

QUATERNARY NEWSLETTER

No. 27

February 1979

Quaternary Newsletters are issued in February, June and November. Closing dates for submission of copy for the relevant numbers are 1st January, 1st May and 1st October. Contributions, comprising reviews, notices of forthcoming meetings, news of personal and joint research projects, etc. are invited. They should be sent to the Secretary of the Quaternary Research Association, Mr. J. Rose, Geography Department, Birkbeck College, London University, 7-15 Gresse St., London W1P 1PA.

THE LIMIT OF THE DEVENSIAN IRISH SEA ICE SHEET ON THE NORTH WELSH BORDER

By D.S. Peake

In April 1978 the Q.R.A. annual field meeting, held at Keele University, included visits to sites on the Wrexham Delta-terrace. In the field handbook this extensive sand and gravel deposit is claimed by E.A. Francis to have been a sub-aerial fan laid down by meltwater from Welsh ice, the edge of which was retreating westwards across the area. No records of Welsh lodgement or ablation till are given, the main evidence for occupation by Welsh ice supposedly being drawn from Wedd *et al.*, 1928.

The limit of the Main Irish Sea ice sheet shown in this section of the north Welsh mountain border in my paper of 1961 was drawn from three memoirs of the Geological Survey, Flint, Hawarden and Caergwrle (Wedd and King, 1924), Wrexham (Wedd *et al.*, 1928) and Oswestry (Wedd *et al.*, 1929). Wrexham lies at the foot of the eastern dip slope of the great Carboniferous cuesta of Ruabon Mountain, up which the Irish Sea ice pushed to heights of over 300 m on the Cefn-y-fedw Sandstone (Wedd *et al.*, 1928, p.136). The authors (p.138) stress that Welsh ice moving eastwards overrode the lower escarpment of the Carboniferous Limestone, but failed to cross the higher parallel grit ridge of the Cefn-y-fedw Sandstone. Gravel hummocks on the latter contain northern erratics and marine shells, the eastern dip slope below the crest being mantled by thin drift of the Irish Sea ice.

In the western mountains the waning Welsh ice sheet shrank to valley glaciers, each with a lateglacial outwash of flood gravel. The

given list (Wedd *et al.*, 1928, pp.138-9) does not include such outwash at Wrexham, a comparatively flat area which is part of the local piedmont plain. On the other hand the description of the Delta-terrace (p.142) appears in the details of the Irish Sea drifts: boulder-clays all around it and above and below it are classified as Irish Sea till. It is suggested that at least the northern part of the extensive sand and gravel platform may be connected with the lateglacial drainage of the River Alyn from the north. The shallower southern part of the deposits are described as probable outwash of the smaller River Clwydog and its tributaries, all of which drain the Ruabon Mountain dip slope, their catchment areas being within the limit of the Irish Sea ice sheet.

My own observations in the area support these views. Taking a wider look at the whole of the north Welsh border, the present drainage pattern provides ample evidence of temporary or permanent southerly diversion of all the major rivers leaving the mountains, a direction consistent with blockage of their outward courses by the Irish Sea ice sheet advancing from the north. Erratic trains and striae show that it impinged on the north Welsh coast in the vicinity of the Great Orme (Smith and George, 1935), the eastern lobe pressing round the coastal areas of Flintshire and closely along the Welsh mountain fringe as it filled the Cheshire basin. The Upper Alyn, once tributary to the Clwyd (Embleton, 1957), was permanently diverted south-eastwards to join the Lower Alyn, which in turn was diverted southwards across two prominent rock spurs of Hope Mountain (Peake, 1961). Farther south the lateglacial Dee and Ceiriog drainage was probably via the now deserted south-easterly valley at St. Martin's Moor (SJ 314357) described by Wills (1912), before being deflected to its present shorter easterly course by the late advance of Welsh ice down the Dee and Ceiriog valleys (Wedd *et al.*, 1928). Wills (1912) comments on this remarkable dry valley, pointing out that in direction it follows almost the exact line of the great buried valley which he had traced in a south-easterly direction from the point where the Dee valley emerges from the hills. The buried channel was considered to be the pre-glacial Dee course, yet there seems to be no valid reason why this large river should then have changed abruptly from its easterly flow along the Llangollen syncline on the line of the great fault belt, to turn southwards at right angles and join with the similarly diverted Ceiriog. Southerly diversion by Irish Sea ice in a pre-Devensian advance could have been the cause, the valley maturing in an interglacial period before burial under new glacial deposits. Re-excavation in the repeated diversion in the Devensian temporarily opened the St. Martin's Moor valley south-eastwards on the same line. Farther south the Severn and its large tributaries were permanently diverted south-eastwards via the Ironbridge gorge.

