

# Driven to Success on the Seismic Superhighway

Whilst the first oil wells in a marine environment were drilled when Queen Victoria sat on her coal-powered throne, the state of Earth imaging at that time would have left most modern explorers unamused. These were the oil exploration dark ages, which lasted until the sub-surface illumination reformation delivered by the development of the seismic method in the 1950s. This new super-power, with the profundity of being able to image into the profound, indeed to see the beating hydrocarbon heart of Mother Earth, has brought the world the oil that has supported our civilization and indeed ensured our species survival ever since.

Explorers today have had a lifetime of experience developing intuition and skills to crack ever harder subsurface puzzles in the hunt for mobile carbon. Yet, post the sequence

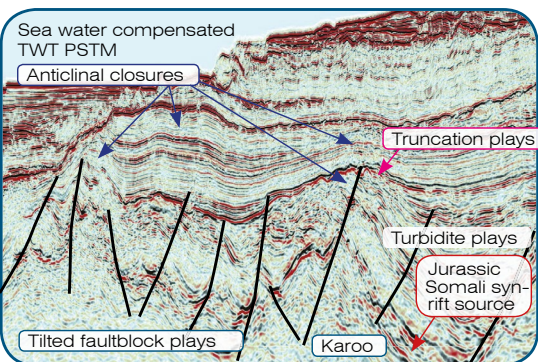
stratigraphy orogeny, the only new tool in the box for explorers has come from new innovations in seismic acquisition and processing technologies, and the integration of this super-vision with new, improved resolution remote sensing tools.

Modern seismic has now evolved into a forensic clue machine, solving issues from idea sublimation to license application. Here, four of Spectrum's geoscientists working in these fields capture the state of practical seismic in applications through the exploration value chain.

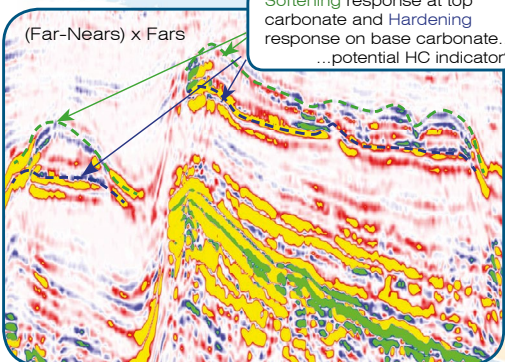


## Hi-Tech Seismic... ... in a Frontier Basin

If you could choose where to work where would it be? Obviously some sun-kissed shores rather than in yet another rain-drenched English summer at best. Recent good quality seismic surveys and targeted reprocessing have opened up the potential in areas such as Barbados and the Seychelles, making the choice possible!



Seychelles: Thick synrift package below thick sediment maturing source rocks



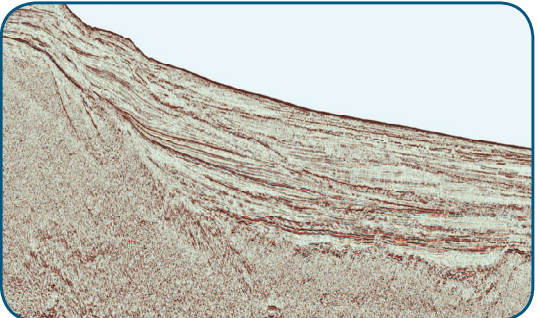
Seychelles: Far offsets dimming on carbonate reef crests suggestive of hydrocarbons

Softening response at top carbonate and Hardening response on base carbonate... potential HC indicator?

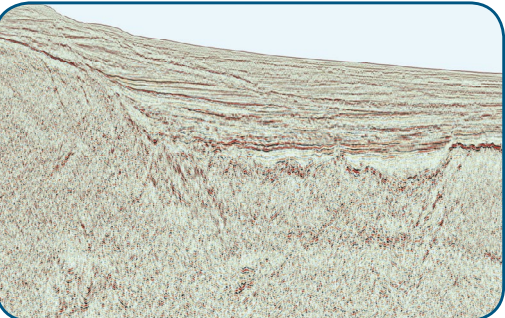


## New Play Systems... ...across the Final New Frontier

Dreams of avarice have driven the industry over the past 20 years to drill in up to 3,000m of water on the Atlantic passive margins, chasing the great successes of the shallow water into the abyss. However, the journey isn't over...



