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PROBLEMS IN THE APPLICATION OF LITHOSTRATIGRAPHIC CLASSIFICATION TO PLEISTOCENE TERRACE DEPOSITS

David R. Bridgland

This paper was presented at the British Geomorphological Research Group/Q.R.A. joint meeting entitled 'British Quaternary river landforms and sediments', at Newcastle upon Tyne in September 1986. An abstract appeared on pages 33-34 of *Quaternary Newsletter* No. 49.

It represents an appeal to geologists working on fluvial and associated deposits in the British Pleistocene to confront certain problems in the application of formal lithostratigraphy to such sediments. This is necessary because the manuals which provide guidance for lithostratigraphic classification (Hedberg 1976, Holland *et al*. 1978) were compiled by, and principally for, geologists working on pre-Quaternary (solid) deposits. They are therefore somewhat ambiguous about procedures necessary for applying this type of classification to superficial deposits, in which thick sequences of superimposed sediments are rare. This is especially true of terrace sequences, where individual sedimentary units (terrace gravels etc.) can be considered as distinct elements of a stratigraphic succession, but are not seen in superposition except in abnormal circumstances.

Thick continuous Pleistocene sequences do occur; examples are found in the Lower Pleistocene of East Anglia and the Middle Pleistocene in the West Midlands, where the deposits can be considered in much the same way as solid geology. Even with this sort of preservation, however, problems arise when different units occur which are lithologically indistinguishable. This particular problem, a feature of terrestrial sequences throughout the geological column, is perhaps the most important difficulty to be encountered in applying lithostratigraphic classification to drift deposits. A sequence of Pleistocene river gravels with identical or very similar lithological characteristics, cannot according to the strictest interpretation of the stratigraphic guides, be subdivided in lithostratigraphic classification, even if distinct aggradations are well established on the grounds of 'terrace stratigraphy'.

Terrace studies

To address the problems encountered in applying lithostratigraphic methods to terrace studies, it is essential to fully understand the nature and origin of terrace sequences and the difference between the various ways of classifying them. The terraces with which this article is concerned are depositional features (similar landforms can arise in other ways), although the term 'terrace' should, in fact, be restricted to the resultant landforms and not applied to the sediments underlying them (Howard *et al*. 1968, Gibbard 1985).

The sediments underlying depositional terraces are the products of past floodplain aggradation, preserved on the valley side following incision. As such they represent remnants of sedimentary bodies which formerly had a characteristic linear geometry, with a typical thickness of a few metres, a width of a few tens or hundreds of metres, a very considerable length (reflecting the length of the river concerned) and a downstream gradient. The reconstruction of such sediment bodies from their various remnants is a geological practice and should not be confused with the reconstruction of terrace surfaces, which is geomorphology. The two methods may, of course, be complementary. The geological method can be applied more readily to older, badly dissected terrace remnants, where there may be no preservation of original terrace surfaces.

Many of the classic terrace studies have involved a mixture of these two approaches. With the notable exception of Hare's (1947) work in the Middle Thames (where terrace surfaces are uncommonly well preserved), the most successful work has usually been based on the geological approach, with due consideration of altitude and downstream height changes but without detailed morphological mapping. Gibbard (1985) has recently elaborated on Hare's Middle Thames succession and applied formal lithostratigraphic nomenclature to the sequence of terrace aggradations in the area, defining them as members of his Middle Thames Valley Gravel Formation. This system, in which individual terrace aggradations are defined as members, is also currently applied to the Thames gravels of southern East Anglia. The latter situation is perhaps accidental, arising from the original definition of the terrace sequence as a whole, before it was successfully subdivided, as the Kesgrave Sands and Gravels Formation (Rose et al. 1976, Rose & Allen 1977). Individual terraces, or members, have been recognised subsequently (Hey 1980, Allen 1984).

Methods of terrace classification

There exists considerable confusion between methods of naming terraces, many being applied without distinguishing between the landforms and the underlying sediments. Three main systems have been used:

(a) the distinction of Lower, Middle and Upper Terraces. This has the considerable disadvantage that extra terraces, recognised later, require complex names, such as 'Lower Middle Terrace';

(b) Numbered terraces. Numbering from highest to lowest and lowest to highest have both been used. This method shares with (a) the same disadvantage of inflexibility, should extra features be recognised. An early numbered system survives in the Warwickshire-Worcestershire Avon (Tomlinson 1925, Shotton 1973), while the British Geological Survey has recently returned to this method of classifying terraces, despite being pioneers of system (c).

(c) Named terraces. In this system terraces are named after type localities. This method may be operated in parallel with the lithostratigraphic approach (d), the same names being given to terrace surface and underlying sediments (e.g. the Boyn Hill Terrace and Boyn Hill Gravel of the Middle Thames; see Gibbard 1985).

(d) Lithostratigraphic approach. This method, with which this article is primarily concerned, involves the recognition of individual sediment bodies and their classification according to accepted stratigraphic practice, as set out in the various guides (Hedberg 1976, Holland et al. 1978). This has similarities to (c), in that units are named after type sections, but the two should not be confused.

Advantages of using the lithostratigraphic approach

The following can be listed as benefits arising from the geological/lithostratigraphic method:

(a) The consideration of deposits instead of (or as well as) landforms prevents confusion of gravel terraces with similar features which may result from other factors, e.g. structurally controlled platforms, erosional platforms, etc.

(b) This approach allows work where terrace surfaces are absent or very poorly preserved, but remnants of fluvial aggradations survive.

(c) Correlation using both geometric (gross sediment body geometry) and lithological evidence is possible, the latter being helpful when there are lengthy downstream breaks in preservation.

(d) Units are precisely defined, replacing unsatisfactory and confusing terrace nomenclature or numbering. However, well established nomenclature may be retained, even if it fails to fulfil the usual requirements of the stratigraphic guides, where this is considered desirable.

Method

The procedure for applying lithostratigraphic classification in studies of fluvial terrace sequences is as follows:

(a) The identification of individual gravel bodies by field mapping.

(b) The determination of their altitudinal and lateral distribution, using surveying techniques where necessary.

(c) The determination of the lithological characteristics of individual gravel bodies by various appropriate techniques, such as clast lithological analysis, heavy mineral analysis, particle size analysis and the study of sedimentary features. The stratigraphic guides indicate that such techniques should not be essential to the definition of units (see below).

The combination of (a) and (b) allows the reconstruction of former fluvial floodplain aggradations. These are then classified according to certain rules set out in the stratigraphic guides, which stress the following:

(i) that the classification is to be based on lithology, not on other evidence such as inferred geological history or mode of genesis (Hedberg 1976, p. 31);

(ii) that the classification should be applicable in the field;

(iii) that the classification should not rely on detailed palaeontological or sedimentological analysis and/or statistical processing of results;

(iv) that the formation, the primary lithostratigraphic unit, should also be the basic mappable unit (Dunbar & Rodgers 1966, p. 259).

The last of these (iv) arises from the hierarchy of lithostratigraphic subdivisions, which is summarised below:

GROUP	(2 or more formations)
FORMATION	(primary unit)
MEMBER	(named unit within a formation)
BED	(named distinctive layer within a formation or member)

Certain important rules govern these units and their hierarchy:

(1) the formation is the primary unit;
(2) formations may be, but need not be, partly or fully sub-divided into members;
(3) members may be, but need not be, partly or fully sub-divided into beds;
(4) all beds and members must belong to formations;
(5) formations may be, but need not be, collected into groups;
(6) groups must be divisible into formations;
(7) formations, members and beds must be defined at type sites, but groups need not be.

<u>The application of this system to river terrace deposits</u>

Most terrace systems of single rivers comprise a series of gravel aggradational units which are mappable as separate sediment bodies, but which are lithologically very similar. Even when lithological changes have been recognised within such systems, they are usually gradational and/or their demonstration requires detailed analysis (e.g. the dilution of Tertiary flint in successively younger gravels in the London Basin). A problem therefore arises from rules (i), (ii) and (iii) above, which emphasise the fact that lithostratigraphic subdivision must be based on obvious lithological differences. In particular, rule (iii) suggests that distinction based on laboratory analysis is inappropriate for such terrace sequences.

The author considers this problem to originate partly from the use of the current model for lithostratigraphic classification in the British Pleistocene, in which individual aggradations are defined as members (as described above in relation to the Thames Valley Gravel and Kesgrave Formations). These are, by definition, subdivisions of formations. The stratigraphic guides indicate that the subdivision of formations into members should be on the basis of lithology. This may not be possible in the case of terraces, so rule (i) above cannot necessarily be complied with. Furthermore, such formations are simply collections of isolated deposits and, therefore, have no obvious type sites. No one site can normally represent more than one of their component members, so none can be representative of the formation as a whole (for example, the Kesgrave

Formation typesite represents only the Waldringfield Gravel Member). However, rule (7) above requires formations to be defined at type sites. The present model is therefore in breach of this rule.

