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QUATERNARY NEWSLETTER

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Quaternary Newsletter is issued in February, June and October. Contributions comprising articles, reviews, notices of forthcoming meetings, news of personal and joint research projects, etc. are invited. They should be sent to the Quaternary Research Association Newsletter Editor. Closing dates for submission of copy (news, notices, reports etc.) for the relevant numbers are 1st January, 1st May and 1st September. *Articles should be submitted well in advance of these dates.* The publication of articles is expedited if manuscripts are submitted both as hard copy and on floppy disc. The preferred type for the latter is 3.5" floppy disc in Apple Macintosh format, but IBM PC compatible formats are also acceptable.

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COVER PHOTOGRAPH:
Late Devensian glacigenic sediments at Traeth-y-Mwnt. This is one of the sites currently being studied by Kenneth Rijsdijk, as part of a wider sedimentological investigation into the style of Late Devensian deglaciation in south-west Wales - see report on the Bill Bishop Memorial Symposium in this issue. Photograph by Stewart Campbell.

OBITUARY

FRANK MITCHELL

1912 - 1997

Frank Mitchell died peacefully in November last year after a short illness, aged 85. Frank was a great friend of the Quaternary Research Association and was a co-founder of the Quaternary Field Study Group (which later became the QRA) in 1964. He was elected as an Honorary Member of the Association in 1983 and spoke, along with several other long-standing QRA members, at the 20th Anniversary meeting of the QRA in Cambridge in March 1984. Many QRA members will remember the splendid visit to his home, Townley Hall, during the QRA's excursion to Ireland for the Annual Field Meeting in 1979.

Frank's Quaternary research began in earnest during his distinguished academic career at Trinity College Dublin. The Royal Irish Academy's Committee for Quaternary Research (Robert Lloyd Praeger was Chairman and Tony Farrington the Secretary) invited Knud Jessen to study the palaeobotany of Ireland's bogs and Jessen required field assistants. Frank Mitchell became one of these assistants during the summer prior to his final examinations, and the training he received in the field and on occasional visits to Copenhagen gave him an expert knowledge of Quaternary science that was to allow him quickly to commence a range of projects on the Irish Quaternary.

Anyone who has read Frank's work *The Irish Landscape* will understand the interdisciplinary approach that he took to analysing and understanding the landscape. The diverse nature of his many publications reflects his broad interests in the physical, geological and biological sciences and also points to his ability to identify and explain so much in the landscape around us. Frank's published work received wide acclaim and he wrote on, amongst other topics, periglacial and glacial geomorphology, landscape evolution and Tertiary remnants in the Irish landscape, palaeobotany (interglacial, late-glacial and Holocene) and archaeology. Many of the crucial sites in Irish Quaternary geology were first identified and worked on by Frank and he has laid a great challenge to those who follow him to add to his research. Frank's view of the landscape is wonderfully expressed to the reader in *The Way that I Followed.*

The quality of Frank's research was quickly recognised and he was honoured by the Royal Irish Academy, TCD and by the Royal Society of Antiquaries of

Ireland prior to becoming elected as the President of INQUA in 1969 (he gave his Presidential Address in New Zealand) and being elected as a Fellow of the Royal Society in 1973.

Frank remained very active in Quaternary research and maintained an interest in the QRA. He attended the excellent QRA meeting to the Isles of Scilly in 1986 (and went swimming every evening). More recently he directed a number of archaeological surveys and carried out extensive work himself on the archaeology and landscape history of Valencia Island, County Kerry. On field excursions Frank left many behind with his able stride across open country, and on an IQUA field meeting to Valencia in 1983, in driving rain, he drove the group out of the ditch in which they were attempting to shelter '... to visit just one more site, over there, by the cliffs'. No one refused, they just followed.

Frank's work on Valencia was far from over in 1989 when he published a magnificent guide to the landscape and archaeology of the island. In the last seven years he had continued to do fieldwork on Valencia every summer and had begun extensive work in the area around Townley Hall (especially on the Bog of Ardee). Frank's paper on Valencia is currently with reviewers and awaits publication.

The Quaternary community, and indeed all who came to know him, will sadly miss Frank Mitchell. He will leave a void in Irish Quaternary studies that will be impossible to fill. The gap he leaves in many of our lives will be still greater.

Some of Frank's Major Achievements

1933	Scholar of Trinity College Dublin
1934	Gold Medallist, TCD
1934-40	Assistant to the Professor of Geology, TCD
1939	Elected Member of the Royal Irish Academy
1940	Appointed Lecturer in Geology, TCD
1945	Elected Fellow of TCD
1945-1951	Junior Dean, TCD
1952-1966	Registrar, TCD
1958-1961	President, Dublin Zoo
1959-1965	Reader in Irish Archaeology, TCD
1957-1960	President of the Royal Society of Antiquaries of Ireland
1964	Co-Founder of the Quaternary Field Study Group (which became the QRA in 1968)
1965-1979	Personal Chair in Quaternary Studies, TCD
1969-1973	President of INQUA (International Union of Quaternary Research)

1973	Elected Fellow of the Royal Society
1976	*The Irish Landscape*
1976	D.Sc. (*Honoris Causa*), Queen's University, Belfast
1976-1979	President of the Royal Irish Academy
1977	D.Sc. (*Honoris Causa*), National University of Ireland
1977	fil.D. (*Honoris Causa*), University of Uppsala
1978	Boyle Medallist of the Royal Dublin Society
1979	Retired from TCD with title of Emeritus Fellow
1981	Honorary Life Member of the Royal Dublin Society
1983	Honorary Member of the Prehistoric Society
1983	Honorary Member of the Quaternary Research Association
1984	Honorary Fellow of the Royal Society of Edinburgh
1985-1987	Pro-Chancellor, TCD
1986	*The Shell Guide to Reading the Irish Landscape*
1987	Monograph: *The Evolution of Townley Hall: A Personal View*, Bulletin of the Irish Georgian Society No. 30
1987	*Archaeology and Environment in Early Dublin*
1989	Cunningham Medallist of the Royal Irish Academy
1989	*Man and Environment in Valencia Island*
1990	*The Way that I Followed*
1991-1993	President, An Taisce
1993	*The Great Bog of Ardee* (with Breeda Tuite)
1994	*Where has Ireland Come From?*
1995	Honorary Member of the Irish Association for Quaternary Studies
1997	*Reading the Irish Landscape* (with Michael Ryan)

P.C.

ARTICLES

DIFFERENCES IN APPROACHES TO TAXONOMY BETWEEN BRITISH AND AMERICAN NINETEENTH CENTURY QUATERNARY ENTOMOLOGISTS

David M. Wilkinson

Before we can advance a step in our proposed inquiry, we must be able to define precisely the meaning which we attach to the term species. This is even more necessary in geology, than in the ordinary studies of the naturalist.

Charles Lyell (1832)

Introduction

The history of Quaternary entomology has been the subject of only limited research (Morgan and Morgan, 1987; Elias, 1994). The conventional view of the development of the subject during the Nineteenth Century is that 'the early investigators assumed that all fossil specimens, even those from late Quaternary deposits, represented extinct species ... this idea was pervasive not only during the Nineteenth Century, but also well into the Twentieth.' (Elias, 1994). Recently, Wilkinson (1996) has pointed out that some of the earliest records of Quaternary insect fossils, from the first few decades of the Ninteenth Century, identified them as extant species and discussed this in the context of the theoretical ideas developed by Charles Lyell.

This paper describes the identifications of Quaternary insects in nineteenth century Britain and compares them with the attitudes of North American workers of the same time. It shows a difference in the approach to the classification of Quaternary insect remains on the two sides of the Atlantic.

Lumping and splitting in Britain and North America

Taxonomists can approach the classification of organisms with different assumptions. Some use minor differences to define new species, genera etc.; these are often referred to as 'splitters'. Others tend to 'lump' similar individuals together into a single taxon (Mayr, 1982). This paper uses a broad definition of 'lumpers' and 'splitters' which extends these terms to cover a worker's approach to the identification of fossil material and the likelihood of a given worker creating a new taxon for a given fossil.

British lumpers

All the identifications of Quaternary insect remains that I have been able to find for ninteenth century Britain are listed in Table 1. In all cases the specimens were identified as either an extant species or as a member of an extant genus with no specific level identification given. The earliest of these identifications was the Trichoptera larval case described by Mantell (1829). He asigned this to the modern genus *Phryganae*, although based on his description the genus *Limnephilus* seems more likely (Ian Wallace, pers. comm.). The 'Mr Curtis' who identified several of the specimens found in the first half of the Nineteenth Century was probably John Curtis (1791-1862). He was one of the first professional scientists, making his living from collecting, scientific engraving and writing. Later in life he was awarded a civil list pension (effectively a research grant) to support his work on insect pest species (Ordish, 1974).

Table 1.

Quaternary insect remains described in Britain during the Nineteenth Century

Mantell (1829). Trichoptera larval cases identified to a modern genus.
Lyell (1832). Elytra of Coleoptera identified by 'Mr Curtis' as two modern species.
Bolton (1862). Hemitera and Coleoptera identified to modern genera.
Wollaston (1863). Coleoptera remains identified as modern genera.
Geikie (1881). Coleoptera remains identified as modern species *Geotrupes stercorium* by 'Dr Purves'.
Goss (1880). Coleoptera identified as four modern genera by 'Mr Curtis' in 1840.
EARLY 20th CENTURY
Bayford (1903). Coleoptera identified as modern species *Hydrophilus piceus* .

North American splitters

The approach to such fossils in North America at the time was very different, with most species being assigned to extinct species. In the second half of the Nineteenth Century in America the subject was dominated by Samuel H. Scudder (1837-1911). He had wide interests which included a large body of work on Quaternary insects; nearly all of which he classified as new species. His obituarist, in *Science*, noted that he 'had the reputation of being an excessive splitter' (Cockerell, 1911). As Elias (1994) pointed out one gets a good idea of the problems Scudder had working on such material from some of the names he gave them such as *Bembidion fragmentum*, *B. expletum* and *B. damnosum*. Other nineteenth century studies in North America also mainly described fossils as extinct species (Elias, 1994) although in numbers of publications Scudder dominated (Buckland and Coope, 1991).

National styles in classification

The conflict between lumpers and splitters in taxonomy is an old one going back at least to Linnaeus (1707-1778), who tended to lump (Mayr, 1982). It exists in other classifications, such as those of brain activity (Sacks, 1997). Clearly an insect fossil is not just a plain fact supplied by nature; it requires interpretation based on the theoretical ideas and expectations of the entomologist. Harre (1972) made the point eloquently when he wrote: 'At least for science, there are no brute facts. There are no facts ... altogether independent of theory.' As the quotation from Lyell (1832) at the start of this paper makes clear, the nature of species in fossils is even more problematic than that for living organisms.

The North American data show how the same fossils can be interpreted in very different ways; mostly as extinct species in the Nineteenth Century and as extant species today. This situation matches the suggestion that 'as a general rule one can say that most taxonomic groups pass through a phase of rather intensive splitting when they are studied more actively, but the splitting phase is reversed when the knowldge of the group reaches greater maturity' (Mayr, 1982). The intensive work by Scudder and others in North America led to the creation of many (extinct) species.This, however, was not the case with British workers. Even Wollaston, who had suggested limited changes in insect species within fixed bounds prior to the publication of Darwin's evolutionary ideas (Desmond and Moore, 1991; Browne, 1995), saw little evidence of variation in the Quaternary material he examined (Table 1); although he suggested that they may not be current English species. In Britain, fossils were lumped into extant species (which matches current ideas). This provides a good example of different national styles in classification, similar to the differences between French and American approaches to vegetation classification in the early Twentieth Century (Nicolson, 1989).

These observations raise a number of questions which require significant further study. One possibility is that the background discipline of a worker may affect how they approach their fossils. For example, entomologists used to the wide diversity of modern faunas could be more likely to identify a Quaternary species as extant compared with a palaeontologist. This may be less of a problem than it appears. Nineteenth century science showed much less specialization than modern science (Bowler, 1992) with many people working on both fossil and modern material (a trend still shown by many Quaternary palaeoecologists). It would be of great interest to evaluate the differences between Britain and America against the wider history of entomology. Was, for example, North American entomology in general more prone to splitting than nineteenth century Britain? It would also be of interest to expand the analysis to the rest of Europe and Russia, a task requiring considerable linguistic skills.

The reasons for these national differences require further study. However, they do indicate that the suggestion by Wilkinson (1996) that the publication of *The Origin of Species* (Darwin, 1859) could have caused palaeoentomologists to look for changes even in recent fossils, is too simplistic. If this affected the thinking of North American workers why not British ones?

Acknowledgements

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THREE-DIMENSIONAL STRATIGRAPHIC DATA REPRESENTATION USING A PERSONAL COMPUTER

Steve Boreham

Introduction

Computer generated three-dimensional stratigraphic data representation is not new; indeed Everett and Shennan (1987) developed such techniques using the hardware and software available to them more than a decade ago. The danger of attempting to describe any data processing or presentation technique based on a personal computer is that it will inevitably, and probably rapidly, become out-dated. This article is not intended to be an exhaustive account of programs capable of three-dimensional representation of data. However, it is hoped that it will give an insight into a number of techniques, which promise to provide new ways of processing and representing stratigraphic data. The challenge is to convince workers that rather than being merely a curiosity, this is a valuable way of looking at Quaternary geology that can bring Quaternary research into the 21st Century.

The figures in this article use selected borehole data from the vicinity of Magdelene Bridge, Cambridge, which are from a database that the author has been compiling as part of an Open University Ph.D. project. Some of these data previously published as a section by Sparks and West (1965). Throughout this article [Mac] indicates compatibility with Macintosh and Macintosh clones, while [PC] is used to indicate compatibility with 'Wintel' (Windows/Intel) personal computers.

Data preparation and problems

The starting point for any stratigraphic analysis must be reliable data from boreholes, trial pits or sections, preferably levelled to metres OD. There is often great variation in the way lithological descriptions are recorded, so that care is needed during interpretation. In the first instance, the lithological descriptions contained within the data should be divided into relatively broad and easily defined categories (for example, 'gravel and sand', 'silty clay', 'peat'). A systematic method of sediment description, such as that of Troels-Smith (1955), can be very useful in this respect. Detailed lithological descriptions can be added easily in the form of appended comments during data entry.

