British Upper Cretaceous stratigraphy

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'*Of all the rocks with which I am acquainted, there is none whose formation seems to tax the ingenuity of theorists so severely, as the White Limestone or Chalk, in whatever respect we may think fit to consider it*'.

Thomas Allan, FRS Edinburgh 1823, (*Transactions of the Royal Society of Edinburgh,* Volume 9, p. 393).

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Contents

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This volume is not intended for use as a field guide. The description or mention of any site should not be taken as an indication that access to a site is open. Most sites described are in private ownership, and their inclusion herein is solely for the purpose of justifying their conservation. Their description or appearance on a map in this work should not be construed as an invitation to visit. Prior consent for visits should always be obtained from the landowner and/or occupier.

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Countryside Council for Wales, Plas Penrhos, Ffordd Penrhos, Bangor, Gwynedd LL57 2LQ.

English Nature, Northminster House, Peterborough PE1 1UA.

Scottish Natural Heritage, 12 Hope Terrace, Edinburgh EH9 2AS.

Preface

Writing this book has been much more fun and instructive than we had originally envisaged. The assumption that the stratigraphy of most of the British Upper Cretaceous GCR sites was well established began to fall apart the more sites we reviewed and visited. This has confirmed the need to retain the existing GCR sites and to add to their number.

The review has highlighted numerous unresolved, controversial stratigraphical and sedimentological problems that have a fundamental bearing on our understanding of Late Cretaceous depositional environments.

Fieldwork on the Upper Cretaceous rocks of the Inner Hebrides has forced us into a radical re-think of these deposits and their tectonic setting. We were surprised by the evidence for re-working, probable olistostromes and debris flows and the influence on sedimentation of major tectonic lines such as the Great Glen Fault and the Moine Thrust. Structural partitioning into local depositional basins parallels the situation in Northern Ireland, and the stratigraphy developed there in thicker, more complete sections, is crucial to the interpretation of the Inner Hebrides Group. A controversial, but nonetheless still to be investigated problem is the age of the first volcanic rocks that rest on the Inner Hebrides Group. The published dates are from lavas and lignites well above the basal volcanic rocks and indicate ages around 63–64 million years (Ma). It is, therefore, possible that the earliest volcanic rocks are of latest Cretaceous age and may possibly span the Cretaceous–Palaeogene boundary and include the iridium anomaly that is used as evidence for the inferred end-Cretaceous meteorite impact (bolide) event.

Detailed studies of small parts of the stratigraphy provide models for the formation of Upper Cretaceous rocks. This was superbly demonstrated by Jefferies (1963) in his groundbreaking study of the Plenus Marls, which set a standard for all subsequent Chalk stratigraphical investigations. Another such interval is the highly condensed sediments comprising the — Chalk Rock at the boundary between the traditional Middle and Upper Chalk. Correlation between the Chalk Rock localities such as Fognam Quarry (Berkshire), Charnage Down Chalk Pit and Dead Maid Quarry (Wiltshire), Shillingstone Quarry (Dorset), and the more expanded successions of Southerham. Pit, Lewes, (Sussex) and the Isle of Wight, has proved to be highly controversial.

On re-visiting the ice-rafted chalk blocks at Sidestrand and Overstrand on the north coast of Norfolk, an internal stratigraphy to the blocks was discovered, particularly the existence of primary marl seams, which has radically altered our view of the stratigraphy and sedimentation during Late Campanian and Early Maastrichtian times, providing an excellent link to the Chalk of the southern North Sea Basin.

Perhaps the most surprising outcome of this review has been the recognition of the absence from the list of GCR sites to date of important sections exposing the Plenus Marls–Melbourn Rock–Black Band succession. This interval spans the Cenomanian–Turonian (C/T) boundary, which has attracted more research papers than any other part of the Late Cretaceous rock column, with the exception of end-Cretaceous extinctions. This attention is owed largely to it representing both a major Oceanic Anoxic Event (OAE), a period of stepwise extinctions, a complete change in sedimentary regime and a possible further bolide event, again leaving an iridium anomaly in the sediment. The correlations between the Black Band of the Northern Province (Lincolnshire–Yorkshire) and the Plenus Marls of southern England have been controversial and again involve crossing major tectonic lines such as The Wash between the Northern and Transitional Chalk provinces, as well as marked differences in sedimentation between the provinces.

