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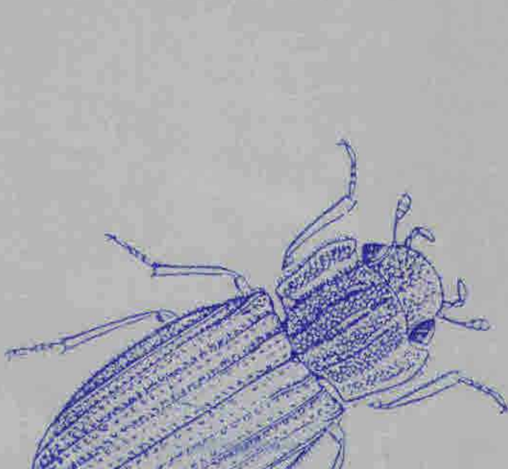
QUATERNARY NEWSLETTER



"From Russia with love . . . ."

QUATERNARY NEWSLETTER

Editor: Dr B J Taylor
British Geological Survey
Keyworth
Nottingham NG12 5GG

Quaternary Newsletter is issued in February, June and November. Contributions comprising articles, reviews, notices of forthcoming meetings, news of personal and joint research projects, etc. are invited. They should be sent to the Quaternary Research Association Newsletter Editor. Closing dates for submission of copy for the relevant numbers are 1 January, 1 May and 1 October.

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Cover design by Linda Wahl, British Geological Survey, Keyworth, Notts.

Cover illustration
Helophorus obscurellus Popp. is a hydrophilid beetle that today lives mainly in Siberia and whose nearest locality to Britain is the Kanin Peninsula. However, during the glacial periods of the Quaternary *H. obscurellus* inhabited a number of sites in the UK along with several other cold-adapted species.

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INTRODUCING THE NEW EDITOR

Colleagues, may I introduce myself. My name is Brian Taylor and I have been nominated (for my sins!) as the new editor of the *Quaternary Newsletter*, at least for the next few years.

In accepting this onerous task, I should like to take this early opportunity of thanking Dr David Holyoak (my predecessor) for his unstinting efforts on your behalf and wish him well with his research activities.

Antarctic experience

For those who may never have heard of me before, perhaps I should provide you with some brief biographical details. To begin at the beginning, I became a geologist in 1959 when I went to the Antarctic with the Falkland Islands Dependencies Survey, later renamed the British Antarctic Survey (BAS).

On my return and while still employed by BAS, I worked at the Univerisity of Birmingham on the richly fossiliferous Mesozoic succession (the so-called Fossil Bluff Formation) of eastern Alexander Island, and thus became particularly interested in some of the more bizarre aspects of a highly diverse fauna, notably the acrothoracic cirripedes, lithophagic trace fossils, the ultra-structure of fossil decapod cuticles and sexual dimorphism—also amongst the fossil lobsters. I also worked independently, or with others, on various forms of sedimentary structures, notably 'cannonball' concretions and sedimentary dykes.

The UN Conference on the Law of the Sea

Fourteen years later, I joined the Natural Environment Research Council (NERC) and became—more by accident than design—the UK spokesman on marine scientific research at three sessions (Caracas, Geneva and New York) of the United Conference on the Law of the Sea. However, when this long-standing conference became progressively less scientific and more politically orientated, I joined the then Institute of Geological Sciences (now the British Geological Survey), initially supervising sand and gravel assessment surveys in Eastern England.

The Quaternary Beckons

At this point, my interest in the Quaternary, which began in the 1960's when I first met Russell Coope and his fellow 'beetlemanics' at the University of Birmingham, gradually developed, and I simultaneously began a period of retraining as a Quaternary palynologist and entomologist. Needless to say, my debt to Russell Coope and to Professor Richard West and Sylvia Peglar (of the Botany School, University of Cambridge) became an enormous one for together, they generated an enthusiasm for the subject which has scarcely diminished—even though my *active* involvement virtually ceased in 1984 with the demise of the Survey's multi-disciplinary East Anglia Regional Survey.

Public Relations and Quaternary Beetles

Since then, I have endeavoured to continue my interest in Quaternary arthropods (particularly beetles), often in my own time, while carrying out my official duties as the Survey's public relations officer—a job that has included supervising the 'Open Days' (1985, 1986 & 1988), improving the Survey's internal and external image and increasing the public's awareness, both of the Survey itself and of the role geology plays in underpinning the industrial and social infrastructure of this country.

The Newsletter—aims and objectives

But to return to the matter of your Newsletter. There has been some discussion recently (and perhaps in the past too) about the quality of the magazine and what it attempts to achieve. Because I have always viewed the Newsletter as a relatively *informal* means of communication, I have expected to find there a range of material from short notes and notices to the occasional longer (perhaps more seminal) article — and this has been the format up until now. However, if you, the reader, feel dissatisfied with the Newsletter in any way, please let me know so that any obvious shortcomings can be put right.

In the meantime, perhaps I should emphasise that I see the Newsletter as a joint effort between me, as editor, and you as contributors and that I can only do my best with the material to hand. So please, let me have as much good copy as possible, preferably illustrated so that the amount of pure text is not too oppressive, however well written that might be.

Last, but by no means least, may I thank you in advance for your support in these matters.

BRIAN J TAYLOR
British Geological Survey
Keyworth
Nottingham NG12 5GG
Tel: 060 77 6111 Ex 3392

QN: articles

THE FROG HALL SAND AND GRAVEL: A POST-"WOLSTONIAN" FLUVIAL DEPOSIT NEAR COVENTRY

M G Sumbler, British Geological Survey, Keyworth, Notts NG12 5GG

The recently opened Frog Hall Quarry [SP 416 736] (Steetley Construction Materials), near Stretton-on-Dunsmore between Rugby and Coventry, was visited by members of the Association on 4th April 1989 during the annual field meeting. It exposes 4 to 4.5 m of flinty gravel with sand seams. The pit lies within a deposit mapped as Dunsmore Gravel by Shotton (1953, fig. 9) and is referred to as such in the field guide published to accompany the excursion (Keen, 1989, p.29). The Dunsmore Gravel is the youngest member of the glacial "Wolston Series", which is the designated stratotype for the Wolstonian Stage (Mitchell, Penny, Shotton & West, 1973); Wolston Pit [410 747], the type locality, lies just over 1 km north-north-west of Frog Hall Quarry.

Mapping by the author in 1977 showed that the sand and gravel deposits at Frog Hall are, in fact, distinct from and younger than the Dunsmore Gravel; they are denoted "Alluvial Fan Gravels" on the published BGS 1:10 000 Geological Sheets SP 47 SW and SP 47 NW and 1:50 000 Sheet 184 (Warwick) and were related to the Fourth Terrace deposits of the River Leam by Sumbler (1985; and *in* Old, Sumbler & Ambrose, 1987, p.85). They are here named the Frog Hall Sand and Gravel.

In view of the continuing controversy over the age of the "Wolstonian" sequence of which the Frog Hall Sand and Gravel (as Dunsmore Gravel) has been claimed to be a part, it is important that the true stratigraphic status of the Frog Hall Sand and Gravel is demonstrated beyond doubt. It has, for instance, yielded *Equus ferus* (Shotton, 1953, p.226), and the current workings may yield other fossils.

The Dunsmore Gravel

The Dunsmore Gravel is a sheet-like deposit of sand and gravel which caps a dissected plateau (=Dunsmore itself) on the Avon/Leam interflue between Clifton upon Dunsmore in the east [530 764] and Ryton Heath in the west [396 727]. Outliers occur both north of the Avon and south of the Leam (Figure 1; Sumbler, 1983a, fig. 1; BGS 1:50 000 Sheet 184).

Lithology and geological relationships show that the Dunsmore Gravel is the outwash from the Oadby (chalky) Till ice-sheet (Shotton, 1953, p.227; Sumbler, 1983a, p.28). It is a poorly sorted sandy and clayey gravel, becoming particularly "dirty" in its lower part. Size gradings based on borehole samples are given by Crofts (1982). It is generally from 1.5 to 3.5 m thick and rarely exceeds 5 m. Though it has been test-drilled in several places, it has not been extensively exploited, probably because of its thinness and poor quality. At the time of survey (1976–9), the only workings were near Clifton upon Dunsmore, where it has been pitted on a small scale, probably as a source of "hoggin" to make up roadways etc. (Sumbler, 1983b). The gravel fraction of the Dunsmore Gravel consists predominantly of angular and subangular flints (typically about 50%) and rounded "Bunter" and ? Carboniferous sandstone pebbles (about 30%). Minor constituents include Jurassic ironstones and Triassic sandstones. Generally the deposit is decalcified throughout its whole thickness, but locally Jurassic limestone and chalk have been recovered from the lower part. A characteristic of the Dunsmore Gravel is the widespread development of ironpan at shallow depth. This takes the form of gravel cemented by purple-black "limonite" into a hard "concrete" often 0.3 m or more thick. Such ironpans are rarely developed in the Frog Hall Sand and Gravel or other fluvial gravels of the region.

Contouring of the top and base of the Dunsmore Gravel shows that it falls gently in height to the north-west at about 2 m/km, and at its northern and southern margins it dips towards the Avon and Leam valleys, respectively. The levels of outlier indicate that before dissection, there were broad depressions of the Dunsmore Gravel where these valleys are now situated, suggesting that the modern drainage system originated during deglaciation, and was functioning during deposition of the Dunsmore Gravel. From this and a consideration of height relationships, Sumbler (1983a, p.28) suggested that the possibly composite fifth terrace deposits of the Avon below Stratford include downstream remnants of the Dunsmore Gravel.

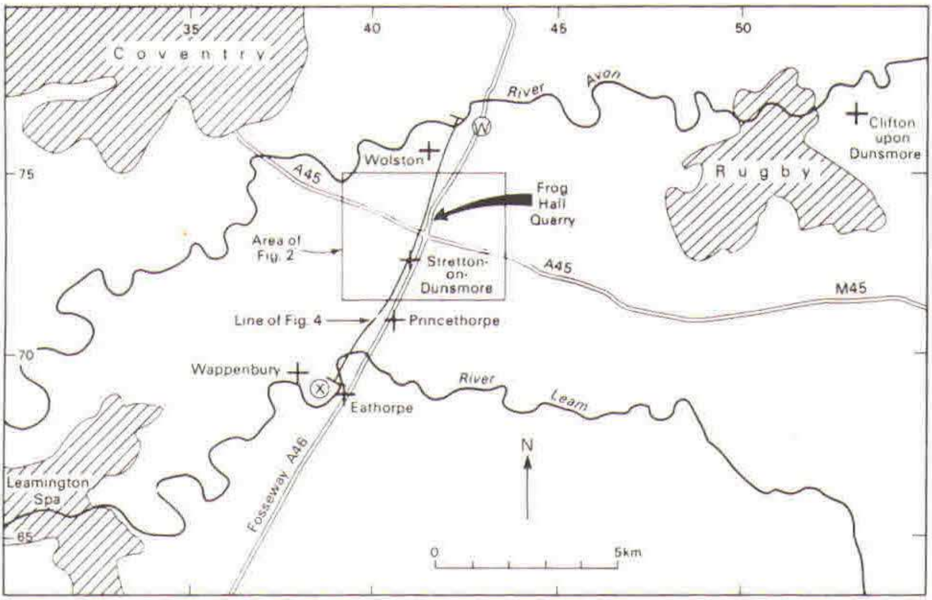

Figure 1 Location map showing localities mentioned in the text, area of Figure 2 and the line of profile Figure 4 (W,X). Main urban areas are shaded.

The Frog Hall Sand and Gravel

The Frog Hall Sand and Gravel infills an elongate depression, its surface lying up to 10 m below the level of the neighbouring outcrops of Dunsmore Gravel to the west and east (Figures 2 and 3). This topographic relationship can be readily observed from the A45 trunk road which crosses the deposit. Shotton (1953, fig. 9) included the Frog Hall Sand and Gravel in the main outcrop of Dunsmore Gravel but, although the outcrop boundaries are obscured by gravelly wash, augering shows that it is separated from the Dunsmore Gravel by outcrops of glaciolacustrine Wolston Clay. Trial boreholes in the neighbourhood of Frog Hall Quarry prove up to 9 m of sand and gravel in the north-south-trending channel. The eastern edge of the channel passes close to the present workings; laminated clays and silts from the lagoons just to the east [417 736] show that they are excavated in Wolston Clay.