Pre-STM data from Uruguay. Reflectors dip seaward, suggesting hydrocarbons can migrate from SE up onto the NW shelf



Depth Migrated (Pre-STM): Landward-dipping reflectors create outward trapping geometries for basin floor sands.



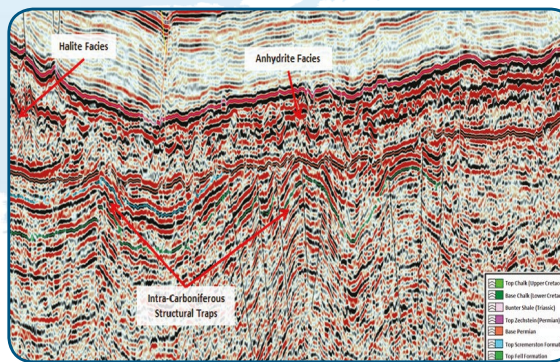
Drilling Success



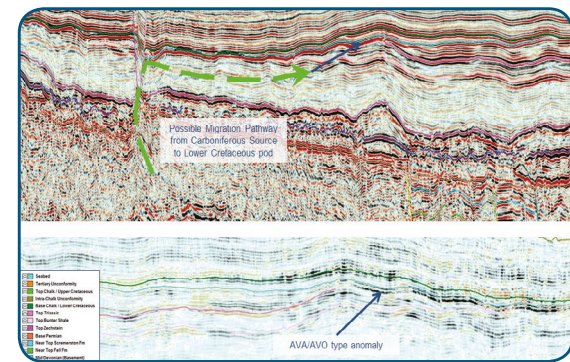
Key to world map:  
● = Existing Spectrum seismic library  
● = New data added to library in 2015

## Seismically Driven New Plays... ...in a Mature Basin

In some areas mature regions are surprising seasoned explorers as they reveal hidden secrets and open up new possibilities. Latest images of the Triassic, Permian and intra-Carboniferous sections in UKCS Southern North Sea have given great clarity...



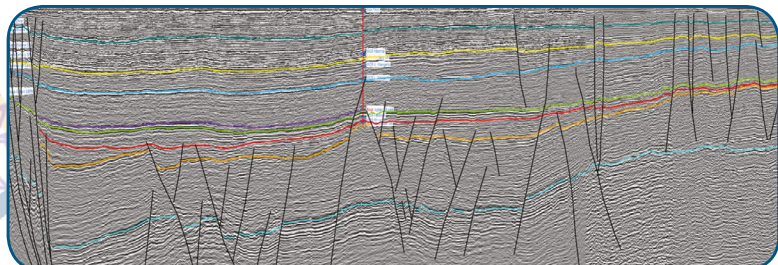
Intra-Carboniferous well-imaged structural traps and Zechstein seal seismic facies



Lower cretaceous AVA type anomalies up dip of a possible hydrocarbon migration window

## 3D Seismic Risk Reduction... ...for a License Round

Headlines in the Caswell basin (Browse), Western Australia are dominated by Shell's Prelude discovery and associated infrastructure investments. But a hat trick of discoveries made over the last few years are stealing the show, proving that significant gains can indeed be made in "mature" basins.



Spectrum's Kyrans 3D survey through Melita Graben and Sahul Syncline defining Jurassic- and Cretaceous-age hydrocarbon traps



# The State of the Art in Seismic

## 3D Seismic Risk Reduction for License Round

PHILLIP HARGREAVES

On Australia's North West Shelf, acreage in shallow water multi-TCF neighborhoods is highly prized and competitively sought. To assess the value of acreage for optimum license round bidding requires investment in detail, to reduce risk and support confident, intelligent action.

The North West Shelf is characterized by frequent licensing rounds, and very rapid development of play ideas by explorers who need to outcompete. Rapid adoption of new imaging technologies supported the exploration for deeper, older reservoirs such as the Lower Jurassic of the Crown, Bassett West and Lasseter (2014) discoveries. The key to imaging and chasing this play is the availability of modern 3D data, and extrapolation

from offset well success into unlicensed acreage.