A solution to these two principal difficulties can be suggested in the form of an alternative model. The stratigraphic guides state that the formation is the primary unit. In terrace studies individual terrace aggradations are the primary units. It is therefore suggested that individual terrace gravels should be defined as formations. Collections of terraces, where there is good reason for naming them, could then be defined as groups. Where lithologically distinct deposits occur within a single terrace aggradation these can be defined as members. A comparison of the existing and alternative models is provided by Fig. 1, using the example of the author's work in eastern Essex (Bridgland 1980, 1983, in press). Provision for changes in rank of lithostratigraphic units without changing their proper (geographical) names and the deposits to which they refer is included in the stratigraphic guides (Holland *et al.* 1978, p. 11).

The alternative model clearly complies with rule (7), but whether rule (i) is also satisfied requires further consideration. If individual terrace aggradations are taken as basic mappable units, the primary lithological distinction necessary is between them and other deposits in juxtaposition. The latter include underlying bedrock or older Pleistocene sediments and any overlying drift deposits. The terrace deposits will normally be separated from these by unconformities, as pointed out by Gibbard (1985). The latter represent the unseen part of the geological record - the downcutting phases which separate terraces. There is considerable precedence for drawing formation boundaries at unconformities. The American Stratigraphic Code states that such boundaries should be "drawn at points in the stratigraphic column where lithologic characters change or where there are significant breaks in the continuity of sedimentation" (Dunbar & Rodgers 1966, p. 259), implying that the latter can be used without a significant change in lithology. Indeed, according to Dunbar & Rodgers (1966, p. 268), "the unity of a formation should not ordinarily be stretched to cover a break in the record significant enough to rank as an unconformity".

Conclusions

The use of lithostratigraphic classification of terrace aggradations can be justified, the present author would argue, on the grounds of their 'mappability' as primary units and the fact that such sediment bodies can be considered to be bounded by unconformities. However, individual terrace aggradations should be taken as the basic units of the scheme and, therefore, be defined as formations. The current model for lithostratigraphic classification of fluvial terrace sequences in Britain, where individual terraces are defined as members, fails to satisfy a number of the requirements of the lithostratigraphic guides.

The author wishes to suggest, therefore a change to an alternative model in which individual terrace aggradations are defined as formations and collective terrace systems as groups. Some might feel that there are grounds for resisting the considerable proliferation of new formations that would result, although there would be no real increase in nomenclature. It is clear that, if these stratigraphic guides are to be followed, the alternative system is to be preferred.

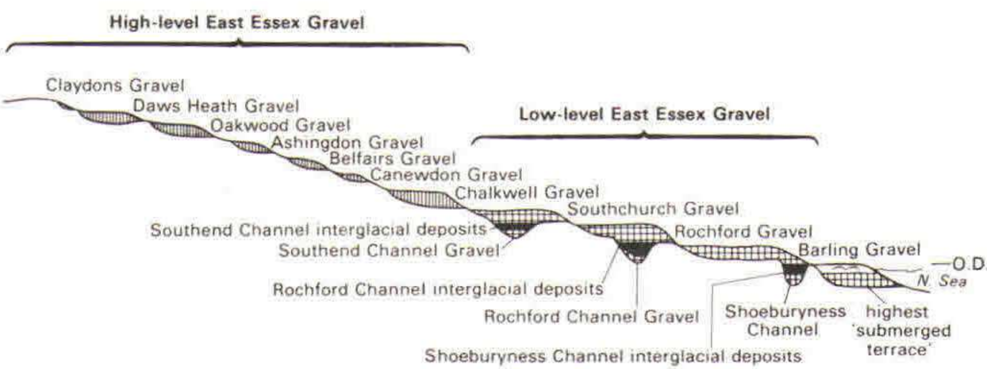
Figure 1.
Illustration of (1) the current model and (2) the proposed alternative model for lithostratigraphic classification of terrace deposits, using as an example the sequence in the Southend area (Bridgland 1983, in press). This sequence can be subdivided into high-level and low-level gravel types on strong lithological grounds, reflecting Medway and Thames-Medway deposition respectively. The primary units are, however, the individual aggradations. These alone have type sites. According to the current model (1) the High-level and Low-level East Essex Gravel are formations and all subdivisions of them are members. According to the alternative model (2) the two gravel types become groups and individual terrace aggradations become formations, some of which can be further subdivided into members.

1

a Formations	b Members
LOW-LEVEL EAST ESSEX GRAVEL FORMATION (LEEG Formation)	Barling Gravel Shoeburyness Channel interglacial deposits Shoeburyness Channel Gravel Rochford Gravel Rochford Channel interglacial deposits Rochford Channel Gravel Southchurch Gravel Southend Channel interglacial deposits Southend Channel Gravel
HIGH-LEVEL EAST ESSEX GRAVEL FORMATION (HEEG Formation)	Chalkwell Gravel Canewdon Gravel Belfairs Gravel Ashingdon Gravel Oakwood Gravel Daws Heath Gravel Claydons Gravel

2

a Groups	b Formations	c Members
LEEG Group	Barling Gravel	Shoeburyness Channel interglacial deposits Shoeburyness Channel Gravel
	Rochford Gravel	Rochford Channel interglacial deposits Rochford Channel Gravel
	Southchurch Gravel	Southend Channel interglacial deposits Southend Channel Gravel
HEEG Group	Chalkwell Gravel Canewdon Gravel Belfairs Gravel Ashingdon Gravel Oakwood Gravel Daws Heath Gravel Claydons Gravel	



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GLACIOFLUVIAL CHANNELS BELOW THE BLAKENEY ESKER, NORFOLK

J.M. Gray

Abstract

Recent renewed quarrying in the Blakeney ridge, north Norfolk, has confirmed the presence of several glaciofluvial channels below the ridge sediments. The coincidence of the channel pattern with the ridge itself, and the relationship between the channels and the infilling sediments support the view that the ridge is an esker and suggest that it was essentially deposited subglacially.

Introduction

Recent sedimentological research by Hoare & Gale (1986) has supported the view that the controversial Blakeney ridge in north Norfolk is an esker formed under full pipe-flow conditions by a subglacial or englacial river. Thus they rejected previous explanations that it was formed ice-marginally (e.g. West 1957), is the linear erosional remnant of a larger mass of sand and gravel (e.g. Straw 1965, 1973) or is an open crevasse filling (e.g. Sparks & West 1964). The latter authors mentioned p. 33) that sections towards the highest point in the underlying relief "show gravel to rest in a channel cut in the marly boulder-clay". They used this and other evidence to suggest meltwater overflow westwards from a water-filled crevasse to the east. Subsequently little attention appears to have been paid to this channelling below the ridge, but recent renewed quarrying has revealed several channels which provide important evidence concerning the origin of the ridge itself.

Description of the Channels

Figs. 1a-c show the location of the main sand and gravel pit in the Blakeney ridge. Fig. 1c shows the position of 4 channels so far discovered. At present the best exposed channel is A, close to the entrance to the pit. It can be traced for a distance of about 100 m parallel to and a few metres away from the southern boundary of the esker. It has side slopes of c. 40-70^{o} and is up to 5 m deep and 15 m wide at the top narrowing to less than 2 m in places on its floor, though quarrying has obviously disturbed its original morphology. Apart from the western section, it has been partly infilled, but throughout, till is exposed in its sides, overlain in places by patches of unexcavated sand and gravel. To the west, the original sediment infilling of the channel remains in the western face of the quarry close to the access road.

Channel B is a wider but shallower feature largely excavated and partially infilled. Part of the original northern bank remains, however, on which the esker sediments overlie till on a c. 50^{o} slope. The channel may narrow eastwards before disappearing below stockpiles and plant in the central area of the pit.

At the eastern end of the pit, however, two further channels have recently been revealed by quarrying. Channel C is exposed in the face immediately below the copse of trees opposite the entrance to the picnic site. The base of the channel is not fully exposed but till is present

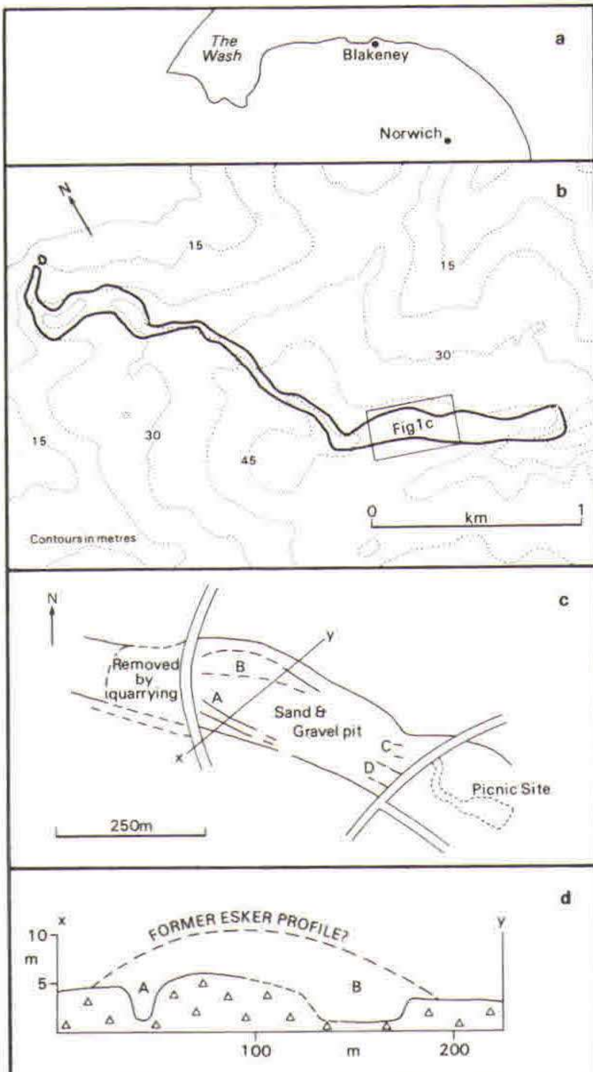

Figure 1. (a) Location of Blakeney
(b) Plan of the esker (after Hoare & Gale 1986)
(c) Plan of pit showing location of Channels A-D and line of section X-Y
(d) Cross-section of till surface along X-Y.

