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EDITORIAL

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QN: articles

EARLY SETTLEMENT IN SCOTLAND: THE EVIDENCE FROM REINDEER CAVE, ASSYNT

by Tim Lawson & Clive Bonsall

Creag nan Uamh (NC 268170) is a rocky crag formed by a dolomite outcrop on the south side of the Allt nan Uamh, 5 km SSE. of Inchnadamph in the Assynt area of Sutherland (Fig. 1). Three large caves penetrate the base of the crag. Clastic deposits in the entrance chambers to these caves were removed in excavations undertaken in 1889 and 1926-7 (Peach & Horne 1892, 1917; Callender *et al.* 1927; Lawson 1981). One stratum of particular interest uncovered in the later series of excavations in the central of the three caves (Reindeer Cave) was a layer of angular and subangular, dolomite-rich gravel, approximately 0.5 m thick, containing hundreds of reindeer, *Rangifer tarandus*, antler fragments and other bones. A radiocarbon date of 10,080 ± 70 a B.P. (SRR-1788) was obtained from a bulked sample of antler fragments from this layer (Lawson 1984). This date, together with the likely frost-shattered origin of the gravel and the presence of bones of several "arctic" species (e.g. arctic or collared lemming, *Dicrostonyx torquatus*, and tundra vole, *Microtus gregalis*: Lawson 1983), imply that the deposit accumulated during the Loch Lomond Stadial. Substantial accumulations of reindeer antler fragments are also known from caves in south Wales and the south-west of England, including Banwell Bone Cave in the Mendips (Sutcliffe 1955), Bosco's Den on the Gower Peninsula (Falconer 1868) and Tornewton Cave in Devon (Sutcliffe & Zeuner 1962). As little attention has been paid to the significance of these deposits, it was decided to make a detailed study of the material from Reindeer Cave to try to establish its origin.

Analysis of the Antler Material

The faunal remains from the 1926-7 excavations are housed in the Natural History Department of the Royal Museum of Scotland in Edinburgh. A careful study was made of the material labelled as having come from the layer of dolomite-rich gravel in the outer chamber of Reindeer Cave. The collection contains a minimum of 480 antlers (calculated by counting the number of basal fragments). The material is in a fragmentary condition,

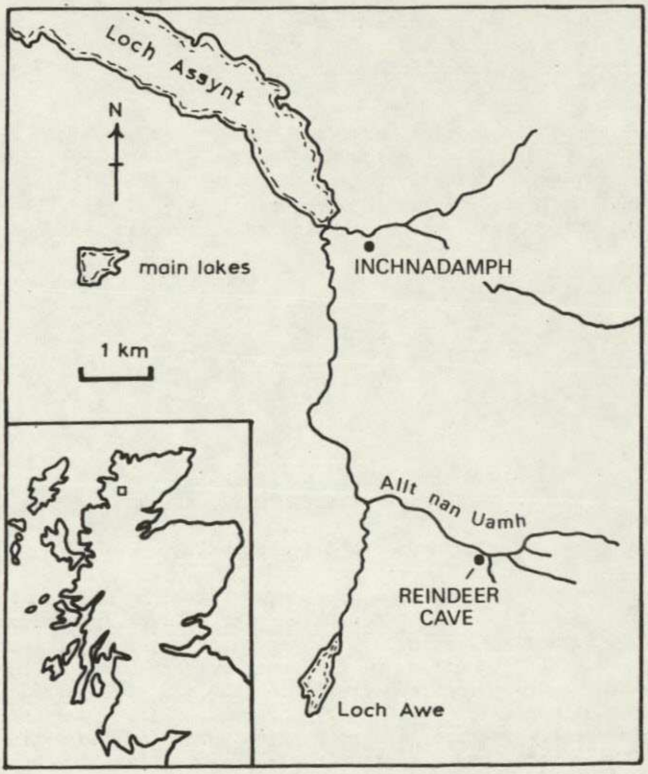

Fig. 1. Location of Reindeer Cave.

with no complete or near-complete antlers. There is no apparent bias in the sample towards particular parts of the antlers, nor are there signs of systematic fracturing. Hence, breakage was probably the result of post-depositional processes once the antlers had become brittle. Many of the fragments have the subcylindrical cross-section reported as characteristic of tundra reindeer, as distinct from the more flattened cross-section of the woodland ecotype (cf. Bouchud 1966). A small proportion (less than 5 %) shows unmistakable signs of having been nibbled by rodents, but there are no obvious puncture marks or other damage that can be attributed to gnawing by large carnivores; nor any signs of chewing of the antlers by reindeer themselves. In contrast to the large number of antlers, very few skeletal remains of reindeer were present - only two bones recovered from the gravel can be positively identified as reindeer.

Age and sex of the reindeer represented by antlers were established by inspection and measurement following the procedure outlined by Bouchud (1966) and Sturdy (1975). Examination of the antler bases showed that all of them had been naturally shed. 47 % were from female animals, with 25 % from males; in the remaining cases the sex could not be determined accurately. Measurements taken on the beam above the first brow tine (Fig. 2) suggest that the majority of the antlers are those of young animals. These measurements were compared with those taken by Sturdy (1975) on reindeer antlers from the late Upper Palaeolithic (Younger

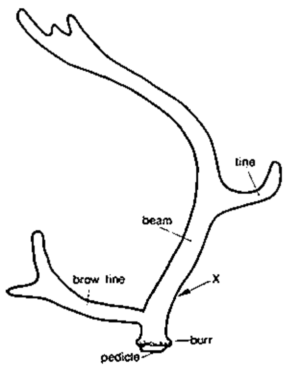

Fig. 2. Sketch of a shed male reindeer antler to illustrate the terms used in the text. X marks the position where, following Sturdy (1975), "breadth" and "thickness" measurements were taken on the antler beam.

Dryas) site of Stellmoor, north Germany. The male antlers from Reindeer Cave correspond closely to the size-range of "young and yearling" males from Stellmoor (animals up to the beginning of their second year); none of the material from Reindeer Cave falls within the range of the adult male antlers from Stellmoor. The female antlers from Reindeer Cave conform to approximately the same size-range as the male antlers, and match the distribution of "young and sub-adult" female antlers (animals in their first to third years) from Stellmoor.

Provenance of the Material

In seeking an explanation for the accumulation of reindeer remains within the cave, three possibilities may be considered:

1. That reindeer were living or periodically sheltering in the cave, or were coming there specifically to shed their antlers. To the authors' knowledge this mode of behaviour is not normally associated with reindeer. Even if it could be shown that modern reindeer occasionally make use of caves for shelter or as convenient places for detaching their antlers, it is difficult to imagine how such behaviour could account for the uniformly small size of the antlers from Reindeer Cave - a random sample of shed antlers from a normal reindeer population would be expected to show far greater variation in size - or for the fact that the antlers were confined to one of three adjacent caves, when reindeer could have entered all three.

2. <u>That the antlers were brought into the cave by carnivorous animals</u>. The remains of both brown bear *Ursus arctos* and wolf *Canis lupus* were found in the Creag nan Uamh caves, the bones of the former within the same lithostratigraphic unit as the reindeer remains under study. However, since all the antlers were naturally shed, they can hardly represent animals killed by carnivores. On the other hand, it has been suggested to the authors that wolves habitually collect antler for their cubs to chew on (A.J. Stuart and K. Scott pers. comm.). As an explanation for the presence of shed antlers within the cave it cannot be dismissed entirely, but the lack of evidence for gnawing of the antler fragments and the dearth of other bones of reindeer within the cave make this hypothesis improbable.

3. <u>That the antlers were collected and brought into the cave by man</u>. Of the three possibilities under consideration, this seems to offer the most satisfactory explanation. Lateglacial reindeer-hunting communities throughout northern Europe are known to have made extensive use of antler as a raw material for the manufacture of a variety of tools and weapons; straight beam portions of large antlers were most often used for this purpose (Clark 1938). Freshly shed antlers are ideal, since they contain the maximum amount of compact antler surrounding the spongy inner tissue of the core. The most striking feature of the antlers from Reindeer Cave is their small size and restricted size-range, implying a high degree of selection either in the collection or discard of the material. The absence of larger antlers of both sexes cannot be explained by seasonal factors. In the absence of any clear evidence of actual habitation of the Creag nan Uamh caves, in the form of artifacts or hearths, and of any traces of working or use of the antlers, we would suggest that the site functioned primarily as a cache or repository where shed antlers, collected perhaps on hunting expeditions, were stored and sorted according to their usefulness as raw material. The larger antlers - those that would have been of most value for the manufacture of artifacts - were subsequently removed to a processing or residential site elsewhere, and the rest discarded inside the cave.

It may be argued that climatic conditions in Scotland during the Loch Lomond Stadial would have been too severe for human occupation. However, there is overwhelming evidence (both archaeological and ethnographic) to suggest that by the Late Pleistocene many hunting societies had adapted successfully to life in the arctic zone (e.g. Klein 1974). The antler evidence from Reindeer Cave demonstrates quite clearly that reindeer were present in the Assynt area for at least part of the year. Such a major potential food resource would almost certainly have attracted predators - man included.

<u>The wider implications</u>

The conventional view of the earliest settlement of Scotland is that people were absent until about 2,000 years into the Flandrian (e.g. Price 1982, Edwards & Ralston 1984). This is based partly on the apparent absence of late Palaeolithic finds, and partly on a series of radiocarbon dates for supposedly "early" Mesolithic occupations at the sites of Lussa Wood I on the island of Jura (Mercer 1974, 1980) and Morton site A in Fife (Coles 1971). These dates, however, are poorly associated with archaeological material and have little relevance to a discussion of early settlement.

Notwithstanding the limitations of the radiocarbon chronology, a strong case can be made on archaeological grounds for placing the earliest Mesolithic settlement of Scotland much closer to the beginning of the Flandrian. Amongst Mesolithic industries in northern England a broad distinction can be made between broad blade and narrow blade microlithic technologies (Radley & Mellars 1964). These contrasting technologies occupy different time-ranges. Radiocarbon evidence suggests that narrow blade technology was in use from c. 8800-5300 a B.P. The chronology of broad blade industries is less secure, although present evidence would indicate a time-range from c. 9600-8600 a B.P.

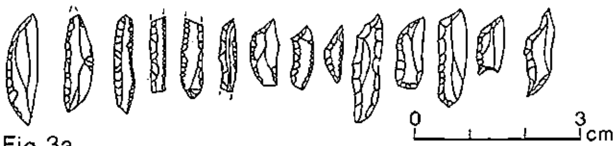

Fig 3a

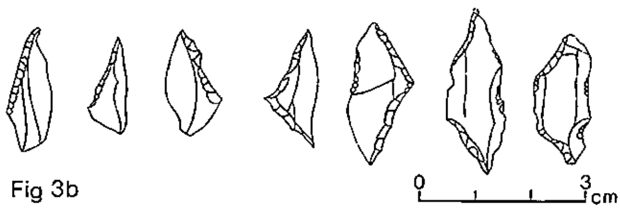

Fig 3b

Fig. 3. Lussa Wood I, Jura. a. narrow blade microliths, b. broad blade microliths (after Mercer 1980).

A similar distinction can be made within the Scottish Mesolithic (Fig. 3). The earliest radiocarbon estimate for a narrow blade industry is 8550 ± 90 a B.P. (mean of two determinations) from the recently excavated site of Farm Fields, Kinloch, on the island of Rhum (Wickham-Jones in press). This is statistically indistinguishable from dates for the earliest narrow blade technology in northern England (cf. Jacobi 1976, p. 71). No reliable radiocarbon dates are yet available for broad blade microlithic industries, but it is reasonable to infer that their appearance in Scotland was only slightly later than in the north of England and took place between c. 9500-9000 a B.P. (Morrison & Bonsall in press).

If man's role in the accumulation of the antler material in Reindeer Cave is accepted, this site pushes back the evidence for human occupation in Scotland even further - into the closing stages of the Lateglacial period. It also extends considerably the known range of Lateglacial settlement in Britain. This interpretation of the Reindeer Cave site, taken together with the above arguments based on artifact typology, suggests there is a strong likelihood of human occupation throughout Scotland in the time period 10,000-8500 a B.P.

Acknowledgements

We would like to thank Antony Sutcliffe, Donald Sutherland and Richard Tipping for reading and commenting on early drafts of this paper: Lin Barnetson, Jenny Bradbury, Andrew Currant, Nicola Murray, and Donna Yorkston for help with the faunal analyses; and I.H. Lyster and R. McGowan (Royal Museum of Scotland) for access to the collections in their care. Figures 2 and 3 were drawn by Mairi Anna Birkeland.

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POSSIBLE PERIGLACIAL INJECTION STRUCTURES OBSERVED NEAR STANSTEAD ABBOTS, HERTFORDSHIRE

by D.T. Shilston

A road cutting for the Stanstead Abbots by-pass, logged as part of a gravel resource survey in 1984, revealed a superficial deposit of glacial gravel over a gently dipping eroded surface of Tertiary clay. In the cutting the interface between the gravel and the Tertiary strata was seen to be severely modified by laterally extensive flame structures. The structures have also been identified as crop-marks on an aerial photograph, taken for archaeological purposes in 1976. This note describes these structures and suggests that they may have been formed by periglacial injection processes.

