East Greenland: A Classic Example of an Elevated, Passive Continental Margin Shaped Long after Rifting and Breakup*

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Abstract

The Atlantic margin of East Greenland shares the characteristics of many elevated, passive continental margins around the world: Elevated plateaux (large-scale, low-relief and high-level landscapes) at 2 km or more above sea level (a.s.l.) cut by deeply incised valleys, Mesozoic-Cenozoic rift systems parallel to the coast, and a transition from continental to oceanic crust farther offshore. Other examples of such margins are found in SE Australia, Brazil, and Norway.

Breakup of the North Atlantic occurred at the Palaeocene-Eocene transition. The geological record in the Kangerlussuaq-Blosseville Kyst area (68-70°N) in SE Greenland shows that the area underwent short-lived uplift immediately prior to breakup followed by km-scale subsidence during the eruption of basalts, with no evidence for crustal upwarping at this time. The earliest basalts erupted partly in a marine environment, and there are marine incursions in the uppermost of the flood basalts. These Palaeogene lavas make-up Gunbjørn Fjeld which is the highest summit in Greenland (3.7 km a.s.l.), and the present topography is thus the result of post-rift uplift.

We have mapped the plateaux surfaces over a wide area in SE Greenland and find that they are erosion surfaces that truncate both Palaeogene basalts and older rocks. Consequently, these surfaces (or peneplains) are post-basalt in age, and we suggest that they formed by fluvial erosion towards the base level of the adjacent sea during the opening of the North Atlantic. The present topography thus formed in two steps: first by erosion to form a peneplain near sea level and second by uplift to form a high plateau. The present topography has developed by incision of this high plateau, initially by rivers and later by glaciers below the uplifted peneplain.

Many apatite fission-track (AFT) studies have been published from East Greenland, and we present new results from 100 samples from the
Kangerlussuaq area. Both published and new AFT data reveal that regional, Cenozoic cooling of the margin started at the Eocene-Oligocene transition. Post-rift subsidence and burial of the margin therefore lasted for about 20 Myr until uplift of the margin at the Eocene-Oligocene transition (c. 35 Ma). Uplift and erosion at this time affected margins around the North Atlantic, and because it also correlates in time with a major plate reorganisation in the region, we suggest that it was related to plate-tectonic forces. Because the regional cooling starting at 35 Ma coincides in space with the post-basalt pen plain, we find that the peneplain along the margin was the end-result of this episode of uplift and erosion. The new AFT data from SE Greenland also show that the peneplain was uplifted to its present elevation in the late Neogene, and thus that the shaping of the present topography began several tens of millions of years after breakup.

Selected Bibliography


East Greenland: A classic example of an elevated, passive continental margin shaped long after rifting and breakup

Mountain building and Ice-Sheet Stability in Greenland (Miss Green), 2008 - 2011

The mountains in East Greenland are not the erosional remains of a former orogen. The mountainous terrain and beyond the Cathedrals and cliffs contain rocks formed from the Caledonian to the Precambrian.

East Greenland – a typical elevated, passive continental margin:
- Buried elevations at 3 km or more a.s.l. that are not yet fully eroded away.
- Mesozoic-Cenozoic rift systems parallel to the coast.
- A transition from continental to oceanic crust further offshore.

Other examples of such margins are found in SE Asia, Brazil and Norway.

Regional peneplain formed after uplift event at 35 Ma:
- Published and new apatite fission-track data from East Greenland.
- Post-rift subsidence and burial of the margin therefore lasted c. 35 Myr. From breakup to c. 15 Ma.
- Regional cooling of the margin started at the Eocene-Oligocene transition, c. 35 Ma.
- The post-breakup peneplain along the margin was the expression of the episode of uplift and erosion.

The shaping of the present topography began several tens of millions of years after breakup by erosion of the highest summit in Greenland.

The peneplain was uplifted to its present elevation after 15 Ma.
- New apatite fission-track analysis (AFTA) data from East Greenland show:
- Post-breakup peneplains for rocks now at sea level were 10-40°C at 15 Ma due to late-stage burial.
- The post-breakup peneplain and the present-day glaciers were uplifted to their present elevation in the Late Miocene, after 15 Ma.

The shaping of the present topography began several tens of millions of years after breakup by erosion of the highest summit in Greenland.

The present topography formed in two main steps:
- First by erosion to form a peneplain near sea level.
- Second, by uplift to form a high plateau.

The uplift of the plateau took place in two phases.

Present topography:
- First episode of post-rift uplift:
  - The peneplain is younger than the Palaeogene basalts.
  - Regional cooling of the margin started before c. 35 Ma.

- Second episode of uplift to form a high plateau:
  - The peneplain was uplifted to its present elevation after 15 Ma.

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