Wrabness, Essex

[TM 171 323]–[TM 174 324]

Potential GCR site

Highlights

The cliffs at Wrabness comprise the major volcanic ash-bearing exposure of the Harwich Formation, with around 34 ash bands present. Its importance stratigraphically is recognized by its designation as one of the two type sections for the distal facies of the Harwich Formation. Of the fossils present in the succession, the macroflora is of particular importance.

Introduction

Exposures of Thames Group strata occur in the banks of a number of rivers in Essex and Suffolk (George and Vincent, 1977). Of these, the most stratigraphically significant is that at Wrabness on the southern side of the estuary of the River Stour, particularly the cliff between grid references [TM 171 323] and [TM 174 324] (Figure 3.19). Here, both the Harwich and Walton Members of the 'London Clay' of King (1981) are represented in the approximately 15 m high cliff, the former having now attained formational status as the Harwich Formation (Ellison *et al.,* 1994).

Whilst the cliff at Wrabness was known to early workers and was figured, for example, in Whitaker (1885), relatively recent years have seen a renewal of interest in the section. This mostly reflects the fact that it is the major volcanic ash-bearing site within the Thames Group, although both the cliff and the adjacent foreshore exposures are also of importance palaeontologically.

References to the fossils present include Daniels (1971) and a brief note in George and Vincent (1977). (Figure 3.24) (after King, 1981) shows the stratigraphical relationship of the Wrabness section with those at Ferry Cliff (near Woodbridge, Suffolk) and Walton-on-the-Naze and the Shotley Gate borehole (grid reference [TM 244 346]). Reference to the volcanic ashes within the Harwich Member was made in Knox and Ellison (1979), whilst its magnetostratigraphical character and significance were considered by Townsend and Hailwood (1985), Aubry *et al.* (1986) and Ali *et al.* (1996). A reference to the section was made in Jolley and Spinner (1991), who sampled it as part of their study of spore-pollen associations from the lower 'London Clay'. More recently, its dinoflagellate assemblages were studied by Powell *et al.* (1996; see particularly their log: fig. 5, p. 150). A recent log is also given in Jolley (1996, fig. 3, p. 223).

This site is a confirmed GCR site for its fossil plant content, a more detailed account will be published in the GCR series volume *Mesozoic to Tertiary Palaeobotany of Great Britain* (Cleal and Thomas, in prep.).

Descriptions

Exposures in the 15 m or so high cliff at Wrabness extend laterally for about 300 m, with parallel stratification indicating a weakly anticlinal structure.

Lithological succession

The succession (Figure 3.20) is something in excess of 16 m in thickness. Much of it comprises muds and silty muds which are concretionary in places. Jolley (1996, p. 253) refers to 10 m of tuffaceous siltstone (sic) containing 32 complete tephra layers (Figure 3.21). The distinctive Harwich Stone Band occurs near the base of the section. The upper part of the Harwich Formation comprises sandy silts and these are succeeded by muds of the London Clay.

Lithostratigraphy

King (1981) designated Wrabness as the stratotype for his Harwich Member ('London Clay'), now the Harwich Formation, for which the site is part of a composite stratotype (Ellison *et al.,* 1994, p. 194) and of which the top 10 m is exposed in the cliff. The uppermost part of the cliff is in the Walton Member of the London Clay. More recently, Jolley (1996, pp. 252–3) has split the Harwich Formation into two members: an upper Wrabness Member, to 'describe the tuffaceous siltstones [sic]' up to the base of the London Clay, and a lower Orwell Member.

Palaeontology

The cliff is poorly fossiliferous. King (1981) reported that, overall, the Harwich Member is decalcified at outcrop, except for calcareous nodules and occasionally shelly pockets (see account of Walton-on-the-Naze in this volume). At Wrabness, a restricted calcareous microfauna from just above the Harwich Stone Band yielded *Cytberidea unispinae* and poorly preserved polymorphinids. Fossils are, however, preserved in the 'stone-bands', including a few molluscan genera such as *Arctica* and *Mytilus* (Daniels, 1971).

