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Crustal thinning and tectonic geomorphology: redefining the passive margin

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We describe Scandinavia's passive margin in terms of a hyper-extended distal margin, a variably tapered proximal margin that includes the outer onshore areas, and an upwarped, unstretched, continent-sloping hinterland that terminates against the "undeformed" cratonic interior. Two benchmark locations, defined as the taper break (TB) and the Hinterland Break in Slope (HBSL), occur at the inner boundary of the distal margin and at the transition from the continent-sloping hinterland and craton, respectively. The elevation of the seaward-facing escarpment is directly scaled to the distance between the taper break and the Hinterland Break in Slope. Scaling relationships between the taper of the crystalline crust in the direction of the distal margin and the length/dip of the hinterland backslope follow directly. The shape factors of major catchments are directly scaled to the taper of the proximal margin and drainage azimuths are parallel to the mean transport lineation recorded from a distinct population of range-bounding normal faults. Topographic expressions of the footwalls and offsets in apatite fission-track age-patterns indicate that fault movement controlled topography, locally and regionally inboard of sharp crustal tapers long after the main phase of crustal thinning.

We extend our definition of the passive margin to other post-breakup margins. One particularly fine example is SE Brasil. New data (Zalan et al., 2011) suggest the direct correlation of SE Brasil's Taper Break with its escarpment elevation in a manner consistent with our Scandinavian and global observations. The Taper Hypothesis appears to hold across old and young, glaciated, and unglaciated margins. Following the stretching, thinning, and exhumation phase, an "accommodation phase" is warranted. During accommodation, the initially elevated escarpments can be eroded to very low base levels and subsequently undergo inboard rejuvenation by footwall uplift, in response to tensile stresses engendered by isostatically-induced flexure. Fault reactivation in the inner proximal margin may contribute to stabilize the location of the escarpment over time at sharply tapering margins. In this model the principal driver behind accomodation is the shifting of loads that commenced during the main phases of rifting and that has continued to present day.