The GCR sites described in this book have made — and continue to make — a major contribution to resolving these controversies and to understanding the stratigraphical events in the Upper Cretaceous succession of the UK and globally. The 37 GCR sites are arranged in regional or sub-regional order, based on depositional provinces. The designation of the GCR status of the sites was made, in some cases, more than 20 years ago, with the inevitable result that some of the sites have become degraded, although site management work by the country conservation agencies continues to improve the quality of exposures where this is practical and desirable in the interests of long-term conservation. Nonetheless, in reviewing these sites we have indicated how they link to other important exposures, locally or more widely (cross references to GCR sites are presented in bold typeface). Some of these complementary sites are worthy of consideration for the GCR in the future.

R.N. Mortimore, C.J. Wood and R.W. Gallois December 2000

GCR site selection guidelines and site networks

This volume describes 37 sites that merit GCR status — and thereby long-term conservation — because of their especial significance to the study and understanding of Upper Cretaceous Stratigraphy in Britain. The general principles guiding GCR site selection are described in the introductory GCR volume (Ellis *et al.,* 1996), but can be encapsulated in three broad components:

- International geological importance (for example, GSSP sites and palaeontological 'type' sites are included; other sites that have informal, but widely held, international recognition are also selected).
- Presence of 'classic' or exceptional features that are scientifically important (for example, 'text-book' examples of particular features or exceptionally rare geological occurrences are included).
- Presence of representative Earth science features (for example, features that are characteristic or typical of a fundamental British geological event) that are essential in comprehensively portraying Britain's Earth history. Thus, a site may be selected for showing the most complete *regional* representation of phenomena that are quite widespread.

It should be assumed that an 'internationally' rated site will also be representative of an event or process and will logically include exceptional features.

In order to ensure true national importance in the selected representative sites, site selection was underpinned by the premise that the particular 'GCR Block' (site selection category) should be represented by the *minimum number* of sites. Only those sites absolutely necessary to represent the most important aspects of Britain's Cenomanian to Maastrichtian stratigraphy were therefore selected; unnecessary duplication of interest was thus minimized.

It must be stressed that not any representative site will suffice, and a series of weightings is applied to the general guidelines to help to distinguish the best or most suitable site for the GCR. For example, preference is given to sites with the most extensive or best-preserved record of a certain feature, the most detailed geochronological evidence or a

particularly long history of study. Sites that have contributed to the development of the principles and theories of the Earth sciences or have significant potential for future research are also preferred.

In some cases, representative sites were selected for their contribution to a group of related sites, for example, the Dead Maid Quarry, Mere, and the Southerham group of quarries, Lewes. This applied especially where there is a geographical component in the scientific interest. Such a group of sites may include different aspects of one type of phenomenon, which shows significant variations in its characteristics, for example, in relation to factors such as regional geological setting within a province (e.g. Hooken Cliff, south-east Devon). In this case there may be 'core' sites, perhaps those showing the most extensive and best researched sequences, while other sites may demonstrate significant variations on the main theme. Nonetheless, it is the group of sites together that remains nationally important.

On an entirely practical level, all selected sites must be conservable, meaning in essence: (a) that development planning consents do not exist or else amendments can be negotiated; and (b) that sites are physically viable, for example, in terms of the long-term stability of exposures and their location with respect to the watertable (Gordon and Campbell, 1992).

To compile the ultimate GCR site list for this GCR Block, extensive consultations were carried out with appropriate Earth scientists, and several hundred sites were assessed before the final listing was produced. There are many problems inherent in producing a truly representative list of nationally important sites that merit conservation. In order to help provide a framework for selecting sites, the concept of GCR Networks is applied.