It is only to be expected that along the north Welsh border the Irish Sea drift contains Welsh as well as northern erratics and marine shells due to the confluence and intermingling of the two great ice sheets. Not only was Welsh material brought down from the mountains by ice and meltwater during the glacial periods, but in its passage southwards the Irish Sea ice also assimilated the Welsh material transported by rivers to the lowlands during the interglacials. Naturally therefore the Wrexham

Delta-terrace contains both erratic types among material which is mainly local. The vast deposit is considered to be one of the largest local reserves of sand and gravel in Britain. In the main the material must have been derived from the ice front retreating from the hills, but the concentrated accumulation at this locality on the piedmont plain seems to be due in part to deposition at the southern end of the great buttress of Hope Mountain; it is of some significance that similar increased deposition took place farther north at the southern end of Halkin Mountain, though not to such a degree. Sand and gravel hummocks containing northern erratics and marine shells occur on the Halkin crest (Wedd and King, 1924), and I have found sandstone fragments and red sand from the Triassic among the crags at over 300 m on Hope Mountain. In the ice retreat, when both ridges reappeared as nunataks, the southerly flow of meltwater was confined to marginal or sub-marginal channels along their eastern slopes, evidence for which remains (Peake, 1961). The load of heavy rock and sediment was dropped by the torrents on reaching the open flatter ground south east of either mountain, where temporary flooding assisted in checking the force of the currents. Furthermore, to occupy the Wrexham area the Irish Sea ice had traversed the westward bulge of the outcrop of soft Lower Mottled Sandstone south of Warren Mountain (SJ 310630), now largely under drift (Wedd and King, 1924), which would account in part for the increased charge of sand and fine sediment held by the ice.

The careful observation and analyses of the sediments by E. A. Francis and his colleagues, reported in the Q.R.A. handbook, show that in the outer zone of the Delta-terrace at least part of the deposition was sub-aerial, as might be expected in the probable conditions of seasonal drainage which interspersed the transitory periods of flooding. The directions of dip of the beds which he noted, similar to mine in 1961, could in general be accounted for by the course of the Alyn at that particular stage. On the other hand his concept of sheets of flow till could not account for the Irish Sea till (up to 8 m) which forms an unbroken lobe over the northern part of the Delta-terrace in the vicinity of Llay.

It is however in the higher western edge of the great sand and gravel platform that evidence for the proximity of an Irish Sea ice front is seen in the sections. Of necessity the descriptions of exposures in my paper in 1961 were curtailed by the limit imposed on the length of text, but the one described at Cymmau (p. 350) and the two sections farther out on the Delta-terrace (pp. 353-4) show indisputable evidence of northern influence in the association of the gravels with heavy red till which contained numerous northern erratics and comminuted shell, and from which red staining was seen to pervade the whole of the jumbled assembly of debris. The lack of sorting, the contortion of the lumps of included till, the general deformation of the rare pockets of bedded sand and the great size of the angular striated boulders were ample evidence that these were ice-contact deposits as described by West (1968, pp. 25-6).

The constricted area between the western hill slopes and the retreating Irish Sea ice front received meltwater flow from the latter augmented by the Alyn drainage from the north. In a distance of four

kilometres upstream the Alyn's three largest tributaries, Terrig, Nant Brook and Cegidog join it from the west, all of them draining the Carboniferous dipslopes north of the Llanellidan Fault belt, which were occupied by Welsh ice from the west (Wedd and King, 1924). Their contribution of Lower Palaeozoic material to the Alyn's deposits in the Delta-terrace must have been considerable.

About twelve kilometres north of the delta-terrace a feature with many similarities to it lies at the foot of the hills sloping down to the Dee estuary. Extending in a narrow belt from Bagillt to Hawarden, a distance of seven kilometres, this terrace of false-bedded sand and gravel has a lower edge at 61 m O.D. like the Wrexham Delta-terrace, and ends in a similar steep slope (Wedd and King, 1924). Interpretations by the authors differ slightly. Wedd (p. 148) writes, 'Its lower edge rather closely follows the 200 ft. contour-line, and appears to represent a level at which the diminishing ice-sheet, still filling the Dee estuary and covering the adjacent low ground, remained stationary long enough to hold up a downwash of sand and gravel from the declivity above, and to distribute it by a marginal flow of water.' King (p. 159), describing local details of the drift, concludes, 'The sands appear to be a marginal deposit formed during a melting of the ice, when large volumes of water washed sands and stones from the ice into the channel that bounded the glacier.' Even if the authors differ to some degree in detail, at least they both conclude that the ice was Irish Sea ice, that the sands were water laid, that the feature was a marginal Kame terrace. From the available evidence I see no reason to believe that the Wrexham sands and gravels cannot be accounted for by similar dual processes.

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ABSTRACTS OF PAPERS READ AT A DISCUSSION MEETING ON "THE LATEGLACIAL ENVIRONMENT OF THE BRITISH ISLES AND POSSIBLE CORRELATIONS WITH NORTH WEST EUROPE".

This meeting was held at University College, London, on January 5th and 6th 1979. Also included are abstracts of short papers that were presented at the meeting on the results of recent Quaternary Research. A more complete abstract of the paper read by Professor Jan Mangerud will be included in the June issue of the Quaternary Newsletter.