Daniels (1971) referred to both unweathered 'London Clay' and pyrite concentrates on the foreshore, from which sharks' teeth, seeds, a cone and woody material were recovered. In addition to plant and fish fossils, George and Vincent (1977) reported the occurrence of beetle remains.

The site has now been designated as an SSSI for its palaeobotanical importance, yielding plants from both members. Small seeds and fruits are preserved in concretions, thereby complementing anatomical detail obtained from pyritized material at other localities.

Biostratigraphy

In work on the Wrabness section, Jolley and Spinner (1989,1991) assigned the Harwich Formation to the *A. hyperacanthum* dinoflagellate biozone (*sensu* Costa and Downie, 1976; Costa *et al.,* 1978) and restricted the succession above the Harwich Stone Band to the *D. oebisfeldensis* acme biozone. However, in more recent work by Powell *et al.* (1996), the whole of the sequence is placed in the *Glaphrocysta ordinata* chronozone (the 'Gor' biozone of Powell, 1992). Ali and Jolley (1996) placed the Harwich Formation tephras in the early Eocene NP10 nannoplankton zone and assigned it to the upper part of the *A. hypercanthum* zone (not *sensu* Powell, 1992). (Figure 3.21) shows the distribution of palynomorph association sequences at Wrabness (after Jolley, 1996).

Magnetostratigraphy

It is not surprising that Wrabness, as the best section in the 'distal' facies of the Harwich Formation, has attracted the attention of magnetostratigraphers. Townsend and Hailwood (1985, pp. 971–2) found that here the lower third of what was then the Harwich Member (including the Harwich Stone Band) is characterized by reverse polarity and the remaining two thirds of the member by normal polarity, which they called the 'Oldhaven magnetozone'. Both stratigraphical levels sampled from the overlying Walton Member of the London Clay have a reverse polarity magnetization, suggesting that the top of the normal polarity magneto-zone approximated to the junction between the two formations.

More recent work by Ali *et al.* (1996), however, indicates that the normal polarity is a recent overprint as a result of the weathering of the section. The whole of the section is therefore characterized by reverse polarity and has been correlated by Ali *et al.* (1996) with Chron C24R.

Contemporary vulcanism

The marked parallel stratification in the cliff represents laterally continuous ash layers. Including the Harwich Stone Band, somewhere around 32 to 34 ash bands are present, their distribution being represented (though not in any detail) in Knox and Ellison (1979, fig. 2) and recently in a more precise log by Jolley (1996, fig. 3, p. 223). The ash layers weather cream to brown but are blue-grey on fresh surfaces. The Harwich Stone Band was not visible during a visit to the site in 1994, but its position approximates to the junction of cliff and foreshore. Daniels (1971) referred to two 'stonebands' separated by 4.25 m of clay, the lower being the Harwich Stone Band (cf. King's 1981 text-fig. 14 representation of Wrabness).

Apart from the Harwich Stone Band, Knox and Ellison (1979) found the more uniform ashes to range from 10 to 80 mm in thickness, that they were mostly altered to bentonite and contained structures such as graded bedding and, more commonly, horizontal- or cross-lamination. Pyroclastic texture and composition are best preserved in the cemented tuffs such as the Harwich Stone Band and where tuffaceous material within concretions has been protected from weathering.

Interpretation and evaluation

Whilst the Wrabness site was recognized by King (1981) to be important stratigraphically as the prime exposure of and type section for his Harwich Member of the London Clay, it is particularly significant on two other counts: firstly, with regard to what it tells us about the distribution of early Eocene pyroclastic deposits and secondly, for contributing to a better understanding of Palaeogene lithostratigraphical relationships and hence also of lateral palaeogeographical variation.

Contemporaneous vulcanism

In their review of the Lower Eocene ash sequence in south-east England, Knox and Ellison (1979) saw Wrabness as the largest and most complete of the onshore ash-bearing 'London Clay' sites. Together, the Shotley Gate Borehole and Wrabness provide a complete sequence of the ash beds. Knox and Ellison (1979) pointed out that most of the ashes above the Harwich Stone Band are laterally persistent (for over 6 km). Whilst the presence of cross-lamination indicates some reworking, such lateral persistence presumably reflects an accumulation in offshore waters below wave base. The better preserved ashes indicate a basic rather than an acid igneous origin.