GCR Networks

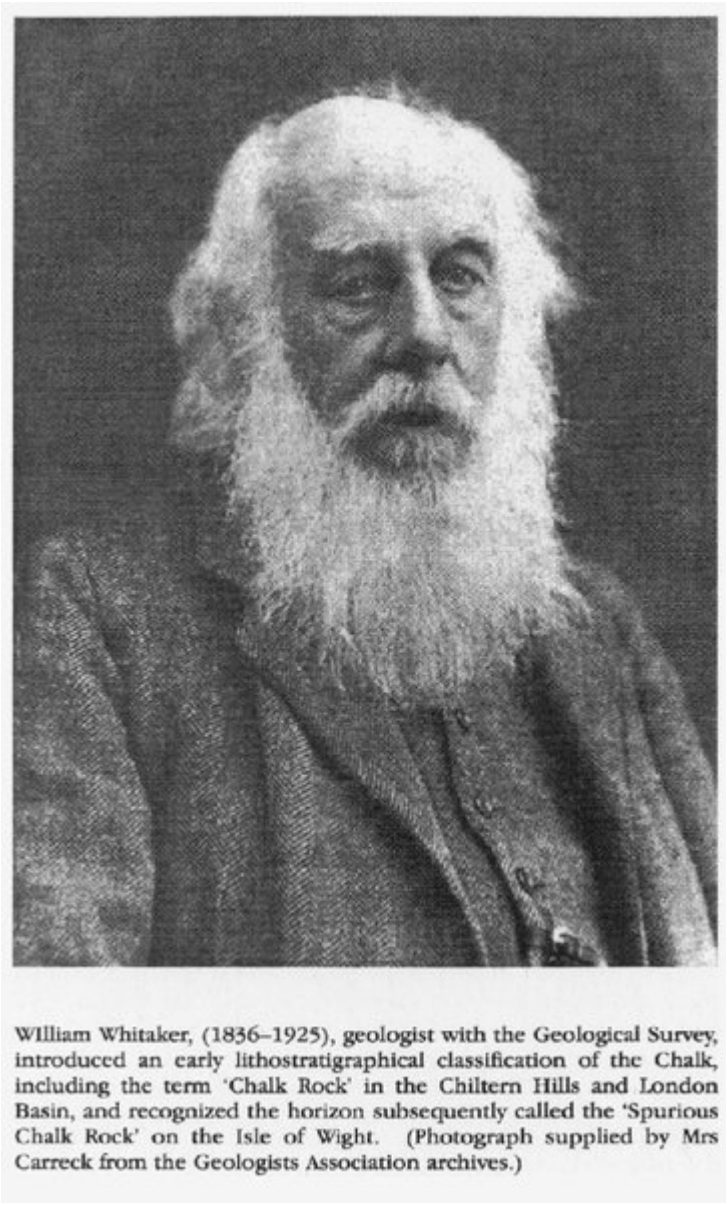
The British Chalk outcrop is strongly characterized by faunal and depositional provinces, and it is the intention within the 'representativeness' rationale of the GCR to be able to demonstrate the geological features of all of these provinces from the evidence present in the selected GCR sites. These provinces can be thought of as providing the main basis for Upper Cretaceous GCR Networks, for which linked clusters of representative GCR sites can be selected. For British Upper Cretaceous Stratigraphy, other GCR Networks, or 'themes', are also represented, for the following features:

- historical importance
- lithostratigraphy
- biostratigraphy
- cyclostratigraphy
- sequence stratigraphy and sea levels
- chemostratigraphy and tephro-events
- tectonic influences

Clearly, any one site may be helpful in elucidating several of these themes and therefore may contribute to more than one GCR network (for example, Southerham Grey Pit provides information about litho-, bio-, and cyclostratigraphy as well as tectonic setting and sequence stratigraphy).

