

# Finding More Gaveas in the Campos Basin and Beyond the Salt Domes...

The recent Gavea discovery is just the latest in a series of successful pre-salt discoveries in the Campos Basin, Brazil. Seismic imaging in the pre-salt section using careful depth migration is key to identifying undrilled analogous structures. Spectrum's 2D seismic dataset provides a tool to understand drilled structures in detail, as well as to extrapolate, locate and evaluate on-trend analogues. It offers a unique opportunity to visualise future potential play types beyond the salt dome province. A new acquisition programme currently being undertaken will help define the plays of the future, both under the salt domes and out into the clastics beyond the salt domes.



Below: PSDM (depth) seismic line through some recent pre-salt discoveries and analogous undrilled structures in the Campos Basin, Brazil.

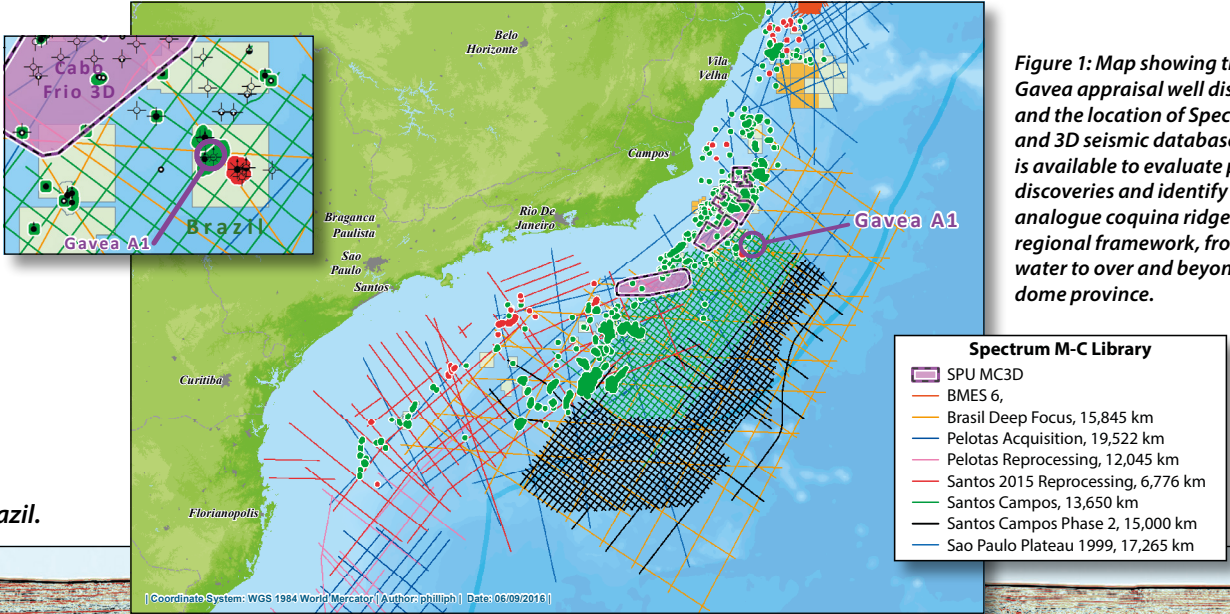
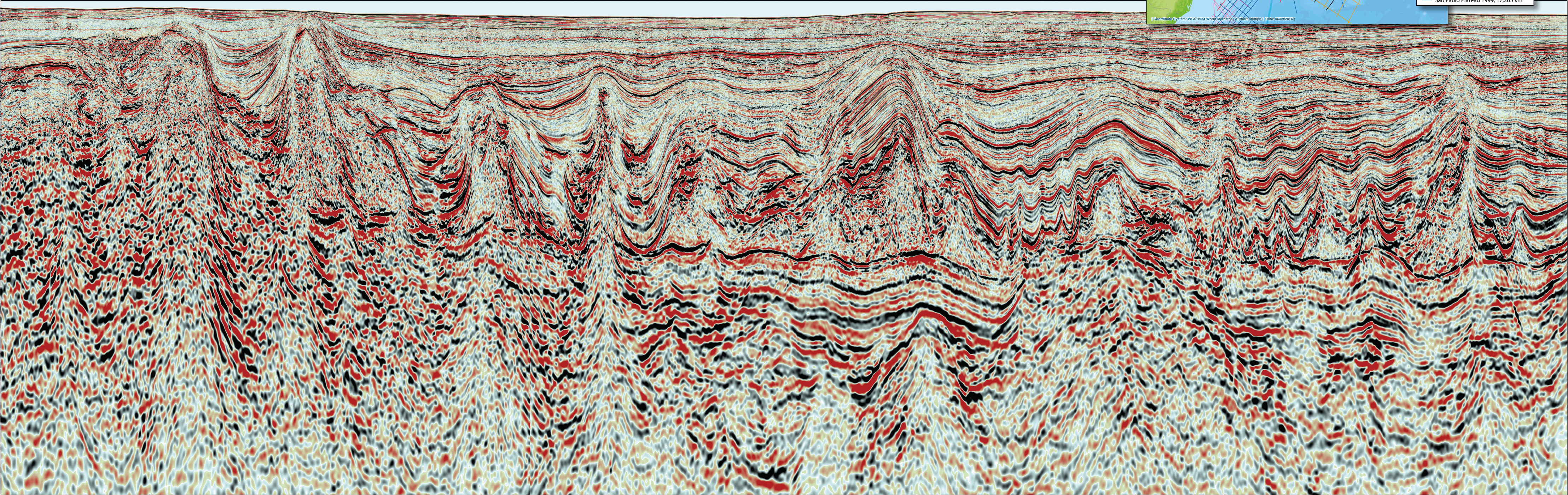