That the ashes at Wrabness were related to those of the North Sea Palaeogene was accepted from the start, although Jacque and Thouvenin (1975) considered the Harwich ash (then only known as an isolated occurrence) as a little younger than the 'main tuff zone' or 'ash marker' of the North Sea. Knox (1984) was later able to show that the East Anglian ashes could be assigned to subphase 2b of the second of two main phases of Palaeogene pyroclastic activity represented in the North Sea succession. The ashes of subphase 2b are the most widely represented in onshore areas around the North Sea and equate to the lower part of the Balder Formation (see Deegan and Scull (1977) for North Sea lithostratigraphical nomenclature).

Correlation with other Palaeogene strata

Early discussions centred in part around possible relationships between the former Harwich Member and other Palaeogene lithostratigraphical units further to the south. King (1981) and Knox and Harland (1979) considered the then Harwich Member to pre-date the ash-free 'London Clay' of Kent. As early as 1971, Daniels noted the similarity of the fish fauna at Wrabness to that of the Oldhaven Beds, but King (1981) considered that his Oldhaven Formation was older than the Harwich Member, whilst Knox and Harland (1979) argued that the absence of volcanic material in the former made any equivalence unlikely. Yet dinoflagellate data suggested that this could not be ruled out. At Herne Bay, the Oldhaven Formation of King (1981) was of *A. hyperacanthum* age (Knox *et al.,* 1983) whilst the Harwich Member had earlier been assigned to the upper part of this zone (characterized by the acme occurrence of *Deflandrea oebisfeldensis*).

With the discovery of ash in the Oldhaven strata by Knox (1983), a major objection to correlation was set aside, whilst (although now not considered valid) it then appeared to be reconfirmed by the assignment by Townsend and Hailwood (1985) of their normal polarity magnetozone at Wrabness to the Oldhaven Magnetozone. This part of the Wrabness section was thought by Aubry *et al.* (1986) to be of NP10 age and to represent a short-period normal polarity interval within the reversed polarity Chron C24R.

The age of the Harwich Formation at Wrabness and elsewhere and its relationship with the London Clay and adjacent strata is now much clearer (see Ellison *et al.,* 1994). Such a resolution illustrates how different types of data can be brought together to solve a problem. In this instance, mineralogy, biostratigraphy, magnetostratigraphy and an appreciation of facies variation complemented each other. Further clarification continues to arise from more detailed study and it is interesting to note that on the basis of dinoflagellate data, Powell *et al.* (1996, p. 179) recently concluded that the succession at Wrabness has no direct equivalent at Herne Bay.

Depositional environment

It is now accepted that the Harwich Formation at Wrabness represents a 'distal' offshore shelf environment coeval with the shallow shelf conditions represented by the sandier 'Oldhaven Beds' strata, found for example at Herne Bay, representing what Ellison *et al.* (1994) called the 'proximal' facies of the formation.

