LATE QUATERNARY LANDSCAPE EVOLUTION, PALAEOENVIRONMENTS AND HUMAN OCCUPATION IN THE NORTH OF IRELAND

Field Guide

Quaternary Research Association

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Postglacial relative sea-level history of Glenariff, Glens of Antrim

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Introduction

The Glens of Antrim dissect the Antrim Plateau along its entire eastern margin, forming a series of deeply incised valleys which trend in a southwest to northeast direction. Glenariff is the largest and most dramatic of the nine Antrim Glens, its sides falling away abruptly from the Antrim Plateau at *c.* 350 m to form a broad, flat-floored valley (Fig. 3.13). The great breadth of the glen (1.3 km at the coast) may be attributed to the influence of faults that have facilitated downcutting by the Glenariff River through Palaeogene basalts, and the subsequent removal of this material during glacial episodes (Smith and Warke, 2001). Today the river is canalised for much of its middle and lower reaches and enters the sea at the northern end of Red Bay, near Waterfoot (Fig. 3.13).

The sediments of the Antrim Glens have played an important role in regional sea-level reconstructions (Stephens, 1963; Prior, 1966; Carter, 1982; see Roe, this guide). Early studies focused on raised beach and other coastal deposits exposed in river sections, for example, at Cushendun in Glendun (Movius, 1940, 1953; see Roe and Swindles, this guide) and occasional foreshore exposures of peats, e.g. Carnlough in Glencloy (Prior, 1966; Prior *et al.*, 1981). These records were considered alongside fragmentary erosional features found along the coast (benches, notches and, less commonly, caves) to reconstruct a series of postglacial shorelines (e.g., Prior 1966; see Roe, this guide). The coastal sediments of the Glens have gained significance because they are amongst relatively few in the region to have yielded datable material and have thus formed the basis for quantitative RSL reconstructions (e.g. Carter, 1982).

At Glenariff the visual evidence for sea-level change is less striking than in some of the other Antrim Glens; the coastal area of the glen lacks the distinct shingle ridges and erosional notches and benches that have been identified for example in Glenarm, Glencloy, Glendun and at Ballygalley (Movius, 1940;