In the Browse Basin to the west of the Ichthys and Prelude LNG projects, 3D data acquired in 2013 covers both the Lasseter discovery and open acreage in the current license round. This 3D images both extensional fault block plays and associated drape structures in which Jurassic and Cretaceous-aged sediments form the primary reservoirs.

When combined with additional 3D coverage over the wider Browse Basin, this dataset presents an essential evaluation tool to support a confident bidding strategy for acreage and subsequent exploration and development activities. Significant remaining prospectivity in the area is present, only fully realized with modern seismic data. ■

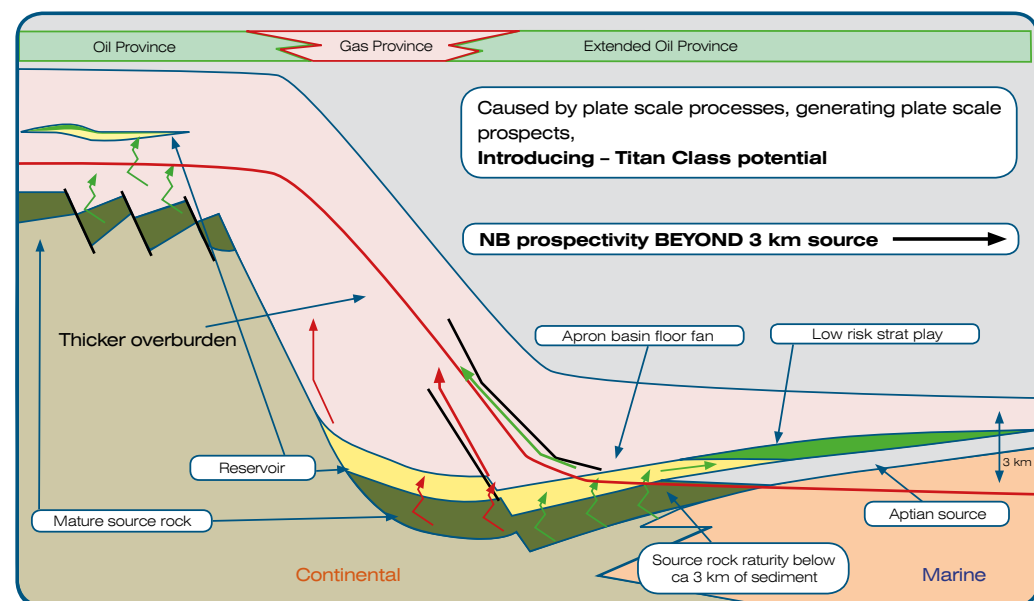
## The Final New Frontier

NEIL HODGSON

One of the main deepwater plays targeted by exploration companies in the past decade has been to chase sands deposited in canyons running down into passive margin basins. Inherently risky, with the potential for up-dip leakage below the resolution constraints of seismic to image, and often small in volume, such exploration in deepwater has brought mixed success and a degree of indifference from the industry.

However, the journey into deepwater isn't over; yet in the new frontier beyond 3,000m water depth lies the real prize: the basin floor fans that provide prospects ten times bigger and at a third of the risk of the constrained canyon plays. Here, 'new' seismic

steps up to the plate: long streamer 2D data, processed in the time (PSTM) and depth (PSDM) domains with new techniques to eliminate multiples (SRME) yield a secret big enough to kick 'Peak Oil' back onto the fiction shelf. In many places along the Atlantic passive margins, plate cooling and loading has depressed the landward margin, so up-dip trapping is guaranteed – outward from the coast (see foldout figures). Structures like these, with zero up-dip risk and oil prone (the source has less burial cover) are present on both Atlantic margins. They form a suite of the biggest as-yet unexplored prospects in the world, affectionately referred to as 'Titan Class prospects'. ■



*Schematic illustration from the Sergipe Basin, Brazil showing the Titan Class potential plays seaward of the conventional oil and gas provinces in the shelf and slope domains – a result of reduced overburden and landward dipping structures.*

