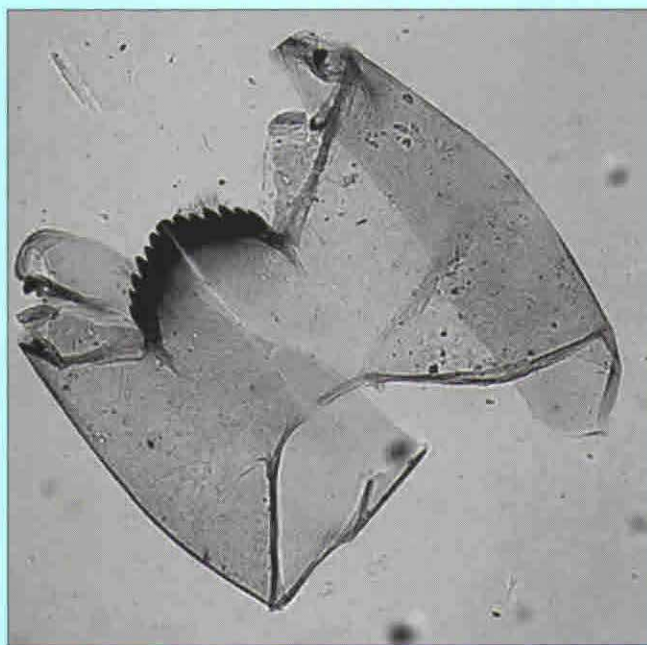

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Quaternary Newsletter is issued in February, June and October. Articles, reviews, notices of forthcoming meetings, news of personal and joint research projects, etc. are invited and should be sent to the Editor. Closing dates for submission of copy (news, notices, reports etc.) for the relevant numbers are 1st January, 1st May and 1st September. These dates will be strictly adhered to in order to expedite publication. **Articles must be submitted at least 6 weeks before these dates in order to be reviewed and revised in time for the next issue of QN, otherwise they may appear in a subsequent issue.** Authors are encouraged to submit material as e-mail attachments, with text in Word format and diagrams and black-and-white photographs in .eps format.

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COVER PHOTOGRAPH:

Photograph (x400) of *Orthocladus consobrinus*-type, the head capsule of a chironomid larva found in lake sediments from Efstadalsvatn, NW Iceland (see report pp.56-60). This taxon is abundant in arctic lakes in Scandinavia. Photograph kindly supplied by Pete Langdon.

OBITUARY

ALEC WESTLEY SKEMPTON 1914 -2001

Professor Sir Alec Skempton's death on 9th August 2001 brought to an end a particularly distinguished and multi-faceted career. Following his secondary education at Northampton Grammar School, he read civil engineering at Imperial College, University of London (1932-35). He completed a research MSc there in reinforced concrete before moving to the DSIR Building Research Station at Watford, where he worked for 10 years (1937-47) in the soil mechanics section. Skempton returned to Imperial College in 1947 as Reader in Soil Mechanics, becoming Professor of Soil Mechanics in 1955 and Professor of Civil Engineering and Head of Department in 1957. On his retirement in 1981, he became Professor Emeritus and a Senior Research Fellow of Imperial College, working very productively in his old room there almost daily until a few months before his death.

The range and distinction of Skempton's work is remarkable. Internationally, he is best known for his very influential contributions to the development of soil mechanics and foundation engineering, particularly in the classification and understanding of soil properties, the consolidation and geological compaction of clays, the influence of discontinuities on mass shear strength, the stability of earth dams and natural slopes, foundation design and the allowable settlements of buildings, as well as his contributions to engineering geology. The honours he received included election as a Fellow of the Royal Society in 1961, becoming a Founder Fellow of the Royal Academy of Engineering in 1976 and, in the same year, election as a Foreign Associate of the National Academy of Engineering of the USA. He was the second President of the International Society of Soil Mechanics and Foundation Engineering from 1957-61 and gave the seminal 4th Rankine Lecture in 1964. He was awarded Honorary Doctorates of Science by the Universities of Durham and Aston and by Chalmers University, Sweden. He was knighted in the millennium New Year's Honours List.

A second major part of Skempton's work lies in the field of the history of civil engineering, where his penetrating studies range from eighteenth century land drainage works and mill foundations to the construction of docks in the Port of London, the development of metal-framed buildings and the improvement of Portland cements during the mid-nineteenth century. Through this work, almost single-handedly, Skempton transformed the subject from that of the

enthusiastic amateur historian to a rigorous academic discipline. Most recently he chaired the editorial panel for the Biographical Dictionary of Civil Engineers in Great Britain and Ireland during the period 1500-1830, making a very substantial contribution to this himself. In connection with these historical interests, Skempton built up a fine collection of contemporary books, mostly dealing with the development of soil mechanics, and early engineering reports. In 1981, with characteristic generosity, he presented this "Skempton Collection" to the Imperial College Civil Engineering Department's History Collection. For many years Skempton gave an informal series of lectures at Imperial College on the history of civil engineering. Originally intended for undergraduates, they soon became the most popular lectures in the department, attended by all who could get in!

Skempton's advice was naturally widely sought on engineering projects both at home and abroad, so consulting work formed a further major activity. It covered earth dams, including the Mangla Dam and two other large ones in Pakistan, building foundations, including both St Paul's and Salisbury cathedrals, and numerous slope stability problems. In this work his approach was holistic, establishing the geological, geomorphological and historical settings early in the process of defining an adequate engineering geological and geotechnical model for the site. He always insisted on seeing things for himself, whether they were morphological features, trial pits, or temporary earthworks exposures, but was very ready to bring in a specialist where appropriate. He believed in airing with his colleagues his initial ideas and problems, generally resolving and refining these by a combination of good observation, intense discussion and impressive single-mindedness. He set an excellent example in writing up most of his consulting jobs, to form invaluable case records. In this way these jobs stimulated and underpinned his research work, which then fed back into engineering practice.

Skempton's interest in geology was awakened during his undergraduate years at Imperial College. It grew with time and informs all his work. He soon realised the great importance of the Quaternary and its deposits in civil engineering activities, as evidenced by his paper on soil mechanics and geology (Skempton, 1953) and his work on the sliding of the M6 Motorway during construction at Walton's Wood, Staffordshire, in 1962 (Early and Skempton, 1972) and on the failure of the Sevenoaks By-pass, also during construction, in 1965 (Skempton and Weeks, 1976). The latter paper, which describes the reactivation by cuts and fills of movement on pre-existing shears within solifluction deposits deriving from the Atherfield and Weald Clays, is particularly significant as it brought to the attention of civil engineers, for the first time, the dangers inherent in disturbing low-angled and often innocent-looking slopes of periglacial clays. In 1976, Skempton (with Hutchinson) organised a Royal Society Discussion Meeting on the morphology, mechanics and Quaternary history of

valley slopes and cliffs in southern England. Under this excellent and inclusive title, half a dozen papers, including that on Sevenoaks, were presented. These experiences were, of course, incorporated into Skempton's undergraduate and postgraduate lectures. This input was supplemented from the early 1980s by an MSc course, given by A.W. Skempton, J.N. Hutchinson and R.J. Chandler, entitled "Engineering aspects of the Quaternary".

Important though Skempton's contributions to the engineering geology of the Quaternary are, his Quaternary interests were in fact much wider, embracing the whole of Quaternary stratigraphy, correlation and dating. I have memories of finding him in his office, writing out lists of diagnostic mammalian fossils for the main glacials and interglacials, an interest doubtless stemming from his encounter (during his work at Mangla Dam) with the famous Pliocene and Early Pleistocene elephants of the Siwaliks of the sub-Himalaya, or drawing yet another revised section of the Thames terraces. He kept in frequent touch with the leading Quaternary geologists and scientists of his day, and maintained an impressive understanding of that complex area. He was closely involved with the 50 or so people who, in early 1964, formed the Quaternary Field Study Group (which became the Quaternary Research Association in 1968) and became a member in 1964 or 1965. Skempton frequently attended the Easter Field Meetings, at which he could be relied upon to ask some penetrating questions. His last such meeting was that of 1995 on the Quaternary of the lower reaches of the Thames, a subject very close to his heart.

I leave the last words to Richard West. "Alec Skempton added greatly to the understanding of Quaternary environments and processes by his especial interest in the relation between soil mechanics and Quaternary stratigraphy. As a civil engineer of great experience in field and laboratory, he brought to the subject new insights which were relevant to the wider Quaternary community. He was particularly concerned with the dating of the sediments and processes he described, and had a grasp of Quaternary stratigraphy and a curiosity about correlations which, if my experience is anything to go by, led to long and discerning letters about such matters as the history of the Thames and Quaternary stratigraphy in general. His contribution to Quaternary studies was important and unique, an illustration of the invaluable injection of another science into our research experience and capability".

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(A full bibliography of Skempton's publications is given by Chandler, *et al.*, 2001).

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ARTICLES

A MID-FLANDRIAN TEPHRA HORIZON, CAMBRIAN MOUNTAINS, WEST WALES

Shaun Buckley and Mike Walker

Introduction

Evidence from Scotland (Dugmore, 1989; Dugmore *et al.*, 1995; Turney *et al.*, 1997), northern Ireland (Hall *et al.*, 1993; 1994a; Pilcher and Hall, 1992; Pilcher *et al.*, 1995) and northern England (Pilcher and Hall, 1996) has shown that microscopic Icelandic tephra reached these areas during the course of the Flandrian. Previous attempts to find tephra in Wales have met with limited success (Lascelles, 1993; Hall, *pers. comm.*). This is surprising because, providing meteorological conditions were suitable, there is no reason why Icelandic tephra should not have been dispersed across the principality (*cf.* Maloney and McVicker, 1993). Therefore, during the course of a recent palaeoecological study in upland west Wales (Buckley, 2000) a detailed search was made for tephra in blanket peat profiles. We report here on the outcome of this exercise, and provide the first published record of a dated Flandrian tephra from Wales.

The sites

The tephra layer was found in two water-shedding blanket mires on the spine of the Cambrian Mountains in west-central Wales: (1) Bryniau Pica, located in the upper reaches of the Afon Teifi, between c. 410–450 m O.D.; and (2) Bryn Mawr, at c. 510 m O.D., at the headwaters of the Afon Elan (Figure 1). In both sites, around 4.5 m of organic sediment have accumulated. Radiocarbon dates from the base of the profiles suggest that organic sedimentation began c. 9000 ¹⁴C yrs BP (Buckley, 2000).

Tephra analysis

The sites were cored using a wide-diameter Russian sampler with a 30 x 10 cm chamber. Fourteen radiometric and AMS ¹⁴C dates provided the basis for age-depth models for the two peat profiles, and the search for tephra was concentrated on those parts of the sequences where two of the most widely dispersed Icelandic tephra, notably the Hekla 4 tephra, dated to c. 4000 ¹⁴C yrs BP (Larsen and Thorarinsson, 1977) and the Lairg tephra, dated to c. 6000 ¹⁴C yrs BP (Dugmore *et al.*, 1995), might be expected to be located. Cores were initially

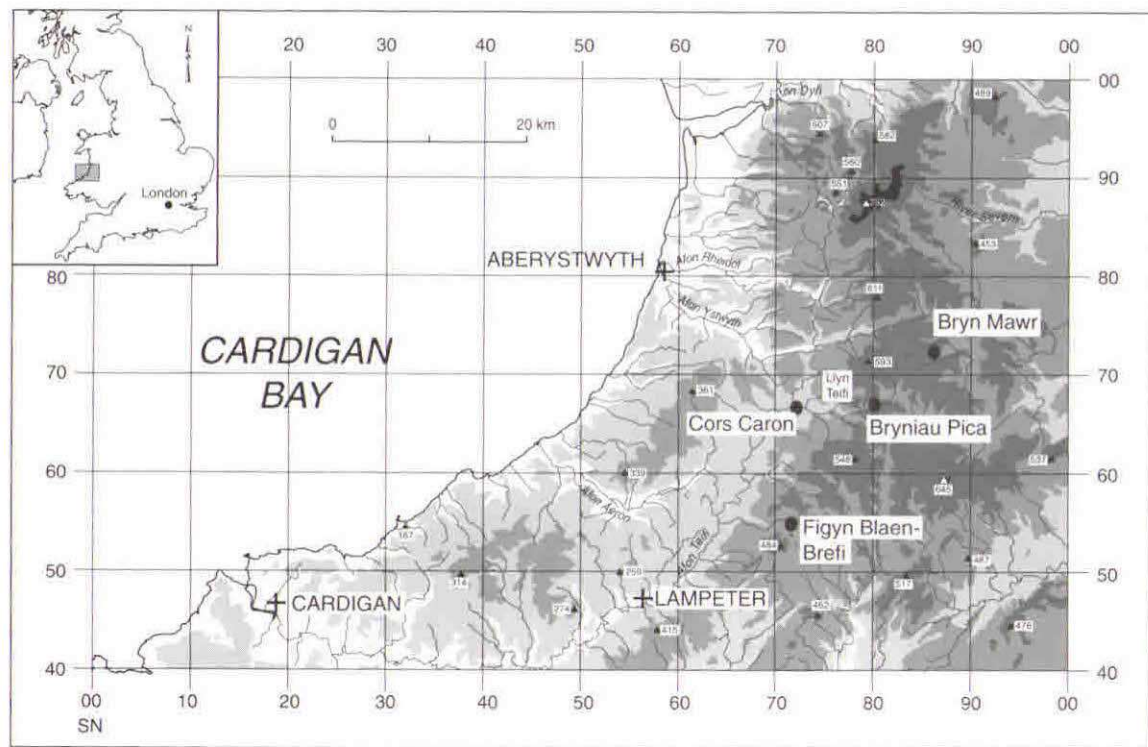


Figure 1. The location of the study sites: Bryn Mawr, Bryniau Pica and Figyn Blaen-Brefi. The well-known site of Cors Caron (Tregaron Bog) is also shown.

sampled at contiguous 5-cm vertical intervals and prepared for light microscope determination following procedures described in Pilcher and Hall (1992), with minor refinements to the chemical treatment and sieving procedure necessary for blanket peats (Hall *et al.*, 1994b). Identifications of tephra shards was carried out using plane polarised light at x400 and x600 magnification, tephra being distinguished from other silicious minerogenic fragments, particularly biogenic silica (or phytoliths), on the basis of colour, vesicularity and morphology (Heiken, 1974; Self and Sparks, 1981). Type material of Hekla 4, Veidvotn and Oraefajokull further aided tephra identification.

Once tephra shards had been located in a 5-cm slice of sediment, contiguous 1-cm vertical samples were extracted from the remaining sections of the same core in order to establish whether or not a clear tephra isochrone existed. Those layers that yielded sufficient tephra were prepared a second time using the wet oxidation method, which does not alter the chemical composition of the tephra shards (Dugmore *et al.*, 1992). The analytical results (Figure 2) show marked peaks in tephra abundance at 286–288 cm in Bryniau Pica and at 280–282 cm in the Bryn Mawr sequence.

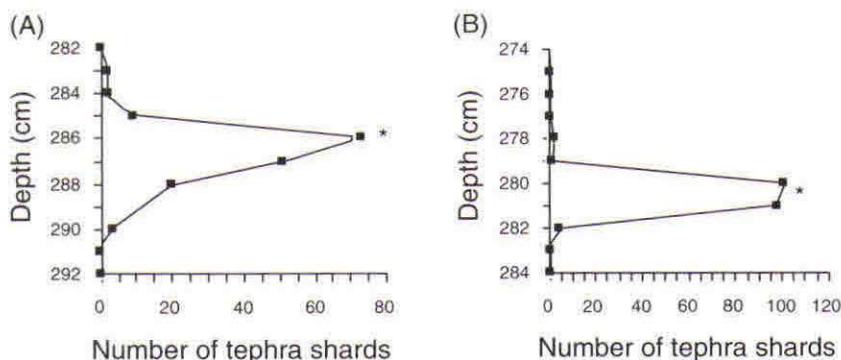


Figure 2. Two tephra layers identified in contiguous 1-cm samples of peat from (A) Bryniau Pica (c. 5875 ^{14}C years BP) and (B) Bryn Mawr (c. 5945 ^{14}C years BP)

The age of the tephtras

Morphologically, the two tephra layers are very similar in that they contain colourless, vesicular shards ($< 40\mu\text{m}$), along with smaller angular fragments. The implication, therefore, is that they date from the same ash fall, a hypothesis that is supported by pollen analytical evidence and by radiocarbon dating. In both the Bryniau Pica and Bryn Mawr profiles, the tephra horizon coincides with a short-lived peak in the curve for *Corylus avellana*, with a short-lived decline in *Calluna vulgaris*, with a reduction in values for *Betula*, and with

minimum counts for Cyperaceae (Figure 3). Linear interpolations from the age-depth models for the two peat sequences date the tephra isochrones to c. 5875 ^{14}C yrs BP at Bryniau Pica and c. 5945 ^{14}C yrs BP at Bryn Mawr.

