High Impact Data Creates High Impact Opportunities

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Abstract

Modern developments in seismic imaging integrated with traditional geological methods have created exciting new exploration opportunities in areas traditionally considered frontier and low prospectivity or mature with very limited opportunities for significant new discoveries.

Extreme examples are presented, from opposite ends of the Australian continental plate and in vastly different tectonic regimes, illustrating the opportunities this new approach offers.

The horseshoe-shaped Banda Arc, north of Australia, has long been of interest to the exploration community because sedimentary rocks outcropping within islands of the region are essentially the same as those occurring on Australia's Northwest Shelf. Abundant oil and gas seeps on these islands, together with deep-sea seeps, attest to a working petroleum system in the area.

The Banda Arc (in reality an arc in the geometric not the geological sense), defined by two strongly curved, sub-parallel ridge systems with intervening troughs, is the site of collision between the northwards-moving Australo-Indian (continental/oceanic) Plate, the SW-moving oceanic Pacific Plate and the (relatively stable) southern promontory of the continental Asian Plate known as Sundaland. The present-day complex geology results from two opposing tectonic forces: northwards movement of the Australian Plate and sinistral shear on the Greater Sorong Fault System (the plate boundary between the Australian and Pacific plates).

Interpretation of new broadband seismic data and detailed geoscientific analysis has significantly improved understanding of geological development of the area.

Geological development has occurred in several distinct phases:

- Formation of a jagged passive margin (non-volcanic with hyperextension) and generation of oceanic crust in late Jurassic times.
- Cenozoic subduction of the Jurassic oceanic crust; slab rollback from about 15Ma.
- Arrival of continental crust into the subduction system around 10Ma, partial subduction until the system jammed, together with fold-and-thrust belt formation and the development of foredeeps (Timor, Tanimbar and Seram troughs) developed in front of the active fold-and-thrust belts.
- Continuing slab-push from the mid-ocean ridge (far) to the south resulting in widespread strike-slip faulting and wrench basin formation together with some obduction and isostatic rebound.

It is believed that the region is in the initial stages of orogenesis, comparable to the Eocene "soft collision" of Greater India with Asia which ultimately resulted in the formation of the Himalayas.

The Gippsland Basin in southeastern Australia is one of Australia's most prolific hydrocarbon systems, having historically generated approximately two thirds of the country's cumulative oil production and one third of its gas.

The basin has a long and proud history – 1964 Esso took over as operator of a joint venture with BHP and spectacular exploration successes followed.

The creaming curve for the basin is essentially flat since the mid-1970s, with no significant kick from either the application of 3D or deepwater success (as has occurred in many other basins of the world). While it could be argued that the curve flattened because the big discoveries have all be made, it could also be argued that imaging problems have masked significant opportunities.

Imaging issues in the basin have long been known: challenges include limited resolution at reservoir level, distortion from shallow complex overburden and poor imaging in the deep section.

Significant new exploration opportunities in the basin have been generated by a major reprocessing project involving application of several technologies. Technologies used include broadband processing, Full Waveform Inversion (FWI) and least squares Q PSDM (LSQPSDM).

Prospects with the potential to contain several trillion cubic feet of gas have been generated, highlighting the impact of enhanced imaging.