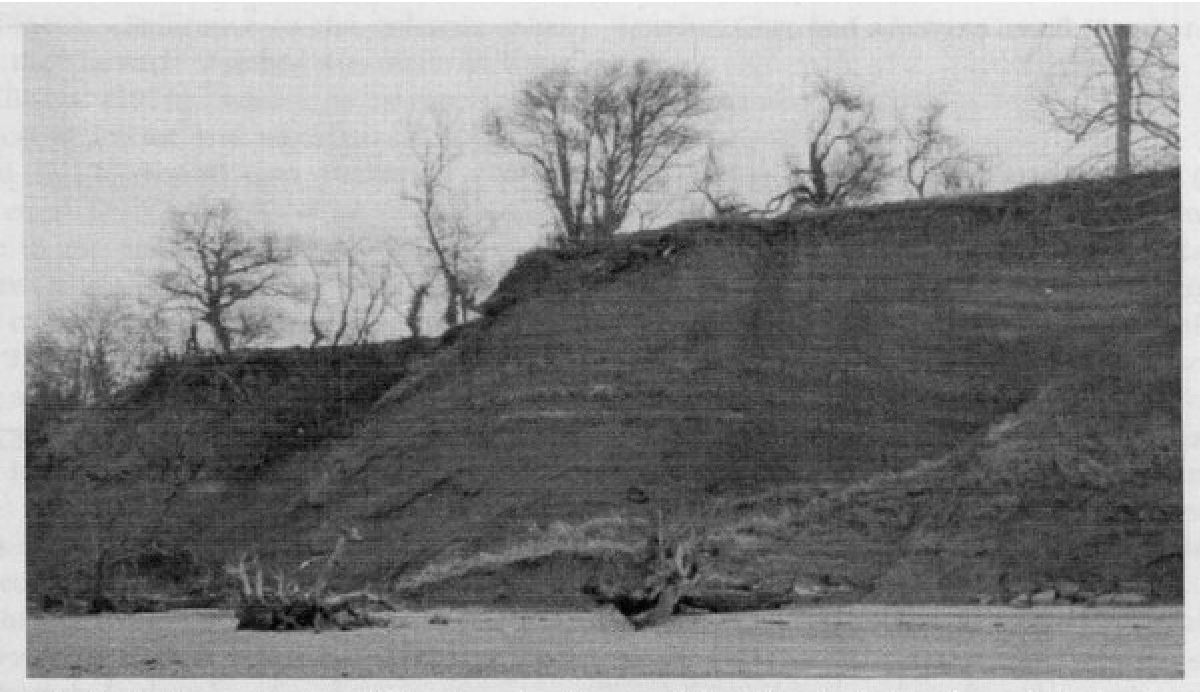
Conclusions

The upper part of the Harwich Formation and the lower few metres of the Walton Member of the London Clay are exposed at Wrabness. This site provides the best exposure of the Harwich Formation, for which it is one of the type sections.