Geology of the site

The Terbets Hill cutting of the Stanstead Abbots by-pass is orientated approximately normal to the contours of the southwest facing side of the

River Lea valley, TL 395110 (Fig. 1). The hillside is slightly convex, increasing in slope from about 2° at the uphill end to about 4° at the downhill end of the 165 m length of cutting described here (Figs. 2 and 3).

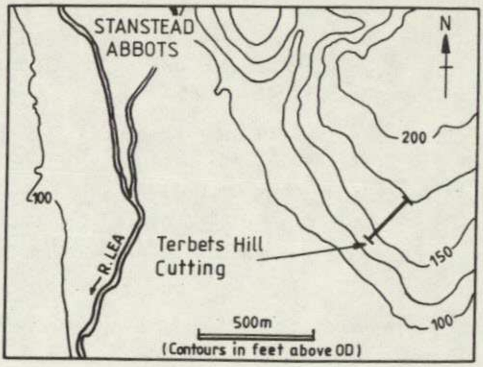

Fig. 1. Stanstead Abbots: Location map.

The solid geology of the site comprises fissured clay and sandy clay of Lower Tertiary age: the London Clay and Reading Beds Clay (Sherlock & Pocock 1924). The superficial gravel deposit exposed in the cutting is up to 3.5 m thick and is overlain by about 0.2 m of gravelly topsoil. The gravel is very sandy with minor silt and clay and a few cobbles. It consists mainly of flint and is orange-brown in colour, except for the upper 0.5 m which is weathered grey-brown. Where the deposit is greater than about 2 m in thickness it displays poor sub-horizontal stratification; elsewhere it appears to be unstratified. Hopson & Samuel (1982) report that uphill from the cutting the deposit is overlain by till and that about 1.5 km north of Stanstead Abbots a till bed occurs within glacial gravels which they consider to be a lateral continuation of the Terbets Hill deposit. The Pleistocene history of the Lea valley immediately upstream of Stanstead Abbots and the relationship between the various beds of till and gravel are described by Gibbard (1977).

Structures exposed in the road cutting

The gravel deposit exposed in the Terbets Hill cutting decreases in thickness from about 3.5 m near the uphill end of the logged face (Chainage 2910 m), to about 0.5 m at Chainage 2800 m and is absent or less than 0.3 m thick downhill of Chainage 2700 m (Fig. 3). The base is slightly convex on a large scale, dipping downhill at about 2° increasing to 4°. However, bodies of the underlying Tertiary clay extend into the gravel creating laterally extensive "flame" structures which strike approximately parallel to the contours (i.e. at about 140 to 170° with respect to grid north). The flame structures are about 1

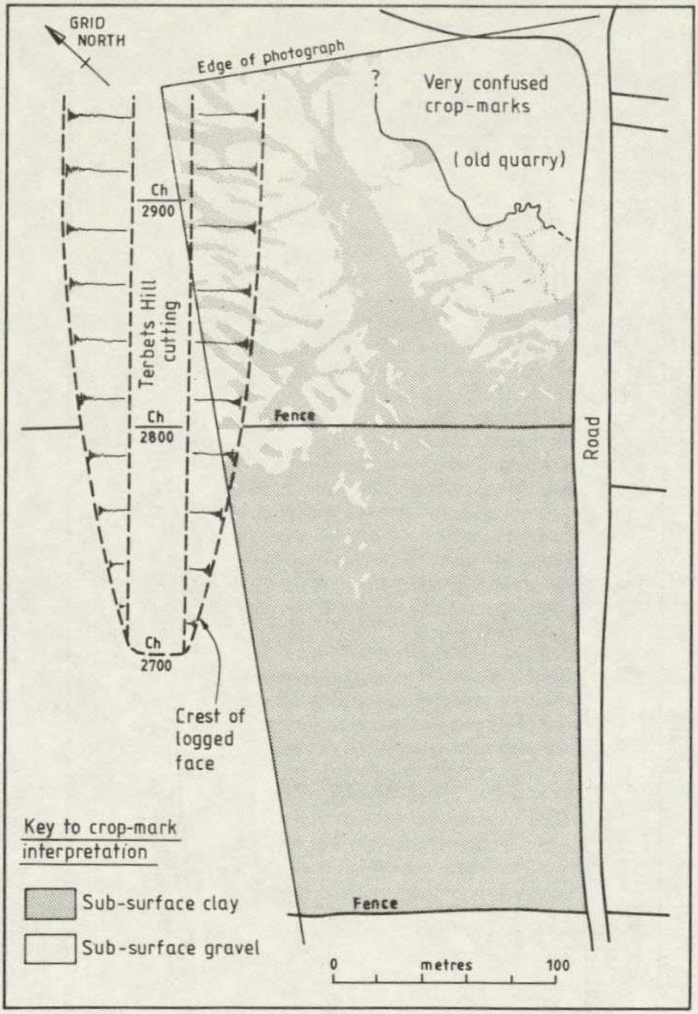

Fig. 2. Stanstead Abbots: Site plan showing crop-marks visible on aerial photograph.

to 3 m wide at their "roots", regularly spaced at 15 to 20 m centres along the cutting and extend through almost the entire thickness of the gravel. They are bent and attenuated downslope, the greatest deformation occurring at the downhill feather-edge of the deposit where the limbs of the structures are almost parallel to the general slope of the present ground surface.

The lateral continuity of the flame structures was difficult to assess as the road cutting had been excavated some distance into the Tertiary

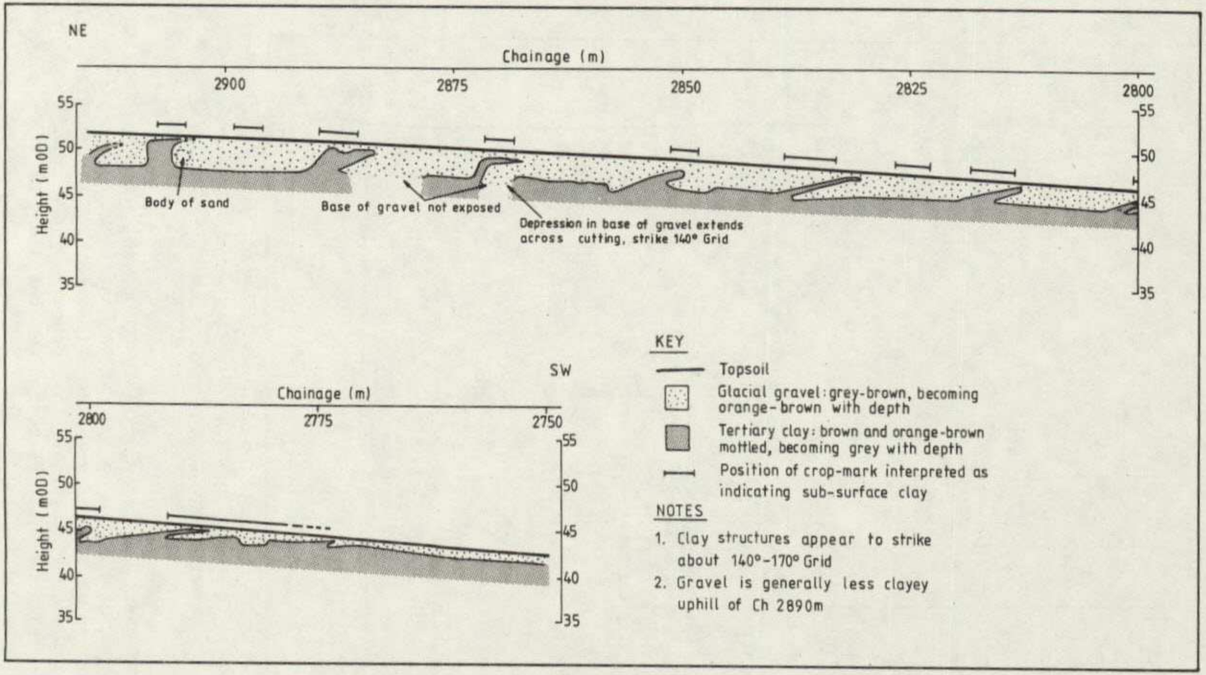

Fig. 3. Stanstead Abbots: Vertical section through south-east face of cutting.

clays when the site was visited. Two of the larger flame structures (Fig. 3) were traced across the cutting for more than 20 m and discussions with the contractor's staff suggest that they were in general 30 to 40 m in length. In the northwest face of the cutting the flame structures were less well developed than those in the southeast face and it was not possible to correlate the structures across the width of the cutting. No transverse structures (i.e. normal to the contours) were encountered during excavation of the cutting.

The clay forming the structures contains gleyed unpolished discontinuities and, in a trial pit adjacent to the cutting at Chainage 2840 m, was observed to contain shallowly dipping or sub-horizontal, ridged and polished shear surfaces which were also gleyed. The clay is weathered to a brown and orange-brown mottled colour and the degree of weathering decreases with depth.

Structures visible on the aerial photograph

Some months after completion of the fieldwork an aerial photograph was obtained showing crop-marks in the area immediately to the east of the Terbets Hill cutting and at the position of its south east face. The photograph was taken in mid-June 1976 and is of remarkable clarity (Royal Commission on Historical Monuments of England, 1976).

The flame structures logged in the south eastern face of the cutting appear as dark grey bands against the light grey speckled background of the gravel deposit and are shown on a tracing of the photograph as Fig. 2. In this area the bands are curvi-linear, with their long axes orientated approximately 150° to 180° with respect to grid north. Most are 2 to 5 m wide and 15 to 50 m in length. The crop-mark information is in good agreement with the observations made in the cutting and, with two exceptions, individual crop-marks can be correlated with the logged flame structures (Fig. 3).

The crop-mark pattern produced by the flame structures exposed in the cutting extends eastwards until it intersects a much larger dark grey linear crop-mark at about right angles. This crop-mark occurs about 20 to 50 m east of the cutting and is composed, near its edges, of coalescing linear or oval crop-marks similar to those produced by the flame structures exposed in the cutting. Its long axis is orientated at about 025° with respect to grid north, that is approximately normal to the ground level contours, and it occupies a slight topographic depression between two lobes with the characteristic gravel crop-mark pattern. This "down-slope" structure extends downhill until it merges with similar dark grey crop-marks in the area where gravel is known to be absent from trial pits excavated during investigations for the Stanstead Abbots by-pass. It is reasonable to suggest therefore that the gravel deposit is absent in the centre of the down-slope structure; this is in accord with the limited trial pit data aavailable from this area.

To the east of the down-slope structure there are crop-marks similar to those produced by the flame structures exposed in the cutting. They appear to occur in sets, approximately normal and parallel to the edge of the down-slope structure with the former being approximately parallel to the local topographic contours and better developed.

Interpretation of the structures

The overall interpretation that may be given to the structures exposed in the Terbets Hill cutting and to the crop-marks visible on the aerial photograph is of flame structures, either a single set or two sets almost at right angles, which are related to the present topography and to the much larger down-slope structure.

The flame structures are unlikely to have formed in the present climatic conditions as the Tertiary clays are too stiff to be deformed to this extent without the occurrence of major landsliding, for which there is no field evidence. As the gravel is thought to be a glacial deposit and is elsewhere overlain by or contains deposits of till, it is reasonable to suggest that the flame structures were formed or initiated under glacial or periglacial conditions.

A possible explanation of their genesis is that the flame structures were produced by the injection of the Tertiary clays into regularly spaced tension or ice wedge cracks in the overlying frozen gravel, the driving force for the injection process being the weight of superincumbent strata. The magnitude of this force would depend upon the strength of the clay and may not have been large as high porewater pressures may have been generated in the unfrozen clay beneath the frozen gravel (see Washburn 1979, ch. 4). It is suggested therefore that the flame structures were formed by an injection process in a periglacial environment.

The near vertical injections of clay would then have been modified by creep and solifluction, as suggested by their deformation and attenuation in a downslope direction. The shear surfaces seen in the clay may therefore have been produced during the injection process or by subsequent downslope movements.

The origin of the large down-slope structure is more enigmatic. The linear or oval crop-marks at its edge are similar to those produced by the flame structures seen in the cutting and may have been formed in a similar way. The orientation of the down-slope structure and its position in a slight topographic depression suggest that more recent erosion has modified its original form.

Acknowledgements

The Terbets Hill cutting and small trial pits nearby were logged as part of a gravel resource survey carried out by the Geotechnical Consultancy Group of Soil Mechanics Limited for John Mowlem and Co. PLC. The permission of both companies to publish this note is gratefully acknowledged. Thanks are also due to Mr. T.W. Spink and Mr. A.J. Bowden for discussions on the genesis of the structures.

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TWO SUBMERGED FOREST SITES IN SOUTH LLEYN, GWYNEDD

by Margaret Griffith

These previously unrecorded sites occur in the tidal range between high and low water at two separate places on the southern coast of the Lleyn peninsula, Gwynedd, North Wales.

