Alum Bay, Isle of Wight

[SZ 305 855]

Highlights

One of the most stratigraphically extensive sections in Western Europe, Alum Bay is the site that best demonstrates the relationship between the more marine succession to the east and the more continental succession to the west. Although less fossiliferous than Whitecliff Bay, it has been an important source of macrofloral remains and for macroinvertebrates at certain levels, such as the Barton Clay. The succession has also proved of importance in microfloral zonation and correlation whilst, from a palaeoenvironmental point of view, a wide variety of depositional conditions are well demonstrated by the succession.

Introduction

For the purposes of this volume, the Totland Bay–Alum Bay site (extending between [SZ 305 852] and [SZ 320 866]) is subdivided into two, both geographically and geologically. The geographical 'boundary' is a short distance to the north of Alum Bay Chine. To the south, a predominantly vertical Palaeogene succession extends from the contact with the Chalk up to and including the Barton Clay (Figure 5.17). This sequence comprises Alum Bay' in the sense used here. Further northwards, predominantly near-horizontal strata extend to Totland Bay. Apart from the Becton Sand at the base, the sequence here comprises the Solent Group up to the Bembridge Limestone Formation. This more northerly part of the site is considered later under the title 'Headon Hill'.

Although mainly known to the general public for its famous coloured sands, the Alum Bay section has been the subject of serious scientific study since the early 19th century. With its continuation in 'Headon Hill', it is one of the most stratigraphically extensive successions in Western Europe, though less so than that of Whitecliff Bay.

From the unconformable contact with the Upper Cretaceous Chalk to the south, a nearly 420 m unbroken succession of near-vertical strata extends northwards to Alum Bay Chine. Predominantly muddy sediments occur near the bottom and top of the succession, whilst the middle part (the Alum Bay Sands of Daley and Insole, 1984) comprises some 230 m of white, yellow, brown and red sands interbedded with brown and grey muds and subordinate lignites.

The first account of the section was provided by Webster (1814), although it was Prestwich (1846) who published the earliest detailed description and whose bed numbers are often still used today (see (Figure 5.21), (Figure 5.22) and (Figure 5.23). Other early general accounts occur in Bristow *et al.* (1889) and White (1921), whilst Fisher (1862) and Gardner *et al.* (1888) undertook more specialist stratigraphical studies.

Over the last thirty years or so, there has been a considerable renewal of interest in the section. Relatively brief descriptions are given in Curry (1968), Curry *et al.* (1972) and Daley and Insole (1984). Recently, a comprehensive account of the whole succession has been published by Daley (1999, pp. 29–39). Parts of it have been studied in some detail by other authors. The presence of fossil soils in the Reading Formation was recognized by Buurman (1975, 1980), whilst King (1981) described the London Clay in his broader study of this formation in southeastern England. Plint (1983a, 1988a) has undertaken a detailed sedimentological study of the Bracklesham Group.

Both the London Clay and the Barton Clay have good molluscan macrofaunas, but these have not been investigated comprehensively in recent years. Crane (1977, 1978) has, however, published on the plant macrofossils, including those from the famous 'Alum Bay Leaf Bed'.

Micropalaeontological studies have included work on the phytoplankton (e.g. Eaton, 1971a,b, 1976) including species of the important dinoflagellate zone fossil *Wetzeliella* (Costa and Downie, 1976). Foraminiferal studies include work by Murray and Wright (1974). Magnetostratigraphical work on the section (Townsend and Hailwood, 1985) subsequently led to research into its relationship with the nannoplankton flora (Aubry *et al.,* 1986).

Description

At the southern end of Alum Bay, where the Chalk cliff extends westwards to terminate in the stacks known as the 'Needles', the Palaeogene sediments lie unconformably on the *Belemnitella mucronata* Zone of the Upper Chalk. As at Whitecliff Bay, there is no angular discordance, although the surface is pot-holed and irregular. Northwards, the near-vertical Palaeogene strata represent a section through the steep, northern limb of the Brighstone Anticline (Figure 5.18).

Lithological succession

The succession in Alum Bay is summarized in (Figure 5.19). Four lithostratigraphical groups are represented: in ascending order, the Lambeth Group, the Thames Group (Figure 5.21), the Bracklesham Group (Figure 5.22) and (Figure 5.23) and the Barton Group (Figure 5.23). The succession is predominantly an alternation of sands and muds. The Reading Formation at the base comprises colour-mottled muds. Above, fining-upwards cycles of the London Clay comprise sometimes glauconitic clays to fine sand. In the Alum Bay Sands' of Daley and Insole (1984) (Bracklesham Group and overlying Boscombe Sand), five sand bodies alternate with laminated strata comprising finely interbedded muds (clay/silt mixtures) and sands (Figure 5.20). Some horizons contain a good deal of lignitic matter. The Barton Group sediments comprise sometimes glauconitic muds and sandy muds below (Barton Clay) and pale quartz sands at the top (Becton Sand). Rudaceous rocks are confined to relatively few horizons. Flint pebbles occur at the contact with the Chalk and within the London Clay, whilst the band of large flint pebbles at the top of the Boscombe Sand is a distinctive marker horizon (Figure 5.23). Concretions occur within some of the muds and several ironstone bands are present in the Bracklesham Group strata but elsewhere the succession is unlithified.

Stratigraphy

The thick and well-exposed sequence attracted the early attention of geologists attempting to establish a local stratigraphical succession. The most significant early stratigraphical work on the section was that of Prestwich (1846, 1847) whose bed-numbering system continues to be of considerable practical value. However, although the section has been studied for many years, only recently has a consensus begun to emerge regarding lithostratigraphy and nomenclature. Differences of opinion have reflected the lateral variation in facies which characterizes the local Palaeogene and the difficulty in assigning the beds at Alum Bay to stratigraphical units named and defined elsewhere. Other differences in the definition of stratal units resulted from disagreement over stratigraphical principles (see Daley *et al.,* 1979).

Alum Bay provides a number of examples of the difficulty encountered in stratigraphical classification and nomenclature. The use of the term Reading Formation (Reading Beds, Reading Clay) follows Edwards and Freshney (1987b) who designated the section here as the Hampshire Basin hypostratotype. The more recent definition by Ellison *et al.* (1994) seems difficult to apply in the Hampshire Basin and has not been adopted for the Alum Bay succession.

There is considerable disagreement over the definition of the London Clay (Figure 5.21). According to White (1921) it is some 124 m thick and includes Prestwich Bed 13. Whilst a number of more recent accounts follow this usage, the present author agrees with Murray and Wright (1974) and Eaton (1976) that the beds younger than Prestwich Bed 6 are logically more allied to the overlying strata. This accords with Prestwich's own usage for the London Clay, but is at variance with the views of King (1981) who carried out the most comprehensive study of the London Clay in recent years and who prefers to include Prestwich Bed 7 in the formation. Furthermore, the lowest 4.3 m (the Basement Bed; see White 1921, p. 87) was assigned to the Oldhaven Formation by King (1981, p. 91), although this is not separately mappable locally and hence not a *bona fide* formation *sensu* Hedberg (1976) (see also Edwards and Freshney, 1987b, p. 49). Consequently, by definition, the Harwich Formation (within which the 'Oldhaven Beds' were placed by Ellison *et al.,* 1994) is not recognized in Alum Bay.

