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Terrane boundary reactivation and the influence of variable crustal strength on rift physiography – An example from the Median Batholith Zone in the Great South Basin, New Zealand

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The protracted amalgamation of crustal terranes along continental margins gives rise to crystalline basement which displays a range of physical and lithological properties and contains multiple suture zones and pre-existing structures. During subsequent phases of continental rifting, the presence of these heterogeneities and contrasting crustal properties can exert a fundamental influence over the geometry and physiography of incipient rift and fault systems.

Using borehole-constrained 2D and 3D seismic data we examine how a series of basement terranes, situated offshore of the South Island of New Zealand, influenced the development of the orthogonally oriented Great South Basin (GSB). The NE-trending GSB sits atop a series of WNW-trending basement terranes which initially formed along the southern margin of Gondwana. The basin experienced multiple phases of extension during the Jurassic-Cretaceous and Late Cretaceous, associated with the breakup of Gondwana and the separation of Australia, Antarctica and New Zealand respectively. Here, we examine the physiography of the GSB across a series of terranes including the Median Batholith Zone, a Carboniferous-Cretaceous magmatic arc terrane composed of numerous plutonic bodies.

The southern margin of the Median Batholith Zone is co-located with a large WNW-trending, SSW-dipping shear zone, which extends down to lower crustal depths. This shear zone shows evidence for later brittle reactivation, being associated with an anomalous WNW-trending rift-related fault, and forms the boundary between two rift segments of the GSB. We interpret this shear zone as the reactivated boundary between the Median Batholith to the north and the Western Province terranes to the south. A $\sim$12 km wide, WNW-trending block is present within the footwall of the shear zone. This block is relatively unfaulted across the top basement surface, compared to adjacent areas. Furthermore, NE-trending faults terminate and form a series of splays to the SW as they approach the area. A series of high amplitude, lenticular reflection packages are identified within crystalline basement beneath the area, which based on their geometry and location within the Median Batholith Zone, we interpret to represent a series of granitic bodies. Based on this interpretation, these bodies form a stronger area, inhibiting the nucleation and propagation of faults in the vicinity. A similar change in rift physiography is proposed between the northern margin of the Median Batholith Zone and the Murihiki and Brook Street terranes, although this is less well resolved in this area.

We show that crustal terranes can have a fundamental influence over multiple aspects of rift physiography. Areas of stronger material may inhibit the development and propagation of faults in certain areas relative to others. In addition, the boundaries between crustal terranes appear to represent fundamental crustal-scale weaknesses. These boundaries may initially be associated with crustal-scale shear zones, but may later be reactivated in a brittle manner during subsequent tectonic events, leading to the formation rift-related faults and rift segment boundaries at a high-angle to the main rift.