The influence of accretionary orogenesis on rift dynamics

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The Wilson Cycle of closing and opening of oceans is often schematically portrayed with ‘empty’ oceanic basins. However, bathymetric and geophysical observations outline anomalous topographic features, such as microcontinents and oceanic plateaus, that can be accreted when oceans close in subduction. This implies that numerous rifted margins have formed in regions characterized by the presence of previously accreted continental terranes. The main factors controlling where and how such continental rifts localize in relation to the inherited compressional structures is yet to be explored properly. Potential factors that can influence the evolution and structural style of a rift in such a tectonic setting include the thermo-tectonic age of the accretionary orogen, the number and type (size, rheology) of accreted terranes, the nature of terrane boundaries, as well as the velocity of rifting.

We use 2D finite-element thermo-mechanical models to investigate how the number and size of accreted terranes as well as the duration of tectonic quiescence between orogenesis and extension (i.e., the amount of time available for the thermal re-equilibration of the thickened lithosphere) affect the style of continental rifting. Our results can further understanding of how rifted margins formed after accretionary orogenesis are influenced by the compressional stage such as the Norwegian rifted margin, where the late-Paleozoic to Mesozoic rifting occurred after the early Paleozoic Caledonian orogeny.

We test two hypotheses. According to our first hypothesis, the location of the rift is dependent on the age of the accretion. If extension directly follows accretion, we expect the thick lithosphere of the orogen to be strong in a brittle sense, causing extension to localize adjacent to the orogen. In contrast, if the onset of extension happens after a period of tectonic quiescence, the accretionary orogen has time to heat up and viscously weaken, allowing it to localize deformation more efficiently. We test this hypothesis by varying the amount of time available for thermal re-equilibration.

Secondly, we hypothesize that the degree to which the compressional structures such as terrane boundaries in the accretionary stack reactivate depends on the size and complexity of the accreted assembly (through the number and size of the accreted terrains) as well as the strength of shear zones. We test this hypothesis by varying the number of terranes accreted prior to rifting.

Our preliminary results show that the subduction interface is reactivated in an extensional regime,
but without a period of quiescence the reactivation is temporary and rifting occurs in the unthickened foreland basin area.