Figure 1: Map showing the latest Gavea appraisal well discovery and the location of Spectrum's 2D and 3D seismic database, which is available to evaluate pre-salt discoveries and identify on-trend analogue coquina ridges within a regional framework, from shallow water to over and beyond the salt dome province.



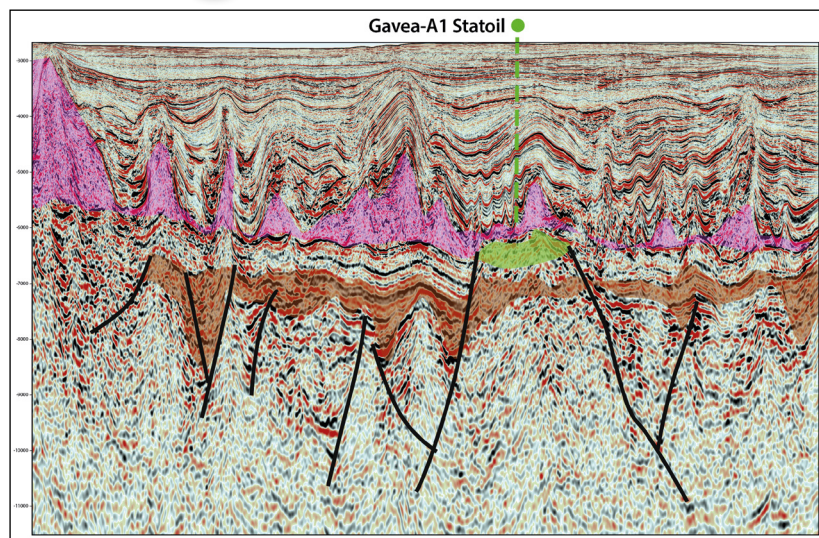
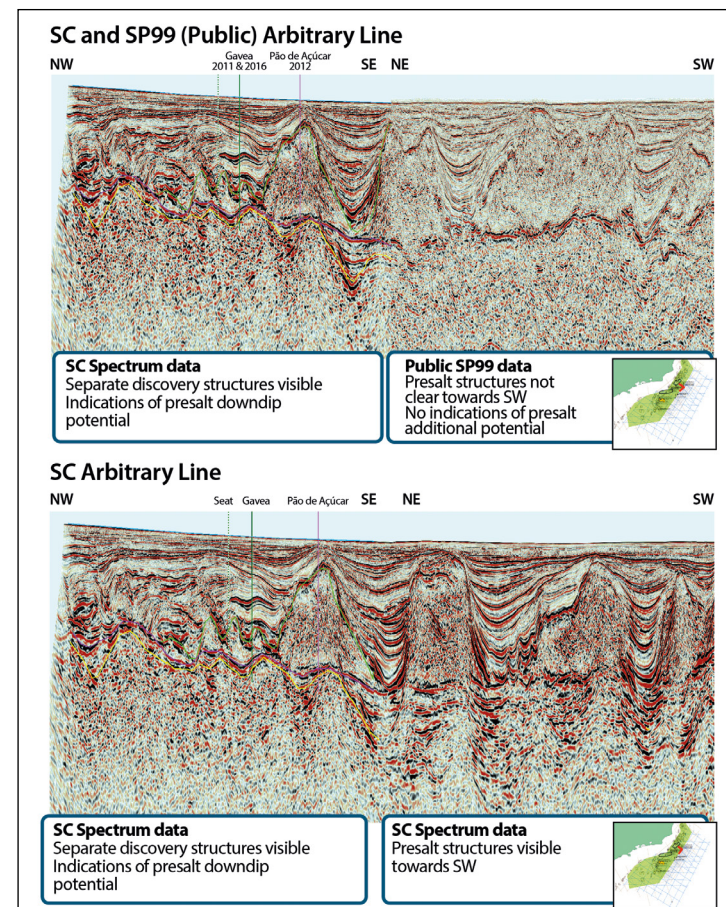
# A Complete Regional Picture