The provenance of the tephra

Having established that the tephra layers in the two peat sequences almost certainly date from the same eruption, an attempt was made to determine the geochemical properties of the tephra shards in order to locate the source.

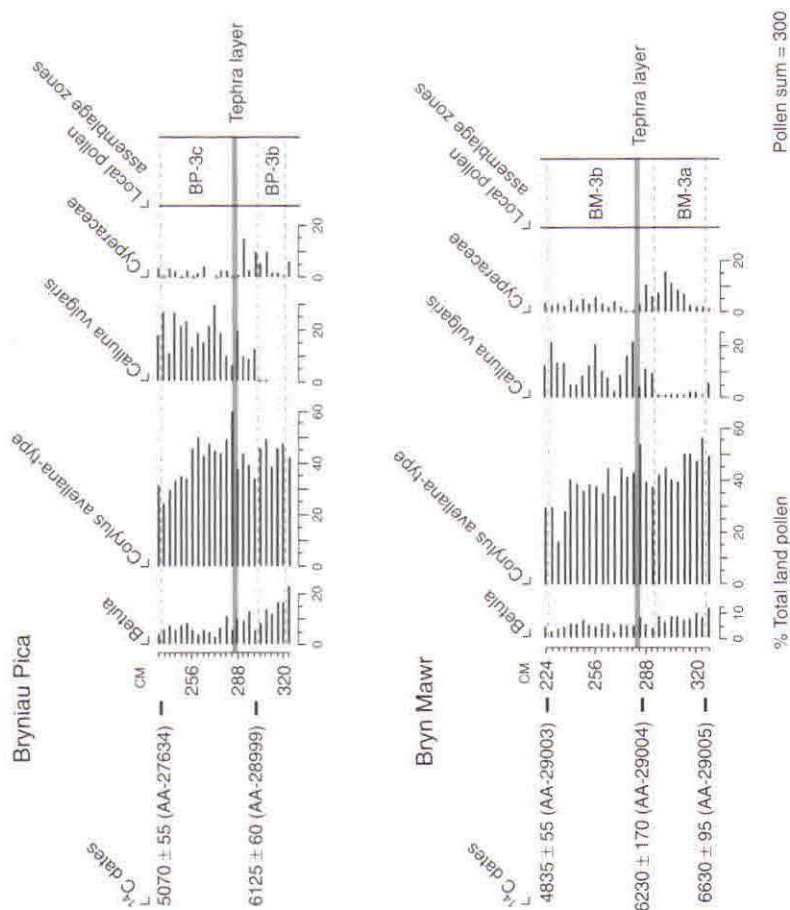


Figure 3. The tephra horizon shown in relation to the pollen record (selected taxa) at Bryniau Pica and Bryn Mawr.

Samples were prepared for electron probe microanalysis (EPMA) at the Electron Microscope Unit in the Department of Geology, University of Edinburgh. Unfortunately, however, owing to the low concentration and small size of the tephra particles recovered, we were unable to determine the major elements of individual shards and thus to 'type' the tephra layers (e.g. Dugmore *et al.*, 1992; Froggatt, 1992; Hunt and Hill, 1993; Larsen *et al.*, 1999). A similar problem has been encountered in samples from other upland sites where tephra concentrations have been low (McVicker, 1993; Dwyer, 1995).

Consequently, the provenance of the Bryniau Pica and Bryn Mawr tephtras remains a matter for conjecture. However, on the basis of other tephrochronological studies in western Britain, Iceland would seem the most likely source. Indeed, the colour and morphology of the shards and, equally importantly, the interpolated ^{14}C age of the tephra isochrone, suggest a correlation with one or other of the Lairg layers (A + B), which have been dated at c. 6000 ^{14}C years BP in sites in Scotland and northern Ireland (Dugmore *et al.*, 1995; Pilcher *et al.*, 1996).

Distribution of the tephra

A third blanket peat site was investigated during the course of the present research programme, Figyn Blaen Brefi, which lies some 15 km to the southwest of Bryniau Pica (Figure 1), and at a slightly lower altitude (c. 410 m OD). A ^{14}C -based age-depth model was also developed for this site. However, despite an exhaustive analysis of the sections of the peat profile that are comparable in age to those which contained tephra in the other two sites, no tephra shards were detected in the Figyn Blaen Brefi sequence. Three explanations might apply to this distributional pattern: (1) the ephemeral nature of tephra deposition; (2) the effects of orographic and/or localised precipitation at the time the airborne tephra passed over the upland plateaux; or (3) that the southern extent of the tephra plume lay between the Bryniau Pica and Figyn Blaen Brefi sites. A fourth explanation, namely that tephtras are present at Figyn Blaen Brefi but in such low concentrations that they have not been detected, cannot be excluded, although this would seem unlikely in view of the systematic and intensive nature of the analytical programme undertaken there.

Conclusions

The occurrence of a single Flandrian tephra layer in blanket peats from Bryniau Pica and Bryn Mawr provides the first unequivocal evidence of distal tephra deposition in the uplands of west Wales. Although the tephra cannot be linked geochemically with tephra layers found in Iceland and elsewhere in north-west Europe, there are grounds for believing that this Welsh tephra may be the equivalent of one of the Lairg tephtras described from northern Ireland and

Scotland. Further investigations are now needed in both upland and lowland areas of Wales to establish whether corresponding or, indeed, other tephras are present in Flandrian peat and lake sediment sequences.

Acknowledgements

We are grateful to Dr Valerie Hall for assistance with tephra identification; to Dr Peter Hill for assistance with the electron microprobe analysis; to the Natural Environment Research Council for providing the ^{14}C dates; to Mike Bradford, Kevin Hawksworth, John James, Lloyd Jenkins and Caroline Rogers for assistance with the fieldwork; and to two anonymous referees for their constructive criticism of the initial draft of the article.

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TIME FOR A MORE OPEN-MINDED APPROACH TO THE STUDY OF BRITISH MIDDLE PLEISTOCENE DEPOSITS?

Harry E. Langford

Recent interpretation (Langford, 1999, 2001) of Middle Pleistocene deposits in the Peterborough area, eastern England, does not conform to conventional explanations based on lithostratigraphy (e.g. Perrin *et al.*, 1979; Horton, 1989), terrace stratigraphy (e.g. Castleden, 1980; Horton, 1989) and Anglian glacial depositional models (e.g. West and Donner, 1956; Perrin *et al.*, 1979). Using some ingenuity it may have been possible to interpret the data to suit existing stratigraphical and palaeogeographical models. The legitimacy of such an approach, however, is questionable, particularly as alternative explanations were found to fit the data more easily. I found this lack of conformity with explanations based on conventional approaches both surprising and worrying. There are, however, limitations associated with conventional approaches to the study of British Middle Pleistocene deposits and differing interpretations therefore should not be viewed with concern. In the light of my findings and the recent literature about controversial issues in British Middle Pleistocene glacial stratigraphy (Bowen, 1999; Bowen and Lewis, 2000; Hamblin *et al.*, 2000; Moorlock *et al.*, 2000a; Straw, 2000; Banham *et al.*, 2001), it seems appropriate to restate some of these limitations.

These limitations concern adopting a lithostratigraphical approach for correlating British Pleistocene deposits (Bowen, 1999), the prevailing subglacial approach applied to British Middle Pleistocene (Anglian) diamictos (e.g. Lewis *et al.*, 2000) and the prevailing terrace stratigraphy approach applied to disparate sand and gravel bodies located on the valley sides, interfluvies and beneath the floodplain of present-day river catchments (e.g. Castleden, 1980; Bowen, 1999).

Restatement of these limitations is merited because awareness of them demonstrates that alternative explanations can be expected. Furthermore, the recent literature referred to above concentrates on areas of conflicting interpretations, and does not consider the extent to which the apparent uncertainties and differences in the debate stem from limitations of the conventional approaches used, both to interpret and correlate British Middle Pleistocene deposits.

There are three further reasons why reiteration of these limitations is important, one of which is that they may not be well-known to non-specialists of glacial and fluvial systems. Individual protagonists may well make reference to alternative views, but invariably debates concerning British Middle Pleistocene deposits use an inductive approach within the favoured research paradigm (e.g. subglacial approach to the interpretation of Anglian chalk-rich diamictos),

rather than a deductive approach that tests competing hypotheses (see McCarroll, 2001). There also is a need to counteract the tendency to focus upon positive associations, or what Watkins (1971; cited in Andrews *et al.*, 1999) refers to as the 'reinforcement syndrome', when research is conducted within the favoured paradigm. Finally, being aware of the limitations associated with favoured paradigms should encourage an open-minded approach to the study of British Middle Pleistocene deposits. Dogmatic adherence to a particular research paradigm can lead to the polarisation of issues (Dardis and McCabe, 1994) and the geological record being used solely to test hypotheses, when its most important role is as a source of discovery (Baker, 1994). Answering predetermined questions is not the most efficient way of enabling the geological record to fulfil its most useful role, because the rocks may record events beyond our experience and imagination.

The lithostratigraphical approach

A lithostratigraphical approach, as advocated by Gibbard (1977) and Rose and Allen (1977), for example, has been adopted by Bowen (1999; Bowen and Lewis, 2000) in the revised correlation of British Quaternary deposits. Bowen (1999) advocates lithostratigraphy because it provides 'the basis of all stratigraphy and the means for understanding geological history'. The limitations of such an approach, in general, are recognised by the widespread adoption of sequence stratigraphy (e.g. Emery and Myers, 1996; and see Whittaker *et al.*, 1991). Martini and Brookfield (1995) have used sequence stratigraphy to interpret Quaternary lacustrine deposits (see also Benn and Evans, 1998; Jones, 1999). The difficulty of applying lithostratigraphy to Quaternary deposits in particular has been recognised in the past (CSN, 1961; Holland *et al.*, 1978; Bridgland, 1988), hence the adoption of climatostratigraphy by Mitchell *et al.* (1973), and the proposal of allostratigraphy by NACSN (1983; see also Jones, 1999). As noted by Bowen (1999), divorcing the climatic inference from Quaternary stratigraphy is not straightforward. Correlation of British Quaternary terrestrial deposits with the deep-sea record is considered to be an important goal (Gordon and Sutherland, 1993), so it is interesting to note that Whittaker *et al.* (1991) refer to the Quaternary marine oxygen-isotope stratigraphy as (climatic) event stratigraphy. Furthermore, attempts have been made to establish a British event stratigraphy (Lowe *et al.*, 1999) based on high-resolution ice-core data from Greenland (e.g. Björk *et al.*, 1998), but the application of this to British Middle Pleistocene deposits is difficult because of the rarity of dated sequences. Hart (1999) and Maddy and Green (1989) discuss the limitations of a lithostratigraphical approach in the context of glacial deposits and fluvial basins, respectively.

Stratigraphical interpretation of British Middle Pleistocene deposits, in general, embraces several lines of evidence, as noted by Banham *et al.* (2001). British

glacial stratigraphy, however, is dominated by lithostratigraphy, which from the 19th century has produced repeated variation in the number of glacial events to have affected lowland Britain (Stamp, 1946; Whiteman, 2000). The limitations of this approach when applied to the British Middle Pleistocene glacial stratigraphy are well demonstrated by the debate surrounding current proposals to expand the number of pre-Devensian glacial events to have affected lowland Britain, and represented by diamictons, from one to four (Hamblin *et al.*, 2000; Moorlock *et al.*, 2000a; Banham *et al.*, 2001). This new stratigraphy largely involves reinterpreting existing data (Banham *et al.*, 2001) and the need to account for concentrations of exotic lithologies in pre-Anglian sands and gravels at Leet Hill (Hamblin *et al.*, 2000; Moorlock *et al.*, 2000a).

Under this scheme a widespread Lowestoft Member is still envisaged (Hamblin *et al.*, 2000), even though Sumbler (1995) has proposed in the Thame and Thames valleys that lithologically similar (Lowestoft Till) deposits can be assigned to separate glacial events. Perhaps this is the reason for not rejecting glaciation of the English Midlands during marine oxygen isotope stage 10. It does, however, leave us in the bizarre situation where broadly the same arguments used for distinguishing between similar deposits in the Thame and Thames valleys are rejected for distinguishing between similar deposits in Lincolnshire and the eastern English Midlands (Bowen, 1999; Bowen and Lewis, 1999), which Straw (2000; and references therein) has always argued should not be interpreted in terms of a single Anglian glaciation.

Pragmatically a lithostratigraphical approach is a useful first step to ordering geological data, particularly when stratigraphically useful data are absent, as often is the case for much of the British Middle Pleistocene glacial record. Given the limitations of a lithostratigraphical approach when applied to Quaternary sediments, would it also be pragmatic to adopt a flexible attitude towards their stratigraphical grouping?

The subglacial research paradigm

Genetic interpretation of British Middle Pleistocene glacial deposits is intricately linked with their lithostratigraphical interpretation, to the extent that diamictons, particularly chalk-rich diamictons, have become synonymous with subglacial deposition and with Anglian glaciation (e.g. Perrin *et al.*, 1979; Horton, 1989). Consequently, studies of presumed subglacial (Anglian) deposits largely have focused upon provenance (e.g. Perrin *et al.*, 1979; Moorlock *et al.*, 2000a) and ice-flow direction (e.g. West and Donner, 1956) to determine ice-sheet limits, rather than detailed sedimentology. The incursion of Scottish ice through The Wash and its subsequent spread over lowland Britain to deposit the Lowestoft Till Member (see e.g. Rose *et al.*, 1999) is a product of this type of research. The inadequacy of such lines of evidence for genetic interpretation are well

documented (e.g. Banham, 1975; Hart, 1987; Lunkka, 1994), and the need to link detailed sedimentology and geomorphology within a depositional-/land-system framework has become increasingly recognised over the past 20 years (e.g. Miall, 1985; Bennett and Glasser, 1996; Menzies, 1996; Benn and Evans, 1998).

There are of course exceptions to this type of research, not least studies of sequences exposed along the North Norfolk coast (see Whiteman, 2000). The most salutary observation to make here is that where a variety of more rigorous approaches has been applied to the study of glacial deposits of presumed Anglian age, divergent rather than convergent views have emerged (see Whiteman, 2000). The same outcome can be observed for the most recent glacial (Devensian) deposits in the Irish Sea basin (e.g. Eyles and McCabe, 1989; McCarroll and Harris, 1992) and along the eastern coast of England (e.g. Eyles *et al.*, 1994; Evans *et al.*, 1995).

That the subglacial research paradigm cannot be applied universally to British Middle Pleistocene diamicton sequences is not a new revelation. This is testified by the ongoing debate over genesis of North Sea Drift deposits exposed along the North Norfolk coast (Zalasiewicz and Gibbard, 1988; Eyles *et al.*, 1989; Hart *et al.*, 1990; Hart and Roberts, 1994; Lunkka, 1994). The difficulty of applying this research paradigm to glacial sediments of Anglian age can be demonstrated by observations made at West Runton and Briton's Lane Gravel Pit on the April 2000 QRA field trip to Norfolk and Suffolk.

West Runton

The most obvious problem raised by a general view of the West Runton coastal section is how to distinguish subglacial deformation (e.g. Roberts and Hart, 2000) from deformation caused solely by the transport and emplacement of the large chalk rafts (e.g. in the manner proposed by Eyles *et al.*, 1989). Overall dimensions are unknown, but some of these chalk rafts are > 100 m long/wide and > 10 m thick. The presence of these huge chalk rafts immediately raises questions concerning their role in the pattern of deformation observed.

At West Runton the problem of identifying the cause of deformation can be exemplified with reference to the sequence at approximately 375 m on figure 16 of Lewis *et al.* (2000). At this location (Figure 1) a chalk raft descends to beach level and rests on stratified diamictic mud (facies Dk of Roberts and Hart, 2000), which in turn overlies pre-Anglian sediments. From the opposing dips of stratification in the diamictic muds beneath the chalk raft (observed by the author in 1995 and 2000) it is evident that deformation occurred during transport and deposition of the chalk raft. A fold nose in the diamictic muds beneath the western side of the chalk raft, observed by the author in 1995 and 2000, indicates movement towards the south to southeast.

