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Palaeogeography, Palaeoclimatology, Palaeoecology 219 (2005) 351–394

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Palaeoenvironmental changes across the Danian–Selandian boundary in the North Sea Basin

Anne Clemmensen*, Erik Thomsen

Department of Earth Sciences, University of Aarhus, Building 120, DK-8000 Århus C, Denmark

Received 14 October 2003; received in revised form 3 August 2004; accepted 14 January 2005

Abstract

The Danian–Selandian boundary (~60 Ma) marks the cessation of 40 million years of carbonate deposition in the North Sea Basin and a shift to siliciclastic deposition. On the basis of variations in lithology, benthic and planktonic foraminifera and calcareous nannofossils in three cores from Storebælt in the eastern part of the North Sea Basin, we have reconstructed the palaeoenvironmental changes across the boundary. The benthic foraminiferal faunas belong to the "Midway-type fauna". They are extremely rich and more than 260 taxa have been recognized. Q-mode cluster analysis groups the benthic assemblages into four biofacies, which correspond fairly closely to lithological units. Correlation of the Storebælt records with marine palaeorecords from the Danish Basin and the North Sea Basin indicate that the transformation of the North Sea from a carbonate to a siliciclastic basin occurred in four steps separated by relatively long, stable periods. The most important external factors involved in the change are, firstly, a drop in the relative sea-level during the late Danian leading to the disappearance of bryozoans from the North Sea Basin and to non-deposition and erosion in many areas. Secondly, coinciding with the Danian–Selandian boundary, an uplift of the Scotland–Shetland area resulting in a massive input of siliciclastic deposits to the North Sea Basin. Thirdly, during the early Selandian, inversion of the Sorgenfrei-Tornquist Zone and Mesozoic basins in the southern and eastern part of the North Sea Basin resulted in a huge influx of reworked Cretaceous chalk and an almost complete stop of carbonate production. Finally, later in the early Selandian, in connection to a general sea-level rise and a reduction in the gateway between the North Sea Basin and the Tethys Sea, the sea bottom conditions became colder and more acidic. This resulted in partial dissolution of the carbonates and the deposition shifted from marl to clay. Comparison with records from the Western Pyrenees, the Nile Basin and the eastern North America suggests that sea-level changes across the Danian–Selandian boundary are primarily of eustatic nature.

Keywords: North Sea; Paleocene; Danian–Selandian; Benthic foraminifera; Calcareous nannofossils; Sea-level changes

* Corresponding author. Fax: +45 86 18 39 36.
E-mail addresses: anne.clemmensen@geo.au.dk (A. Clemmensen), erik.thomsen@geo.au.dk (E. Thomsen).

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doi:10.1016/j.palaeo.2005.01.005

1. Introduction

During mid-Paleocene time, deposition in the North Sea Basin suddenly changed from carbonates to siliciclastics. The shift marks the cessation of 40 m.y. of continuous deposition of carbonates, and it clearly represents an important change in the history of the North Sea Basin. Chronostratigraphically, the shift marks the boundary between the Danian and Selandian stages.

In the central part of the North Sea Basin, the Danian–Selandian deposits are covered by thick successions of younger deposits and their microfossils are generally poorly preserved. Nearly unaltered sediments and much better preserved fossils are available from the Danish Basin, where the Danian–Selandian deposits are exposed in a zone from northwestern Jylland (Denmark) to southeastern Skåne (Sweden) (Fig. 1a). Most studies of the Danian–Selandian deposits in the Danish Basin have concentrated on either the Danian (e.g. Thomsen, 1995; Surlyk, 1997) or the Selandian deposits (e.g. Harder, 1922; Rosenkrantz, 1924; Gry, 1935; Schnetler, 2001; Clausen and Huuse, 2002) and the changes at the transition have mostly been neglected. Palaeontologically, only the boundary outcrops at Svejstrup (Thomsen and Heilmann-Clausen, 1985), Klintholm (Varol, 1989) and Gemmas Allé (Stouge et al., 2000) have been studied in some detail, in all cases with emphasis on biostratigraphy (Figs. 1a and 2). Our knowledge of the Danian–Selandian transition is further limited by the fact that, in all outcrop

