The Jurassic-Cretaceous North Sea Rift Dome and Associated Basin Evolution*

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Abstract

The Middle-Late Jurassic North Sea Rift Dome was established by recognition of the near base Middle Jurassic erosional unconformity in the central North Sea. The distribution and range of the overlying hiatus illustrates the gross outline and duration of the exposed dome. The presence of Upper Jurassic deposits both in the central rifts and in the marginal troughs in the Sole Pit Basin and along the Tornquist Zone documents that the dome continued across the entire North Sea Basin. In addition, thick Lower Jurassic Series preserved beyond the erosional hiatus along the dome margins, suggests that the dome may have been initiated already in the Early Jurassic. The dome raised above sea level during the Middle Jurassic, and deflation of the dome associated with rifting took place during the Late Jurassic. Lower Cretaceous sequences onlap the Central Graben footwall blocks, and this relationship has been interpreted to illustrate that post-rift basin infilling was initiated in the Cretaceous. However, regional isopach maps illustrates that the Jurassic rift system down through the Viking Graben-Central Graben was continued in the Cretaceous. In addition, the marginal basins down the dome flanks indicates that the Jurassic dome continued through the Cretaceous across the entire North Sea Basin between the Sole Pit Basin to the west and the Egersund Basin and the Norwegian-Danish Basin to the east; the sea level was high, and the dome remained below sea level. Post-rift subsidence was not attained until the Tertiary as documented by Cenozoic basin subsidence centered above the central North Sea rifts.

Summary

The Middle-Late Jurassic North Sea Rift Dome was established through the recognition of the near base Middle Jurassic erosional unconformity (Figures 1 and 2) (Ziegler 1990; Underhill and Partington, 1993). The distribution and range of the overlying hiatus illustrate the gross outline and duration of the dome exposed above sea level. The dome is irregular and is interpreted to have formed by southward-migrating dome centers (Graversen 2002). The previously described Middle-Late Jurassic “central” North Sea Rift Dome only documents the emergent and eroded ”stratigraphic” dome (Figure 1) (Ziegler 1990; Underhill and Partington 1993). The presence of Upper Jurassic deposits both in the central rifts and in the marginal troughs beyond the erosional hiatus documents that the dome continued across the entire North Sea Basin. In addition, thick Lower Jurassic Series preserved along the dome margins in the Sole Pit Basin and along the Tornquist Zone suggests that the dome may have already been initiated in the Early Jurassic (Figures 1 and 2). The dome raised above sea level during the Middle Jurassic, and early deflation of the dome associated with rifting took place during the Late Jurassic. Cretaceous sequences onlap the Central Graben footwall blocks, and this relationship has been interpreted to illustrate that post-rift basin infilling was initiated in the Cretaceous. However, structural analysis based on regional isopach maps indicates that the Jurassic rift system down through the Viking Graben - Central Graben continued to develop in the Cretaceous (Figure 3). In addition, increased thicknesses down the dome flanks indicate that the Jurassic dome continued to grow during the Cretaceous across the entire North Sea Basin between the Sole Pit Basin to the west and the Egersund Basin and the Norwegian-Danish Basin to the east. The Cretaceous dome was not eroded as the sea level was high, and the dome remained below sea level (Figure 1). Post-rift subsidence was not initiated until the Tertiary, documented by the Cenozoic basin centered above the central North Sea rifts (Figure 4).