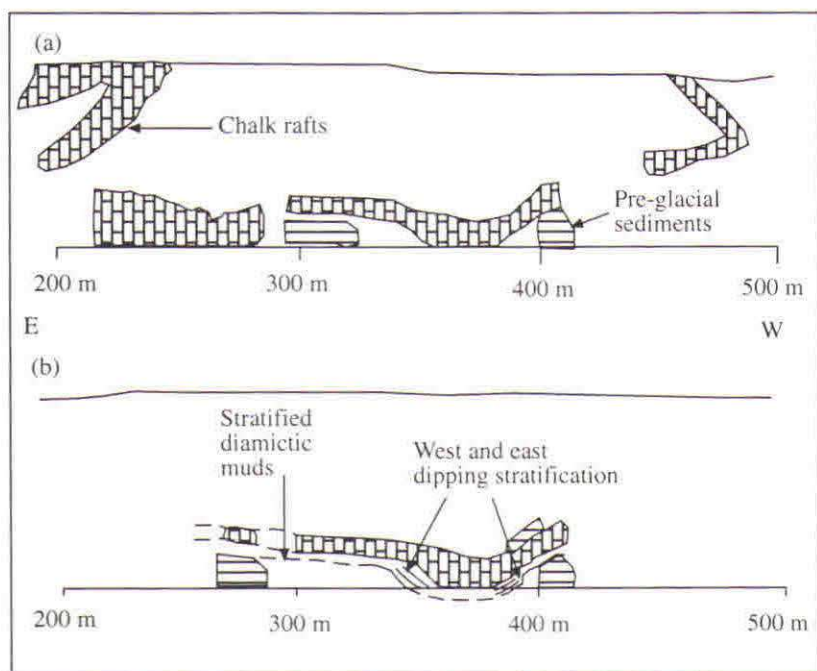


Figure 1. (a) Chalk rafts and pre-Anglian sediments between 200 and 500 m at West Runton, redrawn from Roberts and Hart (2000). (b) Observations made by the author at the same locality on the day of QRA field meeting April 2000 and on 4 September 2000.

Pre-Anglian sediments also are observed on top of the western side of the chalk raft, with sedimentary structures still preserved and no post-depositional deformation evident (see also Eyles *et al.*, 1989). Such preservation suggests frozen conditions at the time of liberation from the bedrock, during transport and deposition, and post-depositionally, unless protected by overlying or surrounding sediments.

This combination of features is difficult to explain within both the glaciotectionic and subaqueous scenarios. Hart and Roberts (1994), however, use the sequence at West Runton as an example of subglacial glaciotectionic sedimentation, and Roberts and Hart (2000) claim that it is 'regarded by many as the "type site" for subglacially deformed till'. Given that the role of the chalk rafts in the deformation process cannot be determined unequivocally on the basis of evidence currently available, is the 'type site' designation appropriate? Furthermore, is it appropriate to use deformation patterns observed at West Runton in the development of subglacial deformation models and to apply these models elsewhere?

Briton's Lane Gravel Pit, Beeston Regis

At Briton's Lane Gravel Pit Jim Rose described a body of sediment with low-angle backsets dipping north and low-angle foresets dipping south that created a large-scale bedform several metres in height and several tens of metres in breadth. The same sediments have been recognised in gravel pits more than 10 km to the west (Moorlock *et al.*, 2000b), where only the low-angle foresets are present. (An example of these structures, but with more steeply dipping beds, could be seen on the exposed west face of the Briton's Lane pit.) Boulder- to cobble-sized exotic erratics, including rhomb porphyry, are reported to be present at Briton's Lane, but in the pits to the west the clast size range of these erratics is smaller. These sediments are interpreted as subaerial outwash deposits by Hamblin *et al.* (2000) and assigned by them to the Overstrand Formation, which they regard as being equivalent to marine oxygen isotope stage 6.

Jane Hart suggested that these sediments could have been deposited at a glacial portal. I would suggest that the low-angle backsets and foresets represent a large-scale bedform deposited in standing water at a glacial portal, and as such indicates water levels above 85 m OD. The surface level of two of the pits to the west is at about 10 m OD, which if these are components of the same bedform (Jim Rose does not believe this to be the case, *pers. comm.*, 2001), suggests water depths of more than 70 m. If this interpretation is correct, the sediments at Briton's Lane are evidence not only of deposition within a standing body of water, but also of an ice front close to the present-day North Norfolk coast. Unless the contact with the underlying diamicton can be demonstrated to be erosional (i.e. the diamicton was deposited by ice that subsequently withdrew—which would have to be the case if the overlying sediments are indeed 'outwash' of a later ice advance), a subaqueous depositional environment cannot be ruled out for the underlying diamicton.

As a subaerial outwash interpretation is favoured (Jim Rose, *pers. comm.*, 2001), under what conditions could such a bedform, particularly at this large scale, be deposited in a fluvial environment?

Terrace stratigraphy research paradigm

Castleden (1980) and Horton (1989) have applied the terrace stratigraphy approach to explain the distribution of River Nene 3rd and 2nd terraces (see Bridgland *et al.* (1991) for an alternative terrace stratigraphy explanation). A different explanation for their distribution is possible (Langford, 1999), without recourse to terrace stratigraphy, and this has led me to examine the assumptions that underlie terrace stratigraphy and the limitations of such an approach to the study of British Middle Pleistocene fluvial deposits.

I have argued (Langford, 1999) that British Middle Pleistocene fluvial terrace

stratigraphy is often based on the *assumption* that spatially separated sand-gravel bodies within altitudinal limits that are defined subjectively, were once genetically, if not spatially, linked. That is, they share a common temporal origin that can be matched to Pleistocene glacial-interglacial cycles, and therefore their accumulation is the result of fluvial response to allocyclic (external) changes. Where these sediment bodies are shown to be similar in age (i.e. they have been dated chronometrically) and composition (i.e. they have similar bio- and lithostratigraphies), it may not be so obvious that this assumption is being made. Figure 2 attempts to explain how this assumption *forces* the geomorphological explanation, and the problems inherent in doing so.

In Figure 2a, A–C are isolated gravel–sand bodies of a similar altitudinal range, composition and age. What this information cannot provide is whether A–C are: (i) the products of fluvial response to allocyclic changes (Figure 2b); (ii) tributary accumulations resulting from temporally and spatially separated events (autocyclic—internal) or tributary channel and/or localised main channel adjustments in response to tributary rejuvenation (allocyclic) (Figure 2c); or (iii) upstream migration of main channel adjustment in response to either autocyclic (e.g. localised influx of sediment) or allocyclic (e.g. fall in base level) changes (Figure 2d).

It is not intended to suggest that sediment bodies A–C (Figure 2a) are not at all related, rather the intention is to show that it is the nature of this relationship that is assumed. For example, there are three variants in the figure (2b–d) for a terrace stratigraphy approach that advocates an allocyclic explanation, each of which have different implications. For instance, the scenario depicted in Figure 2b would require some form of geological process for A–C to be preserved as part of a ‘flight of terraces’ (e.g. Maddy, 1997). The allocyclic scenarios depicted in Figure 2c and d, however, would not necessarily have such a requirement because aggradation, as a result of tributary and main channel interaction, for example, could occur at a variety of altitudes during ongoing development of the drainage network. Thus there could be two assumptions inherent in the application of a terrace stratigraphy approach, involving:

1. the underlying cause, i.e. allocyclic (climatic) change;
2. the nature of the relationship between segregated sediment bodies.

At first glance the distinctions made in Figure 2 may seem trivial from a stratigraphical point of view. It has to be borne in mind, however, that age estimates for British Middle Pleistocene deposits are rare and that the dating techniques available have wide error margins. Another consideration is that in reality the composition and age of only one of these sediment bodies may be known. Furthermore, such sediment bodies may be many kilometres apart.

Despite the development of climatic models to explain the formation (e.g. Bridgland, 1994) and preservation (e.g. Maddy, 1997) of fluvial terrace

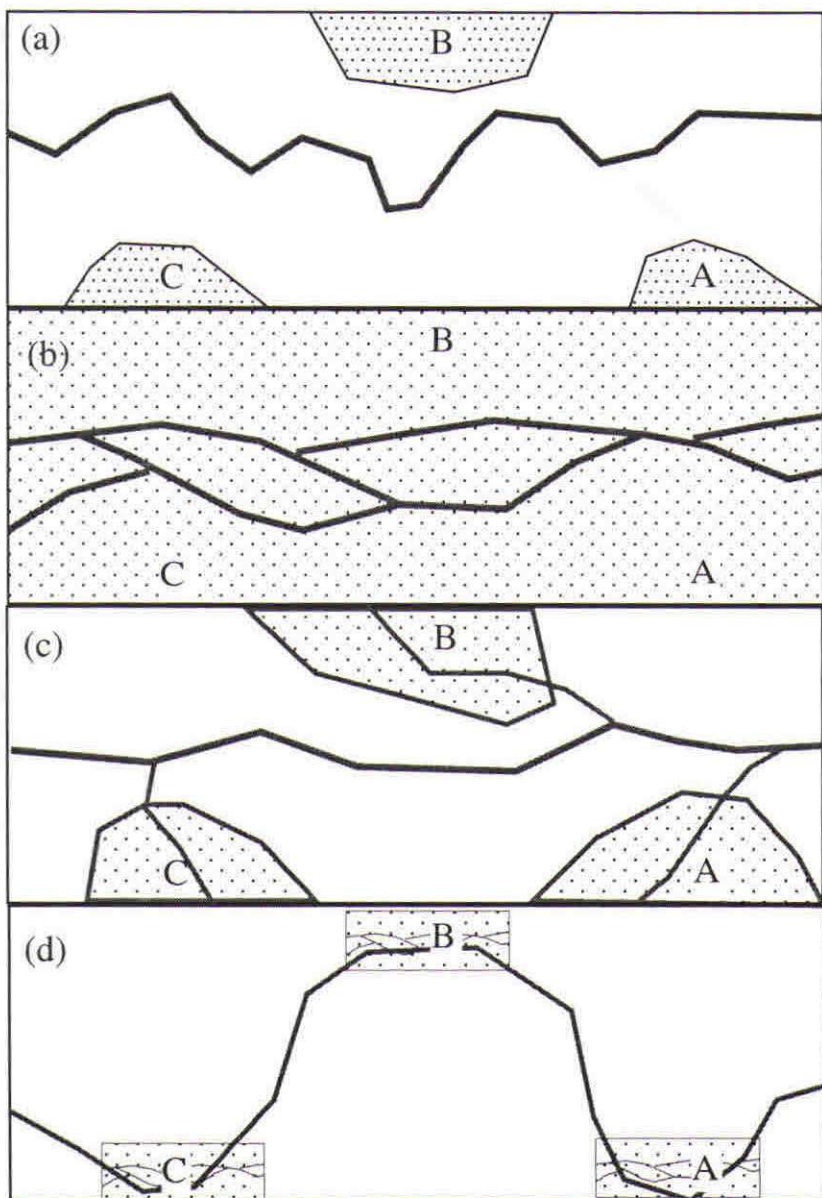


Figure 2. Are the isolated sediment bodies in (a) remnants of a former braidplain (b), former tributary aggradations (c) or upstream migration of channel adjustment to allocyclic or autocyclic change (d)?

sequences, I would argue that the processes of formation and preservation of British Middle Pleistocene terrace deposits are not completely understood. Therefore, stratigraphical grouping of spatially separated sediment bodies on the basis of altitude and composition, as has been done for the River Nene, for example (e.g. Castleden, 1980; Horton, 1989), remains problematic. From a sedimentologist's point of view, knowledge of the genesis of these sediment bodies is a prerequisite to stratigraphical grouping, and for British Middle Pleistocene fluvial successions I would argue that this requires a combination of sedimentological and geomorphological (beyond the recognition that they are fluvial in origin) evidence. If it is our intention to compare the British Middle Pleistocene terrestrial record with the event stratigraphy depicted in the deep-sea and ice cores, such a rigorous approach is essential. If we wish to broadly capture Middle Pleistocene glacial-interglacial cycles in our stratigraphical approach, without really knowing why such groupings occur, then a terrace stratigraphy approach may be adequate.

Conclusions

There are two Middle Pleistocene palaeogeographical models, the Bytham river and Scottish Ice advance through The Wash (e.g. Rose *et al.*, 1999), that I consider are good examples of the 'reinforcement syndrome' (Watkins, 1971), both of which have stratigraphical implications. Although there are several reasons why I believe this to be the case, the anomalous Rosslyn erratic at Ely (Gallois, 1988) will illustrate this, and at the very least lead to a review of the evidence upon which these two models are based. To have arrived at its present position this erratic must have moved towards the west-northwest from its present-day outcrop (S. Boreham, *pers. comm.*, 2000). This of course is incompatible with the movement of Scottish Ice from that same direction (e.g. Rose *et al.*, 1999). To make this compatible, Gallois (1988) suggested that the Chalk escarpment lay at least 10 km to west of its present position. As Gallois (1999) points out, this would mean that the course of the Bytham river ran down the spine of the Chalk escarpment, rather than along the western edge of the escarpment as intuitively should be case. In the light of this evidence:

1. is one of the models incorrect?
2. are both models correct, but we need to find a plausible explanation within this framework?
3. are both models wrong?

Clayton (2000) has modelled a reconstruction of the pre-Anglian relief of East Anglia along the lines of (2). However, he does not critically examine the evidence supporting arguments for Scottish Ice advance through The Wash or the existence of the Bytham river; some of the arguments supporting both scenarios are reiterated, but notably the views of Gallois (1979, 1994) on the pre-Anglian development of The Wash and Fen Basin are not considered.

Furthermore, comparison of figures 2 and 6 in Clayton (2000) raises the question (as in previous publications, e.g. Gallois (1999) and Rose *et al.* (1999)) of why Anglian ice advances and their associated meltwaters appear to have ignored pre-existing lines of drainage?

The aim of this article was to explain that although my interpretation of Middle Pleistocene deposits in the Peterborough area differs from established explanations, limitations in the approaches used to study and interpret these deposits, and in the data available, mean that such differences should not be unexpected. Knowing that there are limitations in the approaches used to interpret and correlate these deposits, is it necessary to defend resultant stratigraphical and palaeogeographical models so stoutly? Furthermore, in the presence of such uncertainty, is it necessary to have to undermine existing stratigraphical and palaeogeographical interpretations before credence can be given to alternative interpretations?

As some types of Pleistocene deposits become increasingly worked out, and as access to these deposits becomes increasingly more difficult, it is imperative that they are studied systematically in an objective manner. This can be achieved by:

- giving due recognition to the value of sedimentology;
- adopting a rigorous sedimentological approach within a depositional/land-systems framework towards genetic interpretation and, consequently, stratigraphical grouping and palaeogeographical interpretation;

Adopting a sedimentological approach requires that stratigraphical grouping should *follow* interpretation of depositional processes and environments. Such interpretation requires facies analysis (e.g. Reading, 1986; Reading and Levell, 1996; Jones, 1999), which necessitates knowledge of the stratigraphical sequence ('facies succession'—Walker, 1990), the hierarchy of bounding surfaces within the succession (Collinson, 1996), and the two- and three-dimensional architecture of units making up the succession (Miall, 1985).

It has to be recognised, however, that such an approach will not always lead to unequivocal interpretation and that such an approach is not always possible. Under these circumstances limitations should be emphasised and alternative explanations presented. In this way the uncertainties inherent in the models produced and the inadequacy of the database are emphasised. This in turn will provide the impetus to improve the database in an objective (open-minded) manner.

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views expressed in this article, however, are entirely mine. To the referee who understood the philosophical nature of the article, although not necessarily agreeing with my views, and my right to express these views in QN, my heartfelt thanks. I hope that this version will appear less antagonistic! The comments of at least three other referees, and of the editor Julian Murton, have led to a more robust version.

