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Formation, uplift and dissection of planation surfaces at passive continental margins

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Many current models of the development of elevated passive continental margins assume that they are either the remains of foot-wall uplift at the time of rifting or due to underplating by magma from a plume or other mantle source. We have studied the rift and post-rift history of such a passive margin in West and South Greenland and have concluded that the present-day elevations developed 50-60 million years after cessation of rifting and local volcanism, suggesting that additional factors need to be considered when modelling such margins.

The morphology of West Greenland is similar to that of many other elevated passive margins. There are high-level, large-scale, low relief landscapes (planation surfaces) at altitudes of 1-2 km cut by deeply incised valleys. In places, the summit areas are separated from an adjacent younger coastal plain by a pronounced escarpment.

We combined analysis of the morphology of the landscape with studies of fission tracks and the stratigraphic record both on- and off-shore. Rifting and the commencement of sea-floor spreading in the Early Paleogene were accompanied by voluminous high-temperature volcanism. The exposed stratigraphy shows that kilometre-scale uplift at the time of rifting was followed shortly afterwards by kilometre-scale subsidence and fission track data suggest that the proximal margin of the rift may then have been transgressed by marine sediments

Maximum burial was at the Eocene–Oligocene transition, after which the area was uplifted and eroded. The present highest-level plateau is the remains of a surface that was formed by denudation to near sea level during the Oligocene–Miocene. This planation surface was uplifted to its present-day altitudes of up to 2 km and offset along reactivated faults during two phases of uplift in the late Neogene. Each phase of uplift resulted in incision of rivers to base level at the time, dissecting the summit surface. The fluvial valleys formed during the first phase are now preserved at altiitudes up to a km above sea level and some of them were further enlarged and deepened by glaciers during the Late Cenozoic.

Similar elevated margins exist all around the northern North Atlantic and in many other parts of the world; eastern North America, on both sides of the south Atlantic, western India, eastern Australia, and in Antarctica. Our results show that we cannot simply assume that these elevations were produced either at the time of rifting or as underplating at the time of plume impact. There is, however, no general agreement as to what caused them and we suggest that the history of these margins need to be re-assessed in the light of our results.