

Henrik Nøhr-Hansen Ph.D.  
Senior Research Geologist/Palynologist  
Department of Stratigraphy  
Geological Survey & Denmark and Greenland  
Øster Voldgade 10  
DK-1350 Copenhagen K  
Denmark

Copenhagen 8/10-2015

### **Introduction**

In order to obtain the PhD degree in Geological Sciences at the Institute of Geological Sciences of the Polish Academy of Sciences.

Mrs. Wieslawa Radmacher, MSci. has submitted a thesis entitled:  
Late Cretaceous palynology of the Norwegian Sea and Barents Sea – Biostratigraphical,  
Palaeoenvironmental and Palaeoclimatic Applications.

The doctorate thesis is prepared under the supervision of Promotor Dr hab. Jarosław Tyszka, prof. nadzw. ING PAN Institute of Geological Sciences, Polish Academy of Sciences, Poland and Co-Promotor Prof. Gunn Mangerud Department of Earth Science, University of Bergen (UiB), Norway

The thesis is written in English and comprises an abstract (English and Polish) followed by 10 chapters, references, list of figures, list of plates, list of tables and supplementary data.

Chapters 6-8 are partially based on and slightly modified from three internationally published multi-authored papers, of which Mrs. Wieslawa Radmacher is the first author:

- I Radmacher, W., Tyszka, J., Mangerud, G., 2014a. Distribution and biostratigraphical significance of *Heterosphaeridium bellii* sp. nov. and other Upper Cretaceous dinoflagellate cysts from the southwestern Barents Sea. *Review of Palaeobotany and Palynology* 201, 29-40.
- II Radmacher, W., Tyszka, J., Mangerud, G., Pearce, M.A., 2014b. Dinoflagellate cyst biostratigraphy of the Late Albian to Early Maastrichtian in the southwestern Barents Sea. *Marine and Petroleum Geology* 57, 109-12
- III Radmacher, W., Mangerud, G., Tyszka, J., 2015. Dinoflagellate cyst biostratigraphy of Upper Cretaceous strata from two wells in the Norwegian Sea. *Review of Palaeobotany and Palynology* 216, 18-32.

### **Review and assessment**

Chapter 1. Introduction.

The chapter gives a short introduction to the Upper Cretaceous palaeoclimate and emphasizes the importance of a dinoflagellate cyst biostratigraphy study from the Barents- and Norwegian seas. Biostratigraphy are poorly documented from these areas, and an increased biostratigraphic resolution based on palynological study is a significant contribution with respect to hydrocarbon exploration.

The end of the chapter outlines the main scope of the project as:

- Assessing the biostratigraphical potential of dinoflagellate cyst assemblages from the selected parts of the Norwegian Sea and southwestern Barents Sea through qualitative (taxonomical) and quantitative studies.
- Establishing the relationships between the dinoflagellate cyst records from the Barents- and Norwegian seas.
- Documenting of the Late Cretaceous dinoflagellate cyst distribution and calibrate the bioevents with foraminiferal data from the same sections (e.g. Setoyama, 2012).
- Identifying potentially isochronous dinoflagellate cyst events and integrate these with published data from adjacent areas in order to establish a regional zonation for the Barents- and Norwegian seas.
- Establishing quantitative and qualitative data of the palynomorph assemblages with the objective to reconstruct palaeoenvironmental conditions in the North proto-Atlantic during the Late Cretaceous.

#### Chapter 2. Background geology of the studied region

The chapter gives a good concentrated review of the geological evolution of the Greenlandic-Norwegian Seaway and the Arctic including an introduction to the Upper Cretaceous lithostratigraphy and to the Late Cretaceous palaeoenvironment and palaeoclimate.

#### Chapter 3. Palynological studies: potential and limits

The present chapter gives an excellent overview and discussion of the potential and limits of palynological disciplines which all, but especially when used together, contribute to an interpretation of the palaeoenvironment.

