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Structural architecture of Australia's 4000 km-long southern rifted continental margin

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Many aspects of the evolution and overall architecture of the Australian southern rifted margin are consistent with current models for the development of non-volcanic rifted margins. However, several key features of the southern margin provide useful points of comparison with the Atlantic and Alpine Tethyan margins from which these models derive. These include the structure of the ocean-continent transition, and variations in timing and style of rifting along the length of the margin.

Australia's southern rifted continental margin extends for over 4000 km, from the structurally complex region south of the Naturaliste Plateau in the west, to the transform plate boundary adjacent to the South Tasman Rise in the east. The margin contains a series of Middle Jurassic to Cenozoic basins—the Bight, Otway, Sorell and Bass basins, and smaller depocentres on the South Tasman Rise. These basins, and the architecture of the margin, evolved through repeated episodes of extension and thermal subsidence leading up to, and following, the commencement of seafloor spreading between Australia and Antarctica. Break-up took place diachronously along the margin, commencing in the west at $\sim$83 Ma and concluding in the east at $\sim$ 34 Ma. In general, break-up was not accompanied by significant magmatism and the margin is classified as "non-volcanic" (or magma-poor).

Initial NW–SE ultra-slow to slow seafloor spreading (latest Santonian–Early Eocene), followed by N–S directed fast spreading (Middle Eocene-present), resulted in: (1) an E-W oriented obliquely- to normally-rifted marginal segment extending from the westernmost Bight Basin to the western Otway Basin; (2) an approximately N-S oriented transform continental margin in the east (western Tasmania–South Tasman Rise); and (3) a transitional zone between those end-members (central Otway–Sorell basins). This margin segmentation appears to have been strongly controlled by the pre-existing basement structure.

The oblique-normal rifted margin (zone 1), and the western part of the transitional margin segment (zone 3), are characterised by a broad region of lithospheric thinning and thick extensional basin development. In the Bight and Otway basins, a well-developed distal ocean-continent transition zone includes basement highs interpreted as exhumed sub-continental lithospheric mantle. In contrast to prevailing margin models, these highs occur within the inner part of the ocean-continent transition. Mapping of stratigraphic sequences within the basins provides some constraint on the processes that took place at the evolving margin. The timing of mantle exhumation is constrained by the relative age and stratal geometry (deformed sediments, growth strata and onlapping packages) of basin sequences adjacent to the exhumed blocks. In the eastern Bight Basin, mantle exhumation occurred in the Turonian–Santonian, and farther east in the Otway Basin, in the Campanian–Maastrichtian. This timing is consistent with break-up decreasing in age from west to east.

The orientation and segmentation of the western (zone 1) and transitional (zone 3) parts of the margin suggests that initial NW-SE oriented slow to ultra-slow spreading prior to $\sim$48 Ma is likely to have been accommodated by short, extension-parallel transform segments. Some of these have been identified on regional seismic profiles in the Bight and Otway basins through offset of continent-ocean boundary rift segments, and structural features typical of transform boundaries e.g. fault blocks with a geometry indicative of flexural uplift.

In the easternmost part of the margin (zone 2), where transcurrent stresses controlled deformation, lithospheric thinning is not as marked and the continent-ocean boundary is interpreted to comprise both rift and long transform elements. Here, NW–SE to NE–SW oriented extension resulted in the development of strongly transtensional basins. In the southern Sorell Basin and South Tasman Rise, the Tasman Fracture Zone forms the

continent–ocean boundary