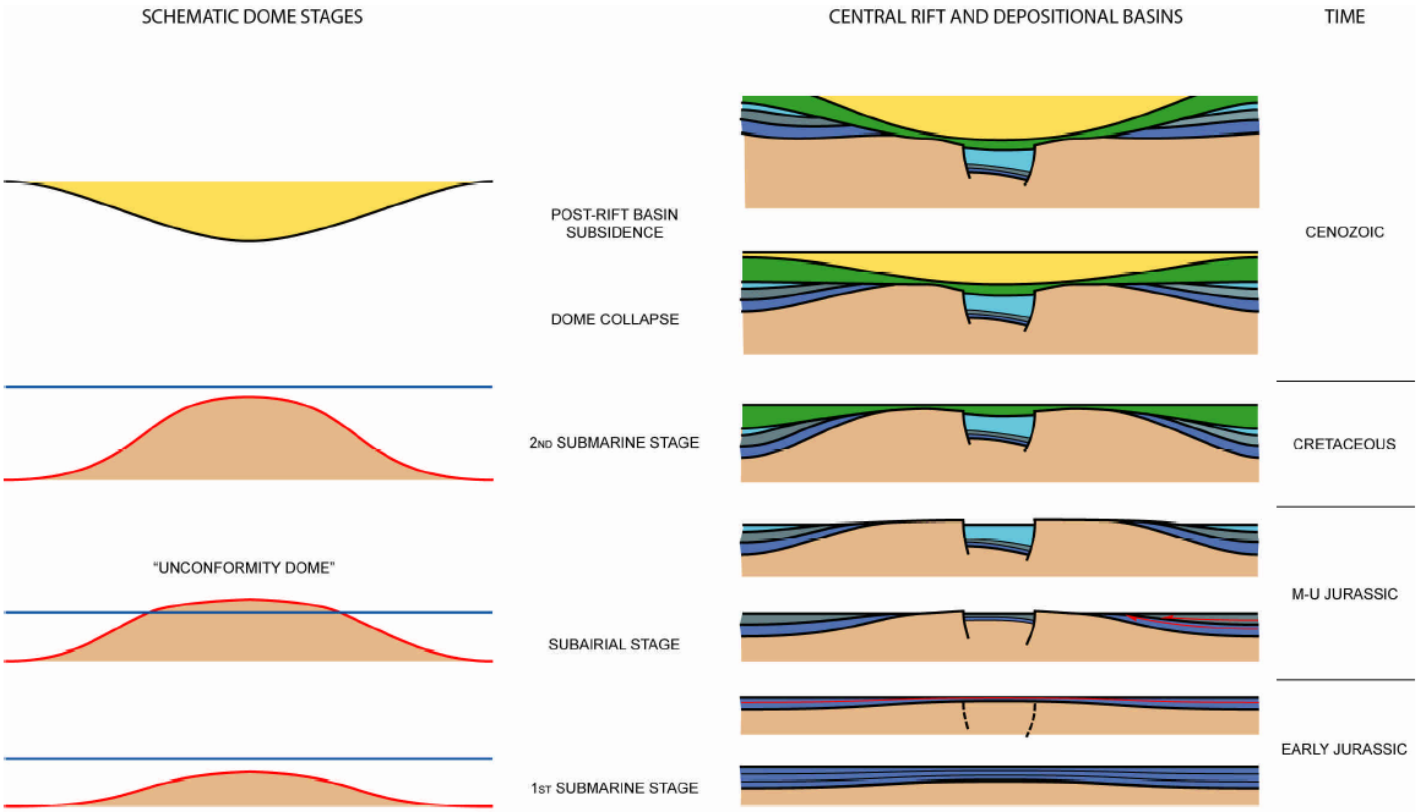

Figure 1. Schematic dome stages (left) and depositional syn-rift and down-flank basins associated with the rising dome during the Jurassic and the Cretaceous (right). The Cenozoic post-rift basin was deposited on top of the collapsed dome.