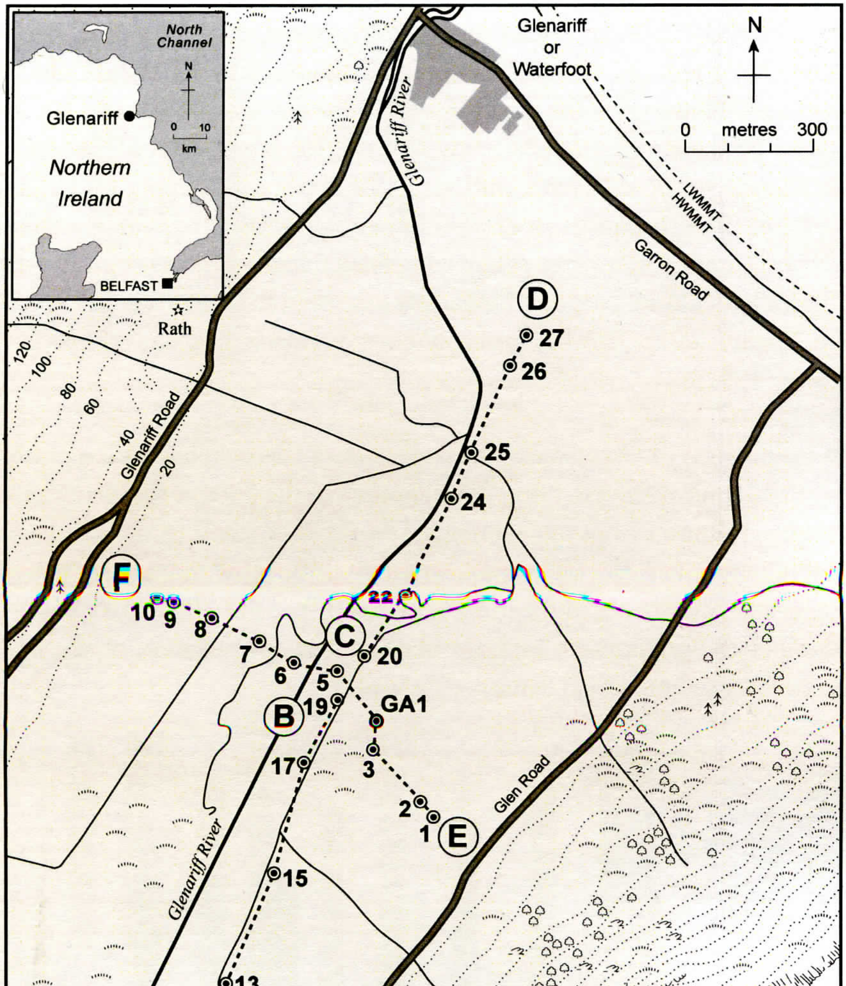

Fig. 3.13. Location map of Glenariff. The locations of the coring transects and boreholes are indicated.

Prior, 1966, 1968). Prior (1966) suggested that wave action must have been substantially reduced within Red Bay and this in turn prohibited notch formation. However, at the northern end of the bay a series of caves cut in Triassic sandstone are thought to attest to two former postglacial sea levels (Stephens, 1963; Prior, 1968). The base of the upper caves lies at *c.* 14 m OD (*cf.* Prior, 1966); the lower set of caves lie at *c.* 5-7 m OD. The central area of the bay is fronted by a series of low-lying fossil dunes. Removal of sand over time for agricultural purposes has largely destroyed the dune-system (Smith and Warke, 2001). This has probably been augmented by coastal erosion (Carter, 1991).

The sedimentary fill underlying the wide floor of Glenariff has until recently remained uninvestigated. Prior (1966) notes that the floor of the glen "must have been almost completely submerged during the highest [postglacial] sea-level", whilst early geological maps describe the valley fill as comprising "raised beach and alluvium" (*cf.* Charlesworth, 1963, p. 191). This contribution describes the preliminary findings of a detailed investigation of the late Quaternary sediments of Glenariff (Fig. 3.14).

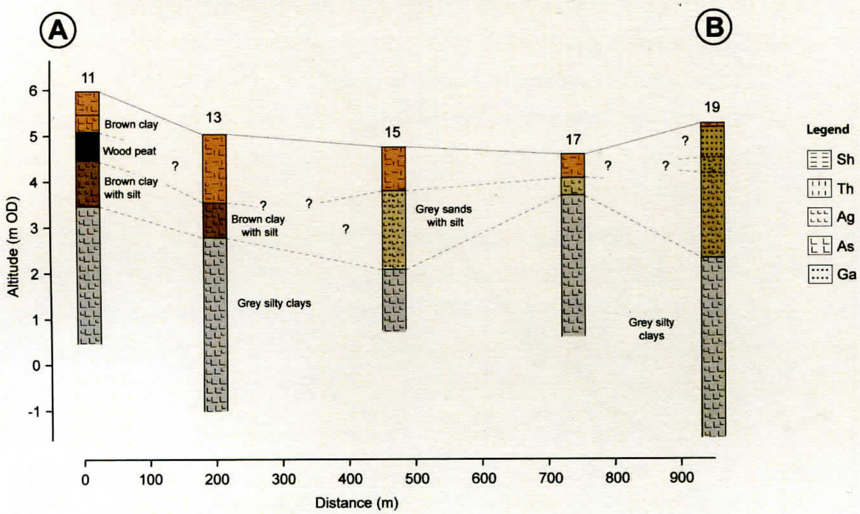

Fig. 3.14A. Section through boreholes along transect A-B. Location of transect is given in Fig. 3.13.

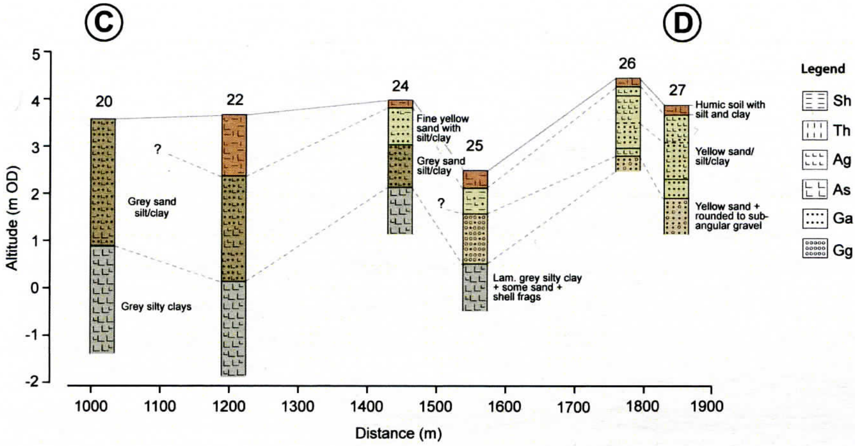

Fig. 3.14B. Section through boreholes along transect C-D. Location of transect is given in Fig. 3.13.

