thebe Discovery has been underdeveloped for over 9 years since its discovery. Although the presence of a significant fluid contact is evident in the seismic data, which has been proven to be gas bearing with the drilling of a further appraisal well, no further wells have been drilled into the structure. This could be related to a number of risks associated to the discovery and the surrounding areas. Through a Cognitive Interpretation analysis, a number of risks such as leaking faults and defining the field limits have been identified and delineated around the Thebe Discovery

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