



## Multiphase oblique extension on the North West Shelf of Australia

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The North West Shelf of Australia has experienced numerous rift events during its prolonged evolution that most likely started in the Lower Palaeozoic and continued through to the formation of the present day passive margin in the Lower Cretaceous. Carboniferous and Permian is associated with rifting of the Lhasa terrane, a phase extension in the Lower and Middle Jurassic associated with the separation of the Argo terrane Upper Jurassic to Lower Cretaceous extension culminated in the separation of Greater India and Australia. Investigations based on interpretation of extensive, public domain seismic data, combined with numerical mechanical modelling, demonstrate that crustal structure, rheology and structural fabrics inherited from older events exert a significant control on the architecture of younger rifts.

Defining the older, more deeply buried rift episodes is challenging, but with seismic data that now images deeper structures more effectively, it is clear that NE-SW oriented Carboniferous to Permian aged rift structures control the overall geometry of the margin. Variations in the timing, distribution and intensity of that rift may account for some of the complexity that governs the Triassic – a failed arm of the rift system might account for the accumulation of thick sequences of fluvio-deltaic sediments in an apparent post-rift setting, while active deformation and igneous activity continued elsewhere on the margin.

A renewed phase of extension began in the latest Triassic in the western part of the Northern Carnarvon Basin, but became progressively younger to the NE. High-resolution mechanical numerical experiments show that the dual mode of extension that characterises the Northern Carnarvon Basin, where both distributed and localised deformation occurs at the same time, is best explained by necking and boudinage of strong lower crust, inherited from the Permian rift event, proximal to the continental margin, and a subdued extensional strain rate across the distal extended margin. A very clear and consistent pattern of ENE oriented extension, which interacts obliquely with the older NE-SW oriented Permian aged structures, is apparent across the whole of the Northern Carnarvon Basin and extends north east into the Roebuck and Browse Basins. This is at odds with the NW-SE oriented extension predicted by the separation of the Argo terrane which occurs at this time. This may be explained by the detached style of deformation that characterises the Mesozoic interval. Alternatively, the separation of Greater India may have exerted a stronger influence on the evolution of the margin during the Jurassic than hitherto recognised.