Similar sand and gravel deposits between Fosse Farm [419 746] and Lammas Hill [419 752], overlooking the Avon valley about 1.5 km north of Frog Hall, were likewise mapped as Dunsmore Gravel by Shotton (1953, fig. 9). Again however, they are several metres below the expected level of the Dunsmore Gravel as projected from the nearest outcrops, and are therefore regarded as Frog Hall Sand and Gravel. From a feather edge against Wolston Clay on the east, the deposit thickens westwards, and the centre line of the original channel probably lay just beyond the western boundary of the outcrop.

South of Frog Hall, between Stretton-on-Dunsmore and Park Farm [403 717] patches of similar sand and gravel occur on the sides of the modern southwards-draining valley. Some of these are shown as Fourth Terrace Deposits by Shotton (1953, fig. 9). Mapping shows that these deposits thicken towards the centre of this valley, though it is excavated well below their base (Figure 4); the modern valley thus follows approximately the line of the original channel. A borehole at Asylum Farm [4120 7177] proved 7.6 m of sand and gravel resting on Wolston Clay (Crofts, 1982, p.59); locally the sand and gravel on the valley sides may be up to 10 m thick.

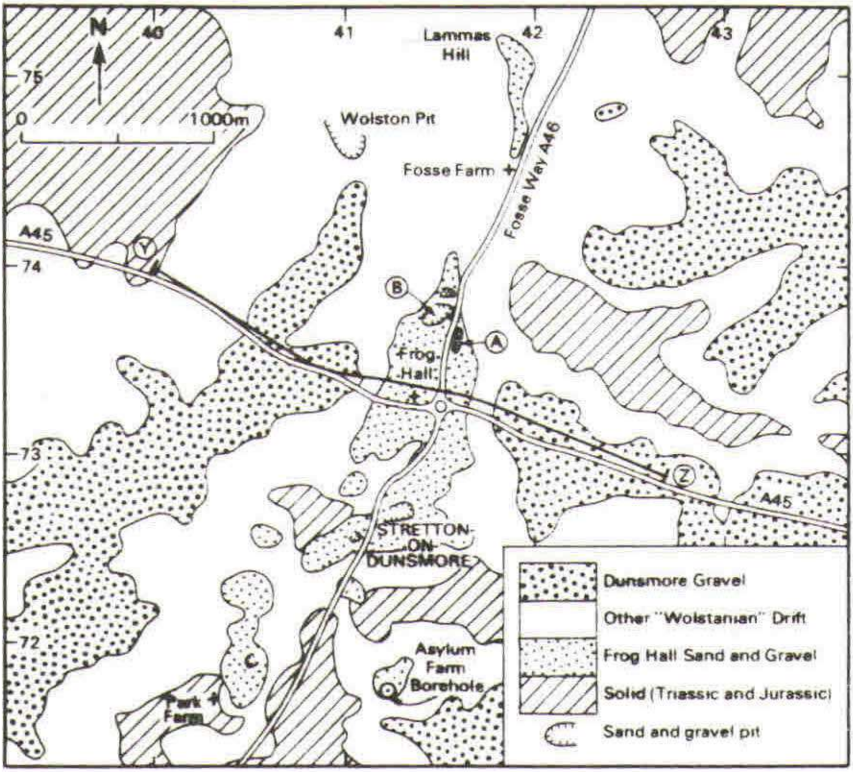

Figure 2 Simplified geological map of the area around Frog Hall. Subdivisions of solid geology, pre-Densmore Gravel drift deposits and all river terrace deposits ommitted. A = Frog Hall Quarry; B = Frog Hall Pit of Shotton (1953) (now infilled): Y,Z = line of section Figure 3.

The Frog Hall Sand and Gravel has been quarried in several places; as well as Frog Hall Quarry [416 736], there is another working pit just to the north [415 738] which adjoins the site of the pit mentioned by Shotton (1953) [415 737]. Older obscured pits occur around Frog Hall itself [413 733], south of Frog Hall [414 731], in Stretton-on-Dunsmore village [413 727; 411 726; 409 724] and near Park Farm [406 719]. Examination of exposures suggests that the Frog Hall Sand and Gravel is better sorted, "cleaner" and less clayey than the Dunsmore Gravel. Indeed, the profusion of workings contrasting with the dearth of pits in the Dunsmore Gravel, itself suggests that this is the case. Pebble counts of material from three pits gave comparable results, showing a distribution of pebble lithologies very similar to that from the Dunsmore Gravel but with the addition of 2 to 3% of worn, irregularly-shaped limonitic ironstone fragments (Sumbler, 1985). These commonly contain sand grains and small flint and quartzite pebbles, and the shape of many indicates that before transport, the material filled the interstices between other pebbles. There seems little doubt that this ironstone is reworked from the Dunsmore Gravel ironpans. Clearly, ironpan development took place during the time interval between the deposition of the Dunsmore Gravel and that of the Frog Hall Sand and Gravel. This period of time seems to be otherwise unrepresented in this area.

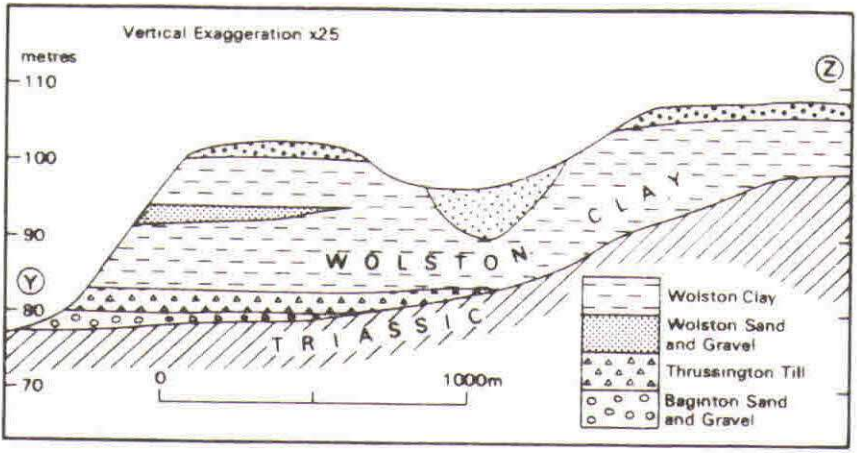

Figure 3 Cross-section through the Frog Hall Sand and Gravel deposit, based on mapping and boreholes. Additional ornaments as Figure 2.

At Park Farm [406 719], the gravel contains a porportion of subangular limestone fragments, some quite large, derived from the Langport Member (formerly White Lias) of the Triassic Penarth Group (formerly Rhaetic). These must have been derived from local outcrops in the valley because, elsewhere in the region, the Langport Member is buried beneath Wolston Clay except where exhumed by modern drainage. It is therefore extremely rare or absent in the Dunsmore Gravel.

Correlation and age

The base of the Frog Hall Sand and Gravel fall southwards from c.95 m OD at Lammas Hill to c.78 m at Park Farm, nearly 4 km to the south-south-west (Figs 2 and 4). Extrapolation of the thalweg suggests that it probably relates to that beneath the Fourth Terrace deposits of the Leam, the nearest outcrop of which, at Wappenbury [386 695], 3 km south-west of Park Farm, lies at c.74 m OD. In the intervening area, outliers of Dunsmore Gravel at Princethorpe [400 703] and Eathorpe [398 688] are considerably higher, at c.90 m OD and, in the stream valley near Park Farm, First and Second Terrace deposits lie several metres below the base of the Frog Hall Sand and Gravel. There are no Third Terrace deposits in this area. Thus, it seems likely that the Frog Hall Sand and Gravel equates with the Fourth Terrace deposits. Unfortunately, the lithology of the deposits is of little help in correlation, since all the Avon/Leam terrace deposits are flint/quartzite gravels similar to the Frog Hall Sand and Gravel and Dunsmore Gravel.

The only fossil yet known from the Frog Hall Sand and Gravel is a metatarsal of "*Equus caballus*" (= *E. ferus*) recorded by Shotton (1953, p.226) from an old pit (now infilled) just north-west of Frog Hall Quarry [415 738]. *E. ferus* has been recorded from a wide variety of deposits of Cromerian to Flandrian age. The Fourth Terrace deposits of the Avon/Leam system have yielded a cold climate fauna (including *Mammuthus primigenius* and *Coelodonta antiquitatis*) and Acheulian implements. Like the Frog Hall Sand and Gravel, they clearly post-date the "Wolstonian" glacial deposits of the region (which may be of Anglian age), and pre-date the mid-Devensian Second Terrace deposits. The Fourth Terrace deposits were thought to be of early Devensian date by Mitchell, Penny, Shotton & West (1973, Table 3), though Sumbler (1983a) suggested that it was more likely that they were Wolstonian *s.s.* (i.e. post-Hoxnian and pre-Ipswichian). Their pre-Ipswichian age has been confirmed by recent work (Whitehead, pp.39–41; Bridgeland, Keen & Maddy, pp.51–67, in Keen, 1989).

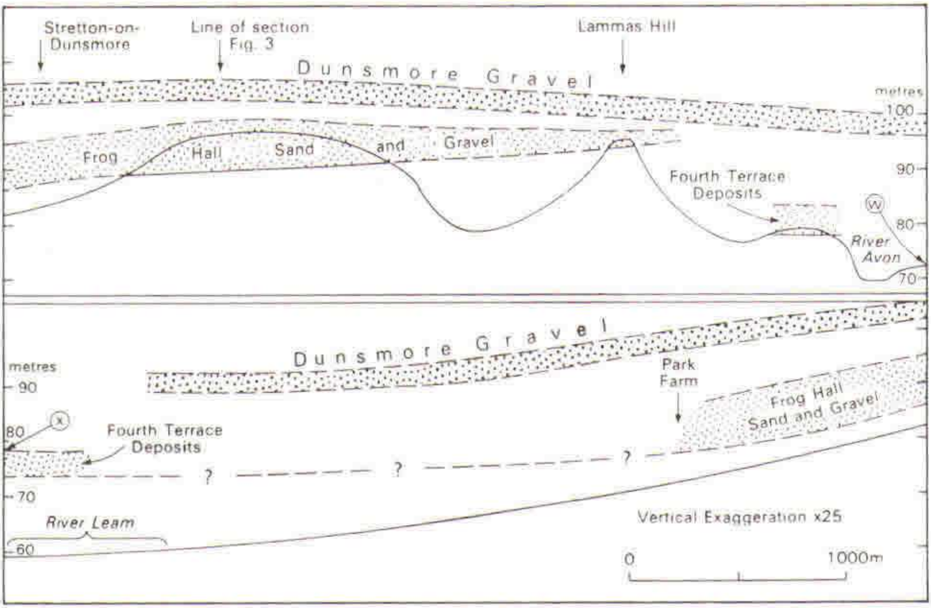

Figure 4 Profile between the Avon and Leam, showing height relationships of Frog Hall Sand and Gravel, Leam Fourth Terrace Deposits and Dunsmore Gravel. Continuous line shows present ground surface. For location, see Figure 1.

Conclusions

The Frog Hall Sand and Gravel is separate from and younger than the Dunsmore Gravel for the following reasons:

1 It lies within a southward-grading channel incised well below the level of the base of the Dunsmore Gravel in neighbouring outcrops.
2 It is better sorted than the Dunsmore Gravel and for this reason has been extensively worked (whereas the Dunsmore Gravel has not).
3 It includes fragments of ironstone derived from ironpans developed in the Dunsmore Gravel, and includes locally derived clasts not found in the Dunsmore Gravel.

The Frog Hall Sand and Gravel probably correlates with the Fourth Terrace deposits of the Avon/Leam. These are cold-climate deposits of pre-Ipswichian, post-Hoxnian age.

Acknowledgements

I wish to thank several colleagues for their useful comments. This paper is published with the approval of the Director, British Geological Survey (NERC).

REFERENCES

Crofts, R. G. 1982. The sand and gravel resources of the country between Coventry and Rugby, Warwickshire: description of 1:25 000 sheet SP47 and part of SP37. *Mineral Assessment Report Institute of Geological Sciences*, No. 125.

Keen, D. H. 1989. *The Pleistocene of the West Midlands: Field Guide.* Quaternary Research Association, Cambridge.

Mitchell, G. F., Penny, L. F., Shotton, F. W. and West, R. G. 1973. A correlation of Quaternary deposits in the British Isles. *Geological Society of London Special Report*, No. 4.

Old, R. A., Sumbler, M. G., and Ambrose, K. 1987. *Geology of the country around Warwick.* Memoir British Geological Survey, Sheet 184 (England & Wales).