Above the London Clay is a thick sequence of variously coloured sands and muds with subordinate lignites, whose stratigraphical affinities and nomenclature have been under discussion since the 19th century (Figure 5.22) and (Figure 5.23). Parts of the sequence have at various times been assigned to the London Clay, the Bagshot Beds and the Bracklesham Beds of earlier authors. Daley and Insole (1984) used the informal name Alum Bay Sands', to include Prestwich Beds 7 to 28 inclusive, partly in order to emphasize the difference in lithological character between this section and others such as Whitecliff Bay. In the most detailed modern sedimentological study of this part of the succession, Plint (1983a) used the term Bracklesham Formation for Prestwich Beds 12 to 29. More recently, Edwards and Freshney (1987b) assigned various parts of the sequence to formations within the Bracklesham and Bournemouth Groups which Interdigitate' in Alum Bay, although the latter term has now been superseded (Bristow *et al.,* 1991; see also (Figure 5.22)).

Following Edwards and Freshney (1987b), Prestwich Bed 29 is included in the Barton Clay and not in the 'Upper Bracklesham Beds' of previous authors (e.g. Curry *et al.,* 1972). This reflects its lithological affinity with the overlying strata and is compatible with the inclusion of the Huntingbridge Division of Curry *et al.* (1977) in the Barton Clay by Edwards and Freshney (1987a).

Sedimentary cyclicity

The cyclic nature of the Palaeogene succession is demonstrated by the Alum Bay section. King (1981) recognized his 'divisions' A and B here (with no representative of the Bognor Member; (Figure 5.21)). Division C is also present, but the definition of D and its relationship to C is less clear. King suggested (p. 93) that the top of the C–D sequence here is represented by the sand at the top of Prestwich Bed 7 and that this may be his Whitecliff Bay Member.

Plint (1983a) recognized five cycles in his Bracklesham Formation at Alum Bay (Figure 5.24), the lowest of which commences towards the top of Prestwich 'Bed 12'. Between the cycles of King (1981) and Plint (1983a) are a series of lenticular-bedded and flaser-bedded clays and sands underlain by a pebble horizon at the bottom of Prestwich Bed 8. King (p. 93) referred to a glauconitic unit within this part of the sequence with rare casts of marine macrofossils (echinoids) and pyritized diatoms. It seems likely, therefore, that these beds are also cyclic with a clearly demonstrable transgressive component. In a later paper, Plint (1988a) developed the idea that whilst some of the erosion surfaces in the succession represent transgressive events, others reflect lowstand erosion and channel incision.

Invertebrate macrofauna

Palaeontologically, Alum Bay is an important section. King (1981) recorded a number of molluscs from his 'Oldhaven Formation' and the London Clay but only up to the higher part of cycle B of the latter. The Barton Clay has a rich and well-preserved macrofauna. A number of species are listed in White (1921, p. 96) but there is no recent published research on this fauna. In contrast with the sections at Bracklesham and Whitecliff Bays, the 'Bracklesham Beds' have no recorded macrofauna except very close to the base, an indication of the relatively 'continental' aspect of this more westerly section. Brachiopods are not particularly common in the local Palaeogene strata. Hence, the occurrence of *Discinisca* attached to *Astarte* valves towards the base of the London Clay is of some interest (Muir-Wood, 1939).

Macroflora

The macrofloral remains in the Alum Bay section are particularly important and contribute to our understanding of early Tertiary vegetation and climate. The best-known plant horizon is the Alum Bay Leaf Bed' (see (Figure 5.22), Prestwich Bed 17), an almost white 'pipe-clay' some 1.4 m in thickness. Leaves have been studied from this horizon since the 19th century (e.g. De la Harpe and Salter, 1862; Gardner and von Ettinghausen, 1879) but are less common now than they once were. The flora has been reviewed by Crane ([1]977, 1978). Most of the leaves have entire margins, an indication of tropicality. The angiosperm families particularly represented are the Lauraceae, Leguminosae and Moracae.

Crane (1977) found a second plant bed higher up the succession (towards the base of Prestwich Bed 24; (Figure 5.22)) which contains leaves with well-preserved cuticles. From this horizon, he identified a fern, *Osmunda lignitum,* a conifer and eight angiosperms.

Microfauna

The microfauna of the section has been studied in some detail. No nummulitids have been found in the 'Alum Bay Sands' but are present in the overlying Barton Clay. Numerous *Nummulites prestwichianus* occur in a bed formerly used to define the base of the Barton Clay, whilst *N. rectus* occurs somewhat higher up, in the upper part of the 'Lower Barton Beds' of Gardner *et al.* (1888).

Other microfaunal work on the section includes that on ostracods by Haskins (1970). Foraminifera were investigated by Bowen (1954), Kaasschieter (1961) and more recently, Murray and Wright (1974), as part of a wider comprehensive investigation of Palaeogene foraminifera in the Hampshire Basin. Although absent from the Alum Bay Sands', a number of foraminiferal assemblages occur in the London Clay and Barton Clay. Lower diversity assemblages characterize the London Clay, and Murray and Wright (1974) interpret them as representing shallow, slightly hyposaline (32–33%), shelf conditions. Faunas devoid of planktonic species are indicative of a restricted situation with limited connections with the open sea. The presence of planktonic species, by contrast, suggests improved circulation, cf the 'Planktonic Datum' of Wright (1972), which in Alum Bay falls just above the base of King's cycle B. Most genera from the Barton Clay are typical shelf forms living on a fine substrate in turbid water of 1–100 m depth, whilst low-diversity values again suggest hyposaline conditions.

Calcareous nannoplankton biostratigraphy

Calcareous nannoplankton is apparently absent from the Alum Bay succession below Prestwich Bed 29 which yields scarce nannofossils including *Reticulofenestra reticulata* indicative of NP Zone 16 (Aubry *et al.,* Hailwood and Townsend, 1986). Above, the 'Lower Barton Beds' yield a rich calcareous nannoflora indicating upper NP16, whilst the overlying 'Barton Beds' belong to NP17.

Dinoflagellate biostratigraphy

Some of the most important micropalaeontological work on the section in recent years has been on the dinoflagellate microflora and its significance for correlation. It has proved particularly important in those parts of the succession (e.g. in the Alum Bay Sands') where the dinoflagellates, together with pollen and spores, are the only fossils preserved. Moreover, they are especially important where at different localities, the successions are difficult to match lithologically.

Eaton's (1971a,b) study of the dinoflagellate cysts and acritarchs enabled him to establish five microplankton zones which could be used to correlate the 'Bracklesham Beds' of Alum and Whitecliff Bays. At Alum Bay, the relationship of these zones to the lithological succession (using Prestwich Bed numbers) is as follows: Zone 1 (Beds 8 to 13, in part); Zone 2 (Beds 13, in part, to 15, in part); Zone 3 (Beds 15, in part, to 24, in part); Zone 4 (Beds 24, in part, to 28, in part); Zone 5 (Beds 28, in part, to 29). These he described in some detail in a later paper (Eaton, 1976), whilst they are formally defined in Bujak *et al.* (1980). Current lithostratigraphical usage means that Eaton's uppermost zone partially falls within the Barton Clay.

Of the five dinoflagellate zones which Bujak *et al.* (1980) recognized from the Barton Beds, four have been found at Alum Bay (Figure 5.23). The uppermost zone is not represented because, the authors suggest, marine strata of this age are absent from the section.