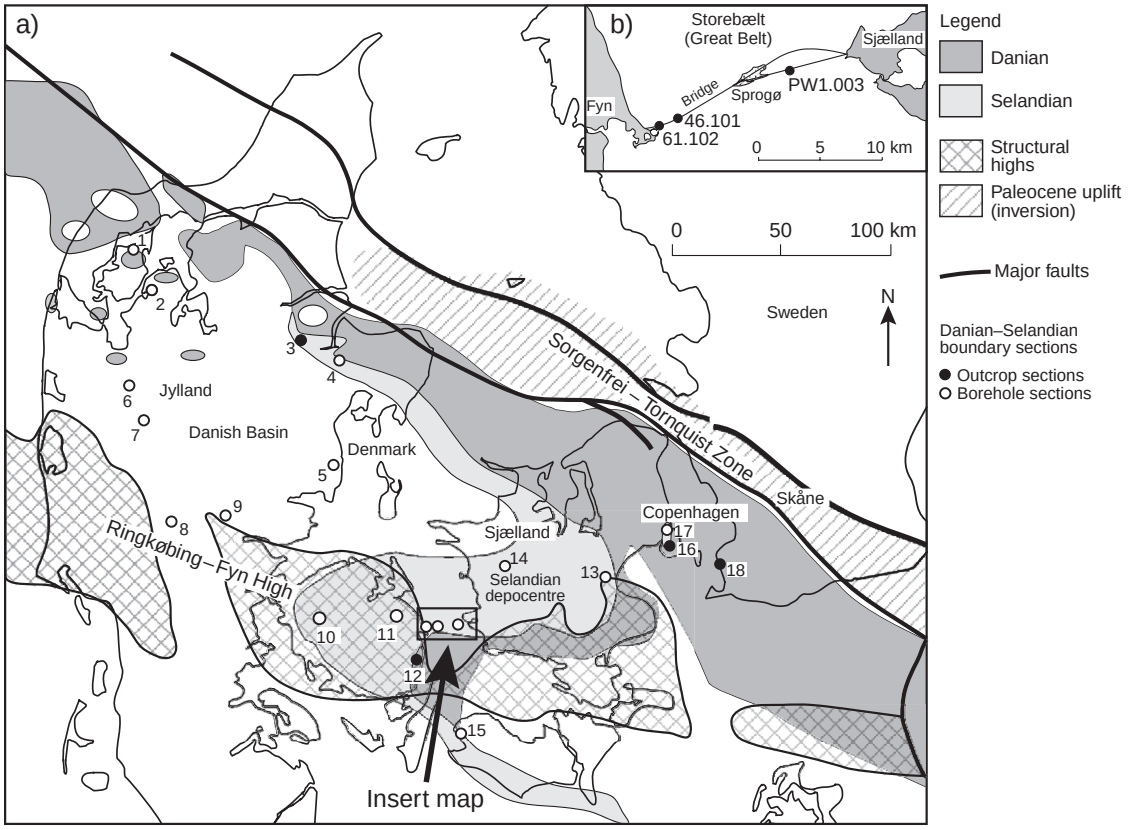

Fig. 1. (a) Simplified geological map of Denmark and southern Sweden showing the distribution of Danian and Selandian deposits. Major structural elements, the Sorgenfrei-Tornquist Zone, the Ringkøbing-Fyn High and the Danish Basin, are shown. Location of Storebælt cores and Danian–Selandian boundary localities are indicated. Names of localities and boreholes are given in Fig. 2. (b) Map showing location of Storebælt cores. The cores were drilled in relation to the construction of a bridge and tunnel across Storebælt (Great Belt) (Foged et al., 1995).