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A WOOLLY MAMMOTH TUSK FROM CLIFTONHALL, NEAR EDINBURGH, SCOTLAND

Andrew C. Kitchener and Clive Bonsall

On 18th July 1820 an ivory tusk was found by workmen digging the Union Canal as it passed through the Cliftonhall Estate to the west of Edinburgh (Figure 1). It was found in "strong old alluvial earth" at 15–20 feet (4.57–6.10 m) below the surface (Bald, 1822; Figure 1). The tusk weighed 25 pounds 12 ounces (11.68 kg) and measured 39 inches (0.99 m) long. Upon its discovery the estate owner, Sir Alexander Maitland Gibson, asked the workmen to bring it to the

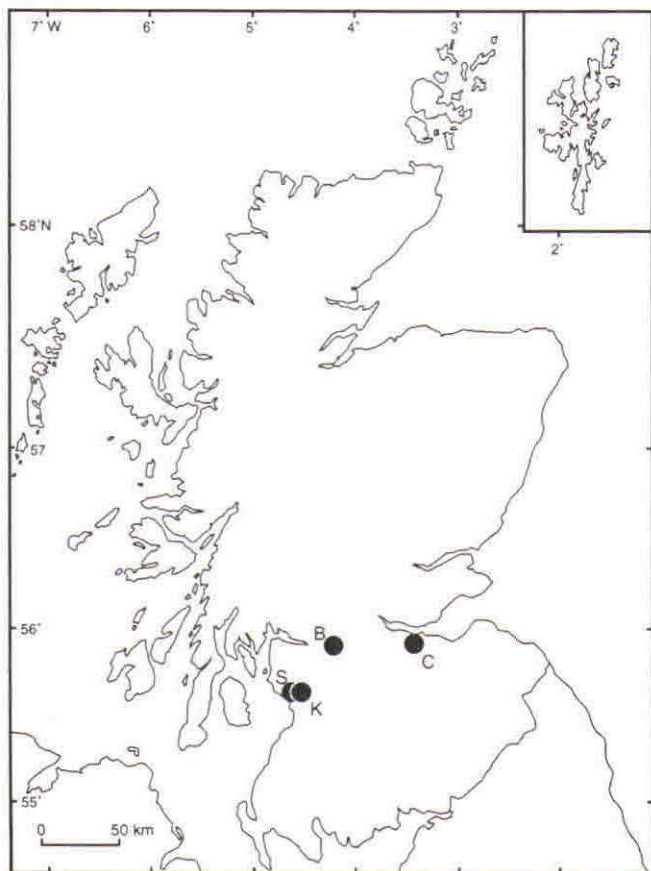


Figure 1. Location of the Cliftonhall (C) site and other sites mentioned in the paper. Bishopbriggs (B), Kilmaurs (K), Sourlie (S).

house of Cliftonhall, but instead the workmen sold it in Edinburgh to an ivory turner for £2 (Bald, 1822). By the time Gibson had discovered the location of the tusk it had been cut across in three places and one piece had been prepared to make chessmen. However, the two remaining pieces were recovered, so that the tusk now 5 inches (12.7 cm) shorter.

Bald (1822) identified the tusk as being from a fossil elephant. Ritchie (1929) identified it as being from a woolly mammoth, *Mammuthus primigenius*, by which time it had become part of the collection of the Free Church College in Edinburgh (Figure 2a, top). When the tusk was transferred there is uncertain.

Thereafter the history of the Cliftonhall mammoth tusk is unknown until 1998. It should have been donated to the Royal Scottish Museum (now the National



Figure 2. The Cliftonhall mammoth tusk (NMSZ 1998.066): (a) in the 1920s (top) with a mammoth tusk from Kilmaurs (NMSZ 1915.005) as photographed by J. Ritchie and (b) its present condition.

Museums of Scotland (NMS)) in 1966 when the Free Church College Museum was closed down and the most important specimens were transferred. In June 1998 the NMS were contacted by Hilary Kirkland of the City of Edinburgh Council Education Department. She had found a section of mammoth tusk, which she had saved from being discarded. Examination of the tusk confirmed that it was the missing Cliftonhall specimen as it still bears the original Free Church College label (Figure 2b). Also, Ritchie (1929) mentioned all the Scottish mammoth remains ever found at that time, but only one specimen from the Free Church College. However, the tusk was now considerably shorter, having been sawn in half. In July 1998 this piece of mammoth tusk was officially handed over to the NMS, where it is now registered (NMSZ1998.066).

Since its rediscovery, we have been able to find out more of its recent history. A Mr Eric Boyd gave the tusk to the Education Department in 1980. In the 1970s Mr Boyd received his piece of the tusk from a friend, Mr John Wallace, who sawed the complete tusk in half so that they could both have a piece. Unfortunately, Mr Wallace has since died and we have been unable to trace his collection. More recently, we discovered a glass plate negative from Ritchie, which shows the mammoth tusk in its original state probably in the 1920s (Figure 2a).

We have obtained an AMS (accelerator mass spectrometry) radiocarbon date of $29,200 \pm 370$ BP (University of Arizona laboratory code no. AA-33588) for a sample of ivory from the newly cut end of the tusk. This is much older than the only other radiocarbon date for a Scottish mammoth, which was 13,700 (+1300–1700) BP for a tusk excavated in 1829 from a bed of clay 34 feet (10.36 m) below the surface at Woodhill Quarry, Kilmaurs, Ayrshire (Sissons, 1967). However, a reindeer antler found at the same locality had a radiocarbon date of >40,000 BP, which was regarded by Bishop and Coope (1977) as more consistent with the stratigraphical context of the tusk. This suggests contamination of the Kilmaurs mammoth tusk with an unknown organic preservative. However, owing to the uncertainties relating to radiocarbon dates from the same site and context, another specimen of Kilmaurs mammoth tusk (NMSZ1915.005; Fig. 2a) is currently being radiocarbon dated (A. Stuart, *pers. comm.*).

There are other radiocarbon dates for large mammals from Scotland that are approximately contemporary with the Cliftonhall mammoth (Figure 1). For example, the left humerus of a woolly rhinoceros, *Coelodonta antiquitatis*, from Bishopbriggs, Glasgow was dated to 27,550 (+1370–1680) BP (Rolfe, 1966; Sissons, 1967) and an antler fragment from a reindeer, *Rangifer tarandus*, from Sourlie, Ayrshire (found alongside woolly rhinoceros bones) was dated to 29,900 (+430–410) BP (Jardine *et al.*, 1988). These dates and faunal remains are consistent with a mammoth steppe fauna living in the Forth/Clyde valleys about 30,000 years ago, prior to the last glacial maximum.

Acknowledgements

We are most grateful to Hilary Kirkland for bringing to our attention the Cliftonhall mammoth tusk and to the City of Edinburgh Council Education Department for sponsoring the radiocarbon date. Gordon Cook of the Scottish Universities Environmental Research centre, East Kilbride, arranged for radiocarbon assay of the mammoth tusk at the University of Arizona AMS facility. We thank Dr Danielle Shreve and an anonymous reviewer for the constructive comments on an earlier version of this paper.

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REPORTS

REPORT ON 7TH INTERNATIONAL CONFERENCE ON FLUVIAL SEDIMENTOLOGY

University of Nebraska, Lincoln, Nebraska, USA, 6-10 August 2001

The 7th International Conference on Fluvial Sedimentology was held over 5 days at the University of Nebraska, Lincoln, USA, and was attended by over 280 delegates from both academia and industry. In addition, there were 8 pre- and post-conference field trips to a range of fluvial environments, including the Grand Canyon and the Colorado River in Arizona, the Western Gulf of Mexico coastal plain in Texas and the lower Mississippi Valley in Missouri, Arkansas and Louisiana. A further three mid-conference field trips to local rivers were also organised. The meeting was sponsored by the International Association of Sedimentologists (IAS), the Society for Sedimentary Geology (SEPM), the American Association of Petroleum Geologists (AAPG), "exxonmobillogo.jpg" ExxonMobil Upstream Research Company, STATOIL, Phillips Petroleum Company, Conoco, Schlumberger Reservoir Technologies and the University of Nebraska, Lincoln.

The conference itself included 15 themed sessions, with over 150 talks and 60 poster presentations. The general quality of talks and posters was excellent. Even though speakers were restricted to presenting only one talk during the conference it was still necessary to have three parallel sessions. While this did enable a large number of talks to be given and, in general, session chairs did ensure that talks ran to schedule, the general consensus amongst delegates was that running parallel sessions was not ideal, as inevitably talks could overrun and clashes of talks of interest to individuals could occur.

Monday 6th August

Day 1 commenced with a range of opening speeches given by the conference committee and representatives of the University of Nebraska. The keynote address was given by **Bill Galloway** (Gulf of Mexico basin record of North American tectonism, climate and drainage basin evolution). Three sessions were held on the first day. *Fluvial System Response to Climate Change Through Time* (chaired by **Kees Kasse**) was a special session organised by the Fluvial Archives Group (FLAG), a Research Group of the QRA. The session evaluated the response of river systems to climate over a range of timescales and the subsequent impacts on sedimentary sequences. The session also dealt

with the issues of dating sediments, including the compatibility of ages determined for alluvial deposits using thermoluminescence and optical stimulated luminescence dating.

The *Floodplain Deposits in Mud-Dominated Rivers* session (chaired by **Sue Marriott**) integrated papers on both ancient and modern fluvial systems dominated by mud-grade material with a view to achieving a better appreciation of the distinctive fluvial type and to develop better criteria for identifying such systems in the geological record. The third session of the day was *Alluvial Architecture* (chaired by **Jonak Bhattacharya** and **Simon Lang**), during which papers were presented on the alluvial architecture in a variety of fluvial settings in locations worldwide over a number of different timescales.

Tuesday 7th August

Three sessions were also held on the second day. The *Dryland Rivers: Process and Product* session (chaired by **Colin North**) highlighted the need to undertake more work on dryland rivers through the integration of geomorphological and sedimentological studies of modern examples, re-evaluation of ancient examples, and regional studies to understand the evolution and sedimentary record of dryland settings. The session *Response of Near-Coastal Fluvial Systems to Sea Level Change: Theoretical and Experimental Models vs. the Quaternary Record* (chaired by **Torbjörn Törnqvist**) focused primarily on linking modelling efforts with the Quaternary record. Numerical stratigraphic models were shown to be quickly evolving with a shift in emphasis from 2D to 3D models. Many papers made use of the Quaternary as a 'testing ground' for physical and numerical models, due to the availability of independent sea-level data and dating control available. During the third session, *Fluvial Channel Systems: Modern and Ancient* (chaired by **Peggy Guccione** and **Phil Ashworth**), a range of papers was presented dealing with a variety of channel patterns and the effects of numerous factors, including base level changes, hydraulics, sediment dynamics and the role of vegetation, on them. A number of papers discussed developments in the use of equipment such as Electrical Resistivity Ground Imaging (ERGI) and Time-lapse Video Imagery.

Wednesday 8th August

On the third day of the conference delegates had the opportunity to visit some local rivers. In temperatures of 35°C and above, over fifty delegates took the option of spending the day wading, swimming and digging in the Platte River, the Great Plains' quintessential braided river (led by **Norman Smith**). Over thirty other delegates opted to visit the Dakota Formation (Cretaceous, Albian) fluvial to estuarine sediments in the lowermost Platte Valley, Nebraska (led by **Matt Joeckel et al.**). Chief among the sites was the Ash Grove Cement Quarry

at Louisville, Nebraska, with working faces over 2 km long. A smaller group of around twenty delegates went to the South Fork of the Big Nemaha River Valley, Southeastern Nebraska, to look at the stratigraphy, lithology, and chronology of late Quaternary alluvium in a series of extensive cutbank exposures (led by **Rolfe Mandel**). In addition, ExxonMobil Upstream Research Co. conducted a short course for postgraduate students in sequence stratigraphy at the University.

Thursday 9th August

On the fourth day, back inside the air-conditioned conference halls, three sessions were held. The *Alluvial and Tectonic System Interactions* session (chaired by **John Holbrook**, **Anne Mather** and **Martin Stokes**) addressed the recognition of sedimentological and geomorphological evidence for tectonic control, at a range of geographical (river reach to sedimentary basin) and temporal (modern to ancient) scales. The session *Alluvial Responses to Accommodation Changes* (chaired by **Martin Gibling**, **Guy Plint** and **Paul McCathy**) was closely linked to the *Response of Near-Coastal Fluvial Systems to Sea-Level Change: Theoretical and Experimental Models vs. the Quaternary Record* session held on Tuesday. The third session was *Channel Flow, Sediment Transport, and Bedform Dynamics* (chaired by **Paul Hudson** and **Trevor Hoey**).

Conference dinner

The Conference dinner was attended by 125 delegates and held on the Thursday night in the Elephant Hall at the Universities Natural History Museum. It was a surreal experience to eat dinner whilst surrounded by the world's premier collection of fossil mammoths! Nebraska has a rich fossil history with more than one million numbered specimens added to the museum collection since 1891. Large mammals, especially proboscideans, ungulates, and carnivores, were the primary targets of the Museum's early collecting efforts and, as a result, enormous quarry samples of some taxa have been amassed. In more recent years, screenwashing techniques have been applied to many classic sites and the resulting samples of "microvertebrates" have added to an already unusually complete record of the evolutionary and environmental history of the central Great Plains of Nebraska during the past 35 million years.

Friday 10th August

The final day included six themed sessions. Oral sessions held in the morning included *The Late Quaternary Rhine-Meuse System* (chaired by **Henk Berendsen**) during which authors presented a wealth of research on Holocene avulsion, sedimentology and river response to climate change in the Rhine-

Meuse basin. The other sessions were *Sequence Stratigraphy of Alluvial Successions* (chaired by **Howard Feldman** and **Jeff Geslin**), *Fluvial-Estuarine Transitions: Modern and Ancient* (chaired by **Allen Archer** and **Erik Kvale**). In the afternoon the sessions included *Overbank Systems: Modern and Ancient* (chaired by **Siân Davies-Vollum**) and *Fluvial Systems and Economic Resources/River Management* and was a poster only session. *Fluvial Reservoirs in the New Millennium: Sedimentology, Stratigraphic Prediction, 3-D Modeling and Business Value* (chaired by **Chris Howells** and **John Howells**) was a session that encouraged speakers from industry, academia, petroleum business/service companies and engineering disciplines to take part in the debate over the value of fluvial sedimentology in the visualisation and communication of reservoir problems.

The meeting was extremely successful due to the excellent planning and organisation of the conference by **Mike Blum** and the conference team at the University of Nebraska. Papers resulting from the meeting presentations will be published as a Special Publication of the International Association of Sedimentologists, which will be edited by Mike Blum and Sue Marriott. Further information regarding the conference and details of individual talks given within session can be found on the following website: <http://www.libfind.unl.edu/geology/ICFS.html>

Acknowledgements

I would like to thank the QRA, the BGRG and the Conference committee, who supported my attendance at this conference.

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CONFERENCE REPORT ON IGCP PROJECT 437: COASTAL ENVIRONMENTAL CHANGE DURING SEA-LEVEL HIGHSTANDS

**Third Annual Meeting, Durham and Fort William, UK,
4th to 12th September 2001**

The third annual meeting of IGCP Project 437 was held in the Environmental Research Centre at the University of Durham, 4th to 7th September 2001, followed by a fieldtrip in the northwest of Scotland using Fort William as a base. The meeting was organised by **Ian Shennan** and **Ben Horton**, with assistance from **Antony Long**, **David Bridgland**, **Callum Firth**, **Alastair Dawson**, **David Smith** and an entourage of post-graduate students. Approximately 50 people attended the meeting from 16 countries, including Australia, Belgium, Canada, Estonia, Finland, France, Germany, India, Italy, Japan, Portugal, Spain, Sweden, The Netherlands, United Kingdom and the United States of America. Thirty-four presentations were given as well as posters.

The conference reception represented an imposing introduction to the formal scientific proceedings by being held in Durham Castle, in a room lined with remarkable tapestries. After dinner, conference delegates were given a very interesting tour of the castle.

Presentations given during the technical sessions were of a very high standard, particularly in terms of the quality of the science. Papers were presented within four principal themes: (1) techniques and applications for sea-level analysis; (2) Quaternary tectonics and relative sea-level changes; (3) Sea-level and isostasy: the North West European Laboratory; and (4) Holocene coastal changes, sea-level and tectonics. In theme one, topics included the application of testate amoebae, diatoms and foraminifera as quantitative multi-proxy tools for inferring palaeosea levels, AMS-radiocarbon dating of peats for studies of sea-level change, and the critical analysis of sea-level index points. In theme two on Quaternary tectonics and relative sea-level change, detailed case studies were presented from a range of tectonic settings that included the Baltic, Russia, Estonia, Aeolian Islands, and the United Kingdom. David Bridgland presented a particularly thought-provoking overview paper on the relative merits of interglacial raised beaches and river terraces in reliably quantifying past sea-levels. In theme three, a particularly stimulating series of presentations examined the role of sea-level studies in defining the nature and timing of crustal response to changing ice and water loads. One of the many highlights of this session was a summary of the BIFROST Project (Space Geodetic Constraints on Glacial Isostatic Adjustment and Neotectonic Deformations of Fennoscandia), which, based on a dense array of GPS measurements, is attempting to precisely quantify neotectonic movements in Fennoscandia associated with the decay of the former ice sheet. The final theme examined aspects of coastal change during the Holocene highstand with examples drawn from the Asia-Pacific region, Lebanon, Italy, the Baltic Sea, Belgium, Portugal, Spain, United States of America, Canada and Australia.