at a high level in both banks and the broad synclinal infilling of the sand and gravel beds is well exposed at present. The channel top width is estimated at c. 20-25 m. Channel C was separated from the large Channel D by a narrow rounded ridge of till (R. Powell, pers. comm.) now largely graded. The predominantly sand infilling of Channel D is presently being excavated and its full morphology is unclear at present.

In terms of the stratigraphy proposed by Hoare & Gale (1986), the channels are cut predominantly in the middle till, a very pale brown, chalk and flint rich till, probably equivalent to the Marly Drift of others workers. Stratification similar to that described by Hoare & Gale in the upper part of the till is clearly exposed in the northern side of Channel A. An overlying diamicton, probably equivalent to the "upper till" of Hoare & Gale, was also observed as a thin (up to 30 cm) veneer over most of area studied, including the channel floors. Thus the stratigraphic sequence appears to be:

4 Deposition of the glaciofluvial ridge sediments;
3 Formation of the "upper till";
2 Cutting of the channels;
1 Deposition of middle till.

Interpretation

The coincidence of the location of the channels and their trend, with the location and trend of the ridge (Figs. 1c and d) suggests a close association in terms of origin, i.e. the ridge was formed by streams flowing along its length. The possibility that the ridge is an erosional remnant of a larger sand and gravel mass is effectively eliminated.

That the ridge is an esker is demonstrated by the undulating long profile of the underlying bed (Fig. 1b) and by the analysis of the ridge sediments demonstrating pipe-flow conditions (Hoare & Gale 1986).

That the esker was formed subglacially rather than englacially is indicated by the fact that the rivers that eroded the channels and deposited the infilling channel sediments at Channel C described above, were clearly flowing on the land surface. The widespread formation of the thin upper till between channel erosion and deposition of the esker sediments suggests that it is a subglacial meltout till deposited during a pause in glaciofluvial activity. Similar diamicts have been observed interstratified within the basal esker sediments, e.g. north bank of Channel A. Thus, it seems reasonable to conclude that the Blakeney ridge is a subglacial esker.

The observations reported here are provisional since the present pit operator intends to work out the quarry fully prior to landscaping. Thus the extent, number and morphology of the channels may well be clarified over the next few years and a fuller report will follow.

Acknowledgements

I am grateful to the pit operator, Mr. R. Powell for access to the sites and useful discussions of the sub-esker morphology. Ed Oliver drew the figure and Carol Gray typed the paper.

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A PRELIMINARY STUDY OF THE DEVELOPMENT OF BEILIBEDW MIRE IN MID WALES

David M. Wilkinson

A preliminary study of the palaeocology of a raised basin mire in mid Wales outlines the history of its development and suggests it would be a good site for more detailed studies. The hydroseral sucession in the early Flandrian lake which occupied the site corresponds well with the model outlined by Walker.

Introduction

Beilibedw Mire (Grid Reference SO 164566) is a slightly raised basin mire at an altitude of 400 m in the hills of mid Wales. The only work carried out at the site prior to this study appears to be that of Wisniewski & Paull (1980) who, as part of a general survey of peatlands in Powys, listed the mire flora and provided a brief description of a single sediment core. The stratigraphy and vegetational history have been described at five other near-by sites (Fig.1); Elan Valley Bog

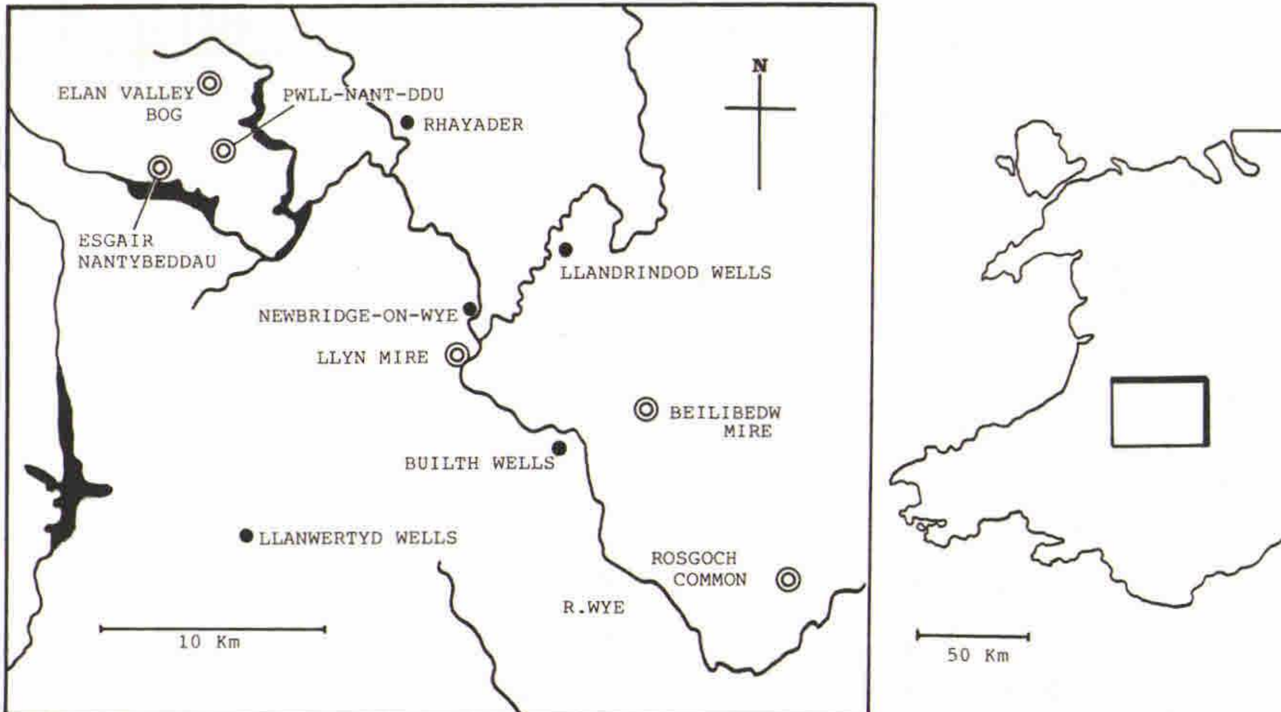

Fig. 1. Location of study area showing the sites referred to in the text.

(Moore & Chater 1969, Moore 1970), Llyn Mire (Moore & Beckett 1971, Moore 1970) Rhosgoch Common (Bartley 1960), Pwll-Nant-Ddu and Esgair Nantybeddau (Wiltshire & Moore 1983). While there are more sites described from western mid Wales there are none to the east of these sites, Beilibedw Mire partly fills this gap.

Site Characteristics and Vegetation

The mire is roughly elliptical, with a major axis of approximately 200 m and a minor axis of 130 m. It is slightly domed, the centre of the mire being about 0.50 m higher than the edge (Fig. 2). At the south east edge of the mire are a series of steep sided pools which cut down through the peat into alkaline clay to a depth of two or three metres. The pH of the steep sided pools was 8.1 while the pH of water in the small mire surface pools was 4.4. The steep sided nature of these pools suggests that they are anthropogenic, possibly the clay had been extracted for use as marl. it is also possible that the mire itself has suffered slight peat cutting in the past as there is a long history of peat cutting in mid Wales (Wisniewski *et al.* 1982).

Plant species recorded growing on the mire are listed in Table 1.

Stratigraphy

A series of five cores were taken using a Russian sediment borer (Jowsey 1966). A main core was taken from near the centre of the mire, this reached a depth of 8.5 m where a whitish clay was discovered. The top 1.5 m of the deposit was wet and fibrous and could not be sampled with the borer. In September 1987 when the water level was low a till could be seen underlying the clay at a depth of about two metres in one of the ponds at the mire edge. The main core was transported to the laboratory for analysis, the results of which are shown in Fig. 3. It showed a transition from organic lacustrine sediments rich in diatom frustules to terrestrial peats as the post glacial lake which occupied the site silted up. A transect of cores was taken on either side of the main core (along line AB in Fig. 2), these were examined in the field and found to show a similar stratigraphy. Cores taken at the edge of the mire showed bands of inwashed clay and darker peat in the top 0.30 m suggesting recent erosion in the catchment.

