FAULT PATTERNS DURING NORMAL AND OBLIQUE RIFTING AND THE INFLUENCE OF BASEMENT DISCONTINUITIES: APPLICATION TO MODELS FOR THE TECTONIC EVOLUTION OF THE PERTH BASIN, WESTERN AUSTRALIA

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ABSTRACT. Rift fault patterns are reviewed, and comparisons are made between the expected fault patterns associated with pure extension and transtension, and those found in the Perth Basin, Western Australia. The orientation of the faults in the Perth Basin can be attributed to reactivation of basement structures during sinistral transtension associated with NE-SE extension. A change to dextral transtension is suggested immediately prior to break-up in the Lower Cretaceous. Other features may be explained by permutations of maximum and intermediate stresses, leading to strike-slip movements on NNW striking faults, and basin inversion.

Introduction

In the formulation of tectonic models for the evolution of sedimentary basins, there often appears to be a lack of understanding of the geometry of faults expected in different deformation regimes. Whilst a great deal of emphasis is put on the interpretation of geological cross-sections (eg. in the understanding of detachment faults and the geometry of flower structures in transtensional or transpressional regimes), the pattern of faults in plan view is often rated to be of lesser importance, leading to the formulation of tectonic models which, when viewed in 3D, are incompatible with known deformation responses.

One basin where several models have been invoked to explain the structural evolution, but where discrepancies and contradictions with theoretical data remain, and where the role of basement structures in controlling faulting in the cover sequence has not been adequately investigated, is the Perth Basin of Western Australia. The N-S trending Perth Basin extends along the west coast of Western Australia adjacent to the Archaean Yilgarn Craton (Fig. 1). Previous workers have interpreted the Perth Basin as either a typical half-graben along a passive continental margin (Playford et al. 1976) or the product of dextral transtension (Marshall et al. 1989; Stein 1989; Middleton 1990).

Basin formation began in the Silurian and culminated in the Early Cretaceous with the separation of "Greater India" from Australia (Veevers et al. 1975; Powell et al. 1988). A detailed description of the broad geometry and depositional history of the Perth Basin is presented in Playford et al. (1976), and a summary is also given in Marshall et al. (1989). The eastern margin of the Perth Basin is marked by a narrow, 1000km long, generally N-S trending fault zone referred to as the "Darling Fault" along which up to 15 km of normal movement has been reported (Glickson & Lambert 1973; Playford et al. 1976).

High-grade Proterozoic gneisses of the N-S trending Darling Mobile Belt (Trendall & Peer...
1975; Fletcher et al. 1985; Harris 1987) underlie the Perth Basin. Basement outcrops in three fault-bounded blocks; the Northampton Block, Leeuwin Block and Mullingarra Inlier (Fig.1). Shear zones (in Archaean rocks) controlling the location of the Darling Fault crop out near the western margin of the Yilgarn Craton.

This paper reviews the two-dimensional geometry of faults in plan view expected during different styles of rifting, and considers also the features resulting from basement reactivation. The compatibility of fault patterns within the Perth Basin with these models, and the influences of basement structure on the localisation and orientation of faults, are then examined, leading to a re-evaluation of the broad tectonic evolution of the Perth Basin.