An afternoon excursion was arranged for the second day of the conference to examine a raised-beach deposit at Easington, to the east of Durham. The gravel beach deposit occurs some 30 m above present sea level and preliminary amino acid racemisation measurements on fossil marine molluscs, have yielded amino acid D/L ratios suggestive of a Stage 7 age for the deposit, with a reworked population possibly of Stage 9 age.

The fieldtrip to Scotland (8th-12th September) provided a detailed overview of the dynamic interplay between deglaciation, isostatic recovery and sea-level rise associated with the post-glacial marine transgression and the subsequent highstand. The Holocene highstand record of northwestern Scotland is preserved within the many isolation basins dotted across the landscape, which collectively preserve a diachronous record of marginal marine sedimentation over the course of the Holocene. Evidence for Late Devensian and Holocene sea-level changes were examined in detail in the Arisaig area, a region that preserves the longest record of relative sea-level change in Great Britain (>16 ka). The fieldtrip also provided the opportunity to visit some classic sites in Quaternary geology such as the "parallel roads of Glen Roy", an area important for defining the centre of the last Scottish ice sheet.

En route to Scotland, a raised Holocene estuarine sequence with an inferred 7 ka tsunami deposit was examined at Broomhouse Farm in Northumberland, and a detailed overview of the Holocene valley fill succession of the Forth Valley, East Scotland was also presented.

The excursion guide presents an elegant synthesis of the research undertaken by Ian Shennan and his colleagues. It includes useful summaries of the key geological features of the sites visited and a selection of benchmark papers. The field guide is available from the Environmental Research Centre at the University of Durham. The full reference is:

Horton, B. & Shennan, I. (2001). Sea-Level Changes and neotectonics: Field guide. The 3rd International Conference of the International Geological Correlation Programme, Project 437, In association with the INQUA Neotectonics and Shorelines Commission. Environmental Research Centre, University of Durham, Research Publication No. 5, (ISSN:1356 0557). Copies may be obtained by contacting Niamh McElherron in the Department of Geography at the University of Durham.

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Collectively, the scientific meeting and fieldtrips represented an important contribution to IGCP Project 437 and stimulated many interesting discussions. The organisers of the meeting are to be congratulated for their hard work.

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THE QUATERNARY OF EAST YORKSHIRE AND NORTH LINCOLNSHIRE

QRA Short Field Meeting, 13-16 September 2001

Introduction

38 people attended various parts of the QRA Short Field Meeting to East Yorkshire and North Lincolnshire from the 13th to the 16th of September 2001; the only QRA field-trip to run in this year of foot-and mouth-restrictions. The area has not been visited comprehensively since 1972, and the revisit is timely, especially given the large amount of work recently undertaken and currently ongoing in the area. **Stephen Thompson** and **Dave Evans** from Glasgow are investigating glacial systems in Holderness. Work in various parts of North Lincolnshire has been undertaken by **Mark Bateman**, **Paul Buckland**, **Charles Frederick**, **Mark Dinnin** and **Nicki Whitehouse**, all past or present Sheffieldites. Archaeological study has also been undertaken during the Hull-based Humber Wetlands Project represented on the trip by **Malcolm Lillie** and **Ben Gearey**. Many of these recent workers were present as were some of the 'old-guard' such as **John Catt**, **Allan Straw** and **Geoff Gaunt**.

Friday 14th September

The main focus of the trip was on the Late Devensian deposits preserved in the area, and the main question – how does an ice-margin behave in a lowland situation? We started at the type-site of the Dimlington Stadial, where the main area of debate was over the age of the Basement Till exposed on the foreshore and beneath the Devensian Skipsea and Withernsea Tills. More debate about the nature of the Devensian ice-margin was possible at Gembling, where an ice-ridge complex has been identified in the low-relief landscape using a digital elevation model. Exposures we visited within this ridge showed thick sequences of glacio-fluvial deposits. Detailed sedimentological study by **Stephen Thompson** has shown that these sands were deposited by meltwater entering a standing water body from the north and the east, suggesting a complex lobate ice-margin rather than the straight edge traditionally envisaged. The dynamic nature of the ice front is also inferred from the presence of a till unit at the top of the sequence, representing a slight oscillation. The final site of the day, at Sewerby, brought the issues raised during the rest of the day together. The age of the Basement Till is constrained by the Ipswichian age raised beach, observed by **John Catt** to overlie it. In addition, the Sewerby Gravels overlying Skipsea Till at the top of the sequence further strengthen the evidence seen at Gembling for complex deglaciation of the area.

Saturday 15th September

At the first stop of the day at South Ferriby, Skipsea Till exposed in the cliff points to the blocking of the Humber Gap by ice (Figure 1). These cliffs have been described for over a century, but current exposures are the first observation of coversands here. These are interpreted as having been reworked from local deposits into a gully in the surface of the till. An OSL sample taken from this location offers the possibility of constraining the end of ice advance into the Humber Gap, and thus the formation of Lake Humber. This ice advance was a significant event, since it also filled the northern end of the Ancholme valley, where our second stop was to see part of the associated glacio-fluvial succession.



Figure 1. South Ferriby Cliff site with beach shingle sitting on a chalk erosion surface in front of till cliff. In the foreground is the carbonate-cemented angular chalk and erratic conglomerate the interpretation of which is uncertain, ranging from Devensian proglacial lake beach deposit to a correlative of the conglomerate found at Sewerby. (Photo by Mark D. Bateman).

The main focus of the afternoon visits was the Late-glacial as we looked at some of the extensive coversands of North Lincolnshire. At Yarborough Quarry we were shown a sequence with the first evidence for periglacial conditions during the Loch Lomond Stadial in the English coversand record, in the form of a sand vein identified by **Julian Murton**. This vein overlies a regionally extensive peat layer containing beetle faunas suggesting cold conditions, though not

necessarily colder summers than today. The coversand is dated to the Loch Lomond Stadial by analogy with the well-dated regional stratigraphy built up by Mark Bateman. OSL dates at this site are yet to be finalised, since preliminary dates are too young in comparison with the regional stratigraphy. At the final section of the day, Black Walk Nook, significant variability was seen in sedimentary structures, suggesting reworking of wind-deposited material by water. This may challenge our traditional concepts of coversand deposition indicating uniform aridity. The nature of the coversand geomorphology was discussed at Twigmoor Woods, where a dune complex has been investigated by Ground Penetrating Radar (by **Charlie Bristow** and **Ian Livingstone**). This suggests that the dunes may have been 'pinned' in position by vegetation, thus cautioning that it may not be possible to determine palaeowind directions from topography alone.

Sunday 16th September

Sunday took us back to the Late Devensian with a vengeance, starting at a vista overlooking the southern end of the area covered by Lake Humber (within the Vale of York. BGS mapping of the area by **Geoff Gaunt** suggests evidence for two levels of Lake Humber, the first at 30m OD and the second, for which the evidence is more widespread, at 8m OD. By now we were keen to see some Lake Humber clays, and so it was quite a surprise to be taken to a sand quarry at Cove Farm! Trough cross-bedded sands and gravels (OSL dated to ~14ka BP at the base) grade upwards into a massive finer sand, in which an organic channel fill has accumulated at one end of the pit. Beetles and pollen from this channel fill suggest an environment consistent with Late-glacial Interstadial age. No convincing evidence for lacustrine deposition is seen, which left us with an interesting situation. **Paul Buckland** suggested that we were seeing the upstream results of a catastrophic drainage of Lake Humber, which had caused an incision of about 6m, followed by rapid aggradation. However, the interpretation is not simple, as the northerly flow seen in the palaeocurrents seems to be contradicted by the presence of coal of a northerly provenance in the gravel fraction. A further larger question was raised by **Allan Straw**, on the basis of this (and other) sites, as to why Lake Humber appears never to have drained to the south, despite gaps in the southerly bedrock outcrops. A further complication in the Lake Humber story was seen at Lindholme Island where we saw one of several gravel-capped ridges which emerges above Lake Humber II deposits (Figure 2). This was mapped by **Geoff Gaunt** as a Devensian ice limit, but its relationship to Lake Humber development is unclear – does it relate to the higher level lake or is it earlier still? This stop also included a view of the rapidly disappearing Hatfield peat moorland where a detailed Holocene record has been pieced together using pollen, beetles and dendrochronology.

Our final stop of the day was at one of the best sites of the trip, the former RAF



Figure 2. QRA members discussing the Lindholme Island site, its status as a moraine vestige and the rapidly disappearing Holocene peat record from the adjacent Hatfield Moor.



Figure 3. The recently-discovered Finningley site, North Lincolnshire, showing view along section with sigmoidal sand unit which interpreted as proglacial Lake Humber littoral deposits and associated lacustrine clay units.

airfield at Finningley (Figure 3). This site is marginal to the Lake Humber II system, and newly exposed just before the field meeting. Littoral sands and silts relating to Lake Humber here overlie a diamictic deposit which greatly absorbed the glacial experts among us – was it a till or a mass-flow deposit? This diamict in turn overlies ‘older river gravels’ – a unit in which Ipswichian deposits have been observed. At Finningley these contain an organic bed for which preliminary beetle analysis by **Paul Buckland** suggests a cold-climate origin. All present agreed on the importance of the site. It provides an opportunity to constrain the age of deposition of Lake Humber II by OSL dating. It should also increase our understanding of the ‘older river gravels’ of the area, and their relation to overlying deposits, both by detailed palaeoecological analysis and by OSL dating.

Summary

Those of us who participated in this field meeting were treated to a comprehensive tour of some superb sedimentary sections in Late Devensian ice-marginal environments, much discussion of processes, and a real sense of research in progress. Much credit goes to the organisers: **Mark Bateman, Paul Buckland, Charles Frederick** (Sheffield) and **Nicki Whitehouse** (Queen’s, Belfast) for an intellectually stimulating and well-run trip. The sites seen provided plenty to think about, and further questions still remain to be answered, for example:

- (1) The paleogeography of Lake Humber:
 - what is the relationship between and timing of the two phases of lake development?
 - which gaps in the surrounding landscape were open and when?
 - why is the general drainage (both of the lake and of subsequent river systems) northwards to the Humber Gap?
- (2) The detailed chronology of Late Devensian glacial and deglacial activity
- (3) The rather more intractable issue of the age of the Basement Till and of glacio-fluvial and fluvial deposits seen further west – do we have in this region evidence for the elusive ‘Wolstonian’ glaciation?

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EUROCONFERENCE ON ABRUPT CLIMATE CHANGE DYNAMICS: ACHIEVING CLIMATE PREDICTABILITY USING PALEOCLIMATE DATA

Castelveccchio Pascoli (near Pisa), Italy, 10-15 November 2001

This conference was part of the European Science Foundation program and the first of three planned on this theme. It commenced on the 10th November and was supported by INTAS (see acronyms list at end of report) and co-sponsored by IGBP-PAGES in association with WCRP-CLIVAR. Around 100 scientists from across the globe assembled in the beautiful Tuscan valley of Garfagnana at the Il Ciocco international conference centre. Delegates were drawn from both the modelling and palaeoreconstruction communities, with the talks strongly angled towards the collaboration and integration of research and ideas from both communities, to promote a deeper insight into achieving climate predictability. The conference was composed of five sessions with **Jean-Claude Duplessy** (CNRS, France) as chair and **Thomas Stocker** (University of Bern, Switzerland) as vice-chair.

Session 1 - Abrupt Climate Change, Past and Future

Keith Alverson (PAGES International Project Office, Switzerland) started the conference with a talk on "Reconstructing Past Global Change and overview of PAGES", stating the necessity for understanding the global palaeoclimate in future climate predictions as this provides a reference 'envelope' to judge human impact and climate changes against; he also pointed delegates towards the PAGES website (<http://www.pages-igbp.org/>). Following this **Jurgen Willenbrand** (Universitat Kiel, Germany) presented a paper on "Achieving climate predictability and overview of CLIVAR" in which he spoke about three levels of modelling within CLIVAR, a) GOALS dealing with seasonal to interannual variation, b) DecCen looking at the decadal to centennial scale and finally c) ACC covering the Holocene to the Pleistocene and the applicability of different types of modelling. **Michel Crucifix** (Universite Catholique de Louvain, Belgium) presented a paper on behalf of **Andre Berger** on "Astronomical forcing: a role in abrupt events", investigating the higher oscillations contained within the Milankovitch cycles. Following this **Andrey Ganopolski** (Potsdam, Germany) concluded the session with "Modelling late glacial events with EMICs" stating that Heinrich and Dansgaard / Oeschger events could be reliably modelled using these systems.

Session 2 - Late Glacial Abrupt Change – is it relevant to the future?

This session was split into palaeo and modelling based talks, starting with four

talks looking at palaeo data. First **Brigitta Ammann** (University of Bern, Switzerland) gave a talk on "Late glacial events recorded in European lake sediments" whereupon issues such as the advantages and disadvantages of lake sediments plus the relationships between plant species and climate were discussed. Following this was work presented by **Elsa Cortijo** (CNRS, France) on "Late glacial events recorded in North Atlantic marine sediments". **Brian Huntley** (University of Durham, United Kingdom) then spoke on "Late glacial events in southern Europe", commenting on research focussed upon lake cores at Lago Grandi di Monticchio, highlighting the relevance of ecosystem and climate interactions and the importance of such issues when considering future abrupt climatic changes. Next **Dominique Raynaud** (Domaine Universitaire, France) spoke on "Late glacial events in bipolar ice core records", focussing upon isotopic analyses used to assess transitions during the last glacial and interglacial as well as bipolar phasing. All the talks illustrated the fine annual and even seasonal resolution climate data that can be extracted from the palaeo record to demonstrate rapid climate fluctuations at the end of the last glaciation. Following this were two talks on modelling. **Thomas Stocker** (University of Bern, Switzerland) looked at "Modelling late glacial events and comparison with ice cores", highlighting the contributions of modelling for example that of the thermohaline circulation. **Andreas Schmittner** (University of Victoria, Canada) followed with the "Instability of glacial climate in a model of the ocean-atmosphere-cryosphere system", showing simulations of the thermohaline circulation and the role feedbacks have when introduced into the model. Both presentations showed the advances and complexities of global climate modelling along with the necessity for palaeo validation of such models.

Session 3 - Early Holocene Abrupt Change – is it relevant to the future?

This session continued with the modelling theme opening with Michel Crucifix speaking about "Modelling ice sheet ocean interactions in the late glacial and the 8200 year event". He demonstrated the non-linearity of model responses and the difficulties this presents for predicting climate. Three palaeo talks followed this, showing the rapid and sometimes contradictory palaeo evidence for climate fluctuations under temperate conditions. **Claude Hillaire-Marcel** (GEOTOP-UQAM, France) talked on "Instabilities in the production rate of Labrador sea water during the Holocene: a forcing mechanism on climate?", assessing differences between interglacials and glacials. **Peter Fawcett** (University of New Mexico, USA) followed with "Holocene millennial-scale climate variability in western North America", summarising research into charcoal layers, core data from bogs and archaeological evidence from three sites in the United States. **Emi Ito** (University of Minnesota, USA) concluded the session with "Abrupt changes in the North American interior during the Holocene", by assessing some isotopic data and its relevance in explaining climatic change during this period.

Session 4 - Mid Holocene Abrupt Change – is it relevant to the future?

Martin Claussen (Potsdam, Germany) started this session by looking at "Modelling abrupt monsoon transition in Africa in the mid Holocene" and showed that rapid fluctuations in climate may be caused by changes at sensitive areas or 'hot spots'. The palaeo evidence for abrupt change in the mid Holocene was presented by **Matti Saarnisto** (Geological Survey of Finland) "Climate of the last millennium recorded in laminated lake sediments in Finland", **Francoise Grasse** (Universite d'Aix-Marseille III, France) "Mid Holocene records from African lakes", **Sigfus Johnsen** (University of Copenhagen) "The Greenland ice core records", **Mikhail Levitan** (Russian Academy of Sciences) "Mid Holocene abrupt change in the composition of heavy mineral assemblages from Yermok Plateau sediments", and **Jean-Claude Duplessy** (CNRS, France) "Role of the ocean in Holocene abrupt changes". These talks clearly demonstrated a number of rapid climate shifts impacting on a hemispheric or global level.