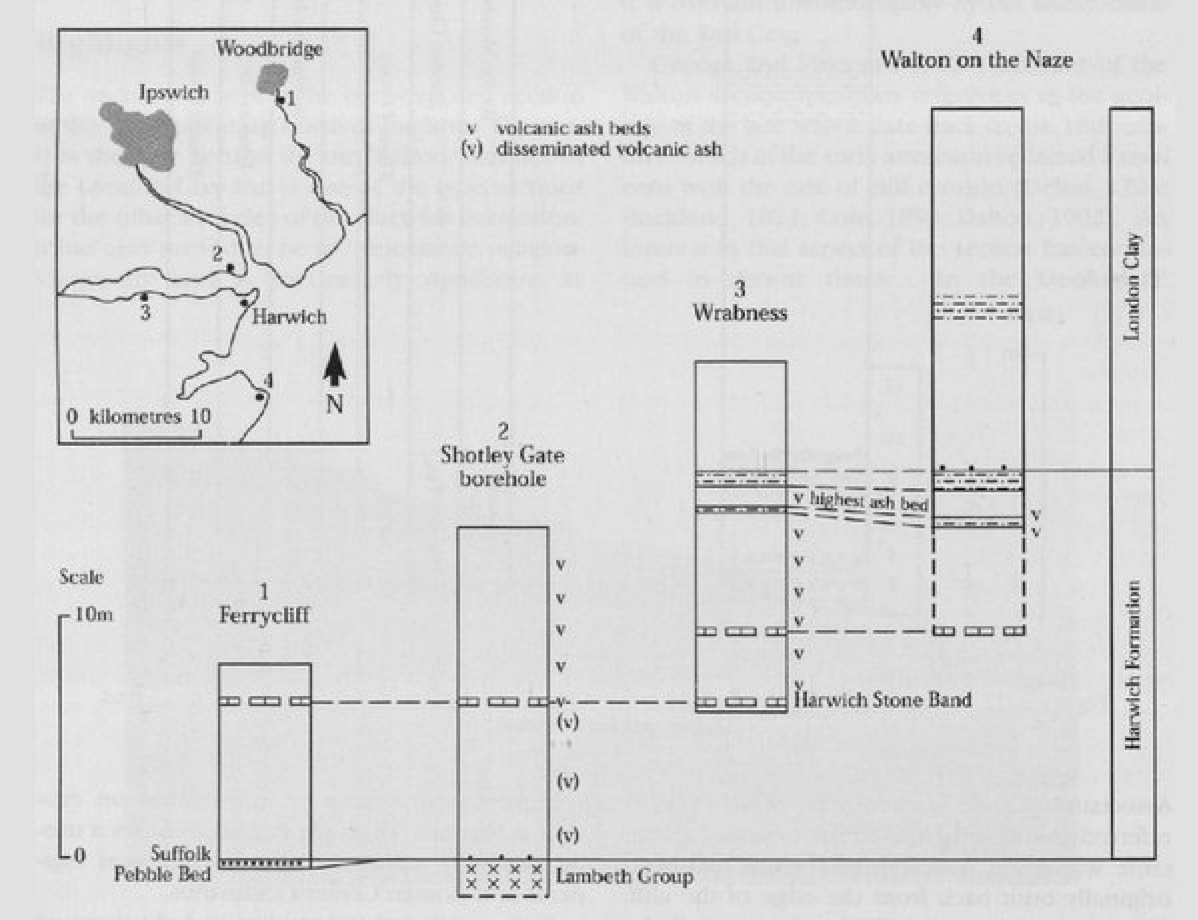
A complete sequence of ash bands is present from the Harwich Stone Band to the top of the Harwich Formation. Something over 30 separate ash layers occur. It is therefore the most important site in southern England at which pyroclastic Palaeogene deposits may be found.