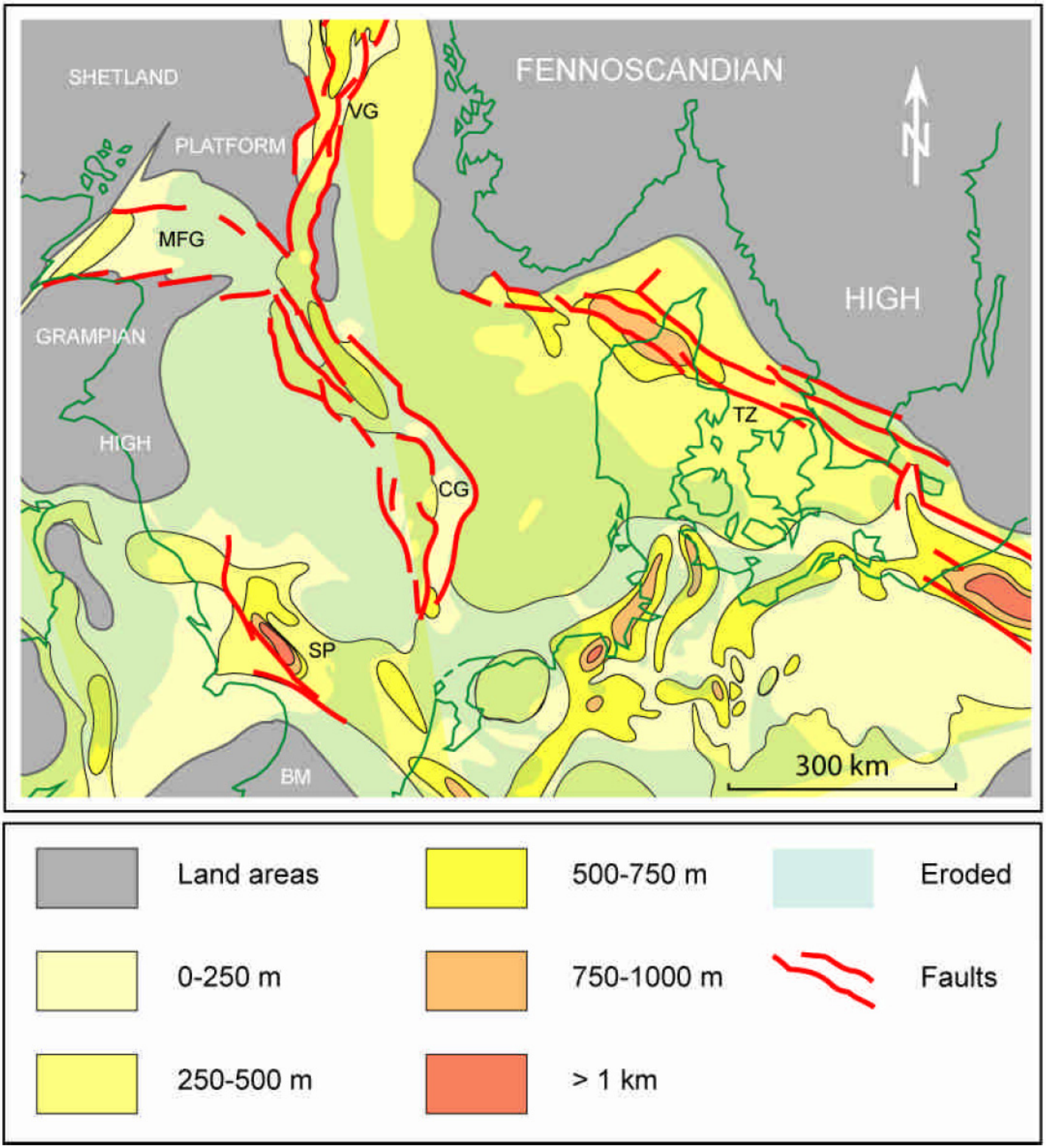

Figure 2. Restored isopach map of the Lower Jurassic. The eroded area illustrates the irregular pattern of the Middle and Late Jurassic composite dome. Redrawn from Ziegler (1990). VG: Viking Graben; CG: Central Graben; MFG: Moray Firth Graben; SP: Sole Pit Basin; TZ: Tornquist Zone.