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First exploration efforts in the Campos Basin began in 1968. The giant Albacora and Marlim fields were found in the mid-1980s and by 2003, 41 oil and gas fields had been discovered in water depths between 80 and 2,400m. Today, this basin is one of the top producing basins in the world with over 1.7 MMboepd.

The recently discovered Seat, Gavea and Pão de Açúcar fields all lie within a Campos Basin block estimated to contain resources of more than 700 MMb of light oil and 3 Tcfg, as estimated by Subsea IQ. Pão de Açúcar was actually reported as one of the world's top five discoveries in 2012. The latest Gavea appraisal well (Figure 2) found a considerable 175m-thick

**Figure 3: Arbitrary lines illustrating the importance of using high quality seismic data to identify pre-salt leads. Note on the top figure how the pre-salt section is not imaged on publically available seismic data on the right, whereas a nearby high quality Spectrum line points to a series of potential pre-salt leads to the south-west.**



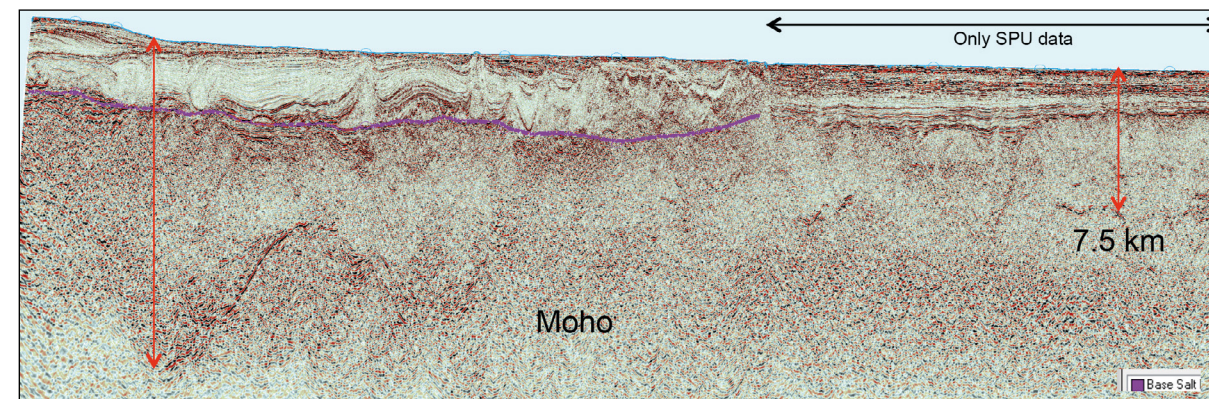
**Figure 2: The 'perfect pre-salt play system' on Spectrum 2D PSDM in depth.**

oil column in a Macabu Formation pre-salt carbonate reservoir.