Unlike the manual interpretation of borehole records, a personal computer accepts the data that it is given without question; the old maxim 'garbage in - garbage out' applies absolutely. Descriptive detail can be essential to the

(a)

```
: Created from setup file: Cambridge Project Setup
SETUP: 6 -3 4457 5887 0
LITH: Lithology
6 4.5 Made ground^
4.5 3 Silty clay^
3 1.5 Clay with peat^
1.5 1 Peat^
1 -2.5 Gravel and sand^
-2.5 -3 Gault Clay
firm, grey^
END-DATA:
END-LOG:
```

(b)

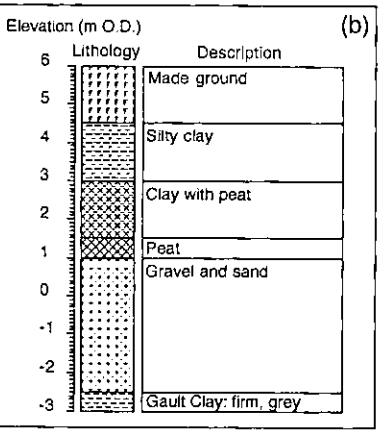

Figure 1a. An individual plain text (ASCII) record file containing stratigraphic and location data.
Figure 1b. A graphic log created from the record file shown in Figure 1a.

correct interpretation of sediments. However, too much detail may give rise to confusing results and difficulty with correlations. In addition, significant facies change within stratigraphic units may present particular problems. For example, a 'silty clay' which laterally becomes a 'sandy silt' will be recognised by most software as two entirely different units even though they are stratigraphically equivalent. Where the same lithology is repeated in a sequence, it may be necessary to use prefixes such as 'upper' and 'lower', or number the units sequentially.

Logs and sections

Data can be entered into individual plain text (ASCII) record files using any word processor or text editor (Figure 1a). Program suites such as Rockware's MacGeoPak-[Mac] or RockWare Utilities-[PC] may then be used to create graphic logs (Figure 1b), two-dimensional sections (Figure 2a) and quasi-three-dimensional 'fence' diagrams (Figure 2b). These programs are easy to learn and use, and link together very well. They can also export plain text (ASCII) xyz data (Figure 3a) for use by other programs, and produce plots showing the distribution of sample points (Figure 3b). Alternatively, there are a number of shareware and freeware stratigraphic section plotting programs

such as MacStrat-[Mac]. Plots can be scaled so that both small and large areas can be equally well represented. The symbols and colours used to represent stratigraphic units in these plots are user definable. Alternatively, stratigraphic data can be typed directly into a spreadsheet program such as Microsoft Excel-[Mac/PC].

Contour maps

The next stage might be to use a contour generating program (MacGeoPak-[Mac]/RockWare Utilities-[PC]) to create a gridded data file by interpolating the randomly located xy co-ordinates of the sample points into a regularly arranged

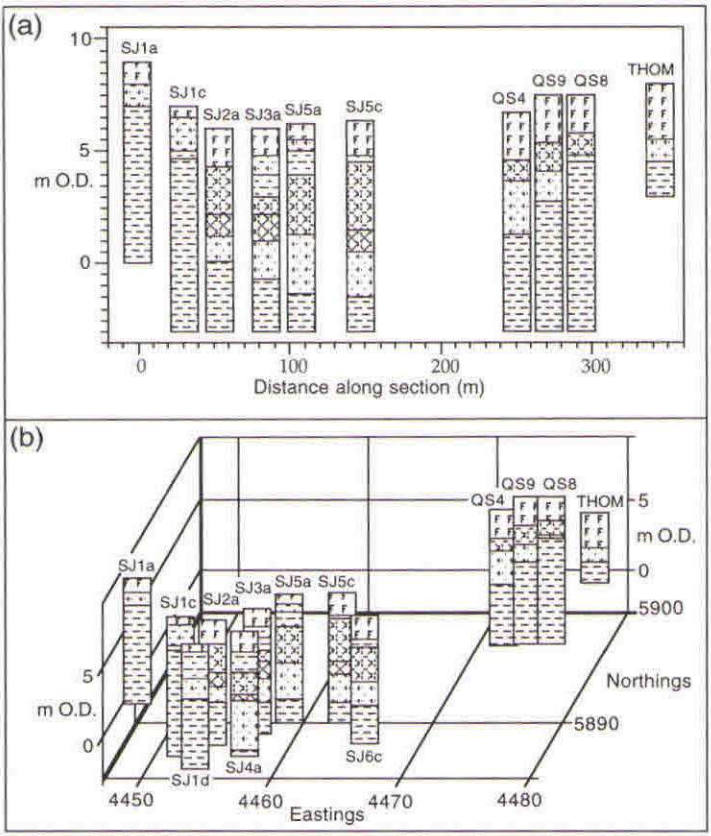

Figure 2a. A two-dimensional cross-section created from ten record files.
Figure 2b. A quasi-three-dimensional 'fence' diagram created from thirteen record files.

grid of z values. From the gridded data it is possible to draw a conventional two-dimensional contour plot of bedrock surface altitude (Figure 4a) which can be shaded or colour coded to enhance the z data (Figure 4b). A raised contour plot, also shaded or colour coded and viewed for different angles and azimuths, creates a three-dimensional image (Figure 5a). To map thickness of a stratigraphic unit, the gridded data for its upper and lower bounding surfaces must be calculated and subtracted to produce isopachs that can also be plotted in the ways described above (Figure 5b). Some programs (RockWare's Rockworks-[PC]) are able to produce stratigraphic block models by taking xyz co-ordinates and assigning a 'G' value for lithological type (for example, 1=bedrock, 2=basal gravel).

(a) : XYZ output file generated for GAULT CLAY surface

```
4449 5888 7.0 SJ1a
4452 5887 4.7 SJ1c
4453 5886 2.0 SJ1d
4454 5888 0.1 SJ2a
4457 5889 -0.7 SJ3a
4457 5887 -2.5 SJ4a
4459 5890 -1.3 SJ5a
4463 5890 -1.5 SJ5c
4465 5888 -0.2 SJ6c
4472 5897 1.3 QS4
4475 5897 4.5 QS8
4473 5897 2.8 QS9
4480 5895 4.5 THOM
```

(b)

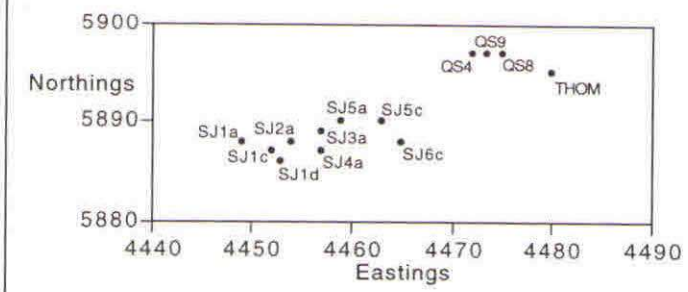

Figure 3a. A plain text (ASCII) xyz data file produced from the thirteen record files shown in Figure 2b, showing spatial coordinates, the altitude (metres OD) of the Gault Clay surface, and site labels.

Figure 3b. A plot produced from the xyz data file shown in Figure 3a, indicating the spatial distribution of sample points.

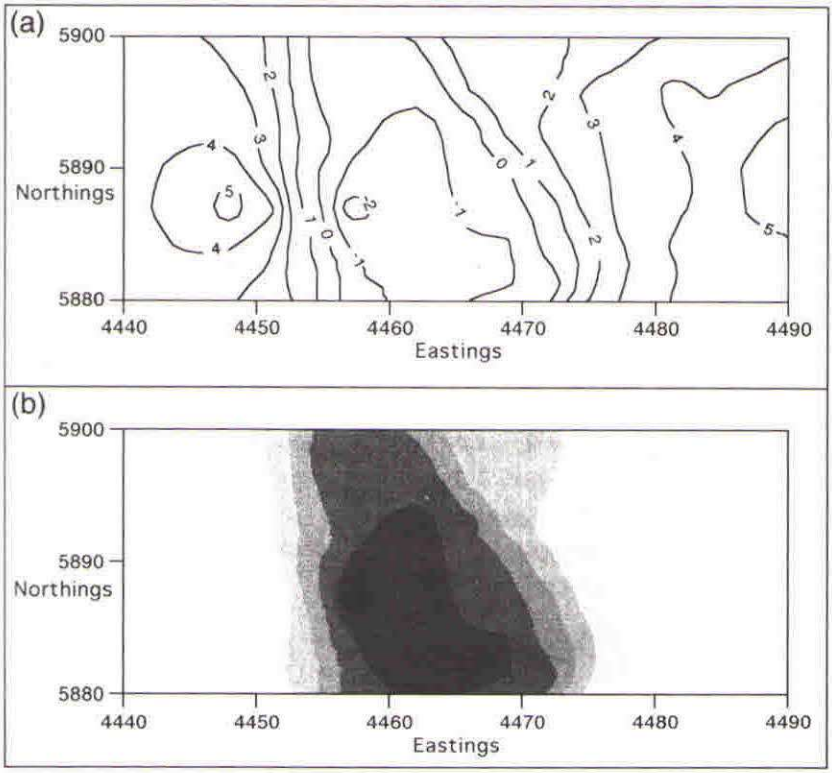

Figure 4a. A two-dimensional contour plot of the altitude (metres OD) of the Gault Clay surface.

Figure 4b. A two-dimensional contour plot of the altitude (metres OD) of the Gault Clay surface, using shading to enhance the z data.

Surfaces, models and movies

Most contour generating programs can also create data files which describe three-dimensional surfaces in formats (such as DEM, DXF, 3DMF, Swivel 3D, 3DGF or 3D Script) that can be read by three-dimensional modelling software. Examples of such programs include MetaCreations' Infini-D-[Mac/PC], MacroMedia's Extreme 3D-[Mac/PC] and Maxon's Cinema 4D-[Mac/PC]. However, a cheaper option for simple three-dimensional modelling would be to use 'plug-ins', which add functionality to ubiquitous two-dimensional drawing packages. An example is the Vertigo 3D Dizzy plug-in for Adobe Photoshop-[Mac/PC].

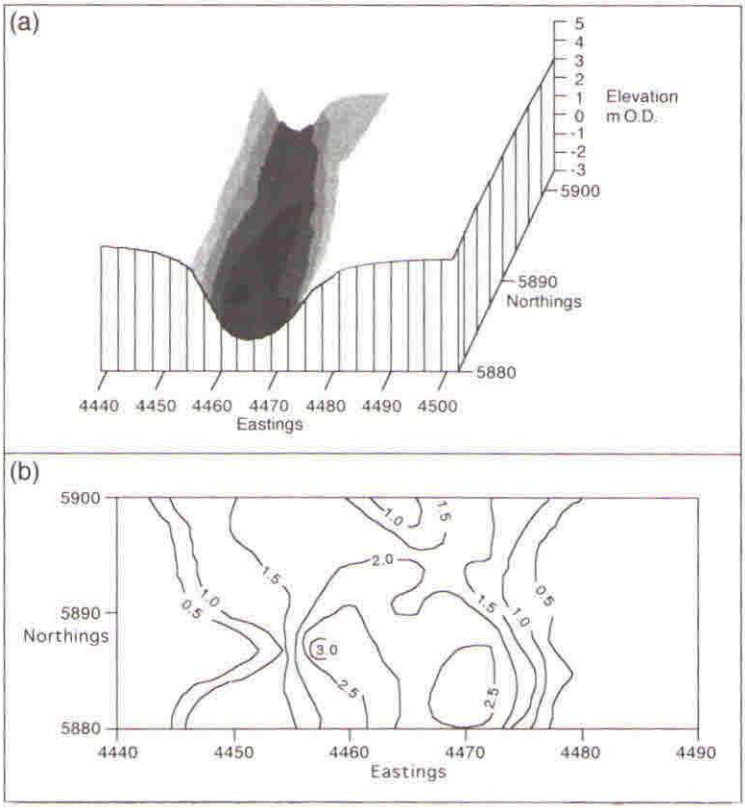

Figure 5a. A raised contour plot showing the altitude (metres OD) of the Gault Clay surface, using shading to enhance the z data.

Figure 5b. A two-dimensional contour plot of isopachs, showing thickness (metres) of the basal gravel and sand unit.

The first stage in three-dimensional modelling is to import the data describing a surface to create a wireframe model (Figure 6a) which can be scaled, rotated and positioned to provide the view required. The wireframe model can then be rendered with a 'skin' whose colour, pattern and texture can be modified by the user (Figure 6b). It is even possible to drape a geological or other map over the wireframe model by scanning the document, importing the image and using it for the rendering stage. Additional surfaces can be superimposed to show the relationship of various stratigraphic units (Figure 6c).

An extremely useful feature of these programs is the ability to animate three-dimensional models to create movie files which use Apple's Quicktime-[Mac/

PC] technology. Such movies can show rotation of the model viewed from a fixed point, stage by stage construction of the model, animated fly-throughs, or a combination of these. Movies can be edited, and dubbed with sound and narration in programs such as Macromedia's Director-[Mac/PC] or Adobe Premiere-[Mac/PC], and saved as Quicktime movie files or as other formats. Such movie files can even be recorded directly onto videotape using video presentation hardware.

