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Geoconservation and the advancement of geosciences: lessons from the Chalk of England

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ABSTRACT

Seven examples from the Chalk of England illustrate the importance of geoconservation to advances in understanding Upper Cretaceous Chalk geology and wider studies relevant to society including construction projects, groundwater investigations and environmental change. Two field sections are now lost to landfill (Asham, Lewes and Downend, Portsdown) and five are extant (Southerham Grey Pit, Lewes, South Lodge Pit Taplow, Berkshire, Peacehaven Cliffs and Eastbourne Cliffs, Sussex). Each of these field sections shows the range of geology that needs to be considered in any conservation strategy. Continued access to such coastal and inland field sections is vital so that new ideas and techniques can be tested and re-measuring and re-sampling can take place.The need for field sections has, and continues to be, challenged and there is a view that borehole cores can provide sufficient reference material to replace field sections. The inadequacies of a borehole alternative to field sections are illustrated with examples from Southerham Grey Pit, Lewes and Downend Quarry, Portsdown, Hampshire. These two sites also illustrate that a trench cut to replace a quarry face will not guarantee exposure of an equivalent geology. There are wider implications for society as field sections are essential for interpreting the geology beneath London and Stonehenge for tunnels and aquifer studies. Local field sections are also part of new initiatives, through the Lewes Railway Land Wildlife Trust, to widen understanding of and integrate geosciences with other natural sciences through environmental education to better inform decisions on environmental issues.

1. Introduction: lessons from the Chalk

A major geoscience focus continues to be the investigation of past climates, sea-level fluctuations, global correlations within a framework of increasingly refined timescales. The Cretaceous is of particular interest as the last Period with a hot-house Earth and exceptionally high relative sea-levels (Barrera and Johnson, 1999; Skelton, 2003; Voigt et al., 2006). The Upper Cretaceous is also the period of supercontinent break-up and the redistribution of oceans and continents that resulted in building mountain chains such as the Alps to Himalayas, which in turn shifted and narrowed climatic belts. Upper Cretaceous marine deposits such as the Chalk of NW Europe, contain the evidence for these global events in a variety of ways especially within the shells of the nanno-, micro- and macrofossils and within the sedimentary record in relation to palaeogeography and tectonic structure. To unlock this evidence requires re-measuring field sections, recollecting fossils such as brachiopods (Voigt et al., 2003; Jeans et al., 2012), sampling the lithologies at increasingly refined scales (millimetre and centimetre intervals) and then applying the latest petrological, geochemical and geophysical techniques. Sedimentary structures can be on a scale of 10–100 s of metres and require large quarry or cliff faces to study them (Mortimore, 2011).

At the same time the palaeontology and palaeobiology within successions like the Chalk have become increasingly refined to the extent that microfossils, particularly foraminifera and nannofossils, can frequently determine the stratigraphy to an accuracy of one metre or less (e.g. Hampton et al., 2007, 2010). These advances in stratigraphy enable studies of migrations across basins and oceans and evolutionary trends. As a result, there is a school of thought that suggests that all that is needed for future research is a cored borehole from which samples can be taken to investigate stable isotopes of carbon, oxygen and strontium for comparison with, and to further develop, standard global scales. Results can then be combined with trace element analyses and microfossil studies from the cored borehole. Such arguments have been used to suggest we no longer need field sections including quarries with their attendant health and safety issues and their potential usefulness for landfill waste disposal, a key local planning consideration with strategic implications for U.K. geosciences and geoconservation. It is also argued that a combination of geochemistry, micropalaeontology and seismic exploration

