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Quaternary Newsletter

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QUATERNARY NEWSLETTER

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Instructions to authors

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

Suggested word limits are as follows: obituaries (2000 words); articles (3000 words); reports on meetings (2000 words); reports on QRA grants (500 words); reviews (1000 words); letters to the Editor (500 words); abstracts (500 words). Authors submitting work as Word documents that include figures must send separate copies of the figures in .eps format. Quaternary Research Fund and New Research Workers Award Scheme reports should limit themselves to describing the results and significance of the actual research funded by QRA grants. The suggested format for these reports is as follows: (1) background and rationale (including a summary of how the grant facilitated the research), (2) results, (3) significance, (4) acknowledgments (if applicable). The reports should not (1) detail the aims and objectives of affiliated and larger projects (e.g. PhD topics), (2) outline future research and (3) cite lengthy reference lists. No more than one figure per report is necessary. Recipients of awards who have written reports are encouraged to submit full-length articles on related or larger research projects.

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COVER PHOTOGRAPH
'Icelandic mist: a high temperature geothermal region of the Reykjanes Peninsula, southwest Iceland'. (Photo: Pete Langdon)

EDITORIAL

Issue 114 of *QN* brings an end to my term as editor. The production of *QN* is a team effort. My job as editor has been most enjoyable and relatively straightforward because of the help of others. I would particularly like to thank Val Siviter for typesetting *QN*, Gwasg Ffrancon for printing it and all the members who have made a contribution, whether it was an article, report or review. I would also like to thank all of you who kindly agreed to act as a referee for the articles.

The new editor of *QN* is Mark D. Bateman. Mark grew up in Kent and went to University at Royal Holloway, University of London where he obtained a first class honours degree in Geography in 1991. He then attended Sussex University where he was awarded, in 1995, a D.Phil for his research into the chronology of coversands in Britain. His first academic appointment was as a post-doctoral researcher at Sheffield University where he set up and ran a luminescence dating laboratory as part of the Sheffield Centre for International Drylands Research. In 1998 he was appointed as a lecturer within the Geography department, University of Sheffield. Now a Reader in this department, Mark's research continues his interests in past aeolian environments be they coastal, hot desert or periglacial desert. Recent work has focussed on former periglacial deserts in Arctic Canada, understanding the effects of bioturbation on dryland palaeorecords, coastal dunes in South Africa and their relationship to early modern humans and in the UK the timing and demise of ice associated with proglacial Lake Humber. He has published widely with over 50 papers in peer reviewed journals. A QRA member since 1991, Mark in the past has served as Meetings Officer for the QRA (2002-2004) and organised the QRA field meeting to East Yorkshire and North Lincolnshire in 2001. He currently also serves on the executive committee for the British Society for Geomorphology.

PRESIDENT'S ANNOUNCEMENTS

Honorary members

The nominations of two new Honorary members of the QRA were proposed at the AGM of the association held at the Royal Geographical Society's HQ in Kensington Gore, London, attended by 48 members. Both nominations were unanimously and warmly endorsed. It is therefore my great pleasure and privilege to announce that Honorary status of the QRA has been bestowed upon **Professor Jim Rose** and **Professor David Smith** in recognition of, and salute to, their distinguished careers in Quaternary science and their considerable and effective contributions to the activities and development of the QRA.

Professor Jim Rose

Jim Rose, currently the Gordon Manley Professor of Geography at Royal Holloway, University of London, is perhaps best known for his influential work in revising the Pleistocene stratigraphy of East Anglia and Eastern England, which led to a fuller appreciation of the important impacts of major former rivers such as the pro-Thames and the Bytham, to re-assessments of the pattern and rate of landscape change throughout the Quaternary, and to improved understanding of the links between landscape evolution and the earliest recorded humans in the UK. He is currently a leading figure in the Leverhulme-funded *Ancient Human Occupation of Britain (AHOB)* project, coordinated by the Natural History Museum (http://www.nhm.ac.uk/hosted_sites/ahob/index_2.html). In addition, however, he has researched a broad range of other topics, too many to report comprehensively, but which include glacigenic processes and sediments and displaced shorelines in Iceland and Scandinavia, the Pleistocene stratigraphy of the North Sea, The Netherlands and Germany, palaeosols as stratigraphic indicators, Mediterranean shorelines, the geoarchaeology of Borneo and responses to abrupt environmental changes in the North Atlantic region during the Last Termination.

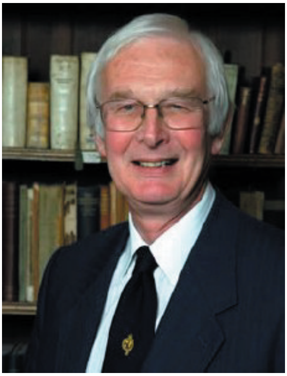
With respect to his contributions to the QRA, Jim was an Executive Committee member from 1976 to 1978, Editor of *Quaternary Newsletter* from 1978 to 1981, Secretary of the association from 1978 to 1982, and QRA President from 1988 to 1991. He has co-led a large number of QRA meetings over the years, and is still active in this regard, having initiated and co-ordinated the very successful Annual Discussion Meeting held in London last month, while he is also one of the organizers and field leaders of the forthcoming September Field Meeting to be based in Glen Roy (September, 2008).

His many other contributions to Quaternary Science are too numerous to adequately summarise in a short space. However, two perhaps deserve special mention, as they have contributed in major ways to strengthening the Quaternary science base in the UK. The first is his unparalleled success in driving the Elsevier journal *Quaternary Science Reviews* to the top of the premier league among Earth Science and Geography journals, an almost super-human feat that is internationally recognized and applauded. The second was his foresight and leadership in forging the Quaternary science research group at Royal Holloway, when Head of the Geography Department. That provided the stimulus and cradle for the emergence of the NERC-recognised Masters course in Quaternary Science (a programme now shared with the Geography Department at UCL), the graduates of which are becoming increasingly prominent in QRA meetings, and who also now make up a significant proportion of the QRA membership.

Many members of the association will also know of Jim's legendary record as a tireless committee man, enthusiastically agreeing to take on advisory roles over what seems to be the entire committee spectrum! These include spells as a member of committees of the Geological Society of London, the Council of the Royal Geographical Society, the British Geological Survey Programme Development Board, the English Nature/ Natural England Natural Sciences Advisory Board, Council of the Geologists' Association, the Royal Society, the British Geomorphological Research Group, the HEFCE Research Assessment Exercise, and the Geological Society of Norfolk, while he has also served as Chair of the NERC Radiocarbon Steering Committee. He has also been an active participant in a number of INQUA congresses, notably as British Representative and Leader of the British Delegation to the XIIIth INQUA Congress in Beijing, China in 1991.

In recognition of his many formative contributions to Quaternary Science, Jim received the Murchison Award of the Royal Geographical Society in 1990 and the prestigious Victoria Medal of the Royal Geographical Society in 2006.

Professor David Smith



David Smith is presently a Distinguished Research Associate at the University of Oxford, a position he accepted in 2003. Before then he was instrumental in building up a once-thriving Geography Department and Centre for Quaternary Science at Coventry University, the institution at which he now holds an Emeritus Professorship. He is best known for his indefatigable investigations, throughout his distinguished academic and research career, of the history and impacts of sea-level variations in Britain. David has contributed to a number of breakthroughs in this field, including the more accurate measurement of the patterns and rates of Holocene land uplift, the interplay between sea-level variations and the deglaciation history of Britain, and the recognition of stratigraphic markers of tsunami events in the late Quaternary record. He has co-edited three volumes dedicated to these themes.

David is not only an internationally-recognised expert in the study of sea-level variations, but also of its connections to global climate change. He led four major research projects in this field and was a major investigator in four others which were all funded by the European Commission (Directorate-General for Science, Research and Development: DG XII) between 1988 and 2001. He has served as the President of the NW Europe INQUA Shorelines Commission, as UK representative on International Geological Correlation Projects (IGCP) 200 and 347, as a member of the EU 3rd, 4th, 5th and 6th Framework planning committees, as a member of the EU 2nd, 3rd, 4th and 5th Framework evaluation committees, as a member of the EU Descartes Prize Committee, as Director of the Centre for Quaternary Science, Coventry University (1995-2002) and as an expert reviewer on the Inter-governmental Panel on Climate Change Report, UNEP, 2004-2007. He has also provided expert advice, through consultative reports and panel membership, for the Atomic Energy Authority, British Petroleum, a number of civil engineering groups (mainly in Russia) and Lloyds. He is presently a member of the consultancy group *Climate Change Risk Management* (www.ccrm.co.uk), a specialist scientific consultancy offering technical and scientific expertise on a range of issues associated with contemporary and future climate change. David has also developed a useful web site that contains information and data concerning relative changes of land and sea around the coastline of Scotland over the last 20,000 years (www.scottishsealevels.net).

David has contributed to a number of QRA, INQUA, EU and IGCP field meetings over the years, and been a frequent contributor to QRA discussion meetings. In recognition of his major contributions to the study of sea-level change, he was awarded the Murchison Award of the Royal Geographical Society in 2003.

Lewis Penny Medal Winner: Dr. Kirsty Penkman, BioArCh, University of York

The *Lewis Penny Medal* is awarded to a young or new research worker who has made a significant contribution to the Quaternary Stratigraphy of the British Isles and its maritime environment. The 2008 medal has been awarded to Dr. Kirsty Penkman of York University. On behalf of all the members of the QRA Executive Committee, I extend our warmest congratulations to Kirsty, who gave an outstanding summary of her incisive research in aminostratigraphy at the January Annual Discussion Meeting, where she received the medal in person. A fuller citation will follow in a subsequent edition of *QN*.

Death of Professor Winifred Pennington (Tutin)

Members of the association, especially those who, like me, had the privilege of meeting her and/or were influenced by her publications and academic instruction, will be saddened to learn of the death of Winifred Pennington in May 2007. Married to the botanist Thomas Tutin, Mrs. Tutin (or "Mrs. T.", as she was affectionately referred to by many) was a pioneer and leading authority in the study of microfossils in lake sediments and in their use for environmental reconstruction. After completing her PhD at Reading University under the supervision of Harry Godwin, Professor Pennington was based for many years at Leicester University, but also had a long association with the Freshwater Biological Association and its base in Cumbria. She forged one of the first truly inter-disciplinary teams in Quaternary palaeoecology, bringing her expertise in palynology into close harnass with diatom studies (Liz Haworth), sediment chemistry (Jean Lishman) and plant macrofossil analysis (Anne Bonny). This all-female team published one of the benchmark papers in this developing field (Pennington *et al*., 1972). Her long and productive career included many incisive scientific papers and also, in 1969, a fine book on the history of the British vegetation (Pennington, 1969). Professor Pennington also contributed to a number of QRA meetings and was a member of the QRA Executive Committee from 1971 to 1973. I had the great fortune of meeting her on several occasions, and well remember the first encounter. Brian Sissons held the tradition of allowing his final year PhD students at Edinburgh, where I was based, to nominate someone to be invited to give a guest lecture in the department. The year was 1973 and I nominated Mrs Tutin, principally because of the important work she was conducting on Scottish lake sediments. When the day came, I was duly despatched to Waverley Station in the department's very small, peat-stained Bedford van to collect her and deliver her to the department. At that time, she had a reputation of being somewhat fearsome (scurilously exaggerated by my then fellow postgraduates in the days leading up to the event), and so it was with some trepidation that I anxiously awaited her arrival at the platform entrance. I need not have worried. She was delightful – polite, kind, interested in my own studies and those of others at Edinburgh, and clearly committed to knowledge exchange and subject development. Her talk was inspirational and she interacted warmly with those who shared her interests in our environmental heritage. And so it was on every subsequent occasion I had the privilege of being in her company.

Pennington, W., Haworth, E.Y., Bonny, A.P., Lishman, J.P. (1972). Lake sediments in northern Scotland. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences,* 264, 191-294.

Pennington, W. (1969). *The History of the British Vegetation*. The English Universities Press, London.

Changing of the Guard

At this juncture I should apologise to James Scourse, as I am no longer the President of the association, and hence have given this piece a fraudulent title. I passed the baton to James at the AGM held in London on the evening of 9th January, 2008. I trust he will forgive this impertinence.

I joined the QRA as a first year PhD student in 1970 and have held it in the highest esteem ever since. From day one I have enjoyed and admired everything about it – its corporate dedication to engaging and assisting all of its members, the way it treats members as equals, the range of endeavours it supports, the absence of snobbery and fudge, and many other appealing attributes. I could not say that about every society or organization to which I have belonged. The QRA combines professional performance with open and enlivening spirit which, in my opinion, is the most potent scientific alchemy. Long may it continue to conduct its business in this manner.

It goes without saying – but I will say it anyway – that I feel deeply honoured, delighted and privileged to have had the opportunity to complete a term of office as the organisation's President. That I did not get overwhelmed by the duties of office or have to deal with a single, real crisis is testimony to the hard work and dedication of those who willingly accepted a share in shouldering the burden. I owe a deep debt of gratitude to all the members of the Executive Committee, the team of willing work-horses who keep the QRA firmly on a forward and upward trajectory. I hope the others will forgive me if I extend particular thanks to Dan Charman and Simon Lewis who have both acted as Secretary over the period, Rick Shakesby as Treasurer, Pete Langdon as Publications Secretary, Tim Mighall as *QN* editor and Jason Jordan as Publicity Officer. These are perhaps the most onerous of the officer positions, though others are beginning to grow in terms of their importance and the demands made on the individual's time. It would be remiss of me not to mention and thank Val Siviter, who keeps the membership up to date and orchestrates the delivery of the association's publications. Then there's VP Pete Coxon, who seems to be the QRA's permanent lucky mascot. He's always involved, and seems to have been there forever. He readily accepted to extend his term of office as Vice-President to help us through a difficult transition period, and eventually I will buy you that promised pint, Pete. Honest.

During my term of office the executive has presided over a number of important changes in the association's affairs. The most significant, perhaps, was the change in the timing of the Annual General Meeting from the April field meeting to the January Annual Discussion Meeting. There has been overwhelming support for this move, though it has necessarily involved a number of modifications to the association's constitution, which continues to be refined to reflect the new position. The ADM's themselves are growing in stature and appeal, evolving into fitting showcase events. The executive has promulgated the policy that future ADM's should address major scientific themes that engage a wide spectrum of the association's members, should be based in major centres that are easily accessible, should (where possible) be organized in partnership with a cognate learned society or organization, and should optimize the opportunities for publishing proceedings in mainstream scientific journals while also engaging the non-expert, general public ('outreach'). The meeting held at the Royal Geographical Society this year met all of these aspirations. Its undoubted success was mirrored in the attendance (230 registered participants, more than 20% of the current membership) and the view expressed by RGS personnel that it proved a 'model' of how a conference should run. The Past President's hat and glass are duly raised to Field Marshall J. Rose, who masterminded and orchestrated the proceedings, and to Barbara Silva, his able lieutenant. Warm thanks and congratulations are also due to the RGS team who helped to make the event such a success, but above all to Catherine Souch, their star player. In passing, it is pleasing to note that nearly 25% of the attendees were postgraduate members of the association, an optimistic portent of the association's future potential.