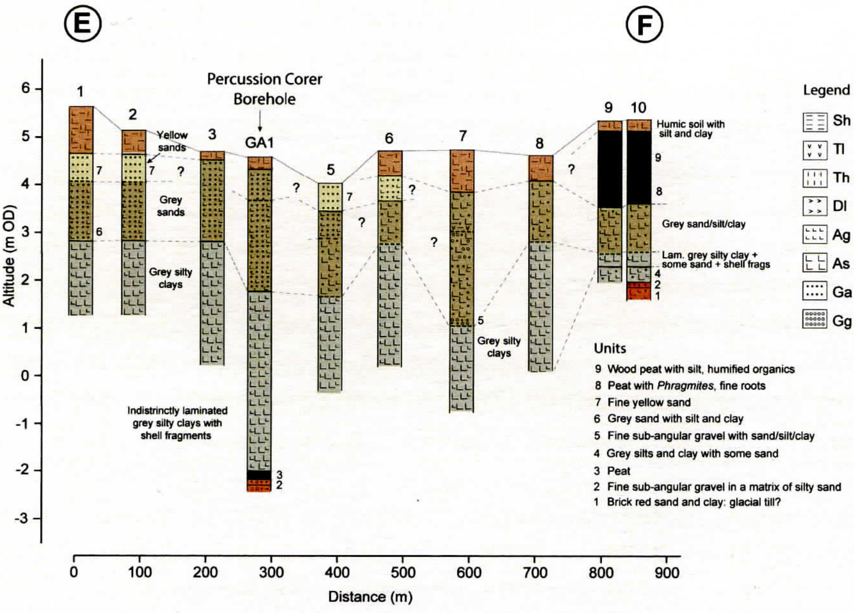

Fig. 3.14C. Section through boreholes along transect E-F. Location of transect is given in Fig. 3.13.

The sediments at Glenariff were described from two transects running lengthways (SW–NE) and breadthways (SE–NW) along the glen (Fig. 3.13). Boreholes were excavated using a percussion corer and a hand-held auger. Samples for AMS radiocarbon dating were collected from cores GA1 and 9. Radiocarbon samples were analysed in the 14CHRONO Centre, Queen's University, Belfast. The dates were calibrated using IntCal04 (Reimer *et al.*, 2004) on OxCal v. 4.0 (Bronk Ramsey, 1995) and expressed with 2 sigma ranges.

Lithostratigraphy

Coring excavations have shown that the sedimentary infill at Glenariff is dominated by fine grained estuarine sediments that are replaced towards the coast by a complex sequence of sands and gravels, and towards the valley margins by colluvial sediments and by localised peats (Swindles, 2002). In the central part of the glen the estuarine beds are truncated by fluviatile sands and gravels. At its thickest, the infill achieves at least 7 m (Fig. 3.14). The full thickness of the Quaternary infill to bedrock is unknown.

The basal part of the sequence is characterised by coarse, red brown sands with occasional angular pebbles. This clastic unit, which is distinguished by its colour, has only been penetrated in the central part of the valley (borehole GA1) at a depth of -2.20 m to - 2.30 m OD. Its full thickness is unknown. A thin layer of red sand and clay recorded at 1.61–1.88 m OD has also been recorded in borehole 10 near the northwest valley margin (Fig. 3.14C). The distinctive brick-red colour of these deposits may be derived from the underlying Devonian conglomerates and sandstones. Many of the tills in the region are of similar colour (*cf.* Movius, 1940; Prior, 1970), although insufficient sediment has been recovered to confirm a glacial origin.