The western site lies towards the east end of Porth Neigwl (N.G.R. SH 2825 2630). It is only visible when storms have removed the normal cover of fine sand. When seen in December 1980, a triangular area 45 m wide by 30 m deep was exposed. The landward side of the exposure lies 90 m south of the gate in the sand dunes at the seaward end of the footpath from the minor road from Towyn farm to Llanengan and Abersoch. The exposure comprises fallen tree trunks up to 3 m in length, large vertical stumps and areas of much smaller stumps. After a preliminary investigation a pollen sample seems to be very similar to the 5500 a B.P. forest at Borth and Barmouth with lots of oak, alder, hazel, etc. (A. Heyworth pers. comm., 1981).

It is recorded that at the end of the nineteenth century fallen trees, like black oak, and peat were dug from the beach by the local women and dragged above high water mark and left to dry. It was used as fuel and it burnt like coal (L. Jones pers. comm., 1981). Whittow (pers. comm., 1980) commented that it might be the seaward extension of the buried channel of the Afon Soch, and may be related to the coastal peat in the cliff section to the east of the gate. A fractured but unworked flint was found embedded in clay by a large tree trunk.

The eastern exposure is at the western end of the beach between Carreg y Defaid and South Beach, Pwllheli (NGR SH 3435 3290), and is frequently visible between high and low water marks. Widely scattered large fallen tree trunks and vertical stumps can be seen in clay between the sea wall and boulder strewn beach.

It is hoped that these sites will be further investigated to see how they relate to other submerged forests around the British Isles. The writer would be pleased to receive any further information concerning either site.

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AGE OF THE BROUGHTON BAY TILL, GOWER, SOUTH WALES:
Comments on the note by S. Campbell and R.A. Shakesby, Quaternary Newsletter 47 (1985), 33-36.

by D.Q. Bowen, A. Reeves and G.A. Sykes

The till overlying the raised beach at Broughton Bay, Gower, contains shells of *Macoma balthica*. Amino acid ratios from these are:

ABER 867B	0.110
ABER 867A	0.070

Compared with a radiocarbon timescale derived from amino acid screened bulk samples of *Macoma* (Bowen, Harkness, Sykes, Reeves & McCabe in preparation) the younger of these shells (ABER 867A) is Late Devensian in age, and the older sample (two shells) (ABER 867B) is Middle Devensian in age.

The Broughton Bay till, therefore, is Late Devensian in age, and any speculation that it may be Early Devensian by Campbell and Shakesby (1985) is without foundation.

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COMMENTS ON THE NOTE BY D.Q. BOWEN, A. REEVES AND G.A. SYKES

by S. Campbell and R.A. Shakesby

We are extremely interested in the announcement of two new amino acid ratios from the Broughton Bay till reported by Professor Bowen and his colleagues in their comments on our note (Quaternary Newsletter 47, pp. 33-36). Since these data were not available to us at the time of writing our note, a speculation that the Broughton Bay till could conceivably have been "Early" Devensian in age would not have been, of course, at that stage "without foundation". Moreover, it should be pointed out that we did not actually argue that the ice advance was "Early" Devensian in age, and in view of the 14C date (GrN-12508) we indeed implied that such an age was unlikely. We merely stated that a "Late" Devensian age for the till was unproven. If substantiated, however, these initial results reported by Bowen *et al.* do have some bearing on the age of the last ice advance onto NW. Gower. From the evidence of the two ratios alone it would, of course, be unwise for us to draw firm conclusions, but several interesting implications for regional environmental conditions do occur to us.

First, the data of Bowen et al. would indicate the presence in the Broughton Bay till of shells of both "Middle" and "Late" Devensian ages, in addition to the probably Ipswichian shells already reported (Campbell et al. 1982). Deposition of shell litter with such a wide age range in NE. Carmarthen Bay would require relative sea-levels on a number of occasions during the Devensian, to be at least close to that reached during the Ipswichian Interglacial; a view of events apparently conflicting with currently established estimates of Devensian sea-levels. Many attempts to establish the position of sea-level during the Devensian glacial maximum have been made and typical estimates range between -100 m and -130 m (e.g. Aharon 1983). Shackleton (1977), however, suggested that eustatic sea-level may have fallen even as low as -165 m during the Late Devensian. As recently as the Devensian Lateglacial it is estimated that sea-level off the west Wales coast may still have been as low as -50 m (Heyworth et al. 1985) and even as low as -60 m (Haynes et al. 1977). Even allowing for possible eustatic sea-level rises during warmer interstadial periods, it seems unlikely that world sea-level ever rose to above about -30 m to -40 m in the Middle Devensian (Aharon 1983, Harmon et al. 1983). Indeed, Bowen (1980) suggested that even during the Upton Warren Interstadial sea-level remained at least 40 m below that of the present day. The implications of such sea-level data are considerable, for an examination of the bathymetry of the seas off SW. Britain shows that the 40 m isobath lies well outside Bowen's (1981) Devensian maximum ice limit on Gower. Thus, according to the available evidence there would seem little possibility therefore that *Macoma balthica* shells in the Broughton Bay till could be from any "Middle" Devensian shoreline, and still less likely from a "Late" Devensian one, anywhere off the South Wales coast.

Second, Campbell et al. (1982) reported 21 identified shell species from the Broughton Bay till, 19 of which are common around the coastal margins of the area today. Two of the species, however, (*Arca lactea* and *Acanthocardia tuberculata*) are normally associated with rather warmer water conditions (Dr. N. McMillan pers. comm.). Indeed, Seaward (1982) has shown that these two species occupy southern waters in Britain at present and thus cannot readily be interpreted as part of any Middle Devensian assemblage at these latitudes. Both our amino acid and faunal evidence therefore point to the preserved shells in the Broughton Bay till representing a warm, fully interglacial assemblage. The new data of Bowen et al. require that the Broughton Bay till contains a mixture of both Ipswichian and "Middle" and "Late" Devensian shells, apparently undifferentiated in terms of their environmental tolerance. In the absence of reported shells with cool water preferences, one would have to assume therefore warmer sea conditions during "Middle" and "Late" Devensian times than is normally envisaged for these latitudes (e.g. Sancetta et al. 1973).

Whilst from the present evidence it cannot be ruled out entirely that such warm and high sea conditions did prevail at times during the Devensian, as with many new data, those reported by Bowen et al. would seem to pose as many questions as they answer. We look forward with great interest to the publication of the full findings by Bowen, Harkness, Sykes, Reeves and McCabe when the implications can be better judged.

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ON THE AGE OF WOOD IN TILL AT BROUGHTON BAY

By Peter Worsley

The recent report of a newly obtained isotopically enriched 14C age of 68,000 +13,000/-5000 a B.P. (GrN-12,508) on wood from Broughton Bay in the Gower in conjunction with amino acid data from associated marine shells is an interesting addition to the developing Devensian glacial chronology (Campbell & Shakesby 1985). The editor informs me that omission of the laboratory's estimate of the uncertainty associated with the counting statistics occurred during preparation for printing. It is urged that subsequent practice will be to quote this date with the two standard deviation age uncertainty i.e. 58-94 ka B.P. This is paramount with an inferred age of such antiquity for, as the authors state 'the result must clearly be interpreted with extreme caution.'

Comparison is made to the closest existing radiocarbon date from Britain, namely the pioneer isotopically enriched date derived from a specimen of _Picea_ from the Chelford Interstadial _sensu stricto_ at Chelford, Cheshire. This was finally reported as 60,800 ± 1500 a B.P. (GrN-1475). However in the judgement of Pieter Grootes some laboratory contamination was present in the system and this was estimated by him to be responsible for reducing the true age by two to four thousand years (Worsley 1980). This view was independent of the 'recent technical improvements'. However it is clear that the Chelford and Broughton Bay 14C age estimates overlap but the vital question is now, is this significant and indicative of real age equivalence?

Problems of post-death contamination of samples submitted for radiocarbon dating are obviously known to the authors but they do not make it clear that it is not just modern carbon which is a potential source of error. We have no way of determining at which stage any potential contamination of an infinitely old sample by more modern material might have occurred. Hence their assertion that 'any contamination by modern groundwater has been minimal' is far from excluding all possibilities of sample contamination. The GrN-12,508 sample was discovered during a visit to Broughton Bay by the British Geomorphological Research Group (May 1983). My recollection from that time was that it was exposed on the intertidal wave-cut till platform so that an estimated former depth of burial beneath 4 m of till might be excessive. Apart from doubts about its isolation from modern groundwaters it must be recalled that by some unknown process this wood became entrained within a glacier. Prior to entrainment it is possible that it had been previously deposited at some unknown locality although the association with a coastal fauna possibly suggests an estuarine depositional environment. Once entrained within a glacier system, presumably under pressure melting point conditions, the fragments were abraded (hence the striations) and transferred ultimately to the aggrading glacier bed via at least a thin water film (after deposition a degree of glacier tectonic disturbance occurred). Whatever the precise details we can be reasonably certain of recycling of the wood and strongly suspect that opportunity occurred for carbonaceous admixture from groundwater to the original natural radiocarbon content of the material assayed.

At present we do not know the precise age of the Chelford Interstadial. In a recent review (Worsley 1985) it was concluded that until the Chelford Interstadial deposit can be shown to lie superimposed upon Ipswichian sediments some caution must be exercised over its precise chronological attribution. However, the probability remains that it is an interstadial of Early Devensian age. Initial confidence in the accuracy of the isotopically enriched 14C dates was partially gained from stratigraphic consistency of the obtained ages (Grootes 1977) but subsequently difficulties emerged. A detailed discussion of the current status of Chelford Interstadial biostratigraphic correlation is deferred until another occasion. For present purposes it is sufficient to note the evidence contained within the long and almost complete successions at Grande Pile (Woillard 1978) and Les Echets (Beaulieu & Reille 1984) in eastern France. Both of these extend from prior to the Eemian (Ipswichian) Interglacial through to the Holocene. Following the classical Eemian at Grande Pile two "interglacial" temperate forest phases occur prior to the main pleniglacial and these are both replicated at Les Echets, although at the latter an additional forest phase is recognised immediately after the Eemian. From a current perspective it appears increasingly likely that these three 'interglacials' are the southern equivalents of the boreal forest phases known in the north European plain as the Amersfoort, Brörup and Odderade Interstadials. The essence of this concept was proposed by West (1980) and the equivalence of the Chelford and Brörup Interstadials has long been suspected (Andersen 1961). Enriched 14C dating of Grande Pile samples (Woillard & Mook 1982) succeeded in demonstrating that the post Eemian 'interglacials' (St. Germain I and II) were beyond the limits of this dating method i.e. older than some 75 ka. It follows therefore that the Chelford-Brörup event probably correlates with St. Germain I and any finite ages associated with it represent varying degrees of contamination of material which in its original state is incapable of yielding a 14C age.

One has sympathy with the authors' frustration with their inconclusive results but in the circumstances it is best to keep an open mind and resist any correlations until such time that some less ambiguous biostratigraphic evidence is forthcoming. Whilst the Broughton Bay succession supports a post-Ipswichian (roughly equivalent to oxygen isotope stage 5e) age for the till, this is the practical limit of the chronology. We can agree that the till age 'still remains unproven' and add that the same applies to the contained wood fragments. Taken on face value the GrN-12,508 age could be seriously misleading and like most dates of this nature, an apparent association with a particular interstadial is an artifact of a 14C assay on contaminated material.

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COMMENTS ON THE NOTE BY P. WORSLEY

by S. Campbell and R.A. Shakesby

Although the 14C dates on wood from till on NW. Gower proved inconclusive, we are pleased by the interest aroused by our note in Quaternary Newsletter No. 47. In broad terms we agree with Professor Worsley. Like him, we regret the accidental omission of the estimate of uncertainty associated with the older date (GrN-12508: 68,000 +13,000/ -5000 a B.P.) at the printing stage and welcome this opportunity to draw attention to it. In view of the degree of uncertainty associated with the Groningen (GrN-12508) date, it might well be wise to err on the side of caution and think of the date in terms of a two standard deviation age uncertainty, as Professor Worsley argues. However, this new level of uncertainty would need to be stressed in any quotation of age in order to avoid confusion when comparison is made with other dates quoted with only the one standard deviation uncertainty. Indeed we support Professor Worsley (1981) in his call that all radiocarbon dates should be quoted in terms of the two standard deviation uncertainty as a matter of convention, in order to increase the likelihood that the true result lies within the error band.

Whether the overlap of the Chelford (GrN-1475) and Broughton Bay (GrN-12508) age estimates represents a real age equivalence or a result of older wood from Broughton Bay being contaminated with more modern carbon and yielding a broadly similar age, may unfortunately never be resolved. We felt that a sufficient range of possible ages (even considering a pre-Quaternary age) was given, to draw attention to the possibility of contamination by more modern carbon. The inconclusiveness of the results did not in our opinion warrant a lengthy discussion of possible means by which the wood may have become contaminated.