#### Chapter 4. Material

The chapter provides useful information on the studied 222 palynological slides representing 7 wells. The Norwegian Sea material is represented by 128 core and 6 ditch-cutting samples from a shallow stratigraphical core (6711/4-U-1) and an exploration well (6707/10-1). Documentation of the sample positions by red spots on core photos in the supplementary data may be very useful for future studies e.g. in combination with sedimentological analyses. The Barents Sea material is represented by 85 ditch-cutting and 3 core samples from 5 exploration wells (7119/12-1, 7119/9-1, 7120/7-3, 7120/5-1 and 7121/5-1).

#### Chapter 5. Methods

Processing, counting and palaeoenvironmental analysis procedures are clearly described together with a presentation of selected dinoflagellate cysts of palaeoenvironmental significance.

Chapters 1–5 introduce the reader to the area, material and methods studied and applied in the following chapters. The chapters demonstrate a detailed knowledge of the literature and disciplines in the fields of regional geology and palynology.

#### Chapter 6. Systematic description of dinoflagellate cysts

The chapter describes very useful information on dinoflagellate cysts systematics and stratigraphy, followed by remarks and compare information for 60, out of 125 recorded species and genera (225 in appendix N) characterized by high biostratigraphical and palaeoenvironmental potential. The chapter demonstrates a good knowledge of systematics and description of dinoflagellate cysts including the description and erection of the new stratigraphically important species: *Heterosphaeridium bellii*.

#### Chapter 7. Norwegian Sea: results and interpretation and Chapter 8. Barents Sea: results and interpretation

The two chapters provide very good introductions to the geological settings, lithostratigraphies and previous studies followed by detailed biostratigraphical, palaeoenvironmental and palaeoclimatic analyses for both areas.

A new palynological zonation for the Albian to Maastrichtian successions from the Norwegian Sea and the Barents Sea is erected. The successions from the two areas are correlated based on the numerous palynological events that define the boundaries of 9 palynological zones and 1 subzone. Five of these zones and 1 subzone are new (described and published by Radmacher et al. 2014b, 2015). The results are correlated and discussed in relation to previous established palyno event stratigraphies and zonations from the Barents Sea, Canada, Greenland, the North Sea and Siberia and to a recent published Campanian – lower Maastrichtian foraminifera zonation from the Barents Sea.

The stratigraphic correlations are well documented on the figures 7.4, 7.5, 8.3, 8.4, 8.5 and well documented by the entire data set presented on range charts A-G.

The palaeoenvironmental and palaeoclimatic parts of the two chapters very nicely illustrate and discuss how the application and interpretation of all the methods described in chapter 5 together can contribute to an overall palaeoenvironment and palaeoclimatic picture of the Norwegian and Barents seas during Albian to Maastrichtian time. The interpretations are well documented in the many very illustrative figures 7.6a, 7.6b, 7.7a, 7.7b, 7.8, 8.6a, 8.6b, 8.7a, 8.7b, 8.8a, 8.8b, 8.9a and 8.9b; figure 7.8 provides the reader with a good key to follow the described interpretations.

The two chapters very nicely illustrate the integration of biostratigraphy, palaeoenvironmental and palaeoclimatic studies of the Albian–Maastrichtian succession.

Chapters 6–8 very nicely present, discuss and interpret the large amount of new data obtained during the study.

#### Chapter 9. General discussion

The chapter contains very interesting ideas and discussion of the palaeoceanographical trends and palaeoclimatic trends, all nicely summarized in the manageable figure 9.1.

#### Chapter 10. Final conclusions

This chapter very nicely presents the conclusions in concise statement.

### **Comments to the thesis**

Chapter 2: A location map would help the reader; alternatively the author could refer to Figure 4.1.