Session 5 - The Last Millennium – applicability to the future, detecting anthropogenic change

In the final session **Heinz Wanner** (University of Bern, Switzerland) talked on "Proxy records of the North Atlantic Oscillation" demonstrating a shift in the pattern of the NAO during the last 25 years. **Olga Solomina** (Russian Academy of Science) discussed "Tree-ring/glaciers conflict: evidences of the last millennium" and showed the difficulties in linking different proxy records at high timescale resolution. **Nalan Koc** (Norwegian Polar Institute) talked on "Sea surface temperature variability in the eastern and western Nordic seas during the last 2000 years" showing that there might be lag responses in the certain proxy records even when recording rapid climate change. **Mojib Latif** (Max-Planck-Institut für Meteorologie, Germany) presented the final modelling paper "Coupled modelling of past and future climate change" and re-stated the need for palaeo data to validate models. The final presentation was by **Dirk Verschuren** (Ghent University, Belgium) on "Rainfall variability in equatorial east Africa during the last millennium", showing that abrupt climate change is unlikely to be uniform spatially.

The conference promoted lively scientific discussion and allowed palaeoenvironmental researchers to engage with modellers, fostering understanding between the two groups about the limitations and requirements of each other's work - an understanding that is essential if further progress is to be made on achieving climate predictability. The excellent standard of the speakers was mirrored in equally diverse poster sessions. Three posters in particular were of very high quality, in alphabetical order: **Thibault De Garidel-Thoron** (CEREGE, France) "Glacial interglacial sea surface temperature changes in the western equatorial Pacific", **Dominik Fieftmann** (University of Bern, Switzerland) "Early- to late-Holocene Indian Ocean

monsoon variability recorded in stalagmites from southern Oman", and **Erica Henty** (Australian National University) "Coral evidence for abrupt changes in ocean-atmosphere dynamics in the western pacific since 1565 AD".

The second conference in this series, which will have a stronger modelling component, is likely to be entitled "North Atlantic Climate Variability" and will be chaired by **Thomas Stocker**. This is scheduled for October 11th -16th, 2003 in Spain, with further plans on the drawing board for a third meeting in 2005.

Acronyms

ACC	= Abrupt Climate Change
CEREGE	= Centre Européen de Recherche et d'Enseignement de Géosciences de l'Environnement
CNRS	= Centre National de la Recherche Scientifique
EMIC	= Earth system Models of Intermediate Complexity
EURESCO	= EUROpean RESearch CONferences
IGBP-PAGES	= International Geosphere-Biosphere Program - PAsT Global ChangES
INTAS	= INTernational ASSociation
NAO	= North Atlantic Oscillation
WCRP-CLIVAR	= World Climate Research Program - CLImate VARIability and predictability

Acknowledgements

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REPORT ON AN INTERNATIONAL RADIOCARBON INTER-COMPARISON 2001

Background

Radiocarbon dating is universally used as an essential dating tool in the archaeological and earth (Quaternary) sciences. There is an inevitable diversity of experimental approaches within radiocarbon dating facilities and in this situation, the issue of comparability of results becomes paramount. The radiocarbon user community perceived a need for assurance of the comparability of radiocarbon measurements and so the laboratory community undertook a large-scale laboratory inter-comparison in 2000.

This was aimed at defining and improving the overall level of confidence that could be placed on results obtained from different measurement systems.

Sample selection, preparation and testing

Careful identification, collection, preparation and homogeneity testing of potential samples are vital components of a successful inter-comparison. Natural materials were sought which are representative of routinely dated material and whose ages span the full range of the entire applied ^{14}C timescale. Potential materials that were identified included wood, peat, bone, marine carbonate and grain together with specific components of samples such as the cellulose fraction of wood and the humic acid fraction of peat. The degree of preparation varied from a thorough physical mixing (e.g. marine carbonate – turbidite sediment), through grinding and mixing (whole peat) to complete chemical homogenisation (humic acid extraction from peat). Bulk sample homogeneity was checked by replicate analyses on randomly selected aliquots and whenever possible, samples were tested at different sub-sample sizes by both an AMS and a radiometric facility.

The results of the homogeneity testing indicated that when laboratories complied with specific instructions concerning sample handling and pre-treatment, all of the samples could be considered to be homogeneous and suitable for use in the inter-comparison.

The inter-comparison

A suite of 10 samples (including 3 sets of duplicates) from a set of 7 core materials (Table 1) formed the basis of the inter-comparison. These were to be analysed and results returned within a one-year period.

Table 1. Core samples

Sample description	FIRI code	Age/Activity
Kauri wood (from New Zealand)	A,B	Near background
Marine turbidite (Madeira Abyssal Plain)	C	~3 half-lives
Dendrochronologically-dated wood (Belfast)	D,F	~1 half-life
Humic acid extract from peat (St Bees, Cumbria)	E	~2 half-lives
Barley mash (Glengoyne Distillery, Scotland)	G,J	modern
Dendrochronologically-dated wood (Hohenheim, Germany)	H	< 1 half-life
Cellulose extract from dendro-dated wood (Belfast)	I	~1 half-life

Results from the inter-comparison

The set of core samples was distributed to over 120 laboratories. By the deadline of December 2000, 92 sets of results had been received. In summary, the broad geographical distribution of participating laboratories is shown in Table 2 and laboratory type in Table 3. Just over 1000 radiocarbon measurements were reported.

Table 2. Geographical distribution of participating laboratories

Broad geographical description	Number of laboratories
Europe (EU)	35
Europe (non EU)	15
North America and Canada	13
South America	2
Asia and the Far East	15
Australia and New Zealand	4

Table 3. Measurement technique

Measurement technique	Number participating
Liquid Scintillation Counting (LSC)	44
Gas Proportional Counting (GPC)	19
Accelerator Mass Spectrometry (AMS)	17
Target feeder for AMS	8
Direct absorption and LSC	4

Laboratory performance

A total of 122 observations from 1056 (i.e. slightly over 10%) were identified as anomalous (i.e. outliers). From the definition of an outlier, around 5% of the results would have been expected to have been classed as outliers, thus approximately twice as many outliers were identified as would be expected were they occurring purely by chance. 39 laboratories (42%) had at least one result classed as an outlier while a relatively small number of laboratories (17 or 14%) generated more than 60% of the outlying observations. The majority of these laboratories use liquid scintillation techniques (including direct absorption), however there remain a substantial number of liquid scintillation laboratories with none or only one outlier. The distribution of outliers was uniform over the 10 samples.

Sources of variation

In general, there is no evidence of statistically significant differences, on average, amongst measurement techniques (AMS, GPC and LSC) and it was concluded that in general measurement techniques are comparable. However, where a lack of comparability was observed was a) in the number of outliers and b) in the near-background Kauri wood sample. For the latter, limits of detection, identification of suitable background materials and accurate background determination become important issues.

Measures of precision and accuracy

The design of FIRI included three pairs of duplicate samples, A and B (Kauri wood), D and F (Belfast wood) and G and J (barley mash) to allow the assessment of laboratory precision relative to the quoted errors.

From an analysis of the differences it was concluded that the average difference between duplicates was zero, but that there was evidence of substantial scatter in the results. There was some evidence of variability between duplicates exceeding what might be expected on the basis of the quoted errors and the results suggested that the differences are adequately described by the quoted errors of approximately 50% of the laboratories.

Consensus values for FIRI reference materials

Accuracy can only be assessed against known age materials or consensus values. For ^{14}C , known-age materials are typically dendro-dated wood and four such samples were included in FIRI. Consensus values for all the FIRI samples are shown in Table 4.

Table 4. Consensus values

Sample	Known age	Consensus value (estimated 1s precision)
AB (pMC)	-	0.24 pMC ¹ (95% CI (0.23 – 0.30))
C (yBP)	-	18176(10.5) yBP ²
DF (yBP)	3200-3239BC (¹⁴ C age 4495BP)	4508 (3) yBP
E (yBP)	-	11780 (7) yBP
GJ(pMC)	-	110.7 (0.04) pMC
H(yBP)	313-294BC (¹⁴ C age 2215BP)	2232(5) yBP
I (yBP)	3299-3257BC (¹⁴ C age 4471BP)	4485(5) yBP

¹ percent modern carbon;

² radiocarbon years before present, where present is 1950.

With respect to the dendro-dated samples, the consensus values and the average 'master ¹⁴C calibration' values agree within error.

Summary findings

- On average, no evidence of significant differences between AMS, GPC and LSC laboratories was observed with the exception of the near-background Kauri sample.
- It was noted that the majority of results identified as extreme or outliers were reported by LSC laboratories.
- On average the difference between duplicates was zero but the magnitude of the difference was, in some cases, larger than would be expected on the basis of the quoted errors.
- There was evidence that a number of laboratories had significant but generally small offsets relative to the consensus results. The results did not allow further examination of the causes of these offsets and the responsibility for investigating them, and amending laboratory procedures, rests with the individual laboratories.

Conclusions

A substantial effort has been made by the ¹⁴C community to develop and apply QA procedures. FIRI provides a part of these procedures in the form of an independent check of laboratory performance. However, it only provides a spot check of operational performance at the time it was carried out and so should not form the basis of a 'league table of laboratory performance' and should be

seen in the broader QA perspective. FIRI provides the laboratory with information that can be used to check and improve performance and in this way it provides indirect but important benefit to the user. A small archive of reference material has now been created and laboratories whose results were deemed problematic in FIRI have been offered assistance and additional materials for identification and correction of procedural difficulties. It is clear that studies like FIRI are, and will continue to be, necessary. Plans for further programmes are under development.

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QUATERNARY RESEARCH FUNDS

QRA RESEARCH FUNDS: NEWS AND AWARDS IN 2001

We are now into the second year of the QRA Research Awards scheme and have completed the first full calendar year of awards. The scheme has bedded down quite well now and we made a total of 38 awards totally over £7000 in 2001 (see details below). We hope to be able to continue at least this level of funding in the future. The grants are being expanded in 2002 to include a special fund to help postgraduates attend the QRA field meetings and the Annual Discussion Meeting. This will provide 50% funding for 6 postgraduates each for the Annual Discussion Meeting and the Annual Field Meeting with three awards available for the Short Field Meetings. If you are interested in applying for these awards please check the details carefully as deadlines will be set appropriately for each meeting and applications will be dealt with by the meeting organisers. Full details of the awards are available on the QRA web site as well as in the circular.

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Applicant	Institution	Award £	Project title
New Research Workers Awards			
Alaric Rae	Coventry University	175	Late Quaternary glaciation in southeast Ireland
Aoibheann Kilfeather	Queen Mary, London	200	The characteristics, genesis and permeabilities of tills in County Laois, Ireland
Chris Stermerdink	University of Newcastle	250	The geochemistry of post Anglian Thames deposits: a further investigation of the Wolvercote terrace sediments
Eleanor Haresign	University of St Andrews	225	Calving dynamics of the lake-calving Glacier Leones, Patagonia
Jon Barber	University of Leeds	200	Devensian and earlier glacial tills in West and North Yorkshire
Keely Dobson	University of Manchester	175	A reinvestigation of the drift stratigraphy of the Lleyn Peninsular
Kim Jardine	St Andrews	125	Dynamics of calving glaciers in Greenland
Lindsey Nicholson	University of St Andrews	200	The response of Himalayan glaciers to climate change
Matthew Jones	University of Plymouth	175	Isotope records from Turkish lakes
Megan Ellershaw	Queen Mary, London	180	Holocene climate change in the North Atlantic region: evidence from ombrotrophic mires
Philip Hughes	University of Cambridge	225	Quaternary glaciation in the Pindus Mountains of Epirus, Greece
Rebecca Briant	University of Cambridge	200	Determination of environmental dose rates for optically-stimulated luminescence dating using Neutron Activation Analysis
Ryan Corcoran	University of Dublin	160	Lateglacial and Holocene environmental change at Lough Avullin, Clare Island, Ireland
Sarah Gilchrist	University of Edinburgh	200	Chironomid records for the last glacial - interglacial transition in Patagonia
Steve Boreham	Open University	200	Amino acid dating of mollusc shells from interglacial sites near Cambridge
Susan Adair	Royal Holloway	175	Clacio-fluvial transfer processes in a Norwegian high Arctic catchment
William Adam	Keele University	170	Debris in the basal ice layers of glaciers and ice sheets
<i>Total New Research Workers Awards</i>		3235	
Quaternary Conference Fund			
Adrian Tams	University of Edinburgh	125	International symposium and field workshop on palaeopedology, Mexico City, October 2001
Amanda Williams	Chester College of HE	150	6th International Drumlin Symposium, INQUA Commission on glaciation, Poland, June 2001
Chris Stokes	University of Reading	120	Palaeo-ice stream international symposium, Aathus, Denmark, Oct 2001

Fabienne Marret	University of Wales, Bangor	180	VIIth International Conference on Palaeoceanography, Sapporo, Japan, Sept 2001
Judy Allen	University of Durham	200	Achieving climate predictability using paleoclimate data, ESF, Italy, Nov 2001
Maja Andric	University of Oxford	200	6th Annual Meeting of the Society for American Archaeology, New Orleans, April 2001
Maria Fernanda Sanchez Goni	Universite Bordeaux	180	Neanderthals and modern humans in Late Pleistocene Eurasia, Gibraltar, August 2001
Mark Lloyd Davies	University of Amsterdam	75	The Quaternary of south west Ireland, QRA Field Meeting, May 2001
Phil Metcalfe	University of Wales, Swansea	200	Achieving climate predictability using paleoclimate data, ESF, Italy, Nov 2001
Phillippa Noble	University of Wales, Aberystwyth	150	7th International Conference on Fluvial Sedimentology, Nebraska, USA, August 2001
Rachel Burbridge	University of Leicester	180	Vth Iberian Quaternary meeting: Climatic variability during the Quaternary in South America, Lisbon, Portugal, July 2001
Richard Waller	University of Greenwich	150	6th International Drumlin Symposium, INQUA Commission on glaciation, Poland, June 2001
Stephen Thomson	University of Glasgow	125	QRA Field Meeting to North Lincolnshire and East Yorkshire, Sept 2001
Will Gosling	University of Leicester	200	Achieving climate predictability using paleoclimate data, ESF, Italy, Nov 2001
<i>Total Quaternary Conference Fund</i>		2235	

Quaternary Research Fund

Alastair Curry	Univeristy of Hertfordshire	200	Holocene slope instability at Mynedd Du, Brecon Beacons
Chris Gleed-Owen	No affiliation	347	To study a Swedish Holocene herpetofaunal collection at Malmo Heritage and Gothenburg Natural History Museum
Colm O Cofaigh	University of Bristol	338	Late Quaternary glacial facies associated with ice stream recession in the Irish Sea, Screen Hills, south-east Ireland
H.E. Langford	No affiliation	300	Sedimentology and paleontology of the March gravel at Whittlesey
J.B. Innes	Queen Mary, London	300	Dating of the rational Betula pollen rise in the Isle of Man
Pete Langdon	University of Exeter	225	A temperature transfer function from chironomid assemblages in Iceland
Rodger Connell	No affiliation	83	Sedimentological, structural and stratigraphic analysis of three key Quaternary sites in NE Scotland

Total Quaternary Research Fund 1793

Total QRA awards in 2001 7263

HOLOCENE ENVIRONMENTAL RECONSTRUCTION FROM NW ICELAND: MODERN AND SUBFOSSIL CHIRONOMID ASSEMBLAGES WITHIN A MULTIPROXY CONTEXT

Background

In order to determine the pattern of climatic change throughout the northern hemisphere, and specifically NW Europe, a detailed understanding of fluctuations in North Atlantic climate is a high-priority research issue. Iceland lies at a key location within the North Atlantic as it is situated at the boundary of water masses with both "polar" (the cold East Greenland current) and "Atlantic" (the warmer Irminger current) characteristics. Recent marine records with high temporal resolution from the Icelandic Shelf and northern fjords close to the major thermal oceanographic boundary (e.g. Andrews *et al.*, 2000; Andrews *et al.*, 2001; Figure 1) have highlighted the deficiencies in the terrestrial record for the region, particularly for the Holocene. In NW Iceland recent high-resolution marine cores have been obtained from nearshore fjord deposits in Ísafjardardjúp which span the whole Holocene, and at present there is no terrestrial palaeoecological or glacial data to evaluate the inferred palaeoclimatic sequence. Attention is currently focussed on the lakes of NW Iceland, and recent analyses of lake sediments from this region have suggested that chironomid (non-biting midge) analyses can be used as quantifiable terrestrial indicators of palaeoclimate change (Caseldine *et al.*, in prep.), making them a valuable tool for palaeoclimatic reconstructions from Iceland.

