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From conjugate volcanic rifted margins to micro-continent formation: Double breakup development of the Norwegian-Greenland Sea

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We re-evaluate the structure and spreading evolution of the Norwegian-Greenland Sea and surrounding volcanic (rifted) margins based on new high-resolution aeromagnetic surveys. The new dataset combined with long-offset seismic and gravity data allow us to have a better understanding of the structure and evolution of the conjugate margin systems in the Norwegian-Greenland Sea from the rifting to the drifting stage. We particularly focus on the new JAS-12 aeromagnetic survey acquired between the Aegir Ridge and the Jan Mayen micro-continent, which was initially part of the Møre-Vøring-Greenland rift system. Combined with the previous NB-07 and JAS-05 surveys, our final compilation fully covers the continent-ocean transition and the whole oceanic spreading system from the Møre margin to the conjugate Jan Mayen micro-continent with high quality, high-resolution and reliable magnetic data.

The new dataset allowed a new, consistent and precise interpretation of the magnetic polarity chrons and oceanic fractures, providing the basis for more accurate rotation poles estimation, and better basin and crustal reconstructions between Norway, Greenland and the Jan Mayen micro-continent. This dataset allowed us to clarify the pre- and post-breakup configurations of the rift system and discuss the mechanisms involved during the onset of the two phases of breakup leading to the micro-continent formation. Our observations and models suggest that the pre-breakup rift system evolved through a significant Late Jurassic-Cretaceous thinning phase. This episode led to a significant thinning of the continental crust and an exhumation of pre-existing lower crust. However, we have not been able to identify and/or validate any clear domains of exhumed and denudated serpentinised mantle. The first Eocene breakup is mostly characterised by severe magmatism (sill, SDRS). Lithospheric/asthenospheric processes leading to rift localisation do not necessarily represent a continuum of lithospheric deformation with the precedent thinning system. Diking and disconnected lithospheric plumbing are proposed to explain the Eocene breakup.

After the first phase of continental breakup, two major phases of spreading influenced the Norwegian–Greenland Sea. Phase I (from C24 to C21r, $\sim$54 to 49 Ma) marks the earliest phase of spreading, probably initiated in the central and outer part of the Møre Basin. During this period, the formation of overlapping systems and pseudo-fault development, indirectly influenced by the proto-margin segmentation, suggests the presence of additional micro-plates in the Norwegian-Greenland Sea. We also observed a significant change in the oceanic spreading system in the late Early Eocene. Based on observations from the surrounding areas, this supports a major and distinct tectonic and magmatic event in the Norwegian-Greenland Sea at around C21r (49-47.9 Ma), the beginning of a second phase. During Phase II, from C21r-C12 or possibly younger (48-<32 Ma) of the Norway Basin development, spreading rates decreased, spreading direction changed leading to the formation of unexpected N-S oriented oceanic fracture zones. Phase II probably coincides with the climax of extension and possibly local spreading that is suspected in the southern part of the Jan Mayen micro-continent forming a complex area of oceanic, transitional and continental fragments before its complete dislocation from East Greenland in Latest Oligocene.