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Palynology and terrestrial ecosystem change of the Middle Triassic to lowermost Jurassic succession of the eastern Danish Basin

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ABSTRACT

The pre-Rhaetian Triassic succession in the Danish Basin is generally dominated by red bed deposits unsuitable for preservation of organic material. However, during the late Middle Triassic a temporary change to wetter conditions resulted in preservation of diverse palynofloral assemblages, dominated by corystospermous seed fern pollen of *Alisporites/Falcisporites* and characterized by high abundances of the conifer pollen *Protodiploxypinus gracilis*, as well as common to abundant lycophyte spores assigned to *Aratrisporites* spp. A mid-Ladinian to early Carnian (earliest Julian) age is inferred for this interval based on the presence of the probable gymnosperm pollen *Staurosaccites quadrifidus*, rare *Retisulcites perforatus* (of unknown affinity) and *Enzonalasporites vigens* of probably voltzialean affinity. No marine palynomorphs were recorded, only rare specimens of *Ovoidites* sp. and *Plaesiodictyon mosellanum*. Thus, together with previously recorded other fossils (a fish microfauna, an ostracod, plant remains and characeans) the recorded palynoflora indicates semi-arid conditions and deposition in a terrestrial to marginal fresh- or brackish water environment. After this, red bed deposition resumed in the area, and it is not until the mid-Rhaetian that well preserved and diverse palynofloras are again encountered in the succession. The Rhaetian palynofloras are significantly different to the Ladinian–early Carnian assemblages, being dominated by tree fern spores (*Deltoidospora* spp.), taxodiacean/cupressacean pollen (*Perinopollenites elatoides*), and the enigmatic gymnosperm pollen assigned to *Ricciisporites tuberculatus*. As much as 62% of the mid-Ladinian to Early Carnian spore-pollen taxa were not recorded in the Rhaetian, suggesting that major restructuring of the terrestrial ecosystem took place in this area during the Carnian and Norian. In comparison, 34% of the Rhaetian spore-pollen taxa recorded in this study, e.g. *R. tuberculatus*, *Polypodiisporites polymicroforatus*, *Limbosporites lundbladiae* and *Cingulizonates rhaeticus*, disappeared during the well-recognized end-Triassic event. The extinction interval is also characterized by a dramatic increase in the number of reworked palynomorphs, indicating erosion of the hinterland at this time. There is a marked drop in diversity from the Late Triassic to the earliest Jurassic. The palynology indicates that the established post-extinction vegetation was dominated by tree ferns (*Deltoidospora*) and pinacean conifers (*Pinuspollenites minimus*), along with common taxodiacean/cupressacean conifers, ginkgos/cycads and corystospermous seed ferns, and that it remained relatively stable during the Hettangian to early Sinemurian.

1. Introduction

In the wake of the end-Permian biotic crisis, the Early Triassic was dominated by arid to semi-arid conditions in large parts of Pangea, as witnessed by widespread red beds and lack of a continuous macroplant record in many areas (see e.g. McLoughlin et al., 1997; Preto et al., 2010). This was especially true for Europe, which was situated within the subtropical climate belt (Kent and Tauxe, 2005), influenced by a strong monsoonal circulation pattern (Parrish, 1993; Sellwood and Valdes, 2006), and thus subjected to harsh climatic conditions during most of the Triassic. During the Late Triassic, conditions changed from the arid climate that dominated most of the Triassic to a greenhouse climate (Preto et al., 2010). The climate shift is believed to have been related to the opening of seaways from the Tethys into the central parts of Pangea (Manspeizer, 1994; Veevers, 1994; Ahlberg et al., 2002), but was towards the Triassic–Jurassic transition most likely influenced by the massive release of greenhouse gases from the Central Atlantic Magmatic Province (CAMP) formed during the initial stages of Pangea breakup (Ruiz-Martínez et al., 2012). The extreme conditions that prevailed in NW Europe during the Middle to Late Triassic greatly hampered preservation of organic matter, which renders analyses of

