Exploration Concepts, Offshore West Coast South Island

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Extended Abstract

The West Coast region of the South Island has long been recognised as prospective for oil and gas based on its geology, including some conspicuous surface seeps. However, exploration activity has only recently resumed after the lack of commercial results from previous campaigns. In this paper we present the petroleum systems concepts behind two recently-initiated offshore exploration ventures: Widespread Energy's PEP 50439 and Grande Energy's PEP 38527, off the central and western sectors of the West Coast respectively (see Fig.1).

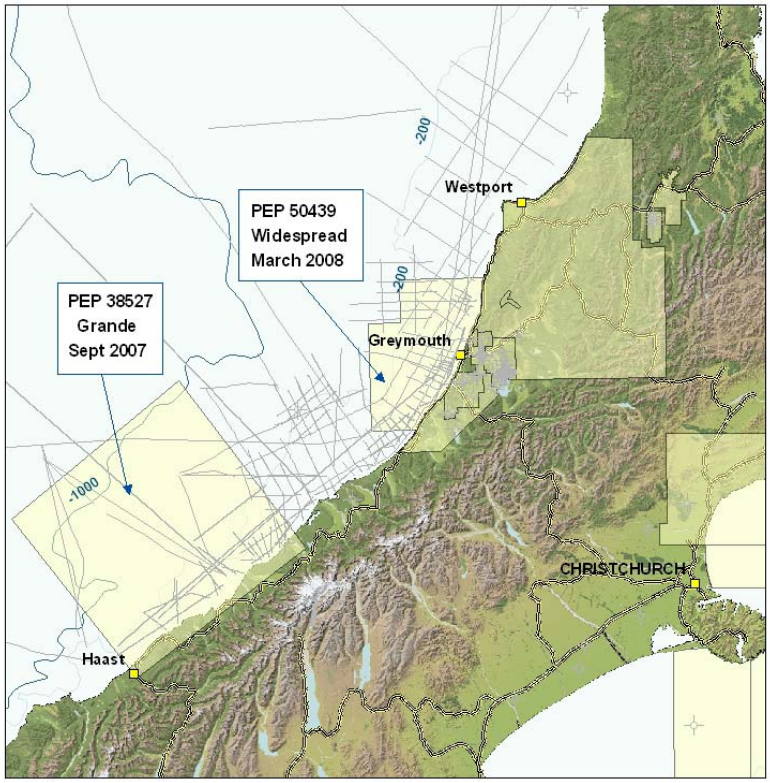

Figure 1. Location Map of the West Coast, South Island, showing PEP 38527 (Grande) and PEP 50439 (Widespread).

The geology of the West Coast basin system, which has been synthesised by Nathan et al (1986) and Breeze and Browne (1999), is broadly a continuation of the Taranaki Basin and in particular, the Southern Inversion Zone (King and Thrasher, 1996). These basins are situated within continental crust of the Australian Plate, where it is impinged upon by the transpressional Alpine Fault segment of its boundary with the Pacific plate to the southeast. Northwards, plate boundary tectonic effects are distributed over a wide zone of deformation, but in South Westland the zone of deformation is both narrower and more intense.

The Pakawau Group (about 70-55 Ma) (Fig. 2), which contains the most important petroleum source rocks for Taranaki's proven oil and gas resources, continues within the Pakawau Graben of NW Nelson; in the central West Coast it is represented by the Paparoa Coal Measures within another NNE-trending inverted extensional basin, the Paparoa Trough. Paparoa section extends beyond the graben both to the east (Kotuku area) and offshore to the west (Mikonui-1 well), but is absent elsewhere (eg Haku-1, Waiho-1 and Harihari-1 wells). Scattered outcrops in South Westland include coal measures (Tauperikaka) broadly correlative to the Paparoa, but passing up into marine sands (Whakapohai Sandstone) within the late Cretaceous.