In an attempt to approximately date these events fossil pollen was extracted by standard methods (Moore & Webb 1978) from sediment at both ends of the lacustrine section of the main core. None of the local sites for which pollen diagrams are available are radiocarbon dated, so it is impossible to put exact dates to the different vegetational events. The pollen sample from the bottom of the core had very high *Corylus* values (54% of the total pollen sum) and matched the early Flandrian parts of local pollen diagrams. The samples from the top of the lacustrine sediments contained *Tilia* pollen and were similar to zone VII of Moore & Chater (1969) suggesting a date of perhaps 5000-7000 BP. This suggests that lake and fen conditions existed at the site for the first three or four thousand years of the Flandrian before mire development. Walker (1970) suggests a time scale of between 2500 and 4000 years for mire formation from open water by way of a fen stage. This is consistent with the present data.

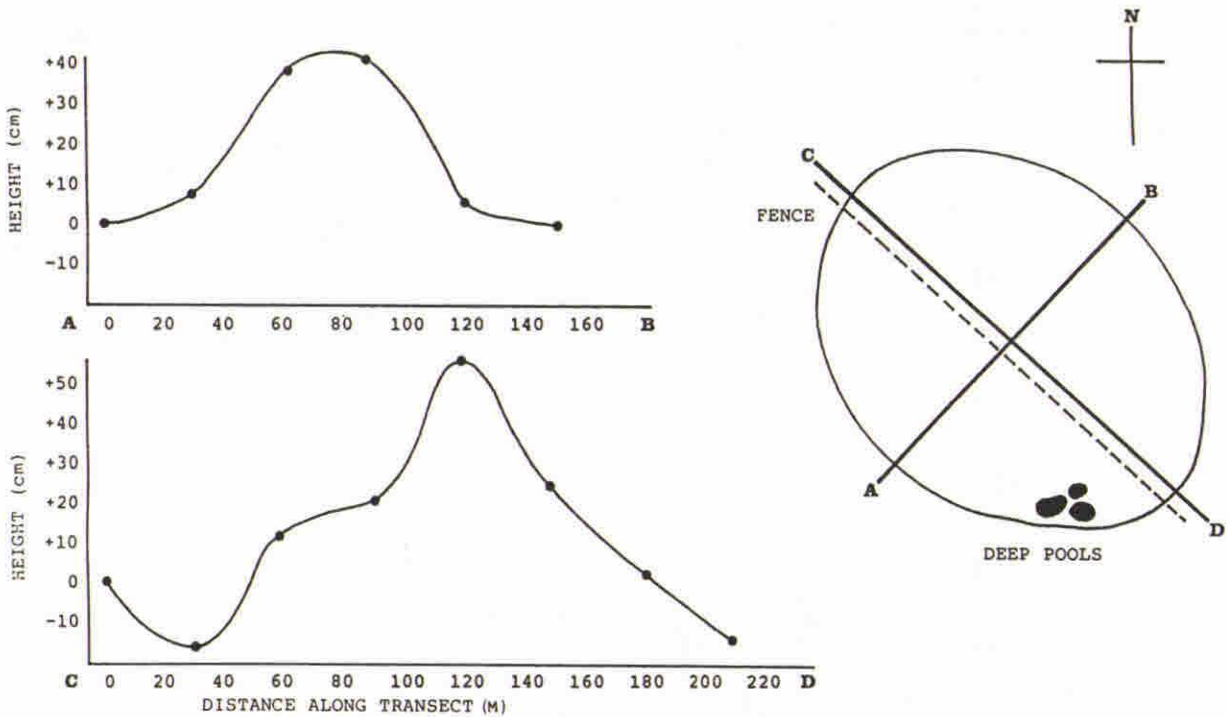

Fig. 2. Plan and profile of Beilibedw Mire with the results of two levelling transects showing the domed nature of the mire.

Table 1. Plant species recorded growing on the mire. Data from Wisniewski & Paull (1980) and Wilkinson (pers. obs). Nomenclature follows Smith (1978) for bryophytes and Clapham *et al*. (1981) for vascular plants.

Lichens and Bryophytes.	Vascular Plants.
Cladonia impexa	*Ranunculus repens*
Hypogymnia sp.	*R. flammula*
	Cardamine pratensis
Sphagnum palustre	*Viola palustris*
S. fimbriatum	*Potentilla palustris*
S. capillifolium	*P. erecta*
S. subsecundum	*Calitriche stagnalis*
S. cuspidatum	*Hydrocotyle vulgaris*
S. recurvum	*Rumex acetosa*
Polytrichum formosum	*R. obtusifolius*
P. commune	*Urtica dioica*
Dicranum scoparium	*Calluna vulgaris*
Aulacomnium palustre	*Erica tetralix*
Drepanocladus fluitans	*Vaccinium vitis-idaea*
Hypnum cupressiforme	*V. myrtillus*
Rhytidiadelphus squarrosus	*Empetrum nigrum*
	Cirsium palustre
	Potamogeton polygonifolius
	Juncus effusus
	J. conglomeratus
	Eriophorum angustifolium
	E. vaginatum
	Festuca ovina
	Glyceria fluitans
	Molinia caerulea

Macrofossil Analysis of Hydroseral Sucession

The use of palaeocological techniques has proved a powerful approach for the investigation of the theory of hydroseral sucession (Walker 1970). This prompted an attempt at investigating the sucession from open water to the start of mire development at the site using macrofossil analysis. The sediment for macrofossil analysis was separated in 10% nitric acid and all potentially identifiable material was removed for further examination. The results are shown in Table 2 in which the degree of reliability of the identifications is indicated by a standard set of conventions (Dickson 1970). All Potamogeton fruits which were tentatively identified to species level using the criteria of Aalto (1970) were identified as P. natans. Thelypteris (probably T. palustris) was identified from the illustrations in Grosse-Brauckmann (1972). Other material was identified by comparison with reference material and standard floras. Bryophytes identified as Sphagnum section Sphagnum include any members of this section other than S. papillosum or S. imbricatum. Two commonly occurring macrofossils, bryophyte X and Leaf X, could not be identified. A fragment of leaf X is illustrated in Fig. 4.

Hydroseral succession was consistent with the general scheme identified by Walker (1970). The fossil succession starts with totally submerged macrophytes (Walker stage 3) e.g. Potamogeton spp., however 'floating leaved macrophytes' such as Nymphaea quickly appear (Walker stage 4). At a depth of 6.5 m 'reedswamp' starts to develop (Walker stages 5-7) and at a depth of around 5.75 m carr is starting to develop with tree species such as Betula and Salix growing with the fern Thelypteris (Walker stages 8 and 9). Pollen analysis revealed Alnus pollen in the carr sediments. The succession eventually progresses to 'bog' (Walker stage 11). In relation to the development of carr vegetation it is of interest that the small light Betula fruit appear in the core before the larger Betula leaf and wood remains. This probably mirrors the encroachment of Betula onto the site, the smaller fruits being able to reach the site of sedimentation from a greater distance than the leaves or twigs.

Several interesting invertebrate fossils were also extracted from the core. Two beetles were recovered from the early Flandrian deposits. Ptinus pusillus is today a rare British species found in dead wood and plant litter, now only known from a few sites in southern England (Key, pers. comm.) and Coccinella hieroglyphica is a ladybird which feeds on the larvae of the heather beetle Lochmaea suturalis (Pearsall 1971). A Cryptostigmatid mite was found along with an egg within the remains of a Phragmites leaf. These mites tend to be associated with plant litter and soils although some species spend part of their life cycle on living plants (Evans et al. 1961). The statoblasts of two species of Bryozoans were found, unfortunately there are few clear relationships between habitat type (such as water chemistry) and the occurrence of particular species. However Cristatella mucedo is most often found in eutrophic conditions (Mundy 1980). The commonest invertebrate macrofossils were the cocoons of leeches in the family Erpobdellidae (Fig. 4). The best preserved of the cocoons was tentatively identified as Erpobdella octoculata, this is one of the commonest fresh water leeches found in a wide variety of habitats (Elliott & Mann 1979).

Table 2. Results of macrofossil analysis of the lacustrine section of the Beilibedw Mire main core.

