

Multiphase Mesozoic Extension and Sediment Response on the Northwest Shelf of Australia

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Abstract

The widely held view of the evolution of the North West Shelf of Australia is that the fundamental basin architecture was established by NW-SE oriented extension in the Carboniferous and Permian associated with rifting of the Lhasa terrane, by a further phase of NW-SE oriented extension in the Lower and Middle Jurassic associated with the separation of the Argoland terrane and by E-W oriented Upper Jurassic to Lower Cretaceous extension that culminated in the separation of Greater India and Australia. The presence of fundamental NE-SW oriented Carboniferous to Permian aged rift structures is well established, and with seismic data that now images deeper structures more effectively, the architecture of that rift system is becoming increasingly apparent. What is less clear is the tectonic setting of Triassic deformation, which forms a passive, post-rift sequence in most of the Northern Carnarvon Basin, but shows a continuation of the Permian extension, and a significant episode of volcanism, further to the NE. This raises the possibility of a failed Permian rift that was subsequently filled by the thick fluvio-deltaic sequences of the Mungaroo Formation that contain the primary reservoirs of the large gas fields in the Northern Carnarvon Basin. Sediment provenance studies indicate that a long-lived continental scale drainage system supplied sediment to this depocenter, but the subsidence mechanism, that allows several kilometres of sediment to accumulate while the depositional surface remains close to base remains enigmatic. 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 proximal to the continental margin, and a subdued extensional strain rate occurs across the distal extended margin. A very clear and consistent pattern of ENE oriented extension, that interacts 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 Argoland rifting and suggests that Greater India rifting may have played a more significant role in the development of the margin than hitherto recognized.