Aims

The aims of this research were threefold: (1) to survey and assess a large number of lakes from NW Iceland along an altitudinal transect which would be suitable for developing a chironomid-inferred temperature transfer function - an important advantage of NW Iceland in this respect is the absence of geothermal activity which could otherwise affect the calibration set; (2) to assess the suitability of a number of lakes for the extraction of a sedimentary record; and (3) to sample the littoral sediments of many lakes in order to (a) assess the individual chironomid fauna from a number of lakes, and (b) develop the Icelandic taxonomy from modern chironomids and relate these to subfossil material.

Icelandic chironomids

Studies on Icelandic chironomids have been largely restricted to ecological studies in freshwater ecosystems (e.g. Jónasson, 1979, 1992; Lindegaard, 1992; Garðarsson *et al.*, 1995; Gíslason *et al.*, 1995). The study of subfossil

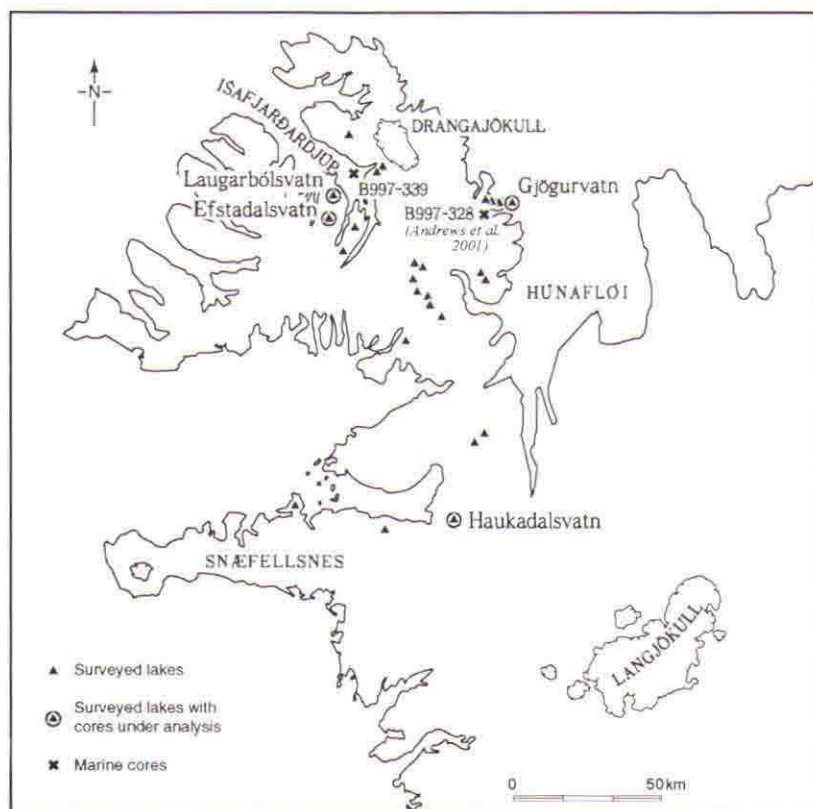


Figure 1. Detailed map of NW Iceland showing the location of recently sampled marine cores, surveyed lakes, and lakes with sediment cores currently being analysed.

chironomids from Icelandic sediments has relied mainly upon the work undertaken at Myvatn (e.g. Einarsson and Hafliðason, 1988), an eutrophic lake fed mainly by spring water, some of which can reach temperatures of up to 30°C. Little else has been published on Icelandic Holocene chironomid assemblages. NW Iceland was selected as a key area from which to analyse Holocene chironomid faunas due to the lack of geothermal activity within the region and the current sedimentological and palynological research being undertaken on lakes in the area (e.g. Caseldine *et al.*, in prep.), coupled with the wealth of environmental data available from the ocean-core records from around NW Iceland (e.g. Andrew *et al.*, 2000; 2001).

Chironomids have been shown to respond rapidly to past changes in temperature (e.g. Walker *et al.*, 1991; Lotter *et al.*, 1999; Brooks and Birks, 2000, 2001),

which make them an attractive palaeoclimatological proxy, particularly as they can be abundant in climatically marginal or severe environments. The construction of transfer functions, based on the development of a modern-day training set from which individual taxon optima can be deduced, has allowed the quantitative reconstruction of temperatures using chironomids. This is particularly attractive for researchers working on Icelandic terrestrial sediments because the vast majority of palaeoclimatic reconstructions from these sites around the Nearctic relies on evidence from pollen spectra (Miller *et al.*, 2001), which remain difficult to quantify in terms of thermal limits.

Icelandic chironomid taxonomy

Initial examination of Holocene chironomid assemblages from a site in North West Iceland at Efstadalsvatn (65°55'N 21°40'W), which was originally the subject of pollen and sedimentological analyses, has provided an abundance of chironomid remains and produced the first terrestrially-based temperature reconstruction for Iceland (Caseldine *et al.*, in prep.). The taxonomy of species is in general comparable to NW Europe and has therefore been based on the European fauna (cover photograph). The Norwegian chironomid-inferred temperature transfer function could thus be used for the Icelandic data (S. Brooks, *pers. comm.*). There are, however, some important differences in the taxonomy and until an Icelandic training set is derived key issues relating to temperature reconstructions from Icelandic lake sediments cannot be resolved.

Recent research suggests that at least 33 genera can be found in Iceland, containing 75 species, with the fauna tending to resemble the European fauna (Hrafnadóttir *et al.*, 2000). The study of Holocene sediments from a variety of Icelandic non-thermal oligotrophic lakes would thus allow important comparisons, not only in terms of the Icelandic Holocene fauna, but also by comparing the results with the Norwegian and North American faunas. Current investigations (Caseldine *et al.*, in prep.) have revealed subfossil chironomids that have not been recorded in the modern fauna to date - hence the need to conduct extensive surveys of the lake surface sediments from the region. Collaborative research is currently underway with Icelandic chironomid experts to resolve some of the issues between the modern and subfossil assemblages.

Lake surveys

Over 30 lakes were found to be suitable for developing a modern-day chironomid training set for NW Iceland (Figure 1). The littoral region of the lakes was sampled for chironomids which were analysed at Exeter University. The lakes surveyed were mainly in the NW peninsula, but also extended west towards the Snæfellsnes peninsula, including the region around Stykkishólmur, and covered an altitudinal range from 0-500 m (Figure 1). Plenty of other lakes were also

observed within the region, which would provide over 100 lakes suitable for the development of a modern-day chironomid training set.

A number of lakes were surveyed from the NW peninsula in order to provide a detailed sedimentary record and ultimately a high-resolution palaeoclimatic reconstruction. Gjögurvatn, in the Strandir area provides the best opportunity to correlate land and sea studies, and Laugarbólsvatn/Efstadalsvatn, two connected lakes, offer the best possibility of a quantitative reconstruction of July temperatures over the past 10 ka from changes in chironomid assemblages. Sedimentological and palynological analyses will also be undertaken on these lakes in collaboration with The University of Iceland and INSTAAR (University of Colorado). The combined results from these lakes will provide a unique palaeoclimatic record for the entire Holocene, with the possibility of extracting the anthropogenic effect from the natural forces on climate in the late Holocene.

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REVIEWS

THE GEOLOGICAL SOCIETY OF NORFOLK 50TH ANNIVERSARY VOLUME: DEDICATED TO BRIAN FUNNELL FOUNDER MEMBER

Editor Roger Dixon, Norwich 2001, 99pp

This bumper special issue commemorates 50 years of continuous activity by the Geological Society of Norfolk and comprises a gallimaufry of papers covering every aspect of the geology of East Anglia. The dedication of the volume to the late **Brian Funnell**, the distinguished micropalaeontologist and stratigrapher, is very fitting. Funnell himself managed to contribute a note on the geology of Norwich, and he is a joint author of a major paper by **J.E. Andrews *et al.***, which deals with the last 10,000 years on the North Norfolk coast. In addition there is a fine tribute from his University of East Anglia colleague **F. Vine**, FRS, and two further short papers by **A. Lord** and **P. Murphy** give appreciations of Funnell's guidance of their work on the Craggs and coastal archaeology, respectively. Indeed, most authors acknowledge Funnell's influence and cite his numerous papers extensively. His contribution as the leading founder member of the Society is made clear by **A.J. Martin's** evocative account of the early days of the Paramoudra Club, as it was at first called. From the late 1940s to the 1960s this self-start VIth form club at the City of Norwich School helped to launch many earth scientists, including this reviewer. All meetings began with an appropriate reading from the works of Lyell, excursions were undertaken to distant parts in borrowed cars and ramshackle, pre-MOT coaches, and important sections such as that in the Norwich Crag at Bramerton near Norwich, were continually excavated and kept open for study.

Clearly the good work continues for the volume includes a report of the Jubilee field excursion to Bawdsey, with an account of the beds and fossils of the coastal section in full professional detail from **R.G. Dixon**, side by side with Vanessa Banks' nicely-researched report of their tour of Bawdsey manor. In the same vein, from much personal knowledge, **R.A.D. Markham** gives a fully-documented account of geological researches at the famous Chillesford Church pit during the last 50 years or so. That both Bawdsey and Chillesford are in Suffolk serves to emphasize a long-standing tradition of cross-border collaboration. Consistent with its eclectic yet comprehensive style, the volume also gives space to useful short papers by **H.B. Mottram** on waste disposal and by **P. Lambley** and **J. Larwood** on earth-science conservation issues and sites within the county.

However, the main bulk of the volume presents scientific papers from authors who are acknowledged authorities in their fields. The paper by **J.E. Andrews *et al.*** reports the results of 40 cored boreholes, several seismic transects and radiocarbon dating to provide both a description of and a chronology for the Holocene sedimentary prism along the north Norfolk coast. Their conclusion includes a heartfelt call for 'better integration of our understanding with coastal-zone management and policy makers'. A fascinating recollection of Quaternary research in East Anglia during the last 50 years from **R.G. West, FRS**, strongly defends 'local stratigraphy firmly based on the local evidence of litho- and biostratigraphy, an approach which has led to the advances noted above (and to which I am naturally attached!)'. Concerning the 'pre-glacial' Quaternary, **J. Rose** provides a well-illustrated synopsis of the deposits thought to be linked to the ancestral Thames and the Bytham and Ancaster Rivers and their tributaries and distributaries. He also summarises current views on the significance of the Valley Farm and Barham palaeosols for interpretations of landscape stability and palaeoclimate in 'pre-glacial' times. This paper is thus an authoritative entree for the increasing number of us who need to gain some understanding of these rapidly-developing fields.

Continuing down the geological column, the Craggs are well represented by three significant papers. **A.M. Wood's** excellent electron micrographs confirm his case that although diagenetic processes normally destroy fossils by dissolution, the leaching and re-deposition of iron minerals can provide internal moulds of foramenifera with fine detail preserved. This evidence will clearly be crucial in interpreting hitherto 'unproductive' Crag deposits. In a short paper, **P. E. P. Norton** provides a tantalising summary of his recent findings from the Swafeld borehole, which has revealed 'the first record of conformable superposition of 'Weybournian' molluscan assemblage biozone deposits upon those of the 'Norwich Crag' molluscan assemblage biozone.' Finally on the Craggs, **P.E. Long** discusses two mollusc-based puzzles arising from the cold period beds at Chillesford, Easton Bavents and elsewhere. First, does the Scrobicularia Crag really belong to the Norwich Crag? The author advances a clear case against that commonly-held belief. Second, how cold was it during the formation of these cold-period deposits? On the evidence at Covehithe in particular, Long argues for 'the Arctic emergence of sub-littoral molluscs into an intertidal environment'.

Throughout the volume the editor has evidently held a loose rein and authors have been allowed to say things in their own way, with much variation in length, presentation and style. Surprisingly, this works very well on the whole. A plea for a more determined editorial input could be based on the two main papers on the Chalk, although **N.P. Peake** and **J. M. Hancock** take a view largely from within Norfolk, whereas **J.M. Hancock** and **N.P. Peake** have a wider international perspective. However, the advantage is that the individual views of these two great Chalk experts are boldly stated. Norfolk evidently continues

as a Chalk cornerstone, not least because it is the only part of Britain where the top Campanian and some Maastrichtian survived widespread erosion during the Palaeogene.

A liberal editorial stance is fully vindicated by the paper from **C.J. Wood**, who has been allowed eight pages of full colour reproductions of classical, hand-coloured geological illustrations, most of them from pre-Victorian times. Wood makes it clear 'that this paper could not have been written without the enthusiastic assistance of Kate Bould and Wendy Cawthorne of the Geological Society of London'. Presumably generous assistance from the Geologists' Association Curry Fund cited elsewhere in the volume, helped to pay the printer's bill. Plates 1, 2, 3 and 5 present long cross-sections and a vertical section of Bramerton published by R. (and/or R.C. and/or Richard?) Taylor between 1824 and 1829. They reveal Taylor's very advanced understanding both of the Craggs and of the uppermost Chalk. Plates 6 and 7 are of Samuel Woodward's (grandfather of H.B. Woodward.) geological map of Norfolk and of his section of the glacial deposits of the Norfolk cliffs. Both of these have an extraordinarily modern look considering that they were published in 1833. More, Wood informs us that S. Woodward's accompanying text included systematic tables of fossils and for the first time sub-divided the Chalk into Lower, Medial and Upper divisions. Plate 4 gives us Harmer's better-known, 66-mile long cross-section of the county published in 1877, which was based on his work for the Geological Survey with S.V. Wood Junior. The detail for the Craggs still astonishes, and Wood reminds us that Wood and Harmer recognised for the first time the 'Tertiary bevel' across the Chalk in the east. With its breadth of interest, scholarly attention to the old masters and elegant prose, Wood's paper is very much in the Funnell style. The only irritations I would mention are that the plates are to be found 11 pages beyond the text, and that Harmer's superb section is tightly synclined into the binding.

Throughout, the presentation of the text is good, although A4 full width and only some papers 'justified' gives a period flavour which is quite appropriate in this context. The numerous figures and plates are of a uniformly high standard. All in all this is a must-see-might-even-buy volume for Quaternary earth scientists especially. The Geological Society of Norfolk, Brian Funnell and the scientific community are well served by this rather special, special volume.

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Copies of the volume are available for £8.50 (which includes postage) from:
Roger Dixon, The Lodge, Cargate Lane, Saxlingham Thorpe, Norwich NR15 1TU
Cheques should be made payable to "The Geological Society of Norfolk".

EAST OF WALLACE'S LINE. STUDIES OF PAST AND PRESENT MARITIME CULTURES OF THE INDO-PACIFIC REGION

Edited by Sue O'Connor and Peter Veth, 2000

Volume 16 of Modern Quaternary Research in Southeast Asia. Series

Editors J Pasveer and K Aplin. Balkema, Rotterdam.

This volume arose from a symposium held, appropriately, on Magnetic Island in northern Queensland, Australia. Inspired by Wallace's (1869) remarks relating to the 'maritime enterprise' that enabled people to move between the islands separating mainland Asia from Australia, this book provides a rich and discursive analysis of the elusive archaeological connotations of the terms 'maritime', 'marine' and 'coastal.' The time frame spans the last 50 000 years, with special emphasis on the last 3 000 years, and the geographical scope is equally broad, again with a focus on islands occupied in the later Holocene.

Two chapters deal with the Pleistocene migrations into Australia. Over the past thirty years archaeologists have extended the accepted duration of a human presence in Australia from 10 000 to perhaps 55 000 (Jones, 1999; Mulvaney and Kamminga, 1999). **John Chappell** examines the 'Pleistocene seedbeds' of western Pacific maritime cultures and concludes from careful scrutiny of site ages and numbers that synchronous occupation of Australia and New Guinea was highly unlikely. He notes also that tropical coastal people were best equipped for voyaging at times of rising sea level, an insight accepted by **Sue O'Connor** and **Peter Veth**, who provide a refreshingly detailed and non-doctrinaire account of early human colonization of Australia.

Atholl Anderson's scholarly disquisition on water-craft, notably single-outrigger canoes, explains how the Austronesians crossed the Indian Ocean about 1500-2000 BP. **Matthew Spriggs** examines the evidence for Neolithic occupation of the western Pacific islands and opts for an inception mainly in the period 3000-4000 BP. The nature and timing of pre-Lapita, Lapita and post-Lapita colonisation of Melanesia and the western Pacific is a contentious issue, and is the subject of thoughtful and robust debate by **Jim Allen** and by **Ian Lilley**. A concise analysis by **David Roe** of the subtle interconnections between coastal and inland societies in the Solomons and Vanuatu concludes that there are 'no major linguistic, kinship or material culture boundaries' between the saltwater, coastal and inland groups discussed. An excellent account of the late Holocene maritime societies in the Torres Strait Islands between Papua New Guinea and northern Queensland by **Anthony Barham** provides a wealth of ecological and chronological detail so essential to productive archaeological enquiry.

