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Mantle detachment faults and the break-up of cold continental lithosphere

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We use a novel numerical approach, which fully couples the energy, momentum and continuum equations, to investigate the physics of extension and break-up of cold continental lithosphere to form new ocean basins. Unlike hot continental systems, where flat-lying detachment faults are nucleated in the strong part of the upper crust, cold continental systems have flat-lying detachment faults nucleating in the strong upper mantle at a relatively early stage. Detachment faults then control the development of a mantle core complex and associated crustal structures. The observed structures are analogous to structures associated with mid-crustal core complexes developed during extension of relatively thick and hot continental crust. In the cold environment, however, a strong elastic core is developed within the mantle, shifting the stress-bearing part of the system to below the Moho. Our modelling results reproduce key tectonic elements of a natural system (the Iberia Margin) by stretching a randomly perturbed, unpatterned lithosphere. The results thus provide fundamental information on the physics underlying continental break-up.