The important zonal dinoflagellate genus *Wetzeliella* is represented by *Wetzeliella* (*Apectodinium*)*homomorpha,* which, according to Costa and Downie (1976), is abundant at certain horizons within the London Clay and 'Bracklesham Beds' of Alum Bay. According to these authors, a number of their *Wetzeliella* species zones are represented in Alum Bay: the *W. meckelfeldensis* Zone (London Clay, below Wright's (1972) planktonic foram datum), the *W. similis* Zone (London Clay, above Wrights datum), the W. *coleothrypta* Zone (Bracklesham Beds, no specific horizon named), and the W. *draco* Zone (base of the 'Lower Barton Clays' up to 36 m) (see Bujak *et al.,* 1980).

Magnetostratigraphy

With Whitecliff Bay, Alum Bay has proved very important in recent magnetostratigraphical work undertaken by Townsend and Hailwood (1985). Five normal polarity magnetozones have been recognized by these authors: two in the London Clay (LCI and LCII magnetozones); two in the 'Bracklesham Beds' (the Wittering magnetozone and the Earnley magnetozone); and one spanning the 'Bracklesham Beds'/Barton Clay boundary (the Huntingbridge magnetozone) (see (Figure 5.21) to (Figure 5.23)). Subsequently, and following the integration of magnetostratigraphical and nannofossil data, they have now been assigned to magnetostratigraphical chrons (Aubry *et al.,* 1986).

Detrital mineralogy

Very little mineralogical work has been undertaken on the Alum Bay section. It was sampled by Walder (1964) but not by Morton (1982b) in his recent study of heavy minerals from the Hampshire Basin. Gilkes' (1968, 1978) study of the clay mineralogy contributes to our understanding of contemporary palaeogeography and provenance. The relatively 'continental' 'Bracklesham Beds' of Alum Bay have a predominantly kaolinite/illite mineralogy, derived from the west, not necessarily directly from Cornubia but from the erosion of earlier Eocene sediments. This suite contrasts with the smectite/illite suite of the 'Bracklesham Beds' of Whitecliff Bay.

Palaeopedology

The Reading Formation of Alum Bay has been the subject of the only published comprehensive study to date of fossil gley soils in the local Palaeogene succession (Buurman, 1975, 1980).

The Reading Formation succession is generally well exposed and accessible in contrast with the slumped and obscured section in Whitecliff Bay. Buurman (1975) used the Reading Formation of Alum Bay to examine the contribution of palaeopedology to a better understanding of stratigraphy, palaeohydrology and palaeoclimatology. Buurman (1980) recognized hydromorphic gley soils and interpreted them as developing in a warm climate with a marked dry season. His suggestion that the Reading Formation is of 'fluviomarine' origin contrasts with the fluvial interpretation of earlier workers.

Sedimentology

Detailed sedimentological work on the succession has mainly concentrated on the various formations within the Bracklesham Group (Plint, 1983a; (Figure 5.24)), since King (1981) provides but a brief lithological description of the London Clay. Plint (1983a) concluded that alluvial sediments dominate the Bracklesham Group to the west of Alum Bay, whilst off-shore sediments are predominant to the east. With its succession of alternating marine, estuarine, lagoonal and allu vial strata, its development in Alum Bay therefore provides a critical insight into the relationship between the more continental conditions to the west and those of more marine aspect to the east.

Interpretation and evaluation

Like Whitecliff Bay to the east, the Alum Bay Palaeogene succession has been extensively studied since the early part of the 19th century. From the Reading Formation to the Barton Clay, the occurrence of around 420 m of more or less continuously exposed strata ranks as one of the finest Palaeogene sections in north-western Europe. With the continuation of the section in Headon Hill (see separate account), a stratigraphical range almost as great as that in Whitecliff Bay may be examined. General features of note include the greater degree of continentality represented by the Alum Bay succession compared with more easterly exposures, and from a popular, touristic point of view, the famous coloured sands for which the site is particularly well known.

Stratigraphical definition and terminology

Although the same stratigraphical terminology has been used for Alum Bay and for Whitecliff Bay by many workers, the definition of individual stratigraphical units and their correlation has been a matter for discussion over many years. The London Clay exemplifies the type of difficulty experienced. At Alum Bay, at least three different horizons have been used to define its top, a difficulty that is compounded with the problem of whether or not it should include the Oldhaven Formation of King (1981). Consequently, quite different thicknesses have been attributed to the London Clay, from the

124 m or so of White (1921) to the approximately 71 m of Edwards and Freshney (1986, p. 53). Interestingly, the latter thickness, adopted in this account, follows the original usage of Prestwich (1846) and that in the 1889 Geological Survey Memoir (Bristow *et al.,* 1989).

Difficulties in correlation in part reflect the problem of relating the more marine beds in Whitecliff Bay to the more continental Alum Bay sequence. This is particularly true of the thick sequence of mainly sands and muds succeeding London Clay, included in the 'Bracklesham Beds' of White (1921) and the Bracklesham Formation of Plint (1983a). As Edwards and Freshney (1986, p. 46) pointed out, Plint used the term Bracklesham Formation chronostratigraphically to describe a laterally variable 'packet' of strata between the London Clay Formation of King (1981) and the 'Barton Formation' of Curry *et al.* (1978) and is invalid lithostratigraphically. Indeed, the use of Bracklesham Beds or Bracklesham Formation for the Alum Bay section appears to reflect more a desire for stratal continuity or persistence than the recognition of lateral differences.

Not that all have followed this practice. Bristow *et al.* (1889) used the term 'Lower Bagshot Sands' for 202 m of strata above Prestwich Bed 6 in Alum Bay, whilst, more recently, Daley and Insole (1984) adopted the informal term 'Alum Bay Sands' for some 230 m of the succession culminating in the coarse conglomerate below the Barton Clay. Edwards and Freshney (1987b, p. 56) considered the Alum Bay section to represent a zone of interdigitation between the dominantly fluvial to barrier shoreline sands of their 'westerly' Bournemouth Group and the laminated clays and sands of the Bracklesham Group more extensively developed in Whitecliff Bay. Strata included by Edwards and Freshney in the Bournemouth Group are Prestwich Beds 14–18, 21–23 and 25–27. More recently (Bristow *et al.,* 1991), it has been argued that there is insignificant justification for having two groups and that their formations should all be assigned to the Bracklesham Group.

Little disagreement now exists over defining the base of the Barton Clay. The muds above the coarse conglomerate at the top of Prestwich Bed 28 are included in the latter, following Freshney and Edwards (1987a, pp. 64–5). Formerly, the base of the formation had been placed at the *N. prestwichianus* horizon by Curry *et al.* (1972) and earlier authors, following Gardner *et al.* (1888) (see also discussion of the Whitecliff Bay site elsewhere in this volume).

Comparison with other sites

Apart from the problems of definition and nomenclature, the succession of Alum Bay differs in various ways from those of other local Palaeogene sites. The Reading Formation is only half the thickness of that at Whitecliff Bay, yet what it lacks in quantity it makes up for in quality. In designating it as the Hampshire Basin hypostratotype, Edwards and Freshney (1986, p. 47) referred to the section as 'probably the best natural exposure of the Reading Formation'.

Comparison of the thickness of the London Clay in Alum Bay with other sections depends partly on definitions, as has already been discussed. Following Edwards and Freshney (1987b), it is, at some 71 m, almost exactly half of the 142.3 m of Whitecliff Bay from which the formation continues to thicken eastwards (e.g. around 155 m at Sheppey; see King, 1981, pp. 52–4). The westward thinning (see isopachyte map in King 1981, fig. 40) is also apparent from individual London Clay cycles. King's cycles (divisions) A and B thin from 37.5 m and 39.8 m in Whitecliff Bay to 16 m and 38 m respectively in Alum Bay. The London Clay of Alum is nevertheless thicker than in Dorset to the west, where, for example, only 28 m occurs in the Bere Heath borehole [SY 860 921].