In core GA1 the red brown sands grade upwards into a thin (8 cm) layer of coarse grey sand, with occasional pebbles. In this borehole, the sands are overlain sharply by a thin (11 cm) basal peat with occasional *Phragmites* remains. A radiocarbon date of 8593 ± 30 ^{14}C years BP (9519-9625 cal yr B.P.) from the base of the peat has been obtained, a sample from the top of the peat yielded an age of 8307 ± 39 ^{14}C years BP (9140-9441 cal yr BP).

Grey silty clays with occasional layers of fine sand overlie the basal peat in core GA1. This deposit has been traced widely across the central part of the glen, and extends inland at least as far as borehole 11, *c.* 2.5 km from the coast (Fig. 3.13). In GA1 the grey silty clays occur between *c.* 1.80 m to 2 m OD. The grey silty clays are laterally variable, and include indistinctly laminated and massive horizons. Scattered shell debris and fine sand inclusions occur intermittently. The unit grades upwards into a medium-grained grey sand with localised silty clay horizons and occasional, scattered shell debris. The grey sands can be traced up-valley as far as borehole 13, where they are replaced by brown clays and silts (Fig. 3.14A). These brown clays thicken towards the valley margins and up-valley and may be of colluvial origin. The approximate upper limit of the grey sands is *c.* 4.20 m OD.

Down-valley, the grey sands are overlain by fine yellow sands and silts, which thicken to *c.* 1.5 m near the coast (Fig. 3.14B). The texture and colour of the sands may suggest an aeolian origin. The yellow sands are locally underlain by coarser sands and gravels, with both rounded and subangular clasts. The composition and proximity of these deposits to the coast may indicate deposition in a beach environment. Close to the former channel of the Glenariff River the grey sands are truncated by yellow-brown sands of possible fluvial origin.

Inland, and towards the northwestern margins of the glen, the grey sands are locally overlain by peats, which attain a maximum thickness of *c.* 1.5 m. The lower sections include *Phragmites* and occasional wood fragments; the upper parts of the peat are wood peats. A radiocarbon date from the base of the peat unit in core 9 gave an age of 4019 ± 39 ^{14}C years BP (4415-4781 cal yr BP).

Biostratigraphy

Foraminifera

Samples from core 19 collected from the central part of the glen (Fig. 3.13), were subject to foraminiferal analysis (Fig. 3.15). Well preserved examples of calcareous foraminifera were recovered from the grey silty clays and overlying grey sands with silts. The uppermost part of this unit and the overlying series of fine yellow sands in this core were barren. The foraminiferal diagram (Fig.

3.15) is divided into two assemblage zones, GA19-A and GA19-B. Zone GA19-A is dominated by *Ammonia beccarii* (Linnaeus, 1758) and Elphidid species, notably *Elphidium aculeatum* (d'Orbigny, 1846) and *Elphidium crispum* (Linnaeus, 1758). Other species present include *Elphidium earlandi* (Montfort, 1808) (Fig. 3.16), *Protoelphidium anglicum* (Hofker, 1977), a number of *Miliolinella* and *Quinqueloculina* species, *Lobatula lobatula* (Walker & Jacob, 1798), *Rosalina williamsoni* (Chapman & Parr, 1932) and *Rosalina anomala* (Terquem, 1875). Zone GA19-B has a lower species diversity than zone A, and includes much lower frequencies of *A. beccarii*, although *E. aculeatum* and *E. crispum* still occur at significant frequencies. Small numbers of *R. anomala* are present near the top of the zone. The boundary between the two zones is close to the contact between the grey silty clays and the overlying grey sands with silts.

The foraminiferal species reported in core 19 are typical of estuaries, brackish lagoons and inner shelf seas. The assemblage as a whole is indicative of an estuarine environment or coastal embayment with reduced salinities. Notable intertidal to shallow subtidal species include *Quinqueloculina* spp., *Miliolinella* spp., and *P. anglicum*, whilst the persistent presence of *A. beccarii* indicates slightly deeper waters. Several of the species present including *A. beccarii* and many of the Elphidid species are today found in shallow shelf or outer estuarine environments. Whilst these species could have been transported into the palaeo-estuary by tidal currents from the adjacent shelf, their dominance throughout the sequence tends to imply that most of the assemblage is *in situ*. Subtidal conditions, with an associated water depth of at least a few metres are implied. The changes in the proportions of *A. beccarii* between Zones A and B probably reflect facies changes, particularly increasing sand content. This sedimentological change may in turn reflect an opening of the embayment to the sea, a relative sea level (RSL) rise, or a more localised change in current energies or sediment supply.