Anne Clarke describes the cross-cultural interactions between Indonesian (Macassan) fishing fleets and northern Australian coastal Aborigines during the period between about 1650 AD and 1906 AD. **James Fox** considers that 'the migration of the Austronesians was one of the transformative events in world history – on a par with the migration of the Indo-Europeans.' He discusses the role of three key Indonesian sailing populations (Bugis, Butonese, Bajau) and explains why they are today among the poorest groups in Indonesia. The final chapter by **Sandra Pannell** is a poignant epitaph on the accelerating disappearance of maritime societies and lifestyles in eastern Indonesia when confronted with powerful external forces (commercial fishing fleets, government-controlled relocation of entire villages) beyond their control.

This volume is a fitting successor to the classic volume edited by Mulvaney and Golson (1971), encompasses a broader geographical region, and shows the increasingly subtle interpretations now available to explain something of the cultural and ethnic diversity of the lands that so fascinated Wallace, Darwin, Cook and Flinders during their 'maritime endeavours'.

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**GEOLOGY OF THE KESWICK DISTRICT: SHEET
EXPLANATION 29, 30PP, ISBN 0 85272 375 X
GEOLOGY OF THE KESWICK DISTRICT: SHEET
DESCRIPTION 29, 48PP, ISBN 0 85272 374 1**

D.G. Woodhall

**Geology of the Ambleside district: Memoir 38, 228pp, ISBN 0 11 884547 0
D. Millward, E.W. Johnson, B. Beddoe-Stephens, B. Young,
B.C. Kneller, M.K. Lee and N.J. Fortey
England and Wales 1:50,000 sheets
Published by British Geological Survey, 2000**

Ambleside Memoir £70, Keswick Sheet Description £15 and Keswick Sheet Explanation £9 or with a folded copy of the cased 1:50,000 map in a tough clear plastic wallet £15, while individual 1:50,000 maps cost £9.95, with 25 % academic discount when ordered from:

**Sales Desk, British Geological Survey, Keyworth, Nottingham NG12 5GG
Tel : 0115 - 936 3100 Fax : 0115 - 936 3200 (prices exclusive of post and packing).**

Keswick is one of the first newly-surveyed 1:50,000 sheets to be covered by a Sheet Explanation instead of a traditional memoir (*Quaternary Newsletter*, 92, 58-60). This affordable booklet provides a concise and well-written account of the geology for this part of the Lake District. Unfortunately, the Quaternary is reduced to less than one page of text, a photograph and a summary diagram showing ice-flow directions and the inferred distribution of the small glaciers that formed during the Loch Lomond Stadial. This minimalist coverage is repeated in the more detailed print-on-demand Sheet Description, which does however contain engineering geology tables outlining the nature of the district's often highly variable Quaternary deposits. While proportionally this level of coverage is similar to that given to the Quaternary in comparable sheet memoirs, the effect is highly unsatisfactory. The account is not long enough to put these deposits into context with regard to the environment and rapidly fluctuating climate in which such deposits and landscapes were formed. Sheet Explanations have been introduced to reduce costs, but they are clearly too short for such upland areas of Britain and need to be either 42 or 46 pages long. This reflects the fact that normally there is simply more geology to report and references to quote than for lowland parts of Britain.

The Ambleside district to the south of the Keswick sheet is covered by a very comprehensive, if expensive, memoir. This is mainly a detailed account of the famous Borrowdale Volcanics, Lower Palaeozoic sediments and intrusions that form the solid bedrock of the area. However, the introduction includes a good

overview of the Quaternary with the names of the different deposits neatly highlighted in the text, and the frontispiece is an impressive colour satellite image of the surrounding region, including Morecambe Bay. The chapter dealing with the Quaternary is a concise account that contains a lot of detailed information and references. The section on glaciation starts with a short poem by William Wordsworth (1770-1850) on the mysterious origins of a huge stone block, which is clearly a glacial erratic. There is a large table that relates the deposits and events in the area to the different climate conditions and deep-sea Oxygen Isotope stages. However, the chapter would have benefited from annotated photographs of the landscape in addition to a summary diagram, similar to one for the Keswick district, showing ice-flow directions, and some extra figures, including one illustrating the stratigraphy of the Windermere Interstadial type section in Lake Windermere on the eastern margin of the sheet.

The Ulverston memoir (sheet 48), covering the area south of the Ambleside sheet, will soon be published, providing a similar account of the local Quaternary deposits. Considering that the 1:50,000 Solid and Drift geological maps (*Quaternary Newsletter*, 90, 53-55) covered by these publications could be improved with the addition geomorphological features and that the highly scenic landscape of this much visited National Park was moulded by glaciers, the Quaternary geology of the Lake District would merit a special memoir. This could include diagrams, like those in the west Cumbria memoir (Akhurst *et al.*, 1997), showing how the local geography changed during the different stages of Devensian glaciation and in post-glacial times. In addition, annotated photographs and sketches could be used to elucidate significant geomorphological features. However, such a memoir is unlikely in the next decade until the remaining 1:50,000 sheets (30, 39, 49) covering eastern Cumbria have been published and the region's Quaternary (Drift) mapping has been upgraded (Walton and Lee, 2001).

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Walton, G. and Lee, M.K. (2001). Geology for our diverse economy: report of the Programme Development Group for Onshore Geological Surveys. British Geological Survey. ISBN 0 85 272386 5 £7

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ABSTRACTS

PALAEOECOLOGICAL INVESTIGATIONS OF BLANKET MIRES IN UPLAND MID-WALES

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This thesis examines the sequence and pattern of Holocene environmental change in upland mid-Wales over the last 10,000 years. The evidence is derived from three water-shedding blanket mires (Bryn Mawr, Bryniau Pica and Figyn Blaen-Brefi) at altitudes between c. 500 and 410 m OD along the spine of the Cambrian Mountains. Pollen, plant-macrofossil, palynomorph (fungal remains and testate amoebae), charcoal and sedimentological (degree of humification and loss-on-ignition) analyses were carried out, while nineteen AMS dates and two conventional ^{14}C dated samples provided chronological control. A fine-grained, low-density, tephra layer was also recorded in two peat sequences at around c. 6000 ^{14}C years BP (Buckley and Walker, this volume). This range of multiproxy data was integrated into a regional stratigraphic framework (*sensu* Chambers, 1996).

Pollen spectra from each site were assessed in terms of local and regional vegetational change, and compared with published palynological evidence within the study area, and particularly from the nearby lowland raised mire of Tregaron Bog (*e.g.* Hibbert and Switsur, 1976). On the regional scale, hazel expanded at c. 9135 years BP, and within c. 100 years had replaced birch as the dominant tree species. A mixed woodland, with *Quercus*, *Alnus glutinosa*, *Corylus avellana*, *Pinus sylvestris* and *Ulmus* became established on the slopes and valley bottoms shortly thereafter. There are indications of Mesolithic interference, but not until after the 'elm decline' around 5000 ^{14}C years BP, is there unequivocal evidence of woodland clearance, a process which accelerated after c. 3275 ^{14}C years BP. The evidence suggests that the present 'cultural landscape' was established by the mid-late Bronze Age, which accords with archaeological evidence for increasing human activity at that time in upland mid-Wales.

Plant-macrofossil records (notably *Sphagnum*), humification data and evidence from fungal palynomorphs and testate amoebae were used to reconstruct changes in mire surface wetness. A simple hydrological index of wet/dry peat components, in turn, was used to produce an approximate proxy climate record for the study area. Regional-scale wet shifts in climate were identified at c. 6370–6125 ^{14}C years BP, c. 4875 ^{14}C years BP, c. 3800 ^{14}C years BP, c. 2130–2050 ^{14}C years BP, c. 1450–1410 ^{14}C years BP and 750 ^{14}C years BP. These

results show broad agreement with palaeoclimatic evidence from across the British Isles.

The study therefore provides an integrated record of vegetation/climate change and history of human impact during the Holocene period. In addition, since all three sites investigated exhibited comparable biostratigraphic sequences, they provide an ideal record against which the patterns of mire development and degradation in upland areas can be compared and potential future restoration practices assessed.

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LANDSCAPE EVOLUTION AND HOLOCENE CLIMATE CHANGE IN MOUNTAIN AREAS OF THE NORTHERN HIGHLANDS, SCOTLAND

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Holocene landscape evolution in the tectonically quiet mountain areas of the Northern Highlands of Scotland has been attributed largely to postglacial relaxation, which has left a legacy of stable, relict landscapes disturbed only by intrinsic local response and modified to an uncertain extent by human activity. A review of this model was prompted by recent improved understanding of (a) the variability of the Holocene climate in mid latitudes, (b) the responsiveness of some geological and geomorphological systems to low-amplitude climate fluctuations, and (c) a small number of field studies from the region reporting mid and late Holocene slope mass movement.

This study confirmed widespread re-organisation of lower slopes during the Holocene. Radiocarbon dating of buried organic horizons at two localities indicated mid and late Holocene landform evolution, millennia after apparent adjustment to postglacial conditions. The increase in debris-flow frequency at one site approached one order of magnitude. Mass movement on slopes has parallels in floodplain aggradation and incision. These transformations appear to have operated on several different time scales and across a strong regional gradient in precipitation.

This study did not substantiate an anthropogenic forcing factor for palaeohydrological changes associated with landscape instability. An alternative driver, which better fits observations, is changing precipitation, interacting with factors such as progressive weathering and vegetation cover, to instigate critical thresholds of change. This explanation underpins a model of landscape evolution for Northern Scotland which incorporates climate change as a critical variable. No good basis was found, however, for the use of dated slope mass movements as palaeoclimate proxies, although changes in characteristic event frequencies, on a timescale of 10^3 years, may be a reliable indicator of changes in forcing factors, including precipitation.

NOTICES

1. CALL FOR PAPERS: POLAR GEOGRAPHY

under new management, publishing rapidly

If you regard *Polar Geography* as an obscure, peripheral journal, think again! Since 1999 it has been under the editorship of Kees van der Veen (a highly-regarded glaciologist at the Byrd Polar Research Center, Ohio, USA), assisted by the eminent Quaternary scientist Ellen Mosley-Thompson. Since then, some very interesting, high-quality papers have appeared, for example:

R.B. Alley, P.A. Mayewski, and E.S. Saltzman: Increasing North Atlantic climate variability recorded in a central Greenland ice core.

C.J. van der Veen: Evaluating the performance of cryospheric models.

C.L. Parkinson: Recent trend reversals in Arctic sea ice extents: possible connections to the North Atlantic Oscillation.

V.M. Kotlyakov and C. Lorius: Four Climatic cycles based on ice core data from deep drilling at the Vostok Station, Antarctica

K.C. Jezek and R.G. Onstott: The role of remote sensing in the environmental monitoring of Antarctica.

Polar Geography is published quarterly and peer-reviewed to a high standard. It accepts scientific papers on all aspects of polar sciences, but particularly those relating to global change and its human dimensions. It is an excellent vehicle for papers that seek a wide, interdisciplinary audience. The journal is also a place where longer papers can be published – distillations of theses, for example, or review papers that place in a global context results from international research efforts. There is a high-latitude emphasis, but in practice the term ‘polar’ is interpreted very broadly to include all aspects of cold-climate research in any latitude. Papers may be submitted directly to Kees van der Veen (e-mail: vanderveen.1@osu.edu) or to any member of the editorial board. A particularly attractive feature of *Polar Geography* is its rapid turnaround time – submission to publication in roughly four months. For further information see the publisher’s web page: <http://www.bellpub.com>

I look forward to seeing a steady stream of cutting-edge papers from the UK community!

Dr Charles Warren
UK editor, *Polar Geography*
School of Geography & Geosciences
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2.

THE XVITH INQUA CONGRESS

**23 – 31 July 2003, Reno Hilton Resort and Conference Center,
Reno, Nevada, USA**

Full details of the Congress can be found on the Congress Web site:

http://www.dri.edu/DEES/INQUA2003/inqua_home.htm

Please visit this site to register your interest in the Congress and find out more about the location, scientific program and field trips.

We look forward to seeing you in Reno in 2003.

3.

PHD STUDENTSHIP

The Countryside Council for Wales and the Department of Earth Sciences, University of Cardiff are jointly sponsoring a three-year PhD studentship:

Quaternary Ground Ice Depressions ("Pingos") in Wales: distribution, internal structure, formation, and palaeoenvironmental significance.

Project supervisors:

Professor Charles Harris and Dr Peter Brabham (Cardiff University)

Dr Stewart Campbell (Countryside Council for Wales)

The research will produce a full and up-to-date assessment of all known ground-ice depressions and related cryogenic landforms (for convenience here termed pingos) in Wales in the context of their future conservation and management. Internal structure and origins will be explored through the application of a range of geophysical techniques, together with drilling, to determine internal structure, sedimentology and stratigraphic relationships. The student will work closely with officers of the Countryside Council for Wales.

Start date: September 2002

For more details and application forms contact:

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Forthcoming Research papers

Van den Bogaard and Schmincke. Linking the North Atlantic to Central Europe: a high-resolution Holocene tephrochronological record from Northern Germany

McElwain *et al.* Stomatal evidence for a decline in atmospheric CO₂ concentration during the Younger Dryas stadial: a comparison with Antarctic ice core records

West *et al.* Evolution of a periglacial landscape in the Late Devensian: environments and palaeobotany of the Mepal area, Cambridgeshire, UK

Hall *et al.* Sedimentology, palaeecology and geochronology of Marine Isotope Stage 5 deposits on the Shetland Islands, Scotland

Allen. Interglacial high-tide coasts in the Bristol Channel and Severn Estuary, southwest Britain: a comparison for the Ipswichian and Holocene

Scott. Microscopic characoal in sediments: Quaternary fire history of the grassland and savanna regions in South Africa

Montuire and Marcoline. Palaeoenvironmental significance of the mammalian faunas of Italy since the Pliocene

Nitsche *et al.* Quaternary depositional history of the Reuss delta, Switzerland: constraints from high-resolution seismic reflection and georadar surveys

Plassen and Vorren. Late Weichselian and Holocene sediment flux and sedimentation rates in Andfjord and Vågsfjord, North Norway

Xiong *et al.* Aeolian origin of the Red Earth in Southeast China

Christiansen *et al.* Holocene environmental reconstruction from deltaic deposits in northeast Greenland

Walden and Ballantyne. Use of environmental magnetic measurements to validate the vertical extent of ice masses at the last glacial maximum

Marchant *et al.* Pollen-based biome reconstructions for Columbia at 3000, 6000, 9000, 12,000, 15,000 and 18,000 radiocarbon years ago: Late Quaternary tropical vegetation dynamics

Massaferro and Brooks. The response of chironomids to Late Quaternary environmental changes in the Taitao Peninsula, southern Chile

Bennike and Björck. Chronology of the last recession of the Greenland Ice Sheet

QUATERNARY RESEARCH ASSOCIATION

The Quaternary Research Association is an organisation comprising archaeologists, botanists, civil engineers, geographers, geologists, soil scientists, zoologists and others interested in research into the problems of the Quaternary. The majority of members reside in Great Britain, but membership also extends to most European countries, North America, Africa, Asia and Australasia. Membership (currently c. 1,000) is open to all interested in the objectives of the Association. The annual subscription is £15 with reduced rates (£5) for students and unwaged members and an Institutional rate of £25.

The main meetings of the Association are the Annual Field Meeting, usually lasting 3-4 days, in April, and a 1 or 2 day Discussion Meeting at the beginning of January. Additionally, there are Short Field Meetings in May and/or September, while Short Study Courses on techniques used in Quaternary work are also occasionally held. The publications of the Association are the *Quaternary Newsletter* issued with the Association's *Circular* in February, June and October; the *Journal of Quaternary Science* published in association with Wiley, incorporating *Quaternary Proceedings*, with eight issues per year, the Field Guide Series and the Technical Guide Series.

The Association is run by an Executive Committee elected at an Annual General Meeting held during the April Field Meeting. Current officers of the Association are:

President: *Professor M.J.C. Walker*, Department of Archaeology, University of Wales, Lampeter, Ceredigion, SA48 7ED, Wales, UK
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Vice-President: *Dr R.C. Preece*, Department of Zoology, University of Cambridge, Downing Street, Cambridge, CB2 3EJ
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Secretary: *Dr C.A. Whiteman*, School of the Environment, University of Brighton, Cockcroft Building, Lewes Road, Brighton, BN2 4GJ
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All questions regarding membership are dealt with by the **Secretary**, the Association's publications are sold by the **Publications Secretary** and all subscription matters are dealt with by the **Treasurer**.

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