The Harwich Formation at Wrabness represents an offshore facies broadly equivalent to the shallow shelf Oldhaven Beds developed further to the south.

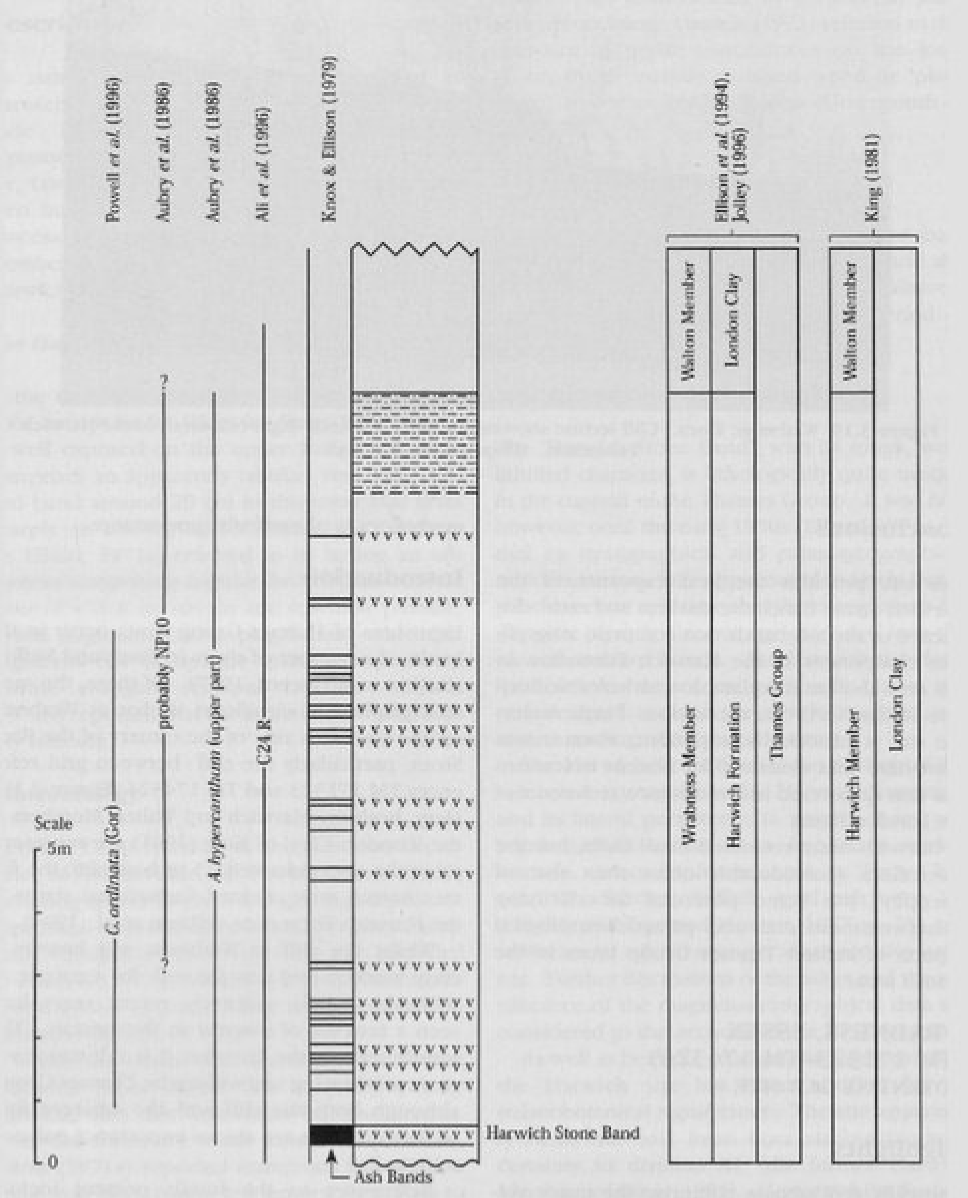
References



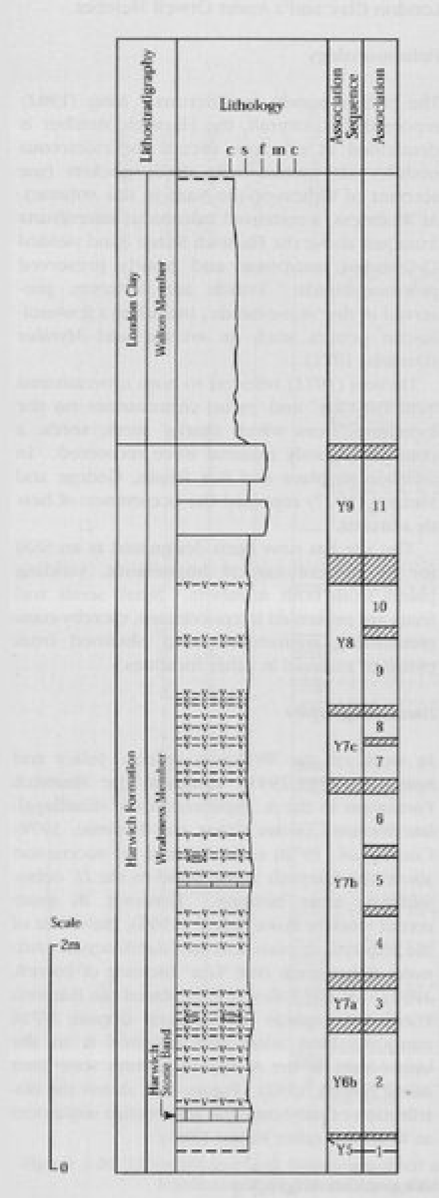
(Figure 3.19) Wrabness, Essex. Cliff section showing parallel ash bands (light-coloured) in the Harwich Formation). (Photograph: B. Daley)



(Figure 3.24) Correlation of the Harwich Formation and London Clay of Ferrycliff, Sussex, Shotley Gate borehole, Wrabness and Walton-on-the-Naze (after King, 1981, text-fig. 14).



(Figure 3.20) Lithostratigraphical, biostratigraphical and magnetostratigraphical succession of the Harwich Formation and London Clay at Wrabness, Essex (after various authors).



(Figure 3.21) Succession at Wrabness, Essex (after Jolley, 1996), to show the relationship of the tephra-bearing lithostratigraphical succession to palynomorph association sequences.