	5.00- 5.25-	5.25- 5.50	5.50- 5.75	5.75- 6.00	6.00- 6.25	6.25- 6.50	60.50- 6.75	6.75- 7.00	7.00- 7.25	7.25- 7.50	7.50- 7.75	7.75- 8.00	8.00- 8.25	8.25- 8.50
Potamogeton fruits		x		x	x	x	x	x	x	x	x	x	x	x
Potamogeton leaves					x									
Chara oospores						x	x	x						
Nymphaea seeds							x		x	x	x	x	x	
cf. *Nuphar* seeds												x		
Carex fruits	x		x	x		x	x	x				x	x	
Cyperaceae fruits	x		x	x	x									
Leaf X							x	x	x	x				
cf. *Equisetum*	x	x												
Phragmites	x				x	x								
Thelypteris	x	x	x											
Sphagnum section *Sphagnum*		x	x	x										
Sphagnum papillosum					x								x	
Sphagnum cf. *recurvum*												x		
Aulacomnium palustre													x	
Dicranella heteromalla												x		
cf. *Drepanocladus*		x												
Dicranum cf. *majus*			x											
cf. *Plagiothecium*			x											
Bryophyte X				x				x	x	x				x
Betula fruit	x		x			x		x						
Betula wood		x	x	x										
Betula cf. *pubescens* leaf			x	x										
cf. *Salix* leaf				x										
Calluna shoot						x			x		x			
Ericaceae wood		x												
Ericaceae flower													x	
Erpobdellidae cocoons	x	x	x	x										
Plumatella statoblasts	x	x												
Cristella mucedo statoblasts								x						
Porifera spicules											x			
Cryptostigmatid mite						x								
Coccinella hieroglyphica													x	
Ptinus pusillus														x

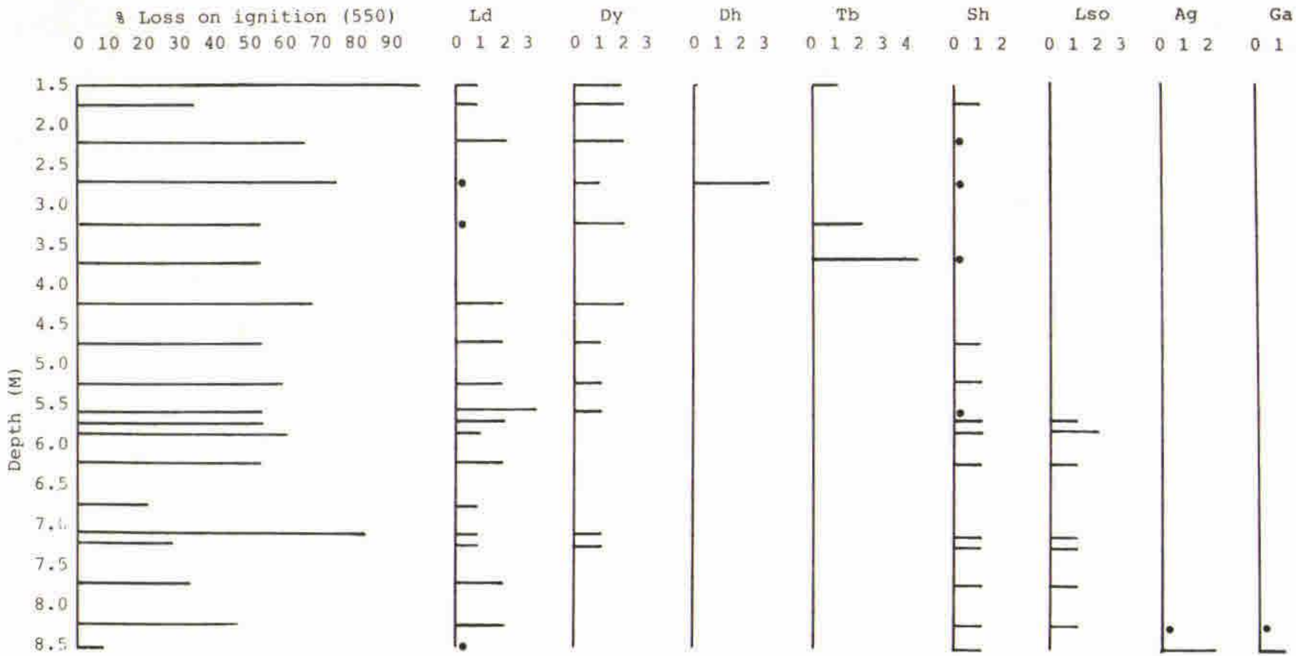

Fig. 3. Results of sedimentological analysis of the main core from Beilibedw Mire. The histograms show the results of percentage loss on ignition at 550°C. and the proportions of the different sediment types characterised according to the scheme of Troels-Smith (1955).

Conclusions

During the Flandrian the site developed from an area of open water to the basin mire which exists to-day. In doing so it corresponded well with the model of hydroseral sucession outlined by Walker (1970). The abundance of different types of biological remains (pollen, diatoms, plant and invertebrate macrofossils) and its location, as probably the most easterly basin mire in Wales, suggests that the site would repay more intensive study.

Acknowledgements

Help with the field work was provided by Steve Richards and Fred Slater. M.L. Cock, Brian Huntley, Roger Key, Fred Slater, A.G. Smith and Roy Wiles provided help with fossil identifications. John O'Halloran and Fred Slater provided constructive comments on the manuscript and Steve Whitehouse drew the figures. I would also like to thank the Manpower Services Commission and the Llysdinam Charitable Trust for facilities provided.

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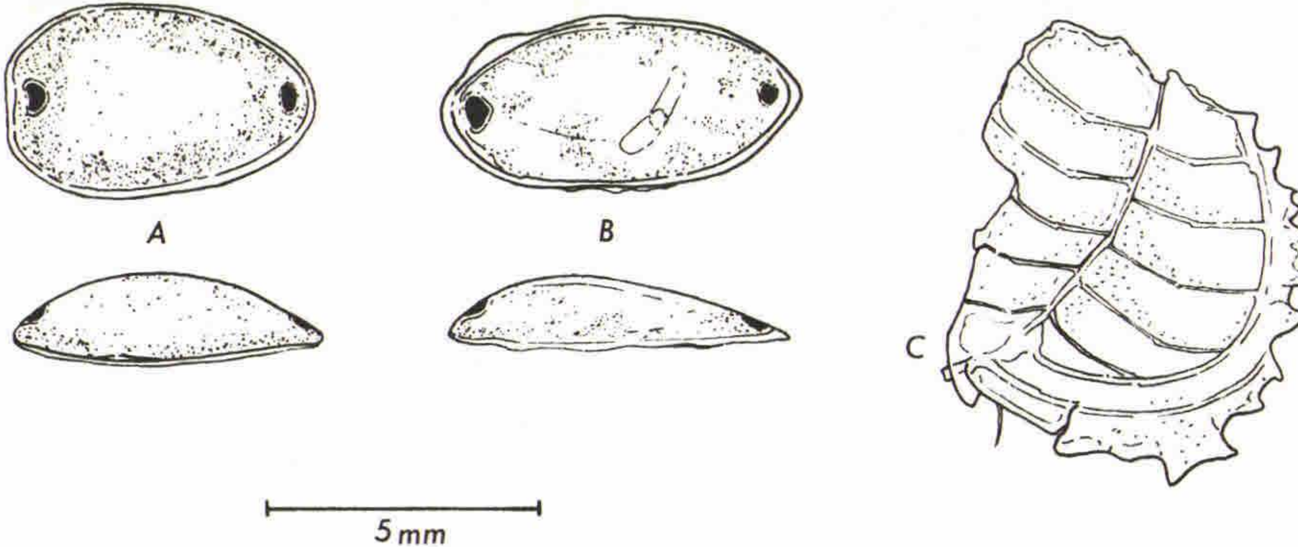

Fig. 4. Macrofossils from Beilibedw Mire. A Modern cocoon of Erpobdella octoculata from mid Wales. B Fossil Erpobdellidae cocoon. C Leaf X, fragments of this unidentified spiky leaf were found at several different levels in the core.

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LATE QUATERNARY OF THE KOPAIS BASIN, GREECE: SEDIMENTARY AND ENVIRONMENTAL HISTORY

Harriet Allen

Ph.D. Thesis, Dept of Geography, University of Cambridge
1986

The Kopais basin, about 80 km northwest of Athens, is one of the most fertile regions of Greece. Before it was reclaimed at the end of the nineteenth century it was a large seasonal marsh. It is an area of considerable archaeological importance because of an attempt by the Mycenaeans to drain it approximately 3,500 years ago. The sediment record (Turner & Greig 1975; this thesis) shows that for most of the Late Quaternary the basin was occupied by a lake and there has been some debate about the nature of the basin at the time of the Mycenaean drainage: whether they drained a lake or a marsh. In an attempt to answer this question and to complement the vegetation history of the basin provided by Turner & Greig two sediment cores were collected and the lake's sediment record, in terms of the erosional history of the catchment, was interpreted from the mineral magnetic properties of the sediment.

