Oblique reactivation of inherited fabrics in rift basins: applications to the Northern Carnarvon Basin

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INTRODUCTION

The Northern Carnarvon Basin has experienced a long and complex history. Many of the hydrocarbon fields in Triassic reservoirs occur in fault blocks developed during Lower-Middle Jurassic and Lower Cretaceous rift events. Fault patterns clearly reveal the influence of older structures, most likely related to Carboniferous and Permian rifting, enabling contemporaneous stress patterns to be revealed.

SUMMARY

Rift basins are typically developed on heterogeneous continental crust. Inherited basement fabrics exert a fundamental control rift basin geometry, and on the geometry of individual faults. Many rift basins are also the result of multiple rift episodes and early formed structures will exert further control on the way in which faults evolve in subsequent rift events.

Inherited fabrics and fault reactivation are often invoked to explain rift orientation and segmentation, often with little independent evidence for their existence. However, analogue models of orthogonal and oblique rifts show that predictable fault patterns result from the partitioning of stress between pre-existing structures and superimposed extension directions.

The Northern Carnarvon Basin provides an ideal laboratory in which to test these models. High resolution 3D seismic data allows detailed imaging of fault patterns developed during separate Lower-Middle Jurassic and Lower Cretaceous rift events. Fault patterns clearly reveal the influence of older structures, most likely related to Carboniferous and Permian rifting, enabling contemporaneous stress patterns to be revealed.

Key words: extensional faults, rift basins, Northern Carnarvon Basin

EXTENSIONAL FAULT PATTERNS ON THE EXMOUTH PLATEAU

The Glencoe 3D seismic survey on the Exmouth Plateau reveals fault patterns within the Mungaroo Formation that are typical of many parts of the area (Figure 2). Planar domino style faults trend NE-SW forming a series of titled fault blocks, but the faults are strongly segmented, forming back-to-back half graben and offset depocentres that in some places define en-echelon NE to ENE trending arrays. The tips of the main extensional faults rotate to a more N-S orientation, forming relay structures between offset faults. Smaller scale faults are also arranged in NE-SW trending en-echelon arrays between the main half-graben bounding faults. Subsidiary, slightly curved, E-W trending faults in the southern part of the survey
area define a loosely concentric pattern and may be related to the emplacement of igneous intrusions.

**INTERPRETATIONS**

Analogue modelling of oblique rifts show that rift border faults typically initiate parallel to underlying oblique structures, but as they propagate laterally their tips rotate to orientations that are at a high angle to the extension direction (McClay et al., 2005). This results in en-echelon fault arrays in which individual faults are also oriented at a high angle to the extension direction while the en-echelon arrays follow the trend of the underlying inherited fabric.

Using this template to the Glencoe 3D data set, the long straight NE-SW trending fault segments which have accumulated relatively large displacements are most likely oriented parallel to inherited structures, while their N-S trending tips have rotated to a high angle to E-W oriented Jurassic extension directions. Rotation of the tips of faults that are propagating towards one another results in the formation of back-to-back graben and offsetting of depocentres. Further evidence of obliquely oriented NE-SW trending fabrics is the en-echelon arrays of minor faults that also follow this trend.

**SUMMARY AND CONCLUSIONS**

There is clear evidence from the Glencoe 3D survey of oblique reactivation of NE-SW trending fabrics (most likely Permian or Carboniferous in age) under E-W extension during the Jurassic in the Exmouth Plateau. The resultant pattern of en-echelon depocentres mimics the arrangement of the Exmouth, Barrow and Dampier sub-basins further to the south. It is therefore likely that significant NE-SW trending structures underlie this area too and have left a significant impact on the most recent, and perhaps more superficial, rift.

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**REFERENCES**


![Figure 2. 3D image of extensional fault patterns in the Mungaroo Formation from the Glencoe 3D seismic survey](image-url)