We support Professor Worsley in his concern that the Broughton Bay 14C result (GrN-12508) should not come to be used as additional evidence for the existence and timing of the 'Chelford Interstadial'. Any stratigraphic evidence for this event is entirely lacking at the Broughton Bay site and we had no intention of trying to enter the controversy over its nature and timing. We accept that other than being post-Ipswichian (on the basis of amino acid evidence (Campbell et al. 1982)), the precise age of the till remains unproven in the light of our evidence.

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REVIEW OF MODERN GEOLOGY, VOLUME 9, NUMBER 2

by F.C. Cox

It was in anticipation of an informed scientific critique that I turned to the review pages of the February Newsletter only to be greeted by a cold shower (Review of Modern Geology Vol. 9, No. 2). Surely your readers deserve better than this? Dr. Catt's comment that many of the papers are "worthy" is hardly informative, and his quest for "hot news" is more fitting to a 'Sun' reader in search of Samantha Fox.

This edition of Modern Geology contains a collection of papers giving some preliminary results from the British Geological Survey investigations into the Quaternary of East Anglia.

Yes, perhaps for the first time in its history, the B.G.S. is taking the Quaternary seriously, and doing so in collaboration with the universities.

The fact that much of Eastern England has never been surveyed in detail is a scandal, and the attempt to remedy this by a multidisciplinary approach using modern techniques will I hoped be welcomed.

In his comments on the contents of the journal your reviewer did not consider it noteworthy that Harmer's classic Crag locations and the type site for the Anglian glaciation had been re-interpreted, or that for the first time in the U.K. an almost complete sequence for the Lower Pleistocene had been recognised, together with an insight given into the many investigative techniques employed in the survey.

The preference for off-shore work may indicate some sort of professional demarcation, but your readers should be aware that whereas such investigations are sponsored by the Department of Energy at a cost of several million pounds, cutbacks in Science Vote funding have brought similar on-shore work almost to a halt.

The lack of 'hot news' reflects the huge task we still face in the investigation of U.K. Quaternary. We in Quaternary studies should seek to work together rather than damning each other with faint praise or patronage.

Finally I can agree with your reviewer on one point; the high price of the journal, although I understand it is available in many libraries.

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REPLY TO DR. COX BY DR. J.A. CATT

I am sorry Frank Cox found my review of Modern Geology 9/2 a cold shower. Perhaps having purchased a copy he finds it necessary to economise on domestic heating. I fully sympathise with his problems of funding Quaternary research in East Anglia. If I had my way they would be speedily resolved, so that Britain could have Quaternary maps at least as good as the coverage in many other countries.

But isn't he taking quite the wrong attitude to reviews in general? Most authors (including myself) regard their reviewers as ignorant, prejudiced and spiteful, but there is also a well-known axiom - the better the book, the worse the review. This is common knowledge to anyone reading the review pages of daily newspapers, and was even known to Chaucer, who wrote in the Augerer's Tale (1393):

> Full curtyus was he in his manuscripte
> To damne ye beste writ en heathenesse,
> And truste thereby it bare full thriftily
> A fulleste honour for its worthinesse.

Scientific support has also been provided by F.U. Poysson & I.F. Penn (Plum Pickers' Gazette and Dried Fruit Beacon, Vol. 186, 1984, 1-511), who found a negative correlation between numbers of complimentary words in book reviews and Inland Revenue statistics of publishers' sales returns. So Frank should in fact regret that I never picked up my special reviewer's pen after reading Modern Geology. A few really spine-chilling remarks, justified or not, and I might have made it a best-seller.

Instead of this valuable self-regulating mechanism, Frank seems to prefer book reviews to be based on the sort of pre-paid praise expected of the advertising scriptwriter. This approach may have some effect on the housewife about to buy her soap-powder, but I doubt if it is very helpful to Q.R.A. members struggling to decide how best to spend their miniscule book allowances. As Frank was dissatisfied with my original and has squeezed his own review into his letter, let's see how effective a really 'soapy' version of it can be:

> This great new edition of Modern Geology, specially created for all you young and attractive Q.R.A. members, contains wonder-working B.G.S. - it's geological, see. This fantastic ingredient, which has been around for 150 years, is now combined with all known universities in the new East Anglian formula, and better than ever. It kills all classic locations stone dead, and reaches the type-sites other journals cannot reach.

Any use? Well - I may try it if it's cheap, just to see what it's like. What's the price? Oh yes, well - er - no thanks.

No, it isn't effective because it doesn't help the prospective purchaser. The reviewer's job is to tell potential buyers what a book contains, honestly point out its limitations, and give a personal opinion (it can never be more than that) of whether it is worth his readers spending time or money on it. Florid praise may add effect, but can easily be interpreted by the reader of the review as part of a mutual back-slapping agreement. If this is what Frank means by seeking 'to work together', I'm afraid I must be counted as a non-collaborator. Surely working together for the good of Quaternary (or any) Science involves maintaining the highest professional standards, and isn't that more likely to be achieved by well-intended review, even if it is mildly critical, than by obsequious flattery?

Perhaps I or some other reviewers will feel moved to praise the final report of the East Anglian regional survey more than the preliminary results given in Modern Geology. But beware - if Poysson & Penn are correct, that praise could sink it without trace.

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CONSIDERATION OF THE PLEISTOCENE MIGRATIONS OF THE RIVER WANDLE

by D.S. Peake

Perusal of the map in Bridgland's interesting reappraisal of the concept of uniclinal shifting of Pleistocene rivers in the London basin (Newsletter 47) shows terraces of one Thames tributary distinct from all the others, those of the Wandle. In general they decline westwards against the pitch of the axis of the London basin syncline, whereas as Bridgland discusses, the majority of terrace flights descend to the south and east.

Many authors have been of the opinion that the Wandle was once a Wealden river flowing through what is now the Merstham wind gap in the North Downs (Peake 1982, 1983). Through the Chalk such a river appears to have conformed to Bridgland's pattern of downland erosion, incising itself in a gorge-like valley free of extensive terrace development. Downstream, from the point where the now beheaded river rises at the mouth of its present dry valley at Croydon, it flows over Thanet Beds, Woolwich Beds and London Clay. Its several migrations westward from the original northward direction of flow in this tract are attributable to repeated river diversions into adjoining catchments (Peake 1982).

In 1973 Worssam showed that so-called river captures in the Weald were effected by permanent diversions of Pleistocene rivers in flood. For such diversions to have occurred the adjoining valley floors must already have been eroded to lower levels than those of the rivers about to be diverted, although the new courses may have been laid over aprons of flood gravel. Early displacements of the Wandle are too remote in time for the causal evidence to be unequivocal, but certainly the diversions in the Upper Pleistocene have left good indications of their mode of occurrence. Two important factors likely to have had influence in the diversions are firstly hard bedrock resistance to erosion and secondly differential river rejuvenation.

From the Weald the postulated Wandle line of drainage was eventually to be along the western fringe of the outcrop of the resistant Blackheath Beds, consolidated pebble beds reinforced by local ferruginous cementation. As described earlier (Peake 1982) when the pebble beds were gradually uncovered by erosion of the overlying London Clay it was inevitable that the more rapid downcutting in less resistant strata in valleys to the west, beyond the Blackheath Beds outcrop, would bring about diversion of the Wandle in floodtime. In the Wolstonian cold stage the process resulted in the great westward curve of the Wandle valley in South Croydon, where the drainage spilled over westward into the lower valley of the Norbury Brook-River Falcon catchment.

At this time the second factor, river rejuvenation, would also have been in operation. In the Anglian cold stage the bisection of the nearby Effra valley by the new Thames line of flow had given enormous impetus upstream to the erosive power of this small river (Peake 1982, p. 113). Rejuvenation obtained for all Thames southern tributaries below the major southerly diversion at Uxbridge. Fisher (1982) suggests that in the Weald the increased erosive power of the Wey after the Thames diversion enabled it to erode more rapidly than the Blackwater, leading to the latter's diversion into it at Farnham. In the Devensian cold stage the Wandle drainage was again diverted westward, this time usurping the parallel valley of the West Wandle, which must already have been eroded to a lower level. The process was undoubtedly aided by the piling up of periglacial outwash from the main valley mouth at Croydon.

Therefore it would appear that in the Upper Pleistocene, at least, the Wandle's westward migrations were due to wholesale river diversions to other catchments, rather than to lateral shifting within the confines of river valleys as reviewed by Bridgland in most of the London basin. The difference accounts for the Wandle's noteworthy departure from the more usual direction of migration.

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PLEISTOCENE MIGRATION OF THE RIVER WANDLE-UNICLINAL SHIFTING: Reply to Mrs. Peake and further discussion

by D.R. Bridgland

The author is pleased to accept Mrs. Peake's explanation of one of the glaring exceptions in the general southward/eastward trend of terrace migration in the London Basin (Bridgland 1985), namely the westward shift of the Wandle. If she is correct in ascribing migration of the Wandles to repeated diversion/river capture, the stronger pattern which then emerges for true terrace flights cries out all the more for an explanation. In his article the author did not suggest any mechanisms which could be responsible for initiating terrace flights in a preferred direction. However, P. Gibbard (pers. comm.) has since suggested that 'aspect' may have been an important influence, as in the smaller asymmetric valleys described by Ollier & Thomasson (1957; see also Tricart 1969). This could have led to increased colluvial activity on south facing slopes, resulting from solar warming during the day; the result would have been a greater accumulation of colluvial material on the northern sides of valleys, resulting in greater erosion of bedrock on the opposite (southern) side. This latter would have been further facilitated by the north-facing slope more often remaining frozen, thereby promoting run off and, therefore, erosion on that side of the valley (Tricart 1969). As indicated in the earlier article, once valley migration is initiated, on clay bedrock it will continue in the same direction with successive 'rejuvenations'. The east/west element of the observed pattern of terrace preservation may, in terms of 'aspect', be related to prevailing winds rather than solar warming, although it is uncertain how these might affect erosive and colluvial activity.

A further possible influence has been pointed out in a letter to the author by Mrs. S. Watson. Mrs. Watson considers that clean sand and gravel are not normally susceptible to solifluction; only when clay or silt are introduced into such sediments is it generally accepted that this process affects them (again, see Tricart 1969). In clay bedrock areas it is likely that bedrock material from bluff areas will accumulate, by sheet wash and solifluction, on the surfaces of terrace gravels and be introduced at least to their upper layers. This would enable the solifluction of gravelly material from these layers onto successively lower bluffs, protecting them from erosion, as envisaged in the original article (p. 30). It also means that solifluction of terrace gravel may be restricted to areas of clayey or silty bedrock - a factor of considerable potential significance for geomorphological development in general. The author wonders whether members have any observations which would confirm or deny the above relationship.

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SOCIETY FOR THE HISTORY OF NATURAL HISTORY AND Q.R.A. DISCUSSION MEETING, LONDON, 7-8 JANUARY 1986: ABSTRACTS OF PAPERS

IRISH PLEISTOCENE STRATIGRAPHY, 1836-1914

Gordon L. Herries Davies

During the 1830s Irish striae, erratics, boulder clays, bedded sands and gravels, and eskers were all explained in terms of a recent marine submergence of Ireland. This explanation of the phenomena - the Diluvial Theory - seemed to be entirely satisfactory, and during the 1830s the discovery that many of the Irish tills contained fragmented marine shells seemed to add to the Diluvial theory significant confirmatory evidence. Then in 1840 there appeared in Ireland Louis Agassiz who now explained in terms of glaciation all the features which Irish geologists were then explaining in terms of diluvial submergence. Initially Irish geologists were not impressed by the new Glacial theory and it was not until the 1860s that the painstaking field studies of Maxwell Henry Close began to win support for the concept of a former ice sheet glaciation of Ireland. From that decade down to 1914 thinking on the subject of the Irish Pleistocene was dominated by a tripartite division of the Irish Pleistocene deposits into firstly a widespread Lower Boulder Clay, secondly a set of marine Middle Sands and Gravels, and thirdly a glacial Boulder Clay believed to have been deposited by valley glaciers at a time when Ireland's lowlands were still submerged beneath a sea in which the eskers were being formed. Not until the publication of William Bourke's The Quaternary Ice Age in 1914 did there dawn the modern era in Irish Pleistocene studies. But does the modern Glacial Theory represent an ultimate truth? In invoking an Ice Age can we be certain that we are invoking an event more real than were our predecessors when they invoked a diluvial submergence? Is it perhaps wiser to suppose that in the 1830s Louis Agassiz discovered not a new truth but rather that his fertile mind then gave birth to a startlingly original idea which subsequent generations of earth scientists have found to be fascinating, stimulating, and in every sense fruitful.

HISTORIC QUATERNARY MATERIAL IN THE BRITISH MUSEUM (NATURAL HISTORY)

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The most important function of the British Museum (Natural History), carried out alongside a programme of scientific research and the education and entertainment of the general public, is the guardianship of the National collections of natural history specimens. Much of the time of the Museum staff is devoted to the curation and protection of these collections which, acquired over a period of more than two centuries, are now of very great quantity. Among them are many type specimens.

