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Numerical modelling of crustal and lithospheric structural inheritance influences on Mesozoic-Cenozoic rifting of the Davis Strait, offshore West Greenland

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The Mesozoic-Cenozoic separation of Greenland and North America produced the small oceanic basins of the Labrador Sea and Baffin Bay, which are connected via the Davis Strait, a region mostly comprised of continental lithosphere. The preservation of continental crust in this region, the overall large-scale 'dog-leg' geometry, widespread magmatism and normal faulting oblique to regional extension have all been attributed to the inheritance of structures from previous tectonic regimes. In particular structures formed during the Paleoproterozoic Nagssugtoqidian and Torngat orogenic belts in Greenland and Canada, respectively, are postulated by previous work to have been rejuvenated during later extension. Structural rejuvenation is proposed to have occurred due to structural discontinuities at the fault, crustal and lithospheric scale.

Our study uses numerical models to analyse the role of crustal and sub-crustal heterogeneities in generating deformation. Using the open-source geodynamics code ASPECT (Advanced Solver for Problems in Earth's ConvecTion), we implement 3D continental extension in the presence of mantle lithosphere suture zones and inherited crustal structures. We present a suite of models analysing: two-phase extension in both perpendicular and oblique directions; the role of suture zone geometry; and the importance of crustal inheritance. In particular, we investigate the respective roles of crust and mantle lithospheric scarring during an evolving stress regime in keeping with reconstructions of the Davis Strait. The modelling results indicate that, as hypothesised, the rejuvenation of pre-existing orogenic structures is capable of producing the observed phenomena in the Davis Strait. Mantle lithosphere heterogeneities are often overlooked as a generator of crustal-scale deformation. However, here we highlight the sub-crust as an avenue of further exploration in the understanding of rift system evolution particularly where oblique opening has occurred.