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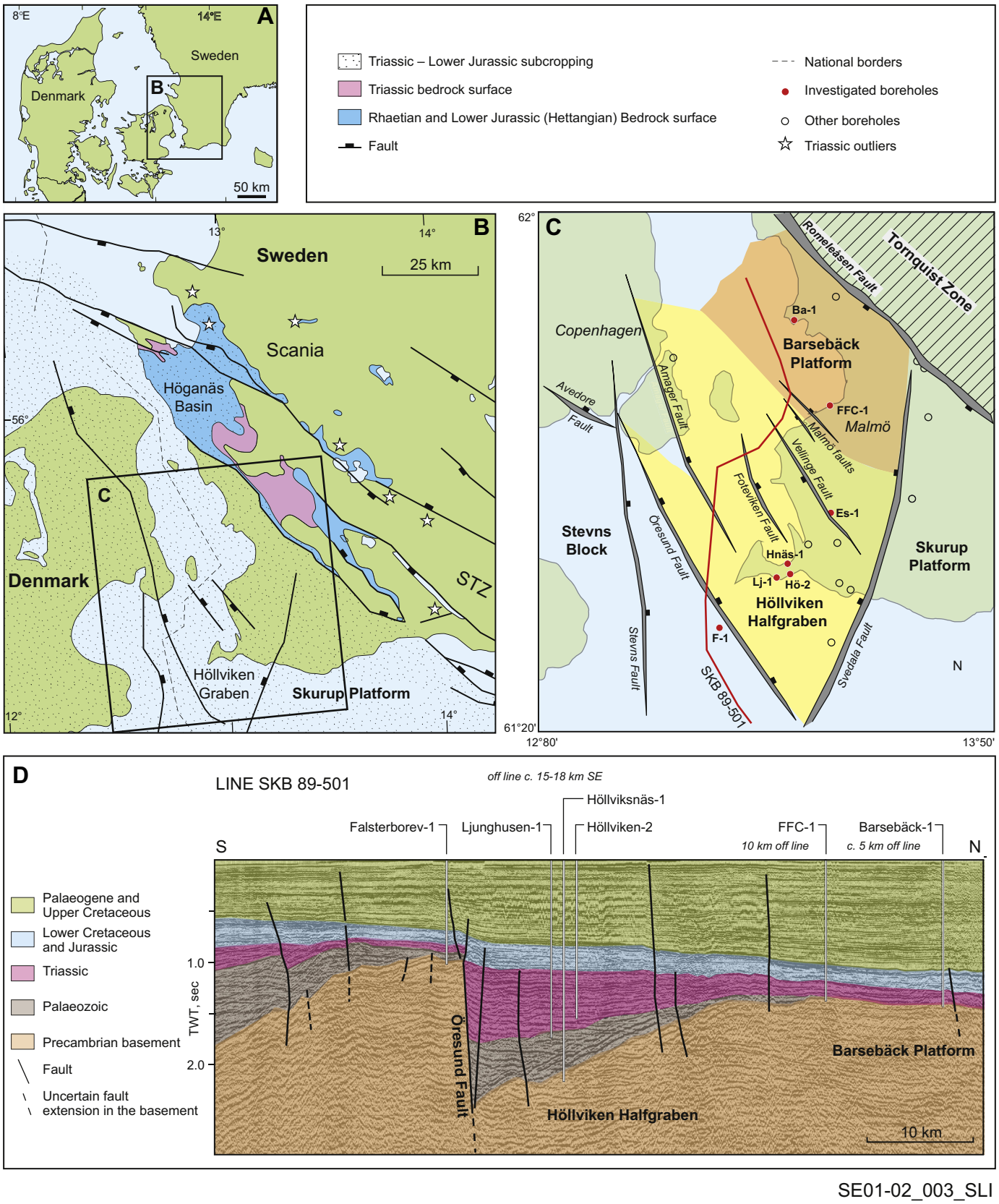

Fig. 1. Geographic, geologic and tectonic setting of the Höllviken Half-graben. A) Map over Denmark and southern Sweden. B) Map over the Øresund area, showing the distribution of Triassic to Lower Jurassic rocks. C) Tectonic setting of the Höllviken Half-graben with investigated wells. The red transect (SKB 89-501) is the seismic line displayed in D. D) Seismic interpretation of the sedimentary succession of the Höllviken Half-graben along the transect SKB 89-501.