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Lower Cretaceous (upper Ryazanian–Hauterivian) chronostratigraphy of high latitudes (North-East Greenland)

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ABSTRACT

Calcareous nannofossils of Lower Cretaceous sediments from four sections of the Wollaston Forland and Kuhn Ø, North-East Greenland, have been examined. Sediments of Ryazanian–Hauterivian age were deposited in North-East Greenland following a major Late Jurassic–earliest Cretaceous rifting event. The upper Ryazanian–Hauterivian marine post-rift sediments consist of fossiliferous calcareous mudstones 27–40 m thick, assigned to the Albrechts Bugt and Rødryggen members. These calcareous mudstones rest unconformably on dark Jurassic mudstones and are overlain by dark Barremian mudstones. The biodiversity of the calcareous nannofossil assemblages from North-East Greenland is lower than contemporaneous Tethyan assemblages of lower latitudes. Well-preserved assemblages consist of common *Watznaueria* spp., *Crucibiscutum* spp., *Biscutum constans* and other taxa. Integrated calcareous nannofossil and ammonite data form the basis of a biostratigraphic zonation scheme for the Boreal-Arctic Province of the Boreal Realm and this is correlated with existing Boreal zonation schemes. Important calcareous nannofossil marker species include *Sollasites arcuatus*, *Crucibiscutum ryazanicum*, *Kokia borealis*, *Nannoconus oviformis*, *Triquetrorhabdulus shetlandensis*, *Micrantholithus speetonensis*, *Eiffellithus striatus*, *Tegumentum octiformis*, *Perissocyclus plethotretus*, *Tegulalithus septentrionalis*, and *Clepsilithus maculosus*. This study shows that the existing calcareous nannofossil zonation schemes are applicable in the Boreal-Arctic Province. The occurrence of diverse and well-preserved calcareous nannofossil assemblages in North-East Greenland at a higher latitude than their typical known area of distribution marks a significant change in their biogeographic distribution pattern during the Early Cretaceous.

1. Introduction

The first geological and palaeontological investigations of the Wollaston Forland of North-East Greenland go back to Ravn (1911), Frebold (1932), and Bøgvad and Rosenkrantz (1934). Geological mapping of Wollaston Forland and the Kuhn Ø area, including studies of fossil material, was carried out by Vischer (1943), Spath (1946), and Maync (1949). Detailed palaeontological studies were undertaken by Donovan (1953, 1955, 1957, 1964) who analyzed the ammonite faunas from Traill Ø. Subsequent studies by Surlyk et al. (1973), Surlyk and Clemmensen (1975a, b) and Surlyk (1978, 1984, 2003) described sedimentological and stratigraphic findings used for modelling the North-East Greenland Basin in the Jurassic and Cretaceous. A sea-level curve for the Jurassic and Early Cretaceous of East Greenland was presented by Surlyk (1990). Nøhr-Hansen (1993) studied the dinoflagellate cyst stratigraphy of the Early Cretaceous of North-East Greenland. Further palaeontological studies were undertaken by Alsen and Rawson (2005) and Alsen (2006), who analyzed the Lower Cretaceous ammonite faunas of North-East Greenland including their taxonomy, biostratigraphy, and biogeography. Palaeobiogeographic aspects of Early Cretaceous brachiopods (Harper et al., 2005) and belemnites (Alsen and Mutterlose, 2009) are the topics of most recent publications.

Early Cretaceous (Valanginian–Hauterivian) calcareous nannofossil assemblages and stable isotopes of the Boreal-Arctic Province have so far only been described by Mutterlose and Kessels (2000) and Mutterlose et al. (2003). The biostratigraphy, palaeoceanography, and palaeoenvironment of the Greenland-Norwegian Seaway in the Cretaceous were considered by Gradstein et al. (1999) and Mutterlose et al. (2003). Biostratigraphic schemes for the Boreal Realm, based on calcareous nannofossils, have been presented by

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Jakubowski (1987), Mutterlose (1992), Bown et al. (1998) and Jeremiah (2001).

The Valanginian of East Greenland has commonly been referred to as the time of the first limestone deposition in Greenland since the late Permian (Maync, 1949). The carbonate content of the calcareous mudstones originates from calcareous nannofossils, as shown by Alsen and Lozar (2003). In this paper the upper Ryazanian–Hauterivian is demonstrated to have a rich and well-preserved calcareous nannoflora, providing the basis for a detailed biostratigraphic scheme. The objective herein is to establish a multi-stratigraphic framework of the upper Ryazanian–Hauterivian for the Boreal-Arctic Ocean based on calcareous nannofossils and ammonites. The existing ammonite scheme (Alsen, 2006) and calcareous nannofossils are used to develop a detailed biozonation including short term bioevents. These bioevents are calibrated to the existing Boreal calcareous nannofossil and ammonite zonation schemes. Our study allows a more detailed biostratigraphic classification of the sediments in North-East Greenland to be presented, and it checks the validity of the well-established zonation schemes and the applicability of ammonites and calcareous nannofossils for biostratigraphy.