Correlating the strata between the London Clay and Barton Clay with the succession in Whitecliff Bay is difficult since they differ in a number of ways (see later discussion of palaeoenvironments and also (Figure 5.28)). The Wittering Formation is probably represented at Alum Bay by Prestwich Beds 7–13 and 19–20 whilst the richly glauconitic and fossilferous marine Earnley Sand is absent (Edwards and Freshney, 1987b). These authors consider that the lignitic and laminated sediments of Prestwich Bed 24 correlate with the Marsh Farm Formation, whilst Prestwich Beds 25 and 26 represent shoreface sands of the Branksome Sand Formation, the lateral equivalent of the Selsey Sand found further east. Edwards and Freshney (1987b) have assigned Prestwich Bed 29 to the Boscombe Sand. At Alum Bay, this formation is about the same thickness as at Christchurch but passes eastwards across the Isle of Wight into marine clays.

Unlike the section at Whitecliff Bay, exposures of the Barton Clay are generally good and exhibit a rich and mostly well-preserved invertebrate fauna. At something over 80 m, the formation is twice as thick as at Barton itself.

Macrofossil remains

Apart from the London Clay and the Barton Clay, the Alum Bay section is not well endowed with macrofossil remains. In the Bracklesham Group, macroinvertebrates are rarely found; there are no nummulitids, but rare echinoid casts, together with rich dinoflagellate assemblages, confirm the former existence of marine conditions at various horizons. A plus for the section is the presence of leaf floras at two horizons, where good cuticular preservation provides improved opportunities for taxonomic assessment and comparison with other Eocene floras on the continent and from North America (Crane, 1977, p. 96). Several of the species found also occur in leaf beds at Bournemouth (Collinson and Hooker, 1987, p. 267).

Biostratigraphy and chronostratigraphy

The importance of the Alum Bay section for developing a local dinoflagellate zonation has already been referred to. As Edwards and Freshney (1987a, p. 12) pointed out, however, dinoflagellates are less valuable for correlating in fluctuating marginal marine environments than had previously been realized. This must particularly apply to the Bracklesham Group, although for the more marine Barton Clay the dinoflagellate floras are more reliable. The diachroneity of Eaton's (1971a,b) microplankton zones is indicated by magnetostratigraphical work undertaken by Townsend and Hailwood (1985). They found Eaton's Zone 1/2 and Zone 3/4 boundaries were younger at Alum Bay than at Whitecliff Bay and concluded that changes in the microplankton assemblages forming the basis for Eaton's zones are environmentally influenced. Presumably the 'younger' zonal boundaries in Alum Bay reflect the time taken for the westerly progression of transgressions from a marine area to the east. Townsend and Hailwood also established the diachronous nature of the transgressive surfaces described by Plint (1980, 1983a). Furthermore, the Alum Bay section contributes evidence that the regressive top of the London Clay was markedly diachronous. *D. similis* occurs in the upper part of the London Clay in Alum Bay, whilst the earlier W. *meckelfeldensis* occurs below the top of the unit at Studland and the younger *D. varielongituda* occupies this position in the London Clay (*sensu* King, 1981) of Whitecliff Bay (Costa and Downie, 1976).

No zone fossils occur in the Reading Formation at Alum Bay. Elsewhere, however, this formation has been assigned to the A. *hypercanthum* Zone (Costa *et al.,* 1978) which is approximately equivalent to nannoplankton (NP) Zone 9 and planktonic foraminifera Zone P5 (see Curry *et al.,* 1978).

The occurrence of the three zonal species *W. meckelfeldensis, D. similis* and *K. coelothrypta* facilitates correlation not only with other British sections but with Belgium and northern Germany (Costa and Downie, 1976, p. 601). Whether the zones established by Bujak *et al.* (1980) can be as widely used is less clear.

Of all the formations in Alum Bay, the Barton Clay is the easiest to date palaeontologically, since it contains not only *Nummulites* and *W. draco* but some nannoplankton. The suggestion by Curry *et al.* (1978) that the formation was approximately equivalent to nannoplankton Zones 16 and 17 has now been confirmed by Aubry *et al.* (1986). The magnetostratigraphical zones recognized at Alum Bay have already been referred to but their development is of particular significance for sections such as this which are relatively poorly endowed with good zone fossils. Having said this, the importance of combining and relating magnetostratigraphical and palaeontological information is well illustrated by an example from Alum Bay (see below).

Palaeogeography and depositional environments

On the basis of dinoflagellate stratigraphy, Islam (1981, 1983a) concluded that at Alum Bay a surface of erosion/non-deposition occurs between the Wittering and Earnley 'divisions' or cycles. Such a relationship is not surprising since the base of each cycle represents a transgressive and hence erosive event. However, this surface has been shown to correspond with others elsewhere such as that forming the boundary between the Jeper and Panisel Formations in Belgium (Islam, 1981). Significantly, the absence of any record of the magnetostratigraphical unit Chron C22N from the Palaeogene sequence of the London and Hampshire Basins (Aubry *et al.,* 1986) more or less coincides with Islam's surface of erosion/non-deposition. Aubry *et al.* (1986) concluded that this combination of evidence indicates a worldwide drop in sea level, marked by the occurrence of lignites above this 'unconformity' both in Britain and Belgium. Such a regression is recorded locally by the distinctive marker horizon, the Whitecliff Bay' Bed, which, according to Edwards and Freshney (1987b, p. 60), may be represented by Prestwich Bed 19 at Alum Bay.

The palaeoenvironmental significance of the Alum Bay section has already been referred to *en passant.* Within the Bracklesham Group in particular, the section represents a vital link between more continental strata to the west and more marine sediments to the east. Plint (1983a, 1988a) considered that this part of the sequence represented a complicated interplay between alluvial, coastal and marine processes in which shoreface sands, lagoonal and marine sediments predominated, with intercalated alluvial and offshore marine sediments respectively representing the more regressive and transgressive phases of the sedimentary cycles. However, at Alum Bay the effect of the transgressions was more limited. The glauconitic Earnley and Selsey Sands with their marine faunas are not present. The former is represented by beach or shoreface sands (Plint, 1983a; Prestwich Bed 21) whilst the equivalent of the latter comprises shoreface sands (Prestwich Beds 25 and 26) succeeded by a succession of lignites and palaeosols probably representing coastal marshes (Prestwich Bed 27) (Plint, 1983a; Edwards and Freshney, 1986).

Whilst Alum Bay has already been extensively studied, it clearly has potential for more research. This could include modern taxonomic and palaeoecological work on macroinvertebrate faunas such as those of the Barton Clay, whilst a number of horizons could contribute to a broader palaeopedological investigation of the lower Palaeogene strata.