THE REGIONAL EXPRESSION OF THE EVENTS OF THE YOUNGER DRYAS PERIOD.

By W.A. Watts.

It is often assumed that the climatic deterioration of the Younger Dryas Period, approximately 11,000 - 10,000 radiocarbon years B.P., was a worldwide event. In north west Europe it is possible to categorise sites with pollen-bearing Younger Dryas sediments into: 1) Sites where the floristic composition is qualitatively different from the preceding and succeeding periods. 2) Sites where the contained flora is quantitatively different. In such cases the size of the quantitative difference can be noted. 3) Sites where there are sedimentary changes, usually an increase in inorganic materials associated with the Younger Dryas age. A review of sites in a broad band from Ireland and Britain to the southern slope of the Alps in northern Italy shows that very distinctive Younger Dryas floras and sediments occur in Ireland and Britain. In the North European Plain, sites show strong quantitative distinctiveness, but only a weakly expressed quantitative distinctiveness can be found in southern Germany and at some sites the episode can hardly be identified. A distinctive sedimentary record can be found on the north slope of the Alps and in Austria, although there is only a slight floristic expression. South of the Alps there is no sedimentary record and only a slight floristic change. Further south and east, and elsewhere in the world, the demonstration of a Younger Dryas period is questionable and, where claimed, rests on relatively weak evidence, although there is suggestive evidence from Greece. The correlation between a strongly marked Younger Dryas period in Atlantic north west Europe and the recently demonstrated re-advance of polar water in the North Atlantic should be noted.

COMPARISONS BETWEEN THE LATE-DEVENSIAN VEGETATION OF HIGHLAND BRITAIN AND THE PRESENT VEGETATION OF WEST GREENLAND

By W. Pennington (Mrs. T.G. Tutin)

Tyge Böcher has described in detail the vegetation of two areas of West Greenland between latitudes 66° and 70° N - one a vegetation

region which is Arctic-Subarctic Oceanic and one which is Arctic-Subarctic Continental. Surface samples, including lake sediments and moss polsters, obtained from these regions in 1977, have provided pollen spectra from (1) oceanic heath (without Calluna) and (2) subarctic steppe. These pollen spectra from two distinct types of herbaceous vegetation will be compared with Late-Devensian herb biozones from Highland Britain, and some conclusions about the Late-Devensian environment will be drawn.

RADIOCARBON CHRONOLOGY AND COLEOPTERAN SUCCESSIONS IN THE LATEGLACIAL - NEW EVIDENCE FROM ST. BEES, CUMBERLAND

By G.R. Coope and M. Joachim

A beetle diagram has been constructed from new data obtained from Lateglacial sediments on the coast south-west of St. Bees. This shows that the Windermere Interstadial was at its warmest prior to 12,200 years ago and was then probably somewhat warmer than present-day conditions. Deposits laid down during the "Allerød period" contain fossils indicating cooler conditions than during the earlier part of the Windermere Interstadial. During classical Zone III times the insect fauna had definite arctic affinities. This sequence of climatic events, interpreted from fossil Coleoptera, is entirely in keeping with similar data from other sites.

Radiocarbon dating of this site is complicated by isotopic dilution. This will be discussed in the light of dating difficulties in Lateglacial deposits in general.

ENVIRONMENTAL CHANGE DURING THE LOCH LOMOND STADIAL: EVIDENCE FROM A SITE IN THE UPPER SPEY VALLEY

By J. B. Macpherson

Pollen stratigraphic analysis of a core from a site at Tom na Moine (NN 683961) in the upper Spey valley, with particular emphasis on the relative contributions made by chionophilous and chionophobous taxa to stadial pollen spectra, is combined with a consideration of the probable conditions of lacustrine sedimentation to permit a phase-by-phase reconstruction of the changing environment during the Loch Lomond Stadial:-

1. Extensive snow-beds in the early part of the stadial provided moisture for the washing of organic and fine mineral soil particles into the lake which at that time occupied the site; thermal stratification developed in the lake in some summers.

2. Snow-beds remained fairly extensive, but the soil was more deeply disturbed, and coarser particles were transported into the lake. Although conditions were favourable for the deposition of graded laminae, their absence implies free circulation of lake water throughout the ice-free season.
3. During the most extreme conditions of the stadial (the Artemisia Maximum) snow-beds were less extensive; pollen of chionophobous taxa reached a maximum. Reduced run-off led to a reduction in the rate of sedimentation. Fine laminae are preserved in the lake sediment; the lake was probably of the cold monomictic type. The environment may have been similar to that found today at the heads of the south-west Greenland fjords.
4. Snow-beds increased again in the latter part of the stadial, but soil disturbance was less severe than during the early phases.

The sequence of early and late phases with appreciable snowfall separated by a phase of most severe cold with restricted snowfall is in agreement with Mitchell's hypothetical frost cycle.