Based upon a nucleus of specimens from the collection of Sir Hans Sloane, who died in 1753, the British Museum opened its doors to the public in Montagu House, Bloomsbury, in 1759. Space soon becoming scarce, this building was reconstructed on the same site between 1823 and 1847 to become the British Museum as we know it today. By the mid 19th century space was again becoming inadequate and it was decided to transfer the natural history collections to a new location in South Kensington, leaving the archaeological and other material at Bloomsbury. The British Museum (Natural History), as the new building was to be named, constructed on part of the site of the Great Exhibition of 1851, was opened to the public in 1881. Its first 'Superintendent' (Director), also transferred from Bloomsbury, was Richard Owen. By the mid 20th century, with increased staff numbers and expanding collections, even this building was proving to be too small and in 1976 the Department of Palaeontology moved into a new, specially designed, extension wing.

Today this new wing houses one of the most important palaeontological collections in the world, with fossils from all parts of the geological column and from most countries. Part of this collection, including many mammalian remains and mollusca and some birds, is of Pleistocene age. The Pleistocene mammalian collection occupies more than two thirds of the storage accommodation of the ground floor of the Palaeontology wing and there is an overflow of large specimens, including skulls of Irish giant deer, at an outstation of the museum at Ruislip in west London. The Holocene part of the mammal collection is looked after by the museum's archaeozoologist in the Department of Zoology.

It is possible to mention here only a representative selection of the Pleistocene mammalian remains in the collection and the scientists who were concerned with their discovery and study. Some of the specimens were collected a very long time ago, the longest surviving being part of a skull and three teeth of a woolly rhinoceros, formerly in the collection of the Royal Society at Gresham College, found by Mr. John Somners in the course of sinking a well at Chartham in Kent in 1668 and described by his brother in the <u>Chartham News</u> the following year. There is a copy of this rare publication in the archives of the Museum's library. Finds from the 18th century include a lower jaw of an American mastodon from Ohio presented by the Earl of Shelburne in 1769 and described and figured by William Hunter in the <u>Philosophical Transactions of the Royal Society</u> the following year. Hunter concluded that the animal was not an elephant, but was probably the same as the mammoth of Siberia and that, if it "... was indeed carnivorous, which I believe cannot be doubted,... as men we cannot but thank heaven that its whole generation is probably extinct".

Among the most famous collectors of the early 19th century was William Buckland, whose findings in Kirkdale and Paviland Caves were described in <u>Reliquiae Diluvianae</u> in 1822. The significance of Buckland's work was to be discussed by Dr. Boylan later during the meeting. The Museum possesses a small collection of mammalian remains from Kirkdale Cave, presented in 1823 and 1827, although this came mostly from a Mr. William Salmond, not from Buckland himself.

1831-1836 were the years of the voyage of the <u>Beagle</u>, with the scientist Charles Darwin on board. Darwin brought back a collection of Pleistocene mammalian remains, including an imperfect skull of <u>Toxodon</u> found near Montevideo, which were described and figured by Richard Owen in the "Zoology of the Voyage of the Beagle" in 1828. These remains were presented to the Royal College of Surgeons in London, in whose Museum they were preserved until 1941, when that building was severely damaged in an air raid.

In the reorganisation which followed, the Darwin specimens, most of which had fortunately survived, were transferred in 1946 to the British Museum (Natural History).

Probably the largest collection of fossil mammalian remains ever to come to the Museum, was that sent from the Siwalik Hills in India, in 1840, by Colonel (Sir Proby T.) Cautley and Dr. Hugh Falconer. It consisted of 214 cases, each weighing about 200 kg of heavily mineralized skulls and bones of elephants, many other species of mammals and reptiles; first offered to the Geological Museum, which lacked storage space, and then to the British Museum, whose masons were kept occupied for several years extracting the fossils from their hard matrix. It is now known that not all the Siwalik remains are of Pleistocene age, but that they range in age from Miocene to Pleistocene.

At about the same time collectors in Australia were finding increasing quantities of fossil remains of marsupials. With insufficient scientific expertise in Australia at that time, many of the finds were sent to Dr. Owen for description and subsequently deposited in London. The history of the guardianship of the skull of the type specimen of the 'marsupial lion', Thylacoleo makes especially complex reading. The skull, even today, is in three separate parts. The cranium and a maxilla, with its characteristic shearing tooth, described and figured by Owen in the Philosophical Transactions for 1859, were given to the Royal College of Surgeons, which supplied casts to the British Museum (Natural History) in 1868, followed by the original specimens in 1946. Owen apparently did not see the anterior part of the skull, which went to the National Museum of Victoria in Australia and was figured by McCoy in an Australian journal in 1896. It was not until more than half a century later that a palaeontologist studying Thylacoleo discovered the relationship of the remains. Thus the type specimen of this mammal is held in two museums at opposite ends of the earth. Both museums now also hold casts of the parts not in their possession.

The mid part of the nineteenth century was a time of special interest in the antiquity of Man. In 1859, at about the same time that Boucher de Perthe was making similar discoveries in the gravels of the River Somme in France, William Pengelly, working with Hugh Falconer under the auspices of the Royal Society, found stone artifacts associated with remains of mammoth and woolly rhinoceros sealed down beneath a flowstone floor in the Brixham Cave in Devon - finally proving that man was of much greater antiquity than had previously been generally supposed. The mammalian remains from this excavation and others collected by Pengelly from nearby Kent's Cavern during subsequent years were presented to the British Museum (Natural History).

Important mammalian collections acquired during the present century include bones and dried skin of the ground sloth, Mylodon, about 13,000 years old, from the Cave of Ultima Esperanza, Patagonia, variously presented and purchased in 1904; the collection of British rodents and other small mammals of M.A.C. Hinton, bequeathed at his death in 1961; all the mammalian material excavated by L.S.B. Leakey in Kenya and Tanzania up to 1935 (later finds are preserved in the National Museums of Kenya and Tanzania) and many others.

With the establishment of National Museums in many countries which had no museum of their own a century or even 50 years ago, there has been a substantial reduction in the quantity of mammalian remains coming to the British Museum (Natural History) from other countries. Even when mammalian remains are collected overseas and studied by British palaeontologists, usually the collection and almost invariably the type specimens of any new species created must be returned to the country of their origin. At the same time there has been a great increase in the exchange of casts between museums and high quality replicas of important specimens are constantly being received by the British Museum (Natural History). There has also been an increase in the quantity of British Quaternary mammalian remains coming to the Museum, more accurately documented than ever before, following directly from the field work of staff members and from other British Quaternary workers. Especially important among collections received during the last twenty years are the middle Pleistocene faunal remains from the fissure at Westbury-sub-Mendip, Somerset; and faunas from caves in Devon, from terrace deposits of the River Thames and from many other localities. When, in 1980 an important collection of wolverine remains, about 83,000 years old was excavated in Stump Cross Cave, Yorkshire, and the proprietors of this commercial show cave needed the specimens to display in their own visitor's centre, high quality fibre-glass casts were made in the laboratory of the Museum and an exchange was agreed, allowing the originals to come to the National Collections.

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HOLANDSFJORD, N. NORWAY - A KEY LOCALITY IN THE DEVELOPMENT OF GLACIAL GEOLOGICAL CONCEPTS

by Peter Worsley

Holandsfjord lies just north of the Arctic Circle and at its head the outlet glacier Engabreen descends to sea level. Although it is one of the most remote localities in Norway as far as road access is concerned it has always been readily accessible by ship. Because of this the history of scientific study extends back into the eighteenth century. The significance of the area lies in its role in promoting the understanding of glacier processes specifically ice marginal variations, glacier erosion rates and the fabrics of glacigenic materials.

From a British perspective, the most important event was the visit in 1865 by Archibald and James Geikie along with William Whittaker. Convinced that the Scottish landscape owed much to glacial processes, they undertook a pioneering field excursion to seek modern analogue data in those areas of Norway currently subject to glaciation. As a consequence they spent seven days based on Fondalen farm in the Holandsfjord and from there they examined the evidence for the main glaciation and the recent (Neoglacial) glacial activity. The results of the observations of A. Geikie have been published and these contain not only the earliest meaningful map of a modern glacier margin in Norway but also sections through it showing land based and aqueous marginal conditions.

In the early 1880's the French geographer Charles Rabot made extensive travels through Norway and he visited Holandsfjord in 1883 to establish the first photographic record. Shortly afterwards the Norwegian geologist Johan Rekstad established a programme of ice marginal observations in 1890 supplemented by photographs and specially built cairns. This kind of study was also indulged in by such personalities as the German Kaiser Wilhelm and the Prince of Monaco again their access being facilitated by its maritime location. A major glacier advance at the turn of the century was closely observed and in particular Rekstad recorded the progressive infill of an ice marginal lake basin by bed and suspended load sediment between 1904 and 1909. With remarkable perception he attempted to quantify the sediment inputs and relate them to rates of glacier bed lowering and thereby deduced a net glacier erosional rate over fifty years before such matters were part of the conventional wisdom.

The third phase of study was in the Inter World War period. In northern Germany Konrad Richter was developing the study of till macrofabrics in the ground moraines left by the Pleistocene glaciers. His results indicated that the preferred orientations of elongate clasts were parallel to the expected direction of former ice movement and hence potential palaeoflow indices. Clearly a test in contemporary environment was desirable and in 1932 Richter worked on the till immediately adjacent to the Engabreen margin and englacial debris bands. He was able to demonstrate that the macro fabrics did indeed show an alignment parallel with the valley axis thereby confirming his original premise. Besides studies of till fabrics Richter also investigated the fabric of fluvial gravels associated with the meltwater rivers. He was able to demonstrate that such studies could be used to reconstruct palaeoflow patterns.

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BRITISH QUATERNARY RIVER LANDFORMS AND SEDIMENTS
BRITISH GEOMORPHOLOGICAL RESEARCH GROUP AND Q.R.A. JOINT MEETING
TO BE HELD AT UNIVERSITY OF NEWCASTLE UPON TYNE, 19-21 SEPTEMBER 1986:
ABSTRACTS OF PAPERS

RIVERS AND FLOODPLAINS IN ENGLAND AND WALES

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The contemporary activity of rivers, particularly concerning erosion and sedimentation, is assessed using the information currently available. This shows that rates and patterns are very varied, on both a national and local scale, so that a variety in patterns of Quaternary sedimentation more generally should not be unexpected. Three particular themes are explored.

1. The spatial variation in available sediments, and implications for present morphology and palaeohydrological reconstruction.

2. Rates of channel change and the dating of floodplain sedimentation.

3. The effects of human activity, in terms of sediment supply, flow regulation and channel engineering.

FLUVIAL PROCESSES, ALLUVIAL SEDIMENTS AND VALLEY FILLS IN SCOTLAND

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This paper reviews recent work in Scotland on channel processes in gravel-bed rivers, magnitude frequency relationships in upland catchments, the sedimentary properties of coarse grained alluvium and Holocene valley fills and associated terraces. Investigations into channel processes have concentraed on hydraulic analyses of zones of convergent and divergent flow within wandering gravel rivers. Such sites comprising bar-riffle-pool units are characterised by a downstream progradation of alternate bars coupled with intermittent avulsion both within and beyond the channel margins. Magnitude frequency relationships within such channels are strongly controlled by entrainment thresholds, sediment availability in areas adjacent to the channel, the coupling of the slope and channel sediment systems and the spatial and temporal ordering of extreme events. Typically the entrainment threshold is relatively high with the result that many upland channels experience periods of prolonged stability punctuated by intense and rapid change. The sedimentary properties of the resulting coarse-grained alluvium have been investigated in terms of changing proximal/distal relationships and associated facies models across a variety of channel and bar types. The stability of the resulting valley floors derived from these sediments determines both the rate and pattern of floodplain formation. These have been found to be highly variable both within and between major catchments. Analysis of the pattern of trenching of these valley fills in the Lateglacial and Holocene is now beginning to reveal a complex pattern of mainstream and tributary valley development since deglaciation of the Scottish uplands.

A TERMINAL DEBRIS-FLOW LOBE IN THE NORTHERN PENNINES, UNITED KINGDOM

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Contemporary coarse debris-flow activity and the associated deposits have not been described widely in the U.K. Examples are essentially limited to small hill-side flows or gully-fans. The recognition of such activity in stream-channels vis-a-vis Newtonian flood-flow effects is important.

This paper describes a contemporary channel-confined terminal debris-flow lobe and seeks to interpret the sedimentary sequence in the light of known and reconstructed hydraulic conditions associated with a flash-flood.

This interpretation, when supplemented by other studies, should aid in deciphering debris-flow deposits from the Quaternary and also shed light on the interpretation of geomorphological depositional features generally ascribed to undocumented large floods within historic times.

WITHIN VALLEY SPATIAL VARIATIONS IN HOLOCENE FLOODPLAIN DEVELOPMENT: RATES AND PROCESSES

A.G. Brown

Most studies of Holocene alluviation have been based upon relatively few arbitrarily or fortuitously located cross-sections. Channelisation of almost the entire length of the River Perry in Shropshire has allowed systematic reach by reach investigations of floodplain stratigraphy. Four major reaches were delimited and at least one of the cross-sections from each was radiocarbon dated. The results show that there are systematic variations in the rates of floodplain development and the residence time of alluvial sediment due to variation in the dominant processes of floodplain formation. This variation in residence time, which is as much as 8,000 years in the Perry, has important implications for studies of alluvial chronology.