Shotton, F. W. 1953. The Pleistocene deposits of the area between Coventry, Rugby and Leamington and their bearing on the topographic development of the Midlands. *Philosopical Transactions of the Royal Society of London,* **B237**, 209–260.

Ssumbler, M. G. 1983a. A new look at the type Wolstonian Glacial deposits. *Proceedings of the Geologists' Association*, **94**, (1), 23–31.

Sumbler, M. G. 1983b. *Geological notes and local details for 1:10 000 Sheets: SP 57 NW (North-east Rugby).* Open File Report British Geological Survey.

Sumbler, M. G. 1985. *Geological notes and local details for 1:10 000 Sheets: SP 47 NW, SP 47 NW, SP 47 SW, SP 47 SE (Rugby West).* Open File Report British Geological Survey.

Larsson, L. et al., 1988. The Skateholm Project: 1 Man & Environment. *Acta regiae societatis humaniorum litterarum Lundensis. Skrifter utgivna av Kungl. Humanistiska Vetenskapssamfundet i Lund LXXIX.*

This is a multi-authored monograph consisting of twelve papers covering anthropological, palaeoecological and geographical aspects of a late Mesolithic settlement at Skateholm in southern Sweden. The first two papers introduce this archaeological site and provide an interpretation of the local geology. These are followed by six papers describing and discussing the palaeoenvironmental evidence using various palaeobotanical and palaeofaunal studies. The remaining four papers deal with the archaeology of the late Mesolithic site. The text gives an informative insight into the Mesolithic population that occupied the area.

The introduction defines the study area and elaborates on its background. Details are given of how the excavation of the gravefields and old land surfaces was conceived and brought to fruition. The second paper describes the lithostratigraphy of the study area and relates it to various minor marine transgressions and regressions occurring at the time of the *Littorina* transgression in the lagoon.

A full account of the palynological studies is found in the next paper. The evidence provides a regional picture of the palaeoenvironment of the Skateholm lagoon and shore area as well as vegetation on the high ground. The discussion also speculates upon the effect of man in the time period represented in the sediment column sampled. A report on the floral macrofossils follows. Due to their taphonomy they indicate more localised vegetational changes. Macrofossil samples were taken between the archaeological settlement and the sea and it seems this area was covered by a lagoonal landscape of alder forest, reed swamp and open shallow brackish water from c.7500 BP to c.4000 BP.

Diatom and insect faunal analyses are covered in the next two papers. Diatom preservation is limited and most of the species recovered are characteristic of communities found in shallow brackish water. The diatom investigation also shows an increase in salinity throughout the profile related to the *Littorina* transgression. All the insect species identified are still found in southern Scandinavia today and are of a temperate climatic type. The insect assemblage does not suggest any real change in climatic conditions during the lagoon development. A summary of the evidence provided by the palaeobotanical and palaeofaunal studies is presented in the preceding paper. The samples for all these investigations were collected from the same profile and the dangers of this were emphasised. However, the point is made that multidisciplinary research of the same material has the advantage of good correlation of the results.

Vertebrate faunal remains from two sites in the area are discussed in a long paper. A large assemblage is recorded and described in great detail with various biotopes recognised. The author of this paper goes on to talk about the exploitation of these biotopes by Mesolithic man.

The remainder of the publication consists of four papers with a theme of the Mesolithic human population of the Skateholm site. The first concerns itself with the Mesolithic skeletons excavated from graves between 1983 and 1984. Each grave is described in detail and in the conclusion demographics, racial types, pathological changes, facial appearances and other traits are inferred. This is followed by a long and detailed paper on the descriptions of human dentitions from the late Mesolithic gravefields. In all 65 individuals were examined and dental age was estimated by tooth formation and attrition of the lower molars. It is stated that odontological studies contribute to the understanding of age distribution, genetic composition, living conditions and to the general way of life of the populations at the site.

The penultimate paper puts the Skateholm site into context with the Mesolithic of western Europe. The authors suggest that the great amount of work done this century on postglacial hunter-fisher-gatherer cultures of western Europe has lead to some sort of standardisation of material culture, time and space units which allow a degree of comparison. The large volume of work also provides a firm empirical base for the discrimination of different types of Mesolithic settlement site. Using human skeletal remains from Skateholm they have attempted to relate physical anthropological observations to measures of social dimensions, social structure, level of organisation, ethnicity and level of success of adaptation to the social milieu in which the inhabitants found themselves.

The final report is a summary of a functional analysis of a selection of flake axes from the settlement area. The results seem to indicate a varied use for these tools; however, butchery was the commonest use. This paper may have been better placed elsewhere in the monograph with the preceding paper being a far better summary paper.

The monograph is well presented with few typographic errors. In general the diagrams are clear and well labelled but the pollen diagram could have been on a smaller scale. Throughout, the photographic reproduction is excellent. The concept of multi-authored, multidisciplinary papers for individual sites can only be encouraged. It is a shame that more researchers do not get together more often. Surely one complete write up, such as this, is far more satisfactory than a number of papers published over a period of time by a multitude of authors.

Michael Field
College of St Paul & St Mary
The Park
Cheltenham
Gloucestershire
GL50 2RH

'This Refugium is all very well, but what about my cold feet?'

Island biota have been a recurring theme in biogeography since the days of Darwin and Wallace. The European connections of the Icelandic flora and fauna were well known by the turn of the century and their origins were being debated. The geologist Thorodssen favoured a *Tabula rasa* and postglacial re-immigration. The biologists, however, led by Lovén's work upon glacial relicts in Scandinavia, preferred a hypothesis of survival in refugia, either since the Tertiary, or from an undefined interglacial with landbridge contact with the European mainland. A cat and mouse game has developed whereby 'centres of dispersal' have been defined on biological grounds and despatched upon geomorphological ones. The landbridge has become increasingly untenable as ocean cores and plate tectonics have pushed any freeway back at least to the Miocene and, uneasy about the apparent lack of endemics in the face of severe selective pressures over 25 m.y., some botanists, in particular, sought to erect new species. It is to the credit of the entomologists, led by the Swedish taxonomist, Carl Lindroth, that, despite the acceptance of the refugia hypothesis by most, no endemic species were defined on minor morphological characters. The insects were seen for what they were, a subset of a European cool temperature, not arctic assemblage. The contradiction of the survival of such a group through frequent precipitate shifts in climate had to be lived with, in the track of almost universal support for the refugia model. The biota of a nunatak on the edge of Vatnajökull were examined, Skaftafell was described as a 'living glacial refugium', albeit perhaps more as a political move to ensure its conservation, and the highest peaks of 'Isafyördur and Ejjafjordar, as well as the glacial edge of the sea were seen as potential refuges. Any taxon which could not be fitted into the model became an S.E.P. (someone else's problem), usually defined as a Norse or later introduction. As a study in Ball's Law—'The less the evidence, the stronger the hypothesis'—the refugia model is particularly interesting in that, in the absence of Quaternary palaeontological data, it could not be tested. The conjunction of putative biological evidence for refuges, geomorphological evidence for ice-free areas and biota on modern nunataks is a red herring (or is it *sild raud*?). The fundamental question remains, whether a substantial part of Iceland's biota, including tree birch and several species of weevil and ground beetle could have survived multiple glaciation. On biological grounds, the answer has to be a negative. A measure of palaeontological information is now available and much of the pre-Landnam flora and fauna is present by the early Holocene but there is little convincing organic evidence for the Late Glacial or earlier terrestrial and lacustrine biota. Moving southwards, the failure of proglacial sediments in, for example, Lake Humber or the Creswell caves to yield contemporary fossils for the period 18 000–15 000 BP suggests that Iceland's best late Weichselian analogues may lie on the more remote Greenlandic and Canadian nunatak, if not in Antarctica, where the biota is reduced to a few algae and lichens at the most. Difficult to conceive as it may be, we are thrown back on the ice rafting (during rapid deglaciation) hypothesis. The refugia lay far to the south and the departure, on sediment-bearing shelf-ice, in the fjords of south-east Norway can be timed to ca.10 000 BP, give or take the vagaries of the ^{14}C timetable. The model can be tested against the fossil record and the Vedde and Saksunavatn tephra provide excellent isochrones to constrain it.

Our geographic training means that we cannot resist a final comment, an antipodean perspective. The model should work in reverse in the South Atlantic and the biota of the Falklands and South Georgia should be in subset of that of southernmost South America—the beetles almost certainly are.

P. C. Buckland
Dept. of Archaeology and Prehistory
University of Sheffield
Sheffield S10 2TN

A. J. Dugmore
Dept. of Geography
University of Edinburgh
Drummond Street
Edinburgh EH8 9XP

SOME POSSIBLE DEVENSIAN ICE-WEDGE CASTS IN MERCIA MUDSTONES NEAR CARDIFF, SOUTH WALES

Charles Harris

Site description

This note records the presence of possible truncated ice-wedge casts within the Mercia Mudstone (Trias) bedrock exposed in low coastal cliffs to the west of Swanbridge, South Glamorgan (ST 170 674) (Figure 1). The bedrock consists of horizontal or very gently flexured beds of soft friable mudstones and harder bands of calcarenites. The area has suffered extensive strike-slip faulting (R. A. Gayer, personal communication, 1989), major fault lines being shown in Figure 1. Jointing within the bedrock is also well developed. Fourteen wedge structures were recorded in a 210 m long section, with spacing ranging from 86 m to 0.6 m. The structures were confined to a section of cliff in which the upper 2–3 m consisted of soft mudstone. Examples of wedge forms are illustrated in Figure 2. The features range from simple anticlinal folds with sharp apices (Wedges Nos. 5, Figure 2), to larger areas of arched strata in which the zone of disturbance is over 2 m wide (Wedge No. 2, Figure 2).

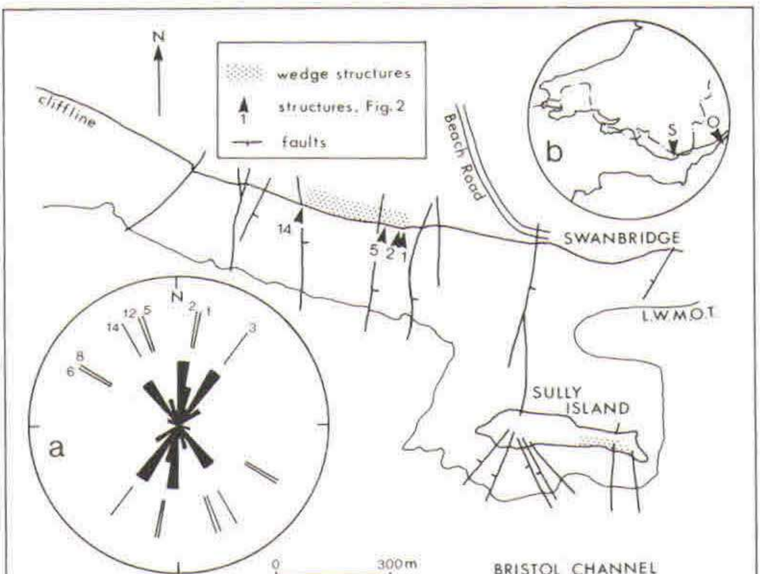

Figure 1 Location map. The wedge structures found on Sully Island were described by Bradshaw and Ingle Smith (1963). Inset (a) shows joint orientations on the wave-cut platform below the wedge structures to the west of Swanbridge (sample size = 30), together with orientations of wedge structures, where possible to determine. Numbers refer to individual wedges, numbered from the eastern side of the section. Inset (b) shows location of Swanbridge (S), and Oldbury upon Severn (O), together with Devensian ice limits.

The actual wedge casts range from less than 1 cm to 46 cm wide at the top, and generally taper downwards to become a mere crack between adjacent upturned strata. The infilling material consists of weathered mudstone and, where small clasts are present, they are generally vertically aligned. There is no input of sediment derived from other sources. Wedge structures extend down from the modern soil to a depth of up to 2.76 m, but in some cases are as little as 0.6 m deep. Two wedges, including wedge No. 14, Figure 2, are clearly located over faults in the strata below, but in the other cases such faulting is absent. The alignment of the wedge structures in plan, where it is possible to measure, shows some relationship to joint orientations in the underlying bedrock (Figure 1).