## Seismically Driven New Play in Mature Basin

KARYNA RODRIGUEZ

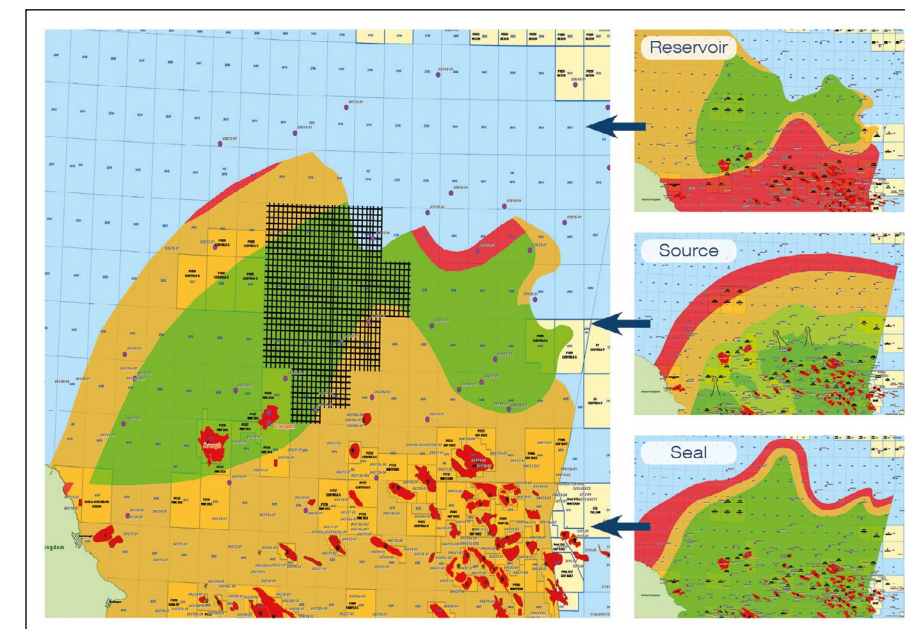
The UKCS Southern North Sea has two major mature plays simply defined by the distribution of Permian and Carboniferous gas fields. North of these, beyond the Rotliegendes pinch-out, exploration of the Carboniferous was hampered by poor seismic data, yet the successful appraisal of the early Carboniferous Breagh Field in recent years indicated that a greater game was afoot.

New seismic acquired in 2013 with long record length has been combined with an innovative processing methodology (delayed-start SRME at Top Chalk level, dual domain Tau-P Decon and high resolution radon), which has re-invigorated the area as for the first time it allows the intra-Carboniferous to be evaluated. An Early Carboniferous Dinantian play fairway analysis evolved from this seismic acquisition, extending the limits of established fairways and developing new untested fairways.

Further north, in areas where the Zechstein top seal thins, hydrocarbons migration from the Carboniferous

section up into higher stratigraphic levels can be investigated now via AVO/AVA analysis, illuminating a strong relationship between migration windows and overlying Triassic Bunter Sandstone, Lower Cretaceous Sandstone and Chalk plays. ■

*Dinantian play fairway analysis.*



## Hi-Tech Seismic in a Frontier Basin

ASHLEIGH HEWITT

In the Seychelles, recent good quality seismic surveys and targeted reprocessing is identifying hydrocarbon traps and accumulations missed in early reconnaissance.

In the '80s and '90s the four wells drilled in the Seychelles proved source and reservoir rocks but only oil shows were encountered. This lack of success was in part a result of inadequate seismic resolution making it difficult to reveal the best place to drill and understand possible trap-breach mechanisms. However, there is no doubt the hydrocarbon system is proven, with tar balls and seeps typing to prolific Jurassic Somali-rift and Cretaceous/Paleocene shales. With longer offset seismic and new processing techniques, oil hunters have returned to better define leads of giant proportions. The use of angle stack data is also proving to be invaluable. For example, evidence of dimming on the far angles at the top of a possible reef and brightening at the base could be indicative of hydrocarbons (see foldout figures). Additionally, initial results from ongoing reprocessing using broadband

processing and PSDM suggest even better definition of deeper potential targets in and around the Seychelles Platform and Mascarene Plateau. ■

*Potential tilted fault block and carbonate plays.*

