Restoration of a Deepwater profile from the Browse Basin: Implications for structural-stratigraphic evolution and hydrocarbon prospectivity.

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Abstract

A Geoscience Australia interpretation of a 600 km long, deep-seismic reflection profile across the Browse Basin, that passes from the Proterozoic craton to Jurassic oceanic crust, has been structurally backstripped, decompacted, restored and adjusted to correct palaeobathymetry for 14 key horizons. The restorations suggest ~10% observable brittle deformation in the upper crust in the Upper Palaeozoic, in the form of Permo-Carboniferous rifts that formed the Caswell Sub-basin and the Scott Plateau Sub-basin. However, 45% extension is inferred in the Middle Jurassic beneath the sub-basins, mainly in the form of rotation of structural dominoes beneath the Scott Plateau from initial dips of ~60° to current dips of 20°. Locally, the dominoes record up to 200% extension and are associated with significant intrusion of the Upper Palaeozoic sequence. This extension was matched by more distributed extension in the lower crust and mantle that caused regional subsidence. The Middle Jurassic extension lead to thick, shallow water deposits in a thermal sag in the Caswell Sub-Basin but regional subsidence of the Scott Plateau into deep water, with a thin veneer of deeper water Middle Jurassic sediments filling in the relief on the tops of the dominoes.

In the Upper Jurassic the Caswell Sub-basin was a shallow shelf with thin Upper Jurassic deposits. However, an 80 km-wide graben formed along the southeast edge of the Scott Plateau, the Scott Graben, and was filled with up to 2 km of Upper Jurassic sediments. At this time the Caswell-Scott Transition became a bald slope exposing Callovian beds at the seafloor and bypassed by sediments. The deep water Upper Jurassic graben probably received significant source rock deposits, as well as a major influx of coarse clastic sediments in submarine fans that passed across the Caswell-Scott Transition from the adjacent shelf. This allowed a favourable juxtaposition of hydrocarbon reservoir and source rocks.

Valanginian to Aptian flooding resulted in a deeper water starved basin with condensed deposits whilst minor inversion in the Scott Graben created potential hydrocarbon traps with several hundred metres of relief. During this time the Caswell-Scott Transition remained a bald slope bypassed by sediments. In the Upper Aptian to Lower Albian, sediment supply increased dramatically and a shallow water sequence prograded into >350m of water on the intermediate shelf. The sediments continued to bypass the Caswell-Scott Transition depositing turbidites in the Scott Graben. Minor inversion continued in the graben, perhaps related to oblique slip, creating further potential hydrocarbon traps.

The prograding shelf continued into the Upper Albian and Cenomanian and buried Callovian outcrops on the Caswell-Scott Transition for the first time. On the Scott Plateau, turbidites filled the Scott Graben and passed across it as far as Wilson Spur, which was growing as an outer margin high. The Paleogene saw continued subsidence, but matched by sedimentation such that shelf progradation continued across the intermediate water depth shelf and turbidites were shed into the deeper water basin as far as the Wilson Spur.

A dramatic increase in subsidence rate and sedimentation occurred in the Late Oligocene and into the Miocene allowing deposition of a thick carbonate sequence with the shelf edge above the Caswell-Scott Transition and thick carbonate turbidites on the Scott Plateau. In the Scott Graben the Upper Jurassic sequence was buried to depths of ~3 km, which may have been enough to generate and migrate hydrocarbons.

The high subsidence and sedimentation rates continued in the Pliocene and yet the shelf-edge regressed ~100 km. This suggests a Late Miocene to Early Pliocene hiatus in sediment supply and then a resumption of sedimentation, perhaps at an increased rate. Significant offset on the faults between the Wilson Spur and the Scott Plateau is inferred at this time.

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