Pollen

Preliminary pollen analyses of samples from core GA1 suggest that the basal peat unit accumulated at a time when *Corylus* was expanding in the region. *Pinus*, *Betula* and *Ulmus* were also present but at low frequencies. The presence

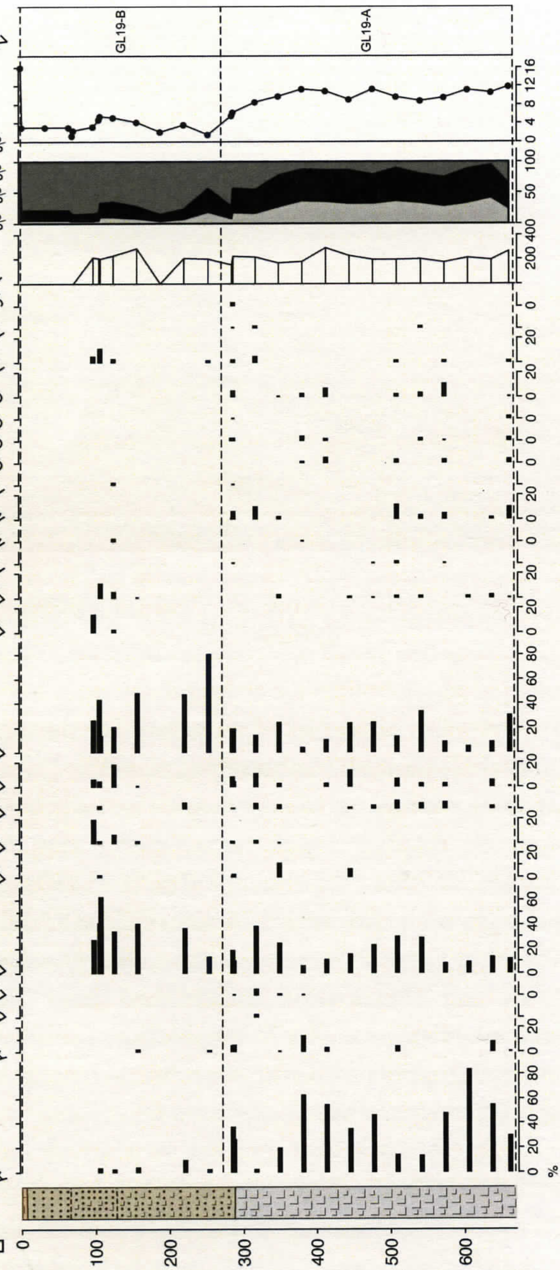

Fig. 3.15. Foraminiferal percentage diagram from core 19 (after Swindles, 2002). Taxa achieving frequencies of <2% are excluded. Foraminifera were prepared following Scott and Medioli (1978).

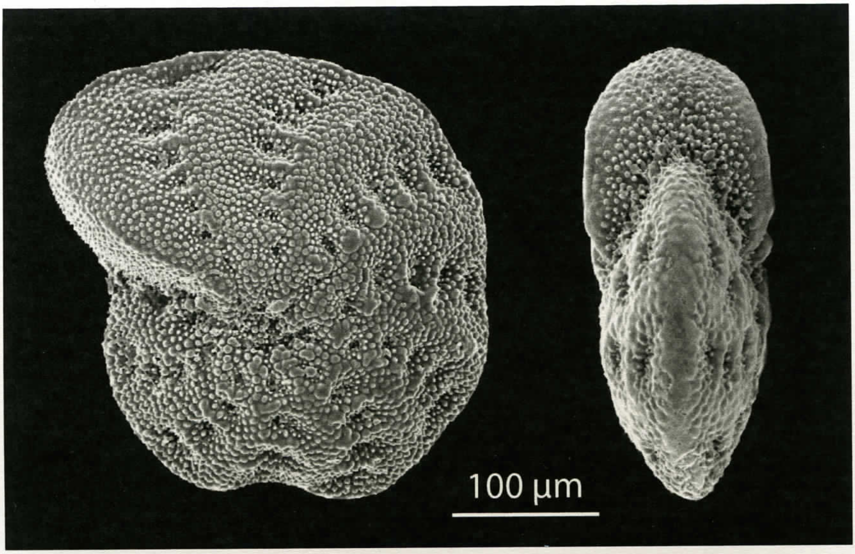

Fig. 3.16. Scanning Electron Micrograph images of Elphidium earlandi *from core 19.*

of Chenopodiaceae pollen in samples of peaty clay from the upper part of the peat unit suggests that saltmarsh was becoming established locally in the later phases of peat accumulation.