The mineral magnetic record together with particle size analysis, carbonate content and radiocarbon dates show that there are two sedimentary units present in the core material: the lower unit has an estimated basal date of 27,000 years BP and ends at 12,500 years BP, while the upper unit is estimated to end between 5,000 and 3,500 years BP. Values of magnetic susceptibility are low throughout the sediment cores but are higher in the lower unit than in the upper unit. The ratio of $IRM_{0 \cdot 08T}$ to $IRM_{1 \cdot 0T}$ indicates that haematite is the dominant magnetic mineral in the lower unit and magnetite in the upper unit. The profiles of the ratio of $IRM_{1 \cdot 0T}$ to susceptibility for both cores show little change in magnetic grain size within each unit. Particle size analysis reveals coarser material (about 50% of each sample finer than 6 um) in the lower unit than in the upper unit (about 80% of each sample finer than 6 um) but there appears to be no relationship between the magnetic parameters and particle size. Carbonate content is higher in the upper unit than in the lower unit and SEM shows that the carbonate in the lower unit is detrital while that of the upper unit is endogenic. X-ray diffraction also shows that the sediment in the upper unit is mostly calcite while that in the lower unit is more heterogeneous. Pollen analysis of the two cores was carried out by Prof. J.C. Ritchie, University of Toronto, who kindly made available the results and these confirm the findings of Turner & Greig (1975).

The interpretation of the two units is in terms of the Greek equivalents of the Last Glacial Stage and the Holocene. In the earlier period conditions were cool and arid with open steppe vegetation. The haematite in the sediments reflects the aerobic nature of the soils. During this period the lake was probably shallower than during the Holocene. In the later period the climate was wetter and warmer with mixed oak forest in the catchment. Phases of soil erosion are shown by peaks in frequency dependent susceptibility which occur in the upper sedimentary unit. These may be linked to clearance of woodland.

It appears that the most recent sediments (for the last 5,000 to 3,500 years) are absent in the basin. There are reports of wastage of up to 3.5 m of peat from the basin following modern drainage and this may account for the missing sedimentary record. Together with recent archaeological excavations (Knauss et al. 1984) it seems likely that the Mycenaeans attempted to drain a marsh rather than a lake. Given the nature of the sediment record and the basin, the change from open water to marsh probably resulted from gradual infilling of the basin rather than climatic change. This point is, however, complicated by the fact that the basin is in a limestone area and there are sinkholes around the basin which in the past may have controlled lake levels.

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MAGNETOSTRATIGRAPHY AND LATE QUATERNARY HISTORY OF THE BARENTS SHELF

Timothy J.F. Austin

Ph.D. Thesis, School of Environmental Sciences, University of East Anglia, 1987

Palaeoenvironmental changes on the Barents Shelf have been reconstructed and dated using evidence from approximately the top 20 metres of unconsolidated sediments beneath the sea-floor. A combination of methods have been used which include principally palaeomagnetic studies and interpretation of 3.5 KHz seismic records; and also sedimentological analyses; oxygen isotope stratigraphy; radiocarbon dating; aminostratigraphy and interpretation of foraminiferal data.

The Barents Shelf was found to have an extensive cover of glaciomarine diamicton containing an Arctic foraminifera fauna typical of a 'glacial' shelf. This diamicton varies in thickness from about 20 metres in the deeper water areas (>250 metres water depth), where it is overlain by approximately a metre of marine sandy clay, to near zero thickness on shallow banks where it outcrops at the sea-bed and has been heavily eroded.

Palaeomagnetic measurements have been carried out on specimens from 30 piston cores from the Barents, Kara and Norwegian Seas. The palaeomagnetic remanence and susceptibility have proved to be an

excellent means of correlating the sediment cores. The best correlation has been obtained by comparing large amplitude down-core oscillations in remanent inclination. These include zones of shallow-to-steep reversed inclinations. The oscillations are shown to be unrelated to magnetic susceptibility, magnetic mineralogical or lithological variations. It is concluded that the reversed polarity zones represent short duration excursions of the geomagnetic field that occurred during the period 10-40 ka BP. The similarity of the inclination records from all the Barents Shelf cores implies that regional geomagnetic phenomena are being recorded. These results have important implications for magnetostratigraphic dating in that the stratigraphically youngest palaeomagnetic reversal encountered in sediment cores in Arctic regions cannot necessarily be assumed to represent the Brunhes/Matuyama boundary (0.73 Ma BP), unless some independant information about the age is available. Geomagnetic models to account for the Barents Shelf palaeomagnetic excursions are reviewed and comparisons with reported Weichselian palaeomagnetic records from other sites around the world are discussed.

Magnetostratigraphic correlations combined with oxygen isotope, radiocarbon and amino acid data provide a chronological framework for the Barents Shelf sediments. The diamicton is thought to have been deposited fairly uniformly across the Barents Shelf, accumulating at a rate of at least 10-20 cm ka^{-1}, in a distal glaciomarine environment during the Middle and Late Weichselian. The upper fine grained marine unit, restricted to the deeper areas on the shelf, is of Holocene age and has been principally derived from erosion of the diamicton in Early Holocene times. It is thus concluded that the Barents Shelf was not glaciated at 18-20 ka BP and has remained unglaciated probably since at least Early Weichselian times. This finding is important because it eliminates the possibility of a pan-Arctic ice sheet during the last Glacial maximum (18 ka BP), which has been suggested by some authors.

HOLOCENE GLACIER FLUCTUATIONS AROUND EYJAFJALLAJÖKULL, SOUTH ICELAND: A TEPHROCHRONOLOGICAL STUDY

Andrew J. Dugmore
Ph.D. Thesis, University of Aberdeen, 1987

Stratigraphic studies of layers of volcanic ash, or tephra, in buried soils have been used to date accurately Holocene glacier flunctuations in Southern Iceland. 132 stratigraphic sections up to 11 m deep, and containing up to 78 tephra layers, were logged to a resolution of 0.25 cm. The chronological framework was completed with 12 radiocarbon dates, and by examining the association of the tephra stratigraphy with moraines representing former ice margins, a chronology of Holocene glacier fluctuations was constructed. The forelands of five glaciers were studied: Seljavallajökull, Gigjökull and Steinholtsjökull (outlets of Eyjafjallajökull) and Solheimajökull and Klifurárjökull (outlets of Myrdalsjökull). This study has shown for the first time that large glaciers existed in mid-Holocene Iceland because after 7000 BP and before 4500 BP Sólheimajökull extended at least 4 km beyond its present limits, and terminated at less than 100 m above sea level. Other major advances

of this glacier culminated before 3100 BP, and between 1400-1200 BP. In the tenth century AD Sólheimajökull was also longer than during the late Little Ice Age (1700-1900 AD). In contrast, Klifurárjökull and all the outlets of Eyjafjallajökull reached a maximum Holocene extent during the late Little Ice Age. It is proposed that the anomalous behaviour of Sólheimajökull may be explained as a result of catchment changes caused by the growth of the Myrdalsjökull ice cap. The great human impact on the landscape since the Norse Settlement (c. 870-930 AD) has also been assessed as a result of the extensive study of the aeolian sediments lying between numerous, accurately dated tephra layers. These studies show that a zone of chronic soil erosion developed in the natural upland pastures immediately after the Norse Settlement and slowly swept down hill to reach lowlying areas during the last 400 years.

QN: correspondence

Dear Sir,

May I add briefly to the correspondence in QN on the Baginton-Lillington-Thurmaston-Ingham Sands and Gravels?

Jim Rose's new sedimentological interpretation is most exciting, not least because it has the potential to link the Pleistocene stories of the Midlands and East Anglia. This is something many of us have tried but failed to achieve. However, does the narrow pathway partly along existing valleys really depict nature or is it restricted by the evidence available to date? Until there is confirmation of Rose's model as a whole any formal proposals concerning a new stratigraphy are surely premature.

If a paradigm is needed, glacial and volcanic rocks share the element of catastrophic arrival and it may be helpful for purist chrono-stratigraphers in particular to ponder stratigraphical developments in the northern Lake District during the last couple of decades, or so. There, in establishing a sequence of events (the guts of stratigraphy surely) for the Ordovician (rocks and time) the angular unconformity at the base of the Borrowdale Volcanics is as important as the graptolite-documented, steady passage up from the Skiddaw Slates to the Eycott Volcanics. Much work from many disciplines, some of it apparently contradictory initially, was required before an apparently full sequence of events emerged. Only then could the "stratigraphy" (in a restricted, terminological sense) be proposed with any confidence.

Yours etc.,

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NERC Group Review of Quaternary Science

We are all indebted to the Expert Group for the work they have put in to produce the review of Quaternary science, to the Director of Earth Science, NERC and to the Editor of the Quaternary Newsletter for publishing it in full, thus enabling the widest discussion and comment by all concerned. Hopefully this will set a precedent.

About the content I am not competent to comment. It is to more fundamental matters that I wish to turn. They concern hierarchies. They are important in that they question certain attitudes endemic to the subject and assumed almost unconsciously. In that they deal with the general methodology and organisation of science they are doubly important at a time like the present, when research, especially that conducted by young workers, is becoming increasingly controlled by committees and committees of committees. The comments I wish to make fall under two headings; one related to scientific method, the other to the sociology of science. Both are epitomised by the hierarchical 'logical structure' of Fig. 1 (QN 54, p. 39) and relate not only to Quaternary Science but to British Geomorphology as a whole.