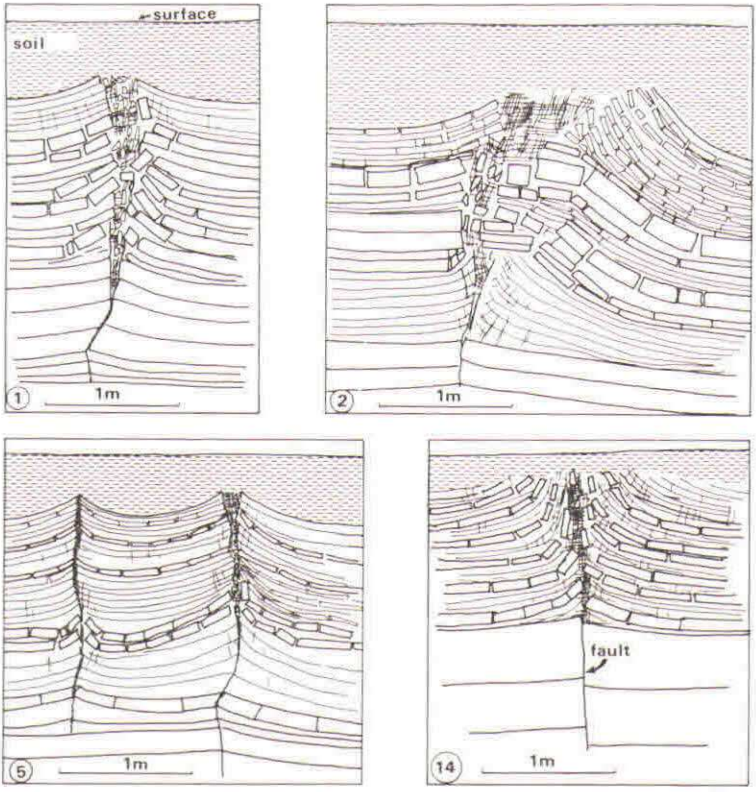

Figure 2 Sketches of selected wedge structures from the cliffs to the west of Swanbridge.

Discussion and conclusions

The wedge structures described above bear a strong resemblance to wedges observed by Allen (1984) exposed in the Mercia Mudstone intertidal platform at Oldbury on Severn, Gloucestershire, on the southern side of the Severn Estuary. Here, a polygonal network is exposed in plan, marked by narrow channels with upturned strata on either side. Allen ascribed the narrowness of the wedge forms to truncation due to surface erosion after casting had occurred. Wedge filling in these, and in similar casts in Triassic mudstone and Jurassic limestone on either side of the Severn Estuary (Allen, 1987), is derived from gravels underlying the Main Severn Terrace. These are compositionally related to the Late Devensian tills of the Midlands, and on this basis Allen suggested that the structures are true ice-wedge casts, and record permafrost conditions during the Dimlington Stadial of the Late Devensian.

A periglacial rather than tectonic origin for the structures at Swanbridge is supported by their restriction to the surface 2 to 3 m. There is no evidence for compressive folding associated with faults or joints in the strata at greater depth.

Similar near-surface structures involving localised upturning of strata were described on the adjacent Sully Island by Bradshaw and Ingle Smith (1963). These authors also ascribed bedrock disturbance to permafrost processes, but considered that upturning of strata was due to water escaping under pressure from the active layer as it froze from the surface downwards. It is, however, difficult to understand how sufficient pressure could be generated to break through a frozen surface layer, and how frozen mudstones could display plastic deformation rather than brittle fracturing under these circumstances. It is also relevant to point out that no observations of water bursting out of the active layer during refreezing have been reported from modern permafrost environments.

In the light of Allen's observations of polygonal networks of wedges in the Mercia Mudstone bedrock at Oldbury, it appears most likely that the structures at Swanbridge and Sully Island are the lower parts of similar truncated ice-wedge casts. The absence of wider sediment-filled casts, despite significant upturning of adjacent strata, may reflect in part a lack of fill material during permafrost thaw, the relatively rigid nature of the disturbed bedrock preventing its complete resettlement as ice wedges disappeared. Although there is no direct evidence for their age, it is tempting, in view of the similarities between these structures and those farther up the Severn Estuary in a similar geological setting, to suggest that the wedge casts at Swanbridge and Sully Island represent westward extensions of the ice wedge polygon systems at Oldbury and elsewhere on the banks of the Severn Estuary. The inference then is that these features formed under permafrost during the Dimlington Stadial of the Late Devensian.

REFERENCES

Allen, J. R. L. 1984. Truncated fossil thermal contraction polygons (?Devensian) in the Mercia Mudstone Formation (Trias), Oldbury upon Severn, Gloucestershire. *Proceedings of the Geological Association* 95, 263–273.

Allen, J. R. L. 1987. Dimlington Stadial (Late Devensian) ice-wedge casts and involutions in the Severn Estuary, southwest Britian. *Journal of Geology* 21, 109–118.

Bradshaw, R. & Ingle Smith, D. 1963. Permafrost structures on Sully Island, Glamorgan. *Geological Magazine* 100, 556–564.

Dr Charles Harris
Department of Geology
University of Wales College of Cardiff
P.O. Box 914
Cardiff CF1 3YE

A HAMMER SEISMIC REFRACTION SURVEY OF A SCOTTISH LACUSTRINE DELTA USED TO ESTIMATE SEDIMENT YIELD: SOME FURTHER CONSIDERATIONS

T. A. Stott and R. W. Duck

In a previous paper in this journal (Scott and Duck, 1988), we reported a hammer seismic refraction survey of a Scottish lacustrine delta forming the division between Loch Doine and Loch Voil. Differences in seismic velocities enabled the detection of what was interpreted as the interface between fluvially-derived deposits and underlying till, thereby permitting the volume of the former to be estimated. This was used as a basis for the evaluation of the long-term average sediment yield from the contributing upland moorland catchment of Monachyle glen. The yield derived in this way (1.7 t $km^{-2}yr^{-1}$), from the entire 17.2 km^2 catchment averaged since the last ice retreat ($\sim 1 \times 10^4$ years), was found to be substantially lower than contemporary yields measured in the upper part of the glen.

Whilst primarily concerned with emphasising the potential of the seismic refraction method in Quaternary studies, we perhaps failed in out earlier paper to draw a clear distinction between measured suspended sediment and bedload yields in Monachyle glen. As reported previously, sediment output monitoring between 1982 and 1985 in the upper 7.7 km^2 of Monachyle glen gave an estimated suspended sediment yield of 38 t $km^{-2}yr^{-1}$. We are now able to report that the 1982–1985 bedload yield was determined to be 0.3 t $km^{-2}yr^{-1}$, prior to this part of the glen being ploughed and drained by the Forestry Commission for afforestation (Stott, 1989). However, additional measurements, made between April 1985 and March 1986, in three tributaries draining a total of 15% of the 7.7 km^2 experimental catchment, revealed the mean bedload yield to be 2.1 t $km^{-2}yr^{-1}$ (Ferguson and Stott, 1987).

The difference between these two estimates can be largely explained as follows. First, different methods of estimating bedload were used. Bedload moving over a rectangular Crump weir at the 7.7 km^2 catchment outlet was monitored by the Institute of Hydrology by Helley-Smith spot sampling during a wide range of discharges. The Helley-Smith data thus collected were combined with the flow duration record using the rating curve method and the resulting load estimates were corrected for inherent statistical bias (towards underestimation) according to Ferguson (1987). The bedload yield estimates for the tributaries were made using specially installed bedload traps lined with 2.8 mm netting. The traps were excavated monthly over the 12 month period and the sediment coarser than 2.8 mm weighed to derive an estimate of bedload yield. A number of workers have criticised the rating curve method of sediment load estimation (e.g. Walling 1977, Walling and Webb, 1981, Ferguson, 1986, 1987) pointing out that in some cases it has given rise to underestimates of loads by as much as 50%. However, the bedload trapping method used in the tributaries, we feel, provides a much more reliable estimate and other workers support this (e.g. Newson and Leeks, 1985).

The second reason for the difference in the estimates can be explained in terms of delivery ratio. If we assume the difference in the estimates to be real, then the delivery ratio of bedload between the tributaries and the catchment weir outlet is low ($\sim$ 14%) and from this we conclude that bedload must be depositing on the mainstream bed in the short term. However, and in the much longer term, we feel that the question of channel storage would be less important over a period since the last ice retreat.

Thus, there is a close similarity in magnitude between the directly measured bedload yields obtained by the trapping method in the upper tributaries of the catchment and the yield value derived from estimates of the fluvial sediment volume of the downstream delta. In our earlier paper, we suggested that, as most of the fluvially-derived sediment is very fine grained, it is deposited away from the delta on the bed of Loch Voil. Although this is still a valid conclusion, we believe that it is the close similarity between the measured bedload and delta-derived yields which should be firmly emphasised, rather than this mis-match between the suspended sediment yield measured in the upper part of the glen ($\sim$ total yield) and the delta-derived yield. We therefore suggest that the fluvial sediments of the Monachyle delta are primarily composed of those materials transported as bedload, the suspended load components being carried out to the "offshore" zone of Loch Voil.

Normally estimates of bedload yield are available for no more than a few years, the 13 year and 46 year figures of Richards and McCaig (1985) and Newson and Leeks (1985) being some of the longest term records known to us. It would appear from this preliminary study that lake deltas deserve further attention with respect to very much longer term bedload yield estimation (cf. Lambert, 1982). Ideally this will require evaluation of both the subaerial and subaqueous deposits. We suggest that onshore seismic refraction and offshore seismic reflection techniques coupled with excavation, coring and the accurate dating of appropriate marker horizons in the sequences could form the basis for further research in this field.

Tim Stott
Orielton Field Centre
Pembroke
Dyfed
SA71 5E2
Wales

Rob Duck
Dept. of Geography and Geology
Division of Geology
University of St Andrews
Fife
KY16 9ST
Scotland

References

Ferguson, R. I. 1986. River loads underestimated by rating curves. *Water Resour. Res.* **22,** 74–76.

Ferguson, R. I. 1987. Accuracy and precision of methods for estimating river loads. *Earth Surf. Proc. Landf.* **12,** 95–104.

Ferguson, R. I. and Stott, T. A. 1987. Forestry effects on suspended sediment and bedload yields in the Balquhidder catchments, Central Scotland. *Trans. Roy. Soc. Edinburgh: Earth Sciences,* **78,** 379–384.

Lambert, A. M. 1982. Estimation of erosion and sediment yield by volume measurements on a lacustrine river delta. *Int. Åssoc. Hydrol. Sci. Publ.,* **137,** 171–176.

Newson, M. D. and Leeks, G. J. 1985. Mountain bedload yields in the United Kingdom: further information from undisturbed fluvial environments. *Earth Surf. Proc. Landf.,* **10,** 413–416.

Richards, K. and McCaig, M. 1985. A medium term estimate of bedload yield in Allt a'Mhuillin, Ben Nevis, Scotland. *Earth Surf. Proc. Landf.,* **10,** 407–411.

Stott, T. A. 1989. Upland afforestation. Does it increase erosion and sedimentation? *Geography Review,* **2,** No. 4, 30–32.

Stott, T. A. and Duck, R. W. 1988. A hammer seismic refraction survey of a Scottish lacustrine delta used to estimate sediment yield. *Quat. Newsl.,* **54,** 1–8.

Walling, D. E. 1977. Assessing the accuracy of suspended sediment rating curves for a small basin. *Water Resour. Res.* **13,** 531–538.

Walling, D. E. and Webb, B. W. 1981. The reliability of suspended sediment load data. *Int. Assoc. Hydrol. Sci. Publ.,* **No. 133,** 177–194.

IGCP PROJECT 274 "COASTAL EVOLUTION IN THE QUATERNARY— UK WORKING GROUP

National Correspondent:
Ian Shennan
Department of Geography
University of Durham
Durham DH1 3LE

The first meeting of the UKWG was held at the NCC HQ, Peterborough, on 21 December 1988. This notice details the main points agreed there and gives the program for the project within the UK.

1 The International Organisation and Scientific Objectives of IGCP 274

IGCP 274 was conceived from IGCP 200, in part to extend the work of sea-level studies. However, the project is not specifically a sea-level project. From the inaugural meeting in Amsterdam, September 1988, the aims of IGCP 274 were agreed as:

1 Documentation and explanation of coastal evolution.

2 The undertaking of specific thematic studies which are necessary to help solve problems of human occupancy of the coastal zone.

These aims are to be achieved through the following scientific objectives:

1 Models of coastal evolution, including the continental shelf.

2 Coastal evolution in critical earth environment zones.

3 Impacts of sea-level change on coastal environments.

4 Education and promotion and communication of knowledge to other audiences upon matters concerning coastal evolution and impacts of sea-level change.

The theme of the project is mainly coastal evolution, with work concentrating on the coast loosely defined to include the shelf and the perimarine environments.