An earlier phase of extension (100-80 Ma) (Fig. 2), generally trending at right angles to the Paparoa, hosts the Pororari Group (which includes Hawks Crag Breccia as well as other generally coarse-grained terrestrial facies). Offshore sub-surface examples of this phase include the Takutai Graben immediately west of Greymouth (Bishop, 1992), and a rift in the SW corner of the Challenger Plateau some 300km offshore (Wood, 1991). In South Westland, the Otumotu Formation is a correlative of the Pororari, and includes carbonaceous mudstones and thin coal seams within its upper member. Based on limited seismic coverage, several further examples of rift fill of the same age as the Otumotu and Pororari occur within the offshore region, and potential source rocks within these are a crucial component of the exploration case.

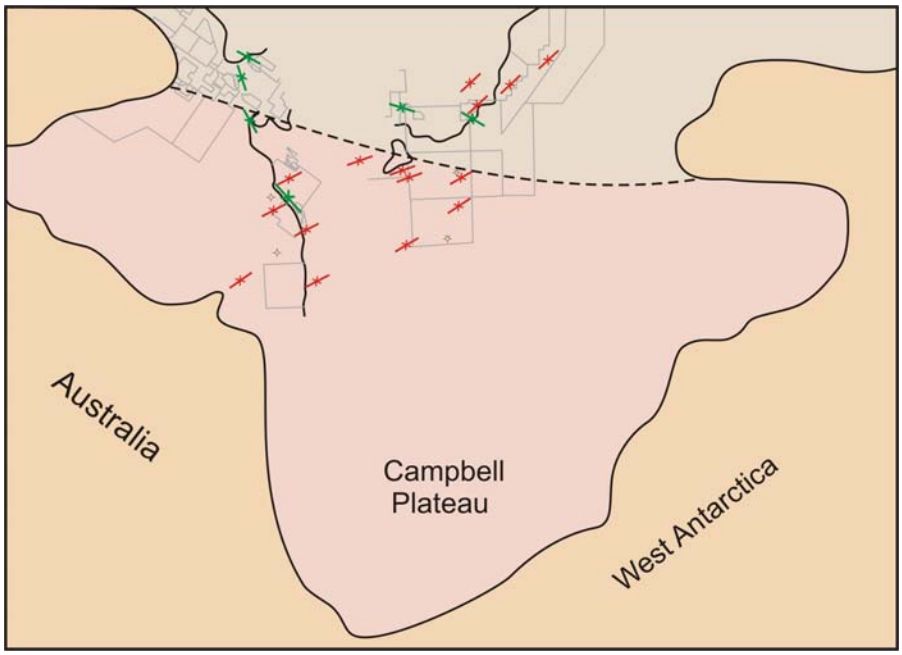

Figure 2. Known extensional features approx. 70 – 55 Ma ago are shown in green. The Pakawau Group which contain the most important petroleum source rocks for the Taranaki Basin are represented in central Westland as the Paparoa Coal Measures. Earlier known extensional features (100 – 80 Ma) are shown in red, trending at right angles to the Paparoa Group.

In South Westland, there are scattered occurrences of a marine sequence of Paleocene-Eocene age (Tokakokiri and Abbey formations) which is intercalated with basaltic rocks. This sequence is suggestive of a passive margin origin on the southwestern margin of the Challenger Plateau during the opening of the Tasman Sea.

The central and northern West Coast region (the landward projection of the axial Challenger Plateau) experienced uplift and erosion across an unconformity (also present through southern Taranaki and Western Southland basins) that separates mid Eocene or younger strata from Paleocene or older. The Paparoa Trough was re-activated in the mid-late Eocene with deposition of Brunner Coal Measures, which was succeeded within the trough by up to about 1000m of transgressive marine facies including the Kaiata Mudstone, various members of which constitute attractive reservoir objectives (Island Sandstone, Omotumotu Formation).