Photorealistic landscapes

A further refinement to the three-dimensional modelling process is the production of photorealistic landscape images using programs such as MetaCreations' Bryce 2-[Mac/PC], or RomTech's Vistapro-[Mac/PC]. Surface data are imported to create wireframe models which can be rendered with realistic rock and

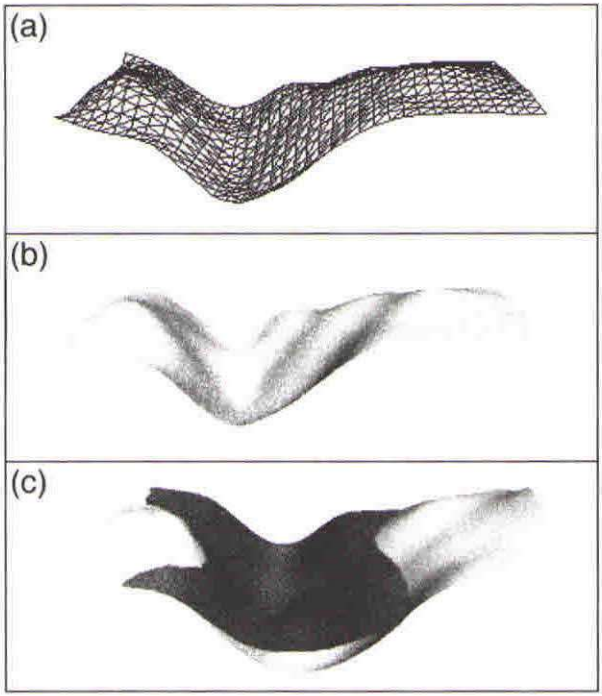

Figure 6a. A wireframe model of the Gault Clay surface.
Figure 6b. A model of the Gault Clay surface rendered with a grey 'skin'.
Figure 6c. A rendered model of the Gault Clay surface, with the surface of the basal gravel and sand unit superimposed to show the spatial relationship of the deposit.

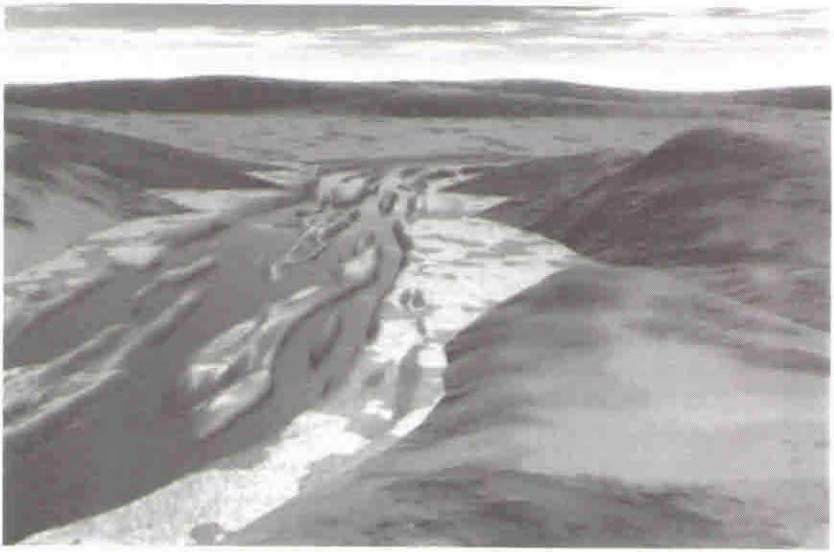

Figure 7. A photorealistic image showing a braided River Cam as it might have appeared in the Late Devensian during the deposition of the basal gravel and sand unit.

vegetation patterns and textures. In addition, water bodies, skies, trees and other features can be added to make a convincing photographic image (Figure 7). It is even possible to convert these images for viewing using Apple's Quicktime VR-[Mac/PC], a program which allows the user to pan, zoom and even move through a virtual landscape. This capability is incorporated in Metacreations' Bryce 3D-[Mac/PC].

Conclusions

Many Quaternary scientists might benefit from the computer-based data handling, logging and section production described in the first part of this article. In addition, the creation of contour plots is undoubtedly a useful adjunct. These programs are easy to learn and use, and their relatively modest price should commend them to anyone who routinely deals with stratigraphic data.

The three-dimensional modelling of stratigraphy using rendered surfaces, and the production of animated movies has only recently become a commonplace capacity of personal computers; part of the currently expanding and improving field of three-dimensional computer graphics and multimedia. It is this area that offers great possibilities for the interpretation of large amounts of

stratigraphic data, for example within the complex architecture of fluvial terraces. Likewise, there are exciting possibilities for using geological data to recreate landscapes as they might have appeared at various times in the Quaternary, especially for those involved with museums and education. The cost of three-dimensional modelling software varies enormously, as does its ease of use. It is therefore important to establish which package can cost-effectively achieve your goals before you go ahead and purchase.

Table 1.

Web pages of the software cited

Adobe Photoshop	http://www.adobe.com/prodindex/photoshop/
Adobe Premiere	http://www.adobe.com/prodindex/premiere/
Macromedia Extreme 3D	http://www.macromedia.com/software/extreme3d/
Macromedia's Director	http://www.macromedia.com/software/director/
MacStrat	http://www.wsu.edu:8080/~geology/pages/S_earth.htm#part2.2
Maxon Cinema 4D	http://www.maxon-computer.com/cinema4d/
MetaCreations' Bryce 2	http://www.metacreations.com/products/bryce/
MetaCreations' Bryce 3D	http://www.metacreations.com/products/bryce3d/
MetaCreations' Infini-D 4	http://www.metacreations.com/products/infini-d/
Apple's Quicktime	http://quicktime.apple.com/
Apple's Quicktime VR	http://quicktimevr.apple.com/
RockWare's Rockworks	http://www.rockware.com/
RockWare's MacGeoPak	http://www.rockware.com/
Vertigo 3D's Dizzy	http://www.vertigo3d.com/Products/dizzy.asp
Microsoft Excel	http://www.microsoft.com/excel/
RomTech's Vistapro	http://www.romt.com/products/vista4/

Acknowledgements

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REPORTS

THE LATE QUATERNARY IN THE EASTERN MEDITERRANEAN
MTA GENERAL DIRECTORATE, ANKARA, TURKEY

1st – 4th April, 1997

Arranged under the auspices of INQUA and held at the Turkish Geological Survey (MTA) in Ankara, this four-day symposium aimed to discuss the causes, geographical links and consequences for human populations of palaeoenvironmental change in the eastern Mediterranean region since the Last Glacial Maximum. Attended by 100 or so delegates from as far afield as the USA, Moldova and Japan, the symposium also lured several Quaternary workers from Britain, including **Henry Lamb** (Aberystwyth), **Keith Bennett** and **Kathy Willis** (Cambridge), **Neil Roberts** and **Jane Reed** (Loughborough), **Jamie Woodward** (Leeds) and **Suzanne Leroy** (Belfast). The proceedings were well organised by **Neil Roberts** (Loughborough), **Catherine Kuzucuoglu** (CNRS, Meudon) and **Mustafa Karabıyıkoglu** (MTA, Ankara).

Day 1

This began with an opening address by **Neil Roberts**, whose impassioned plea for strict time-keeping and slow delivery by native English speakers over-ran by 15 minutes, despite the breakneck speed at which he spoke! Palaeoceanography was the order of the day, with a keynote address by **Michel Fontugne** (CNRS, Gif-sur-Yvette) on sedimentary marine records spanning the last 20,000 years in the eastern Mediterranean. This was followed by a series of lively talks from such notables as **Bill Ryan** (Colombia), who discussed evidence for a possible abrupt submergence of the Black Sea shelf during the Holocene and **Martine Rossignol-Strick** (Paris), who talked about a massive odd monsoon event at 528 ka (not *quite* within the LGM – present timescale covered by the conference, but fascinating nonetheless!). **Glenn Goodfriend** (Washington) kicked off the final session of the day with a comprehensive keynote paper on isotopic studies of late Quaternary climate change derived from eastern Mediterranean continental records. This was closely followed by **Melanie Leng** (NERC Isotope Geosciences Lab, Keyworth) and **Henry Lamb** (Aberystwyth), whose presentation on stable isotope variations within individual snail shells and their connection to climatic variability led us effortlessly into the first of several quality poster sessions.

Day 2

Michael Stürm (Dübendorf, Switzerland) opened the palaeolimnology session with his keynote paper on lacustrine sedimentary archives as records of environmental changes. This session continued with a variety of talks presenting palaeoclimatic data from Lake Van (Turkey), Lake Pamvotis (Greece) and the Dead Sea. **Catherine Kuzucuoglu** (CNRS, Meudon) then discussed Pleistocene records of environmental change in the Konya Basin (Turkey) and **Neil Roberts** (Loughborough) presented the rationale and some preliminary results of the Konya Basin palaeoenvironmental research programme.

The first of several high quality geomorphological papers was given by **Ilhan Kayan** (Izmir) who introduced the Holocene evolution of the Anatolian Aegean coastal plains before handing over to **Jamie Woodward** (Leeds), who presented a series of carefully detailed Pleistocene rock shelter records from north-western Greece. Rock glaciers (Attila Çiner, Ankara) and palaeoseismology (Ismail Kuşçu, Ankara) ended the working day, leaving the evening free for a reception at the British Institute of Archaeology at Ankara, organised by **Roger** and **Wendy Matthews**. The evening's entertainment continued well into the night, as Ankara erupted into a riot of flag-waving and horn-blowing following the defeat of Holland by the national football team, all of which made marvellous spectator sport for the British contingent.

Day 3

The penultimate day began with **Fekri Hassan** (UCL), who brought the African side of the Mediterranean into perspective with his presentation of geomorphic dynamics of the Egyptian Sahara, before **Helmut Brückner** (Marburg) detailed his interpretation of rapid coastal regressions in western Turkey. Vegetation history filled the remainder of the day, with carefully considered presentations from **Donatella Magri** (Rome) talking on west to east Mediterranean comparisons in vegetation change and **Kathy Willis** (Cambridge) demonstrating the influence of late-glacial vegetation upon early Holocene soil development.

Day 4

The vegetation session continued into the final day with a mixture of papers presenting results from pollen, plant macrofossil and charcoal analyses from sites across the entire region, in particular Albania, Croatia, Syria and Jordan. The final session, on human prehistory and environmental change, began with a keynote presentation by **Ofer Bar-Yosef** (Harvard) and continued with several talks concentrating largely on archaeological research from a variety of Anatolian sites. The symposium was splendidly concluded with a larger-than-life presentation from **Celal Sengor** (Istanbul), who flamboyantly attempted to

link the geological and biological environment of the prehistoric peoples of the region with their art and culture. All that remained was the conference meal, a splendid blow-out at a traditional Turkish restaurant set in the Hisar (citadel) with stunning views over the city.

Field excursions

The following day, around 25 delegates set off on what was to prove a fascinating and equally successful 4-day field excursion to the Konya Plain and Cappadocia. Despite mixed weather (ranging from heavy snowfalls to bright sunshine), the conference organisers did splendidly, espousing the attractions of (amongst others) the remarkable Neolithic sites of Çatalhöyück and Asıklı Höyück, as well as the palaeoshoreline of Lake Konya and the fabulously surreal badlands landscape of the Cappadocian Volcanic Province. One of the highlights of the trip (and there were many) was surely the visit to the underground city of Derinkuyu, a Hittite settlement carved from the volcanic tuff of the plain somewhere between 1,900-1,200BC and apparently capable of housing a population of 15-20,000 people.

The final day of the excursion began with a visit (in brilliant sunshine) to Göreme, a monastic settlement dating from the 4th Century, bored into the ignimbrite to create dining halls, living quarters and a series of over 30 carved Christian churches complete with frescoes. Unfortunately, by the time of the final field stop at the maars crater lake of Eski Acıgöl (to examine a core of laminated lake sediments that Neil Roberts and crew had recovered that morning), the snow was settling thickly and temperatures were falling rapidly. Conditions worsened on the return to Ankara, until driving blizzards and treacherous roads forced all traffic to a standstill as the light faded. There was nothing for it but for the delegates to settle down on the bus for the night, although it must be said that morale remained high throughout (surely nothing to do with several bottles of Cappadocian wine that suddenly appeared!). The first snowploughs came through at about 6am the next morning, although painfully slow progress thereafter meant that Ankara wasn't reached until around lunchtime, a mere 18 hours late!

Sincere thanks must go to the organisers for running such a successful, comprehensive and (for at least 25 delegates!) highly memorable symposium. A selection of the papers presented will appear in a forthcoming special issue of Quaternary Science Reviews.

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IGCP 367 "LATE QUATERNARY COASTAL RECORDS OF RAPID CHANGE" UK WORKING GROUP ANNUAL MEETING AND FIELD EXCURSION, NORTH NORFOLK

9th-12th September, 1997

Approximately thirty members of the working group arrived at the Norwich Sport Village Hotel to attend the annual meeting. Two full days were spent in the field examining the Holocene development of the North Norfolk coast, and the nature of coastal management problems and strategies. Six research papers were presented over two evening sessions in the hotel.

Wednesday 10th September

Day 1 concentrated on a number of sites in the Blakeney - Cley, Stiffkey Marsh and Brancaster Marsh areas. The Holocene evolution of Cley Marshes Nature Reserve was discussed within the contexts of the present coastal zone (**Ian Boomer**) and the inshore sea bed zone (**Robin Wingfield**). This discussion included the development of the present barrier and back-barrier areas, and the significance of the shallow bathymetry offshore for the prior existence of a land-bridge between north Norfolk and the Netherlands. Discussion also focused on the influence of the pre-Holocene relief on coastal development, and on the age-old problem of the interpretative issues surrounding organic - inorganic overlaps within a Holocene coastal sequence.

Switching timescales to the historical period, cartographic evidence for coastal changes since 1586 was presented (**Ian Boomer**). The impacts of very recent storm surges and inundation of the marshes (in 1996) were examined in the context of coastal management issues (**Steve Crooks**). This area serves as a good illustration of the issues surrounding the effectiveness of, and local response to E.C. wetland habitat directives. The management of Cley Marshes was presented as an example of successful 'consensus building' between authorities and the local population.

At Stiffkey Marsh, processes and rates of marsh accretion and erosion were considered, which were based on radionuclide profiles and *in situ* measurements of sedimentation rates. Data were also presented on Palaeomagnetic Secular Variation from a borehole, which were compared with radiocarbon and OSL dates (**Ian Boomer, Julian Andrews and Greg Samways**). At the final site for the day, Brancaster Marsh, there was a discussion on the latest views on the evolution of this section of the coast, based on recent LOIS-LOEPS work. This included the Holocene evolution of the marsh/back-barrier area (**Ian Boomer**),

a chronology (based on IRSL) for the inception and erosion of the coastal dunes (**Julian Orford**) and contemporary management issues (**Steve Crooks**). It was advocated that the dune building period of the 15th-16th centuries may be related to a rise in relative sea level during that part of the Little Ice Age. Contemporary management issues were brought to light by having the group photographed by the local media next to a 'sensitive' (in more ways than one!) section of dunes that were being eroded. The resultant newspaper report next day described the field meeting as representing a gathering of experts from around the world to help solve the problem of coastal erosion. Having done that we returned to the hotel.