Pollen spectra for the horizon of the Artemisia maximum throughout the Scottish Highlands are mapped, and are used as a basis for comparison with the changing spectra at the Tom na Moine site. Only sites north and east of the main watershed reveal well-marked continental affinities at this horizon; windward regional slopes continued to receive appreciable snowfall.

A LATE DEVENSIAN SITE AT STORMONT LOCH, NEAR BLAIRGOWRIE, EASTERN SCOTLAND

By C.J. Caseldine

The analysis of two adjacent profiles from Stormont Loch, near Blairgowrie on the fringe of the Eastern Grampian Highlands, demonstrates the existence of comparable sequences of local pollen assemblage zones covering the Late Devensian period. Relative counts from both sites are supplemented by absolute counts from one site expressed as grains/cm³. Pollen concentrations support the assemblages defined on relative grounds but as yet radiocarbon dates are not available for the calculation of influx rates. The sequence of local assemblage zones is dissimilar to that found at most sites in the eastern and southern Grampians for there are two zones dominated respectively by Juniperus-Empetrum and Betula-Juniperus which are separated by a Rumex-Cyperaceae zone. Total pollen concentration varies from over $30 \times 10^3/\text{cm}^3$ in the zones dominated by woody species to only $10 \times 10^3/\text{cm}^3$ in the Rumex-Cyperaceae zone. The occurrence of such a sequence is not thought to be due to slippage and redeposition of older sediment but is thought to represent a significant change in the local vegetation communities with the almost

complete disappearance of *Juniperus* and *Empetrum*. It is suggested that the sequence of assemblage zones is comparable to that found by Walker (1977) at Corrydon in Glenshee and represents the Bölling-Older Dryas-Allerød chronozones. The vegetation record of the Loch Lomond Stadial is defined by three local assemblage zones with high values for *Salix*, *Rumex*, *Thalictrum* and *Artemisia*, the latter becoming important towards the end of the Stadial due to a combination of increased dryness and the loss of the local soil cover which developed during the interstadial.

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INTERPRETATION OF THE LATEGLACIAL MARINE ENVIRONMENT OF NORTH WEST EUROPE BY MEANS OF FORAMINIFERA.

By A.R. Lord

The Lateglacial is in geological terms very short and in absolute chronology closely defined. Within NW Europe planktonic foraminifera are rare or absent and study is consequently confined to bottom-dwelling species. As these species are essentially all extant, biostratigraphic studies depend upon the interpretation of sequences in terms of environmental change as indicated by the benthonic foraminifera present. Correlation of such 'environmental stratigraphy' over any distance is unreliable unless underpinned by absolute chronology. The evidence provided by foraminifera for conditions in the marine environment of the Lateglacial North Sea and adjacent waters is at present fragmentary.

THE MARINE OSTRACOD RECORD FOR THE LATEGLACIAL PERIOD IN BRITAIN AND NORTH-WEST EUROPE

By J.E. Robinson

Like other benthos, marine ostracods do reflect changes of sea water temperature through the Lateglacial period into the Flandrian. Several sections through marine clays of the west coast of Scotland offer evidence of such changes, including the climatic oscillation of the Loch Lomond Readvance. East coast sequences can sometimes seem

less straightforward. Lateglacial sections in Jutland for which foraminiferan fauna has been described, do contain ostracods, including 'arctic' species, but these have not been fully documented. Preliminary examination, however, suggests that there may be ecological grounds against too direct a correlation with the British North Sea seaboard.

DEGLACIATION AND ENVIRONMENTAL CHANGE IN SOUTHERN SCANDINAVIA.

By B. Berglund.

This paper reviews the history of research and opinions concerning the deglaciation chronology of southern Sweden during the Late Weichselian, 13,000 to 10,000 radiocarbon years B.P.. Ice marginal zones are defined and lithostatigraphic key areas and biostratigraphic transects with radiocarbon dated lake profiles are described. A revised deglaciation chronology is outlined which is distinctly different from the traditional views, but is in agreement with recent results from Norway and Scotland. The deglaciation of southern Sweden is considered to have occurred 500 - 900 years earlier than expected from the varve chronology. Of the ice-marginal zones in southern Sweden the following ages and correlations with Norway are proposed:

Halland Coastal Moraine	13,500-13,100	¹⁴ C yrs. B.P.	= Lista
Gothenburg Moraine	13,000-12,800	" "	} = Spangereid
Berghem Moraine	about 12,500	" "	
Trollhättan Moraine	about 12,300	" "	= Kristiansand?
			Faerder-
			Hvaler.
Levene Moraine	12,000-11,800	" "	= "Outer Ra"
Skövde Moraine	10,800-10,500	" "	= Ra
Billingen Moraine	10,400-10,200	" "	= Ra

GLACIOLOGICAL ASPECTS OF THE LATE-GLACIAL IN NORTH-WEST EUROPE

By G.S. Boulton

Air-photo interpretation of the area covered by the main Loch Lomond readvance ice cap has revealed series of moraines some of which are analogous to push moraines forming at modern glacier margins. These moraines reflect the activity of the glacier. Analysis of their frequency in the area south of the Great Glen suggests an early period of rapid retreat and a later period of slower retreat characterised by greater glacier activity. It is concluded that the Loch Lomond ice cap did not decay by stagnation as an inactive mass, but conducted an

orderly retreat as an active glacier. We are currently attempting to establish the pattern of retreat in the North-West Highlands as well as the area south of the Great Glen which, in association with a new energy balance model allows us to build up a picture of changing climate during the waning phase of the Loch Lomond readvance ice cap.