Figure 2.2 gives a nice overview of the regional lithostratigraphy. According to the heading and figure text, the chronostratigraphic timescale of Gradstein et al. 2012 is used; unfortunately the stage boundary ages appear to be similar to those of Gradstein et al. 2008 (a similar mistake occurs on figs 7.3, 7.5, 8.5 and 9.1).

Chapter 3: Subchapter 5.4 could as well be included in chapter 3.

Chapter 6: A few mistakes were noted in the present chapter

Exemples: The FO of *Cerodinium diebelii* is referred to as FO Late Campanian in Greenland (Nøhr-Hansen, 1994); the species is not reported in Nøhr-Hansen (1994), whereas a FO in early Maastrichtian is reported from West Greenland by Nøhr-Hansen (1996).

In general it would be good to have a comment on more of the FO recorded from the core study, but especially of *Palaeohystrichophora infusorioides* (p 73) since this event is later (7.4.2) used to define the base of the *Palaeohystrichophora infusorioides*–*Palaeohystrichophora palaeoinfusa* Interval Zone sensu Radmacher et al. (2014b)

Under the description of the species, the size of species or processes is occasionally described as big, short or long; a measured size or size range is recommended.

Chapter 7 and 8

Definition of the biozones is missing in chapter 7, but previous published in Radmacher et al. (2014b, 2015).

Few discrepancies exist between range chart A and Figs 7.4 and 7.5 e.g. FO of *Palaeohystrichophora infusorioides* and between range chart A and text e.g. p 100: "*Heterosphaeridium difficile* has its FO, co-occurring with the FO of *Chatangiella* spp. Both taxa are consistently present within this interval"

The palaeoenvironmental part of the two chapters is based on new very interesting data and interpretations accompanied by many well illustrated figures, which I certainly hope will be published in the future after careful review.

Attention should be paid to the discrepancies between the ranges of *Trithyrodinium suspectum* and *Trithyrodinium* spp. on figure 7.7 and on range chart A.

It would have been interesting with some comments on caving in chapter 8.

Chapter 9

The subchapter 9.1 could be a bit more structured, e.g. some parts are repeated within the chapter. It would be good to have a detailed explanation of Kuhnt et al. (1989) hypothesis p 154.

General:

It would be interesting to have a note of or explanation as to why all fossil zone and subzone names not are written in *italic*.

References:

A few references are missing in the reference list including the key references:

Brinkhuis H. 1994: Late Eocene to Early Oligocene dinoflagellate cysts from the Priabonian type-area (Northeast Italy): biostratigraphy and palaeoenvironmental interpretation. *Palaeogeography, Palaeoclimatology, Palaeoecology* **107**:121–163.

Order of authors initials cause confusion; see Davey, J.R.; Davey, R. and Davey R.J. p 168 – 169

### **Summary**

The thesis consists of 10 chapters, of which 3 are partially based on and slightly modified from three internationally published multi-authored papers, of which Mrs. Wieslawa Radmacher is the first author. The thesis clearly demonstrates that Mrs. Wieslawa Radmacher is able to provide an original solution to a scientific problem and demonstrate her general theoretical knowledge within geology and particularly within palynology, as well as the ability to independently carry out scientific work.

The thesis is well written and certainly fulfills the main scope of the project as outlined in chapter 1. The thesis contains new and extremely interesting data, which promote our understanding of the palynostratigraphy, palaeoenvironment and palaeoclimate

of the Upper Cretaceous successions in the Norwegian Sea and Barents Sea, important for both academia and the hydrocarbon industry.

### **Recommendation**

The doctorate thesis fulfills Law Article 13 paragraph 1 of the Polish ACT of 14 March 2003 on Academic Degrees and Titles and on Degrees and Title in Art. 221 and Mrs. Wieslawa Radmacher should be congratulated on having produced a high quality thesis integrating a large body of work across a variety of geological and especially palynological disciplines. I would also recommend awarding the PhD candidate for her scientific achievements following your institutional/national regulations.



8/10-2015