Conclusions

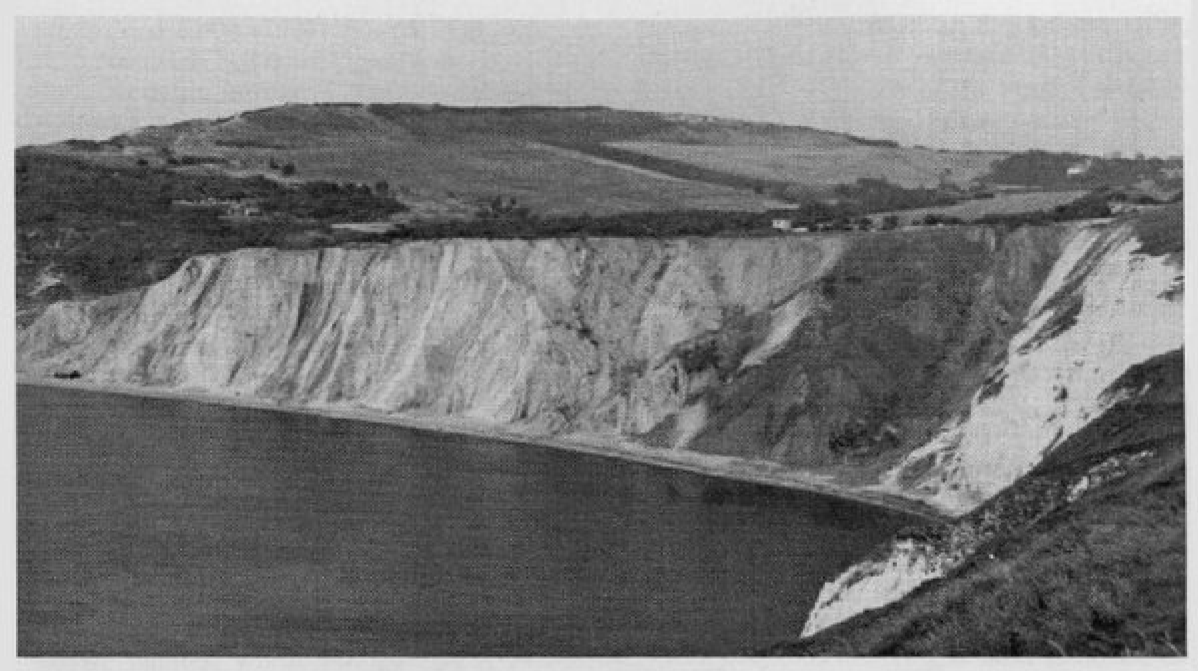
Since the early 19th century, the Palaeogene rocks in Alum Bay have attracted the attention of researchers in many aspects of geology. It helped early geologists begin to understand the stratigraphy of the Tertiary strata in the Hampshire Basin, and more recently has contributed to many aspects of palaeoenvironmental research.

Comprising some 420 m of strata, and representing in excess of 15 million years of deposition, it is stratigraphically more extensive than any other Palaeogene section in Britain apart from that at Whitecliff Bay. Indisputably, it is one of the finest Palaeogene sites in Western Europe. Stratigraphically a 'difficult' section, it exemplifies some of the problems of stratigraphical classification and nomenclature which are a particular feature of paralic successions. The placing of the upper boundary of the London Clay and the lithostratigraphical affinities of the constituent parts of the Bracklesham Group are two examples.

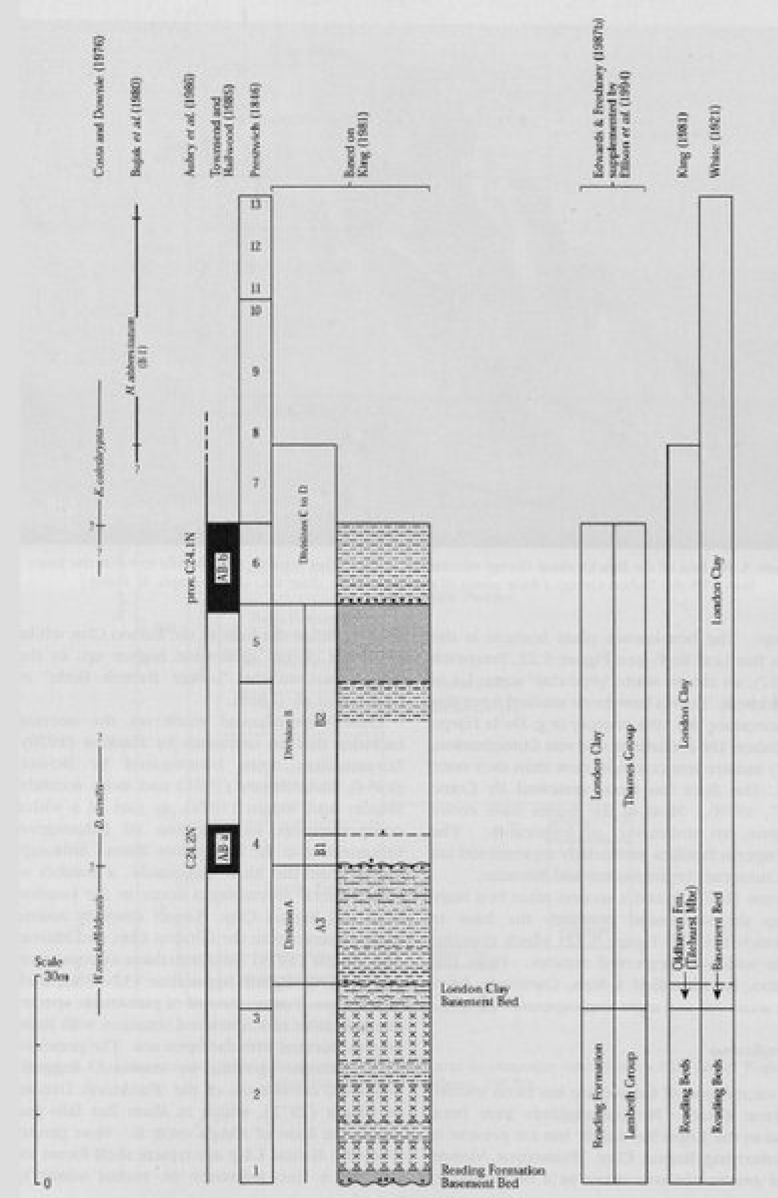
Although generally poorly fossiliferous compared with Whitecliff Bay, the section has proved important from various aspects of correlation. Together with Whitecliff Bay, it facilitated the establishment of a local zonation based on dinoflagellates and contributed to the development of the 'event' stratigraphy of King (1981) and Plint (1983). More recently, the recognition of magnetostratigraphical zones at both Alum Bay and Whitecliff Bays, has shown that both the dinoflagellate zonal boundaries and the surfaces representing transgressive 'events' are diachronous.

Perhaps the most significant aspect of the Alum Bay section is that it provides a major key to the palaeogeographical interpretation of the local Palaeogene strata. It is, in fact, the site that best demonstrates the relationship between the predominantly marine succession of Whitecliff Bay to the east with the more continental succession to the west. This is particularly true at the level for the Bracklesham Group whose constituent formations represent the complicated interplay between alluvial, coastal and marine processes in a paralic situation.