Thursday 11th September

At the first site (Sea Palling), Holocene coastal evolution, the coastal sediment transport régime and the effectiveness of recent coastal defences, in the form of artificial reefs, were examined. Biostratigraphic data were presented (**Jim Innes, Jerry Lloyd, Jenny McArthur and Ian Shennan**) from which relative sea-level change tendencies have been constructed for this area. One objective of this work has been to compare the pattern of sea-level movement with that predicted by glacio-hydro-isostatic rebound models with the intention to refine the models and to calculate rates of crustal movement in this region. The interplay between coastal sediment transport and coastal engineering was illustrated well by the effects that the artificial reefs have had on beach profiles and sediment volumes (**Frank Thomalla**). The original four reefs have had an adverse effect on beach sediment transport, which forced a change to the design of the most recent four reefs. The exposure of the site, and the tidal range, have posed particular problems to this scheme. The need for regular monitoring and for a detailed understanding of coastal processes was stressed.

The final sites in the Yare Valley and Mautby Marsh were presented by **Mike Godwin**, and focused on a detailed reconstruction of the Holocene development of the area, and a brief discussion on the modern environments and the proposed flood alleviation strategy. The Mautby Marsh site was used as a case study of the impact of Holocene relative sea-level change. The stratigraphic sequence at Mautby includes evidence for a rapid sea-level rise creating open estuarine conditions. Subsequent switching between lagoonal and open estuarine conditions culminated in the establishment of a freshwater marsh by Anglo-Saxon times.

Paper Sessions

Six papers were presented which were aimed at relative sea-level and/or coastal change reconstructions. A number of these papers focused on techniques employed to undertake such reconstructions. In the order that they were

presented, *'Differential crustal rebound along the east coast of the UK - comparison of new and existing field data with geophysical model predictions'* (by **Jim Innes, Ian Shennan, Jenny McArthur and Jeremy Lloyd**) stressed the need for reliable sea-level index points so that models of crustal movement could be tested and revised. This was illustrated with examples from Northumberland. *'The use of foraminifera, testate amoebae and diatoms as a multi-proxy tool for sea-level reconstruction'* (by **Helen Roe, Roland Gehrels and Dan Charman**) introduced a new technique (testate amoebae analysis) aimed at acquiring reliable indicative meanings from salt marsh stratigraphies using biostratigraphic techniques. Data from contemporary marsh surface sediments were presented to illustrate this. **Siegbert Otto** and **Charlie Bristow** presented *'Coastal morphodynamics along the north Norfolk coast: insights gained from wave refraction modelling'*, which indicated that zones of accretion and erosion along the north Norfolk coast could be explained by wave refraction modelling. **Anne De La Vega** discussed the reconstruction of Holocene back-barrier environments on Orkney using pollen and diatom data, and the need to establish links between barrier development and back-barrier deposition in a paper entitled *'Holocene coastal environmental changes in the Bay of Carness, mainland Orkney, with particular emphasis on back-barrier sediments'*. **Zongqiang Zong** presented information on diatom zonation which was diagnostic of certain tide levels, especially MHWST, and which could, therefore, aid the reconstruction of past tide levels. His paper was entitled *'Diatom-based tidal-level transfer functions as an aid in reconstructing Quaternary history of sea-level movement in Britain'*. Finally, **Antony Long, D.H. Roberts** and **M. Wright**, in their presentation *'Rapid relative sea-level change in West Greenland: initial results'* presented new data from a series of isolation basins which date from around 14,000 BP. Data from the last 4,000 years include evidence for a rapid and substantial relative sea-level rise.

It should be evident from the summary above that this was a very full and interesting meeting, and the organisers, especially Greg Samways, Ian Boomer and Julian Andrews, should be congratulated for organising such a successful programme.

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THE BILL BISHOP MEMORIAL SYMPOSIUM "RECOGNISING RESPONSES TO ENVIRONMENTAL CHANGE" BURLINGTON HOUSE, LONDON

11th November, 1997

Professor Michael Day (NHM; Chairman of the Bill Bishop Memorial Trust) opened the meeting with some well-chosen remarks concerning **Bill Bishop**, whose early death in 1977 had cut short a very influential international career in the Earth Sciences based in Britain (universities of Birmingham, Glasgow and London - Bedford and Queen Mary Colleges), Africa (National Museums of Uganda and Kenya) and the USA (the Peabody Chair at Yale). Appropriately, following Bill's own interests, the programme ranged from the Quaternary of Britain to Late Cenozoic hominids and their context in Africa.

The five short papers in the first session chaired by **Dr Peter Banham** comprised a late Quaternary time-slice from northern Europe to southern Africa. **David Anderson** (Oxford) began by applying a range of techniques to demonstrate the versatility of the peatlands of north-west Scotland as palaeoclimate archives. Rapid transitions from warmer and/or drier to cooler and/or wetter conditions had been found at *c.* 7.4, 5.8, 3.6 and 1.0 ka ^{14}C BP, and implications were drawn out for woodlands and human settlement, in particular. At least some degree of correlation was suggested by the results of **James Wells** *et al.* (Coventry) from one of Bill Bishop's localities, Brighouse Bay, south-west Scotland. Here, a lower peat is capped by a shingle barrier and marine to freshwater marls with an associated '*Alnus*' rise dated to between 7.6 and 7.1 ka, interpreted as the Main Postglacial Transgression. An upper peat then formed until a pronounced deforestation episode which lasted between *c.* 5.0 and 2.4 ka; the dunes of the area had developed since that time. **Ken Rijsdijk** (Swansea) then took a fresh look at the late Quaternary, Devensian glacial deposits of south-west Wales. A wide variety of structural and sedimentological evidence, including listric thrusts, rapid horizontal and vertical facies changes, loadcasting and syn- and post-depositional tilting of strata, were quite convincingly, if somewhat controversially, interpreted as consistent with the decay of a stagnant terrestrial ice sheet. According to **Mark Trout** (Leeds), at about the same time, namely the Last Glacial Maximum, a severe glacio-eustatic fall in sea level caused the Alkyonides Gulf on the Gulf of Corinth to become virtually a freshwater lake. Evidence for this dramatic conclusion came principally from the dinoflagellates found in a deep core of the seafloor sediments. The final paper in this session took us south to the Mega

Kalahari desert, and also farther back in time. **Stephen Stokes** *et al.* (Oxford) interpret optical dating (OSL) of sands in presently inactive dunes to indicate four major periods of widespread dune formation at 115-95, 46-40, 26-20 and 16-10 ka, with a further possible period during the Holocene. New, realistically based atmospheric modelling studies suggested a strong correlation with variations in sea surface temperature in the adjacent Atlantic, with high latitude forcing as an important influence.

The next session of four papers was chaired by **Professor Bob Savage** (Bristol) and concerned the British Pleistocene as a whole, particularly the area of Bill Bishop's first, Birmingham-based, stamping ground, the English Midlands. Fully in the spirit of Bill himself, **Jane Hart** (Southampton) kicked-off by chiding many of us for overlooking crucial evidence within glacial sequences, when a knowledge of glacial processes from glaciological studies could lead to better interpretations. Aspects of the 'theory of the deforming bed' were then well illustrated from a range of Anglian and Devensian sites across the British Isles, including the Midlands, with implications particularly for glaciotectonic deformation, till formation and the dynamics, landscapes and sequences of glaciation. The Midlands theme swelled when **David Keen** (Coventry) reviewed the evidence and arguments surrounding the 'Wolstonian' concept. Recent geochronometric and biostratigraphic evidence from the interglacial sediments at Waverley Wood and Frog Hall was cited to suggest a late 'Cromerian' age for the events immediately pre-dating the main glaciation, and an age no younger than Oxygen Isotope Stage 9 for the temperate sediments resting upon the tills. Discussion revealed that not all were prepared to go so far, or at least not precisely in that direction. Likewise, **Darrel Maddy's** (Cheltenham) conclusion that there had been no link between the Severn and Thames basins during the early Middle Pleistocene also raised more than eyebrows. After reviewing the history of the development of ideas, Darrell had presented clear and apparently firm evidence from the deposits of the West Midlands Baginton River to show that all clast lithologies could be accounted for locally, and had not come from source rocks west of the Birmingham area. With the Midlands still as a background, **Jim Rose's** (RHUL) paper appropriately concluded this session with an analysis of fluvial régimes in the glacial context. Students at all stages will surely welcome his threefold subdivision of river systems: 1. large, integrated systems developed before a region is glacierised, providing crude but robust stratigraphical evidence; 2. relatively small, poorly integrated systems developed upon glacierised landscapes, providing highly sensitive stratigraphical evidence; 3. moderate-sized systems developed without the influence of glaciation within the catchment, highly sensitive to climate change and providing detailed stratigraphic evidence for the later Middle and Late Pleistocene in particular.

The morning programme concluded with the launch by the **Joint Nature Conservation Committee** (JNNC) of their **Geological Conservation Review** (GCR) Volume 13, '*Fluvial Geomorphology of Great Britain*'. After JNCC's **Neil Ellis** had given us the necessary background, **Jim Rose** was on his feet again to welcome this major work concerned with the best of the fluvial sites across the country. To mark the occasion, and to warm applause, he presented its editor, **Ken Gregory**, with the first volume, hot from the presses of Chapman & Hall. In reply, Professor Gregory thanked his fellow authors, and expressed their joint relief that they had finished a project which had been very worthwhile, but which had been with them for the best part of ten years in all. With that, all rapidly dispersed downstream to lunch.

The first session of the afternoon was chaired by **Professor Peter Andrews**, and began with a paper on the early Miocene sites in Uganda discovered and excavated during 1958-65 by Bill Bishop. More recently, excavations under the supervision of **David Pilbeam** (Harvard) were restarted, and **Laura McLatchy** (NY Stony Brook) presented their joint paper. She described the fossil sites of Moroto and Napak, both now dated to between 19 and 21 million years ago, and she presented the new discoveries from Moroto that dramatically change our conception of hominoid evolution. A partial femur of the newly named *Morotopithecus bishopi* from the original hominoid locality and a partial scapula from Moroto I, combined with the previously described vertebra show this fossil genus to be more similar to living apes than were any of the other known fossil apes up to about 12 million years ago.

The rest of the afternoon was devoted to the Baringo Basin in Kenya's rift valley, an area that is particularly associated with Bill Bishop. With **Professor King** of Bedford College, Bill set up a long-term research and training programme in the Baringo area, where a series of students cut their teeth on the complexities of rift valley geology and palaeontology. **Robin Renaut** (Saskatchewan) presented the first paper on the geology of the Tugen Hills and the Kerio Valley, presenting new data on X-ray diffraction and electron microscopy of minerals that showed that the palaeolakes were deposited under strongly saline conditions. The lakes occupied tectonic depressions that were hydrologically closed, and the rift basins in which they were formed were strongly influenced by NW-SE trending transverse zones much as are the present-day lakes Baringo and Bogoria. The stratigraphical sequence in the Baringo Basin/Tugen Hills sediments was reviewed by **Andrew Hill** (Yale), who showed that by following the faunal changes through time a picture could be built up on the changes in environment and of the faunas that make it possible to understand the development of the Ethiopian faunas seen today. In particular he described the primate faunas present through the succession, culminating in the presence of *Homo* in the later Kapthurin Formation.

The final session in the afternoon was chaired by **Professor Michael Day**, and it continued the Baringo theme. **John Kingston** (Yale) described the isotope analyses that he has done both on palaeosol carbonates and on the enamel of the teeth of herbivores through the sequence. The carbon isotope signal from the soils picks up the type of vegetation growing on the spot, and the signal from the teeth reflects the type of food eaten by the animals concerned. He was able to show that 15.5 million years ago, woodland conditions prevailed in the area, and although C4 grasses became more common later in the sequence, at no stage did they become so dominant as to indicate the presence of open grassland conditions. **John Gowlett** (Liverpool) then described some of the archaeological evidence associated with hominid fossils, concentrating on the Kilombe Acheulian complex from about one million years ago. He discussed the function of the Acheulian hand axe and its meaning for human evolution, and finished up with a detailed account of the Kapthurin Formation, the youngest geological formation that has been the focus of his recent research. One of the earliest hominid fossils was found in this formation, the so called Kapthurin mandible, which is a well preserved mandible of *Homo erectus* which was described in the final paper of the afternoon by **Bernard Wood** (George Washington). He gave a witty account of the trials and tribulations of working in East Africa. The hominid record in the Baringo Basin is all too scanty, despite the extensive field work that was started by Bill Bishop, and is continuing to this day by Andrew Hill, but the richness of the deposits, their time span covering the last 15 million years, and the capacity for accurate dating make this a most rewarding area to work in and one that sooner or later will produce the evidence on human origins.

Posters

The meeting attracted an excellent array of posters, including: Suids in the Tugen Hills succession, Kenya, by **Laura Bishop**, **Andrew Hill** and **John Kingston** (Yale); Late Pleistocene birds of Gibraltar, by **Joanne Cooper** (RHUL); Setting their sights/sites on Uganda: W.W. Bishop and E.J. Wayland, by **Julie Cormack** (Liverpool); Time and energy: the ecological context for the evolution of bipedalism, by **Sarah Elton** and **Robert Foley** (Cambridge); Using GIS to simulate African palaeoenvironments, by **Piers Gollop** (Cambridge); Use of fire, Beeches Pit and Chesowanja, by **John Gowlett** (Liverpool); Quaternary sedimentary structures, by **Joe McCall** (ex-Kenya Geological Survey); Late Pleistocene glacio-eustatic changes, Gulf of Corinth, by **Mark Trout** (Leeds); Holocene peats etc., Brighouse Bay, by **James Wells** (Coventry).

Publication

These and selected other relevant papers will be collected as the **Bill Bishop Commemorative Volume**, to be published in 1999 by the Geological Society Publishing House in the format of a Special Publication.

Acknowledgements

The organisers and trustees of the Bill Bishop Memorial Trust wish to thank all those who contributed in any way to the success of the meeting, especially **Sheila Bishop** who initiated the project and who as Secretary was involved in all stages of preparation. In addition we wish to express our gratitude for the full support provided by the officers of the Geological Society and the Quaternary Research Association.

