

The Chalk of the Northern Province: a synopsis

S. K. Donovan^{1*} & S. G. Molyneux²

¹ Taxonomy and Systematics Group, Naturalis Biodiversity Center, Postbus 9517, Leiden 2300 RA, the Netherlands

² British Geological Survey, Keyworth, Nottingham NG12 5GG, UK

 S.G.M., 0000-0002-8257-7588

*Correspondence: Steve.Donovan@naturalis.nl

Received 31 July 2018; accepted 31 July 2018



The thematic set of papers in this issue of the *Proceedings*, ‘The Chalk of the Northern Province’, arose from a symposium of the same name at the University of Hull, 10–13 September 2015. The meeting was organized jointly by the Hull Geological Society, the Yorkshire Geological Society and the Department of Geography and Earth Sciences at the University of Hull, and was supported by the Stratigraphy Commission of the Geological Society of London. The seven papers published herein represent a cross-section of the presentations enjoyed by attendees.

In a broad review, **Mitchell** evaluates the litho- and biostratigraphy of the Chalk in the Northern Province. Six formations are recognized, although the Rowe Formation (Campanian) is hidden by drift. Unlike the Southern Province, where the Chalk rests on the Gault Clay Formation, that of the Northern Province sits on the Hunstanton Formation (=Red Chalk). The Chalk of the Northern Province is also less flint-rich and is harder with more stylolites than that of the Southern Province. Its deposition was controlled by a series of structural highs. Particular attention is paid to the internationally important sequence at Speeton with its expanded Albian to mid-Cenomanian succession. This review ably supports the other papers in this volume, including as it does comprehensive discussion of stage boundaries and fossil zonation of the Chalks of this Province.

Hildreth offers a quantitative examination of the complexities of the distribution, form and physico-chemical development of flint in the Chalk Group, particularly in East Yorkshire and Lincolnshire. The utility of flint bands as widespread lithostratigraphic marker horizons, useful for regional correlation, is well known. As such, flints are indicators of the prevalent stability of environmental conditions in the Late Cretaceous. Influences on flint formation are many, including sedimentary cyclicity and periodicity, volcanic ash bands (bentonites), iron content and infaunal sedimentary mixing. Flints are developed where the fabric of the chalk shows change. After all, there are flints and flints.

Gradstein & Waters summarize the revised and unified stratigraphy of the Chalk Group for the UK and Norwegian sectors in the North Sea, following a more detailed report by **Gradstein et al. (2016)**, which described the biostratigraphy and lithostratigraphy of the entire Cretaceous succession of the UK and Norwegian sectors. The contribution in this part

thus provides an overview of a rationalized Chalk Group stratigraphy that can be applied across the UK and Norwegian sectors, alleviating the misuse of names and the use of unique names for reservoir units without documentation, and lack of biostratigraphical and correlative insight. Revisions to stratigraphic units are of two types: (1) redefinition of the groups and formations; and (2) redefinition of lithological criteria.

The macrofauna of the Vale House Flints member in its two best quarry exposures in Lincolnshire is recorded by **Green**. The Vale House Flints Member is a lithologically and palaeontologically distinct unit of the Burnham Chalk Formation (Upper Turonian). The nekton (ammonites, sharks) and benthos are diverse. There are conspicuous faunal similarities and differences between the two sites, which are both worthy of conservation.

A relationship between Chalk stratigraphy and borehole geophysical logs is long- and well-established across southern England and into parts of East Anglia. In the distinctly different Chalk of Lincolnshire, Yorkshire and parts of north Norfolk, borehole geophysical log profiles have been matched with formational subdivisions for large parts of the Chalk Group, but the youngest and thickest part of the succession at outcrop, the marlstone-rich and largely flint-free Flamborough Chalk Formation, has not been characterized geophysically hitherto. In his contribution, **Woods** develops a stratigraphical interpretation of geophysical logs in the Flamborough Chalk based on a comparison of logs from deep hydrocarbon boreholes beneath Holderness (East Yorkshire) with generalized patterns of outcrop stratigraphy. This approach reveals geophysical log patterns that are consistent with variations in lithology and thickness seen at outcrop, are compatible with geophysical data from a cored borehole at Carnaby, near Bridlington, and are traceable northwards and westwards towards the margin of the Flamborough Chalk outcrop. Comparisons with geophysically-logged offshore successions suggest the presence of Flamborough Chalk beneath Holderness that is younger than anything seen at outcrop, which casts doubt on the likely subsurface onshore extent of typically flint-rich Rowe Chalk Formation.

A scheme of classification for paramoudra form is provided by **Yeomans**, who argues convincingly for their origin in the benthic environment in association with

sponges and sponge reefs. New descriptive terms for paramoudra flints include rimprint, where an imprint of a sponge epidermis is left at the top of the inner rim of a paramoudra, and protoflint, formed in association with sponges by secretion of silica gel. Seven sorts of paramoudra are recognized, such as barrel-shaped hollow flints with a chalk fill (paramoudra typica) and broad, multi-ringed structures (paramoudra multa).

Hart transports us to a time of global crisis. The expression of the global Cenomanian–Turonian boundary event in the Northern Province is the Black Band, rich in dinoflagellate cysts whose abundance was stimulated by enhanced nutrient supply. This boundary marks a global extinction associated with oceanic anoxia, the Oceanic Anoxic Event II. The organic-rich sedimentary rocks of the

Black Band are a local response to this event, produced by a combination of factors, including geological setting, water depth, plankton productivity and preservation. Analogous black mudrocks are known from this stratigraphic interval worldwide.

Acknowledgements We thank our contributors for responding so enthusiastically to the call for papers and our reviewers for their sagacious comments.

Funding This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

- Gradstein, F.M., Waters, C.N. *et al.* 2016. Stratigraphic guide to the Cromer Knoll, Shetland and Chalk Groups, North Sea and Norwegian Sea. *Newsletters on Stratigraphy*, **49**, 71–280.