It is immediately apparent on looking at Fig. 1. that the arrows flow one way only. The assumption is that science or at least Quaternary science, is a purely inductive pursuit. That this is no slip of the illustrator's pen is vouchsafed by the general tenour of the accompanying text. Data is collected in the lower divisions, collated and correlated and otherwise processed and then 'modelled'. Models are then promoted upwards for the modelling of models, to reach final apotheosis in a grand coupled global model. One would not wish to go as far as those for whom inductive science is little more than stamp collecting but if a discipline is to take off, in the graphic phrase of Morris Kline, then a deductive approach is imperative. The logical structure of Fig. 1. is not Newton, it is not even Kepler, at best it is Tycho Brahe. In the highest scientific endeavour theory is paramount. Data is selected and interpreted in the light of a theory. To misquote Maynard Keynes, - 'show me a practical scientist and I will show you the ideas of a defunct theorist'. Here, as in British Geomorphology as a whole, the theoretical side is quite left out. In Fig. 1. the arrows should also flow the other way. What we have here is an efficient venous system without the life giving arteries.

Throughout the review there is a great deal about measurement and instrumentation and the collection and analysis of data. This is what an hierarchical system does best. It is acknowledged that British Geomorphology is lamentably weak on theory and ideas. But the implied cure seems to be more of the disease, - more surveys, improved resolution, greater data-bases, larger maps, all directed from the top by national committees. All worthy, no doubt, but at best this can only be the prolegomena to science. The theoretical constructs of the upper levels of Fig. 1 do not spring Minerva-like out of the heads of data-collectors or data-processors. Theories imply thought and thought implies ideas. But ideas get scant attention in a review crowded with coring and sampling and inductive modelling.

No better example to illustrate our theme could be found than that detailed on the opposite page. A 'theoretical development' that has played a 'unifying role' equated to that brought about by plate tectonic theory. So we find that there is a place for deductive theory in Quaternary science, but it lies in the past. The impression given is that all the real thinking has been done, the framework has been set and all that is now required is to work out the details and fill in the gaps, while leaving the main structure intact. Bertrand Russell has some fine passages on this complacent academic attitude in the '<u>Scientific Outlook</u>'. As a general principle it is surely unsound to programme for no future change. In this particular case change is pretty well certain. As I have pointed out elsewhere, the days of well-behaved coupled dynamic systems, especially in something as complex as the atmosphere, are things of the past. So even here the outlook is unsettled.

Wherever ideas are to come from they do not automatically spring out of logical structures such as Fig. 1. Quite the reverse such structures tend to inhibit ideas and conserve the status-quo, and this brings us to the second main heading.

The scientist is a social animal. The scientist alone is either a God or a beast, as Aristotle would say. Group dynamics is now a commonplace in industry and in other walks of life where more than two or three are gathered together, but it has made very little impact on the academic fraternity. We cannot enter into all aspects of this topic and will restrict ourselves to just one. In very general terms the time honoured way of inducting young research workers was of the one-to-one, master and apprentice variety. In industry this is known as 'sitting next to Nellie' and it is still very much with us. It can be highly effective but we all have our own supervision horror story. Now, increasingly, we see the imposition of a corporate format. It is idle to think that this will not involve a great many changes over and above those of funding or formal structure. There are a great many myths attached to organisational behaviour and it is vital to the future well being of a scientific discipline that these do not become built in to an official dogma. Here again we can speak of just one, but it is cognate to what has gone before in that it concerns the birth, blossoming and propagation of ideas.

No-one who has worked in an hierarchical organisation needs to be reminded by Galbraith that ideas do not emanate from the top but from deep down in the corporation and the same is true of the scientific community. It is in the very nature of hierarchies to produce one way flows. They prefer induction for it preserves the status quo. Data collection is easily organised and predictable, big is beautiful, things are controllable and safe. But ideas, - they can spring up from anywhere, even from the outside. There is no economy of size, in fact the reverse. They are uncontrollable and subversive.

On reading this review there can be little doubt as to the place of a young research worker in this logical structure or where the cursus honorem lies. He or she is expected to auger and bore, collect and collate, to add their contribution to the existing total of knowledge; whereas it is the aim of the scientist to change it.

Worthy as this review may be within its self-inflicted restrictions, it is only half the story and the duller half at that. Where is the excitement, wonder and awe to motivate the young seeker after the truth? An elegant scientific theory is the precious life blood of a master spirit. Scientists are the unacknowledged poets of our time. But there is no poetry here, more like gradgrind.

The only saving grace is the introductory letter from the Director of Earth Science NERC. This has a breadth and vision lacking in the pages that follow. It includes the phrase - "that important new ideas might not be taken up and exploited as they should".

Significantly, this is the only use of the word 'idea' that I can find throughout the entire review. With present attitudes and one way logical structures new ideas face a very uncertain future not only in Quaternary Science but in Geomorphology as a whole.

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ORIGINS

from Dr. J.E. Robinson
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We often use terms in our work without really knowing their origins, or sometimes, their original meaning. Such may be the case with Calcrete and Silcrete, terms which have slipped into most people's usage, probably with a grudging assumption that they were the creation of some 'foreign' pedant. Well, it isn't so, they're both good English words, introduced to the literature of Geology by that sadly underestimated Survey field geologist, G.W. Lamplugh.

You might be forgiven not knowing this if only because he chose to introduce the terms for very practical field use reasons when he himself was in the field, mapping in Holderness, and did it in the form of a letter to "Geol. Mag." In 1902, this was the accepted route to quick publication, as well as a guarantee that a new idea would reach the active work force of the subject.

The letter is a masterly effort, sparing in words; eloquent and clear in meaning. "Process" was linked with the end product usefully for the field geologist, and one word conveyed what otherwise could have been a lengthy sentence. Currently, I am myself grateful to Lamplugh and this same letter for offering the less-used third term, ferricrete, for what otherwise people have been calling 'iron-bound conglomerate', 'rubble conglomerate' or simply 'ironstone'. Again, it is process which is of prime importance, iron-rich groundwaters doing what lime- or silica-rich waters would do in the more familiar cases. For the record, here is the letter in full, from Geological Mag., 1902, vol. IX, p. 575.

'CALCRETE'

Sir, - "Murder will out," whether of person or language, and the appearance in the October number of the Irish Naturalist of a new word for which I am responsible makes requisite an open confession. The word is 'calcrete,' applied in this instance by a friend who has become accustomed to the term through our conversation, and has trustfully used it as a 'good' word in describing the shelly drift-gravels near Dublin. The indiscretion will be repeated, by my colleagues as well as myself, in the forthcoming new edition of the Geological Survey Memoir on the neighbourhood of Dublin, and preliminary explanation and definition seems therefore desirable. In the drifts around Dublin, as in most places where in like manner limestone-débris enters largely into the composition of the superficial deposits, the sand-and-gravel beds are often cemented sporadically into hard masses by solution and redeposition of lime through the agency of infiltrating waters. In order to indicate this condition on the field-maps a terse expression was sought to replace such long and awkward circumlocutions as 'conglomerated gravel,' 'calcareous concreted gravel,' etc., and for this purpose the abbreviation 'calcrete' was invented and found adequate. Other workers under similar conditions may find the word equally serviceable, and to them I therefore recommend it.

Moreover, I have the hardihood to suggest that the term might be complemented by equivalents, - 'silcrete,' for sporadic masses in loose material of the 'greywether' type, indurated by a siliceous cement; and 'ferricrete' when the binding substance is an iron-oxide. I will grant that these terms are etymologically somewhat imperfect, but the inconvenience of an additional syllable would be a more weighty objection where expressive brevity is of prime consequence.

G.W. LAMPLUGH.

Bridlington Quay.
November 4th, 1902.

From: The Vice President

At the meeting of the Executive Committee immediately following the latest Annual General Meeting on April 9th 1988, a discussion paper was tabled. This is reproduced below without any changes. The Committee received the paper with enthusiasm and agreed that initially it should be brought to the attention of the membership. Accordingly, members are encouraged to respond by writing to the Secretary in the first instance and if suitable material is submitted, this might be published in a subsequent issue of the Newsletter.

A REGIONAL STRUCTURE FOR THE QRA?

The organisation and mode of operation of the QRA has not changed to any great extent since it was founded back in 1964. Now we are approaching the Silver Jubilee, the time is opportune to reappraise the modus operandi of the association especially since we are in the midst of radical reviews of the earth sciences and NERC has undertaken its own 'expert review'. But note, however, that the QRA has had no effective role in these reviews.

I would suggest that the most sèrious defect in the present structure is that in any given year, only a small proportion of the membership -

now approaching one thousand - actually participates in a QRA activity, whether it be a field meeting, the annual discussion meeting or one of the rare taught courses. The majority have as their sole contact the receipt of the Newsletter three times a year. As will be generally agreed, face to face contact is vital in so far as it leads to creative discussion and the development of ideas etc. If the QRA is to raise its level of effectiveness, then it needs to be more active in generating contacts between the membership and concurrently raising its profile in the scientific community.