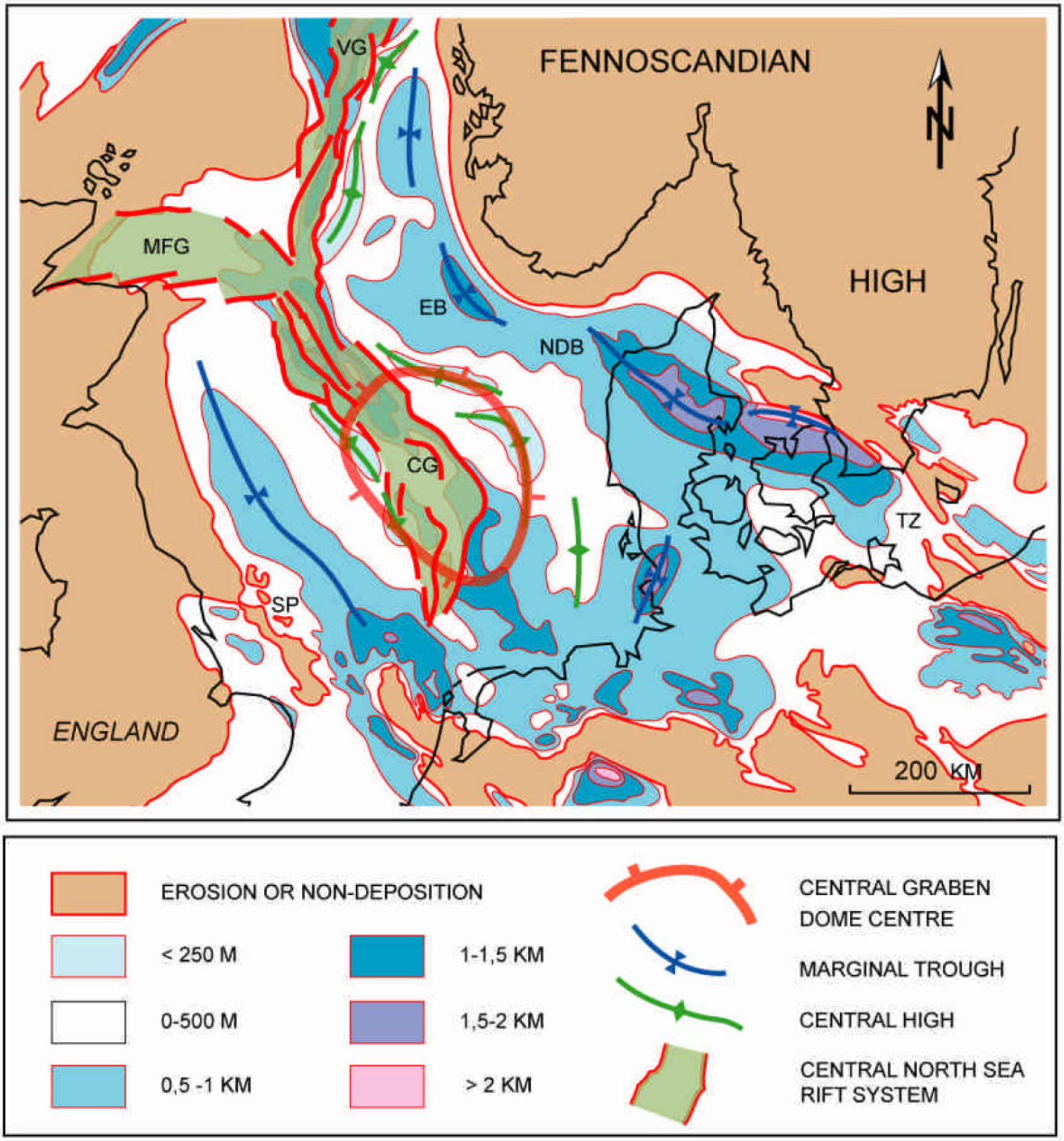

Figure 3. Upper Cretaceous isopach map of the North Sea (redrawn from Ziegler, 1990). The Late Cretaceous dome is illustrated by the thick deposits both in the central rift system and in the marginal troughs of the Norwegian-Danish Basin (NDB), along the Tornquist Zone (TZ) in the eastern North Sea, and in the Sole Pit (SP) area in southwestern North Sea. The rift shoulders along the southwest margin of the Central Graben (CG) are intact, while the apex of the dome to the east of the Central Graben has migrated towards the northeast. The Late Cretaceous dome has thus developed into an asymmetric structure. EB: Egersund Basin; VG: Viking Graben; MFG: Moray Firth Graben.