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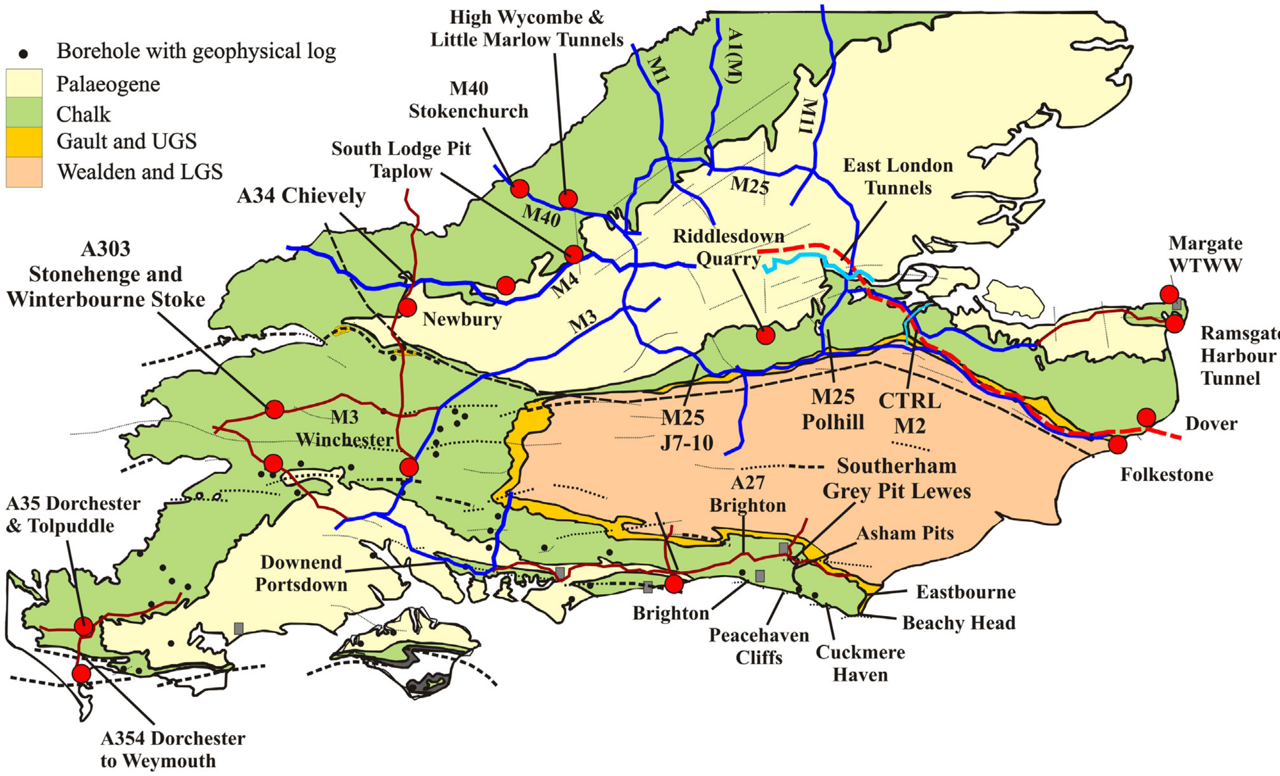

Fig. 1. Locality map for geological sections mentioned in the text.

methods will provide sequence stratigraphical models and lithostratigraphy will, therefore, become redundant (e.g. Gutteridge, 2008) and the era of macro-fossil collecting and field stratigraphical studies will be over.

The case studies presented below provide evidence for an alternative view, suggesting that conservation of field sections and continued access to field-scale measuring and collecting is equally essential to the well-being of U.K. geosciences alongside any advances in geochemistry, geophysics or micropalaeontolgy.

During the last three decades, as the cement manufacturing industry and lime production in England has contracted, the numbers of invaluable exposures in quarries, large and small, has shrunk dramatically. Decisions have had to be made about which Chalk pits to conserve against those to potentially lose, knowing it would be impossible to save them all. Unique geological sections that have been lost include those at Asham Quarries (Beddingham) near Lewes, Sussex and Downend Pit on Portsdown, Hampshire (Figs. 1 and 2). Examples of geological sections that have been saved for the future are Southerham Grey Pit, Lewes, Riddlesdown near Croydon, Surrey and South Lodge Pit, Taplow Berkshire (Figs. 1 and 2). Combined with key coastal sections at Eastbourne and Peacehaven these inland quarries have, and continue to contribute to the advancement of geosciences. Conservation of these geological exposures forms a key part of the future of geosciences and the future of environmental education. The next generation of students are increasingly interested in past and future climates and environmental change in human and geological timescales. They are introduced to these topics through organisations such as the Lewes Railway Land Wildlife Trust.

As with other parts of the U.K. geology, the most important field sections in the Upper Cretaceous Chalk have been given the status of Sites of Special Scientific Interest (SSSIs') and their scientific value summarised in the Geological Conservation Review (GCR) Series No. 23 (Mortimore et al., 2001). There are some notable sites not included such as the cliffs with the Plenus Marls at Eastbourne discussed below.

2. Lost chalk sections

For local authorities with waste disposal problems, holes in the ground provided by old chalk pits have been a relatively easy and cheap alternative to long distance transport of waste or alternative more expensive options including separation of waste products and incineration. Such views are changing and more environmentally acceptable methods of waste disposal are being developed, however, not before several invaluable geological exposures have been lost.

2.1. Beddingham Landfill: unique stratigraphy lost

Asham Pits at Beddingham near Lewes, Sussex (Figs. 1, 3 and 4) comprised three cement works quarries which exposed a section from the Albian Gault through the entire Cenomanian Grey Chalk Subgroup into the Turonian Holywell Nodular Chalk Formation in the White Chalk Subgroup (Fig. 2). Asham Pit 1 exposed a unique angular discordance of approximately 15° between the Gault and the overlying Grey Chalk (Mortimore and Young, 1980). If this exposure had remained, recent developments in micropalaeontology and geochemistry could have been used to determine the degree of disconformity. The number of cored boreholes required to provide the range of samples needed to study this angular discordance would now be prohibitive in the context of a research programme.

In international terms the overlying basal Chalk Member, the Glauconitic Marl, contained a very rich assemblage of fossil ammonites and other fossils used for determining the age range of the base of the Chalk (Kennedy, 1969, 1971). The only other exposure in the Sussex South Downs at Cow Gap, Beachy Head near Eastbourne (Mortimore, 1997), was significantly different