Those resident in the south east of England have long benefited from the open house policy of the Sub-Department of Quaternary Research at Cambridge with respect to its 'Quaternary Discussion Group' meetings. I stimulated the founding of a similar group based on Oxford a number of years ago and more recently the embryonic 'Midlands Quaternary Seminar' which has up to now met in Coventry. Of course, we also have the London Quaternary Lecture Series as a well established feature of the capital's scene.

My feeling is that we need to distinguish two functions, one basically an adjunct to teaching which is normally achieved by promoting public lectures and the other research which is best served through the small group/seminar/workshop kind of format with maximum informality. If we take the numbers attracted to the 'Midlands Quaternary Seminar' as a guide, there is clearly huge demand, arising from our involvement in undergraduate teaching, to supplement the numerous option courses in Quaternary Studies etc. Indeed I believe that one group travelled all the way from Plymouth to the first Coventry 'seminar'. One suspects that the enormous turn-out in the Coventry case is powered by the fact that in most institutions Quaternary interests are numerically limited and at the departmental level we are concerned with minority groups which are hardly viable in terms of justifying a significant programme of outside speakers. However, if we act collectively, the situation is transformed as the Coventry and London experience shows. I submit therefore, that the QRA should be the focus of an attempt to create a regionally based programme of lectures specifically aimed at the third year option level market but open to all who are interested. The benefits are obvious and I shall restrict myself to noting the potential impact on the stimulation of future research students etc.

Despite the just mentioned teaching support role which the QRA could assume, I believe, that priority must be given to research, after all the QRA is notionally primarily concerned with the 'advancement of knowledge'. I hope that I am not being unkind if I suggest that as a promoter of research the QRA has not been totally successful. I fully acknowledge that the association has been a splendid vehicle for publicising and disseminating the results of research but as an initiator and stimulus to research it has achieved little. Indeed, the sole role in this connection which comes to mind is the fund recently established to provide small grants to younger research workers. However, I doubt if the QRA can realistically aspire to becoming a significant provider of financial resources. Consequently, the QRA needs to promote research in other ways. Following comments which I made at the 1984 AGM in Carmarthen, the External Affairs Committee was established and has struggled to raise the external awareness of the importance of Quaternary science, its multidisciplinary character and dangers of vulnerability in a scenario of contracting funding. This is an ongoing crusade.

Within the QRA research can be facilitated using the ultimate resource, that of our own membership and this leads to the concept of a regional structure. If we establish a pattern of regional groups oriented towards the local membership and their interests I can foresee a number of advantages accruing some of which include:

encouragement of regular contact and collaboration;

more viable communities with multidisciplinary strengths;

potential to share limited resources, equipment etc;

rapid dissemination of information arising from local discoveries and organisation of shared 'watching briefs' on new exposures etc;

exposing research workers, especially research students, to a wider expertise than that normally available in a single institution;

encouragement to those who are outside the higher education system but who are keen to participate if costs can be minimised;

better liaison with existing learned societies and government agencies such as NCC;

seminar programmes.

Those who are members of large institutions will probably say that they already experience the benefits just noted through existing structures. Obviously in some instances this is the case and any QRA initiative must work with these since duplication is unnecessary. The main point is that a majority of the membership are not in such a favoured position and if the current trends in the university system are to continue, matters are not going to improve.

To conclude, I suggest that the QRA should undertake a fundamental examination of its future role. My personal view is that the adoption of a regional structure would radically improve the benefits of membership to a majority who currently are not actively involved in the association's operation. The QRA through regional groups can help fulfil a clear need for help with teaching by promoting lecture series but most importantly it has the potential of actively promoting and initiating research rather than serving in a more passive role, as of now, in disseminating the results of research. Hopefully a more creative research association will ultimately have a greater influence in national resource allocation.

Peter Worsley
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QN notices

CORRECTIONS

Esmée Webb wishes to correct a misrepresentation of arguments by Charles Turner given in the report of the Palaeolithic conference in January 1988 (QN 54, pp. 20-21). Dr. Turner would not wish to correlate the Holsteinian interglacial with oxygen isotope stage 7, but with some earlier stage, probably 11. It was intended to suggest that others have made the stage 7 correlation, but the printed sentence is less than clear.

Esmée's address in the last QN was incomplete. It should have read: Centre for Prehistory, University of Western Australia, Nedlands, WA 6009, Australia.

Q.R.A. YOUNG RESEARCH WORKERS' GRANTS

In the 1988 round grants have been awarded to: Lorraine Allen (£60), Lesley George (£50), Li-Ping Zhou (£60) and Caroline Jill Tate (£100).

GLACIERS AND ENVIRONMENTAL CHANGE IN NORWAY: AN INFORMAL RESEARCH GROUP

A one-day workshop organised by Wilf Theakstone was held in Manchester on 25th March 1988. Current research projects in Norway were discussed, and possible future collaborative research was considered. It was agreed to establish a directory of research equipment available in British universities and polytechnics, this list to be compiled by Dr. Brian Whalley, Queens University, Belfast. A one-day symposium on glaciers and environmental change in Norway will be held in Cardiff in October 1988, to be organised by Dr. John Matthews. Anyone interested in this research group please contact: Wilf Theakstone, School of Geography, University of Manchester, Manchester M13 9PL. Details of symposium from: John Matthews, Geology Department, University College Cardiff, P.O. Box 78, Cardiff CF1 1XL.

GEOLOGICAL ASSOCIATION OF CANADA/ MINERALOGICAL ASSOCIATION OF CANADA

The joint annual meeting of the GAC/ MAC will be held in Montreal, Canada, May 14th-17th 1989, with the participation of the Canadian Geophysical Union. For further information please contact Dr. Colin Stearn, Chairman, Local Organizing Committee for Montreal '89, Rm. 238, 3450 University Street, Montreal, Quebec, H3A 2A7, Canada.

Vth INTERNATIONAL SYMPOSIUM ON PALEOLIMNOLOGY

This Symposium will be held in Ambleside, Cumbria, U.K. in the heart of the English Lake District, from August 31st to September 6th 1989. Papers and posters on all aspects of paleolimnology are welcome, but five major themes - Accuracy and precision in sediment chronology, Sedimentary record of atmospheric inputs, Aquatic ecology and paleolimnological interpretation, Sediment records of drainage basin processes, Paleolimnology of saline lakes - will form the core of discussions. Pre- and post-conference excursions will be held in Southwest England, the English Midlands and Wales, Galloway and Ireland, and Galloway and Northern Scotland. For further information, please contact Professor Frank Oldfield, Department of Geography, University of Liverpool, P.O. Box 147, Liverpool L69 3BX, U.K.

EUROPEAN WORKSHOP ON LANDSCAPE ECOLOGICAL IMPACT OF CLIMATIC CHANGES

To assess the potential effects of a man-induced climatic change on terrestrial ecosystems and landscapes. To be held at the Congress Centre "de Leeuwenhorst", Noordwijkerhout, The Netherlands in autumn 1989. For detailed announcement and call for papers contact the LICC-secretary: Drs. F.A. Eybergen, Dept. of Physical Geography, University of Utrecht, P.O. Box 80.115, 3508 TC Utrecht, The Netherlands.

CALENDAR OF MEETINGS

(NOTE Q.R.A. Meetings are listed in the accompanying Circular)

10th-15th July 1988	International Working Meeting on Soil Micromorphology, at San Antonio, Texas, U.S.A. (see Newsletter 51, p. 23).
9th-15th September 1988	INQUA Shorelines Subcommission for NW. Europe: Symposium and Field Excursion to Scotland (see Newsletter 54, p. 50).
19th-23rd September 1988	International Symposium on Engineering Geology, at Athens, Greece (see Newsletter 51, p. 22).
22nd-25th September 1988	Quebec Association for Quaternary Studies, 6th Congress at Rimouski, Quebec, Canada (see Newsletter 54, p. 50).
2nd-6th October 1988	Field Meeting and Workshop on Glaciotectonics (WGGT/INQUA) in Norfolk, U.K. (see Newsletter 53, p. 42).
16th-17th March 1989	Marine Studies Group of the Geological Society, Meeting on Glacimarine Environments: Processes and Sediments, at Geological Society, London (see Newsletter 54, p. 50).
14th-17th May 1989	Geological Association of Canada/ Mineralogical Association of Canada joint annual meeting in Montreal, Canada (see notice above).
9th-19th July 1989	28th International Geological Congress to be held at Washington, D.C., U.S.A. (see Newsletter 48, p. 44).
31st Aug. -6th Sept. 1989	Vth International Symposium on Paleolimnology, at Ambleside, Cumbria, U.K. (see notice above).
10th-14th September 1989	Geological Society/International Association of Engineering Geology Conference on "Quaternary Engineering Geology" at Heriot-Watt University, Edinburgh (see Newsletter 54, p. 50).
25th-29th September 1989	Second Iberian Quaternary Meeting in Madrid, Spain (see Newsletter 53, p. 42).
autumn 1989	European Workshop on Landscape Ecological Impact of Climatic Changes to be held in the Netherlands (see notice above).

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