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SECOND ANNUAL QUATERNARY RESEARCH ASSOCIATION POSTGRADUATE SYMPOSIUM: GREGYNOG, UNIVERSITY OF WALES

12th-14th November, 1997

Some 40 postgraduates met to share their progress and problems in Quaternary research, and to relax in peaceful and extremely well appointed surroundings. For some this was a renewal of old friendships, and for others their first meeting with Quaternary researchers. For all, the meeting was a great experience, and the hosts from Swansea, **Mat Wooller**, **David Swain**, **Kenneth Rijsdijk** and **Tim Bower** should be congratulated for a job well done.

For a short time, post-registration, people explored the magnificent grounds and house (not to mention the Nineteenth Century WC!) in awe at their sheer splendour. Tea and cakes in a beautiful Seventeenth Century, carved oak-panelled room set the scene for the excellent (and frequent!) repasts to follow. These started with a wine reception and dinner following an evening lecture by **Professor Andrew Goudie**. His theme was the significance of hot, sandy places in the reconstruction of palaeoclimates, a tempting alternative for all those currently researching in cold, wet locations! This thought-provoking talk generated much debate, including the potential for tufas in paleaoenvironmental reconstruction.

The next two days saw talks on *Glacial and Stadial Environments*, *The Palaeo Tropics*, *Palaeolimnology*, *Sea-Level Changes* and *Palaeoecology*. **Chris Fogwill** (Aberdeen) opened the first session with his plan to study the high resolution late-glacial climatic signal from Patagonian montane glaciers. Closer to home, **Tim Bower** (Swansea) presented his reconstruction of periglacial Cadair Idris during the Younger Dryas (Loch Lomond Stadial). **Kenneth Rijsdijk** (Swansea) discussed sedimentological evidence for the style of Late Devensian deglaciation in south-west Wales. Working in the Himalayas, **Peter Taylor** (Luton) presented palaeo ice limit reconstruction for the North-West India Himalaya and **Ben Richards** (Royal Holloway) enlightened us all to the skill involved in collecting luminescence samples at 20,000 feet.

Richard Telford (Aberystwyth), working on an Ethiopian caldera lake, discussed the problems of using diatom-inferred hydrochemistry as a proxy for climatic reconstruction. **Angela Lamb** (Aberystwyth), also working in Ethiopia, presented a detailed salinity reconstruction for the last 9,000 years based on $\delta^{13}C$ and $\delta^{18}O$ stratigraphy. **Mat Wooller** (Swansea) and **David Swain** (Swansea) demonstrated new methodological applications for palaeovegetation reconstruction, using fossil grass cuticles, and palaeoecophysiology and plant functional types respectively.

Mick Frogley (Cambridge) presented an ostracod-derived 20,000-year stable isotope record from north-west Greece, and **Sam Nash** (Kingston) pragmatically discussed what to do when Mexican lake sediments fail to contain that vital fossil ostracod record! **David Horne** (Cambridge) illustrated the sensitivity of East Anglian lakes to climate fluctuations during the late-glacial and Holocene.

Rapid coastal flooding events were examined by **Stella Kortekaas** (Coventry) who presented foraminiferal and stratigraphical evidence for paleaotsunami-induced coastal flooding in south-west Portugal. **Lucy Holloway** (Coventry) presented evidence for shifting rates of marine sedimentation during the Windermere Interstadial and Loch Lomond Stadial in eastern Scotland. **Justin Taylor** (Aberystwyth) reported on North Sea sedimentation dynamics at the continental margin as revealed from echo-sounding data and sonar images.

The palaeoecological session opened with **John Merry** (Coventry), promising us elephants from Lincolnshire but giving us very small Ipswichian molluscs. **Rich Meyrick** (Cambridge) discussed Holocene land snail successions throughout north-west Europe. **Sarah Read** (Royal Holloway) (who did have the longest *Tilia* diagram by far!) talked about the potential of Coleoptera for environmental reconstruction. **Chris Gleed-Owen** (Coventry) summarised the Pleistocene herpetofauna for the British Isles. Tephra isochrons from Scottish peat bogs were utilized by **Pete Langdon** (Southampton) to correlate palaeoclimate records. **Matthew Higginson** (Bristol) demonstrated the use of the chlorin record as an indicator of oceanic phytoplankton productivity in the Holocene and Late Pleistocene.

As a hi-tech contribution in the symposium, **Andrew Rebeiro-Hargrave** (Kings College) presented computer modelling-based research examining the influence of tectonic uplifting on gully evolution in southern Spain.

Thank you to everyone for presenting and discussing a stimulating collection of diverse Quaternary research. Thanks once again to all those involved behind the scenes and to the Quaternary Research Association for another great Postgraduate Symposium. A final thanks to **Justin Taylor** who coped admirably with all the slide projector problems. Good luck to Exeter University which was voted to host the Third QRA Postgraduate Symposium in 1998 .... Aberdeen has volunteered for 1999!

Lucy Holloway
Stella Kortekaas
and
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PERIGLACIAL WORKSHOP
UNIVERSITY OF WALES, CARDIFF

16th-17th December, 1997

The aims of the Workshop were to discuss recent advances in periglacial research and identify avenues for future, collaborative research. The Workshop was organised by **Charles Harris** (Cardiff) and **Julian Murton** (Sussex), and affiliated with the International Permafrost Association Working Group on Periglacial Processes and Environments; the Cryostratigraphy Research Group of the Quaternary Research Association; and the IGU Commission on Climate Change and Periglacial Environments.

Day 1

The first day focused on cryostratigraphy and palaeoenvironmental reconstruction. *A review of cryostratigraphic methods*, the opening keynote address by **Hugh French** (Ottawa), summarised the cryostratigraphic description of permafrost, emphasising the importance of thaw unconformities and cryostructures. A regionally extensive thaw unconformity in the Canadian Western Arctic formed during a warm interval at the beginning of the Holocene, and can be identified from features such as truncated ice wedges, mudflow deposits, cryostructural contacts and isotopic discontinuities. Similar thaw unconformities probably exist in other areas of permafrost, and palaeo-thaw unconformities may occur where permafrost no longer exists.

Jef Vandenberghe (Amsterdam) gave a keynote talk on *climate change and periglacial environments*. A regional study of Weichselian palaeoclimate based on multi-proxy data in north-west and north-central Europe suggests that the temperature gradient varied from north-south to east-west at different times during the last glacial, dependent mainly on ice cover and oceanic circulation, respectively. A second study, of cyclical grain-size variations in intercalated loess and tundra gley palaeosols at Kesselt, Belgium, suggests quite rapid climate change during the Weichselian Middle Pleniglacial. Coarser sediment at Kesselt is attributed to colder intervals with stronger atmospheric circulation and the development of ice wedges, whereas finer sediment is attributed to warmer intervals associated with ice-wedge casting and soil formation.

Julian Murton (Sussex) gave a keynote talk on the *cryostratigraphy and dating of thermokarst terrain in the Pleistocene Mackenzie Delta, Canada*, using case studies of thermokarst-lake deposition and active-layer deepening. A progradation rate of ~4 cm yr^{-1} is inferred from ^{14}C dating of detrital organic material in a thermokarst basin, and active-layer deepening commencing at ~11 ka is inferred from optical dating of sand wedges and AMS ^{14}C dating of *in situ* rootlets in a palaeo-active layer. The next step planned is to combine

measurement of deposition rates on lacustrine benches with optical dating of bench sand deposited in clear, shallow water, to determine respectively short- and long-term rates of bench development in oriented thaw lakes.

Matti Seppälä (Helsinki) discussed *recent permafrost formation in Finnish Lapland.* Permafrost ≤0.5 m thick has formed since 1995 within pounus (peat hummocks) as a result of locally thin snow cover and strong temperature inversions in winter; hence the pounus "sleep in summer and are active in winter". Long-term observations on snow cover are essential because snow depth is probably the key control on permafrost formation in northern Fennoscandia and because it is difficult to predict the effect on snow depth of climate change.

Stephen Gurney (Reading) considered *pingos and equifinality: a case study from south-west Banks Island, NWT, Canada.* Equifinality occurs when a specific feature results from different initial conditions and/or formative processes. Geomorphic and sediment mapping in the Sachs River Lowlands has distinguished five morphological types of pingo. Some of the pingos are thought to be equifinal, developing by growth hybrid between hydraulic and hydrostatic mechanisms.

Steve Boreham (Cambridge) spoke about *thermokarst features in the Cambridge area.* The question here concerns the origin of near-circular depressions and flat-bottomed embayments as large as a few kilometres across and ≤~15 m deep that are cut into clays or silty bedrocks. It is suggested that depressions like Grunty Fen, Cow Fen and that near south-east Cambridge developed by thermokarst processes during the Devensian or earlier cold stages.

Peter Brabham (Cardiff) described some *geophysical investigations of relict ground-ice depressions, west Wales.* Resistivity surveys, ground-penetrating radar and vibrocore drilling have recently been conducted in the ramparted depressions of the Cledlyn Valley. Resistivity measurements across the 'Pingo U' basin suggest that the silt-clay beneath the peat is ≤~15 m thick and has a concave-up lower surface. Ground penetrating radar survey indicates that the upper surface of the silt-clay is also concave-up but has surface irregularities. Further studies are planned.

Mark Bateman (Sheffield) discussed the *age and origin of Lincolnshire coversand deposits.* Thermoluminescence dating of coversand above and below a regionally extensive peat horizon, radiocarbon dated to the Windermere Interstadial, indicates three episodes of coversand deposition, a particularly extensive one during the Younger Dryas. The sand is thought to have been blown from the west, from fluvioglacial and lacustrine deposits and from the Sherwood Sandstone.

Hanne Hvidtfeld Christiansen (St Andrews/Copenhagen) discussed *windpolish of boulders and bedrock in Scotland.* Wind abrasion of boulders

and rock surfaces by sand, silt and snow in the Scottish uplands has produced facets, flutes, pits and polished surfaces on a variety of rock types. Mapping of these features suggests that palaeo-wind directions as late as the Younger Dryas have been primarily from the north and south-west, and recent abrasion is extensive on mountain-top deflation surfaces.

Colin Ballantyne (St Andrews) gave a particularly lucid talk on the *age and significance of periglacial blockfields*, specifically, how they relate to glaciation. Mapping of blockfields on 140 mountains in north-west Scotland has identified three weathering zones separated by two weathering limits. The limits are interpreted as periglacial trimlines, the lower marking the maximum altitude of glacial ice during the Younger Dryas, and the upper marking that of the last (Late Devensian) ice sheet. Support for this interpretation includes three distinct clusters of cosmogenic exposure ages on outcrops from the three weathering zones (Stone *et al.*, 1998), indicating blockfields of different age.

Andrew Rochelle (Wolverhampton) discussed *patterned ground phenomena between Wolverhampton and Telford.* Mapping of patterned ground from large-scale aerial photography indicates that the patterns occur on slopes <2° and are commonly oriented downslope; the soils tend to be sandy; the average long and short axes of patterns are respectively ~10 and 6.5 m; and the average number of sides is five. The patterns show up particularly clearly in winter wheat and during drought conditions.

Brigitte Van Vliet Lanöe (Lille) discussed *patterned ground, pedogenesis and Holocene climate changes.* Excavation of patterned-ground phenomena in a variety of periglacial environments commonly reveals internal soil deformation, for example within Icelandic thufa (hummocks). The deformation is attributed mainly to differential frost heave, and is strongly influenced by soil moisture and gradients in frost susceptibility. Three episodes of climate cooling since 6,000 BP are inferred from periglacial features in certain subarctic and low arctic regions.

Hideki Miura (Tokyo) presented *a new interpretation for fossil periglacial wedges and reconstruction of permafrost environment during the Last Glacial Maximum in northern and eastern Hokkaido, northernmost Japan.* Periglacial wedges dated to ~42-12 ka are interpreted mostly as relict soil wedges, with a smaller number of ice-wedge casts. Comparison with wedges in modern permafrost regions suggests that the boundary between continuous and discontinuous permafrost during the Last Glacial Maximum passed through northern and eastern Hokkaido.

Charles Harris (Cardiff) and **Julian Murton** (Sussex) discussed the *physical modelling of cryoturbation: full-scale laboratory and small-scale centrifuge simulations.* The objectives of these simulation experiments are to test two hypotheses of involution formation: soft-sediment deformation and differential

frost-heave. Centrifuge modelling of thaw of ice-rich clay beneath sand indicates: (1) a rapid, saw-toothed rise in pore water pressure in the clay to excess of hydrostatic; (2) the formation of involutions by soft-sediment deformation; and (3) the occurrence of tubular cavities probably formed by water-escape. Thaw of ice-rich loam and sand have not produced involutions.

A round-table discussion of the day's presentations focussed on the following themes:

(1) time resolution of palaeoclimate reconstructions from periglacial *vs* ice-core data;
(2) ground climate measurement (e.g. snow depth, temperature, moisture) to qualify transfer functions relating periglacial structures to atmospheric conditions;
(3) ice content of Yakutian silts *vs* Cambridgeshire silt and clay bedrocks; and
(4) icing formation, burial and modern analogues for the Cambridgeshire depressions.

The evening's entertainment consisted of a conference dinner with musical interludes. A flute-guitar duo of **Wilfried Haeberli** (Zurich) and **Norikazu Matsuoka** (Tsukuba) played a selection of folk tunes from around the world, later followed solo on the piano by **Stanislav Grechishchev** (Moscow). Their audience was most appreciative and awaits the Yellowknife encore.

Day 2

The second day of the Workshop concentrated on monitoring and modelling of periglacial processes.

The opening keynote address, by **Jean-Claud Ozouf** (CNRS, Caen), considered *laboratory modelling of cryogenic rock weathering: a case study of limestones*. To establish the climatic significance of fossil periglacial deposits, the size of laboratory-formed gelifracts has been compared with those, for example, in stratified slope deposits. Comparison suggests that the effects of freezing intensity and moisture content (key climate controls) vary according to pore size and number of microfissures in limestones (key rock controls). Problems remaining include the relationship between micro- and macrogelifraction (i.e. from blocks to rock face), and developing a scale of frost susceptibility for siliceous rocks.