The transgressive sequence is capped by the Oligocene Nile Group, including the dense Cobden Limestone and marly equivalents (basinal facies of Nathan et al, 1986). The Nile Group acts as a regional seal (except where breached by subsequent faulting), isolating the subjacent sequence from the Miocene and younger sequence above.

In the early Miocene, a change in the pole of relative plate motion brought about the development of a compressional basin system as a foredeep to a west-directed over-thrust well to the east of the offshore West Coast region (Fig 3). Early Miocene clastic sedimentation was ponded to the east of the Paparoa inversion, and the offshore section is thin and of deep water aspect. In the middle Miocene, the Grey Valley Trough was filled and clastic sediment began to spill into the offshore area to the west.

Accelerated sedimentation ensued in the late Miocene with the development of the Alpine Fault and growth of the Southern Alps generating a considerable sediment yield. The West Coast shelf was developed by progradation from then through the Quaternary. The associated loading of early basin elements, especially close to the coast, suggests the likelihood of source rock maturation and the charge of oil and gas into trapping structures.

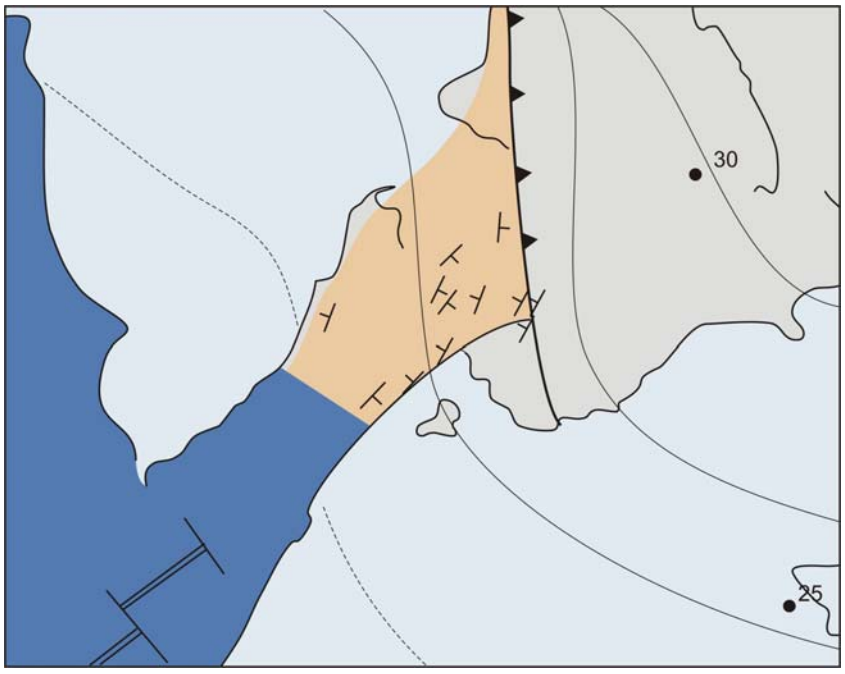

Figure 3. Mid Cenozoic extensional basin system (late Eocene-Oligocene) followed by influx of clastics from east.

Conclusions

The complex geological evolution of the offshore West Coast has created a combination of factors conducive to the generation and entrapment of oil and gas. Exploration ventures in this region do however rely on a relatively simple petroleum system: The existence of a late rift or passive margin with Cretaceous source rock (and reservoir sequence) that has become mature in Quaternary time due to late burial by material eroded from the Southern Alps and migration into reservoirs (of quartzose provenance) related to broad simple, structural traps.

More seismic and other data are required, to map:

- the distribution of late Cretaceous source rocks
- the distribution and facies of potential reservoir and associated top-seal units within several formations
- the locus and timing of burial and maturation
- the locus and timing of structural closures
- seismic attributes indicative of hydrocarbon pore fluid.

With pending surveys designed to provide a more complete basis for prospect definition, the prognosis for future oil and gas discoveries in the offshore West Coast region is very good.

References

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Speaker

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