Other significant developments have been fuelled by the increased income from the *Journal of Quaternary Science*, and here I take the opportunity to record my personal thanks to Chris Caseldine, JQS editor, to the members of the JQS editorial board, and to the staff of Wiley International (now Wiley-Blackwell) for their continuing endeavours on our behalf, and for the professional and friendly partnership that they maintain. Their success with the journal has enabled us to support more fully a number of activities that are core to the association's ethos. More money can be allocated to support the activities of postgraduate, early career and unwaged members, a formal budget has been created to support outreach activities, the association's financial awards have been increased in value, and a 'war chest' (not the friendliest reverse-euphemism to use) is being set up to maximize the participation of UK personnel in the next INQUA Congress (Bern, Switzerland, 2011). Plans are afoot to digitize the association's records and publications and subsequently to make them internet-accessible, to employ a 'historian' to document the history and development of the association, and to instigate a fuller photographic record of the association's affairs (e.g. annual photographs of the executive committee members) – all initiatives I wanted to instigate, but lacked the time-energy quotient to get installed.

The association appears, therefore, to be going from strength to strength, while remaining acutely sensitive to both the needs of its membership and the evolving scientific agenda. Indeed, it will surely grow in stature and service, given the challenging future which human society has to confront, and the centre stage position which Quaternary records are destined to command. As I slide towards the comfortable back seat that awaits me, it is reassuring to know that I hand the reins over to James Scourse, a committed, experienced and very able supporter of the association. I could be prised out of that seat, if he or the association were to require my assistance.

John Lowe
President, QRA (2005-08)
Royal Holloway
University of London

ARTICLES

LOWER PALAEOLITHIC QUARTZITE ARTEFACTS FROM THE TRENT VALLEY AT EAST LEAKE, NOTTINGHAMSHIRE (SK 558248): NEW LIGHT ON A HIDDEN RESOURCE.

Tom S. White, Mark J. White, David R. Bridgland and Andy J. Howard

Introduction

The Trent Valley Palaeolithic Project (TVPP), funded by the Aggregates Levy Sustainability Fund, was conceived as a detailed survey of the both the Lower and Middle Palaeolithic archaeology of the Trent Valley and the Quaternary sediments that form its context.The monitoring of sand and gravel quarries currently exploiting these sediments formed a major element of this research (Bridgland *et al*., 2006; in preparation) and led to the discovery in 2005 of three quartzite artefacts, two cores and a heavily struck flake, at the CEMEX Gravel Pit at East Leake, Nottinghamshire (SK 558248; Figure 1).

Lower and Middle Palaeolithic artefacts are scarce in the English East Midlands and, accordingly, research in that region has been limited in comparison to the richer areas of southern and eastern England. Several recent review articles have sought to raise the profile and highlight the potential of the region (e.g. McNabb, 2001; Graf, 2002), but little new archaeological information has been forthcoming since Posnansky's (1963) synthesis *The Lower and Middle Palaeolithic Industries of the English East Midlands*. Conversely, this interval has witnessed significant developments in the wider Quaternary sciences, which have provided valuable information pertinent to our understanding of the geological context and probable ages of the extant artefact assemblages from the region (e.g., Brandon and Sumbler, 1988, 1991; Wymer, 1988; Maddy, 1999; Howard *et al*. in press).

The discovery at East Leake has also raised afresh several questions concerning the preservation, visibility and recovery of Lower and Middle Palaeolithic artefacts in gravel deposits in the Midlands, especially those manufactured on non-flint raw materials such as quartzite.

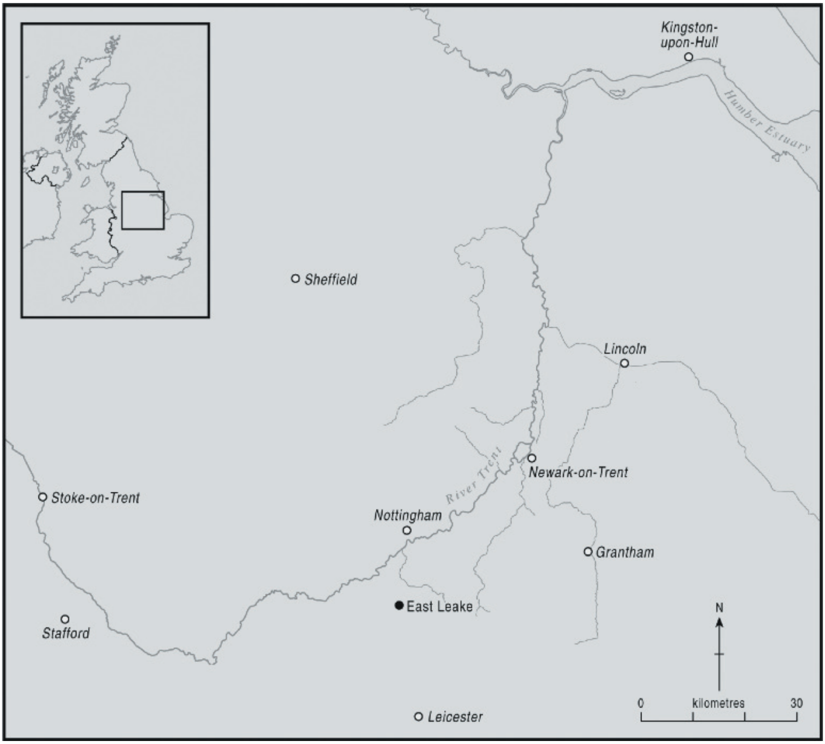


Figure 1: Location of study area.

Geology and Context of the Finds

Early mapping of the area to the south of Nottingham by the Geological Survey (Sheet 142) indicated a number of hilltop patches of 'Glacial Sand and Gravel' at a range of altitudes. The quarry at East Leake is situated within one of the most extensive of these, at an altitude of *c*. 80m O.D. These deposits had not previously been included in reconstructions of Trent terrace stratigraphy due to the assumption that they were glacial outwash of probable Anglian age. Although the most recent Geological Survey mapping has redefined some of these patches as Thrussington or Oadby till, the nature of many of the deposits remains uncertain.

The deposits at East Leake consist of somewhat clayey sands and gravels, disposed as stacked 'bar-core' gravels interspersed with supra-bar sands, suggesting deposition within a braided river environment (*cf.* Bryant, 1983a, b). Clast lithological analysis (Table 1) indicates that the sediments are dominated by reworked Triassic ('Bunter') quartz and quartzite, derived locally from the Sherwood Sandstone Group, with flint almost entirely absent.

Carboniferous chert is also common. Palaeoflow measurements from foresets, often picked out by coal fragments, indicate an easterly direction, suggestive of a course flowing towards the Ancaster Gap.

Table 1: Clast lithological analysis 16 – 32mm

Carboniferous Chert	**19%**	Other	1%
Fossiliferous	52	Skerry	2
Homogeneous	36	Quartzitic Sandstone	1
Fine-grained	3	Ferruginous Sandstone	2
Quartzose	**80%**	Igneous	1
Orthoquartzite	325	Flint	1
Metaquartzite	44		
Vein Quartzite	13	Total Clasts	480

Historically, the majority of high-level sands and gravels were correlated with deposits attributed to the former Hilton Terrace, which has since been redefined as three separate units; the Eagle Moor, Etwall and Egginton Common sands and gravels (Brandon and Sumbler, 1988, 1991; Maddy, 1999; see Table 2). However, the deposits at East Leake are situated at a significantly higher altitude, relative to the longitudinal profile of the Trent, than any of the above;

Table 2: Trent Valley terrace stratigraphy (after Maddy, 1999)

MIS	**Trent (after** Posnansky 1960)	**Middle Trent** (after Maddy 1999)	**Proto-Trent (Lincs.)** (after Maddy 1999)
1			
2	Floodplain Terrace	Holme Pierrepoint Terrace	Holme Pierrepoint Terrace
3			
4	Beeston Terrace	Beeston Terrace	Scarle Terrace
5d-5a			Whisby Bed
5e			
6	Lower Hilton Terrace	Egginton Common Terrace	Balderton Terrace
7			Thorpe-on-the-Hill Bed
8	Upper Hilton Terrace	Etwall Terrace	Whisby Farm Member
9			
10			
11			
12	Outwash Gravels	Eagle Moor Sand & Gravel	Eagle Moor Sand & Gravel

they may, therefore, represent an older Trent deposit, albeit possibly fed by glacial outwash.

The three artefacts were recovered by the TVPP team during field examination of sections in the East Leake Quarry. They were found in recently fallen talus at the base of the sections and, although they were not found *in situ*, their rolled condition and the absence of any other sediments in these sections implies that they came from the East Leake gravel. The presence of artefacts at East Leake provides the first substantial evidence for human occupation of the Trent valley at around MIS12; indeed, their heavily rolled condition suggests that they could pre-date the Anglian. The only other artefacts of such demonstrable antiquity from the English Midlands are the andesite handaxes and associated materials from the Cromerian Complex (MIS13 or 15) deposits at Waverley Wood, Warwickshire (Shotton *et al*., 1993; Lang and Keen, 2005; Keen *et al*., 2006).

Description of the artefacts

The three artefacts from East Leake are manufactured on sub-spheroid pebbles of fine-grained Triassic quartzite. They comprise two cores and a broken hard-hammer flake. All are in heavily rolled condition, but some characteristically anthropogenic technological features are still clearly visible.

The larger core (Figure 2) is of a type now commonly called a migrating or multiple platform core and shows 8-9 removals. Technologically it is dominated by an episode of alternate flaking, in which the scar of an initial large flake has formed the knapping platform for a series of parallel removals in the opposite direction, with two additional episodes consisting of single removals from different knapping platforms (*cf*. Ashton and McNabb 1996; Ashton 1998). The remainder of the piece (*c*. 50% by area) consists of an unworked rounded cobble surface.

The smaller core (not illustrated) is similar to the first, but shows less intensive working. Again, it shows an alternate knapping sequence, with the flake scar of the first removal forming the platform for 2-3 subsequent flakes.

The flake (Figure 3) is represented by the proximal end and shows an ancient medial break running perpendicular to the axis of percussion. It has been struck extremely hard and has a heavily pronounced cone and bulb of percussion. The F. W. G. Davey collection in Nottingham City Museum contains a similarly heavily struck flake with two very clear cones showing repeated striking (NCM.1991-527/98), the only other piece of quartzite debitage recovered so far from a Trent gravel context.

It was initially assumed that the flake was a small pebble that had been intentionally split. However, experimental work on the knapping

Figure 2: Artefacts from East Leake: the larger core of Triassic Quartzite

of orthoquartzite pebbles by John Lord and the TVPP has indicated that thick, lumpy flakes such as the one found at East Leake might in fact be produced in the reduction of quite large cobbles, a far easier process than cleanly splitting the cobble. These may have been the preferred blanks for handaxe manufacture in the region and research into quartzite reduction strategies is ongoing.

The Palaeolithic Occupation of the East Midlands: Invisible Archaeologies

Figure 3: Artefacts from East Leake: the flake of Triassic Quartzite

Flint artefacts dominate the extant museum collections, despite the absence of primary sources of flint in the region and the rarity of large fluvial clasts of flint suitable for handaxe manufacture. There are less than 400 Lower and Middle Palaeolithic artefacts from the Trent Valley, most of which are handaxes. Only a small proportion are manufactured from quartzite pebbles, the most abundant constituent of older gravel deposits west of Lincolnshire. A few more are known to exist in small private collections, but recent finds, as reported to the local Historic Environment Records, have been minimal. Consequently, the entire corpus of Palaeolithic finds from the Trent Valley is less than that found in some single localities in southern and south-eastern England. Lang and Keen (2005) suggested that the similar dearth in the West Midlands could be related to the way in which Middle Pleistocene hominins moved through their landscape. In particular they proposed that the absence of significant drainage networks flowing through the Midlands after the destruction of the Bytham River during MIS 12 restricted the number of natural conduits and ease of access into the area, thereby limiting human occupation (*cf*. Ashton *et al*., 2006). During the course of the TVPP, several other explanations for the very low number of finds in this region have been considered:

1. Although flint may have been preferentially transported by hominins from the Chilterns to the south or the Lincolnshire Wolds to the east, its dominance in the present collections is probably also a function of collection bias. Most British collectors, past and present, consciously or subconsciously, have preferentially targeted flint artefacts because they are most familiar with them. In other words, many do not have their 'eye-in' when it comes to non-flint artefacts. Furthermore, patinated flint artefacts stand out against the predominantly quartzite background of the Midlands gravel deposits, making them more visible; rolled quartzite artefacts are well camouflaged and the difficulty in simply seeing them is a serious hindrance to the discovery of new archaeological assemblages. Indeed, work in the similarly flint-sparse Oxford region has shown just how many non-flint tools begin to emerge once perceptive collectors actively start to look for them (*cf*. MacRae, 1982; Hardaker, 2001). Since 1989 twice as many quartzite artefacts have been found in that region than flint ones, quadrupling the number of quartzite objects (from 101 to 392) and greatly enhancing the evidence for occupation upstream of the Goring Gap in general (Hardaker and MacRae, 2000). A similar program of work could perhaps produce comparable results in the Trent.

2. The products of quartzite knapping often display far fewer unequivocal indicators of human workmanship. Older experimental research on the knapping characteristics of quartzite pebbles demonstrated that clear evidence for hominin workmanship may be absent even at the time of manufacture, let alone after hundreds of thousands of years in a dynamic

gravel deposit (Moloney, 1988; Moloney *et al*., 1988; Wallis, 1988; TVPP pers. obs.). The debitage from soft-hammer thinning of quartzite is extremely fragmentary and recognisable thinning flakes are rarely produced. Most objects, even very rolled handaxes, would probably be rejected by cautious field archaeologists.

3. The relative abrasion rates of flint and quartzite objects is another probable contributory factor. It has long been accepted that the richest artefact assemblages from the former Hilton (MIS 8/6) and Beeston (MIS 4) terraces have largely been reworked from older gravel deposits (Armstrong, 1939; Posnansky, 1963; Wymer, 1999). It is here important to note that current field mapping has failed to identify any deposits that can be correlated with the period MIS11-9 (Maddy, 1999; Howard *et al*. in press). A number of researchers have suggested such destruction may be associated with widespread post-Anglian / pre-Devensian glaciation possibly during MIS 10 (Sumbler, 1995), MIS8 (Straw, 2005) or MIS6 (Straw, 2005; Lang and Keen, 2005; Howard *et al*., in press) flushing out any artefacts for incorporation into later aggradations. How far the Trent artefacts have been moved during reworking episodes and how many times they have been reworked, are questions open to debate. That the flint artefacts would have been the hardest 'clasts' in the river system, far harder and more resistant than the quartz-quartzite gravels, yet are heavily rolled, suggests long periods/distances have been involved.

The mechanical properties of orthoquartzite varies considerably, ranging from poorly-cemented, sugary cobbles held together largely by the external weathering 'crust', to extremely hard and well-cemented examples that will fracture conchoidally through the individual quartz grains, resulting in a sharp, functional edge. Experimentation with a variety of cobbles from the East Leake gravels has shown that adequate edges can still be obtained on the softer variants, but their durability is limited. Flint, being more durable than the hardest quartzite, will retain its shape even after several episodes of reworking, especially when discarded in rivers with a significant non-flint bedload. Quartzite artefacts, on the other hand, may return to an unrecognisable form relatively rapidly (depending on hardness and texture), which, assuming the use of quartzite as a major lithic resource (see above) and given the lack of primary context sites, may be rendering the majority of the evidence for archaic humans practically invisible in the Trent Valley and similar regions.