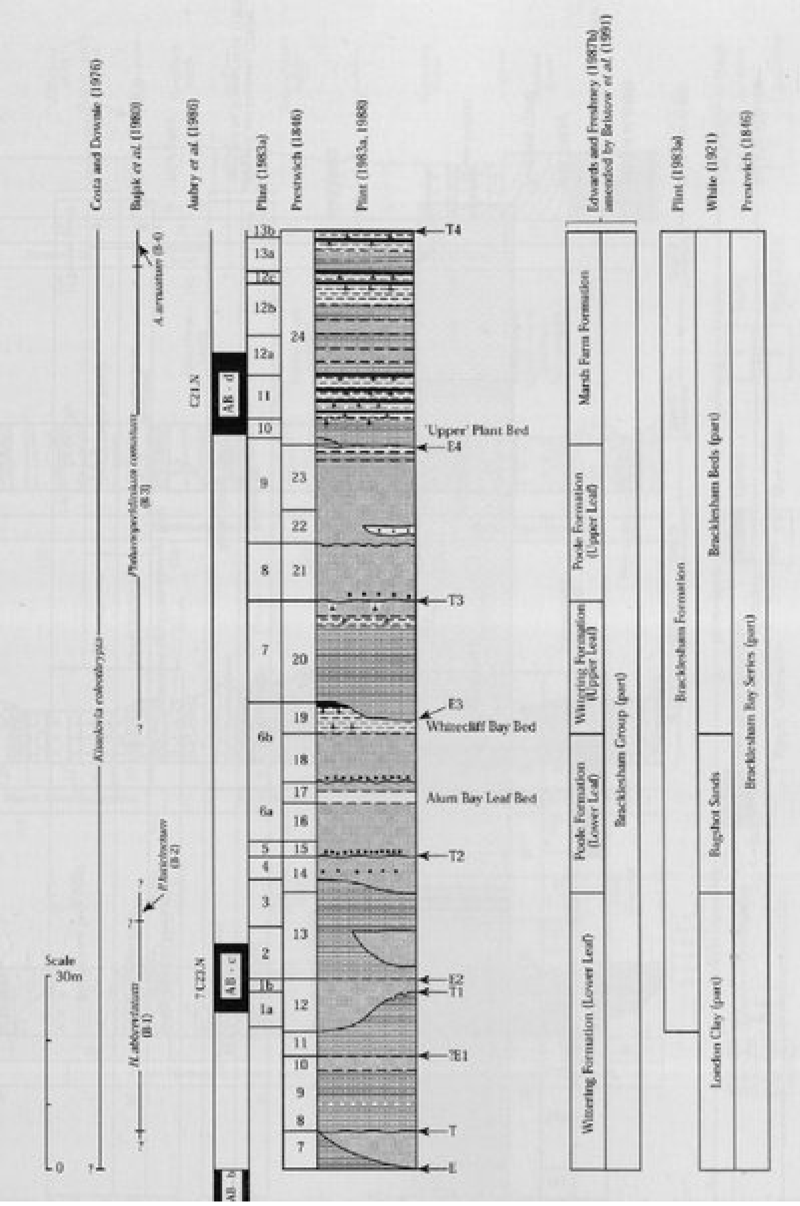
References



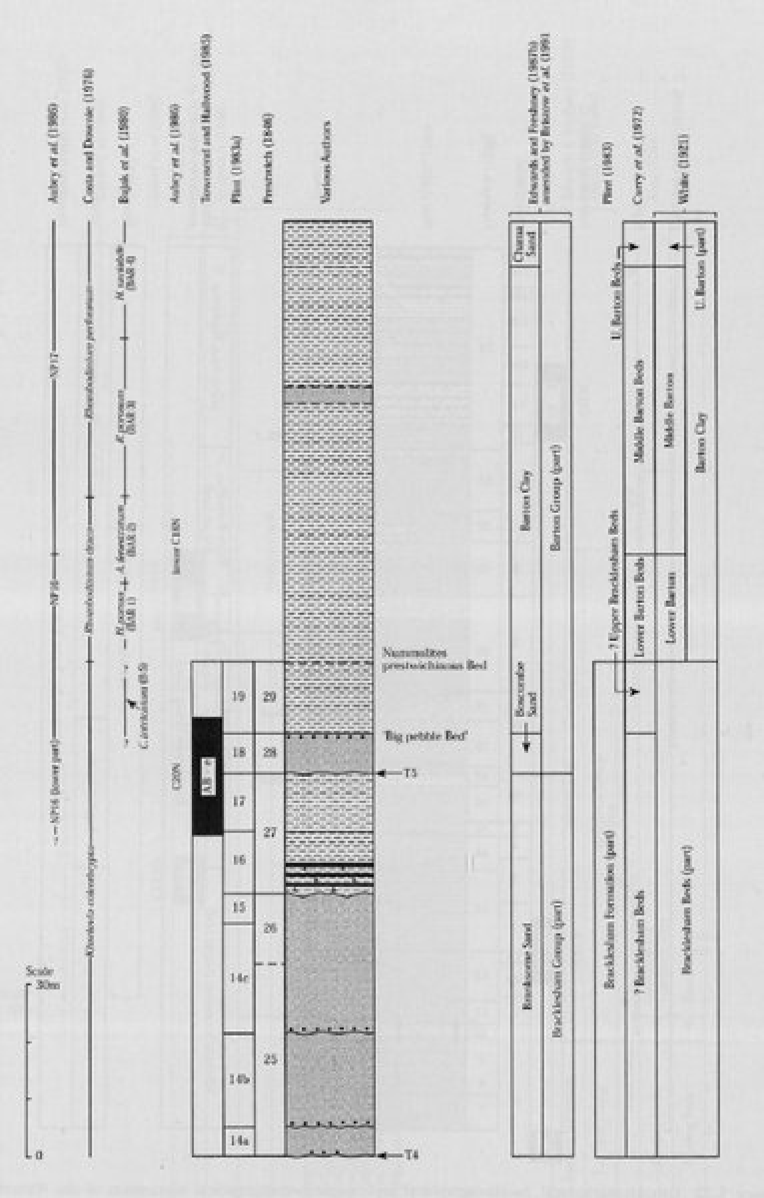
(Figure 5.17) Alum Bay, Isle of Wight, viewed from West High Down. Steeply dipping, light-coloured Bracklesham Group Strata form the central part of the cliff section. To their right (south), the darker units are the London Clay and (forming a gully) the Reading Formation which rests unconformably on the Chalk. The lower cliff profile at the left (north) of the photograph comprises the Barton Clay. (Photograph: B. Daley.)



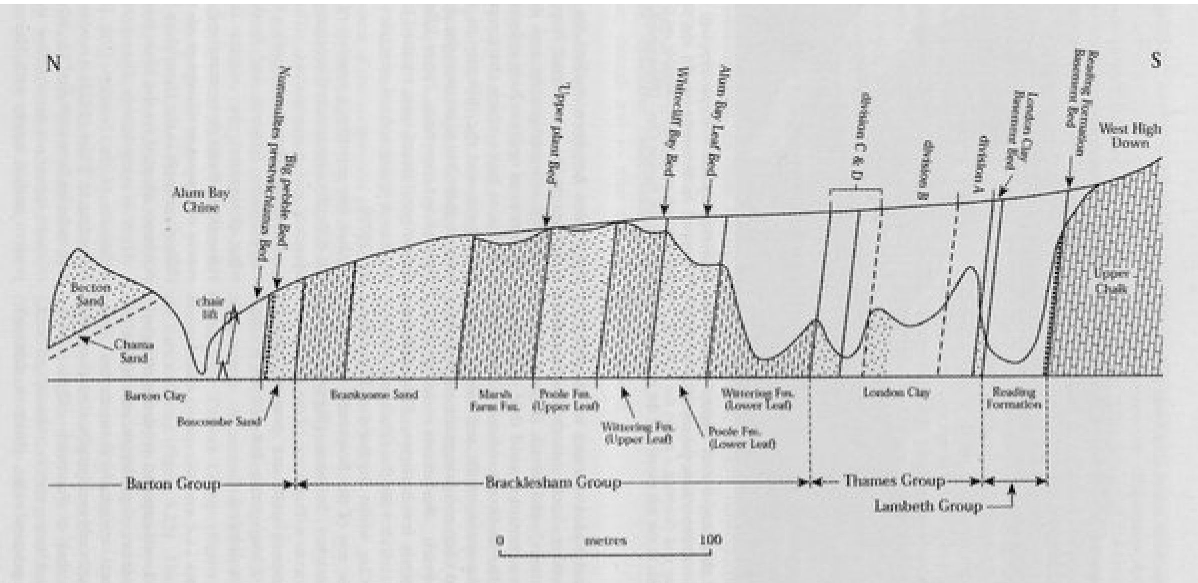
(Figure 5.21) Lithostratigraphical, biostratigraphical and magnetostratigraphical succession of the Reading Formation and London Clay, Alum Bay, Isle of Wight (after King, 1981 and other authors). (Figure 5.22) Lithostratigraphical, biostratigraphical and magnetostratigraphical succession of the Wittering, Poole and Marsh Farm Formations (Bracklesham Group), Alum Bay, Isle of 'Wight (after Plint, 1983a; Edwards and Freshney, 1987b and other authors).