2 Contribution of the UK Working Group and Annual Meetings

2.1 *Annual Meetings*

The timing and location of meetings of the UKWG were agreed as:

September 13–15 1989: Durham (Ian Shennan)
September 21–23 1990: South Coast (Simon Jennings)
1991: Moray Firth (Callum Firth)
1992: N. Ireland—Final Meeting (Bill Carter)

The format of the Durham meeting was agreed as:

A: Two days field excursions to the coasts of Durham, Northumberland, Morecambe Bay and Cumbria.

B: One day of discussion in the form of four seminars on topics related to project 274.

The 1990 meeting will have the theme "Engineering and Conservation". Either the 1991 or 1992 meeting would include a session on recent post-graduate work.

2.2 *Objectives of the UK Working Group to Project 274*

The objectives of the UK working group are:

1 To integrate existing data on shoreline evolution and sea-level history in the British Isles into a framework for exploring and predicting coastal changes.

2 To examine the sensitivity of shoreline response to factors such as sea-level change, sediment supply, wave power, basement geometry and basement material, in such environments as gravel beaches, sand beaches, sand dunes, saltmarsh, cliff, shore platforms and engineered coasts.

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To obtain further details of the international project, please write to Ian Shennan for a participation form.

QRA DISCUSSION MEETING: 'ENVIRONMENTAL CHANGE IN ICELAND: PAST AND PRESENT'

The QRA Discussion Meeting on 'Environmental Change in Iceland: Past and Present' was held at Aberdeen University on 12–14 April 1989. The meeting was attended by nearly 50 participants, including researchers from Iceland, Sweden, West Germany and Switzerland. Icelandic participants were generously funded by the Curry Fund of the Geologists' Association. The paper sessions were followed by a morning Workshop aimed at identifying particular research problems and promoting international research programmes to tackle them. The Workshop proved highly successful and resulted in the following projects being set up:

(i) an interdisciplinary/international lake coring project for Iceland;

(ii) an interdisciplinary/international sediment and water transfer project based on an instrumented glacial catchment (from ice cap to valley sandur to offshore zone) at Solheimajokull;

(iii) an Icelandic research newsletter, to be edited by Dr Halldor Petursson (Akureyri Museum) and Dr Damian Lawler (Birmingham University);

(iv) a bibliographic centre/service for research into environmental change in Iceland (co-ordinator to be Dr Halldor Petursson);

(v) a volume of papers to be published by Kluwer, to be edited by Judith Maizels and Chris Caseldine;

(vi) a QRA field trip to Iceland in July 1990;

(vii) a follow-up conference to review progress in research to be held at the University of Reykjavik in July 1991, to be co-ordinated by Dr Kjartan Thors, Marine Research Institute, Reykjavik.

Further details of any of these projects can be obtained from Dr Judith Maizels, Dept. of Geography, University of Aberdeen AB9 2UF, or from Dr Chris Caseldine, Dept. of Geography, University of Exeter EX4 4RJ.

Abstracts from 'Environmental Change in Iceland: Past and Present', a QRA sponsored meeting held at the Department of Geography, University of Aberdeen on 12–14 April 1989.

The organisers of this meeting were Dr J. Maizels, University of Aberdeeen and Dr C. Caseldine, University of Exeter.

HOLOCENE DEGLACIATION PROCESSES IN NORTHERN ICELAND

Ian Y. Ashwell
University of Salford

Current theory accepts a stadial process of deglaciation in Iceland, with readvances in the Alftanes (12 500–12 000 y BP) and Budi (11 000–10 000 y BP) stages. I have examined critically the evidence of stadial deglaciation in North Iceland on the ground and found that it needs reassessment. In particular, there are no firm dates associated directly with the key sites. Most dates are inferred from shell sites in Western and Southern Iceland. In Western Iceland I was led to question the whole theory of stadial deglaciation and put forward an alternative process involving sub-glacial water action. A similar suggestion resulted from examination of an area in North-east Iceland. In the summer of 1988 I examined key areas in Central Northern Iceland, on which much of the stadial theory is based, the Reykjahlid 'moraines', the Laugaholar in Reykjadalur, Ljosavatnsskard, and the terrace/channel system in Fnjoskadalur and am suggesting here that the evidence for stadial deglaciation processes is at least balanced by that for sub-glacial process. Because of its continuous availability of geothermal heat and thus melt-water generated at high altitudes in the build-up of the sub-glacial 'Moberg' mountains, Iceland can provide a key reference source as the theory of sub-glacial processes is developed.

LATE GLACIAL AND HOLOCENE CHANGES IN THE S.E. ICELAND CONTINENTAL SHELF

Geoffrey Boulton
Grant Institute of Geology, University of Edinburgh

A geophysical, oceanographic and sedimentological survey extending from Reynisdjup to east of Breidamerkurdjup has been undertaken over recent years in collaboration with the Icelandic Marine Institute. This reveals a repetitive stratigraphy on the Continental Shelf comprising a till unit which extends over much of the shelf, a mud unit confined to the glacially eroded troughs across the shelf, a thick coastal-sediment wedge representing major progradation of the coastline, and a series of volcanic accumulations which are intercalated within the stratigraphy. It is suggested that Late Weichselian glaciers reached the shelf edge over much of southern Iceland, and that they halted along the line of a well-defined shelf moraine before retreating from the shelf and coastal zone. A number of volcanic cones were formed after the glaciation which indicate a much more extensive Late Glacial volcanic zone than at present. Early Holocene sea levels fell to about 60 metres below the present sea level before rising to present values and accomplished a great deal of erosion of glacial deposits on the shelf and volcanic cones. At the time of deglaciation the southern coastline of Iceland was a fjord coastline, but this has been progressively filled in by progradation of glacially-derived sediments to form the modern relatively straight coastline.

LICHENOMETRIC DATING IN NORTHERN ICELAND— THE CONTRIBUTION OF LICHEN POPULATION STUDIES

Chris Caseldine
Department of Geography, University of Exeter

Studies of populations of *Rhizocarpon geographicum* agg are discussed for eight sites in the Skidadalur valley of Tröllaskagi, Northern Iceland. Measurements from a range of locations including moraines, debris flows and rock glacier illustrate the value of such studies in the following areas: (i) Evaluation of the likely validity of the largest lichen as an accurate measure of the age of a landform; (ii) Derivation of a dating curve based on the gradient of the population curve; (iii) Identification of composite populations of lichens of very different ages; and (iv) Identification of breaks in the structure of lichen populations due to external factors e.g. vulcanicity, snowkill.

The results of the population studies will also be evaluated in terms of the general problems of dating Holocene glacier variations in Northern Iceland.

TEPHROCHRONOLOGY AND LATE HOLOCENE SOIL EROSION IN SOUTH ICELAND

Andrew Dugmore
Department of Geography, University of Edinburgh

Gudrún Sveinbjarnardóttir
Department of Scandinavian Studies, University College London

Paul Buckland
Department of Archaeology and Pre-History, University of Sheffield

The scale of soil erosion in Iceland since the Norse Settlement is generally known, but the detailed patterns of change are less clear. Through the application and refinement of tephrochronological frameworks, established by the late Professor Sigurdur Thórarinsson and Gudrún Larsen, it has been possible to study in some detail the pattern of aeolian sediment accumulation around Eyjafjallajökull, and infer a pattern of soil erosion at a parish scale. Later pre-historic rates of sediment accumulation seem to have been comparatively uniform in the zone between ca.500 m above sea level and the sandar edge, but historic rates vary with altitude. In the early historic period, dramatic increases in upland sediment accumulation rates imply the early onset of acute local soil erosion in natural grasslands. These high rates decline through time, presumably as slopes stablized at bedrock or gravel surfaces. At progressively lower elevations inferred onsets and peaks of severe local soil erosion occur progressively later, indicating that a zone of chronic instability moved slowly downhill, reaching low lying areas during the last two centuries. The timing and location of these changes reinforces the view that they are primarily anthropogenic. Settlement in the area has always tended to be restricted to the coastal strip and the lowest slopes rising from major floodplains. Extensive early denudation in the uplands may have been an important contributory factor in the early abandonment of Landnam farm sites in the Thorsmork area. Although later inland abandonments appear to be ultimately the result of social and cultural factors, some may have also been encouraged by the effects of anthropogenic soil erosion.

ICELANDIC TEPHRA LAYERS IN THE NORTH ATLANTIC REGION

Andrew Dugmore
Department of Geography, University of Edinburgh

Gudrún Larsen
Nordic Volcanological Institute, University of Iceland

Paul Buckland
Department of Archaeology and Pre-History, University of Sheffield

The outstanding power of tephrochronology as a dating tool in Iceland is well known, primarily as a result of the pioneering work of the late Professor Sigurdur Thórarinsson. Major Icelandic eruptions have spread airborne ash clouds through the N.E. Atlantic region forming important isochrones in mainland Scandinavia and the British Isles. The identification, correlation and dating of Icelandic tephras in areas distant to source requires a refinement of tephrochronological techniques, and highlights the need for detailed knowledge of the geochemical characteristics of major Icelandic tephras, and a reasonably complete record of such events. There are many wide ranging implications associated with the long distance correlation of Icelandic tephras and these are highlighted with particular reference to the occurrence in the UK of airfall Hekla ashes, and an ocean rafted pumice, possibly of Icelandic origin.

AN ASSESSMENT OF THE FACTORS INVOLVED IN RECENT LANDSCAPE CHANGE IN ICELAND

John Gerrard
School of Geography, University of Birmingham

The Icelandic landscape shows abundant evidence of recent phases of landsliding and soil erosion. A number of factors such as climatic change, overpopulation and grazing pressure and volcanic ash falls have been suggested as causes of such instability. A framework is devised to enable the impact of such factors to be assessed. This framework is then tested by an examination of numerous slope exposures from all parts of Iceland as well as analysis of processes currently in action. Use is made of tephrochronology to deduce past landscape change. The general conclusion is that all the major factors mentioned earlier have been significant in initiating landscape change but that their relative effect depends very much on local environment factors. The major influence appears to be human pressure with climatic changes such as that associated with Little Ice Age periods of somewhat lesser importance. But the results must remain tentative until subjected to a wider analysis.

LANDSCAPE CHANGE IN BERUFJORDUR, EASTERN ICELAND, IN THE LAST THOUSAND YEARS

John Gerrard
School of Geography, University of Birmingham

Many studies have demonstrated that the landscape of Iceland is potentially extremely unstable and has been subjected, in recent times, to numerous external influences that could affect the balance between stability and instability. Such external influences include climatic change, the pressures created by settlement expansion and the effects of numerous tephra falls. Instability is reflected in extensive soil erosion, mass movements of various types, gullying and shifting river courses. This paper seeks to analyse

the effect of some of these processes on the landscape around Berufjordur, Eastern Iceland. The main area examined is Fossardalur, a narrow remote valley leading off Berufjordur, which, at one time, possessed 8 or 9 farm sites compared with the one presently occupied. Examination of exposures indicates that quite major changes have occurred over the last thousand areas. There have been several phases of erosion and deposition on the slopes, the creation of alluvial fans of different ages and marked changes in the location of the main stream. Assessment of geomorphological processes and landscape change has been aided by tephrochronology, using two dark ashes, one from the Katla eruption of 1755 and one probably representing an eruption at Vatnajokull in 1477, and a yellow-white tephra, the result of the 1362 eruption of Oraefajokull. It is not possible to state categorically the causes of the phases of instability but fluctuations in climate in combination with settlement and grazing pressure have been important.

HOLOCENE GLACIAL HISTORY OF BARKÁRDALUR, TRÖLLASKAGI, NORTH ICELAND

Thomas Häberle
University of Zürich, Switzerland

The research area is situated to the west and southwest of southernmost Eyjafjördur in North Iceland and to the east of the main watershed of Tröllaskagi peninsula. River Hörgá is the main river of the area and 46 glaciers and névés can be found in Hörgárdalur and its tributary valleys.

As it is rather difficult to make any chronological statements concerning not only the High Glacial but also the Late Glacial period in the above area, my main work has been focussed on the Holocene period.

It is known that the area near the confluence of the two rivers Hörgá and Öxnadalsá has become ice-free not later than 8900 BP (D. Bartley, 1973). Also moraines at the mouth of Barkárdalur, which is a long tributary valley of Hörgálur, must be rather old, i.e. older than tephra layer H 5 and older than a radiocarbon date of 7500 BP. Some samples are still being prepared and new radiocarbon dates are expected. Fossil soils have not been found in the moraines excavated but Tertiary bedrock has been reached.

