The role of inherited thermal and lithospheric heterogeneities in rifting and continental breakup

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Many Atlantic margins exhibit major along-strike variations in the rift geometries, crustal architectures and magmatic budgets associated with continental breakup (i.e. conjugate margins of South Africa/Argentina, Morocco/ Nova Scotia, Labrador/Greenland). Variations in these rift characteristics often seem to develop during the same rifting event and over short distances.

Recent work on the Labrador margin, for instance, suggests that the northern segment is characterized by a lack of synrift structures and a magma-rich breakup with seaward dipping reflections (SDR) documented in the continent-ocean transition domain (COT). In contrast, the southern segment shows major synrift structures that accommodated continental stretching, a wide hyperextended crustal domain, and a magma-poor breakup with a wide domain of exhumed serpentinized mantle in the COT. We attributed this contrasting evolution within the same oceanic basin to Archean–Proterozoic inheritance, which shaped the pre-Mesozoic lithospheric structure.

The initial lithospheric structure in the south was characterized by thicker crust and a hot depleted subcontinental mantle, whereas the north contained a thinner crust and a cooler primitive subcontinental mantle. This heterogeneous prerift structure occurred across two major Precambrian structural zones that can be traced onshore through the Canadian Shield and SW Greenland. We propose that southward thickening of the prerift crust likely produced a corresponding thickening of the ductile middle crust, which promoted delayed vertical coupling, hyperextension, and a wide domain of exhumed serpentinized mantle. In contrast, a significantly thinner ductile middle crust in the north may have led to the quick formation of lithosphericscale detachment faults that limited the amount of stretching, hyperextension and mantle exhumation and serpentinization.

Here, we will use thermo-mechanical modelling to investigate these hypotheses and examine the role of structural inheritance on rifting processes. Using constraints from the Labrador Sea, we specifically plan to examine the interplay between heat flow, radiogenic heat distribution, crust and lithosphere thickness, rheology and mantle composition during continental stretching and breakup.

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