David Robinson (Sussex) discussed *experimental weathering of sandstone in the presence of alum salts and in some mixed salt solutions*. Alum salts are double salts with the general formula: $M_2SO_4.R_2(SO_4)_3.24H_20$, where M is a univalent ion like Na^+ or K^+, and R a tervalent ion, usually Al^{3+}. Such mixed salts are common in nature but their effects on rock weathering have been little studied. Experiments using alum salts and mixtures of alums and gypsum on

75 mm cubic blocks of sandstone, cycled between +20°C and -30°C, resulted in increased rates of disintegration relative to control blocks. In cold environments, both salt and frost weathering may operate at different times of the year.

Colin Thorn (Illinois) discussed *chemical weathering rates and processes in Kärkevagge, Sweden.* To investigate in more detail Anders Rapp's (1960) conclusion that the main agent of removal in this glacial trough is chemical, an ongoing study is examining: (1) soil formation, (2) weathering rinds and rock varnish on coarse debris, (3) surface water solutes, and (4) weathering of rock disks and granules. Results to date confirm the importance of chemical weathering and suggest that weathering processes in this periglacial environment are similar to those in temperate areas.

Fiona Thompson (Warwick) spoke on *thaw-consolidation behaviour of some British soils.* To investigate the mechanics of formation of relict shear surfaces and associated periglacial slope deposits in Britain, a special oedometer equipped with freeze-thaw capabilities, pore water pressure devices and thermocouples has been constructed and was shown to the audience. The oedometer is being used to monitor pore water pressures during freezing and thawing of undrained soils and to study thaw-consolidation behaviour in drained soils.

Norikazu Matsuoka (Tsukuba) gave a keynote talk on *field monitoring and modelling of periglacial soil movements.* Continuous monitoring of soil displacement, soil temperature, soil moisture and snow depth in the Swiss and Japanese Alps reveals a difference between crest and foot slopes. Crest slopes have little winter snow, thin debris covers (<0.5 m) and small solifluction lobes, with soil movement occurring mainly by diurnal frost creep in spring and autumn. By contrast, foot slopes have late-lying snow patches, thick debris covers and large solifluction lobes, with movement mainly by solifluction in early summer and by diurnal frost creep in autumn. The diurnal frost creep on crest slopes has been empirically modelled in the Japanese Alps, the rate of creep being a function of slope gradient, thickness of fine debris layers and freeze-thaw frequency.

Stanislav Grechishchev (Moscow) discussed *pore water pressure in soils on seasonally thawed slopes, West Siberia.* On the Yamal Peninsula, slides occur on slopes as gentle as 1.5°. Pore pressures measured along a downslope transect in a silty active layer near the time of maximum thaw varied in time and space from zones of low pressure (soil under suction) to high pressure (floating soil). Important controls on pore water pressure during thaw are thought to include the distribution and volume of ice lenses in the basal part of the active layer.

Charles Harris (Cardiff) discussed *laboratory simulation of periglacial solifluction: towards a rheological model.* Measurements of undrained shear strength of soil during a thaw cycle of a solifluction experiment indicate an

inverse logarithmic relationship with soil moisture. From this and measurements of soil rheometry at high moisture contents it appears that thaw-induced solifluction observed in the experiments represents pre-failure soil shear strain. The strain is attributed to loss of strength resulting both from raised pore water pressures during thaw consolidation and from upward seepage pressures as water flows from the thaw front to the surface.

Wilfried Haeberli (Zurich) gave a keynote address on *key questions in rock-glacier dynamics*. Techniques such as drilling, geophysical soundings and high-precision photogrammetry have significantly advanced understanding of the development and movement of rock glaciers. For example, the viscous appearance of active rock glaciers results from long-term permafrost creep; the excess ice within them has variable origins; and the permafrost thickness is typically a few tens of metres. Such understanding, however, remains largely qualitative. A quantitative understanding requires numerical modelling and laboratory experiments to investigate key questions such as the nature of the coupling of mechanical strain and the ground geothermal régime; the effects of anisotropic ice-rock mixtures on permafrost creep; the geophysical detection of the permafrost base; and prediction of thaw-related processes triggered by climate warming.

Ole Humlum (St Andrews/Copenhagen) discussed *the significance of rock glaciers*. A significant geomorphic role of rock glaciers is the mass transfer of weathered rock fragments. Estimates of the volume of such fragments in some rock glaciers on Greenland suggest locally very high rates of headwall retreat (e.g. ~21 and ~25 m at two sites during the Holocene, viz. ~2-2.5 mm yr^{-1}). However, such rock glaciers generally transport little sediment into the adjacent sea, in contrast to glaciers.

Michael Davies (Dundee) presented a keynote address on *geotechnical centrifuge modelling: cryological research applications*. The stress/strain behaviour of soil is highly non-linear and thus stress-level dependent. Thus to simulate accurately a natural phenomenon (i.e. prototype) using a small-scale physical model, that model must reproduce the *in situ* stresses. The correct self-weight stresses are reproduced by placing the model in an elevated gravity field produced by centrifuge rotation. Centrifuge modelling has advantages of repeatability and cost, allows simulation of slow, large-scale processes by scaled acceleration of time and length, permits determination of physical mechanisms and validation of analytical procedures, and provides a technique for hazard reduction or rehabilitation. Cryological research applications of centrifuge modelling include frost heave, cryoturbation, permafrost creep, active-layer movements and thaw settlement.

The final talk was given by **Duncan Irving** (Cardiff) on *centrifuge modelling of permafrost creep*. Novel experiments aim to monitor deformation of ice and ice/rock mixtures using deformation threads, linear voltage displacement

transformers and an embedded grid of markers in order to construct a finite-element model and establish flow laws for various ice/sediment mixtures. The results will be compared with photogrammetric data on surface deformation patterns on Swiss rock glaciers. Preliminary experiments have successfully monitored deformation within pure ice.

The Workshop ended with a visit to the Cardiff Geotechnical Centrifuge Laboratory in the School of Engineering. The centrifuge can accelerate to 100 gravities a model with a mass of up to 1,000 kg. A platform size of 1 m x 1 m enables large areas of soil to be modelled because centrifuge modelling laws scale linear dimensions directly with acceleration; hence model scales of up to 100th prototype scale may be used. Refrigeration of the model is by way of vortex tubes mounted on the test platform. A centrifuge test flight was demonstrated and explained by Michael Davies, Charles Harris and Duncan Irving, using one of Duncan's model glaciers.

The Workshop proved highly successful and enjoyable, drawing attention to a number of key themes for future research. These include:

- examination of ground ice and evidence for its former existence, to reconstruct permafrost history and interpret modern and relict periglacial features;
- monitoring of the ground geothermal and hydrological régime and its controls (particularly snow depth and ice content), to establish the effects of climate change on periglacial features and improve understanding of slope stability;
- dating of geomorphic and cryostratigraphic features (e.g. by cosmogenic, luminescence and radiocarbon methods), to establish regional chronologies, determine rates of landform development and improve correlations with other proxy indicators (e.g. ice cores) of climate change;
- measurement of periglacial processes and landforms using advanced technologies (e.g. resistivity soundings and high-resolution photogrammetry), to determine stratigraphy and rates of movement; and
- modelling of periglacial phenomena (particularly by centrifuge and large-scale physical laboratory simulations), to monitor cryogenic processes, measure their rates and test hypotheses.

It is hoped that participants in the Workshop will collaborate in addressing these themes.

Reference

Stone, J.O., Ballantyne, C.K. and Fifield, K. (1998). Cosmogenic isotope dating and validation of periglacial weathering limits, NW Scotland. *Geology*, in press.

Julian Murton
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GLACIAL DEBRIS TRANSPORT AND DEPOSITION: PROCESSES AND PRODUCTS UNIVERSITY OF LEEDS

9th-11th January, 1998

This was a joint meeting of the International Glaciological Society British Branch, the QRA, the British Geomorphological Research Group and the British Sedimentological Research Group. The conference attracted around 120 delegates, with representatives from North America and Europe, as well as the UK.

Day 1

The conference was opened on Friday by **Mike Hambrey** (University of Wales, Aberystwyth) on behalf of the organising committee and the IGS British Branch. He welcomed the delegates and outlined the background to the conference and its importance in various aspects of glacial debris. Further welcoming speeches were made by **Mike Kirkby** (Leeds) and **Ian Fairchild** (Keele).

The first session, chaired by **Mike Hambrey**, took as its subject *subglacial and supraglacial debris entrainment and transport*. The approaches taken varied widely from multiple regression analysis of factors influencing sediment and solute transport through Svalbard glaciers (**Andy Hodson**), to the effect of tephra cover on ablation rates in Iceland (**Andy Dugmore** and **Martin Kirkbride**). **Peter Clark** hypothesised that the shift from high-frequency to low-frequency ice volume variations in the Middle Pleistocene resulted from geometric changes in the Laurentide ice sheet associated with regolith removal (and resulting change from deformable to hard bed conditions). **Richard Waller** examined patterns of motion within debris-rich basal ice.

Julian Dowdeswell (University of Wales, Aberystwyth) chaired the second session on *water and sediment within and beneath glaciers*. Here the emphasis was on contemporary glaciation, although **Geoffrey Boulton** used observations of glacier hydraulics and esker formation in Icelandic glaciers to make inferences about the last European ice sheet, and **Philip Marren** presented sedimentological evidence of palaeo-jökulhlaups in Iceland. Other papers examined the effects of the 1996 Vatnajökull jökulhlaup (**Andy Russell**), calcite dissolution at the Tsanfleuron Glacier, Switzerland (**Ian Fairchild**), and fluvial sediment transport using a conceptual cellular model (**David Collins**). An opportunity was then provided for those with poster presentations to advertise them and encourage comments and questions from delegates.

With the final session of the day came a chance for the mathematicians to demonstrate their skills in *modelling sediment transport by glaciers*, chaired by **Dick van der Wateren** (Vrije Universiteit, Amsterdam). **Felix Ng** investigated the closure of subglacial channels by sediment creep, whilst **Andrew Fowler** presented a new model of drumlin formation analogous to dune and anti-dune formation in rivers. **Daniel Howell** presented a model of the late Weichselian Eurasian High Arctic ice sheet based on geologically determined boundary conditions. **Neil Arnold** demonstrated a predictive model of subglacial suspended sediment entrainment and transport. Discussions were then continued at a wine reception and the conference dinner.

Day 2

Saturday began with a session on *ice sheets and their sedimentary products* chaired by **Ian Fairchild**. This session was an eclectic mix, including papers on ice margin reconstruction from geomorphological evidence (**Kim Jardine** and **Colm O'Cofaigh**), microscopic rotational structures in tills (**Jaap van der Meer**), large-scale structures in glaciomarine sediments associated with the polar continental margins (**Julian Dowdeswell**) and the evolution of the Labrador section of the Laurentide ice sheet (**Chris Clarke**).

Glacier surges and their geomorphic and geologic significance was the subject of session 5, chaired by **Jane Hart** (Southampton). Two papers were presented here about Kongsfjorden, Svalbard: the relationship between ice marginal processes and landforms (**Mike Hambrey**), and the record of surging recorded in marine sediments (**Robert Whittington**). **Dave Evans** used the margins of surging glaciers in Iceland as an analogue for the Laurentide ice sheet in Alberta, whilst **Oskar Knudsen** examined eskers at Bruarjökull, Iceland, from a new perspective.

Andy Russell (Keele) chaired the final session on soft glacier beds. Once again there was a wide diversity of subjects on offer (including a paper that slipped in on the role of ice in the formation of p-forms by **Brice Rea**). Papers covered structural analysis of tills (**Dick van der Wateren**), implications of deforming beds for British glaciations (**Jane Hart**), and micromorphology (**Jim Rose**). **Doug Benn** presented the only southern hemisphere work at the conference, on subglacial deposits in Chile. There then followed another opportunity for the advertisement of poster presentations.

Day 3

Sunday was taken up with a workshop on the use of thin sections in the study of glacigenic sediments. This was extremely informative and thanks are due to **Dick van der Wateren** (Vrije Universiteit, Amsterdam) and **Jaap van der Meer** (University of Amsterdam) for their considerable efforts in organising

this event and preparing a comprehensive and authoritative handout. Half of the day (organised by **Jaap van der Meer**) was given over to the process of obtaining, preparing, describing and interpreting thin sections from soft sediments. Following a theoretical discussion, there was an opportunity for delegates to spend some time at the microscope viewing thin sections for themselves. The other half of the day (with **Dick van der Wateren**) was devoted to the structural analysis of micro- and macro-fabrics in tills as indicators of subglacial shearing. This session proceeded from a theoretical description of deformation to an analysis of the types of structures that may be expected in soft sediments. Numerous examples of deformation at micro- and macro-scales were provided, showing how real deformation structures may be interpreted in terms of the applied stresses and cumulative deformation (finite strain). Because thin sections and exposures are two-dimensional but the deformation structures are three-dimensional, the importance of obtaining thin sections with different orientations was stressed if reliable interpretations are to be made. The importance of structural geological principles to interpreting deformed glacial sediments was made readily apparent.

The consensus amongst the delegates less experienced in the use of thin sections was that considerable experience would be required to recognise many of the features described. Nevertheless, this technique appears to provide a very promising means of examining deformation in soft sediments. As such, it is a tool ideally suited to the task of reconstructing conditions in deformable glacier beds.

Thanks are due to the organising committee (**Tavi Murray**, **Mike Hambrey** and **Neil Glasser**) and the postgraduates at the University of Leeds whose efforts made the conference a great success. An informative and enjoyable time was had by all.

The conference papers are to be published in a special edition of *Quaternary Proceedings* towards the end of 1998.

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ABSTRACTS

LATE DEVENSIAN AND HOLOCENE RELATIVE SEA-LEVEL CHANGES ON THE ISLE OF SKYE, SCOTLAND

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Five coastal sites have been studied on the Isle of Skye to investigate Late Devensian and Holocene relative sea-level changes. In the field, detailed stratigraphical work, geomorphological mapping and levelling were undertaken and representative cores were sampled. Detailed pollen and diatom analyses were undertaken in the laboratory and samples were submitted for radiocarbon assay where distinct pollen, diatom or lithostratigraphical changes were recorded. Loss-on-ignition analysis was also undertaken to ascertain the carbon content of the samples.

