Controls on Normal Fault Growth Along Australia's Rifted-to-Passive Southern Margin Using the Analysis of 3-D Seismic Datasets

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ABSTRACT

Recent studies using 3D seismic datasets have significantly increased our understanding of normal fault growth on the decimetre to kilometre scale. We aim to add to this growing pool of research by documenting and characterising the growth of Upper Cretaceous-Cenozoic aged normal fault arrays located along Australia's rifted-to-passive southern margin. We have used 3D seismic datasets along Australia's southern margin from the frontier Ceduna Sub-Basin of the Bight Basin and the Gambier Embayment, the present-day shelf-edge break and the Shipwreck Trough of the Otway Basin. Australia's southern margin and its constituent basins (Bight and Otway basins) were formed from the break-up of Australia and Antarctica since the Middle to Late Jurassic. The E-W to NW-SE oriented, Middle Jurassic to Upper Cretaceous aged, Bight Basin hosts the Ceduna Sub-Basin, which is characterised by two temporally isolated, stacked delta systems, each displaying evidence of delta top gravity-driven extension, compensated down-dip by a delta deepwater fold-thrust belt. The NW-SE oriented, Upper Jurassic to Cenozoic aged, Otway Basin is a rift-to-passive margin basin, which extends from SE South Australia to NW offshore Tasmania. Using classic normal fault growth methodology, such as throw-distance plots, throw-depth plots and cross-section analysis, we document the spatial and temporal growth of several normal fault arrays. Based on this analysis, we describe the differing controls on the growth of these normal fault arrays in various tectono-stratigraphic settings of the Ceduna Sub-Basin and Otway Basin, such as deltaic sediment loading, crustal extension, perturbation of stress orientations and basin compartmentalisation, resulting from the growth of a continental transform fault. We show that the primary driving forces of Upper Cretaceous normal fault growth in the Ceduna Sub-Basin are basin subsidence and sediment loading. We also show that Upper Cretaceous crustal extension in the Otway Basin had a considerable control over the development of Upper Cretaceous normal faults, with evidence indicating that normal faults which developed directly over (and are partially or fully dip-linked to) basement normal faults display earlier nucleation and greater overall throw accumulation. These findings are applicable to other passive and rifted margins around the world including the Gulf of Mexico, the Niger Delta, the Baram Delta, the North Sea, the Suez Rift and the East African Rift.