During the research, Barkárdalur has proved to be an important "key-valley" for the postglacial chronology of the area. In this valley one can find about 250 m outside the outermost forefield moraine (Little Ice Age) another large moraine which is—in contrast to all forefield moraines—covered with a thick layer of vegetation. What I interpreted in Munich as a moraine between 3000 BP and 6000 BP years old I am interpreting now—due to new results from radiocarbon dates—as a glacial advance at 2240 BP—due to timber found and dated beneath the moraine.

A similar situation exists in Bægisárdalur, a tributary valley of Öxnadalur, where the outer moraine which does not belong to the forefield, must be older than 1000 BP. Here more dates are to be expected.

Other research has been in lichenometry, and a pollen analysis from a glacial lignite in Bægisárdalur is still in preparation undertaken.

SEA-LEVEL CHANGE IN VESTFIRDIR

Jim Hanson and David Briggs
Department of Geography, University of Sheffield

Recent observations in the Vestfirdir area of Iceland have revealed a wealth of raised marine features from c.70 m a.s.l. to 2 m a.s.l. that may reveal a different isostatic uplift pattern from that of the rest of Iceland.

At 8.5 m a.s.l. at Hvithalid, dinoflagellate-rich marine silts are capped by a peat layer which yielded a radiocarbon age of 8830 yrs BP. The peat was itself capped by a storm beach deposit above which a second peat layer yielded a radiocarbon age of 6910 yrs BP.

At Smahamrar nearby, a suite of raised beaches between c.70 m a.s.l. and present sea-level are older than 8875 yrs BP.

It appears that sea-level dropped rapidly from 70 m to clm shortly before 10 000 yrs BP and peat began to accumulate on beaches at about 8800 yrs BP. However, a rise of sea-level to 8.5 m occurred at about 9000 yrs BP. The ensuing regression was temporarily halted by a high energy event such as a storm surge at 6900 yrs BP which reached an altitude of 6.5 m a.s.l. and deposited a marine fauna at Hvithalid.

ENVIRONMENTAL CONTROLS ON THE DEVELOPMENT OF SMALL-SCALE SOLIFLUCTION LANDFORMS IN ORAEFI, SOUTHERN ICELAND

Stephan Harrison
Department of Geography, Middlesex Polytechnic

This paper looks at the nature and distribution of actively forming small-scale "turf-banked solifluction steps" found above the Neoglacialtrimlines of Oraefi outlet glaciers in southern Iceland. These features are widespread on slopes of between 4 and 21 degrees from 300 m to 700 m a.s.l.

Local controls affecting the distribution of these landforms include aspect and altitude. Aspect controls the exposure of the features to wind which in turn affects vegetation, snow cover and frost penetration. There steps are restricted to wind-exposed southwest-northwest aspects. As a result the tread surfaces are swept clear of snow, promoting deep winter freezing, frost heave and the winnowing of fines from the surface and subsequent devegetation of the treads. Altitude controls the number of freeze-thaw cycles per year and hence the degree of disruption of tread surfaces by frost heave and creep.

The presence of these features confirms that above 300 m or so, mass-wasting processes operate actively in southern Iceland. Similar low altitude maritime research sites are absent south of the Arctic Circle from the rest of Europe and this area may prove to be an appropriate analogue for similar processes operating during the British Quaternary.

SCHMIDT HAMMER DATING OF RECENT PROGLACIAL LANDFORMS

Chris Hunt and Alan Thompson
Department of Earth Sciences, University of Liverpool

The Schmidt Hammer, designed originally to test the surface hardness of concrete for engineering purposes, has recently been used by geomorphologists to quantify the degree of weathering of boulders as a measure of the age of landforms on which they occur. To evaluate the technique for use in Iceland the instrument was used to obtain measurements from a variety of proglacial landforms, calibrating the results against independent dates obtained by lichenometry. For river terraces at a single site there was a consistent decrease in "R" value with age, but these results proved to be incompatible with data from nearby moraines. The technique appears to have considerable potential for relative age determination within limited geographical areas providing it is restricted to a single type of deposit. It cannot, however, be extended over wider areas because of lithological variations, and must be restricted to relatively recent surfaces (up to 250 years old) because of the increasing coverage of boulders by lichens and moss on older surfaces.

NEW EVIDENCE ON THE LATE WEICHSELIAN AND PREBOREAL DEGLACIATION OF ICELAND

Olafur Ingólfsson
Department of Quaternary Geology, Lund University, Sweden

Recent investigations on the glacial history of western and southern Iceland indicate a significantly more extensive glaciation during the Younger Dryas and Preboreal times than previously recognized.

In the Borgarfjördur area, western Iceland, Younger Dryas glaciers extended to positions in the outer coastal areas. Terminal moraines in the Borgarfjördur tributary valleys probably relate to a Preboreal glacial position. In the larger Reykjavík area, southwestern Iceland, glaciers extended to a position beyond the present coast some time after 11 000 BP.

The Búdi moraine complex, which can be traced across the lowlands of southern Iceland, has for long been considered to mark the terminal position of a Younger Dryas ice advance. New stratigraphic investigations and a radiocarbon chronology for the glacial events indicate a Preboreal age for the Búdi moraines.

A new concept of a heavy Younger Dryas and Preboreal glaciation will be discussed with reference to recent evidence on the deglaciation from northern and eastern Iceland, as well as with evidences from adjacent North Atlantic areas.

INVESTIGATIONS INTO THE LOAD OF A PROGLACIAL OUTWASH CHANNEL: NESKVISL, SVINAFELLSJOKULL, SOUTH-EAST ICELAND

Arnold Jones
School of Geography, Liverpool Polytechnic

Many British sand and gravel deposits have been produced by fluvial and glaciofluvial processes operating within the context of glacial land systems. A series of investigations were made in a proglacial outwash stream in south-east Iceland to further our understanding of proximal transportational and sedimentary processes.

Intensive studies of radiation, precipitation and ablation on the glacier, associated with discharge and stream load studies, demonstrate diurnal variation patterns, lag times, and the complex nature of the spatial and temporal relationships between the variables. The nature of some of these relationships will be examined and quantified.

It is concluded that there are many advantages offered by proglacial channels for short term monitoring of stream load.

A NEW RHIZOCARPON DATING CURVE FOR TRÖLLASKAGI PENINSULA IN THE NORTH OF ICELAND

Ottmar Kugelmann
Institut für Geographie, Universität München

In the Tröllaskagiarea an lichen growth curve for *Rhizocarpon geographicum* was established at 19 different sites (abandoned farmsteads, memorial stones, bridges, mudflows) of known age. Using this curve the moraines of eight "Gletschervorfelder" were dated. Several phases of glacier advances could be pointed out, at about 1810, 1850, 1870/80, 1890, and in the twenties and forties of this century. An attempt was made to compare the phases of glacier advance with climatic parameters as temperature and precipitation and the sea ice around Iceland.

SUSPENDED-SEDIMENT TRANSPORT IN JÖKULSÁ Á SÓLHEIMASANDI, SOUTHERN ICELAND: SOME PRELIMINARY RESULTS

Damian M. Lawler
School of Geography, University of Birmingham

This paper describes the first step of a longer-term research project designed to test the hypothesis that geothermal activity under glaciers can result in particularly distinctive meltwater sediment and solute concentrations. Inversion of subsequent models, combined with the continuous monitoring of meltwater quality variations, may eventually allow the prediction of future geothermal and volcanic activity in the Katla system, and hence jökulhlaups.

Pilot results were obtained in 1986, although the main measurement programme was conducted over 2.5 months of the 1988 summer melt season at the bridge c.4 km from the snout of Sólheimajökull (19° 25'W; 63° 30'N). Field research was in three overlapping phases: (a) installation of a datalogging system for the automatic monitoring of river, screen air, and ground surface temperature, light/radiation intensity, river level, meltwater conductivity and turbidity; (b) automatic water sampling to provide checks on the turbidity meter and sediments for source analysis and (c) establishment of the rating curve for the Jökulsá.

Preliminary results indicate that:

(i) Solute concentrations here are very high for proglacial rivers. The sources may relate to long residence times, extensive contact of meltwaters with bedrock or glacial debris and/or mixing with solute-rich groundwaters.

(ii) Suspended-sediment concentrations for the Jökulsá are also very high, and increase dramatically at higher flow-levels.

(iii) Rainless days lead to a clear diurnal flow variation, with peak stage around 1800 h, and a minimum around 0800 h. However, rainstorms produce the highest peaks.

(iv) Sharp drops in river level occur relatively frequently, followed by equally dramatic "rebounds" to higher levels. Whether they are related to a collapse of glacial tunnels and a temporary damming of meltwaters, to mini-surge events, or to other causes remains to be seen. Interestingly, these flow irregularities are marked by substantial variations in suspended-sediment concentration and river temperature.

Future work will involve linking glacier behaviour to the hydrological record, and the identification of geothermally-derived components in the meltwaters of the immediate proglacial area.

HOLOCENE SANDUR EVOLUTION IN AREAS OF JOKULHLAUP DRAINAGE, SOUTH ICELAND

Judith Maizels
Department of Geography, University of Aberdeen

This paper explores the extent to which some of the sandur plains of south Iceland owe their origin to infrequent catastrophic flood events derived (a) from drainage of ice-dammed or subglacial geothermal lakes (e.g. Grimsvötn), and (b) from subglacial volcanic eruptions (e.g. Katla). Examination of stratigraphy and sedimentology of sandur deposits in these two environments reveals contrasts which reflect differences in the hydrographs and sediment concentrations of the flood flows, and also in the nature of the long-term evolution of the sandur deposits.

The sediment facies assemblages associated with volcanic drainage comprise thick massive pumice/tephra sequences overlain by ripple and megaripple lithofacies and boulder lags, locally eroded to form deep channels and terrace sequences. This assemblage is interpreted as representing repeated two-stage flow events, with an initial hyperconcentrated flood surge associated with a rapidly rising hydrograph, followed by a more fluid, dewatering stage. Lake drainage sediment sequences, by contrast, comprise numerous thin, normally graded, sediment cycles, reflecting smaller flow fluctuations superimposed on the long recession curve of the flood hydrograph.

Morpho-stratigraphic analysis combined with ^{14}C, tephrochronologic and lichenometric dating, indicate that, at Solheimasandur for example, only 8 major jökulhlaups have occurred over the past 4.5 ka, but that their effects have dominated the long-term Holocene evolution of the sandur plain.

CLIMATIC CHANGES IN ICELAND IN HISTORICAL TIMES

Astrid E. J. Ogilvie
Climatic Research Unit, University of East Anglia

In this paper, possible changes during the historical and pre-instrumental period of Iceland's climatic history (c.879 to 1850) are considered. The evidence for these changes derives from documentary historical sources. The nature and use of these sources will be discussed.

The evidence suggests a possible mild period when Iceland was first settled, with cooler periods around 1200 and 1290. The fourteenth century was very variable with a marked cold period from c.1350 to 1380. From 1430 to c.1560 very little evidence is available. The latter part of the sixteenth century was cold. There was a distinct mild period from c.1640 to 1670 but the 1630s, 1690s, 1740s, 1750s and 1780s were cold.

A preliminary analysis of the period 1800 to c.1850 suggests that the 1820s and 1830s were all relatively cold. The years 1841 to 1850 were unusually mild.

CONTROLS ON BEDLOAD SEDIMENT TRANSPORT IN A GLACIAL MELTWATER STREAM, SÓLHEIMAJÖKULL

Judith Maizels
Department of Geography, University of Aberdeen

The aims of this project were to (i) derive a predictive model of sediment transport rates in a gravel-bed river; (ii) estimate volumes of material being removed from the glacial meltwater system and (iii) develop a model of channel changes in a braided river in relation to the processes controlling change, and particularly the processes that control bed scour. The preliminary stage in achieving these aims was to test for the likely controls on the amounts and rates of transport of bedload material in a meltwater stream. This paper reports on some early results of this test, which was carried out in a tributary meltwater stream of the Jokülsá á Sólheimajökull.

The results so far indicate first, that the controls on rates of bedload transport are highly complex, and cannot be predicted in a direct or simple manner from hydraulic measures of local stream power or bed shear stress. The patterns of bedload sediment transport reflect not only local hydraulic conditions, and exceedance of local thresholds for entrainment, but are particularly dependent on rates of sediment influx from upstream. Indeed, in glacial meltwaters, which have access to a large, unconsolidated sediment supply readily available for transport during the diurnal flood peaks, upstream sediment influx may dominate over local bed and bank conditions in controlling rates of bedload transport. The predictive model suggested in this paper therefore considers bedload transport rate as a function not only of local hydraulic conditions, but also of local bed and bank conditions (e.g. armouring, bank resistance); upstream bed, bank and sediment transport conditions; and upstream channel pattern changes (e.g. channel development, avulsion or abandonment).