HOLOCENE DEBRIS CONES IN GLEN FESHIE

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Alluvial fans, debris cones and rockfall talus cones are amongst the most widespread landforms in Highland Britain that characterise the postglacial landscape. In Upper Glen Feshie (W. Cairngorms) the river has eroded the distal part of three coalescing debris cones. This exposure has yielded buried roots and soils that have been radiocarbon dated. Some of these results are now available, These suggest two periods of debris flow activity initiated ca. 2000 a B.P. The burial of soils suggests episodic debris flow activity during periods of aggradation, reflecting the accumulation of sediment in the gully above. Denudation in the gullies is comparable with other cone and fan sites in Scotland, and may suggest that elsewhere fan aggradation has been shortlived. The hypothesis of paraglacial activity sensu stricto is not supported at this site, whilst the anthropogenic cause of accelerated debris flow activity is unlikely in such a steep catchment. The close association with known periods of increased storminess along with cooler temperatures suggests that climatic factors are the most likely causes of activity at this site.

LATE DEVENSIAN FLUVIAL ENVIRONMENTS OF THE LOWER SEVERN BASIN, U.K.

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Extensive valley floor fluvial aggradations developed in the lower Severn and Warwickshire Avon basins under both 'paraglacial' and periglacial conditions during the late Devensian glacial period. These deposits are preserved in the form of terraces (where incised), or as the basal units of the late-glacial to Holocene valley alluviation.

Examination of the sedimentary characteristics of individual terrace fragments indicates the preservation of up to five architectural elements including:

- Channel zone sediments
- Overbank deposits
- Flood and avulsion units
- Alluvial fan deposits
- Slope deposits

The development of such genetic elements during aggradation seems to have been partly related to valley topography, but was strongly influenced by the nature and rate of channel zone sedimentation.

Channel zone deposits are the major elements in the terraces examined, and are present as coarse grained, sheet-like, bodies within the aggradations. The geometry and structure of depositional units comprising the channel zone bodies indicate the former occurrence of low sinuosity channels with high width-depth ratios. These may have had a braided planform. Despite similarities in the depositing channel type, distinct differences in the preserved structure of channel zone and related overbank deposits are apparent between terrace fragments. These may be related to such controls as discharge regime, the nature of the sediment input into the channel, and channel slope.

PROBLEMS IN THE APPLICATION OF LITHOSTRATIGRAPHIC CLASSIFICATION TO PLEISTOCENE TERRACE DEPOSITS

David R. Bridgland

The application of stratigraphic classification procedures in studies of Pleistocene deposits is increasingly carried out, giving the considerable advantages that are derived from a clearly defined standard methodology and nomenclature. Problems arise, however, when attempts are made to apply formal lithostratigraphic classification in the separation of terrace gravels. Lithostratigraphic codes state that subdivision at member level (individual terrace gravels have normally been classed as members) requires a recognisable lithological distinction between units but, unless some progressive change in catchment or provenance has occurred, such distinction is rarely possible between terrace gravels of a single river. Even where a progressive lithological change occurs, this may be insufficient for clear differentiation of individual terraces without the statistical appraisal of repeated analyses. It is doubtful whether this approach would satisfy the requirements of the codes, which suggest that visual classification should be possible, for field mapping purposes.

Whether a lithological approach is used or not, terrace gravels are, by definition, invariably distinct in terms of altitude. It is important to recognise that the separation of such deposits on the basis of elevation is not the same as the morphological or morphostratigraphic study of terraces, which rely on the mapping of their surface form as geomorphological features. The former method can often be carried out where the original morphology is entirely lost as a result of erosion. The author would argue that the distinction of an individual gravel deposit as part of a river terrace aggradation relies essentially on the study of its three-dimensional form and its relationship to other deposits (the latter would include other 'members' of the same formation); measurement relative to ordnance datum is largely for convenience. As such the method is a short step from the three-dimensional mapping of deposits as outlined in the stratigraphic codes at the formation level. The application of separate formation names to individual terrace gravels would, however, be an undesirable elevation in the status of such deposits. Some redefinition of stratigraphic procedures in relation to the classification of terrace gravels is clearly required.

TERRACES OF THE RIVER GREAT OUSE

R.J. Rogerson and R.C. Young

Lithological analyses of samples of gravels from the basin of the Ouse indicate that there are two suites of gravels - fluvioglacial and fluvial - which can be separated on the basis of lithology using Cluster Analyses. The fluvial gravels cannot be separated by lithological composition. The record of faunal remains previously reported in the 19th and early 20th centuries has been augmented by new site information, such as at Stoke Goldington, which suggest the presence of at least four temperate episodes in the Ouse valley. Faunal and morphological evidence indicates that there are four river terraces in the Ouse basin.

AN APPROACH TO THE RECONSTRUCTION OF PLEISTOCENE RIVER HISTORY

P.L. Gibbard

The principal evidence of fluvial activity during the Pleistocene is the sediment accumulations along valley sides. These accumulations are often altitudinally separable and are thought to represent periodic aggradations of both fluvial and non-fluvial origin alternating with progressive river incision. The sequence of deposits thus produced often displays a series of step-like surfaces that have been conventionally termed terraces.

Until recently the separation of Pleistocene fluvial deposits was principally based on a morphostratigraphical scheme dependent upon the recognition of such stairway like surfaces. In many major systems discoveries of fossil bearing sediments, archaeological artifact assemblages, and fossil soils have shown deposits to be far more complex than would be explained by the single terrace model. With the recent major advances in the understanding of the processes of sedimentation, the refinement of palaeontological sequences, the application of dating techniques and the application of modern analogue studies to taphonomic and derivational problems, the old ideas of terrace sequences are finally being superceded.

In the modern investigation of fluvial deposits it is essential to apply the full range of methods available to the Pleistocene geologist to unravel a river's history. The techniques applied will vary from study to study and will depend on the availability of suitable materials. However, the results, which provide a complex and intriguing history of deposition and erosion through the climatic complexities of Pleistocene time, can only be understood if all available evidence is integrated into the resulting scheme.

This lecture will concentrate on the approach adopted in the unravelling of the history of the Middle Thames system. The difficulties and the nature of the problems encountered will be outlined. The need to apply modern knowledge of processes and palaeoenvironmental reconstruction will be stressed. Finally, particular emphasis will be placed on the development of the stratigraphical scheme based as far as possible on the application of standard geological principles to provide a firm foundation for the reconstruction of the fluvial sediment sequences.

QN: reviews

Geomorphology and Soils. Edited by K.S. Richards, R.R. Arnett and S. Ellis (1985). (ISBN 0-04-5510938), 459 pages, numerous illustrations. George Allen & Unwin (Publishers), London. £35-00 (hardback).

This collection of 21 chapters includes contributions by geomorphologists, soil scientists, Quaternary geologists and engineering geologists. They clearly exemplify an interdisciplinary approach to problems common to soil science and geomorphology.

The book is divided into five sections and focuses on certain key areas of integration:

(a) the improved understanding of land form development, particularly in the context of the processes involved;

(b) the improved understanding of hill slope process;

(c) the interpretation of past processes from evidence preserved;

(d) dating of episodes of land form development;

(e) the solution of land management problems.

Land form relationships are given in the first four chapters in Part I. They include short term changes in volcanic areas, aspects of chemical denudation and the long-term consequences of pre-Quaternary tropical and sub-tropical weathering in the form of duricrusts, weathering residues and sediments.

Part II considers the ways in which certain soil properties influence slope processes particularly subsurface hydrology. Of particular significance is the attention given to the potential of new techniques particularly micromorphology in elucidating slope processes.

Part III contains five contributions on processes reconstruction based on evidence contained within soils and sediments. Such evidence given by a range of techniques includes grain surface morphology, soil micromorphological characteristics, optical and clay mineralogy and magnetic mineral properties. The papers also illustrate an important distinction between incorporated evidence into soils, preservation of evidence within soils such as the inheritance of clay minerals and maintenance of soil properties in sediments formed after erosion.

Part IV provides examples of the establishment of a chronological framework for the identification of past processes based on soil studies. These chronologies are based on 14C studies of organic material in paleosols and on chronofunctions for surface soils. The examples of chronosequences and paleosols are particularly interesting even although speculative in parts. Also included is paleosolic evidence used in a stratigraphc context to interpret long-term land form development.

Part V is devoted to the application of geomorphology but there are only three contributions. The first is a discussion of soil degradation and erosion as an interaction of fluid stress and soil resistance. This is followed by a dynamic model of soil trafficability with agricultural application.

The final paper in this section and the book as a whole deals with the engineering geological approach to geotechnical weathering and the application of these investigations to the interpretation of Quaternary geomorphology.

The editors have produced a very useful introduction and review of the relationships between geomorphology and soils. In addition, they must be congratulated on the choice of the authors and the presentation of the book.

A particularly pleasing aspect of this book is the number of young contributions which clearly indicates a bright future for this area of investigation. This is one of the best review books of its type and is very strongly recommended to all pedologists and geomorphologists.

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<u>The Quaternary History of Ireland</u>. Edited by K.J. Edwards & W.P. Warren (1985), 382 pages: Academic Press. ISBN 0-12-232730-6.

This book, with an appropriate emerald green cover, contains thirteen Chapters covering various aspects of the Irish Quaternary, written by eighteen chosen specialists. It is dedicated to the memory of Francis Synge whose last contribution appears in this volume. The aim has been "to provide a text at the senior undergraduate and postgraduate levels and for all who require a knowledge of the Quaternary history of Ireland, whether for advanced study or as a starting point for research".

After an introductory Chapter by the two editors, Mitchell (Chapter 2) bravely searches for clues to Ireland's preglacial history. From this distant and enigmatic past we move up the geological column to a discussion of Ireland's more recent history. Inevitably it is the interpretation of this stratigraphy that has caused the greatest problem and controversy. The heart of the debate relates to the number of interglacials "for without evidence of interglacials we cannot count glacials" (p. 7). Watts (Chapter 8), using palaeobotanical evidence, maintains the 'traditional' view that the Gortian is a correlate of the British Hoxnian and eagerly anticipates the discovery of a younger interglacial, dominated by hornbeam in its Late Temperate zone, correlatable with the British Ipswichian. Warren (Chapter 3) rejects Mitchell's concept of a 'Hidden Interregnum' and reaffirms his earlier view that the Gortian is the Last Interglacial. The Midlandian and Munsterian, traditionally regarded as Last and penultimate cold stages respectively, Warren now groups into the same cold stage, for which he proposes the name "Fenitian". Although there is some "logic" to this scheme, Warren goes much further than this in his stratigraphical revision. Indeed there is hardly any stratigraphic boundary that he does not redefine in some way. For example, he regards the Nahanagan site as "a very poor stratotype" (p. 59) for the Irish Younger Dryas preferring to rename it and assign it to the "Ballybetagh Substage". He redefines its lower boundary on lithostratigraphic criteria stating that "pollen assemblage zones are likely to be diachronous and often site specific". Similarly he regards the base of the Littletonian (Post-glacial) as defined by Mitchell on biostratigraphic criteria as "unsatisfactory" (p. 60) and again "likely to be diachronous" choosing instead a slightly lower lithostratigraphic boundary. Implicit in this approach is Warren's obvious belief that lithostratigraphic boundaries are in some way synchronous whereas in reality they are likely to be even more diachronous and site specific than even his much disliked pollen assemblage zones.

Warren makes several other huge assumptions in his revised stratigraphic model. For example, he suggests that the Courtmacsherry Raised Beach, exposed along stretches of the south and south-west coasts, represents a single "isochronous unit" (p. 42) which he believes is Gortian (i.e. Last Interglacial) in age. This correlation is based principally on Mitchell's palynological evidence from Fenit and from "the coincidence in level of these deposits". Warren by equating the Courtmacsherry Raised Beach with that at Ballybunnion, Co. Kerry, derives a glacial-interglacial-glacial sequence from the lithostratigraphy. The compact till below the raised beach at Ballybunnion is given Formation status and assigned to his new tongue-twisting stage the "Ballybunnionian". This altitudinal argument for dating raised beaches is extremely weak and such a basic assumption needs further justification from either amino acid data, TL dating or good old palynology, where this can be applied. After all Synge (Chapter 6) tells us that the Courtmacsherry Raised Beach shows indications of cold conditions from the presence of ice-rafted erratics and that interdigitation of head deposits with beach gravel has also been interpreted as implying cold conditions.

It is doubtful whether this revised stratigraphy will gain wide acceptance and it is questionable whether such personal and idiosyncratic schemes ever should without formal ratification from the appropriate Stratigraphic Committee. If this were not so, the doors would be open for anyone to move and redefine stratigraphic boundaries they do not like and chaos would ensue.

