Early Paleogene rift-to-drift transition at the NE Atlantic – new insights from rift propagation and paired extension-compression

Po Wan Wong[a], Ivar Midtkandal[a], and Jan Inge Faleide[a]

[a]Department of Geosciences, University of Oslo, P.O. Box 1047, Blindern, N-0316 Oslo, Norway

Abstract

The breakup at the northeast Atlantic at ca. 54 Ma has long been considered a direct result of the Paleocene continental rifting (Faleide et al. 2008, Gernigon et al. 2020). This notion, however, poses a question on how the northeastern tip of the rift accommodated tensile strain prior to the formation of the sheared margin (Senja Fracture Zone, or SFZ). Our recent study (Wong et al. 2023) indicates that the Paleocene continental rift propagated northeastward – a scenario does not require a long-living, regional-scale transform fault between Greenland and Eurasia.

Our detailed reconstruction of the tectono-magmatic elements of the Paleocene rift shows trends of propagation comparable to analogue model results (Schmid et al. 2022) – along-axis development of magmatism, and migration of tectonic faulting inward and towards its tip (a horst-and-graben system, or H&G) at the SW Barents Sea. Being truncated by the SFZ, the H&G is of pre-breakup origin and is abutted by a coeval V-shaped anticline (VA) bounding the Tromsø Basin. Together, the H&G and the VA represent a paired extension-compression (PEC) of rotational kinematics (Hey et al. 1980, Martin 1984) and signify forward projection of the rift's rotational driving force during the termination of the propagation.

Overall, the early Paleogene evolution of the NE Atlantic can be summarized by a 3-stage model. During rift initiation in early Paleocene (Stage 1), boundary faults started to develop along the Greenland-Norway shelves while magmatism dominated the Faroe-Shetland region (ca. 63 - 59 Ma). In late Paleocene and early Eocene (Stage 2; ca. 58 - 55 Ma), the rift propagated northeastward and was eventually stalled by an elevated mafic-ultramafic body at the Barents shelf (Fichler and Pastore 2022). With its pivot of rotation fixed, the rift's rotational kinematics started to create PEC structures (the H&G and the VA) and dissipated the along-strike force component during this process. The sudden domination of the axis-perpendicular component then drove orthogonal extension, which promoted breakup and the development of sheared margin (Stage 3, ca. 54 Ma), as exemplified by the strong parallelism of the C24n.3n chrons at the two ends of the Norwegian-Greenland Sea (Gaina et al. 2017).

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