Second, the results indicate that although overall sediment transport rates are very high for most flows during the meltseason, the rates fluctuate constantly through time and can vary by up to 400 per cent within a short period. Maximum sediment transport rates of 160 g m s^{-1} were measured, representing a daily total approaching ca.13.8 t m^{-1} d^{-1}.

The project aims to continue during the next field season with a more integrated test of both upstream and downstream controls on channel changes and sediment transport rates in the same meltwater stream, as the basis for developing a more reliable model for predicting bedload transport rates through time.

NEW OBSERVATIONS ON THE GLACIAL HISTORY DURING THE POSTGLACIAL TIME IN NORTH ICELAND

Johann Stötter
Institut für Geographie, Universität München

The exposure of a moraine complex, close to the outermost moraine of Vatnsdalsjökull gives a new opinion of the postglacial history of Iceland. By means of radiocarbon and tephrochronological analysis, two glacial advances can be dated. The results show a first advance in the period between the deposition of the H_5 tephra layer and about 5500 BP and with a glacier readvanced after about 3000 BP.

The time in between seems to have been a period of relatively good climatic conditions with the Snow and tree lines about 200 m higher than today.

LATE WEICHSELIAN SEDIMENTS ON WEST MELRAKKASLÉTTA, NORTH-EAST ICELAND. A NEW INTERPRETATION OF THE TYPE SITE OF THE BÖLLING (KÓPASKER) INTERSTADIAL IN ICELAND

Halldór G. Pétursson
The Akureyri Museum of Natural History, Iceland

On the basis of the stratigraphy of five sedimentary profiles on the west coast of Melrakkaslétta, a composite stratigraphy for the area has been set up. The stratigraphy can be divided into three groups, which are all considered of Weichselian age. The youngest group is of Late Weichselian age, and is represented in all profiles.

The sediments reflect deglaciation and a period of relatively high sea level (>40 m a.s.l.), represented by glaciomarine perlite (unit A) with dropstones and shells dated to 12 600 BP. Deglaciation proceeded and isostatic recovery of the area set in, represented by marine sand (unit B) and sublittoral gravel (unit C). The bottom of unit B is dated to 12 100 BP. Unit C is found in small hollows eroded down in unit A and B at a low sea level (<10 m a.s.l.). It contains some stones of foreign origin, an evidence of far travelled sea ice. In the Younger Dryas, glaciers advanced beyond till (unit D). Deglaciation and formation of a Late Weichselian marine limit is represented by sublittoral, littoral sand and gravel (unit E) and is dated to 10 100 BP.

EVIDENCE OF HIGH SEA LEVEL OLDER THAN LAST ICE ADVANCE. EXAMPLES FROM SOUTH OF TJÖRNES AND WEST MELRAKKASLÉTTA, NORTHEASTERN ICELAND

Halldór G. Pétursson
The Akureyri Museum of Natural History, Iceland

Recent investigations in the area south of Tjörnes revealed sediments deposited at relatively high sea levels. All these sediments are overlain by till, deposited by the last ice advance in the area. The deposits are found at levels from 50 m to 110 m a.s.l., rising from north to south. Raised terraces formed at the Late Weichselian marine limit, and dating from the last deglaciation of the area are found at considerably lower level, at 10 m to 40 m a.s.l. rising from north to south.

On west Melrakkaslétta, glaciomarine, marine and sublittoral sediments are overlain by till. The glaciomarine sediments, which are dated to 12 600 BP, were deposited at a sea level which was at least 40 m a.s.l. The ice advance which deposited the till is considered to date from Younger Dryas. The Late Weichselian marine limit from the last deglaciation of the area, and dated to 10 100 BP, rises from 0–20 m a.s.l. from north to south.

The sequence of events in both areas is the same with a major ice advance overriding older glaciomarine and marine sediments. On the basis of radiocarbon dates from west Melrakkaslétta, it seems reasonable to conclude that this occurred in Younger Dryas times.

STABLE ISOTOPE MEASUREMENTS IN ICELAND

Árny Erla Sveinbjörnsdóttir
Science Institute, University of Iceland

The first stable isotope measurements on Icelandic waters were performed in the United States in the years 1948–1957 (Bödvarsson, 1962, Friedman et al., 1963). In 1976 a comprehensive study on groundwater systems in Iceland based on deuterium was published (Árnason, 1976). In this study precipitation, surface water, hot and cold groundwater and Icelandic glacier ice were analysed at the Science Institute, University of Iceland. The results showed that all groundwater in Iceland is originally meteoric and does not change its deuterium content on its way from the origin to the sampling point.

During the years 1976–1985 no stable isotope measurements were done in Iceland due to lack of facilities. In 1984 the Science Institute received a new mass spectrometer (Finnegan MAT 251) as a technical aid from the Atomic Energy Agency in Vienna. Since then a considerable amount of data has been collected on Icelandic waters and glacier ice. The earlier measurements in Iceland were limited to deuterium analyses and the few oxygen analyses available from those years were done in Denmark. Presently however, it is possible to analyse both for oxygen and deuterium and thereby to study in greater detail the $\delta D - \delta^{18}O$ relationship. It has been shown that a linear relationship exists between δD and $\delta^{18}O$ in precipitation and surface water that is not affected by other separation processes than evaporation and condensation in the atmosphere. This linear relationship, generally called the meteoric line, may vary from place to place, but in the Northern Hemisphere it has been shown to be $\delta D = 8\delta^{18}O + 10$ (Craig, 1961). The deuterium excess is defined as $d = \delta D - 8*\delta^{18}O$. Recent study has shown that it is possible to use the deuterium excess to pinpoint the origin of the precipitation (Johnsen et al., 1987).

In this paper new stable isotope results for several Icelandic water systems are discussed and the deuterium excess used to estimate the origin of the precipitation. Among the studied areas is the glacier Vatnajökull. In the summers 1986 and 1987 holes were drilled through the winterlayer for stable isotope measurements. The results are characteristic for temperate glaciers, where $\delta^{18}O$ ranges from $-7‰$ to $-20‰$ and δD from $-51‰$ to $-148‰$. The deuterium excess generally lies between 12 to 18‰, but at the top and bottom of the well it is $< 10‰$ and the minimum value obtained is 5.5‰.

Precipitation from Írafoss SV-Iceland has been collected daily from January 1987 for stable isotope—and chemical analyses. The deuterium excess in these samples as well as the other δ-values varies greatly. When $\delta^{18}O < -7‰$ the measurements follow closely the meteoric line ($d = 10$) whereas part of the heavier samples show higher deuterium excess and the maximum value obtained is 23‰. These results indicate different source areas for the precipitation.

Some snow samples were collected in Reykjavík in early spring 1987 and the $\delta^{18}O$ values range from $-7‰$ to $-15‰$, whereas the deuterium excess ranges from 15‰ to 26‰. According to the model of Johnsen et al. (1987) these data suggest a northerly source area.

Finally, cold groundwater within the National Park at Þingvellir will be discussed as an example of a groundwater system that closely follows the meteroric line with $d = 10‰$.

References

Árnason, B. 1976. Groundwater systems in Iceland traced by deuterium. Science Institute, University of Iceland, 255 pp.

Bödvarsson, G. 1962. The use of isotopes of hydrogen and oxygen for hydrothermal purposes in Iceland. *Jökull 12*, 49–54.

Craig, H. 1961. Isotope variations in meteoric waters. *Science*, 133, 10702–10703.

Friedman, I. P. Sigurgeirsson and Ö. Gardarsson. 1963. Deuterium in Iceland waters. *Geochim. Cosmochim. Acta*, 27, 533–561.

Johnsen, S. J., Dansgaard, W. and White, J. W. C. 1987. The origin of Arctic precipitation under present and glacial conditions. *Tellus* (accepted for publication).

EVIDENCE OF LOW LATE WEICHSELIAN OR EARLY FLANDRIAN SEA LEVEL IN EYJAFJÖRDUR, NORTHERN ICELAND, AND HVALFJÖRDUR, SOUTHWESTERN ICELAND

Kjartan Thors
Marine Research Institute, Reykjavík

Seismic profiles from Eyjafjördur and Hvalfjördur reveal features which are thought to represent sea levels lower than present.

In Eyjafjördur a submerged delta and wave-built platform indicate a sea level at −39 metres. Higher up on the fjord slope drowned deltas and spits probably stem from a transgression to present sea level.

In Hvalfjördur an erosional unconformity and terraces at about −30 m similarly indicate a sea level of −20 to −25 metres.

Without dated samples it is only possible to time the low sea level stands in the two fjords indirectly. Present knowledge of the sequence of events in adjacent land areas indicates that the regression occurred in Late Weichselian or Early Flandrian times.

ENVIRONMENTAL CHANGE IN ORAEFI, SOUTHEAST ICELAND

Alan Thompson
Department of Earth Sciences, University of Liverpool

Environmental changes on a variety of timescales are reflected in the landscape and geological structure of Oraefi in southeastern Iceland. The Oraefajokull massif, an ice-capped central volcano on the southern edge of Vatnajokull, is built of subaerial lavas and subglacial tuffs and breccias, the alternation of which reflects the growth and decay of ice sheets throughout the Quaternary period. Within the predominantly volcanic succession are rare fossiliferous sediments of glaciolacustrine origin, dating from the middle Pleistocene. Historical eruptions of Oraefajokull in 1362 and 1727 caused widespread devastation of surrounding farmlands and generated jökulhlaup floods and debris flows which built out steep alluvial fans along the mountain front. These have subsequently been dissected by readjustment of the outwash streams to form spectacular terraces. The steep outlet glaciers of Oraefi respond rapidly to climatic fluctuations and their variations since the Neoglacial ("Little Ice Age") maxima of the late Nineteenth Century are preserved in the landforms and sediments of the proglacial areas, providing a detailed record of environmental change over the last 100–150 years.

ENVIRONMENTAL SIGNIFICANCE OF ROCK GLACIER FORMATION IN NORTH ICELAND

Liz Thomas
Sheffield

The Tröllaskagi Peninsula, north-central Iceland, is described as marginally glaciated. Quaternary research in this area has concentrated on investigations of glaciers and moraines. Aerial photograph analysis reveals that rock glaciers are spatially as important as glaciers and moraines. This paper details preliminary investigations into the use of rock glaciers as environmental indicators and their potential role in the reconstruction of the late Quaternary environment in Tröllaskagi. Problems of rock glacier origin, age, dynamics and relationship to glacial systems are considered. It is concluded that whilst there are currently many gaps in the understanding and interpretation of rock glaciers, rock glaciers in Tröllaskagi have a potentially important role in Quaternary environmental reconstructions.

PLIOCENE AND QUATERNARY ENVIRONMENTAL CHANGE IN KASHMIR, NORTH-WEST HIMALAYA

Abstract of thesis presented for the Degree of Doctor of Philosophy by Jonathan A. Holmes, Hertford College, University of Oxford, Michaelmas Term, 1988

Late Cainozoic environmental changes in Kashmir (33°30′ to 34°30′N: 74°10′ to 75°30′E) have been reconstructed using a range of techniques. The sedimentary record in Kashmir consists of a thick (> 1000 m) basin-fill sequence known as the Karewa Group, together with glacial and related sediments in the surrounding mountain flanks. The Karewa sediments are fluviolacustrine in origin and comprise alternations of conglomerates, sands and clayey silts.

Work on the lower Karewa Formation, which has previously been dated palaeomagnetically to between 4 and 0.4 Ma BP, involved the semi-quantitative analysis of clay-mineral assemblages by X-ray diffraction. The clay minerals in the lower Karewa Mudstones are interpreted as detrital clay which reflect weathering within the Kashmir basin. The analyses showed a change in clay mineralogy between about 2.5 and 2.3 Ma BP, from abundant kaolinite to abundant smectite.

Work on the upper Karewa Formation involved field description and mapping of facies, sedimentological analysis, dating using thermoluminescence (TL) and amino-acid racemization, and analysis of ostracod assemblages from lacustrine sediments. Areal restriction of the lake in Kashmir occurred about 0.4 Ma BP with the rapid uplift of the Pir Panjal Range. Sedimentological data show that aeolian dust formed a major input into the lake. Ostracod assemblages show that the lake itself was cool, shallow, alkaline and had abundant plant macrophytes. The lake drained between 120 and 80 ka BP. Stratigraphical, sedimentological and faunal evidence suggests that this was a result of tectonically-induced drainage rather than climatically-induced desiccation.