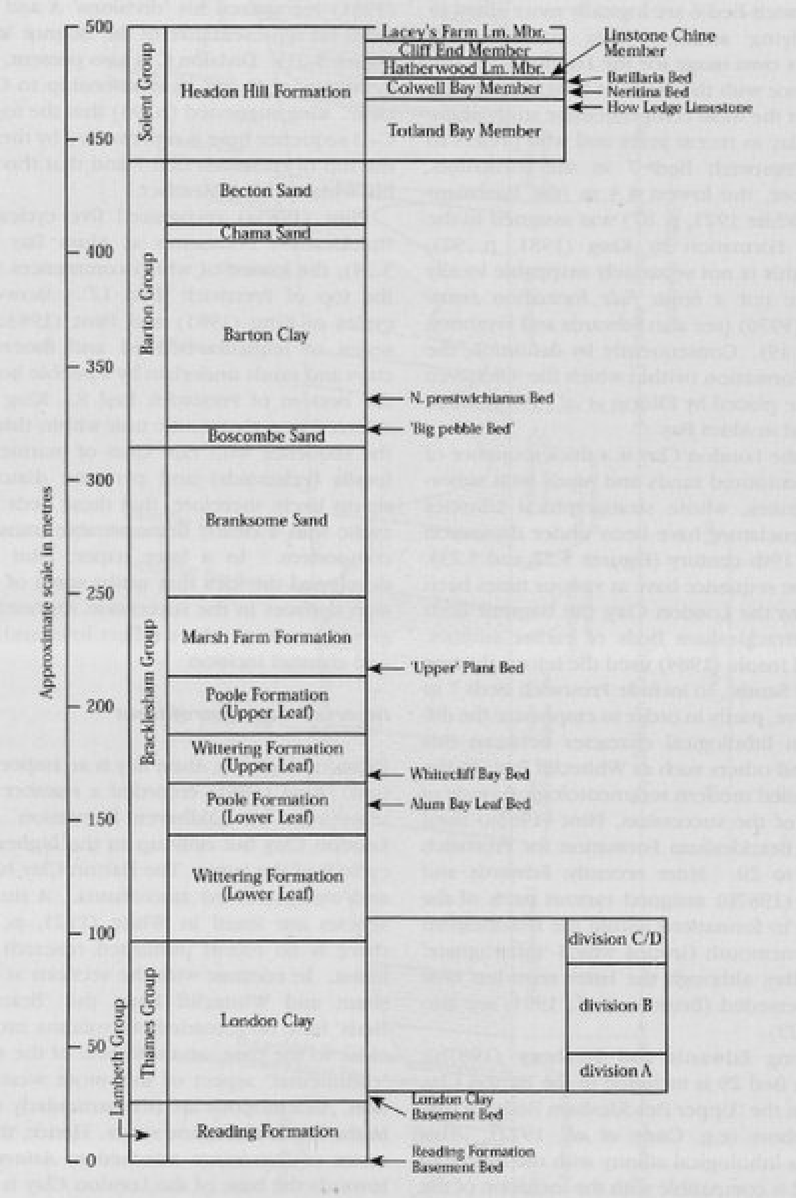
(Figure 5.22) Lithostratigraphical, biostratigraphical and magnetostratigraphical succession of the Wittering, Poole and Marsh Farm Formations (Bracklesham Group), Alum Bay, Isle of Wight (after Plint, 1983a; Edwards and Freshney, 1987b and other authors).



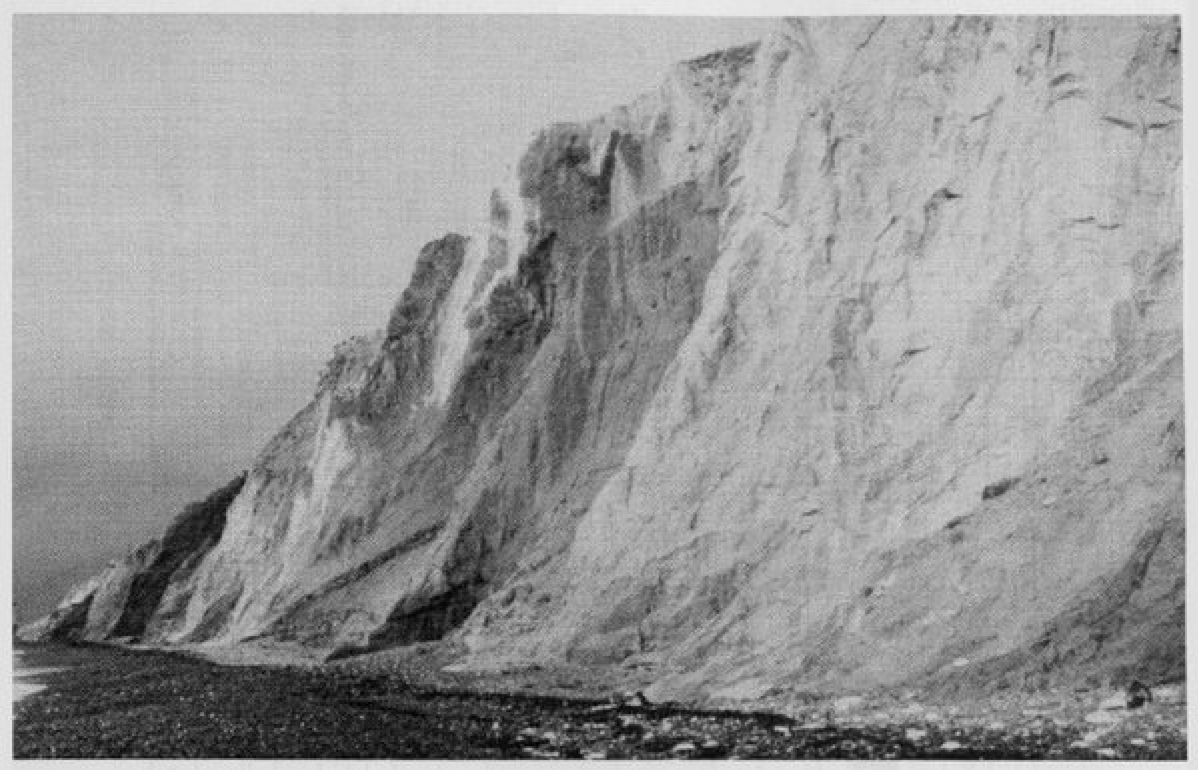
(Figure 5.23) Lithostratigraphical, biostratigraphical and magnetostratigraphical succession of the Branksome Sand (Bracklesham Group) and Barton Clay and Chama Sand (Barton Group) in Alum Bay, Isle of Wight (after various authors).



