

## Mesozoic rift-related exhumation along the Newfoundland margin recorded by low-temperature thermochronology

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### Summary

Tectonic models for the magma-poor Newfoundland margin predict discrete phases of lithospheric extension during the Mesozoic breakup of Pangea and opening of the Atlantic Ocean. The stepwise progression of these extensional phases resulted in margin-parallel architectural domains that were generated by lithospheric stretching and thinning (proximal and necking), hyperextension and mantle exhumation (distal), and breakup (outer and oceanic; Figure 1). Correspondingly, extensional deformation is predicted to progressively shift oceanward during Triassic to Cretaceous rift-margin development. Mesozoic brittle deformation resulting from extensional processes is evident throughout the Newfoundland margin, including offshore syn-rift basins targeted for petroleum development. However, there has yet to be regional studies that quantify the spatial patterns and rates of rift-related exhumation along the Newfoundland margin. We used low-temperature thermochronology to constrain the timing, rates, and spatial distribution of bedrock exhumation in the eastern Newfoundland Appalachians and offshore regions to evaluate how upper-crustal deformation was accommodated during Mesozoic rift evolution.

### Method

New low-temperature thermochronology data comprising zircon and apatite fission-track and (U-Th)/He (ZFT, AFT, ZHe, and AHe) analyses on bedrock samples from onshore Newfoundland were integrated with published detrital ZFT and U-Pb results from the offshore Jeanne d'Arc basin (Grand Banks). Each onshore bedrock sample was analyzed with a combination of two to three thermochronological systems. Inverse thermal history modelling was used to characterize the timing and rates of cooling and inferred exhumation from ~300°C to ~50°C. Detrital zircon FT and U-Pb double-dating studies in the Hibernia and Hebron oil field areas were used to identify exhumation- versus magmatic-cooled grain components and characterize sediment sources for Lower Cretaceous strata in the Jeanne d'Arc basin.

### Results and Conclusions

Inverse thermal modelling results for onshore bedrock samples show accelerated, late Permian to Jurassic cooling that corroborate the timing of lithospheric stretching phases and require Mesozoic brittle deformation in Newfoundland (Figure 1). The highest rates of exhumation are observed along a mid-Paleozoic suture and suggests that inherited structures accommodated some Mesozoic extension. Onshore rocks yield slow cooling rates during the Early Cretaceous and indicate that deformation propagated oceanward during the onset of thinning and hyperextension. Early Cretaceous ZFT exhumation-related cooling populations from offshore strata confirm that rift-related exhumation continued in the Grand Banks region during hyperextension and mantle exhumation (Figure 1). Extensional deformation generally propagated oceanward as predicted by rift margin development models, but the distribution was complicated by inherited structures and more widespread than anticipated. Tectonic processes are a first-order control on clastic deposition in syn-rift basins and quantitative timing constraints on rift processes will be informative to the energy sector's development in offshore Newfoundland.

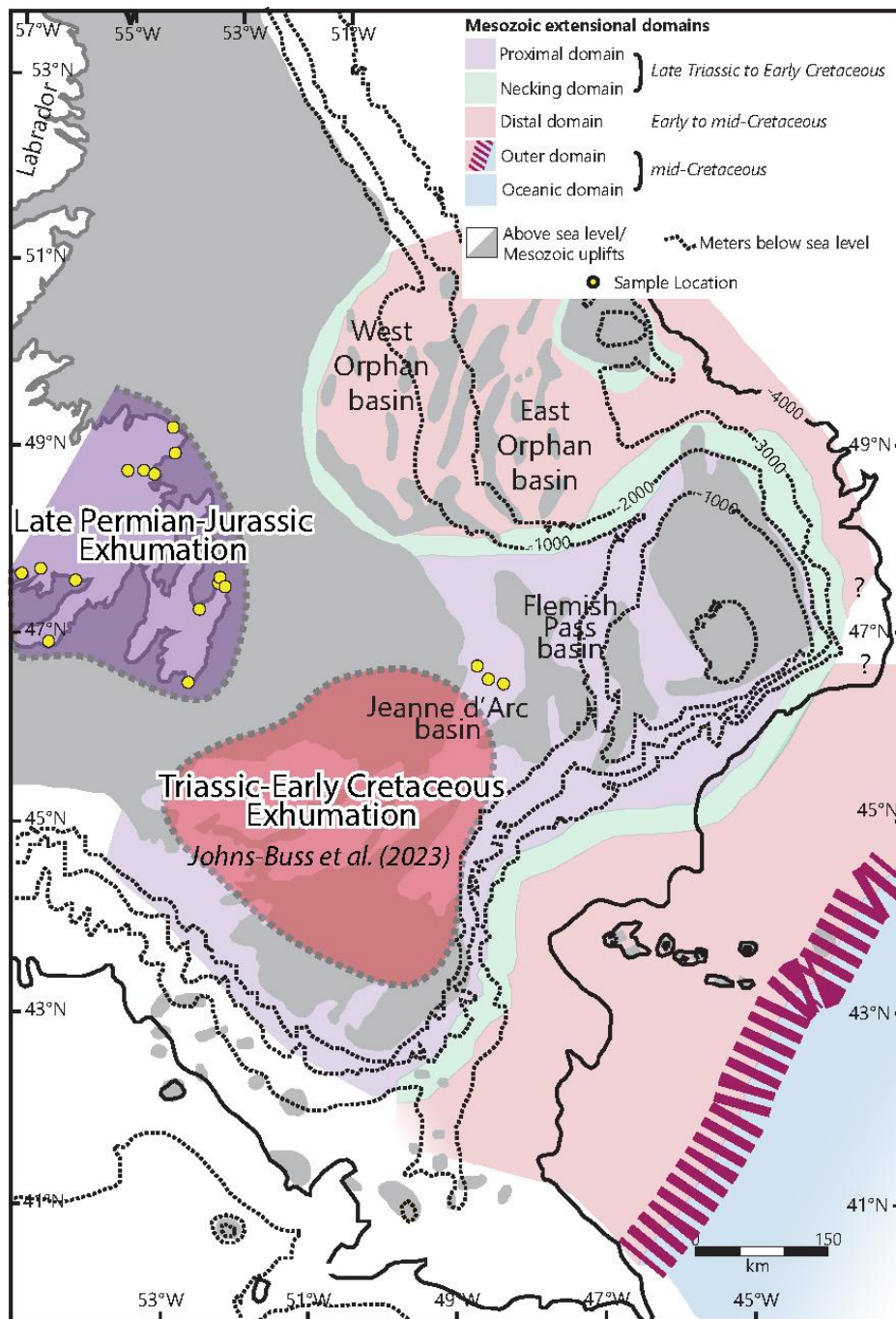


Figure 1: Spatial distribution of Mesozoic rift-related exhumation constrained by thermochronological studies from onshore Newfoundland bedrock (this study) and offshore detrital ZFT-U-Pb (Johns-Buss et al., 2023). Locations of Mesozoic architectural elements and bathymetry of the Newfoundland margin after Grant and McAlpine (1990), Bell and Howie (1990), Péron-Pinvidic et al. (2013), Welford et al., (2010), and Sandoval et al. (2019).

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