Pre-Variscan back-arc extension of Avalonia: The genesis of the Southern North Sea Basin

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The Devonian-Early Carboniferous was a period of intense rifting in the Avalonia microplate in between the Caledonian and the Hercynian-Alleghanian collision phases. This rifting phase created the typical horst-and-graben structure of much of East Avalonia's crust that is best known from the UK and Ireland where the horsts and the graben infill are located at or near the surface. In the Southern North Sea, the Netherlands and northwest Germany, the Late Devonian-Early Carboniferous rift structure and units are obliterated by the thick cover of Late Carboniferous-to-Recent basin fill and by the recurrent fault reactivation. Although this rifting created the basis for 350 Ma of lithospheric memory, its dynamics remains relatively unknown. Major open questions include the mode and total amount of extension as well as the age and origin of the Central Graben and the relation between structures located east and west of it.

This study addresses these issues by integrating existing data from lithosphere to basin scales and a map-view restoration. We have revised the crustal map of the Thor Suture Zone. The newly defined northern margin of Avalonia and the Thor Suture Zone are key elements in the reconstruction of Devonian-Carboniferous rifting of Avalonian lithosphere. We present a revised map of Devonian-Carboniferous basin structures including the main horsts and grabens and the governing faults east of the Central Graben.

Based on these maps, we present a new paleotectonic reconstruction and a novel geodynamic scenario for the Devonian-Carboniferous rifting. These findings are key for better understanding of long-lived tectonic compartmentalisation and post-rifting deformation phases.