The investigations have revealed that during the Late Devensian, marine transgressions were experienced at two sites in southern Skye. These are thought to relate to readvances of the ice that arrested the isostatic recovery of the land, caused renewed isostatic depression and, upon deglaciation, allowed marine waters to penetrate the sites. At Inver Aulavaig the transgression is thought to relate to the Wester Ross Readvance recorded in Wester Ross, Coll and Tiree, and at Point of Sleat the transgression is thought to relate to the Loch Lomond Readvance recorded extensively in Scotland. Relative sea level at Point of Sleat (southern Skye) then fell below an altitude of 4.13 m OD at 10,460 ± 50 BP and remained low during the early Holocene until the Main Postglacial Transgression occurred. This transgression is recorded at three of the sites: at Inver Aulavaig (southern Skye) at 8,850 ± 70 BP where it had attained an altitude of at least 5.10 m OD, at Peinchorran (eastern Skye) where it is thought to have been underway by 7,980 ± 70 BP and attained an altitude of 4.49 m OD and at Talisker Bay (western Skye) at 7,790 ± 100 BP where it had attained an altitude of -2.18 m OD. At Ardmore Bay (northern Skye), it is thought that the Main Postglacial Transgression did not reach an altitude of 3.34 m OD. It is possible that barrier formation at some of the sites accompanied the early stages of the Main Postglacial Transgression.

It is thought that regression of the sea occurred between *c.* 6,600 BP and *c.* 5,400 BP and remained low until *c.* 4,200 BP when a later rise in relative sea

level took place at Peinchorran, attaining a maximum altitude of 4.90 m OD. A late Holocene transgression is also recorded at Point of Sleat at between *c.* 3,800 BP and *c.* 2,900 BP where it attained an altitude of greater than 4.13 m OD and at Inver Aulavaig after *c.* 3,200 BP where it attained an altitude of between 5.10-6.01 m OD. It is unclear whether this episode of high relative sea level represents the diachronous nature of one late Holocene transgression or several fluctuations in relative sea level during the late Holocene. Following the late Holocene transgression, relative sea level fell until the present day.

Comparison of the data obtained from Skye with the isobase maps and rheological models suggests that the isobases for the Main Lateglacial Shoreline (Firth *et al.*, 1993) show a good fit in age and altitude but the rheological model of Lambeck (1993b) for 10,500 BP requires modification. The isobases for the Main Postglacial Shoreline appear to lie *c.* 4 m too high for the sites studied on Skye and the isobases produced for a late Holocene shoreline appear to be greatly in error (Firth *et al.*, 1993). It is possible that the build up of ice during the Loch Lomond Stadial may have had a greater effect on crustal movements than previously thought and this may account for discrepancies identified in the isobase maps. The study of isolation basins and back-barrier environments has allowed an assessment of their potential in recording relative sea-level changes. The use of isolation basins in areas devoid of estuarine sedimentation has been particularly demonstrated.

The vegetation reconstruction undertaken, suggests that variations do occur in coastal locations compared to sites further inland, although these are subtle. The dates obtained for the increase in taxa such as *Corylus avellana* and *Alnus* and the recording of anthropogenic indicators on the vegetation, agree with those previously obtained for Skye. The use of pollen analysis in verifying the radiocarbon dates obtained, particularly for the Late Devensian, has been recognised and, combined with diatom analysis, has provided a comprehensive database from which to reconstruct past relative sea levels.

THE BIOSTRATIGRAPHY, PALAEOECOLOGY AND GEOCHEMISTRY OF A LONG LACUSTRINE SEQUENCE FROM NORTH-WEST GREECE

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Examination of an important new 319 m core of lake sediment recovered from Ioannina in north-west Greece has attempted to relate changes in the lake to variations in the regional climate of south-central Europe over the last 600,000 years. The site is known to have been extremely sensitive to past climatic change for three reasons: (i) temperate vegetation persisted throughout glacial stages (albeit at low frequencies), so the vegetational response to climatic change would therefore have been almost immediate; (ii) the extreme thickness of the sediments suggests that accumulation rates were high (at times, >1 m per thousand years), which has enabled high-resolution palaeoclimatic reconstructions; and (iii) precipitation of authigenic carbonate has preserved a remarkably sensitive proxy record of productivity variations for most of the lake's history. Well-defined shifts from glacial – interglacial mode have been correlated with vegetational changes identified in a core previously analysed from the same basin (using magnetic susceptibility profiles), enabling tentative correlations to be suggested with other European terrestrial sequences and with the marine oxygen isotope record, back to isotope stage 16. Twelve AMS radiocarbon determinations from the upper part of the core, together with the identification of a series of reversed palaeomagnetic events within the Brunhes chron, support the proposed age model for the sequence.

The sediments at Ioannina, unlike most of the other long terrestrial European sequences, are calcareous and contain mollusc and ostracod assemblages. Part of this project has involved a comprehensive review of Quaternary and modern aquatic faunas from the lake, as well as the description, illustration and critical assessment of several poorly known endemic taxa. Faunal assemblage data have been used to provide valuable information concerning the variable response of lake level to climatic change over time. Convincing new molluscan evidence indicates low lake levels at the Last Glacial Maximum, agreeing with regional pollen data, but conflicting with geomorphological evidence derived from Kastritsa, a well-documented nearby Palaeolithic cave site. It is suggested that this discrepancy may be a result of subsequent tectonic uplift of the rock shelter. In addition, stable isotopic analyses of both the ostracods and the bulk carbonate within the sediments have contributed towards deriving a comprehensive palaeoenvironmental history for the site.

Although the study analysed physical, biological and geochemical aspects of the entire core, two distinct parts of the record were selected for more detailed investigation. High-resolution analysis over the last interglacial (the Eemian) has revealed evidence for a clear, two-step deglaciation at the beginning of the period, known from elsewhere as the Zeifen-Kattegat Oscillation. Climatic instability has also been detected within the full interglacial. Comparisons are drawn with a range of other Eemian records from across Europe, as well as the Greenland ice cores. High-resolution analysis of the period from the end of the last glacial to the present day has also revealed evidence for climatic instability. A cool and arid oscillation is demonstrated by several climatic proxies that may constitute the first recognition of the Younger Dryas stadial from Greece. A shorter, but more subdued cooling event has also been detected during the first half of the Holocene, which may correspond with a widespread climatic oscillation from high-resolution terrestrial, marine and ice core records that has been dated to between 7,500 and 8,000 years BP.

GLACIER DYNAMICS AND THE EVOLUTION OF THE SUPRAGLACIAL SEDIMENT SYSTEM IN SPITSBERGEN AND NORTHERN NORWAY

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Glacier changes and the spatial distribution of sediments have been studied in Nordenskiöld Land Svalbard, an area with limited prior sedimentological studies. The research takes a systems approach to a comparative field and laboratory tests, which has been excluded in much theoretical glaciological modelling. The research investigates the origin of the supraglacial sediment system at a glacier that is known to have surged in 1930 (Scot Turnerbreen), and five glaciers that have not surged (e.g. Ayerbreen, Gibsonbreen, Plogbreen). A comparison site, Corneliussensbre in Nordland, has been studied to determine the effect of latitude on Little Ice Age and contemporary sedimentology, at non-surge-type glaciers.

There are three main components that set the focus and context of the process-form research: a) observations of debris-rich basal ice facies and analytical description of enclosed debris; b) following the ablation of basal ice, the observation and analysis of landforms, sediments, geotechnics and spatial/ temporal redistribution; c) the development of a model of supraglacial sedimentation. The model is tested using air photographs from Nordenskiöld Land and general applicability of the model to Quaternary sediments is discussed.

Laboratory experiments have been used to investigate particle size, clay mineralogy, shear strength, plasticity and chemical composition of sediment. These results are an integral part of determining sedimentological characteristics of surge and non-surge type glacier dynamics, and resulting landform sequences. The sediment source for the area is Tertiary sandstone. However, the particle size of sediment at each site is fundamentally different, which may suggest differences in glacier basal erosive processes.

Results show that diamict at the surge-type glacier is weaker, more mobile, and laterally extensive with controlled landforms. The landform-sediment association shows an inner zone of controlled ridges and hummocks, expansive zones of sediment flow, a maximum height surge moraine, with an outer zone of lower ridges extending to the Little Ice Age limit. The patterns are related to the outcrops of thickened debris-rich basal ice. In contrast the sediment at the non-surge-type glacier is preserved with greater strength and cohesion, and the topography is uncontrolled. The inner zone is chaotic, with superimposed

sediment flows, the highest ridge is the outer Little Ice Age limit. Lichenometry dates the ridges and records the stability of ridges in a temporal framework. The results have implications for interpretation of Quaternary sequences and extent of diamicton in the British Isles (e.g. Boulton *et al.*, 1977). The geotechnical properties from present-day deposits may be preserved in geological record.

Differences in basal freezing mechanism, enclosed debris, geotechnical properties and preservation of diamict may affect the spatial distribution of landforms, moraine morphology and preservation of diamict at surge and non-surge-type Norwegian glaciers. The model of landforms and sedimentation proposed is tested using the spatial distribution of sediment from air photographs of 18 other glaciers in Nordenskiöld Land, and discussed in context of Quaternary ice-sheet dynamics to help identify surge deposits in the geological record.

NOTICES

1. FORMATION OF GROUPE MANCHE

REPORT OF A MEETING HELD AT THE CENTRE DE GEOMORPHOLOGIE DU CNRS, CAEN, 26th November, 1997

The Quaternary evolution of Britain and the neighbouring continent has been intensively investigated for over a century; the main sequences in these regions being now well-established and their evolution well-known, albeit controversially in parts. However, in contrast to the terrestrial sequences, our understanding of the Quaternary of the neighbouring shelves is still at a preliminary stage, in spite of the enormous advances made by the geological surveys of the respective countries in recent years. Today, our clearer idea of the large-scale evolution of the shelves, particularly that of the North Sea where long sedimentary sequences are preserved, has had important implications for our interpretation of events on the surrounding land. Yet by comparison, the Channel remains curiously poorly understood. Clearly this is, in part, because the Channel, unlike the North Sea, is mostly floored by bedrock and lacks substantial sedimentary successions. The floor is incised by a series of channels that have been related to extended fluvial courses during periods of low eustatic sea level. Erosion during marine transgression and regression phases seems to have recycled deposits that accumulated in these valleys, except in protected areas, and has meant that any long-term record on the sea floor is absent. The contrast then with the North Sea could not be more marked. Moreover, since the Channel has been extra-glacial throughout the Pleistocene, surrounding terrestrial sequences are difficult to relate directly to the glaciated areas farther north. Nevertheless, the important long terrace sequences of the valleys of the Seine, Somme, Solent and lesser English rivers appear to span much of the Pleistocene and where they can be combined with loess - soil sequences, particularly in Normandy, and related to raised beach - fossil cliff sequences, erosion surfaces, karstic evolution and sequences infilling local tectonic basins, such as those in Contentin and Haute-Normandy, etc., and the archaeological evidence, a detailed, firmly based Quaternary history can be established.

A further contrast to the North Sea lies in the effects of tectonic activity. In the former, the overall effect of the tectonic setting is to cause downwarping of the basin, onto which shorter-term isostatic changes are superimposed. In the Channel region, the situation is much more complex, with long-term uplift characterising the Artois-Weald anticline and possibly the whole eastern

Channel region, local basinal subsidence occurring in the Contentin and Hurd Deep areas and transform movements acting in the central southern Channel.

This knowledge has emphasised the need to undertake investigation of the Channel region as a single basin, if we are to understand the region as an integrated unit, and not as politically divided segments from which only half the story can be reconstructed at best. Although there has always been a natural exchange of information, such as that between national geological surveys, it has mostly been somewhat 'piecemeal' and dependent largely on the interaction of one or two individuals.

With this knowledge in mind it was suggested that an international group of continental geomorphologists, Quaternary geologists and marine geologists interested in the Channel should unite to study the Quaternary evolution of the Channel region by developing integrated investigations between the continent and the Channel. To initiate the co-operative work a one-day discussion meeting was convened on 26th November, 1997 at Caen. The meeting was attended by 20 colleagues from Caen, Brest, Cambridge and Lille.

The meeting consisted of a series of short presentations followed by lively discussion of topics arising from the talks, as well as more general problems of relevance to the theme. Among the topics that were felt to be particularly significant were the age and infilling of the palaeovalley system, the age and origin of the opening of the Dover Strait, the form and evolution of the apparently little-modified Armorican coast in comparison to that of the chalk cliffs farther to the east, the continuation of the high terraces in the large valleys beneath the Channel and the morphology of the intervalley sea floor areas. In order to investigate these topics a work group has been established, the theme of which was centred on the continent - sea interface in the Channel basin. It is particularly hoped to investigate the evolution of the coast, its origin, age, the influence of tectonics, dating of the formation and infilling of the valley and fluvial systems on land and the fosses (deep erosional valleys) beneath the Channel; and finally, the development of study of the two deep deltas of the Atlantic Ocean at the foot of the continental platform. (Copies of the full minutes of the first meeting are available from the co-ordinators.)

This Groupe Manche, as currently convened, includes colleagues from France, England and The Netherlands, but it is open to all who are interested in the Quaternary (and Neogene) evolution of the greater Channel (the seaway itself, its floor and surrounding drainage basins). The group is informal and has been established to bring workers from the full range of disciplines together, in the first instance not to apply for substantial financial support, but to exchange information and to originate new ideas and approaches to unified studies. All

topics of relevance to this theme will be warmly welcomed. To this end it is planned to hold small, workshop-style, themed meetings annually to report progress, the next, probably in England, in September 1998. Presentations will be welcomed in both French and English.

All colleagues interested in the aims of the group are encouraged to join as corresponding members. A list of members will be prepared and circulated in early spring. There is no formal structure, but Groupe Manche is currently jointly co-ordinated by Jean Pierre Lautridou and Phil Gibbard.

For further information, including minutes of the first meeting, please contact:

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2. THE WEST RUNTON ELEPHANT DISCOVERY AND EXCAVATION

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The book comprises 12 pages with 24 black and white and 16 colour illustrations. It is in A4 format and has a full colour cover.