Given recent findings from East Leake and Waverley Wood, the apparently limited human presence north of the 'Severn-Wash line' (Dawkins, 1880; Evans, 1897) may yet prove to be an illusion created by the factors considered above. It is expected that in the Trent Valley, just as in their original African homeland and other areas of Europe, hominins would have used a wide-range of locally abundant non-flint rocks. If so, then issues relating to the recognition and survival of such artefacts are probably contributing significantly to the apparently low human presence. As we become more aware of these biases and begin to understand more about the dynamics of quartzite artefacts as clasts, this situation may change.

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A TREE FROG (*HYLA* SP.) FROM THE WEST RUNTON FRESHWATER BED (EARLY MIDDLE PLEISTOCENE), NORFOLK, AND ITS PALAEOENVIRONMENTAL SIGNIFICANCE

Simon Parfitt

Abstract

Tree frogs are rare in British Pleistocene deposits. Previous discoveries consist of single records from three interglacial stages falling in the late Middle and Late Pleistocene (Marine Isotope Stages 11, 9 and 5e). At each site there is clear palaeoenvironmental evidence for significantly warmer summer temperatures than at the present day. An ilium of *Hyla* from the West Runton Freshwater Bed, the type site of the Cromerian Stage, constitutes its earliest known Pleistocene occurrence in Britain. This is described and its palaeoenvironmental and palaeoclimatic significance discussed.

Introduction

The West Runton Freshwater Bed (WRFB), the stratotype of the Cromerian temperate Stage, has produced an impressive diversity of faunal and floral remains (Stuart, 1975, 1996; West, 1980; Preece and Parfitt, 2000), including one of the richest early Middle Pleistocene amphibian and reptile assemblages in Europe (Holman, 1998a). Previous work on the amphibian and reptile fossils by Holman (Holman, Clayden and Stuart, 1988; Holman, 1989c) identified ilia of moor frog *Rana arvalis* and edible or marsh frog *R*. '*esculenta*' or *R*. *ridibunda*. These continental species do not occur naturally in Britain today but *R*. *arvalis* was found at an Anglo-Saxon site in eastern England, suggesting that it was native becoming extinct within the last 1000 years (Gleed-Owen, 2000). The West Runton herpetofauna is otherwise unremarkable; it consists of a restricted number of species, all of which are ubiquitous in Britain or the continental mainland bordering the North Sea at the present day. The absence of strong thermophiles (e.g. pond terrapin *Emys orbicularis*) distinguishes the Cromerian Stage from subsequent interglacials, and suggests that summer temperatures in southern Britain during the early temperate substage of the Cromerian were no warmer than at the present day. The discovery of a bone of *Hyla* sp. from the WRFB is therefore an important record providing further insights into the palaeoenvironment.

The identification of tree frog in the WRFB is based on a minute partial left ilium (Figure 1) found amongst unidentified small vertebrate material housed in University Museum of Zoology, Cambridge. This is a significant addition to the West Runton herpetofauna, and it records earliest known presence of

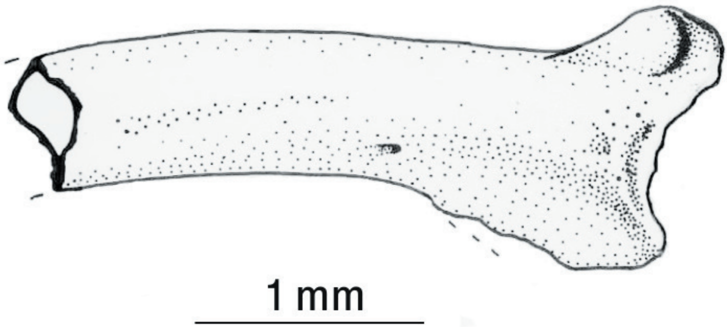

Figure 1: Left ilium of *Hyla* sp. (UCZM WR. 1952) from West Runton in lateral view.

the *Hyla* in the British Pleistocene. The specimen (University Museum of Zoology, Cambridge (UCZM catalogue number WR. 1952, Fig. 1) is incomplete, lacking the anterior part of the ilial shaft and most of the acetabular fossa. Although fragmentary, the morphology of West Runton specimen is highly characteristic and matches the ilial morphology of the Hylidae in every respect. Key morphological features are the broad *pars descendens*, an ilial shaft that lacks a dorsal crest, and a dorsal prominence situated above the anterior edge of the acetabular fossa. The length of the ilium as preserved is 2.9 mm, but because of the breakage it is not possible to estimate the length of the intact specimen. The relatively small size of the ilium is consistent with a juvenile: the dorso-ventral diameter of the ilial shaft is 0.61 mm, compared with 0.86-1.11 mm (mean = 0.99 mm, n = 7) in a modern-day sample of adult *Hyla arborea* (Parfitt, unpublished data). Identification to species level is more problematical. The Hylidae is a huge anuran family with as many as 33 recognized genera (Duellman, 1993), but only two species (i.e. *Hyla arborea* common tree frog and *Hyla meridionalis* stripeless tree frog) are found in mainland Europe, neither of which occurs naturally in Britain today (Arnold and Ovenden, 2002). Skeletal elements of *H. arborea* and *H. meridionalis* are difficult to distinguish. However, several authors have suggested that ilia of these two species can be differentiated using characters of the dorsal prominence (e.g. Holman, 1992, see Figure 1 for terminology). Holman (*ibid.*) has suggested that in *H. meridionalis* the dorsal prominence of the ilium is high and triangular in shape and the dorsal protuberance is laterally placed relative to the prominence, whereas in *H. arborea* the dorsal prominence is relatively low and the protuberance is elevated above the prominence. Studies by other authors (e.g. Sanchiz and Młynarski, 1979) have concluded that the distinctions are subtle, with a high degree of morphological variability and overlap in these characters. This makes identification to species level difficult, especially when dealing with fragmentary isolated elements, such as the West Runton ilium.

Tree frogs are poorly represented in the Quaternary fossil record of Europe (Sanchiz, 1981; Holman, 1998a). In Britain, tree frogs were hitherto known from only three localities (Holman, 1998a; Gleed-Owen, 1999), all in East Anglia. Stratigraphically, the British records appear to come from different interglacial stages. The oldest record of *H. arborea* comes the Lower Palaeolithic site at East Farm Barnham, Suffolk (Holman, 1998b; Ashton, Lewis and Parfitt, 1998), where 18 specimens were recovered from interglacial channel infill that has yielded the one of the richest herpetofaunas yet recorded from any British Pleistocene locality (Holman, 1998b). The fossiliferous sediments overlie Anglian glacial deposits and there is good palaeontological and aminostratigraphic evidence to suggest deposition during the Hoxnian Stage, equivalent to the early part of Marine Isotope Stage (MIS) 11, *c*. 400 kya. (Ashton, Lewis and Parfitt, 1998; Preece and Penkman, 2005). Several of the amphibian and reptiles found at the site no longer live in Britain, including strong thermophiles such as *Zamenis longissimus* (aesculapian snake, formerly *Elaphe longissima*), *Natrix maura* or *N. tesselata* (a natricine snake) and *Emys orbicularis* (pond terrapin), which indicate summers were warmer than the present day. A humerus of *Hyla* sp. was recorded amongst the rich herpetofauna from fluvial detritus muds at Cudmore Grove, Essex. (Holman, Stuart and Clayden, 1990). The Cudmore Grove record seems to be somewhat younger than Barnham with several lines of evidence suggesting that the fossiliferous sediments were deposited in a tributary of the Thames-Medway during MIS 9, *c*. 339 kya. (Roe *et al*., in prep.). Associated herpetofauna include several that are of climatic significance, such as *E. orbicularis* and southern European snakes (*Z. longissimus* and *Natrix maura* or *N. tesselata*). This species-rich herpetofauna, which includes as many as six exotic taxa, indicates summer temperatures in southern Britain were warmer than at the present. An ilium of *H. meridionalis* from Itteringham, Norfolk, represents its only know occurrence from Britain (Hallock *et al*., 1990, Holman, 1992). The specimen came from organic sands and detritus muds correlated with the Last (Ipswichian) Interglacial, equivalent to MIS 5e. Itteringham has yielded a relatively small herpetofauna, notable for the presence of *E. orbicularis*. The presence of *E. orbicularis* implies that summer temperatures in southern England were at least 2° C higher than at present.

The habitat preferences of *H. arborea* and *H. meridionalis* are broadly similar. Tree frogs are the only European amphibians to climb extensively and their long broad, flat feet with sticky pads on their toes enable them to cling firmly to smooth surfaces and to jump from branch to branch in search of food. They are typically found in well-vegetated habitats, usually in reed beds, woodland and areas of dense shrubby growth fringing scattered deep pools and river backwaters in which they breed (Arnold and Ovenden, 2002). Palaeontological evidence from the West Runton Freshwater Bed suggests that much of the channel infill was deposited in a tranquil river backwater or oxbow lake (de Deckker,

1979) that was fringed by reed swamp and fen vegetation with grassland and woodland growing on drier ground (West, 1980). This reconstruction of the local environment is consistent with the habitat requirements of tree frogs, and the mix of aquatic and terrestrial habitats available at the site would have provided cover as well as suitable breeding sites.

Discussion

A number of amphibian and reptile species found in British Pleistocene deposits no longer occur in northwestern Europe, and these provide useful information on past climates (Stuart, 1979; Holman, 1993; Gleed-Owen, 1999). Indeed, amphibian and reptiles are of particular value in climatic reconstruction because they are poikilothermic animals and consequently their distributions are influenced strongly by environmental factors such as temperature, precipitation, humidity and seasonality (e.g. Stuart, 1979; Holman, 1993; Gleed-Owen, 1999; Böhme *et al.*, 2006). Climatic changes during the Quaternary had major repercussions for amphibian and reptile populations living in northern Europe. For example, during the warmest periods, southern thermophilous species (e.g. *Emys orbicularis*, *Hyla meridionalis*, *Zamenis longissimus* and *Natrix maura* or *N. tesselata*) expanded well to the north and west of their present breeding range, reaching the British Isles during episodes of maximum climatic amelioration (Holman, 1993; Preece *et al.*, 2007). In contrast, during colder periods, the British herpetofauna was impoverished, comprising species that are broad-habitat generalists with extensive modern ranges that today extend north of the Arctic Circle (Holman, 1990). Tree frogs are climatically sensitive and their northern limit today respects the 16° C July isotherm in northwestern Europe. Their fossil record shows that although tree frogs are not native to the British Isles, they were present in at least four previous temperate stages. These include periods of peak interglacial warmth representing some of the warmest interglacials during the last 1my in northern Europe. At West Runton, however, the herpetofauna is not especially diverse and lacks strong thermophiles. The implication of the relatively species-poor assemblage is that summer temperatures were not significantly warmer than today (Holman, Clayden and Stuart, 1988; Gleed-Owen, 1999). However, although climate may be the principal factor in the controlling the species composition of the West Runton assemblage, other factors may have had an important influence. These additional factors include sample size, taphonomy, local ecology and palaeogeography. The last is important when considering British interglacial assemblages, because most amphibian and reptile species result from re-immigration from continental mainland refugia. In subsequent interglacials, such as the Last (MIS 5e), flooding of the Strait of Dover and the southern North Sea basin early in the interglacial would have presented a formidable barrier inhibiting the northward spread of many thermophilous amphibians and reptiles species into Britain (Holman, 1993). The influence of the English Channel and the southern North Sea as dispersal barriers can be seen in the composition of the modern British herpetofauna, which is impoverished when compared with those of neighbouring countries (Arnold and Ovenden, 2002). Currently, eleven amphibian and reptile species have ranges that today reach only as far as the northwestern seaboard of continental Europe and do not extend into Britain. It seems likely that these taxa were late colonisers, which did not reach northern Europe from their refugia before Britain became separated from mainland Europe between 8000 and 7000 years BP (Lambeck, 1995). Others species such as *Emys orbicularis* (Stuart, 1979), *Rana arvalis*, *R. dalmatina* and *R. lessonae* (Gleed-Owen, 2000; Beebee *et al*., 2005) were able to colonise, but subsequently became extinct due to climatic change and/or habitat loss. During the early Middle Pleistocene, however, a marine barrier to colonisation did not exist and terrestrial plants and animals would have been able to enter Britain by way of the 'Wealden-Artois landbridge' (Gibbard, 1995). This landbridge, and the extensive delta top in the southern North Sea embayment (Funnell, 1995) would have presented an ecologically varied landscape that included chalk hills, coastal dunes and extensive wetlands of salt marsh, river floodplains and deltas.

Other factors (i.e. taphonomy, sample size and local ecology) are unlikely to have had a significant influence on the composition of the West Runton herpetofauna. Firstly, the herpetofaunal assemblage is very large (several thousand specimens), resulting from predator accumulation (cf. Mayhew, 1977), natural mortality within the waterbody, together with material washed into the channel during flood events. Secondly, the local environment and depositional conditions are similar to other British Pleistocene sites with extensive herpetofaunas (e.g. Cudmore Grove, Roe *et al*., in prep.). Consequently, the species composition is unaffected by the confounding influences of palaeogeographical barriers and the biases introduced by selective taphonomic factors or insufficient sample size. Therefore, the West Runton assemblage is probably an accurate reflection of the contemporary amphibians and reptiles. The conspicuous absence of strong thermophiles is therefore significant and has climatic implications. It provides compelling evidence that the early temperate sub-stage of the Cromerian interglacial was not particularly warm and that summer temperatures were no warmer than those of East Anglia at the present day. The presence of tree frog, but the absence of strong thermophiles suggests summer temperatures were no higher than about 16° C, a conclusion supported by other faunal evidence, palaeobotany and isotopic data (West, 1980; Coope, 2000; Davies *et al*., 2000; Preece and Parfitt, 2000; Stuart and Lister, 2001).

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REPORTS

THE 8TH EUROPEAN SUBFOSSIL CHIRONOMID WORKSHOP, REYKJAVÍK, 7-8TH MAY 2007

Since first meeting in Helsinki in 1997, European subfossil chironomid workers have held workshops every year or two to discuss progress and problems. More recently, many of these meetings have been attended by our North American colleagues (or 'dead headers'), adding greatly to the discussions. This was the first time we had met as a community on 'neutral territory', i.e. the middle of the North Atlantic. Iceland is an exceptional place to visit, as was demonstrated on an introductory field visit for the majority of those attending the workshop. Our hosts, Jón Ólafsson and Thora Hrafnsdóttir took us on a tour around the SW peninsula, noting the geothermal geology, wildlife (fulmars, kittiwakes, and gannets for the bad birdwatchers) and a splendid crater lake of pH 2. At the end of the fieldtrip we were treated to a well earned soak in the Blue Lagoon to prepare us for the discussions over the next two days.

Palaeoenvironmental reconstructions from analyses of subfossil head capsules are now well established in mainstream and specialist literature, and are often incorporated as key proxies in scientific debates at the forefront of research agendas. However, as with any technique there is a need to constantly discuss progress and problems, and these workshops provide the ideal vehicle with which to undertake this. The discussion did not shirk from debating key, sometimes controversial issues, and while much of the questioning/debating was critical, it was most certainly inclusive, fair and good-humoured. Workshops should be a focus on discussion and debate, and this one succeeded admirably. The theme of the workshop was on the *Cricotopus*/*Orthocladius* dilemma, and whether we can split these genera successfully within our subfossil taxonomy. It has been traditional within these workshops to always devote a large chunk of time to taxonomic debates, and while this workshop was no different (we all recognise that taxonomy underpins our environmental reconstructions) we also managed to debate equally important aspects of our research, especially those related to the numerical techniques we use and ecological complexity within palaeoecology.