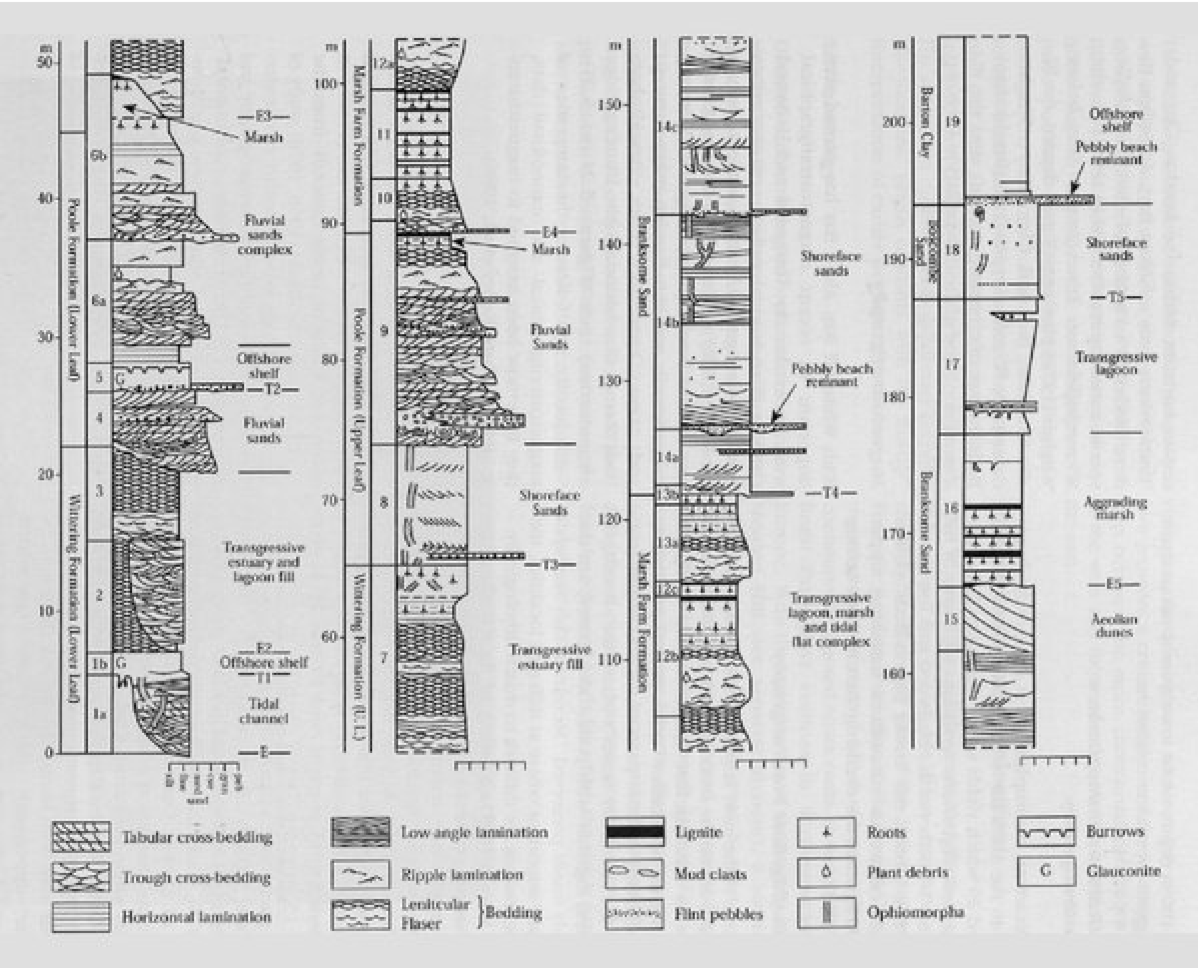
(Figure 5.18) Alum Bay, Isle of Wight: cliff profile (adapted from Daley and Insole, 1984).



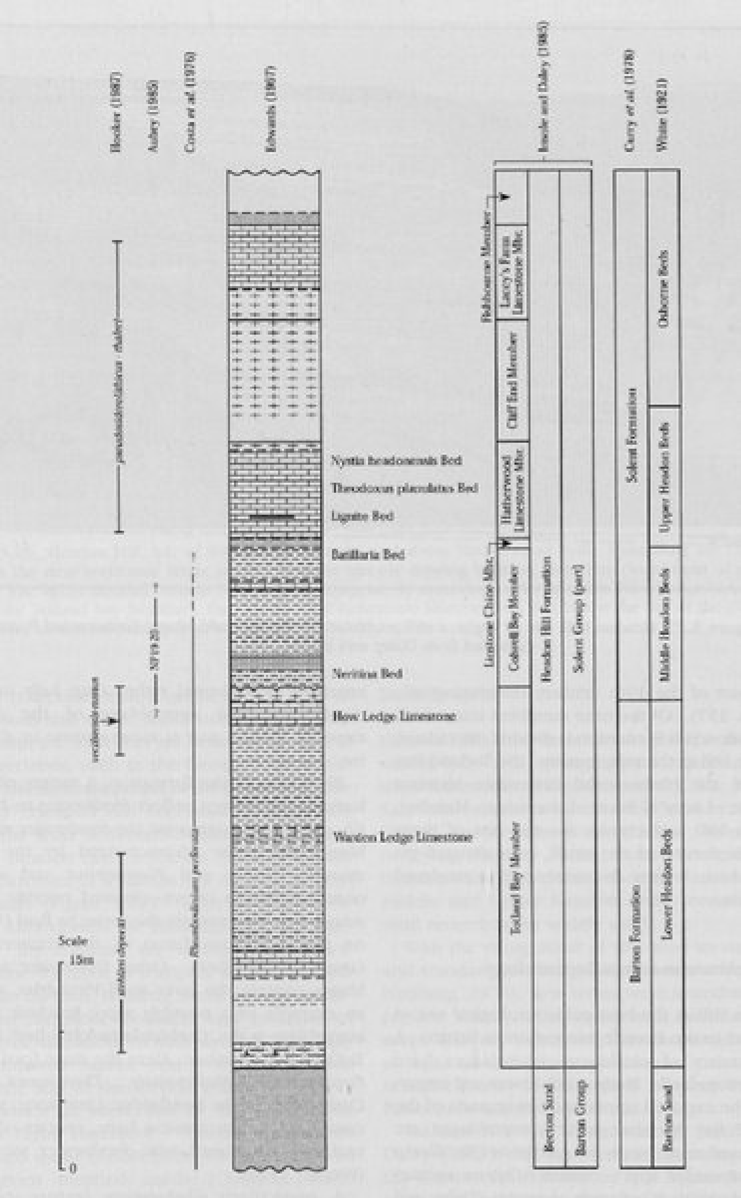
(Figure 5.19) Lithostratigraphical succession in Alum Bay and its extension into Headon Hill, Isle of Wight (after Edwards and Freshney, 1987b).



(Figure 5.20) Part of the Bracklesham Group succession in Alum Bay, looking northwards towards the junction with the Barton Group a little south of the base of the chair lift. (Photograph: B. Daley.)



(Figure 5.24) Bracklesham Group succession and facies in Alum Bay, Isle of Wight (after Plint, 1983a, 1988a).



(Figure 5.28) Lithostratigraphical succession of the Headon Hill Formation at the western end of Headen Hill, Isle of Wight, above Hatherwood Point (after Edwards, 1967; Insole and Daley, 1985 and other authors) and biostratigraphy (mammal concurrent range zones after Hooker, 1987).