DELTA MORAINES: A DISCUSSION OF THEIR CHARACTERISTICS AND SIGNIFICANCE IN THE DEGLACIATION OF RANA FJORD, CENTRAL NORDLAND, NORWAY

By S. Levell

Delta Moraines are produced where valley glaciers are forced to jettison their load directly into the sea. Their genesis is poorly understood and there have been very few systematic studies of their sedimentary characteristics. In central Nordland, a number of isostatically raised deltas are being investigated. On the basis of evidence already collected these have been subdivided into several genetic types. Principle causes of variation are considered a response to differences in the sediment/ice interface and level of marine modification.

These moraines are associated with retreating ice at the end of the Last Glaciation. Marine fauna found in association with some of these deltas will be radiocarbon dated. Synchronous shorelines and neighbouring deltas can be correlated with sites of known age once the regional trend of isostatic uplift has been calculated. In this way different stages of glacial retreat can be established. It is considered important to determine the pattern of Late Glacial ice retreat in this region as the Quaternary of large areas between Finnmark and southern Norway still remains uninvestigated. Recent evidence from northern Nordland suggests that valley glaciers persisted, in wetter parts of the north west coast, into Boreal times (Andersen 1975). In Rana fjord, 4 main glacial retreat stages have so far been distinguished. It is not yet certain whether these stages correspond with those established for northern Nordland and Troms. Speculative evidence does however suggest that coastal valley glaciers may well have persisted into early Flandrian times in this part of central Nordland.

EVIDENCE FOR A GLACIAL READVANCE PRE-DATING THE LOCH LOMOND ADVANCE IN WESTER ROSS, SCOTLAND

By C. K. Ballantyne and M. Robinson

No substantive evidence has hitherto been presented to indicate that the retreat of the last (Late Devensian) ice sheet in Scotland was

interrupted by glacier readvance prior to the Lateglacial Interstadial that began c. 13,000 years B.P. A series of lateral moraines and other ice-marginal features in the Wester Ross area of the North-West Highlands are described. These total nearly 30 km in length, and indicate the former existence of a lobe of ice nearly 25 km in width across lochs Gairloch and Ewe and the surrounding low ground. The ice-marginal features are interpreted as marking the limit of a glacial readvance, here named the Wester Ross Readvance that took place in this area some time between the Late Devensian maximum of 17,000 - 18,000 B.P. and the onset of the Lateglacial Interstadial.

ASPECTS OF FORMER CLIMATE INFERRED FROM LOCH LOMOND ADVANCE GLACIERS IN SCOTLAND AND NORTH-WEST ENGLAND

By J. B. Sissons

During the Loch Lomond Stadial by far the largest glaciers were in the west, suggesting snowfall associated with winds from a westerly point. Superimposed on this is another pattern: glaciers were normally larger and had lower firn lines on the south sides of individual upland areas than on the north sides. Along with analysis of probable snow transfer by wind, this implies snowfall associated with winds from southerly directions. This points to frequent fronts approaching from the west and south-west associated with numerous depressions following more southerly tracks than prevail today, this in turn being related to the location of the Polar Front in the Atlantic Ocean. Southward movement of this front probably caused optimal conditions for glacier accumulation during ice sheet growth to pass from north to south across the British Isles.

PROBLEMS OF RADIOCARBON DATING DEPOSITS FROM RECENTLY DEGLACIATED TERRAIN

By D. G. Sutherland

Errors that are likely to influence the accuracy of radiocarbon dates from recently deglaciated terrain are considered. Younging errors which can result from such factors as late melt-out or sediment mixing are contrasted with errors that produce an ageing in the radiocarbon dates due to the hard water effect and to the unique chemical and hence biological character of recently deglaciated terrain. Means of detecting the presence of these errors and the possibility of their removal by laboratory pre-treatment are discussed. Although each radiocarbon dated site must be considered on its own merits, it is concluded that current practice can neither detect nor remove all the

contaminants and that radiocarbon dates from recently deglaciated terrain are likely to be in error, the most probable errors resulting in an ageing of the sample and hence too early an estimate of deglaciation. Examples are taken from the Lateglacial period in Highland Britain.

COUPLED OCEAN-ATMOSPHERE CIRCULATION DURING THE LATE-GLACIAL: A DYNAMICISTS'S VIEW

By J. S. A. Green

Knowing the variety of possible ocean-atmosphere circulations places constraints on the interpretation of palaeoclimate data. Circulation systems that could have occurred during the Interstadial period will be discussed: distribution of winds; ocean temperature and currents; deserts; ice cover; and land temperatures.