The workshop presentations were focussed around 3 main themes: environmental reconstructions (mainly climate based), ecological functioning, and taxonomy. The reconstruction talks focussed on a range of sites and timescales. Records from the last 1-2 millennia were discussed by **Naomi Holmes**, **Yarrow Axford**, **Elizabeth Thomas** (all Icelandic sites) and **Nicholas Rolland** (a site in Nanavut, Canada), whereas **David Porinchu** considered records covering the last 150 years from western USA. The Arctic was a key theme of this meeting, perhaps no surprise as this workshop followed the Arctic workshop, held in Skaftafell, SW Iceland, two days previously, and presentations from **Gaute Velle**, **Donna Francis**, **Isabelle Larocque** and **Marie-Claude Fortin** all discussed work from projects they are currently working on in this region. It was not all Arctic science though, as **Craig Woodward** showed us his 'Diptera down-under', discussing his research on New Zealand sub-fossil chironomids as indicators for long-term environmental change. Many of the subfossil sequences presented were analysed in terms of quantitative temperature reconstructions. **Steve Brooks** assessed how reliable these chironomid-inferred temperature reconstructions are in terms of the late-glacial and Holocene in NW Europe. The main consensus was that late-glacial records seemed to agree well although some regional differences exist, whereas there is far less agreement between Holocene temperature reconstructions. This is thought to be mainly due to the range of lake developmental pathways that exist, for example changing pH throughout the Holocene will also influence chironomid communities. Discussion focussed on whether we are actually at the limit of what we can achieve regarding the magnitude of error estimates for Holocene thermal changes, and that 1-2 ºC errors were actually quite good when we consider the complex ecological functioning underlying chironomid response to environmental change. These points withstanding, there are clearly some Holocene temperature reconstructions that appear to work well and show good agreement with other (quantitative) proxy evidence.

The workshop highlighted the need to improve our understanding of the role of chironomids in ecological functioning, as well as generating autoecological data. **Klaus Brodersen** illustrated this point succinctly by presenting new data on *Corynocera ambigua* ecology. He combined oxygen respiration experiments on the larvae with stable isotope data in order to try to understand the ecological mechanisms through which this taxon is governed. The results suggested that these processes are complex, and Klaus noted that while we now have good data for this taxon, we still have many other taxa for which we require experimental data. Other talks relating to ecological functioning focussed on the role of macrophytes and chironomid communities in the UK (**Peter Langdon**), lake-climate interactions (**Wing Wai Sung**), and analyses of the chironomid community structure in Icelandic lakes (**Thora Hrafnsdóttir**). Discussion focussed on the ecodynamics of Lake Myvatn (led by **Árni Einarsson**) and an understanding of ecological scaling and complexity in palaeoecology (led by **Gaute Velle** and **Klaus Brodersen**), where the challenge of validating and interpreting the results of inference models was discussed. One conclusion was that when using inference models, taxon optima can change depending on what other environmental factors change, as well as what other taxa are present; or in other words palaeoecological simplicity may need to be considered more carefully in the face of ecological complexity.

Taxonomic discussions did, as usual, form the brunt of much of the discussion, and were led by (in no particular order) **Jón Ólafsson**, **Thora Hrafnsdóttir**, **Ian Walker** and **Oliver Heiri**. New taxonomic guides have recently been produced, including Larocque and Rolland (2006), Brooks *et al*. (2007), and a Provisional Interactive key to Larval Chironomidae by Pete Cranston (available on CD from the author at: pscranston@ucdavis.edu), which stimulated much debate. This was an important discussion, for both new and more experienced chironomid palaeoecologists, and a number of key points were identified as important to consider:

- Taxonomy provides a unique and stable name for every taxon and it underlies studies in ecology, palaeoecology, biogeography etc. Results (e.g. reconstructions) are dependent upon the correct use of taxonomy, i.e. correct identifications. We want as high a resolution in our taxonomic data as possible, however, we should be conservative in our identifications, and to guard against over-splitting.
- Correct taxonomy is especially important in terms of retrieving the correct ecological information about chironomid taxa from the literature.
- Consistent taxonomy is important for training set data and core data in order to obtain sound reconstructions.
- The term ‘morphotype’ or ‘type’ is used to refer to a taxon with a particular morphology, but there may be more than one species included and these are indistinguishable based on subfossil features.

- At present much of the fossil taxonomy is based on fossil examples, not reared/living larvae. Ways to link the larvae to the adults would be through rearing and DNA methods.
- In future identification guides we could add photos of reared larvae next to photos of fossil larvae. There are few reared specimens in collections, so these may not be representative of the species (thus we have little or no information on intra-specific variation). Also, the photos of fossil larvae are still needed because these are more representative of what palaeoecologists see under the microscope.
- In our publications it is important to cite the key used or the description of a taxon, so others can refer to this in the future as well as to prevent misconception in the future. We should also take photographs, and record (publish if possible) 'odd' specimens found.

One important topic of debate, and the workshop theme, was the possibilty of differentiating *Cricotopus*/*Orthocladius*/*Paratrichocladius* (led by **Oliver Heiri**). It is impossible to do this at the generic level if we cannot make a species-level diagnosis (on fossil material), but some species (or at least morphotypes) are distinctive. Numerous morphotypes that can be consistently distinguished are described in the new taxonomic guide by Brooks *et al.* (2007). The guide provides an essential standard for our community at the present time. One problem is that different instars may falsely appear to be different morphotypes (e.g. for *Pseudodiamesa*) and it is essential to keep an eye out for this. The "dilemma" is that we must choose between potentially committing "type II" errors (in which we do not recognise differences that actually exist) and "type I" errors (in which we see differences that do not actually exist). Some suggestions as how to proceed included:

1. Test existing datasets at high taxonomic resolution. Send resulting ideas, pictures, etc amongst our community.
2. Check the literature for ecological notes regarding different taxa.
3. Check for co-existence with other taxa – a source of clues regarding the ecology of morphotypes.
4. Check trophic optima vs. temperature optima.
5. Test model performance at different taxonomic resolutions. This will save time if splitting does not add information. Note that lumping may yield more precise but less accurate models. Splitting may be less worthwhile for transfer-function based reconstructions, but could be very useful for palaeoecology (studies of diversity, palaeogeography, etc.).

Overall this was an excellent meeting, and as a research group we got to grips with many of the key issues that affect our discipline, much of which above. Warm thanks go to Jón Ólafsson and Thora Hrafnsdóttir who organised the workshop, the Institute of Freshwater Fisheries, where the meeting was held, and to Hilmar Malmquist who organised an excellent reception at the Natural History Museum of Kopavogur where we sampled such delicacies as dried fish and rotting shark (hákarl) washed down with shots of brennivín (translation: Black Death). Delicious.

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IGCP 495 (UK WORKING GROUP) AND INQUA COMMISSION ON COASTAL AND MARINE PROCESSES (NW EUROPE WORKING GROUP) JOINT SEA-LEVEL MEETING AND FIELDTRIP

St Andrews, Scotland 1st – 4th July 2007

The scenic coastal city of St Andrews in Scotland provided the setting for the third joint meeting of the UK working group of IGCP Project 495 and the NW Europe working group of the INQUA commission on coastal and marine processes. The conference organisers, **Sue Dawson** (University of St Andrews) and **Alastair Dawson** (University of Aberdeen) are congratulated for their tremendous efforts in bringing together over 20 colleagues from around the UK and NW Europe to St Andrews for a one-day scientific session followed by a two-day fieldtrip to visit coastal sites across eastern Fife and Tayside.

Colleagues were welcomed to the scientific paper session by **Roland Gehrels** (Plymouth) who dedicated the meeting to Simon Jennings (Figure 1), who died on October 3rd 2006. Simon, who was based at London's Metropolitan University, devoted his working life to the study of shingle beaches and sea-level change. As an active member of the UK IGCP sea-level working group, Simon will be sorely missed by both friends and colleagues alike.

The scientific session opened with a series of papers that examined human

Figure 1:

coastal interactions. The first by **Cecile Baeteman** (Belgium Geological Survey) examined Roman peat-extraction pits as possible evidence for the timing of coastal changes along the Belgium coastal plain. The second, by **David Dawson** (Plymouth), examined the impact of future sea-level rise and increased storminess on the London-Penzance railway line – a topic which has wide ranging implications for government policy. The session continued with presentations from **Helene Burningham** (UCL) who detailed work on inlet-barrier behaviour in northwest Ireland, and **Peter Vos** (Geological Survey of the Netherlands) who presented evidence for the development of the Oer-IJ estuary in Holland.

The development of microfossil-based transfer functions for quantitatively reconstructing changes in relative sea level (RSL) has been a major theme at recent IGCP 495 meetings. In the second scientific session of the day, **Sarah Woodroffe** (Durham) illustrated the potential of this approach in the salt marshes of Greenland. Here, small pockets of salt marsh are being investigated in terms of their sedimentary, microfossil and isotopic characteristics for the first time. Staying with a northern theme, **Alastair Dawson** then presented chemistry data from the GISP2 ice core and combined this with historical records of past climate to highlight a major change in North Atlantic circulation around 1420 AD. Moving on, **David Smith** (Oxford) outlined the analysis of high quality altitude data using Gaussian Quadratic Trend Surface Analysis. Using this technique, patterns of glacio-isostatic uplift for displaced shorelines around the UK and Ireland were determined and are argued to be the most accurate yet produced for a glacio-isostatically uplifting area. In the last presentation of the session, **Jasper Knight** (Exeter) demonstrated the links between (raised) shoreline features and sea level from a sedimentological viewpoint, using examples from the Cornish and southern Irish coastlines.

The final scientific session of the day focussed on the theme of methodologies for reconstructing and dating. The session began with a keynote address by **Michael Tooley** (St Andrews and Kingston) who provided a review of the development of the Troels-Smith scheme of stratigraphic classification. Michael's presentation stimulated a lively debate on the advantages and disadvantages of using the Troels-Smith scheme in the context of modern computing and graphical developments. A debate which we re-visited several times during the field days. The theme of the session then continued with two presentations which examined the use of glacial rebound models in sea-level research. The first, by **Antony Brooks** (Trinity College Dublin), used sea-level data from Ireland's west coast to constrain models of Irish Ice Sheet evolution prior to the Last Glacial Maximum (LGM). The second, by **Robin Edwards** (Trinity College Dublin), highlighted the controversy regarding high Irish relative sea levels by presenting field data which is in disagreement with existing glacial rebound models. Four papers followed which addressed methodologies for reconstructing and dating in salt-marsh environments. Sarah Woodroffe had earlier demonstrated the potential use of quantitative reconstructions in salt marshes in Greenland and **Antony Long** (Durham) went on to present the first RSL reconstructions for the Greenland salt marshes using this approach. **Roland Gehrels** demonstrated the use of sediment fingerprinting for reconstructing recent sedimentation history in the salt marshes of the Avon estuary in Devon. **Katie Szkornik** (Keele) presented a series of RSL curves for western Denmark, reconstructed using both a quantitative (diatom-based transfer function) and a more traditional, lithological, approach. Moving on, **Kate Southall** (Trinity College Dublin) further highlighted the potential of the transfer function approach in Dublin Bay, eastern Ireland, this time using foraminifera as the preferred microfossil group. The final paper of the day moved away from salt-marsh environments, and **Sytze van Heteran** (Geological Survey of the Netherlands) demonstrated the use of 3D-seismics as a new way to reconstruct Holocene coastal systems.

Posters were displayed throughout the day and allowed delegates to view and discuss further work which addressed the themes of IGCP Project 495. **Phillip Teasdale** (Brighton) presented a detailed geochemical study investigating sedimentation rates in the salt marshes of Argyll, Western Scotland and **Katie Szkornik** demonstrated the use of diatoms as sea-level indicators in the Ho Bugt embayment, western Denmark.

Despite the recent poor weather, the first day of the field trip began bright and early under warm sunny skies. Leaving St Andrews we headed south towards the Forth Estuary to our first stop at Cocklemill Burn. The stratigraphic sections along the Cocklemill Burn have attracted attention since the late 1800s and display records of sedimentary environments extending from the Late Devensian to the present. Here we visited the sections that have formed the basis of studies by Tooley and Smith and more recently by Robinson *et al*. In these sequences, *limnus* is overlain by a series of estuarine/marine sands and capped by aeolian sand. Within the marine sands, the Holocene Storegga Slide tsunami deposits are recorded. These sections provided the stimulus for more lively debate on the present-day applicability of the Troels-Smith sediment classification scheme. After a discussion on the reliability of the ^{14}C and OSL chronologies of Cocklemill Burn, we climbed the flight of raised shoreline features to Kincraig Point, where we were presented with spectacular views over the Outer Forth estuary (Figure 2). This coast was one of the first areas of eastern Scotland to undergo deglaciation and the raised shoreline features

Figure 2:

are interpreted as having formed *c*. 16 – 17 kyr. The landforms provided an opportunity to discuss the methodology used in the identification and measurement of raised shoreline features.

After a sun-drenched lunch break in the picturesque coastal village of Elie (Figure 3), we returned briefly to St Andrews, to our next stop overlooking the famous golf course. Undaunted by a short rain shower, the location provided us with an overview of the foreshore stratigraphy of the St Andrews area, where a cuspate foreland is well-developed, and stimulated discussion on the status of possible interglacial shore platforms. As with many of the sites visited during the two field days, the lack of detailed investigation and a robust chronology limit our understanding of the coastal evolution of the area. Resisting the temptation to core the golf course, we journeyed northwards to our next stop in the valley of the River Eden. The stratigraphic sequences in the Eden valley were last investigated by Chisholm in 1971. However, a lack of radiocarbon dating to constrain the age of these deposits means that the Holocene evolution of the area, and associated RSL changes, are poorly understood. Palaeoenvironmental reconstruction coupled with AMS radiocarbon dating over the next few years by Dawson and Dawson will enable the limited dates available to be placed in their wider context. As with other locations visited over the two days, this stop provided an opportunity to highlight the great potential for new work in this region.

Figure 3:

After a stimulating day in the field, the evening was rounded off with a trip to Discovery Point in Dundee, where Captain Scott's famous polar exploration ship RSS Discovery is berthed and where the conference dinner was served. We were greeted onboard the ship with a champagne reception before being taken on a guided tour of the vessel. Launched for the National Antarctic Expedition of 1901 under the command of Captain Scott, Discovery was one of the last wooden three-masted ships built in Britain, and the first to be constructed specifically for scientific research. Highlights of the tour included viewing the laboratory area and cabins that belonged to the scientists onboard the vessel, including the cabin belonging to Captain Scott himself. The ship provided a spectacular backdrop to the conference dinner, held in the adjoining Discovery museum. Whilst enjoying our haggis, Antony Long recalled happy memories of our recently lost colleagues, Simon Jennings, to whom this meeting was dedicated, and Rhodes Fairbridge, best known for his research on coral reefs and shorelines and the 'Fairbridge' sea-level curve.

