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Passive margin formation through continental extension: Constraining numerical modelling with geophysical data, a case study from the Browse Basin, northwest Australia.

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The formation and evolution of continental margins and its significance to hydrocarbon exploration is a major research theme in the geosciences. We present simulations of lithospheric extension and basin formation using the finite-element code Underworld (Moresi et al., 2003) to investigate the evolution of the hydrocarbon-prolific northwest Australian margin. The Browse Basin is one of four basins that form the margin, and is the result of multiple rifting phases since the Devonian. A ridge jump during the basin's rifting history was invoked by Robertson et al. (2008) to explain their gravity-derived stretching factors. Thinning of the crust causes replacement of weaker crustal rocks with stronger mantle lithologies, which increases the overall strength of that part of the lithosphere. Stretching then relocated to an adjacent weaker region of the lithosphere.

Simulations were run to test this concept, and to consider the length of time after the initial stretching period required for the lithosphere to strengthen. Also considered were effects that may counteract rift migration, such as the ability of crustal shear zones formed during initial rifting stages to localize strain. Models were run using parameters (e.g. crust thickness) consistent with seismic and gravity data.

As the basin formed on the Archaean/ Proterozoic Kimberley Craton, a high viscosity value was used for the mantle, giving a strong viscosity contrast between the lower crust and mantle. Preliminary modelling results indicate the conditions favour detachment/décollement formation. Faults initiated or imposed are rotated to much lower angles as extension proceeds, resembling décollements. The décollements become steep normal faults at the base of the upper crust, and resemble the 'concave downward' faults first described by Lavier and Manatschal (2006). The impact of strain rate and the influence of syn-rift sedimentation and erosion on the evolution of continental margin over a timescale of millions to hundreds of millions of years will be discussed.