A recent Campos Basin prospectivity evaluation carried out by Spectrum has identified a significant number of untested pre-salt structures in open acreage, a very exciting prospect for any company looking to explore in this basin, as it is strongly rumoured that this area will be offered in the upcoming licensing round. Not only is large additional pre- and post-salt potential identified on available 2D and 3D datasets, but also potentially huge basin floor fans lying over mature Aptian source rock can be seen beyond the salt dome province on the only dataset available with coverage over this area.

## Gavea and Untested Pre-salt Potential

There are three main proven play types within the syn-rift and post-rift sequences in the Campos Basin. These include the pre-salt rift play, baptised by Statoil as the 'Perfect Play System', with lacustrine enhanced reservoir quality microbial carbonates developed on basement highs created by faulting or volcanism. These are locally sourced from underlying lacustrine shales and sealed by thick evaporites, allowing for large accumulations which can be filled down to base salt spill (Figure 2). Post-rift proven plays include the Macae carbonate play and Cretaceous and Tertiary turbidite clastic plays draped over salt-induced extensional structures. These are sourced by the same syn-rift lacustrine shales, as the mature hydrocarbons can migrate to the post-rift sequence through salt withdrawal windows.



**Figure 4: Regional deep focus data with unique deep imaging which extends beyond the salt dome province.**

Using Spectrum seismic data it is possible to carry out a detailed analysis of the pre-salt discoveries to date (as shown by the seismic foldout example), and also to identify on-trend analogues and map a significant number of leads. These align in a series of south-west to north-east trending coquina ridges of similar size as, or larger than, the existing discoveries and, even more excitingly, they are located in open acreage. These leads are best identified on high quality PSDM seismic data (Figure 3).

## Post-well Analysis

A post-well analysis of key wells with both pre- and post-salt targets showed very interesting and encouraging results. Post-salt wells have targeted carbonates, sandstones and calcarenites and have either been dry, found uncommercial hydrocarbon accumulations, or had oil accumulations with challenging compartmentalisation and low pressure conditions. One of the post-salt wells in the Campos Basin encountered thin effective oil thicknesses in the low permeability Campanian Carapebus Formation reservoir. What is exciting about these post-salt wells is actually deeper in the untested pre-salt, as the seismic data shows strong indications of pre-salt structures usually directly below the well.

A post-well review of key pre-salt wells is even more encouraging as not only are most associated with very significant discoveries, but also by reviewing their seismic characteristics a large number of undrilled analogue pre-salt structures can be mapped using the Spectrum 2D seismic grid.

## Sneak Preview of Future Exploration Targets

The unique regional dataset available over the Campos Basin has the imaging quality needed to study pre-salt discoveries and leads in detail but, more importantly, it provides a unique dataset which allows a complete regional picture to be obtained, with the added bonus of revealing huge potential beyond the salt dome province.

The deep focus regional data images the Moho, allowing the interpretation of crustal architecture for improved understanding of heat flow and geothermal gradient, which in turn leads to more reliable maturity modelling (Figure 4).

More importantly, however, a future huge potential play type is indicated beyond the salt dome province, where large structures containing

basin floor fans with high amplitude anomalies overlie mature Aptian source rock. The presence of this source rock is inferred from the conjugate Gabon margin, where it is identified by the same low frequency, semi-transparent seismic character observed all along the southern Atlantic margin and repeated here in the Campos Basin. Basin modelling carried out in Gabon indicates that under similar conditions of burial depth, the Aptian source rock will be mature for oil (Figure 5).

## Astonishing Promise

High quality seismic data is essential for both detailed and regional evaluation of proven pre-salt and post-salt plays, and indicates huge untested pre-salt potential in one of the most productive basins in the world. In addition, an ongoing acquisition programme aims to image below the salt dome province, where pre-salt structures similar to the main discoveries are indicated on existing data. And if that wasn't enough, the regional dataset provides an insight into future exploration targets in the form of basin floor fan structures over oil-mature Aptian source rock. The industry has just begun to realise the potential of the perfect pre-salt trapping hydrocarbon system.

In the third quarter of 2016 Spectrum will be acquiring a broadband long-streamer survey over the salt basin and out to the thick clastic sequence beyond the salt, where an abundance of high amplitude anomalies reveal a future oil domain of astonishing promise. ■

**Figure 5: The seismic shows huge basin floor fan potential for future oil exploration in the Campos Basin.**

