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A basin-to-plate deformable plate framework to capture the multi-phase rifting of the Northeast Atlantic

Grace E. Shephard[1,6], Mansour M. Abdelmalak[2], Jan Inge Faleide[2], Edward Clennett[3], Sebastien Gac[2], Sabin Zahirovic[4], Peter Haas[5], Carmen Gaina[1], and Trond H. Torsvik[1,7]

[1]Centre for Planetary Habitability, Department of Geosciences, University of Oslo, Oslo, Norway (g.e.shephard@geo.uio.no)
[2]Department of Geosciences, University of Oslo, Oslo, Norway
[3]Department of Earth and Planetary Sciences, Jackson School of Geosciences, The University of Texas at Austin, Austin, USA
[4]School of Geosciences, University of Sydney, Sydney, Australia.
[5]GEOMAR Helmholtz Institute for Ocean Research, Dynamics of the Ocean Floor, Kiel, Germany
[6]Research School of Earth Sciences, Australian National University, Canberra, Australia
[7]School of Geosciences, University of Witwatersrand, Johannesburg, South Africa.

The Northeast Atlantic is a key region where advances in plate tectonics have been developed, tested, and refined. Final breakup and the onset of seafloor spreading started around magnetic Chron C24n (~55 Ma; earliest Eocene). However, prior to breakup, the Northeast Atlantic's margins underwent at least four discrete phases of lithospheric-scale rifting and basin formation, extending back to mid-Permian times (ca. 264 Ma) following the Caledonian orogeny. The total amounts of extension are in the order of several hundred kilometers and therefore relevant to implement in regional and global plate tectonic reconstructions. Recently, deformable plate models using the GPlates software have emerged as a tool to capture such non-rigid domains. However, deformable models to-date have been largely constructed in an overall rigid plate framework, applying pre-existing Euler rotations from the surrounding plates to the intervening rift. Here we detail why, and how, a basin-to-plate scale approach should be considered in future regional and global refinements of deforming reconstructions, using the multi-phase Northeast Atlantic rifting as a focus site.

We place basin-scale observations based on extensive seismic, stratigraphic and geophysical interpretations for the Norwegian margin and its Greenland conjugate (Abdelmalak et al. 2023) into new digital plate tectonic model (Shephard et al., in review). Central to our methodology is identification and restoration of rift basin hinges, and accounting for their along-margin variability. In this presentation we will detail the timing, location, amount and direction of extension across four discrete rift phases and their associated time-dependent rotations. A conjugate profile from the Foster and Northern Vøring margins (totalling 282 km of extension at average rates ranging between 0.13-0.58 cm/yr during rifting) yields the best fit accounting for along-margin heterogeneity whilst retaining the overall rigid framework requirements. We compare our results to previous regional models, including Barnett-Moore et al. (2018) and Müller et al (2019), and showcase some of the GPlates scalar field functionality including crustal

stretching and tectonic subsidence. Finally, we have also developed an external routine for a backward-restored crustal thickness workflow which successively restores present-day thickness in conjunction with our deformable model.