The grey sands and clays found between *c.* 2.5-3.5 m OD in core 9 in the northwestern margin of the glen (Fig. 3.14) have yielded a pollen assemblage which is dominated by *Corylus*, *Quercus* and *Pinus*, with subsidiary frequencies of *Alnus*, *Betula* and *Ulmus* (Roe, unpublished data). Relatively high proportions of *Pinus* bladders may reflect inputs from far-travelled estuarine sources. The overlying upper peats, in contrast, are dominated by herbaceous pollen taxa, notably sedge and grass pollen and fern spores.

Environmental reconstruction and relative sea-level change

The preliminary litho- and biostratigraphical data presented above show that Glenariff has undergone a complex Holocene evolution which has included the following phases:

foraminiferal data presented here from sediments which lie at 4.20 m OD in core 19 are indicative of subtidal conditions, suggesting that RSLs may have been a few metres higher than this at the time of maximum flooding. Further microfossil analyses are required to constrain this more closely, supported by additional radiocarbon dates.

Phase 3: RSL regression

Detailed reconstructions of the evolution of the glen during the immediate post-highstand phase are poorly constrained due to the lack of good dating control and the uncertainty of the depositional context of some of the sandy deposits recorded near the coast. However, it is likely that this period was associated with the seaward migration of beach facies and a localised increase in aeolian activity. Sands of probable aeolian origin extend inland at least as far as borehole 24 (Fig. 3.14B), and locally overlie the uppermost estuarine and beach facies. The dune system may have evolved in a seaward direction as the glen became increasingly isolated from the coast. Upstream, the Glenariff River would have begun downcutting to lower base levels, incising through and locally reworking older estuarine sediments, whilst on the valley margins, freshwater marsh and fen communities became established by *c.* 4000 ^{14}C years BP. These were later succeeded by woodland communities.

Phase 1. RSL transgression

In the early part of the Holocene, *c.* 8600 ^{14}C years BP, freshwater conditions prevailed in the central part of the valley, and herbaceous peats developed locally above older clastic sediments. Shortly after 8307 ± 39 ^{14}C years BP, relative sea-level rose, breaching the mouth of the glen and marking the onset of a major period of estuarine sedimentation. A thick sequence of predominantly fine-grained sediments, typical of estuarine channel, subtidal or shallow intertidal environments developed across the valley floor and extended at least *c.* 3 km inland from the present coast.

Phase 2: Mid-Holocene highstand

At the time of the mid-Holocene highstand, which is estimated to have occurred at *c.* 6500 year BP along the North Antrim coast (Carter, 1982), a large estuarine embayment existed in Glenariff. Changes in water depth, current energies as well as lateral channel migration may account for the varied facies assemblages found in the sediments spanning this interval. Some fine clastic inputs may have been derived from fluvial and aeolian sources. In the coastal area of the glen, beach gravels appear to have been deposited locally above the estuarine sediments. In some of the other Antrim Glens, e.g. Glendun, there is evidence to suggest that large, swash–aligned spit or bar structures developed across the glen mouths during the mid-Holocene (Carter, 1982; J. Orford, pers. comm.), promoting isolation of the hinterland areas from the sea (see Roe and Swindles, this guide). It has not been possible to demonstrate that Glenariff became isolated in this way as no lagoonal facies have been confirmed.

It remains difficult at present to confirm the maximum elevation attained by the mid–Holocene RSL highstand in Glenariff. At other sites along the northeastern and north Antrim coasts, an inferred maximum of approximately 3-4 m OD is indicated (Carter, 1982; see Roe, this guide), although some high energy beach gravels of probable mid Holocene age extend several metres higher than this, in some cases up to 8 or 9 m OD (*cf.* Carter, 1982; Roe and Swindles, this guide). As Carter (1982) suggests, these deposits may be the product of storm waves and as such, their elevation cannot be clearly related to prevailing sea levels. It is interesting to note that the preliminary