McCabe (Chapter 4) and Lewis (Chapter 5) discuss the occurrence and distribution of glacial and periglacial features in Ireland, particularly with respect to the 'Southern Irish End Moraine'. McCabe contrasts the subdued topography with deep weathering profiles, south of this Moraine, which he regards as "a major limit of late Midlandian ice" (p. 68) with the "fresh Midlandian topography dominated by morphologically distinct moraines, kettleholes, eskers and kames" (p. 72) to the north. However Warren (Chapter 3) not only doubts the dating of this End Moraine but also (p. 9) records that glacial and glaciofluvial features where they occur south of it are not significantly more degraded than similar features to the north of it. Moreover Culleton & Gardiner (Chapter 7) point out that an outstanding feature of Irish soils is their youth and the fact that they are not deeply weathered. Despite these differing views, there is a concensus that the pattern of deposition was different on either side of the Moraine with a scarcity of eskers, moraines and drumlins to the south.

Another controversial topic discussed in several Chapters concerns the existence, location and timing of a landbridge connection(s). Synge's

(Chapter 6) proposal of a Celtic Sea landbridge operative for a short period during the Late-glacial is particularly interesting since this would provide a routeway for many faunal elements including the much discussed Lusitanian species. It is interesting to compare this concept with Devoy's conclusion, also published last year, that the most likely location for a landbridge was between northern Ireland and south-west Scotland again during the Late-glacial (Quat. Sci. Rev. 4, 43-58). Early severance of a landbridge is regarded as the main reason for the marked faunal and floral impoverishment discussed by Stuart and Wijngaarden-Bakker (Chapter 10) and Edwards (Chapter 9) although the more restricted range of habitats is also invoked. The landbridge problem also has a bearing on human occupation of Ireland which is only known to extend back to 9000 a B.P. (Woodman, Chapter 11) although Woodman regards this as a minimum date, anticipating future discoveries. This faunal impoverishment restricted the range of resources available to Mesolithic and later communities and forms "one of the most fascinating aspects of Irish prehistory" (p. 257). Edwards (Chapter 9) provides a balanced and critical assessment of the anthropogenic factor in vegetational history noting a marked impact during the Neolithic and definite evidence of cereal cultivation prior to the elm decline.

Turning to less controversial subjects, I found Chapter 12 a useful summary of various dating techniques used in Ireland and the main problems on which they have been focussed. These include radiocarbon dating of the Late-glacial/Post glacial transition, the evidenc of early agriculture, the elm decline and the initiation of blanket peat formation. Later sections of this Chapter describe the building of a 5000 year tree ring chronology (by Baillie & Pilcher) and the establishment of the Irish palaeomagnetic master curve (by Hirons, Edwards & Thompson).

A final Chapter by Warren, O'Meara, Daly, Gardiner & Culleton is devoted to economic aspects of the Quaternary deposits, that cover 90 % of the land surface of Ireland, including an assessment of mineral resources, soil and peat productivity and hydrogeology.

The standard of production of this book is high as is the general quality of the artwork. The range of topics covered is also varied although I was disappointed to find the coverage of faunal history restricted, as is too often the case, merely to vertebrates. An idea of the extent of divergent opinions will have been gained from my earlier comments and the editors state in the introduction that they have deliberately made no attempt to "harmonize" them. Here lies the greatest problem for the frustrated reader - who should be believed? One naturally expects differences of opinion over interpretations of evidence but one certainly does not expect such conflicting accounts of primary evidence. For example, are ice-wedge casts commoner south of the End Moraine as Watts (Chapter 8) claims or are they equally common either side of it (Lewis, Chapter 5, fig. 1)?

Despite these reservations, this book does provide a useful up-to-date synthesis and is a welcome, addition to the Quaternary literature. It is now almost a cliche to complain about the price of new books, but £50 for 382 pages with only two half-tones is simply outrageous and will undoubtedly confine it to library shelves. This is particularly regrettable since a more realistic price would I'm sure have attracted sales from a reasonably wide and varied readership.

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Lake Sediments and Environmental History: Studies in Palaeolimnology and Palaeoecology in honour of Winifred Tutin. Edited by Elizabeth Y. Haworth and John W.G. Lund. Leicester University Press, 1984. Price: £39.

Lake sediments play a very important role in Quaternary Research, and palaeolimnology can be regarded as a microcosm of such research in that it is itself a multidisciplinary field of study that requires the active collaboration of both physical and biological scientists. Friends and colleagues of Winifred Tutin, who is one of our few, very special honorary members of the Q.R.A., have joined together to produce this volume of studies which reflects the wide range of her interests, the influence of her skill and enthusiasm on fellow-workers and students, and the stimulus that she has given to the development of other techniques beyond her own palaeobotanical field.

Virtually all the studies relate in time to the Flandrian Post-glacial or Devensian Late-glacial, but they have a broader interest. Not only does this volume range over the contributions of different disciplines to palaeolimnology and palaeoecology, but also in the form of these contributions. Firstly, there are state-of-the-art reviews such as the lengthy account by Engstrom and Wright of geochemical studies of lake sediments and that by Thompson of global patterns of palaeomagnetic stratigraphies. Oldfield and Appleby not only review 210Pb dating of lake sediments but they then proceed to discuss the validity of these dates and how they can be tested independently, in particular re-examining the dating of surface sediments from the Great Lakes of North America. Very different in approach, indeed almost philosophical is Deevey's account of the problems of modelling lacustrine ecosystems through time.

Then there is a rich assortment of studies that describe original and generally previously unpublished work. Eakins, Cambray, Chambers and Lally describe how they used a small Lake District basin, Brotherswater, and its catchment to measure the deposition, transport and retention of natural and artificial radionuclides. Haworth amplifies the record of changing diatom floras in Blelham Tarn within the last 200 years. Bonny and Allen give an account of their pollen trapping experiments, both from the air and in the water column, at Crose Mere, Shropshire and the recruitment of pollen to the lake sediments. This is clearly essential reading for anyone contemplating studies of this kind. Botanists and biogeographers in particular will welcome Watts' account of the Post-glacial vegetation of the Burren and Judith Turner's attempt to elucidate the former treelines of the northern Pennines, previously matters of controversy, now with firm data on which arguments can be based. Another very important contribution in the field of pollen analysis is that from Davis, Moeller and Ford on sediment focussing and pollen influx. This is both a review and a summary (indeed an amplification) of the detailed pollen and sedimentation studies that have been carried out at Mirror Lake and adjacent lakes in New Hampshire. It is extremely useful to have this study summarised here. Other contributions are by Cranwell on organic geochemical studies, Hilary Birks on Late-glacial plant macrofossil assemblages from north-west Scotland and Livingston on algal remains in recent lake sediments. Perhaps the most esoteric account is Andersen's account of how he has tried to identify which groups of soil invertebrates are responsible for the fragmentation of fungal hyphae that get preserved in buried soil profiles, an aid to recognition of changing soil types.

The strengths of this volume are its stress on methodology and on the multidisciplinary approach to the study of lake sediments. Though it is not a book that everyone will want to possess, it is one that every Quaternary scientist with an interest in lake sediments should at least browse through and be aware of its contents. The book is rather on the expensive side but technically it is well-produced and well-edited with only the occasional misprint. One criticism is that in several cases diagrams, particularly graphs, would have been much easier to read and understand if relevant information such as species names had been clearly labelled on the diagram and not tucked away in the captions. Perhaps a general plea might be made both to editors and referees to remember to be as critical of diagrams as of text in all publications in our field.

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Handbook of Palaeoecology and Palaeohydrology. Edited by Bjorn E. Berglund. (1986), ISBN 0-471-90961-3, 869 pages. John Wiley and Sons Ltd., Chichester. £65.00 (Hardcover).

International Geological Correlation Programme 158 (Palaeohydrology of the Temperate Zone) was instigated in 1976 as one of the Unesco and International Union of Geological Sciences (IUGS) research projects into geological changes of importance to man. The aim of IGCP 158 was to investigate environmental changes during the past 15 ka within the framework of two subprojects: 158A which was concerned with fluvial environments and 158B whose brief was to examine lake and mire environments. This handsome volume is the product of the latter subproject. To entitle it a 'handbook', however, could be regarded as a contravention of the Trade Descriptions Act, for it consists of nearly 900 pages, contains 41 chapters on almost every conceivable aspect of the Holocene environment and is very much more than simply a field, laboratory or computational manual. Parts of the book have already been published, but these have now been revised and updated, and a further thirteen chapters have been added. Forty five scientists have contributed to the volume, the majority of whom are European. Surprisingly, only four are presently based in North America.

The book is divided into eight sections. The first (three chapters) consists of a general background to Holocene environmental changes and includes contributions on the two main sources of data, namely mires and lake sediments. The second section (four chapters) deals with research strategies for the investigation of different depositional environments (lakes, mires and soils) while the third part (also four chapters) outlines various sampling and mapping techniques. Stratigraphical methods including characterisation of peat and lake deposits and core correlation are discussed in section four, while the fifth section (six chapters) considers the range of dating methods applicable to the Holocene timescale. These include radiocarbon; 210Pb, 137Cs and similar short-lived isotopes; palaeomagnetism; tephrochronology; annually-laminated lake sediments and dendrochronology. Chapters 20 and 21 deal with stable oxygen and carbon isotope analyses, and with chemical analysis of sediments, peats and soils. The longest section of the book (Part 7) contains fifteen chapters, each of which discusses a particular form of biological evidence. Topics range from pollen, diatom and various types of plant macrofossil analysis, through the investigation of fungal and algal remains, bryophyte, rhizopod, cladocera and ostracod analysis, to the palaeoenvironmental significance of Coleoptera, chironomids and Mollusca. The final section (five chapters), and one that many Quaternary palaeoecologists will perhaps find the most daunting, outlines aspects of the numerical treatment of biostratigraphical evidence which can lead, for example, to climatic calibrations of pollen and coleopteran data. Four of the five chapters, however, are concerned with statistical and computational manipulations of palynological data, reflecting the fact that, despite the wide range of fossil material that is available (see above), quantitative methods have thus far had a relatively limited application in analysis of Holocene environments. Each paper is followed by a bibliography, the majority of which are comprehensive and up to date, and the book concludes with a ten page subject index.

In many ways it is impossible to do justice to this impressive volume within the space of a short review. The papers are of variable length and naturally differ in depth and breadth of coverage in the light of the subject matter. They are, however, of a uniformly high standard and their compilation represents a major editorial achievement. Although it may appear invidious to select particular contributions from such a rich crop of material, certain papers caught the eye of this reviewer. These included the wide-ranging introductory paper by John Birks, the consideration of radiometric dating by Ingrid Olsson, Matti Saarnisto's discussion of annually laminated lake sediments, and Bjorn Berglund & Magdalena Ralska-Jasiewiczowa's review of pollen analysis and the depiction of pollen-analytical data. Throughout, the standard of presentation is impeccable, diagrams are clearly-drawn and well-reproduced and the text is remarkably error free. It is unfortunate that the book is so expensive, for it is clearly beyond the pocket of most Quaternary researchers and, in the present economic climate, will also be beyond the budget of many libraries. In this respect, one wonders whether the decision to combine all of the sections into a single volume was the correct one, when shorter (and presumably less expensive) handbooks would have been a more marketable proposition. The lasting impression is of a masterly compendium on Holocene palaeoecology and palaeohydrology that many will covet, but few will be able to afford.

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OBITUARY

Dr. M.A. GIRLING, 7 February 1950-24 December 1985

The death of Maureen Girling at the early age of 35 has robbed Quaternary science of one of its few practitioners in the field of palaeoentomology. Maureen entered the University of Reading in 1968 to read for a B.Sc. degree. Early impressions were of a shy student unsure of her new academic environment. However, after a first year following courses in geography, geology and zoology she elected to read for a degree in physical geography with subsidiary geology. In connection with the latter she attended a field class in East Anglia led by John Allen and Peter Worsley and this was her baptism in the Quaternary. Thereafter her enthusiasm blossomed and in her final year she was the leading member of her Quaternary Studies special option class. Her undergraduate dissertation was a study of the geomorphology and sedimentology of the braided Lower Spey in Scotland. After graduation Maureen moved to the Department of Geology, University of Birmingham (in September 1971) as a research student under Russell Coope. Her research centred upon insect faunas from interglacial and Devensian sites in south Lincolnshire, principally the then recently discovered organic sediments in gravel pits around Tattershall. Her entomological work was meticulous and her doctoral study, submitted in 1980, added many taxa to the list of insects from the Pleistocene and, with a short note in Nature (1974), she substantially revised our ideas on the nature of the Mid-Devensian interstadial. At the time of her death, she was working upon the rewriting of her thesis with a view to a more extended publication and it is to be hoped that this will still appear.

After three years as a research student, Maureen, like many others, found few opportunities to continue her work and could only stay in the subject by a sideways shift into archaeological entomology, a field of study being developed by Peter Osborne in Birmingham. Its potential was rapidly grasped by Maureen, who proceeded to obtain the necessary archaeological field experience with the Somerset Levels project and a series of seminal papers, principally on the nature of the Old Forest fauna but also including work on the Meare Lake villages, ensued.