ISBN 0903101 64 5
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3. THE CLIMATE IN NORTH-WESTERN EUROPE DURING THE YOUNGER DRYAS; A COMPARISON OF MULTI-PROXY CLIMATE RECONSTRUCTIONS WITH SIMULATION EXPERIMENTS

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Netherlands Geographical Studies 229, 160pp. November 1997 (Dfl. 32.-)

This thesis describes efforts to reconstruct the climate during the Younger Dryas. This cold period took place at the end of the Weichselian, the last ice age. The Younger Dryas lasted from *c.* 12,500 to 11,500 years ago and the cold climate was registered throughout the northern hemisphere. The study area comprises north-western and central Europe. The reconstructions are based on

a combination of proxy climate data, collected from literature. Emphasis was on periglacial (e.g. ice-wedge casts, fossil frost mounds) and botanical (pollen, plant macrofossils) data. Beetle data and evidence based on glacier fluctuations were used in conjunction. Transfer of the proxy data to climate parameter values (e.g. mean summer temperature) is based on a comparison of, for example, fossil periglacial features with the climate conditions under which their modern equivalents develop. The reconstructions were compared with experiments executed with an Atmospheric General Circulation Model (AGCM). To simulate a Younger Dryas climate, the boundary conditions (that drive the model) were changed according to the Younger Dryas situation. These boundary conditions include, amongst others, sea-surface temperatures and CO_2 content of the atmosphere. A data-model comparison enlarges our understanding of the Younger Dryas climate. Furthermore, it enables validation of the climate model used.

The reconstructions show a significant decrease in temperatures in north-western and central Europe. Mean annual temperatures were between –1 and –8°C. Younger Dryas winter temperatures were ~20°C lower than today, the temperatures ranging from -15 to -23°C. During the first and coldest part of the Younger Dryas a temperature gradient of ~5°C existed between 50 and 55°N, namely, northern France/central Germany and southern Sweden. Younger Dryas annual temperature ranges, indicating the difference between mean winter and mean summer temperature, were near 30°C throughout the study area. This clearly contrasts the modern values; 7°C for Ireland and 17°C for Poland, which imply a west to east gradient of ~10°C.

Both temperature reconstructions and model simulations show that the Younger Dryas cooling was most pronounced in areas near the Atlantic coast. The similarities between palaeodata and model simulations for the northern areas (60°N) puts confidence in the prescribed sea-surface temperatures at higher latitudes. Since the reconstructed summer temperatures are reliable, the too high temperatures produced in southern parts of the study area may be explained by a model deficiency. Alternatively, errors in the prescribed boundary conditions may have played a decisive role. It is suggested that to simulate winter temperatures approximating the reconstructed values, the prescribed sea-ice margin should be positioned farther to the south.

The conjunction and comparison of aeolian data (dune morphology) with simulated wind fields indicate a strong westerly flow over Europe during the Younger Dryas. Aeolian data and simulation experiments show that depositional winds, as well as aeolian activity, were relatively strong in The Netherlands when compared to Poland. It is shown that the increase of the frequency of high velocity winds from westerly directions reflects an enlarged cyclonic activity

due to a relocation of the Icelandic low and the orographic effect of the Laurentide ice sheet in North America and Canada.

It is concluded that the low Younger Dryas temperatures in Europe can be explained by a very cold ocean, with sea-ice at least as far south as 52°N during winter, and strong westerly winds blowing over these cold ocean waters. Improvements for future research include a reconstruction and quantification of palaeoprecipitation and an increase of spatial and temporal resolution of Atmospheric General Circulation Models.

This publication can be ordered from:

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4. PALAEOGEOGRAPHY OF LATEGLACIAL VEGETATIONS: ASPECTS OF LATEGLACIAL VEGETATION, ABIOTIC LANDSCAPE, AND CLIMATE IN THE NETHERLANDS

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Netherlands Geographical Studies 230, 160pp. December 1997 (Dfl. 32.-)

In this study, aspects of the late-glacial and early Holocene vegetation, abiotic landscape and climate in The Netherlands are discussed. Based on a large amount of palynological and geomorphological data, a critical evaluation is presented considering relationships between climate, abiotic landscape and vegetation development in The Netherlands during the late-glacial and early Holocene (13,000 - 9,000 ^{14}C BP).

After the general introduction and chapter outline of this study (Chapter 1), different aspects of the late-glacial and early Holocene vegetation, abiotic landscape and climate in The Netherlands are outlined.

An introduction to the Weichselian late-glacial vegetation is given in Chapter 2. The vegetation development is considered in a biostratigraphical sense. A general zonation for the late-glacial and early Holocene pollen diagrams has been developed, which is based on corresponding trends in the regional pollen component. Problems concerning definitions and sub-divisions of the late-glacial in general are discussed. A comparison of the vegetation development in The Netherlands with neighbouring countries is made.

In Chapter 3 it is demonstrated that a close relationship exists between climate and regional vegetation development during the late-glacial in The Netherlands. A critical review of all available radiocarbon dates from over 100 pollen diagrams has led to a chronostratigraphical framework for The Netherlands and direct surroundings. The regional pollen assemblage zone boundaries were pin-pointed to the radiocarbon timescale with the help of ^{14}C-intensity curves. Furthermore, an attempt has been made to relate the dated regional vegetation trends to larger-scale climatic oscillations, as recorded in oxygen isotope curves from the Greenland ice cores and Swiss lake sediments.

In Chapter 4, abiotic landscape evolution in The Netherlands during the Weichselian late-glacial is outlined. Late-glacial abiotic landscape types and geomorphological features in the different landscape types are considered. The interaction between vegetation and the late-glacial abiotic landscape is evaluated, showing the close relationship between those components. It will appear that knowledge of the vegetation development is significant to understand landscape development as a whole.

In Chapter 5, it is demonstrated that there is a significant influence of the abiotic landscape on vegetation patterns during the late-glacial in The Netherlands. The patterns of three distinct late-glacial taxa in The Netherlands for specific time windows are used to demonstrate relationships between iso-pollen patterns and abiotic landscape. Selected maps for *Juniperus*, *Pinus* and Ericales show variations in distribution in a spatial context. A comparison is made with a map of the late-glacial abiotic landscape types of The Netherlands.

In Chapter 6, environmental changes recorded in late-glacial calcareous gyttja deposits at Gulickshof, southern Netherlands, are described. Pollen, plant macrofossils, freshwater mollusca, stable isotopes ($\delta^{18}O$ and $\delta^{13}C$) and geochemical analyses were performed and the combined evidence was put into a chronostratigraphic framework based on regional biostratigraphy and AMS radiocarbon dating. The well-dated, multi-proxy environmental record can be considered as a standard for this region. Early in the Allerød, at around 11,900 BP, the composition of aquatic taxa and stable isotopes of CaCO3 changed significantly. These changes are interpreted to reflect fluctuations in groundwater level caused by the definite melting of ground ice and associated changes in the nutrient availability.

A review of the environmental and climatic changes during the late-glacial and early Holocene in The Netherlands is presented in Chapter 7. The changes in climate, vegetation and abiotic landscape are considered in a time-stratigraphical context. Aeolian and fluvial processes and lake-level changes are correlated with the vegetational record and temperature reconstructions based on Coleoptera and plant climate indicator species.

This publication can be ordered from:

See Notice 3 for details.

5. ATLAS TO PALAEOGEOGRAPHY OF LATEGLACIAL VEGETATIONS: MAPS OF LATEGLACIAL AND EARLY HOLOCENE LANDSCAPE AND VEGETATION IN THE NETHERLANDS, WITH AN EXTENSIVE REVIEW OF AVAILABLE PALYNOLOGICAL DATA

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Netherlands Geographical Studies 231, 176pp. December 1997 (Dfl. 38.-)

Landscape and pollen distribution maps of (selected) plant taxa for different time-windows during the late-glacial and early Holocene (13,000 - 9,000 ^{14}C BP) in The Netherlands are presented. Iso-pollen maps and pollen abundance maps, based on 260 pollen diagrams, show changes in vegetation composition and patterns in time and space. A selection of summary pollen diagrams from different regions is added. The review of late-glacial and early Holocene pollen diagrams in The Netherlands and adjacent regions gives a compilation of over 500 pollen diagrams for the period under consideration.

Over 450 palynological sections in The Netherlands, covering a part or the whole of the Weichselian late-glacial and early Holocene, have been investigated by several institutes in the last few decades. This unique amount of data provides the opportunity to construct a detailed picture of late-glacial and early Holocene vegetation development in a spatial context. As a first step in this study, a thorough inventory has been made of the available palynological data of the period under study.

For compilation of the data from over 250 pollen diagrams, use was made of the European Pollen Database structure. For subdivision in pollen assemblage zones, a regional zonation scheme has been developed, based on published diagrams. Dated shifts in the arboreal pollen content constitute the basis of the zonation scheme. In Chapters 2 and 3, a description of the vegetation development and landscape during the investigated period is given.

To illustrate the regional variety in pollen composition in The Netherlands during the investigated period, a selection of pollen diagrams is presented in Chapter 4. The pollen diagrams are constructed with an identical pollen sum and plotted against an uncalibrated radiocarbon timescale for direct comparison. On the basis of a considerable number of palynological investigations, iso-pollen maps have been constructed, in order to visualize the vegetational development. These permitted analysis of the relationships between vegetation and various abiotic factors in time and space. The dense network of palynological sequences in The Netherlands permitted construction of high-resolution iso-pollen and abundance maps. For zones and sub-zones within the late-glacial and early Holocene, iso-pollen maps were constructed showing the average percentages of specific taxa in that zone. A total of 206 iso-pollen and pollen abundance maps for selected taxa are presented with a brief description, and show changes in vegetation composition and patterns in time and space. Relations between abiotic factors of the landscape and vegetation patterns can in this way be visualized in many instances. In those cases where a relationship of this kind cannot be demonstrated, climate may be a dominant factor explaining the observed patterns of pollen distribution. Thus it should be possible to distinguish more clearly between climate and other abiotic agencies

of the environment which affected vegetational development. In Chapter 6, a synthesis is given of the main conclusions derived from the pollen distribution maps.

In Chapter 7, a particularly complete overview is presented of pollen diagrams that have been constructed in The Netherlands, the northern part of Belgium and the north-western part of Germany, which contain Weichselian late-glacial and/or early Holocene deposits. More than 500 pollen diagrams are given with author, institute where pollen data are stored, and location. The pollen diagrams included in the database are indicated by their entity number. From these pollen diagrams, a short description of the recorded zones, basin characteristics and main lithology is presented. Furthermore, an extended literature list, including internal reports, is given.

This publication can be ordered from:

See Notice 3 for details.

6. ANNUAL FIELD MEETING 2000

The QRA Executive Committee, mindful of the significance of the new century soon to begin, invites members' suggestions for a suitable Annual Field Meeting for the year 2000.

Please send your ideas to:

Dr Peter Allen
13 Churchgate
Cheshunt
Herts
EN8 9NB
e-mail: peter.allen6@virgin.net

7. EXCURSION TO POLAND

As there is a QRA field meeting to south-west Poland being offered for May 1998 (see current Circular), an abstract from last September's FLAG meeting in The Netherlands, on a topic to be included within the forthcoming excursion, is reproduced here. This appertains to a poster presented at the FLAG meeting, full details of which can be found in Issue 2 of *FLAG News*. The Polish abstract discusses the role of neotectonics in the development of river systems on the northern edge of the Sudeten Mountains, where drainage has been affected by neotectonic movement during the Quaternary on the Sudetic Marginal Fault. Evidence from such areas is of potential relevance in connection with the current debate about the role of uplift in river terrace formation.

The terraces in the Sudetic marginal area, which was amongst the first topics to be addressed by the celebrated geologist and archaeologist Frederick E. Zeuner, form just one of the themes of the May 1998 QRA excursion. Participants will also be able to see the extraordinarily extensive exposure of Quaternary sediments provided by opencast lignite mining in that part of the World, on the visit to the quarry at Belchatow, near Lodz. Several glacial-interglacial climatic cycles are represented in strata (up to 200 m thick) above the Tertiary lignite at this site. The Glogow region will also be visited, where evidence for glaciotectonics associated with the Weichsel limit and loess will be examined. Those interested in active fluvial processes will be able to see the dramatic effects of last year's serious flooding of this region.

For further information, contact:

Peter Allen
See Notice 6 for details.

ABSTRACT

The role of neotectonics and glaciations on terrace formation along the Nysa Klodkza River in the Sudeten Mountains and the Sudetic Foreland (south-western Poland)

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The Nysa Klodzka river drainage basin in the Sudeten Mountains, south-west Poland, preserves a complex late Cainozoic sequence that includes eight fluvial series/terraces and deposits from two glacial episodes, as well as localised volcanic rocks, slope deposits and loess. Sedimentation took place in two stages, during the Late Pliocene and again from early Middle Pleistocene (Cromerian Complex) times, with a lengthy erosion phase (hiatus) during the Lower Pleistocene.

The fluvial series date from: (1) the Late Pliocene; and (2) the Cromerian, Holsteinian, late Saalian/Eemian, Weichselian and Holocene. The early Elsterian and early Saalian stages are represented by glacial deposits. These stratigraphic units have been observed in three geomorphic zones: the mountainous Klodzko Basin, the uplifted Bardo Mountains (Bardo Gorge) and in the mountain foreland.

Major tectonic uplift, causing strong erosion, occurred during the Lower Pleistocene. Minor uplift occurred in the post-early Saalian (*c.* 30 m), very probably in the post-Elsterian and possibly in the Pliocene. The post-early Saalian and post-Elsterian uplift phases most probably result from glacio-isostatic rebound.

The Quaternary terrace sequence can be attributed to base-level changes, epigenetic erosion after glaciations and neotectonic movements. The early Middle Pleistocene fluvial deposits/terraces do not display any tectonic influence, but all the other Quaternary terraces indicate clear divergence, and the post-early Saalian terraces are deformed by fault scarps.

Once the drainage system was formed, during the Pliocene, it remained unchanged until recent times, with only minor modifications within the uplifted block, deepening the Bardo Gorge, for which an antecedent origin can thus be inferred. Only during post-glacial times have epigenetic incisions slightly modified the valley.

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.* 1,250) 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, with six issues a year; the monograph series *Quaternary Proceedings* also in association with Wiley, the Field Guides 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. The current officers of the Association are:

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