2. Geological setting

The uppermost Jurassic–lowermost Cretaceous in the Wollaston Forland–Kuhn Ø area studied (Fig. 1) is characterized by succession of coarse clastic sediments up to 3 km thick that accumulated in submarine fans along fault scarps in westward-tilted half-grabens during rift-climax in the middle Volgian–late Ryazanian (Surlyk, 1978, 2003). Sediments of late Ryazanian–Hauterivian age were deposited at the end and shortly after a major Late Jurassic–earliest Cretaceous rifting event in North-East Greenland. Towards the east, in a distal direction, the succession rapidly wedges out and is finer grained. The early post-rift time was associated with a transgression, draping the syn-rift deposits with a thin cover of Ryazanian–Hauterivian sediments. These Ryazanian–Hauterivian early post-rift sediments are represented by fossiliferous mud- and marlstones of the Albrechts Bugt and Rødryggen Members (Fig. 2; Surlyk and Clemmensen, 1975b; Surlyk, 1978), which are the subject of the present paper. At the sections studied the Albrechts Bugt Member is between 12 and 40 m thick and consists of calcareous sandy and silty mudstones, which commonly appear in light grey and yellowish colours. It is overlain by the Rødryggen Member, which is up to 5 m thick and everywhere has an unconformable upper boundary. The units commonly rest unconformably on black Jurassic and Ryazanian mudstones and are overlain by black mid-Cretaceous mudstones, both characterized by only a few or no benthic fossils. The Ryazanian–Hauterivian thus consists of a relatively thin interval of vividly coloured, calcareous sediments that are sandwiched within a kilometre-thick mid-Jurassic to

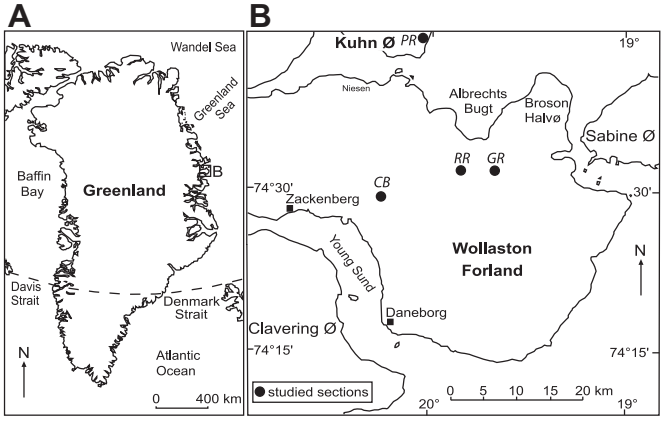

Fig. 1. Maps showing the location of sections studied in North-East Greenland. A, Greenland. B, Wollaston Forland and Kuhn Ø area; RR, Rødryggen section; CB, Cardiocerasbjerg section; GR, Grænseryggen section; PR, Perisphinctes Ravine section.

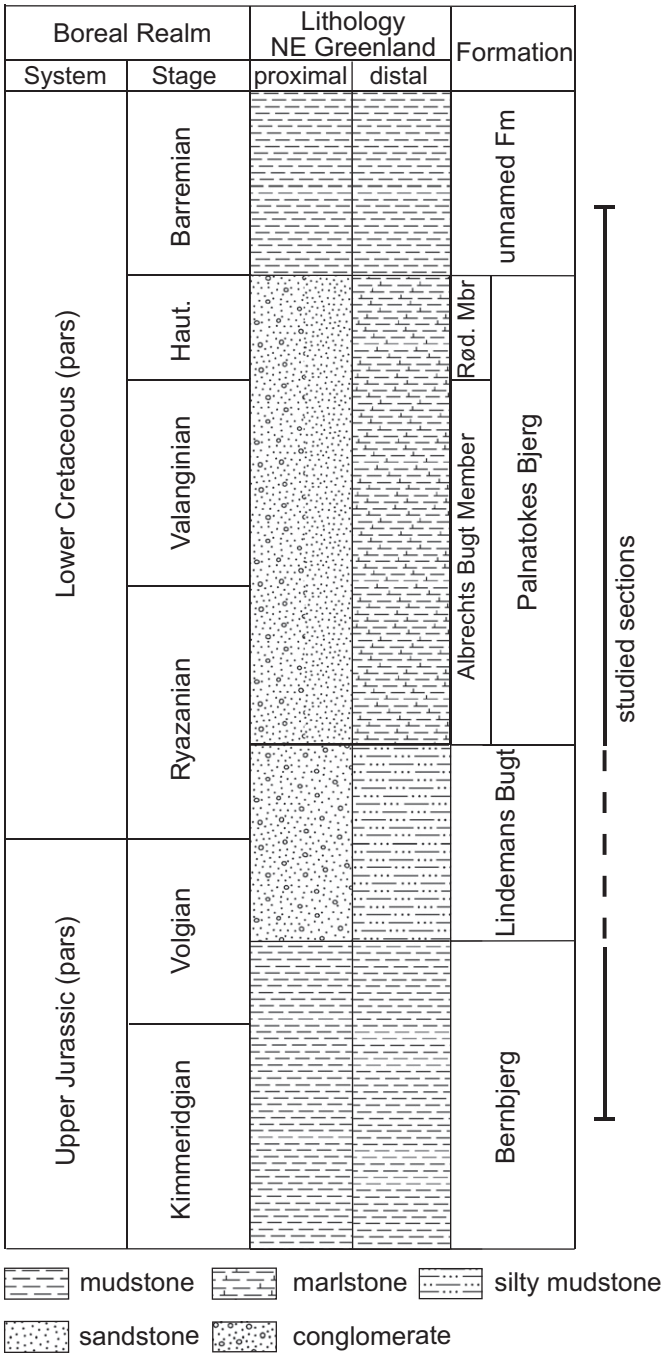

Fig. 2. Upper Jurassic–lower Cretaceous lithostratigraphy of North-East Greenland; Haut., Hauterivian; Rød., Rødryggen.