It is clear from the foregoing that many factors have been involved in selecting the sites proposed for conservation and described in this volume. Sites rarely fall neatly into one category or another; normally they have assets and characteristics that satisfy a range of the guidelines and preferential weightings used. A full appreciation of the reasons for the selection of individual sites cannot be gained from these few paragraphs. The full justification and arguments behind the selection of particular sites are only explained satisfactorily by the full site accounts given in subsequent chapters. This, after all, is the raison d'être of the GCR Series of publications.

References



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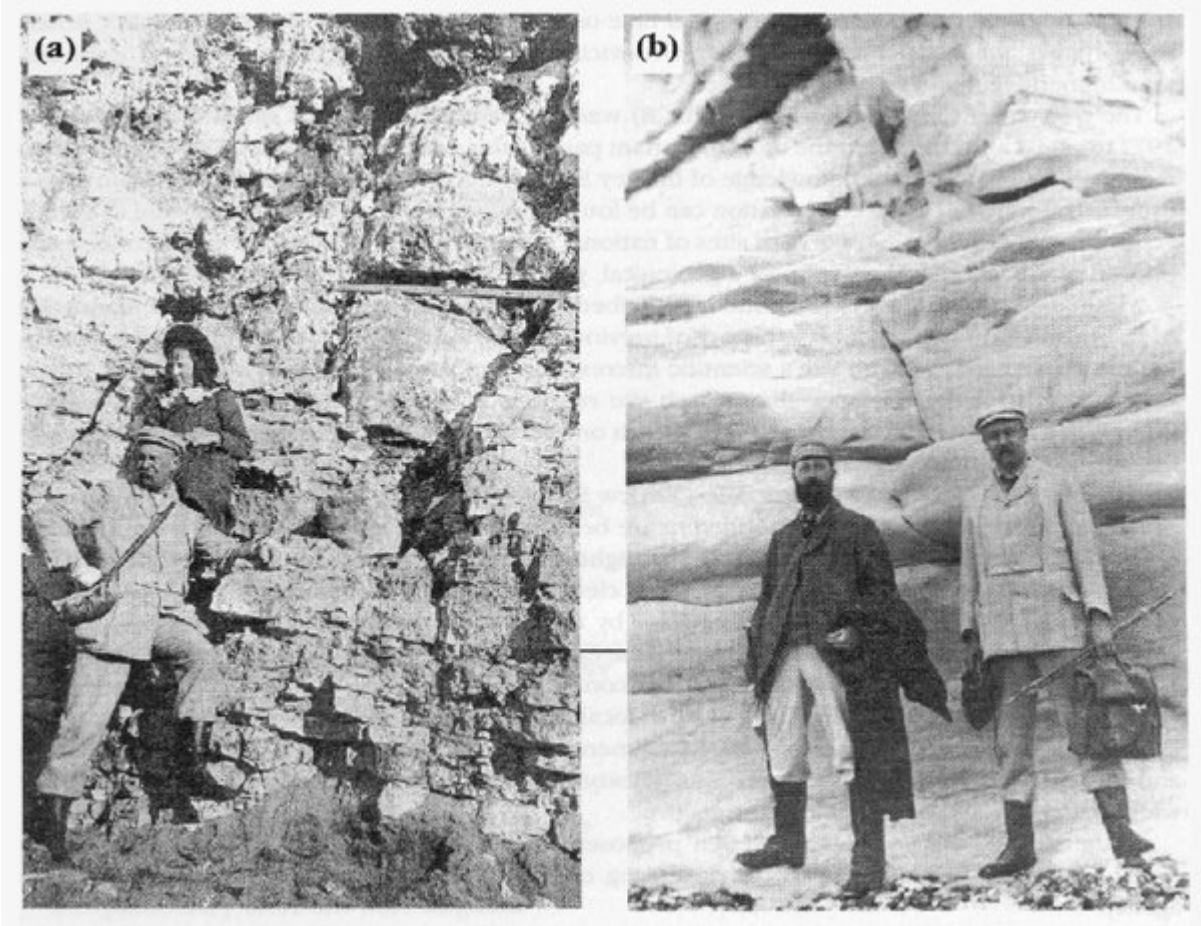

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