THE AGE AND ORIGIN OF THE MAIN ROCK PLATFORM IN JURA, SCARBA AND NORTH-EAST ISLAY, SCOTTISH INNER HEBRIDES

By A. Dawson

On the western coast of Scotland a well-developed raised rock platform and backing cliff originally considered to be post-glacial in age (Wright, 1928) and later interglacial (MacCallien, 1937; McCann, 1966; Gray, 1974), has recently been proposed to be late-glacial (Sissons, 1974; Gray, 1978). This shoreline described by Gray (1974, 1978) in Lorn, E. Mull, Knapdale and Kintyre is also well-developed in Scarba, West Jura and North-East Islay. Here the platform is cut in Dalradian quartzite and slopes to the south-west from 7 m O.D. in North Scarba to sea level in North-East Islay with a gradient of 0.13 m/km. In South-West Jura and North-East Islay this shoreline crosses an intertidal rock platform considered to pre-date the last period of general glaciation. It is suggested that the tilted shore platform and cliff were formed by shore erosion during the cold periglacial conditions of the Loch Lomond Stadial (Younger Dryas). Assuming a minimum duration of 1,000 years for the Loch Lomond Stadial it is estimated that the minimum rate of cliff retreat was 7 cm/year; equivalent to the removal of 1.03 m³ of rock per metre of coast per year.

PREDICTION OF FOSSIL ICE-WEDGE POLYGONS FROM THE LINEAR DISTRIBUTION OF ASSOCIATED WEDGE STRUCTURES ALONG VERTICAL EXPOSURES

By J.K. Maizels

Little analysis has so far been directed towards the distribution of ice-wedge pseudomorphs within a single locality, particularly in areas where any associated network of former ice-wedge polygons has been destroyed or buried by more recent deposits and hence is no longer visible at the ground surface. In addition, few accurate attempts have been made to determine whether the distribution of fossil wedge structures observed along vertical exposures is related to palaeo- polygonal networks, and if so, in what way.

A series of empirical, predictive relationships between the distributions of wedge structures along linear exposures and the areal distributions of associated polygonal networks has been developed from the analysis of air photos of these networks in northern Alaska, southern Sweden and eastern England, and in a number of other areas described in the literature. The predictive value of these relationships is demonstrated in relation to the distribution of 18 Weichselian ice-wedge pseudomorphs exposed in a Scottish gravel pit. Estimates are given of several former polygon characteristics, including polygon diameter, and a computer simulation of the possible palaeo-polygonal network in the vicinity of the gravel pit is also presented. Current research is being directed towards relating both observed and predicted polygon patterns to palaeo-environmental conditions.

ROGEN MORAINES: A POSSIBLE MECHANISM OF FORMATION

By R. Cornish

A series of cross-valley ridge landforms is described from the west-central Southern Uplands of Scotland. These features are composed entirely of till and are orientated at right angles to the direction of former ice movement. It is suggested that these features are akin to the Rogen or 'ribbed' moraines that have been described from Scandinavia and Canada. These moraines have been variously interpreted as having been formed by the overriding of reactivated ice; beneath active ice in zones of tension where basal crevassing caused irregular deposition of till into ridges; or debris accumulation at the base of shear-planes in zones of compressive flow. The discussion considers morphological, sedimentological and topographical aspects of the ridges and it is suggested that the features owe their formation to a dilatancy process acting beneath an actively back-wasting ice-sheet.

DEPOSITIONAL MODELS FOR GLACIODELTAIC DEPOSITS: EXAMPLES FROM THE MIDLAND VALLEY OF SCOTLAND

By J. H. Martin

Sand and gravel bodies in the valleys of the North Esk (Midlothian) and the Avon Water (Lanark) exhibit overall coarsening-upward sequences. Sands with gentle to steep depositional dips are truncated by gravel sheets and/or channel fills. Examination of faces in working quarries reveals the complex geometry of 'delta-front' deposits. Small-scale cyclicity of grain-size and sedimentary structure indicates the varying importance of bedload and suspended load transport. Sedimentary sequences generated by deposition in different situations within individual deltas do not invariably correspond to a simple topset-foreset-bottomset classification - it may be possible to characterise a series of depositional subenvironments. Three deltas examined during 1978 show different features possibly indicating:

- (1) progradation without major changes of lake level
- (2) partial abandonment due to a drop in base level
- (3) downcutting associated with ice-margin fluctuations.

LATE-GLACIAL PLANT COMMUNITIES AT MORRONE, BRAEMAR

By B. Huntley

Detailed pollen analytical and plant macrofossil studies of a radiocarbon dated core (12,600 - 9,900 B.P.) from a small basin (altitude 430 m) in the Morrone Birkwoods provide the data for local vegetation reconstructions in a sub-montane situation. The relative amounts of different plant communities present can be estimated and changes in these amounts can be related to changes in the environment.