Following the delicious conference dinner, day two of the field trip focused on former RSL changes in the Tay area and also considered broader issues relevant to RSL changes in Scotland as a whole. In western Scotland, analyses by Shennen et al. for the Arisaig area using isolation basins have greatly aided our understanding of RSL changes in the area. However, these studies are not easily comparable with the classic work of Smith and Cullingford for eastern Scotland, based on geomorphological mapping and lithological studies. In addition, these contrasting methodologies are not easily replicable between east and west. The east lacks the isolation basin sequences used by Shennan, and the west lacks large estuarine sediment sequences comparable to the Forth and the Tay. With these debates in mind, our first stop of the day was at the Gallowflats Claypit. Here, during the Lateglacial, marine and estuarine sedimentation was dominated by the deposition of laminated pink clays and silts, known as the Errol Beds. This location provided us with the opportunity to discuss the relations between the earlier (Lateglacial) and younger (Holocene) raised marine sequences as well as discussing the debate surrounding the existence of the Perth Readvance.

Our second stop of the day, on the southern side of the Tay estuary close to the village of Newburgh, provided us with a panoramic view across the estuary. Here we discussed the relations between the raised marine strata along the southern and northern sides of the Tay. Along the northern embankment, extensive carseland deposits are found, associated with the large volumes of sediment available during the early and middle Holocene. However, along the southern bank of the estuary these deposits are found only in small pockets, such as those viewed close to Newburgh. After another stimulating morning in the field, we made the short journey to Tentsmuir Forest for lunch. Here, another example of widespread dune formation was seen, although the planting of pine plantations in the 1920s by the Forestry Commission made interpretation of the dune suites more difficult. Now, with many of us feeling slightly sunburnt, we headed back to Leuchars rail station where the meeting ended and colleagues bid one another farewell.

On behalf of all delegates who attended this meeting, it remains to pay a heart-felt thanks to the conference organisers Alastair and Sue Dawson for running such a splendid meeting. Thanks also go to Michael Tooley and David Smith for their considerable and much-valued contributions to the two field days. Continuing in the spirit of previous IGCP meetings, the combination of excellent and illuminating science, lively debate and a relaxed and informal atmosphere means that all of us will have fond memories of the St Andrews meeting for many years to come.

Further information on IGCP495 "Quaternary Land-Ocean Interactions: Driving Mechanisms and Coastal Responses" can be obtained from the UK National Correspondent, Dr. Roland Gehrels (University of Plymouth, w.r.gehrels@plymouth.ac.uk) or found online at:

http://www.geography.dur.ac.uk/Projects/Default.aspx?alias=www.geography.dur.ac.uk/projects/igcp495

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THE 6TH INTERNATIONAL QUATERNARY RESEARCH ASSOCIATION POSTGRADUATE SYMPOSIUM

Copenhagen, Denmark
21st – 24th August 2007

This year's symposium was held at the Institute for Geology, University of Copenhagen and expertly organised by **Jesper Olsen** and **Mikkel Ulfeldt Hede**.

21st August:

The conference was opened with a mystery tour across Copenhagen, which took the delegates to a floating drinks reception, on a boat trip around Copenhagen's harbour and canals. This provided a chance for everyone to get to know each other as well as an opportunity to see some of the historical sights of the city.

22nd August:

The conference was opened by the first guest speaker, **Professor J.P. Steffensen**, who gave us an introduction to atmospheric sedimentology, as recorded in the polar ice core records. Professor Steffensen took us through an "ice core shopping list", illustrating the "hows" and the "whys" of his Greenland ice core research. We were shown some striking images of the practicalities of coring and carrying out lab work on more than 3km of ice in such extreme conditions. The importance of the ice cores in providing both an understanding of global climates of the past and an insight into future scenarios was discussed, and some exciting new discoveries presented.

Session 1: Geochronology

- **Benedict Reinardy** (Swansea) opened, taking us straight to the Antarctic to consider how the offshore sedimentary palaeointensity record can help us to build chronologies for ice retreat on the Larsen Shelf.
- **Inger Seierstad** (Copenhagen) took us back north to Greenland, with an introduction to tephrochronology and the search for volcanic marker layers in MIS 3 section of the NGRIP ice core.
- **Christine Lane** (Oxford) discussed the need for improved characterisation of fine-grained volcanic ash deposits and methods to improve tephrostratigraphical correlations.
- **Anna Oh** (Oxford) presented early results from a chronological and palaeoenvironmental study of punctuated occupation of Moroccan Mid Palaeolithic cave sites.

- **Cilia Derese** (Ghent) concluded the geochronological session with an interesting discussion of the difficulties of combining multiple dating methods, presenting OSL results on aeolian sands in NE Belgium.

Session 2: Environmental archaeology and Palaeoecology 1

- The session opened with **Emily Forster** (Southampton), who questioned whether the British dark ages really saw a cultural decline after the Roman withdrawal, through the use of palaeoecological analysis of lake sediments from the Lake District.
- **Alice Milner** (Leeds) then gave us an introduction to her work on Tenaghi Philippon in Greece, hoping to increase the resolution on Europe's longest continual record of vegetation changes from this region.
- We remained in Greece for **Tim Jones'** (Leeds) talk on lake level changes as a proxy for local environmental and global climatic change in the Late Pleistocene and Holocene sediments of Lake Ioannina.
- **Bronwen Whitney** (Edinburgh) gave a fascinating talk on the 45ka fossil pollen record of Laguna La Gaiba in Bolivia and the climatic changes recorded by the shifting vegetation.
- **Michelle Farrell** (Hull) closed the session with a beautifully illustrated comparison of the environmental and archaeological records from Orkney, questioning the long standing theory of a Bronze Age decline.

Session 3: Palaeoecology 2

- **Claire Twiddle** (Exeter) opened up the final session of the first day with a new approach to pollen analysis. Using data from Inshriach Forest, Scotland, Claire illustrated the potential of mechanistic models in building quantitative maps of pollen transfer and development over time.
- **Anthony Ruter** (Copenhagen) followed with a high resolution, multi-proxy approach to understanding the paelaeoecology and landscape modification around Lake Tissø, Denmark, during the Mesolithic-Neolithic transition.
- Day one closed with last year's presentation prize winner, **Barnaby Crocker** (Royal Holloway), who demonstrated the use of detailed bone morphology analysis as a potential indicator of age and provenance in the Pleistocene woolly rhinoceros.

23rd August:

Everyone was in high spirits on the second day of the conference after an evening spent at Tivoli, Copenhagen's unique theme park in the centre of the city.

Session 4: Climate reconstruction

- **Deborah McCormack** (Manchester) began the first session on climate reconstruction, taking us to the Torridon area of Scotland; where she is using a combination of landform mapping, LiDAR-derived DEMs and cosmogenic dating of glacial deposits to analyse glacial activity during the Lock Lomond Stadial.
- **Paul Butler** (Bangor) presented an enlightening talk on the use of banding patterns in the shells of benthic mollusc (*Arctica islandica)* as a high resolution proxy for environmental changes in the Irish Sea.
- **Jesper Olsen** (Aarhus) then discussed his research on Bliden Lake deposits, Denmark, to reconstruct changes in lake level and precipitation during the Holocene, with comparisons to regional trends.

Session 5: Climate reconstruction

- The session on climate reconstruction continued after tea with an interesting talk from **Mikkel Ulfeldt Hede** (Copenhagen), looking at sediment cores from Lake Højby Sø, Denmark, in order to constrain the factors driving the Mesolithic-Neolithic transition in Denmark.
- **Ningning Li** (Liverpool) gave the first of a series of talks involving loess, describing her use of geochemical methods to reconstruct Quaternary environmental changes associated with human activity in China.
- **Marie-Louise Siggaard-Andersen** (Copenhagen) gave a fascinating talk on the analysis of Chinese loess from within the Greenland Ice Core as a means of determining lake level changes in Western China.
- **Daisy Tysmans** (Brussels) concluded this session with an insightful talk on the heterogeneity to be found within ‘homogeneous’ loess deposits, through the use of Automated Dynamic Image Analysis (ADIA).

Session 6: Glaciology and sedimentology

- **Lorna Linch** (Queen Mary) gave a dynamic talk on the start of her research into the macroscopic and micromorphological signal of iceberg scour within the glaciolacustrine sediments of Glacial Lake Agassiz, Canada.
- **Aidan Parkes** (Keele) provided an exciting introduction into his thesis on the reconstruction of ice-marginal geomorphological processes in Britain, and the identification of associated basal conditions.
- **Susanne Lilja Buchardt** (Copenhagen) presented a fascinating talk on the observation, variation and rates of basal melting found within Northern Greenland.

- The final talk of the session returned to the UK, where **Hannah Mathers** (Edinburgh/BGS) gave a confident talk on her work to resolve the dynamics and thermal regime of the British Ice Sheet in NW Scotland and The Minch, through the use of cosmogenic isotope analysis and field observations.

This was followed by a talk from our second guest speaker, **Professor Minik Thorleif Rosing**, from The Natural History Museum of Denmark, University of Copenhagen. This fascinating talk closed the session with a step back in time and some new concepts for us all. Professor Rosing introduced us to the idea that life is responsible for the geological development of the planet earth as we know it. We were taken on a journey through time, looking at the chemical processes responsible for the physical and biological development of our planet. Beginning in Greenland, with rocks around 3.8Ma old, we were shown evidence for photosynthesis during the Early PreCambrian period, suggesting life has existed on earth longer than previously believed. Professor Rosing then demonstrated the immense power of photosynthesis in producing energy and an atmosphere, which is capable of altering the chemistry of rocks and driving both planetary and biological evolution.

However, the day was not complete without a brief introduction to the field day, which was to be led by **Dr Stig Schack Pedersen**, senior geologist at the Geological Survey of Denmark and Greenland. Dr Pedersen described the site that we were going to visit – Møns Klint - the most famous and spectacular geology site in Denmark! Comprising largely of Cretaceous chalk, Møns Klint is a large scale example of glacial tectonics, displaying a complex of thrust faults, antiformal stacks and imbricate fans, formed between 17-14ka. Today the cliffs are prone to collapse (most recently in January 2007) but the site is still widely popular with tourists, fossil hunters and geologists alike.

Kathryn Rose and Christine Lane completed the day's events by thanking Jesper Olsen and Mikkel Ulfeldt Hede for managing such a well organised and eventful conference. Their hard work was very much appreciated, as was the attendance of all the delegates at the conference. Special thanks were also given to Professor J.P. Steffensen and Professor Minik Thorleif Rosing for their insightful keynote addresses.

The standard of delegate presentations was again high and the variety of subject matter made for a fascinating two days. This year the prize for the best presentation was awarded to **Lorna Linch** for her presentation on the microscopic structure of glacigenic sediments (see below). Voting was also carried out for the location of the next postgraduate symposium and the next representative. The University of Liverpool were successful in their bid to hold the 7th symposium in 2008. In addition, Lorna Linch was voted in as the new postgraduate representative to replace Kathryn Rose, after her two year term. Following this, the conference dinner concluded the two days of talks. It was held at the restaurant 'Viva', a boat which, located on one of the many canals of Copenhagen, provided picturesque views of the city.

24th August:

Even with the merriment of the conference dinner, everyone was up and ready for the early start to the field trip. On the bus, Dr Pedersen welcomed us with the day's schedule, pointed out local features of interest, and kindly gave us three geological maps of the area we were to be visiting, including detailed diagrams on the thrust sequences. On arrival at Møns Klint we were told that Charles Lyell was one of the first to look at the chalk stratigraphy of Europe and comment that the formation of a Scandinavian ice sheet would provide a good explanation for Møns Klint as a glaciotectonic feature. Dr Pedersen provided amusing anecdotal accounts of the arguments that had ensued concerning the cliff formation, sufficient to almost capsize Lyell's boat! We were then put through our paces as Dr Pedersen strode along the cliff top, pipe in hand, highlighting significant features, such as the glacial sediments, chalk overhangs, evidence of mass movement, and the remains of the 'Summer Spear' (a famous chalk stack that had collapsed). The views were incredible, with the clear east-west strike of the bedding visible out to sea, in waters that were milky with chalk.

Next it was 500 steps down a wooden staircase to the base of the cliffs! The sun finally appeared as Dr Pedersen guided us along the shore pointing out the key areas of tectonic activity. We were able to view an overturned anticline and imbricated zone to the south, an area of foreland thrusting further north, interspersed with fans of glaciolacustrine clays and meltwater sands folded up within the basin. At lunch we were able to scour the shore for fossils and note the scale of landslides in this area, as we viewed the chalk peninsular that still remained following a major landslide in 2003. Dr Pedersen highlighted a zone of superimposed deformation resulting from a change in the direction of the ice sheet advance, before we headed back up the stairwell to the cliff top. 500 steps later we were all relieved to see the strategic location of an ice cream van at the summit! However, our final stop was further along the cliff to the Queen's Chair, an impressive antiformal stack. The area provided fantastic views back down along the cliff sequence, emphasising the complexity of glaciotectonic activity at this site.

Jesper Olsen and Mikkel Ulfeldt Hede expressed our great thanks to Dr Stig Schack Pedersen for leading the day's field trip with such enthusiasm and in-depth knowledge of the history of the area. It was a fitting end to a very successful symposium.

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QRA POSTGRADUATE SYMPOSIUM, AWARD FOR BEST PRESENTATION

A MICROMORPHOLOGICAL INVESTIGATION OF DEFORMATION STRUCTURES BENEATH ICEBERG SCOURS

Iceberg scouring is a post-depositional mechanical process caused by free-drifting icebergs that periodically contact unconsolidated lake floor or seabed sediment when their draft exceeds water depth. Once grounded, if the iceberg continues to be driven forward by waves, currents and wind, its keel will plough through surficial sediments in an identical manner in both glaciolacustrine and glaciomarine environments. This action creates characteristically curvilinear or straight scour marks that consist normally of two raised embankments (berms) of sediment on either side of a central trough, hundreds of metres to several kilometres in length, tens of centimetres to hundreds of metres in width, and centimetres to metres in depth.

The effects of iceberg scouring are of relevance to planning the construction of sea/lake bed structures such as telecommunications cables and oil or gas pipelines. As a result, great efforts have been made in understanding scouring and grounding processes from sonograph records and diving operations using submersibles. In turn, this has lead to a wealth of information on offshore iceberg scour surface morphology. What remains relatively poorly understood, however, is what iceberg scours look like in stratigraphic section where surface morphological characteristics are absent (e.g. through deterioration or burial) from both the Quaternary and pre-Quaternary geological record.

The primary aim of this investigation is to establish a definitive set of diagnostic keys for identifying iceberg scours in the Quaternary and pre-Quaternary rock record by macroscopically and microscopically (2D, 3D and Metripol stress mapping) examining a) Late Pleistocene sub-scour sediments from former Glacial Lake Agassiz and the North Sea, b) actively iceberg sub-scoured sediments from cores previously retrieved from the Antarctic and, c) thin sections (already in the Queen Mary University of London collection) suspected of showing iceberg sub-scoured sediments.

This analysis will in turn enable palaeoenvironmental reconstructions including glacial activity (e.g. ice margin extents, deglaciation etc.), the presence of large, deep water bodies, the presence of fast flowing outlet glaciers, palaeocurrent and palaeowind directions and reinterpretation of sediments previously interpreted as subglacial. In addition, all information from this project may eventually aid structural engineering on Arctic shelves, which could be of great value to oil and gas companies given the anticipated increase in number, size and frequency of icebergs within areas of petroleum exploration and extraction as a result of climate change.