The glacial history of the surrounding mountain flanks was reconstructed by field mapping of glacial sediments and dated using TL and radiocarbon methods. Present and past patterns of glaciation were assessed by the determination of equilibrium-line altitudes (ELAs), glaciation thresholds (GTs) and cirque altitudes. Glaciers extended to 2150 m a.s.l. in the Great Himalayan flank and 2600 m a.s.l. in the Pir Panjal. There is evidence for only 2 pre-Holocene advances in Kashmir, the older of which predates 35 ka BP. Present patterns of glacierization indicate a SW to NE rise in the height of ELAs and GTs suggesting topographic and precipitation control. An apparent reversal of trends during the past is explained by Quaternary uplift of the Pir Panjal Range.

Present address:
School of Geography
Kingston Polytechnic
Penrhyn Road
Kingston upon Thames
Surrey KT1 2EE
UK

QN: notices

LAKE, MIRE AND RIVER ENVIRONMENTS DURING THE LAST 15 000 YEARS

G. Lang and C. Schluchter (editors). A. A. Balkema. Rotterdam. 1988. 119pp £25.50.

This volume derives from a jointly sponsored meeting held in Berne in June and july 1985 of the 'INQUA-Eurosiberian Subcommission for the study of the Holocene' in association with IGCP project 158 'Palaehydrology of the temperate zone in the last 15 000 years'.

In total, 21 papers are presented in the proceedings volume which has a predominantly East European flavour, with 5 papers from Poland and 2 each from Hungary, Czechoslovakia and the USSR. The volume is divided into 3 major sections, with 10 papers on lake and mire environments, 9 on fluvial Environments and 2 on fluvial environments and palaeohydrology: the state of the art. This latter section represents two views from a Polish standpoint. All but one paper (in French) are in the English language.

Despite apologies by the editors, for a delay in publication my first impression, apart from a now reflex reaction of 'What, not another Symposium Proceedings?' is one of a hastily assembled volume, paying scant regard to production, presentation, organisation and, even more importantly, editorial control of language and grammar. This is doubly dissappointing since, first, several of the papers are difficult to interpret in their present form and, secondly, those authors not writing in their native tongue deserve better editorial guidance in presenting their material.

Since this is a proceedings volume, the editors cannot be held responsible for the balance of material submitted which, in fact, covers a wide spectrum from review papers in the final section to detailed case studies of specific fluvial, lake and mire sites, as well as regional scale studies of both contemporary (USSR) and historical plant distributions, the latter achieved from the construction of isopollen maps for Czechoslovakia. However, the editors are responsible for setting the proceedings in context and for synthesising the major conclusions of the meeting, neither of which appear between the covers.

It is difficult, in the space available, to synthesise the variety of material covered, so I shall not attempt to do so. However, there is much of interest for palaeohydrologists and palaeoecologists in terms of the regions and techniques represented. Pollen analytical work forms the cornerstone of the environmental reconstructions presented in Part 1, but other interpretations derive from analysis of diatoms, Cladocera, Mollusca, bacterial pigments, geochemistry, particle size, ^{18}O and ^{13}C isotope analysis. Despite the apparent sophistication of the analytical techniques applied, interpretations, particularly with regard to Holocene hydrological changes, are often oversimplified. In several papers, lake levels appear to fluctuate indiscriminately with little regard to the hydrological implications of such changes in terms, for example, of closed or open lake basins. Furthermore, interpretation of water balances during the Holocene pay scant regard to contemporary hydrological analogues which could form a basis for sounder interpretation. In parts two and three, three papers are particularly worthy of individual mention. First, Kozarski et al., present a remarkably detailed and thorough account of the palaeohydrological changes in the River Warta using both facies models and palaeohydraulic flow estimation. Secondly, Starkel uses similar methods to examine tectonic, anthropogenic and climatic factors in the history of the River Vistula and, finally, Rotnicka and Rotnicki give an objective overview of the problems of palaeohydrologic reconstruction which are exemplified in studies of several Polish rivers.

Overall, the volume contains many interesting papers of value to us insular academics incapable of reading anything outside the English language. It is by no means comprehensive in coverage, as one would expect of a proceedings volume, but it is still a worthwhile addition to the bookshelf!

Ian Foster
Coventry Polytechnic

FIRST CANQUA/AMQUA JOINT MEETING (CANADIAN QUATERNARY ASSOCIATION/AMERICAN QUATERNARY ASSOCIATION)

Date(s) Conference June 4–6 (inclusive), 1990.
Associated field trips June 1–3 and 7–9 and Short Courses

Place University of Waterloo, Waterloo, Ontario, Canada

Theme Rapid Change in the Quaternary Record

For details contact:

A V Morgan
Quaternary Sciences Institute
Department of Earth Sciences
University of Waterloo
Waterloo
Ontario
N2L 3G1

Phone (519) 885-1211 (ext. 3231)
FAX (519) 746-2543.

E-Mail; FOSSIL@WATDCS on BITNET, NETNORTH or EARN

RESEARCH 'LEAVE' AT THE UNIVERSITY OF WATERLOO, CANADA

The Quaternary Sciences Institute at the University of Waterloo is seeking well-qualified scientists interested in spending post-doctoral or research leave abroad to pursue research on various aspects of Quaternary stratigraphy, geomorphology, climatic history or paleoecology of the Great Lakes Region. Areas of on-going research include mapping glacial lake shorelines, stratigraphy and derivation of glacial deposits, climatic history and paleoecology of interglacial, interstadial, and postglacial deposits using fossil pollen, plant macrofossils, insects, diatoms, molluscs and ostracods.

The University of Waterloo is located in the south-central part of the Great Lakes region in the heart of a classic glaciated landscape produced by competing ice lobes from the Erie, Ontario and Huron basins. The campus lies about 100 km west of Toronto in a quiet rural setting near the northern ecotone of the deciduous forest association.

A number of international exchange programs exist to support visiting scientists during their stay in Canada. The Quaternary Sciences Institute expects to direct and support applicants who might qualify for such programs.

For further details and information about the Quaternary Sciences Institute, please contact:

Dr P. F. Karrow
Director
Quaternary Sciences Institute
Department of Earth Sciences
University of Waterloo
Waterloo
Ontario
Canada
N2L 3G1

TREE RINGS AND ENVIRONMENT

Thomas S Bartholin
Björn E Berglund
Dieter Eckstein
Gordon Jacoby
Fritz Schweingruber

International Symposium in South Sweden
First Circular

This is the first announcement of a symposium to take place near Lund, South Sweden, 4–9 September 1990. It will be performed under the auspices of IUFRO (International Union of Forestry Organisations), IIASA (International Institute of Applied Systems Analysis) and the International Tree-Ring Society. The organizers are Thomas S Bartholin and Björn E Berglund, Lund, Dieter Eckstein, Hamburg, Gordon Jacoby, Palisades, and Fritz Schweingruber, Birmensdorf.

The symposium will be designed for an exchange of ideas and information around 'Tree Rings and Environment' and will thus include topics such as:

- dendroecological techniques (tree-ring width, density, image analysis, isotopes, chemical elements, signature years, statistics, etc.)
- biology of tree growth, including roots, branches and phloem
- forestry (stand and tree-line dynamics, fire, wind, avalanches, etc.)
- forest decline (including urban trees)
- animal damage to trees (defoliating insects, cambium miners, beavers, deer, goats, etc.)
- forest management (pruning, fertilization, thinning, damage through harvesting, etc.)
- tropical trees
- network of tree-ring chronologies
- dendroclimatology, particularly aiming at a worldwide coverage of palaeoclimatic curves for the last 1000 years
- historical timber trade and historical economy, landscape development
- geomorphology (subfossil timber, drift wood, earthquakes, volcanism, glacier).

In order to organize the meeting and plan an attractive program, we would request you to complete and return the short questionnaire below at your earliest convenience. The context of this symposium will be structured more clearly as soon as we get your answer and the topic of your paper or poster.

All the contributions presented (papers and posters) will be published in the form of Proceedings soon after the meeting. You will receive guidelines for the preparation of ready-to-print manuscripts together with a second circular letter later this year. We will expect your manuscript to be delivered during the symposium.

We are counting on some 100 participants as an upper limit and would particularly like to encourage junior scientists to contribute.

The conference fee will be SEK 4800 (+ addition for single room); this covers transportation from Malmö/Lund to the conference site and back, the excursion, as well as full board and lodging from the afternoon of September 4 to the morning of September 9. It also includes the symposium proceedings.

The address of the conference secretary is:

Thomas Bartholin
Department of Quaternary Geology
Tornavägen 13
S-223 63 Lund
Sweden

We would like to welcome you to Sweden next year and would ask you kindly to inform your colleagues of the meeting.

TREE RINGS AND ENVIRONMENT

International Dendroecology Symposium

4–9 September 1990

I would like to receive further notices about the International Dendroecology Symposium.

I would like to present a paper/poster on the following application, subject or methodology:

....

....

....

I prefer ☐ oral presentation

☐ poster session

☐ I need a personal invitation for official permission

Name ....

Address ....

....

....

Please return this form no later than 20 June 1989 to:

Thomas Bartholin
Department of Quaternary Geology
Tornavägen 13
S-223 63 Lund
Sweden

Tel. no. +46 46 107880 or 107891
Fax no. +46 46 104830

* After telephoning Sweden, I have extended the original closing date of 15 May to 20 June — so that recipients of this Newsletter have time to respond — but please respond promptly! *Editor.*

IGCP PROJECT 274 "COASTAL EVOLUTION IN THE QUATERNARY—" UK WORKING GROUP

Annual Meeting—September 1989

The official programme will start at 9.00 am Wednesday 13 September and finish at 5 pm on Friday 15 September.

Programme (order not yet finalised)

A — Field excursion to Northumberland coast—Holocene coastal development and impact studies.

B — Field excursion to Morecambe Bay and Cumbria—Holocene coastal development, interglacial sea-level indicators and present coastal development.

C — Four seminars and a visit to the Thermoluminescence Dating Laboratory.

D — Annual business meeting.

Accommodation has been reserved at St Aidans College, single rooms, full board at £22.00 per day (this price is reserved for bookings received before 1 July). Thirty rooms have been booked and will be allocated on a first come basis.

The registration fee covers use of one minibus and cost of the field guide.

Please complete the booking form, copy, and return to Ian Shennan.

- -

IGCP PROJECT 274 "COASTAL EVOLUTION IN THE QUATERNARY—" UK WORKING GROUP

Annual Meeting—September 1989

Please tick

I enclose the £10.00 registration fee (non-returnable) [ ]

Please reserve accommodation for 3 full days:
arrive for dinner on the 12th
depart after lunch on the 15th [ ] OR
Please reserve accommodation for 4 full days:
arrive for dinner on the 12th
depart after lunch on the 16th [ ]

Name .... Signature .... Date ....

Please send to: Dr Ian Shennan, Geography Department, University of Durham, Durham DH1 3LE

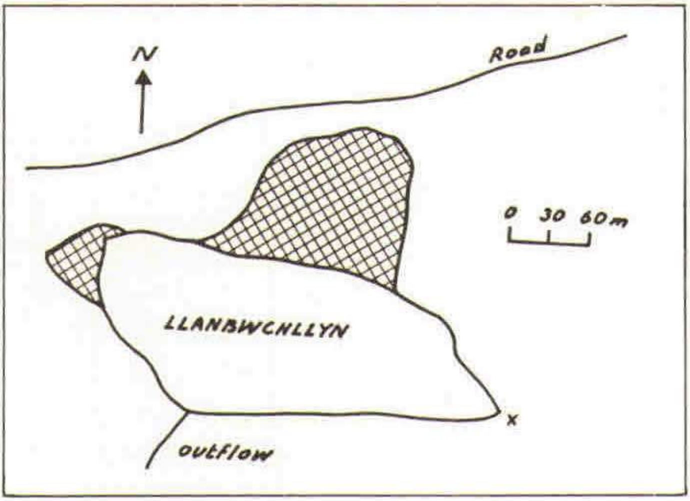
ERRATUM

In a paper by Tim Stott and Rob Duck in *Newsletter* No 54, a square root sign was omitted from the formula on p.3, which should have read:

$$D = Xc/2\sqrt{V_2 - V_1 / V_2 + V_1}$$

Thank you, Rob, for drawing my attention to this typographical error.
Editor.

Apologies to David Wilkinson, in his article in the last issue the site of the peat band (x) was omitted from this diagram.



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