A MEDLEY OF RADIOCARBON DATES FOR THE LOWE'S FARM BOS

By R. Burleigh and J. Clutton-Brock

After giving the surprising initial result of a Late Glacial date radiocarbon measurement has finally shown that the skull and fore part of a skeleton of *Bos primigenius* from the Upper Peat at Lowe's Farm, Littleport, Cambridgeshire, dates to the Sub-boreal period, circa 3350 bp. This result is of particular interest for three reasons.

Firstly, the skull and skeleton, which were of a large bull, have previously been attributed on the basis of stratigraphy and pollen analysis to Zone VIId in the Fenland sequence, that is to the early Bronze Age. Since it was described by Shawcross and Higgs in 1961 this Bos primigenius has therefore been acclaimed as one of the most recent specimens known from the British Isles and radiocarbon dating has now provided direct support for this claim. The measurements of the bones of this animal were, however, close to those of Pleistocene examples. Thus the second point of interest is that the direct date obtained for these remains contradicts the view that Bos primigenius underwent a reduction in size at the end of the Pleistocene. Thirdly, the highly misleading date of circa 12,000 bp that was initially obtained for the remains has wider implications which are discussed in the paper.

A RECENTLY DISCOVERED BURIED PALAEOSOL IN THE NORTH-EAST LAKE DISTRICT

By J. Boardman

In the Glenderamackin drainage basin of northern Cumbria a series of deeply weathered deposits comprising heads, tills and fluvial beds has been recognised over an area of 12 km². Weathering profiles exist which show gradation from unweathered to severely weathered containing totally rotted stones. Pedogenic features have been examined using micromorphological techniques. The weathered sequence is overlain by unweathered Devensian glacial deposits and Late Glacial Zone III terrace gravels. At Laddray Wood a palaeosol with A and E horizons apparently relates to a underlying weakly developed argillic horizon in rubified till; the sequence is overlain by what appears to be soliflucted till. The nature and severity of the weathering in the region together with the rubification at Laddray Wood suggests an interglacial climate which in view of the stratigraphic relationships must be Ipswichian.

THE STRATIGRAPHY AND SEDIMENTOLOGY OF GLACIAL TERRACES IN THE WAVENEY VALLEY, EAST ANGLIA

By P. Coxon

Using several geomorphological techniques the terraces of the Waveney Valley have been classified stratigraphically and the sedimentological aspects of their deposition have been studied. The valley contains three main terraces and these have been dated using biostratigraphical and lithostratigraphical methods.

QUATERNARY STUDIES AT DUBLIN

By F. M. Sygne

Quaternary studies in Dublin date back a little over a century, to the writings of the 'father' of the Glacial Theory in Ireland, the Rev. Maxwell H. Close, whose reputation as an accurate and reliable observer has been well attested. When geological mapping was carried out at the turn of the century, a number of geologists, notably G. H. Kinahan and J. R. Kilroe, became sufficiently interested in the glacial deposits to record them with a surprising amount of detail in the memoirs and maps of the Geological Survey of Ireland. This interest grew, to culminate in the production of the first glacial drift maps in the early 1900's, based very largely on the work of W. B. Wright. These maps, on a scale of 1:63,360 are simple in concept (they show the distribution of boulder clay, glacial sands and gravels, glacial striae and alluvium) and cover the neighbourhood of the main urban areas - Dublin, Belfast, Londonderry, Cork and Limerick; Killarney was later added as a district of particular tourist interest!

After the first world war interest in the Quaternary re-emerged and developed semi-independently in Dublin and Belfast. In the Department of Geology at The Queen's University, Belfast, J. K. Charlesworth for fifty years (1923-1973) spent a lifetime unravelling the glacial history of Ireland; his techniques were largely morphological, developed from his training in Germany, and involved the mapping of moraines and other glacial landforms in order to reconstruct in maps the successive position of the ice margin during deglaciation. This work stimulated the interest of members of the Irish Naturalists' Field Club to submit a series of useful observations in the Journal; it also inspired A. Farrington of the Royal Irish Academy to embark on similar studies from Dublin. Influenced by the work of Wright during earlier years working for the Geological Survey, and by contacts with European scientists, Farrington introduced a type of lithological analysis of drifts by means of stone counts; this was used to identify the provenance of different drifts, and also to determine relative age by degree of weathering, reflected particularly in the limestone/chert ratio. This latter work, carried out in Co. Wicklow, has become a classic.

After the second world war, palaeo-ecological studies were developed in Trinity College, Dublin, through the efforts of G. F. Mitchell who was trained and inspired by K. Jessen of Copenhagen when he investigated certain interglacial deposits in the south of Ireland in 1934-35. These studies have been carried on up to the present day by W. A. Watts of the Department of Botany, Trinity College. Also there has been a growth of academic studies into the nature and analysis of glacial deposits. These were first developed by N. Stephens and F. M. Sygne and many parts of Ireland and the greater part of Ulster has now been covered. Some of this is by graduate thesis work under the leadership of N. Stephens from the Department of Geography at the Queen's University, Belfast. One graduate, E. A. Colhoun, extended this type of research to the Department of Geography in Trinity College; and under his guidance A. M. McCabe and P. G. Hoare covered north east Leinster.