Several short term contracts served to stress the important contributions to archaeological interpretation possible from palaeoentomology and in 1975 Maureen was appointed to a more permanent post within the Ancient Monuments Laboratory of the Department of the Environment (now Historic Buildings and Monuments Commission). Despite working in an institution where priorities for research were no longer purely academic - many sites had to be examined because the archaeologist said so rather than because they were intrinsically important - she continued to produce work of a high academic standard, often working long hours to meet the somewhat whimsical deadlines imposed upon her by archaeologists who had (and still have) little idea how long an entomological study might take. Work in the Ancient Monuments Laboratory brought her into contact with a much wider range of archaeological sites and her publications extend from the Mesolithic of Hampstead Heath to a Little Ice Age water beetle extinction from Leicester. The Hampstead Heath study, carried out in cooperation with James Greig, presents one of the few fully integrated palaeoecological studies which have so far appeared and Maureen, although herself a rather sad, lonely figure, fully recognised the great value of very close cooperation between the various specialists, an aspect further well indicated in her work upon material from the Norman castle at Hen Domen. Her latest paper - for several remain to be published - upon the elm bark beetle from Neolithic deposits at Hampstead Heath has raised accolades from those wishing to exonerate man from the Elm Decline yet she was more cautious in her interpretation. She pointed to the presence of this insect as part of the natural forest fauna and its ability to seek out trees under stress. Her more important conclusion, the rise in dung inhabiting species as the first farmers broke the cover, equally implicates man on the path to forest destruction. It is a pity that she did not live to carry on the argument.

Maureen was an assiduous, at times almost frenetic worker, employed where few could understand the time taken to identify satisfactorily and to interpret fossil insect assemblages. Her list of over thirty published papers and a completed Ph.D. in little over ten years is a most impressive achievement and gives some indication of what might have been. Several sites remain to be published. Reports upon the insects associated with the bog body from Lindow Moss and upon a fauna from a Roman well at Chichester have reached proof stage. The latter provides an interesting picture of almost a market garden within the Roman City. Important sites like Seamer Carr and Flag Fen, both germane to her interest in the fauna of the natural landscape, are partly studied. It would be a gross insult to her memory if these and all her other incomplete work was now abandoned.

Maureen continued to develop new avenues of research into arthropods from archaeological sites. Over the last few years she had begun the study of fossil spiders and had also completed the first three chapters of a book upon archaeological entomology. The former is lost but it is to be hoped that the book might be completed and published.

On the personal side, she was a quiet, unassuming individual, fond of children and a capable musician, playing the viola in her local orchestra. Her loss is felt personally by all those who knew her and by many others in the field of research which she helped to establish.

P.C. Buckland
Peter Worsley

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THE STATUS OF GEOLOGICAL MAPPING OF THE UNITED KINGDOM

A committee, under the chairmanship of Sir Clifford Butler, is presently conducting an enquiry into the status and future of the geological mapping of the United Kingdom. As this subject is of particular importance to the work of many Q.R.A. members, the Executive Committee submitted written evidence to this committee. The Summary of Conclusions and Recommendations of this submission is as follows:

1. The British Geological Survey, or some similar government-funded research body, should continue to have the responsibility for the basic geological mapping of the United Kingdom.

2. The basic geological mapping, particularly of the Quaternary, of the United Kingdom is incomplete and large areas require revision.

3. Geological mapping should follow a system that involves review and revision at periodical intervals.

4. It is recommended that a specialist Quaternary Geology Unit should be established within the B.G.S. to carry out the necessary mapping of Quaternary Geology.

5. The opportunity to tender for contracts for specific mapping projects or for Quaternary specialists to be contracted or seconded to the B.G.S. is welcomed.

6. A programme of mapping the sand and gravel resources of areas near centres of population or areas of development must be continued.

7. A programme for producing engineering geology, geotechnical and environmental geology maps based on computerised interactive mapping systems should be introduced for certain areas of complex geology and/or development potential.

8. The basic mapping and description of the Quaternary deposits of the United Kingdom would undoubtedly benefit from a greater input of geomorphological data.

9. The geological mapping of the United Kingdom continental shelf is as important as the mapping of the land area and should remain a B.G.S. responsibility.

10. There is a significant gap in offshore mapping at water depths of less than c. 40 m and a national mapping programme for these coastal areas is required.

11. Systematic programmes assessing those areas at risk from natural hazards and the likelihood of recurrence of particular hazards would be of undoubted utility to planners and engineers.

Members may obtain a copy of the full text of the submission by writing, enclosing a stamped (12 p), addressed A4 envelope to Dr. D.G. Sutherland, 2 London Street, Edinburgh EH3 6NA.

XII INQUA CONGRESS

The XII Congress of the International Union for Quaternary Research is to be held in Ottawa, Canada, from 31 July to 9 August 1987, and prospective U.K. participants should by now have received a copy of the first circular from the Canadian Organizing Committee.

In due course, it is hoped that Council of the Royal Society will make available a block grant to assist potential U.K. participants. In addition, monies will be available from the X INQUA Congress Fund (administered by the Royal Society) to the same end.

In order to assist the British National Committee for Geology and its Quaternary Research Subcommittee in formulating an application for a block grant, it would be helpful if intending U.K. participants could advise the Royal Society before 1 October 1986 of (a) their intention or expectation of attending the Congress; (b) the code of the scientific excursion(s) in which they hope to participate; (c) whether they propose to apply to the Royal Society for a grant in connection with the INQUA Congress.

It should be noted that to be eligible to apply for a grant from the Royal Society, applicants must be of Ph.D. status, normally domiciled in the U.K. and not employed by central or local government, a Research Council, the British Museum, state-aided research establishments or industrial or commercial bodies. To be eligible for a grant from the INQUA Congress Fund, applicants must be British subjects who are normally domiciled in the U.K. and are expected "to be capable of furthering the repute of British Quaternary studies in international circles".

The availability of application forms and the date by which they will need to be submitted to the Royal Society will be advised in a later issue of this Newsletter; an application form will, however, be sent automatically to all those who respond to this notice and indicate a wish to apply for a grant. Responses should be sent to the Executive Secretary, The Royal Society, 6 Carlton House Terrace, London SW1Y 5AG (ref.: INQUA/CRA).

GEOLOGICAL ASSOCIATION OF CANADA/ MINERALOGICAL ASSOCIATION OF CANADA/ CANADIAN SOCIETY OF PETROLEUM GEOLOGISTS

A Joint Meeting will be held at St. John's, Newfoundland, from 22nd-25th May 1988. For information contact: John Fleming, Newfoundland Department of Mines and Energy, P.O. Box 4750, St. John's, Newfoundland, Canada A1C 5T7. Telephone (709) 576-2768.

INQUA MEETINGS

Madrid, Spain: 16-21 June 1986. Symposium on Climatic Fluctuations during the Quaternary in the Western Mediterranean Regions. Details from: Departamento de Geologia y Geoquimicá, Facultad de Ciencias, Universidad Autonoma de Madrid, E- 28049, Madrid, Spain.

Amsterdam, The Netherlands: 5-14 September 1986. Symposium and Field Meeting on Tills and End Moraines in the Netherlands and NW. Germany. Details from Dr. J.J.M. van der Meer, Fysisch Geografisch en Bodemkundig Laboratorium, Dapperstraat 115, NL-1093, BS Amsterdam, The Netherlands.

Hamburg, GFR: 22-26 September 1986. Symposium on the Holsteinian Interglacial. Details from: Dr. G. Linke, Geologisches Landesamt, Oberstrasse 88, D-2000, Hamburg 13, GFR.

Denmark: 26 September- 1 October 1986. Field Symposium on Tills, Glacial Tectonics and Quaternary Stratigraphy in NW. Germany and in W. part of Denmark. Details from: Dr. Steen Sjoerring, Institute of General Geology, University of Copenhagen, Oester Voldgade 10, DK-1350 Copenhagen K, Denmark.

Belgium: 2-8 October 1986. Meeting on Paleohydrology of the temperate zone during the last 15,000 years: fluvial environments. Contact: Prof. Dr. F. Gullentops, Instituut voor Aardwetenschappen, Redingenstraat 16 bis, B-3000 Leuven, Belgium.

Moen, Denmark: 3-5 October 1986. Field Meeting on Glacial Tectonics. Details from: Dr. M. Houmark-Nielsen, Institute of General Geology, University of Copenhagen, Oester Voldgade 10, DK-1350 Copenhagen K, Denmark.

FIELDWORK OPPORTUNITY IN IRAQ FOR GEOMORPHOLOGIST

The British Archaeological Expedition to Iraq, North Jazira Project, requires a geomorphologist to help in a Quaternary survey for three to four months of fieldwork in Iraq in late 1986/early 1987. Details from: Esmée Webb, 42 Wallace Crescent, Carshalton, Surrey SM5 3SX.

BRITISH GEOMORPHOLOGICAL RESEARCH GROUP

The B.G.R.G. will meet in Oxford from 27th to 29th September 1987. Accommodation will be at Keble College, and lectures and meetings will be held at the School of Geography, Mansfield Road. The themes of the meeting will be: Karst, The tropics, Rates of geomorphological processes, Dating techniques. In addition there will be the A.G.M. of the B.G.R.G. and the Frost lecture. For further information contact Professor A.S. Goudie, The School of Geography, Mansfield Road, Oxford OX1 3TB.

LATE CENOZOIC PALEOENVIRONMENTS AND GEOLOGY OF THE ARCTIC

A Workshop on this theme is being organized by the Norsk Polarinstitutt and will be held in Norway, at a mountain lodge between Oslo and Trondheim, from 26th-30th April 1987. Details from: Dr. Anders Elverhøi, Norwegian Polar Research Institute, P.O. Box 158, 1330 Oslo Lufthavn, Norway.

LOESS LETTER

Editorship of the Loess Letter moved in May 1986 from Canada to the Geography Department, Leicester University, Leicester LE1 7RH. Besides Loess Letter 16, two supplements have been published recently: Supplement 8 "Lyell on Loess" and Supplement 13, a Bibliography of publications on loess.

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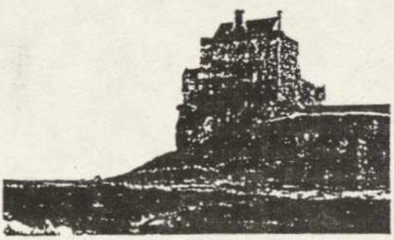

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CALENDAR OF MEETINGS

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

16th-21st June 1986	INQUA Symposium on Climatic Fluctuations during the Quaternary in the Western Mediterranean Regions, in Madrid, Spain (see notice above).
29th June -7th July 1986	International Symposium and Field Excursion "The Cultural Landscape - Past, Present and Future" at University of Bergen, Norway (see Newsletter 47, p. 58).
30th June -4th July 1986	Sixth International Conference on Geochronology, Cosmochronology and Isotope Geology, Cambridge (see Newsletter 47, p. 58).
20th-27th August 1986	Joint Meeting of the INQUA Loess Commission and the IGU Commission on the Significance of the Periglacial Phenomena, to be held in Jersey, Normandy and Brittany (see Newsletter 48, p. 44).
5th-14th September 1986	INQUA Symposium and Field Meeting on Tills and End Moraines in the Netherlands and NW. Germany, in Amsterdam, The Netherlands (see notice above).
20th-21st September 1986	Conference on the evolution of Romney Marsh, at Hertford College, Oxford (see Newsletter 48, p. 44).
21st-25th September 1986	Third Symposium on the Geology of Libya, in Tripoli (see Newsletter 47, p. 58).
22nd-26th September 1986	INQUA Symposium on the Holsteinian Interglacial, in Hamburg, G.F.R. (see notice above).
26th Sept. -1st. Oct. 1986	INQUA Field Symposium on Tills, Glacial Tectonics and Quaternary Stratigraphy, in NW. Germany and W. part of Denmark (see notice above).
2nd-8th October 1986	INQUA Meeting on Palaeohydrology of the temperate zone during the last 15,000 years: Fluvial Environments, in Belgium (see notice above).
3rd-5th October 1986	INQUA Field Meeting on Glacial Tectonics, in Moen, Denmark (see notice above).
26th-30th April 1987	Late Cenozoic Palaeoenvironments and Geology of the Arctic, Workshop to be held in Norway (see notice above).

25th-27th May 1987	Symposium on Coastal Lowlands: Geology and Geotechnology, at the Hague, Netherlands (see Newsletter 48, p. 44).
31st July-9th August 1987	XIIth INQUA Congress, Ottawa, Canada (see Newsletter 48, p. 44, and notice above).
27th-29th September 1987	BGRG Meeting in Oxford (see notice above).
22nd-25th May 1988	Geological Association of Canada, Mineralogical Association of Canada, Canadian Society of Petroleum Geologists, Joint Meeting at St. John's, Newfoundland (see notice above).
9th-19th July 1989	28th International Geological Congress to be held at Washington, D.C., U.S.A. (see Newsletter 48, p. 44).

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