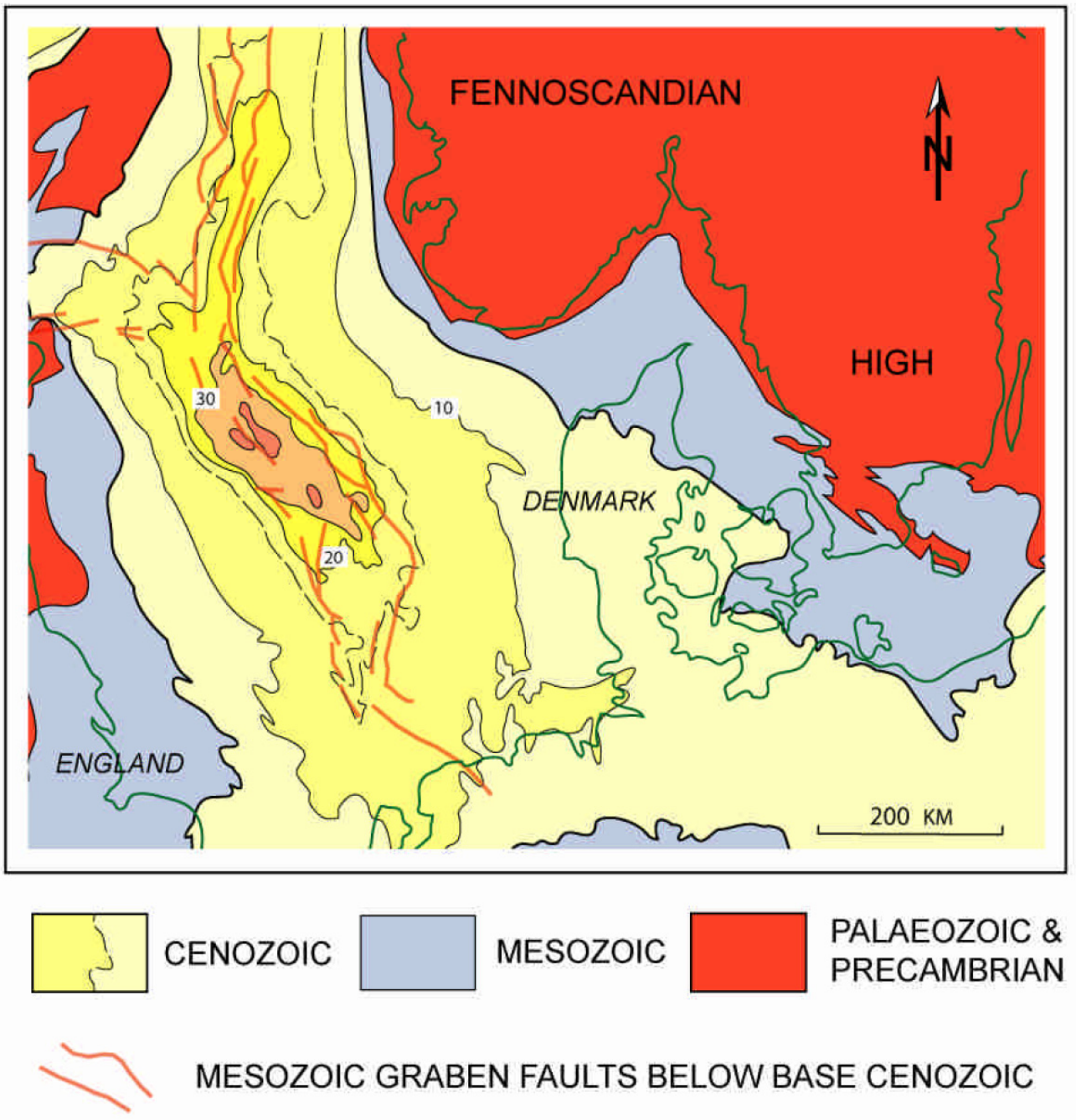

Figure 4. Geological map of the North Sea Basin; Cenozoic isopach contours redrawn from Ziegler (1990). The Mesozoic graben faults, illustrated at the base of the Cenozoic series, demonstrate that maximum Cenozoic subsidence occurred above the central rifts. This relationship establishes the Cenozoic basin as a post-rift basin that formed above the Jurassic-Cretaceous dome.

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