The project is funded by a NERC PhD studentship in the Department of Geography, Queen Mary University of London. Project supervisors are Professor Jaap van der Meer (QMUL), Dr Simon Carr (QMUL) and Professor John Menzies (Brock University, St Catharines, Ontario).

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Queen Mary, University of London

QUATERNARY RESEARCH FUND

THE SEDIMENTOLOGICAL AND GEOPHYSICAL ANATOMY OF THE 'PIGEON POINT' DRUMLIN IN CLEW BAY, CO. MAYO, IRELAND

Background and Rationale

The drumlin (Figure 1) remains one of the most intriguing and elusive features of the subglacial landscape. The landform (as a subglacial feature) has been studied for well over a century and although we continue to increase our knowledge of processes that operate at the glacier-substrate interface (see e.g. Boulton, 1987, 1996; Alley, 2000; Piotrowski *et al*., 2004; Evans *et al*., 2006; Smith *et al*., 2007), the exact mechanisms by which the conspicuous inverted spoon-shaped hills are formed are still poorly understood. There are two obvious reasons for this: 1) the lack of *in situ* observations in the inaccessible subglacial environment, and, 2) the great variability – often even within one single drumlin field - in morphometry, sediment composition, sediment architecture and structures.

Figure 1: Pigeon Point drumlin, Co. Mayo, western Ireland (view to the south, Croagh Patrick in the background).

There is an ongoing quest for the ultimate, unifying theory that should explain the genesis of drumlins in general. Three avenues have traditionally been explored (see Menzies and Shilts, 2002): 1) subglacial erosion and moulding of pre-existing sediments, 2) subglacial deposition and substrate deformation, and 3) catastrophic subglacial meltwater drainage and associated deposition. Today, the focus seems to be on the idea that anisotropies in basal ice or substrate (i.e., deformation, avenue 2) could lead to flow instabilities and drumlinisation of the glacier bed. Although some modelling successes have been reported (e.g. Hindmarsh, 1998; Fowler, 2000), such theoretical studies have yet to provide a solution for the sedimentological and structural-architectural variability in drumlins as recorded in the field.

Methodology and approach

We believe that the complexity of the drumlin problem calls for a multi-disciplinary approach. In this study we investigate the sediment make-up and the geophysical anatomy of the Pigeon Point drumlin in Clew Bay (Figure 1). We expand on work by Kulessa *et al*. (in press), who conducted the first known seismic study on a drumlin in Northern Ireland. The current study would be the first to attempt integrating geomorphological, sedimentological and geophysical data from a drumlin.

Preliminary results: work in progress

The Pigeon Point drumlin is *c*. 735 m long, *c*. 265m wide and *c*. 33m high (Figure 2). More than half of its basal periphery is exposed through tidal wave action, which gave us good access to the sediments and which should allow a good correlation of sedimentological and geophysical data.

A total of nine clast fabric analyses (N=50) were carried out around the drumlin. The first assessment of the data reveals that preferred orientations of clast a-axes are spatially variably. Samples from the western end of the drumlin show primary (or secondary) modes at more or less right angles to the drumlin long axis, whereas along the flanks of the drumlin preferred orientations tend to be parallel or slightly oblique to the drumlin long axis. Shape and roundness characteristics of all clasts were recorded to investigate possible effects on orientation and fabric strength.

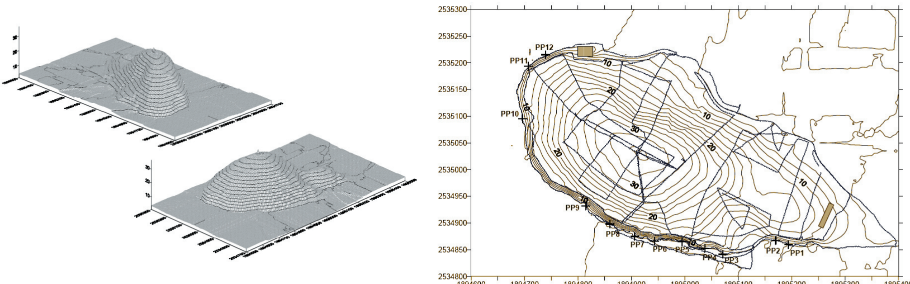

Figure 2: Results of a detailed GPS survey of the Pigeon point drumlin. Note that cliffs have developed on the southern flank as well as around the western end. PP numbers refer to locations of sedimentary logs or clast fabric analysis

The twelve recorded sedimentological logs suggest that the bulk of the landform is composed of silty to sandy, matrix-supported, limestone-derived diamicton. Occasional stratification consists of discontinuous laminae or dm-scale clayey and gravelly lenses or boudins. Such structures suggest that the diamicton has been subglacially deformed, an idea that seems to be supported by the observation of disrupted, apparently glacitectonised bedrock towards the eastern end of the drumlin (see Figure 3a).

The south and west sides of the drumlin show remnants of a partly cemented composite unit consisting of inclined stratified gravels and sands (Figure 3b). It comprises fining-up series of subrounded, coarse to fine gravels and haphazardly arranged subangular to subrounded cobbles and boulders. The character of the sediments suggests deposition by running (melt)water. Where this unit was eroded away (blocks on beach), the main diamicton is exposed (Figure 3b). Close examination suggests that the sands and gravels overlie the main diamicton. It looks as they form a 'shell' that may once have encompassed the entire drumlin form. It seems unlikely that this unit forms the core of the Pigeon Point drumlin (Hart, 1997; cf. Menzies and Brand, 2007). Our geophysical work should provide some insight in this matter (see below).

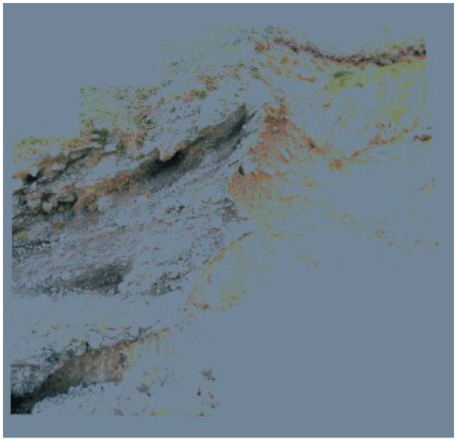

Figure 3a (left): Glacitectonised limestone grading into clast-supported diamicton. Note inclined structure offsetting fractured boulder. Knife for scale.

Figure 3b (right): Contact and relationship between main diamicton (right)

The third and final unit that was identified is a massive to stratified sandy diamicton forming an up to 2.5m thick carapace across the entire drumlin. Its character, lithologically and structurally, and its stratigraphical position suggest that this unit represents paraglacial deposition.

Preliminary processing of the acquired seismic and electrical geophysical data reveals a strong seismic reflector (Figure 4) and a pronounced increase in electrical resistivity (Figure 5a) at similar depths. We interpret this as the limestone bedrock surface. The origin of the positive chargeability anomalies in the induced polarisation section (Figure 5b) is less clear and awaits further

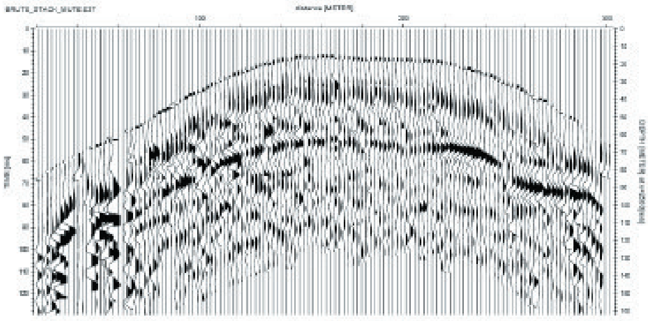

Figure 4: Preliminary seismic reflection profile: drumlin short axis. The strong reflector at depth broadly follows changes in surface topography and is interpreted as the top of the bedrock.

processing and analysis. We propose in the first instance that an association between increased chargeability and clay content in the sediments is not unlikely, notably for the anomalies higher up in the drumlin. What produced the 'core' of high chargeability values between 250 and 300 m in Figure 5b remains to be investigated.

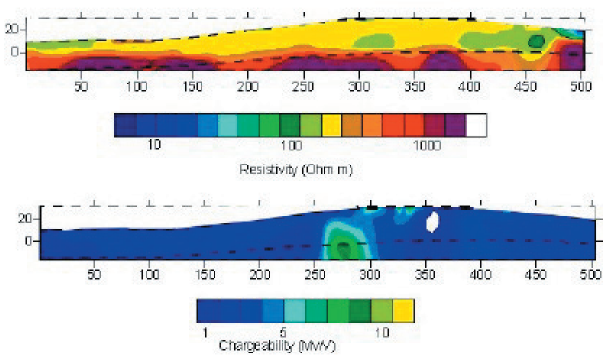

Figure 5a (top): Preliminary electrical resistivity section: drumlin long axis. The dashed line indicates our preliminary interpretation of the bedrock surface.

Figure 5b (bottom): Preliminary induced polarisation section: drumlin long axis.

Acknowledgements

Fieldwork was financially supported by the QRA (Quaternary Research Fund award to JFH). ECK acknowledges financial support from the British Antarctic Survey.

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THE DE GEER ARCHIVE

Between 1880 and 1920 Friherr Gerard De Geer, Docent at the University of Stockholm regularly visited Spitsbergen. Although he is best known for the development of the varve method, he also had other interests and his visits to Spitsbergen were much more of a cartographic nature. In his mapping of Spitsbergen and his involvement in the measuring of the length of a degree he employed high quality photogrammetric camera's. In short reports in the journal Ymer (e.g. 1896) he reported were he had worked and how many photographs had been taken. Over the years we come to around 2500 photographs. Some of sites he visited only once, others he visited regularly, and were he most likely erected cairns to mark his photostations. He also regularly made continuous, partly overlapping panoramas (van der Meer, 2004). Because of the high quality of his camera's the surviving negatives are of high scientific importance (Rapp, 1960; van der Meer, 1992).

In the mid 1990es over 2000 negatives had been 're-discovered' in two different departments of the University of Stockholm (van der Meer, 1996, 2001). At both localities there were also maps and notebooks that were all related to the negatives and allowed the exact pinpointing of geographic locations. Both parts of the collection had been only preliminary inventoried, leaving the need for a detailed catalogue. When the two departments moved into new joint premises, the collections of negatives were moved to the Royal Swedish Academy of Sciences, also in Stockholm.

My visit in 2006 was meant to re-establish contacts within the now merged departments, establish links with the Academy in order to plan the proper cataloguing of the negatives and plan their scientific use. The outcome of the visit is that it is possible to pinpoint the exact storage of only part of the collection. It is very well possible that the missing part has been stored under a different name.

It is the intention to follow this study with further visits to Stockholm in order to establish the whereabouts of the whole collection and to work towards the publication of a proper catalogue. Once that is done the scientific community can start to use the collection. Because high quality images have been collected from an area that is most sensitive to climate change, while furthermore the collection starts right at the beginning of the industrial revolution, the value of the collection cannot be overestimated.

Acknowledgements

I would like the QRA and the Department of Geography QMUL for funding my visit to Stockholm. Furthermore Jan Lundqvist, Per Holmlund, Barbara Wohlfarth and Kalle Grandin for discussions on the whereabouts of the negatives and plans for their future use.

View NW over the northern part of Ekmanfjorden in 1896. It shows Sefströmbreen to the left, half overrunning Coraholmen in the middle of the fjord. Most likely this is the situation just after the surge. In the valley to the right we can see the big push moraine in front of Holmströmbreen.

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NEWRESEARCHERSAWARDSCHEME

THE DYNAMICS AND CONFIGURATION OF WELSH QUATERNARY GLACIATIONS

Background and rationale

Reconstructions of the last British-Irish Ice Sheet often describe the ice mass as a configuration of several independent ice domes (Bowen *et al*., 2002). Reconstructions indicate that Wales was repeatedly covered by a terrestrially based Welsh Ice Cap, in addition to the Irish Sea Glacier that encroached on the coast (Hambrey *et al*., 2001). The Welsh Ice Cap was semi-independent from the British-Irish Ice Sheet and had several dispersion centres in the upland areas of North and Mid-Wales (e.g. McCarroll and Ballantyne, 2000). However, these reconstructions are seldom based on detailed geomorphological mapping.

To provide detail to palaeoglaciological reconstructions three areas in northern Wales with contrasting nature were selected for detailed geomorphological mapping; (1) the upland intensely glaciated landscape of Cadair Idris in South Snowdonia, (2) the Central Cambrian Mountains, an area of minimal or less obvious glaciological impact, and (3) a lowland area in the North Cambrian Mountains with varied depositional landform assemblages. The QRA New Research Workers Award was used mainly to fund the costs of fieldwork in the Central Cambrian Mountains. This report focuses on the results of this fieldwork.

The term "Cambrian Mountains" has historically been used in a general sense to mean the upland plateau occupying most of Wales. Later it has become refined to encompass the hills and plateaux which link Snowdonia in the north with the Brecon Beacons in the south. The mapped area of the Central Cambrian Mountains (Fig. 1) (52º28'N; 3º47'W) consists of an upland area, ca. 450-750 m a.s.l, with the highest massif consisting of Pumlumon Fawr (752 m a.s.l). This upland area is separated from the lower lying dendritic river basin of Afon Dyfi by an escarpment. The investigated area shows little glacial imprint and has a limited spatial density of landform assemblages. This is explained by preservation under cold-based ice, since the area was situated under the ice divide of the Welsh ice-cap (Jansson and Glasser, 2005). The scarcity of reported landforms and dated sediments has made the glacial history of the area poorly understood.

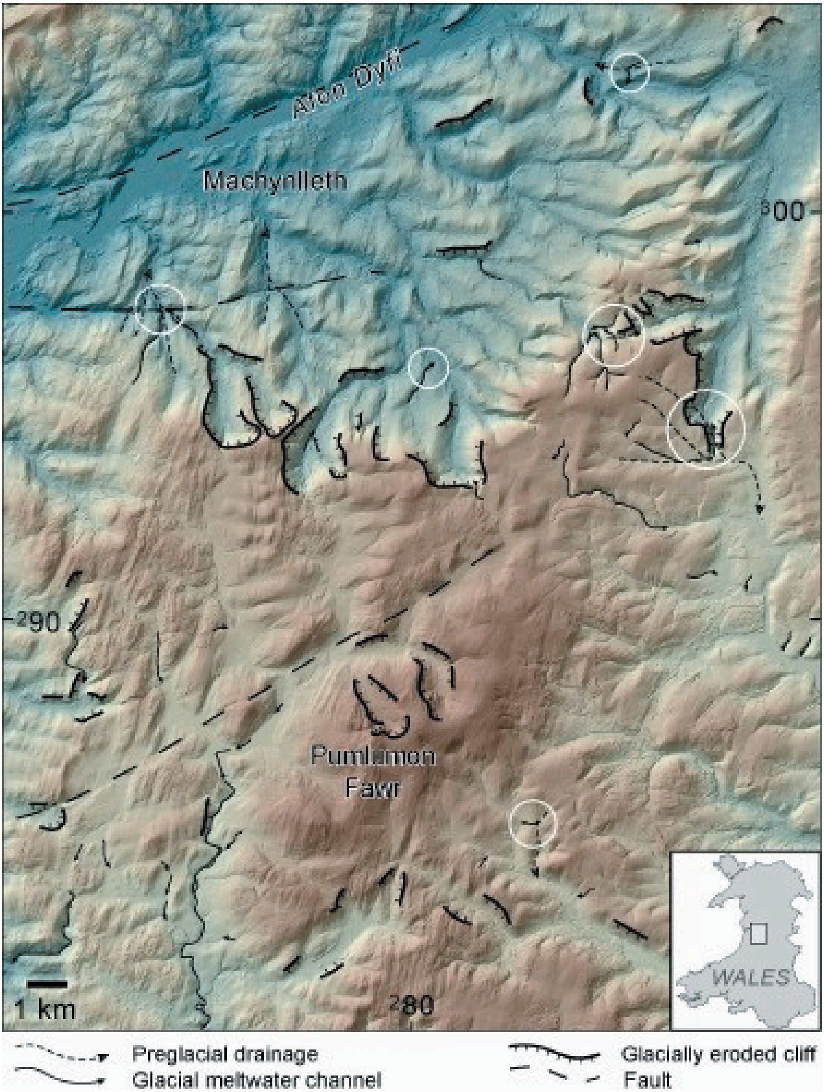

Figure 1: Relief-shaded DEM of the Central Cambrian Mountain study area. Circles mark sites where glacial meltwater have breached watersheds or changed the course of the preglacial drainage.

Methodology

The geomorphological interpretation and mapping were carried out with the use of 396 vertical colour aerial photographs from 1992 at a scale of 1:10 000 and subsequent field controls. Interpretation was mainly done with a Hilger and Watts mirror stereoscope with 2x – 6x magnification. The cartographic art work was done in OCAD.8. Digital Elevation Models (DEMs) sourced from NEXTMap Britain were compiled in ArcGIS.9 (ArcMap) to aid identification of palaeo-drainage patterns, glacial impact and bedrock structure. The DEMs has a horizontal resolution of 5 m, and vertical accuracy of 1 m or better.

Results

Several new localities of glacial striations, moraines, glacial meltwater channels and regolith have been found in the investigated area. Analysis of detailed DEMs and interpretation of aerial photographs show the existence of large variations in the amount of glacial modification within the area. The Dyfi basin exhibits a dendritic river pattern, with V-shaped cross profiles and valley spurs typical of valleys formed by fluvial processes. Several localities have been identified where glacial meltwater incision has cut into the pre-existing river valley system, causing river capture across watersheds. Some of the valley heads ending towards the escarpment have been occupied by cirque glaciers. Large parts of the uplands have been subjected to glacial erosion, with an erosive gradient increasing towards west.

Conclusions

The Dyfi basin has in large part retained much of its preglacial drainage pattern. It is proposed here that the general river valley morphology of the Dyfi basin is of a pre-Late Devensian age. The degree of preservation indicates moderate modification by glacial processes, despite the area being subjected to Late Devensian glacier activity. It is possible that major parts of the basin were covered by cold-based or slow-moving ice, with the major ice drainage occurring along the weaker zone of the fault line by the Afon Dyfi, causing minor adjustments to the surrounding interfluves and uplands. Preservation of these landscapes indicates a cold-based ice sheet during much of the Late Devensian.

This is the first time the investigated area has been mapped in detail using aerial photography and high-resolution DEMs. The study has revealed previously unknown landforms, which have been overlooked by large-scale mapping projects. This shows the importance of conducting mapping at the most detailed level possible. The new findings add detail and aid large-scale palaeoglaciological reconstructions, giving clearer insight into the palaeoglaciology of the Welsh uplands.

Acknowledgements

The author gratefully acknowledges the financial support given by the QRA New Research Workers' Award which contributed towards fieldwork costs. Principal funding for this PhD project was provided by the Countryside Council for Wales (CCW) and the University of Wales, Aberystwyth (UWA). The author would also like to thank supervisors Prof Neil Glasser, Prof Mike Hambrey (UWA), Dr Stewart Campbell (CCW) and Dr Krister Jansson (Stockholm University) for constructive comments on the manuscript. DEMs were constructed from NEXTMap Britain elevation data from Intermap Technologies in collaboration with the British Geological Survey (NERC).

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THE FORMATION OF TOPOGRAPHIC ‘BASINS’ AND ‘TRENCHES’ WITHIN CONTEMPORARY GLACIAL SYSTEMS

Background and Rationale

It is well established that the formation of large topographic depressions beneath and at the margins of glaciers and ice sheets can play a major role in the behaviour of such ice masses. Where large proglacial depressions allow the build up of meltwater, proglacial lake formation causes an increase in ablation through calving, resulting in compensatory ice draw down and increased ice flux. Thus, glaciers calving into proglacial lakes often become decoupled from local climate (Chinn, 1996) and have the potential to increase subglacial erosion (Joughin *et al.*, 2004; Eyles and Eyles, 1992). Proglacial lakes may act as sediment traps with profound implications for down stream environments, such as the formation of the proglacial lake Jökulsárl∂n at Brei∂amerkurjökull in South East Iceland. Sediment transported in the river Jökulsá has reduced from 9 million m^3 to ≈ $0m^3$ (Knudsen *et al.*, 2001) since the formation of the lake. Furthermore, the presence of such depressions in a subglacial position have the potential to alter the behaviour of glaciers over an ice sheet scale. Tunnel channels and tunnel valleys identified beneath the margins of the former Laurentide and Scandinavian ice sheets are believed to have played a huge role in transporting water through the subglacial hydrological network and thus impacting ice sheet glacier dynamics (Jørgensen and Sandersen, 2006).

Fieldwork (carried out during the summer of 2006) funded in part by the New Research Workers Award Scheme investigated the formation of a series of such topographic depressions at the margin of Skei∂arárjökull in South East Iceland (Figures 1 and 2). Detailed sedimentological investigations of basins walls were carried out using standard techniques (sedimentary logs, grain size analysis, clast fabric analysis, etc) as well as detailed Differential GPS (DGPS) surveying.

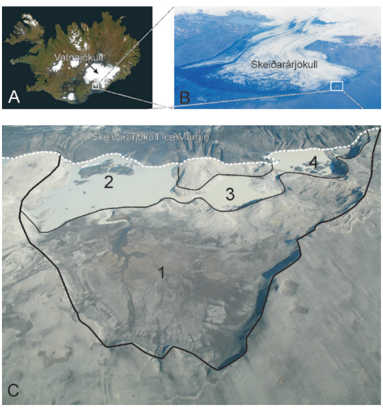

Figure 1:
A) Satellite image of Iceland showing the location of Vatnajökull icecap and Skei∂arárjökull.

B) Oblique aerial photograph of the margin of Skei∂arárjökull showing the location of figure 1c.

C) Oblique aerial photograph of the Sæluhúsavatn basins (numbered), one of a number of locations along the Skei∂arárjökull ice margin where large topographic depressions have been identified.

Results

Initial sedimentological investigations into outer basin walls show large quantities of diamicton which exhibit many characteristics of deformation as well as containing numerous pipes / dewatering structures. Sediments making up basin inner walls are primarily made up of bimodal glaciofluvial sands and gravels similar to those found in deltaic environments or eskers. Creation of a number of digital terrain models from DGPS data allow a greater understanding of their geometry and scale (Figure 2).

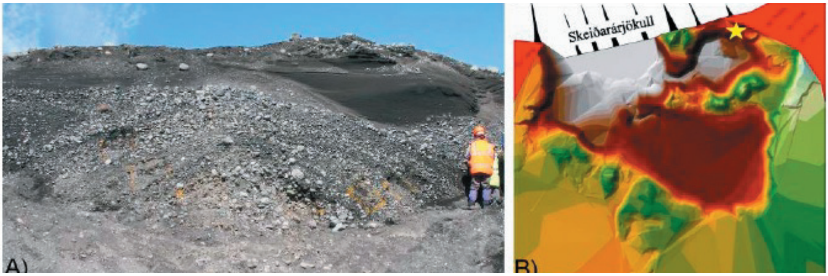

Figure 2:

A) Section through the internal wall of a topographic basin at the margin of Skeiðarárjökull showing anticlinal bedding of glaciofluvial sands and gravels capped by well sorted medium to fine sands.

B) Digital terrain model of the Sæluhúsavatn basin area produced with DGPS data.

Note: Star = location of section A.

Discussion

Preliminary analysis of the field data shows that the topographic basins at Skeiðarárjökull have a specific spatial distribution, often located towards the eastern edge of the ice margin. This may have interesting implications for the configuration of the subglacial drainage system. Sedimentological analysis shows that the sediments of the outer basin walls show evidence of deformation and water piping. These attributes support the ideas that subglacial excavation is a result of sediment deformation and ground water movement such as those of proposed by Boulton and Hindmarsh (1987) and Piotrowski (1994) although as only a portion of the wall sediments are deformed, this process can not be responsible for the formation of the whole feature. Large linear ridges composed of glaciofluvial sands and gravels that make up the internal walls of some of the basins are interpreted as Eskers. The close proximity of eskers within basins suggest that basins may be the resultant 'hollow' in-between numerous subglacial landforms that have graded to an older, lower outwash surface and that subsequent sandar aggradation has filled only parts of these hollows, leaving a basin in the areas of non-deposition. It is also reminiscent of much of the tunnel channel literature that highlights the presence of eskers along tunnel channel floors.

Implications

This project adds significant knowledge to our understanding of topographic depressions of glacial / glaciofluvial origin, contributing to our understanding of the subglacial hydrological regime, ground water movement, ice proximal sediment flux and large scale ice sheet behaviour.

Acknowledgements

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MIDDLE PLEISTOCENE FLUVIAL AND GLACIAL DEPOSITS AT SPARHAM, CENTRAL NORFOLK: CORRELATION WITH THE REGIONAL LITHOSTRATIGRAPHY

Introduction

Since the 1800s, the Pleistocene glacial history of Norfolk has been heavily contested with several different stratigraphic and chronological models presented (Reid, 1882; Banham, 1968; Hart and Boulton, 1991, Hamblin *et al.*, 2000; Lee *et al.*, 2004a). The most recent of these models (Lee *et al.*, 2004a) proposes that in the Sparham region of central Norfolk, there is a succession of four glacigenic formations resting on Early Pleistocene marine and fluvial sands, gravels and muds. As demonstrated by Clarke *et al.* (2004), to the north-west of Norwich on the BGS Old Series 66NW East Dereham map, a 'spiral stratigraphy' exists, caused by two stratigraphically distinct sand and gravel units being mapped as a single deposit. This is therefore a prime area for a robust mapping-based re-examination of the local lithostratigraphy.

The aim of this study (Davies, 2005) was to contribute to an understanding of both the local and regional Pleistocene stratigraphy of Norfolk through the sedimentological and stratigraphical investigation of deposits from a borehole, trial pits, exposed sections as well as field mapping in the area of Sparham, central Norfolk (Figure 1). These deposits were then compared to the existing regional stratigraphy in order to test its robustness. The 3km2 study area was mapped in conjunction with the ongoing BGS survey of the Aylsham area. The further results of this study are being prepared and will be combined with BGS geological mapping to be published as part of a detailed regional paper in the near future.

Methodology

Geological mapping was undertaken at 1:10,000 scale. Morphological features and changes in soil properties were recorded. Shallow auger holes of up to 1.2m depth were used to identify the sub-soil parent lithologies. Data collection points were located with a GPS system, accurate to approximately 3m, and recorded on paper field slips. Individual road sections, and sections exposed within trial pits were cleaned, logged and described on the basis of sedimentary structures, texture, lithology, and sediment geometry.

A shell and auger percussion borehole was drilled down to 20m beneath ground level within the study area (BGS borehole A24). Bulk samples were collected within bags and as core within U100 sample tubes. Samples were analysed in terms of particle size, clast lithologies, opaque heavy mineral content, calcium carbonate content, and magnetic susceptibility following standard procedures (Gale and Hoare, 1991).

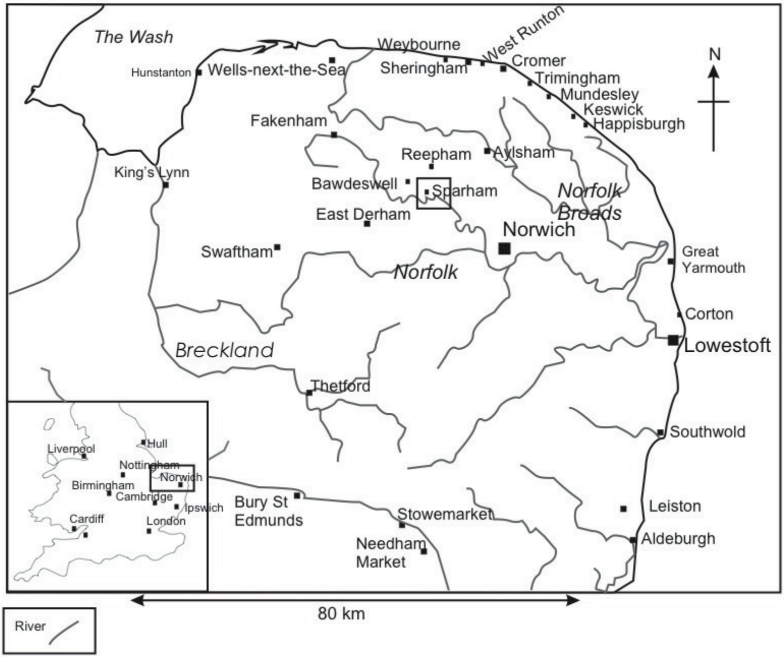

Figure 1. Location of Sparham, Norfolk

Results and Discussion

Six lithofacies were recorded in the study area (Figure 2). Lithofacies A is stratigraphically lowest and rests on the Chalk bedrock. It consists of rhythmically-bedded sandy silts and silty clays with occasional mud flasars and seams of pebbles. Such sediments indicate cycles of deposition within moderate and low energy regimes, and are characteristic of inter-tidal sedimentation. Based on its clast content, Lithofacies A is correlative with the Mundesley Member of the Wroxham Crag Formation (Pawley *et al.*, 2004).

Above this is Lithofacies B (Figure 2), a massive, brown, matrix supported, sandy diamicton with a clayey-sand matrix-texture with common flint and comminuted shell debris. Pebbles are rare but soft lithologies such as limestone are often faceted and striated. The base of the diamicton is gradational with the underlying Lithofacies A. This lithofacies is interpreted as a subglacial till (Roberts and Hart, 2005). The lithological properties indicate that it is correlative with the Corton Till Member of the Happisburgh Formation mapped further to the east and south in Norfolk (Lee 2001; Lee *et al.* 2004a).

Overlying this is Lithofacies C, which comprises stratified, chalky sand and poorly sorted sand and gravel that rest upon the irregular upper surface of

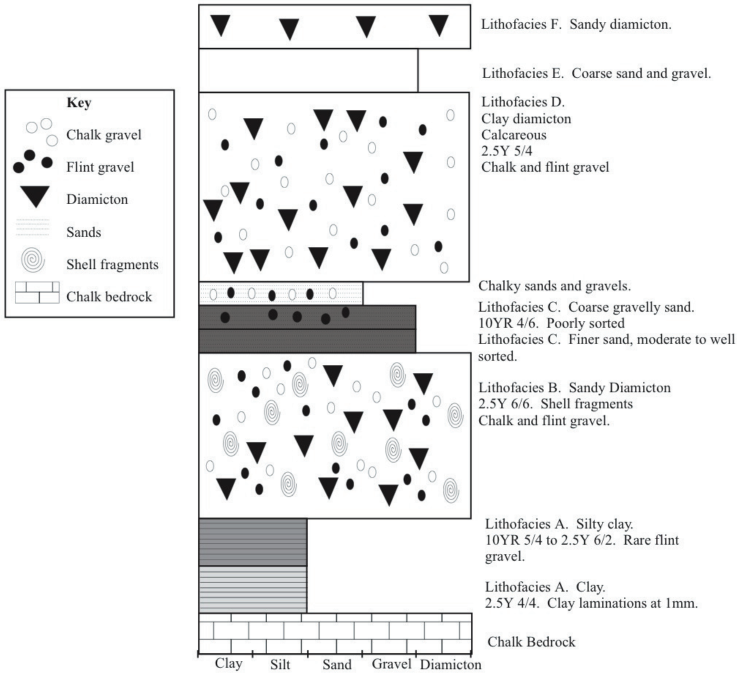

Figure 2. A local stratigraphy for the Sparham river valley.

Lithofacies B. These sands and gravels are interpreted as proximal glaciofluvial outwash based upon their angular and poorly-sorted nature, erosional base, and the presence of low-durability detrital chalk grains. This lithofacies has lithological properties similar to the Leet Hill Sands and Gravels (Rose *et al*., 1999; Lee *et al*., 2004b).

Lithofacies D is a calcareous, matrix-supported, over-consolidated, clay-rich diamicton. Lithologies present include chalk, black flint gravel and Scottish clasts. Pebbles are striated and faceted. It is interpreted as a subglacial till on the basis of its far-travelled, striated pebbles, massive structure and over consolidated nature. The lithological properties of the diamicton suggest that it correlates with the Anglian Lowestoft Till Member of the Lowestoft Formation (Lee *et al*., 2004a). However this interpretation depends on further geological information from adjacent sites and the regional context. The till could potentially be correlated to the Sheringham Cliffs Formation.

Lithofacies E is a unit of coarse sand and gravel. It forms a sinuous, discontinuous deposit on a raised area adjacent to the River Wensun. It contains angular, chaotic, unsorted coarse sand and gravel. This deposit is probably a soil developed on the upper service of a terrace of the River Wensun.

Lithofacies F comprises of sand, clay and gravel and is the most recent deposit of the River Wensun valley. This deposit is interpreted as Devensian head. Holocene alluvium is present along the floor of the Wensum Valley.

Conclusions

Six lithofacies were mapped and logged in the Wensun river valley near the village of Sparham and correlated to regional stratotypes. Lithofacies B is correlated to the Corton Till based on the textural and lithological properties, and was deposited subglacially during the incursion of glacial ice into the region during a pre-Anglian glaciation, possibly equivalent to MIS 16 (Lee *et al*., 2004b). Lithofacies D is correlative with the Lowestoft Till and represents the Anglian glaciation of the locality.

Acknowledgements

This research was undertaken as a dissertation for an MSc in Quaternary Science at Royal Holloway, University of London. The project was undertaken in conjunction with the British Geological Survey, and the author would like to thank Dr Brian Moorlock, Dr Jonathan Lee, and Anna Harrison for their constructive comments, instruction and help with the mapping. The boreholes and trial pits were funded by BGS and the Environment Agency. The author gratefully acknowledges a grant from the QRA to complete the fieldwork. The author would also like to thank Professor Jim Rose for his supervision and guidance during the MSc, and Dr Dave Roberts and Dr Colm O'Cofaigh for constructive criticism in writing this QN report.

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BRITISH GEOLOGICAL SURVEY (2005) GLEN COE. BEDROCK. 1:25 000 GEOLOGY SERIES (KEYWORTH, NOTTINGHAM, BRITISH GEOLOGICAL SURVEY)[1]. KOKELAAR, B.P. AND MOORE, I.D. (2006) CLASSICAL AREAS OF BRITISH GEOLOGY : GLENCOE CALDERA VOLCANO, SCOTLAND. KEYWORTH, NOTTINGHAM, BRITISH GEOLOGICAL SURVEY[2].

[1] ISBN 0751833002 - £12
[2] ISBN 08527252565 - £15
Book and map pack - £22

Available from **BGS Sales Desk, British Geological Survey, Keyworth, Nottingham NG12 5GG Tel. 0115 936 3325,** or the **Online Shop www.geologyshop.com .** Note prices do not include postage and packing.

This map and companion volume have been published by the British Geological Survey as the latest in a series of maps and booklets dedicated to presenting detailed information about areas of particular geological interest in Britain. The underlying rationale, according to the B.G.S. online catalogue (http://www.bgs.ac.uk/catalogue/docs/classical.pdf), is that in order to properly appreciate the geology of such areas, maps which are more detailed than the standard 1:50 000 maps are required, hence the maps in this series are published at a scale of 1:25 000. At present the series runs to 49 map sheets, including ten which have accompanying Classical Areas Explanatory Booklets, the most recent of which is the subject of this review. This map has as its central focus the major valleys of Glen Coe and Glen Etive, and the surrounding mountains, including the Black Mount, which forms the western boundary of the bleak landscape of Rannoch Moor.

The principal geological interest in the area covered by the map and the Explanatory Booklet is the presence of what is described in the booklet as perhaps the prime example in the world of '…a tectonically controlled, piecemeal, multiple-subsidence caldera volcano' (p. 10). The information presented in both the booklet and the map is the product of a complete resurvey of the area. This has resulted in earlier theories as to the genesis of the rock structures in and around Glen Coe being modified considerably. Both map and booklet make particular play of the significance of volcanic processes and environments in the creation of the present-day landscape. In consequence, although the map is exemplary in its clarity, and in its use of cross-sections, there is almost no information of interest to someone studying the Quaternary sediments and landforms of the area save for useful indications of possible sources for clasts of different lithologies in the local glacigenic sediments. The Holocene rockfall deposits in the Lost Valley, just south of Glen Coe, are the only superficial sediments to be represented on the map.

The Explanatory Booklet is likewise an extremely handsome production. It is written in a manner so as to be accessible to the amateur geologist as well as to the professional, though possibly it is a bit too technical and detailed to really appeal to the casual browser. It is beautifully embellished with excellent colour photographs, block diagrams, maps and other illustrative material. As with the map, however, there is little outside the last chapter of the Booklet to raise the pulse rate of students of the Quaternary. This final chapter is entitled 'Shaping the landscape' and is divided into two sections - the Pleistocene and the Holocene. As the entire chapter is no more than 4 pages in length and includes a colour plate, a block diagram, and a graph linking events in the Glen Coe area with fluctuations in the oxygen isotope record from the GISP ice-core, there is not much space for any analysis of sediments and stratigraphy, never mind details of glacial limits and fluctuations. Much of this section is given over to an introduction to the range of geomorphological phenomena which can be seen in the area. Locations at which good examples may be seen are given as 6-figure grid references. This at least helps the curious to inspect some of these features, although it is clear that the locations cited would be difficult to turn into an integrated itinerary for the casual visitor.

For all its excellent qualities, there is one aspect of this package which is rather worrying. Quite correctly the Explanatory Booklet points out very early on (p.2) that the terrain in the Glen Coe area is very rugged and remote, to the degree that some of the localities and mapped features require rock climbing skills to access them. It further notes that weather conditions can deteriorate with alarming speed, a point that places further emphasis on the fact that some of the descent routes are far from easy. Wisely, the booklet goes on to say that '…no site is perfectly safe and field safety is not indicated by the following descriptions that imply accessibility' (p.2). The problem lies with the fact that a series of numbered locations is clearly shown on the map, with notes about the features visible at each location being tabulated in the margins of the map. A similar list of Key Field Localities appears as an appendix in the Booklet and gives details of location, key features, notes on access and other information. What rapidly becomes clear on closer inspection, but is not stated anywhere obvious, is that the numbers given to localities listed in the appendix do not correspond to the location numbers shown on the main geological map! Given the authors' justifiable concerns about field safety, it is rather worrying that such a potential for confusion exists in this package.

Overall this is a handsome package, but one which will appeal mostly to the more geologically-inclined members of the QRA.

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GLACIER SCIENCE AND ENVIRONMENTAL CHANGE

Edited by Peter G. Knight

2006; Oxford, Blackwell Publishing. Xiv + 527pp.
ISBN – 10: 1 4051 0018 4, ISBN – 13: 978 1 4051 0018 2, hardback
£125

As the editor explains in his initial introduction, this book can best be described as providing a "snapshot" of current activity and ideas across the wide panorama of glacial research. Well over one hundred authors contribute to ninety-two papers arranged into five main themes: 1) Glaciers and their coupling with hydraulic and sedimentary processes; 2) Glaciers, oceans, atmosphere and climate; 3) Changing glaciers and their role in earth surface evolution; 4) Glacier composition, mechanics and dynamics, and 5) The practice of glaciology. Each of these sections incorporates contributions from field and modelling-based perspectives, encompassing glacial geomorphology, glacial sedimentology, contemporary process glaciology, palaeo-environmental reconstruction, glacial modelling and remote sensing of the cryosphere, neatly packaged together as "glacier science". This ambitious book therefore attempts to bolster an interdisciplinary approach by setting side by side, research topics that would normally inhabit different journals and authors that would normally attend different conferences. This is to be applauded, but needs a strong conceptual framework to hold it together as a coherent volume of work.

The editor has tried to achieve this by establishing a "hierarchy" of chapters within each section. Thus keynote introductions by "elder statesmen"(yes, they *are* all men) are intended to place each section into the wider context and provide personal perspectives on the fundamental issues of each section. These are followed by a series of articles by "leading authorities" designed to explore some of these main issues and themes in more detail. Finally, a series of very short chapters are distributed throughout to provide research case studies that substantiate or challenge the issues discussed in the longer chapters. Unfortunately, this structure is only clear because the editor says it is so in the introduction. For example, the keynote chapters vary greatly in length from four pages to twenty pages, indicating that authors have interpreted the editorial brief quite differently. This seems to be true of the other papers, such that it is sometimes not clear which are the authoritative reviews and which are the case studies. Clearer editorial directions along the way would highlight the structure and linkages between contributions.

That said, a little structural uncertainty is a small price to pay for such a comprehensive collection of research reviews and personal perspectives on where we are at and where we are heading in relation to the role of glaciers and ice sheets in responding to and driving environmental change over the range of temporal and spatial scales within Quaternary science. Although much of the content of the chapters has been published elsewhere, it is increasingly difficult for individual students or even professional researchers to keep up to date with the vast range of relevant published research beyond their immediate fields. Although this is a large book, it does manage to summarise the whole subject such that the reader should come away with an impressive range of knowledge and an insight into its potential depths. It is clearly not a textbook but it will be a valuable supplementary source for students of the broad topic of glaciology and deserves to succeed in its aim of providing a thorough overview of glacier science to the wider environmental science community of geologists, hydrologists and climatologists.

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ABSTRACTS

ASPECTS OF VEGETATION AND LAND USE CHANGES DURING HISTORICAL TIMES FROM ENGLISH LOWLAND LAKE RECORDS

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A major focus of palaeoecological research has been to reconstruct the vegetation history of Britain and examine the impact of humans and climatic variability on the landscape. Most studies undertaken have concentrated on the prehistoric period and less attention has been given to changes occurring in the historical period. This project therefore aims partially to redress this imbalance by presenting the findings of two palaeoenvironmental reconstructions from lake deposits in the English Midlands during the historical and archaeological periods.

Palaeoenvironmental changes as inferred from pollen and mineral magnetic signatures preserved in lake sediments of two diverse lowland catchments (Kyre Pool, Worcestershire and Aqualate Mere, Staffordshire) have been placed within a rigid chronological framework using combinations of Radiocarbon, Spheroidal Carbonaceous Particle profiles, Lead-210 and Caesium-137. Key periods of vegetation change have been successfully correlated with archival and archaeological records of land-use change; including the impacts of Romanisation on the landscape and agricultural changes occurring during the Medieval period. Additionally more catchment specific alterations, such as Nineteenth Century landscaping and plantation of woodlands, are identified and correlated with archival sources. Attempts to detect the short-term regional impact of the Laki Fissure eruption of A.D.1783 was trialled at Kyre Pool with limited success: the eruption could be stratigraphically constrained but no impact in the pollen diagram could be discerned.

Findings of an assessment of the taphonomic processes operating in lake systems highlight the effects of surrounding vegetation in modifying the atmospheric component of pollen deposited into lakes. A comparison between sediment source changes and the preserved pollen assemblage highlights a possible relationship between the two. Changes within the pollen record occur alongside sediment sources changes. The taphonomic process of both hydrological and atmospheric pathways has implications for preserved pollen assemblages and interpretations based upon them.

MIDDLE TO LATE HOLOCENE SEA-LEVEL CHANGE IN WESTERN DENMARK: A DIATOM-BASED STUDY

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Modern diatom assemblages and associated environmental variables were collected from six transects across the salt-marsh surface in the Ho Bugt embayment in western Denmark. The relationship between diatom assemblages and environmental variables (elevation, pH, salinity, loss on ignition, grain size) was explored using ordination techniques to assess the potential use of diatoms as sea-level indicators. Results for the two data sets analysed in ordinations indicate that elevation exerts a strong, independent and statistically significant influence on modern diatom distrbutions in the Ho Bugt embayment. Diatom-based transfer functions were subsequently developed to reconstruct changes in palaeomarsh-surface elevation based on the relationship between diatoms and elevation in the modern training set. Maximum likelihood (ML), weighted averaging (WA) and weighted-averaging partial least squares (WA-PLS) transfer functions were developed from 97 surface samples and 151 taxa. The WA-PLS transfer function were found to perform best ($RMSEP_{jack}$ = 0.12 m, r^2 = 0.93 and max $bias_{jack}$ = 0.11 m) and was subsequently applied to interpret the diatom assemblages in a series of fossil cores and reconstruct palaeomarsh-surface elevations. The statistical reliability of these reconstructions was assessed via the use of 'goodness of fit' and 'analogue' statistics. Combination of these palaeomarsh-surface records with reliable age-depth models has enabled the relative sea-level history of the Ho Bugt embayment to be reconstructed. Relative sea-level curves for the Ho Bugt embayment document around 7 m of rise in the last 7000 cal. yr BP. Four stages in the evolution of the Ho Bugt salt marshes can be recognised: basal peat formation from 7000 – 2000 cal. yr BP, salt-marsh formation from 2000 – 1200 cal. yr BP, a fresh water phase from 1200 – 350 cal. yr BP and renewed salt-marsh deposition from 350 cal. yr BP to the present. Geophysical modelling suggests that the dominant control on relative sea-level change in the Ho Bugt embayment during the last 5000 cal. yr BP is glacial isostatic adjustment, following decay of the Fennoscandian Ice Sheet. The Ho Bugt relative sea-level data are best matched by a glacial isostatic adjustment model that includes a zero eustatic function for the last 5000 cal. yr BP.

QUATERNARY RESEARCH ASSOCIATION

The Quaternary Research Association is an organisation comprising archaeologists, botanists, civil engineers, geographers, geologists, soil scientists, zoologists and others interested in research into the problems of the Quaternary. The majority of members reside in Great Britain, but membership also extends to most European countries, North America, Africa, Asia and Australasia. Membership (currently *c.* 1,000) is open to all interested in the objectives of the Association. The annual subscription is £20 with reduced rates (£10) for students and unwaged members and an Institutional rate of £35.

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

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