At this time also, the development of the National Soil Survey has led to further knowledge of the glacial drifts. Soil bulletins are being published by counties; some of these contain maps of Quaternary Geology that have been prepared jointly with the Geological Survey (viz., Wexford, Carlow, Clare, Limerick and Kildare). Certain soil types correspond with particular glacial deposits.

During the last decade there have been further changes in the development of Quaternary Studies in Dublin. In the Department of Geography, Trinity College, D. Huddart has been actively developing studies in Sedimentology and Glacial Geomorphological processes, particularly in connection with ice-marginal deposits. Also the studying of structures and microfauna in the Irish Sea drifts has received special attention. At University College, Dublin (Department of Geography) C.A. Lewis has been promoting studies in the Lateglacial landforms of cirques and in periglacial landforms in the south of Ireland.

Other universities and colleges currently pursuing Quaternary and related studies in Ireland are the Department of Geography, The Queen's University, Belfast - Sedimentology and process studies; the New University of Ulster, Coleraine in the School of Biological and Environmental Studies - Sedimentology and process studies; the Ulster Polytechnic, Newtownabbey, Co. Antrim in the School of Environmental Sciences - mapping and the analysis of glacial deposits; the Department of Geography, University College, Cork - palaeoecological studies.

In the Geological Survey of Ireland, at Dublin, a policy of drift mapping has been initiated to parallel the county scheme developed by the Soil Survey, under the direction of F.M. Synge. Fabric analysis and lithology of the drifts are investigated along with air photograph interpretation.

An appreciation of Quaternary studies in Ireland may be gained by consulting the following publications:

Mitchell, F., 1976. The Irish Landscape, Collins, London.

Davies, G.L.H., and Stephens, N., 1978. Ireland; in the series The Geomorphology of the British Isles, edited by Brown, E.H. and Clayton, K.M., Methuen, London.

BOOK REVIEW

Quaternary Geology. A Stratigraphic Framework for Multidisciplinary Work. By D.Q. Bowen, 1978. Pergamon Press, Oxford. xi + 221 pp. Price: £5.00 soft back.

Because of its broad approach and critical examination of much long accepted and recent dogma, David Bowen's book is essential reading

for everyone working on the Quaternary, from second- or third-year undergraduates onwards. The stratigraphic framework referred to in the title is that based on the climatic oscillations deduced from oxygen isotope studies of deep sea cores. This work is admirably summarised in Chapter 3, following brief critical discussions in Chapter 2 of classical stratigraphic models from five continental areas (Alps, northern Europe, Britain, central north America and east Africa). All existing models of Quaternary subdivision are rejected as "no longer adequate, and their terminology at best subject to redefinition, at worst persistent and downright misleading".

Subsequent chapters set out to reinterpret terrestrial successions within the oceanic framework, but of course do so with only limited success. Chapters 4-9 cover stratigraphic classification and procedure, geochronometric dating, the main fossil groups, sea level changes, glacial deposition, and non-glacial sediments (including palaeosols) respectively. Many specific problems related to Britain and other countries are briefly discussed as examples in these chapters, but the approach is too generalised for a comprehensive survey of the Quaternary of any one area to be presented. Radiometric and geomagnetic dating is at present too sparse, especially in older parts of the Quaternary, for much satisfactory correlation between continental and oceanic areas. Chapter 10 (Overview) therefore suggests the widespread use of floating chronologies in terrestrial sequences, and stricter adherence to recommended stratigraphic practice, so that the distinction between fact and hypothesis in correlation is made clear to everyone. This is sound advice; probably all of us have erred, knowing the limitations of our own work, yet failing to communicate those limitations adequately to others. However, some features of Quaternary deposits make the stratigraphic pill a difficult one to swallow, and careful explanation with gentle encouragement might have achieved more success here than the somewhat hectoring style sometimes adopted by the author.

Another disappointing aspect of the book is the large number of typographical errors. Few pages are completely free of them, and some have 8 or more. However, the sense is seldom lost as a result; in a few places where it is, one suspects that words have been omitted. Obviously this is the price to be paid for rapid, economic production, which the publishers explain was achieved by reproducing the original typescript. However, elimination of most errors would surely have added little to the cost or time involved. It is a pity, because in other respects presentation is good; the text is completely to the point, and there are about 80 very clear line drawings, 40 tables and a useful list of references. The author obviously intended to promote personal rethinking and group discussion of fundamental principles in Quaternary geology, and in this role the book has few equals.

J. A. Catt

OBITUARY

E. K. Tratman.

It is with regret that we have to report the death of Dr. E. K. Tratman at the age of 79 on 21st August 1979. Many members will recall his leading a field day excursion during the Q.R.A. Bristol Easter Field meeting in 1977. This was to sites in the Mendip Hills at which he had been present at or initiator of some of the original archaeological and geomorphological work. 'Traf' entered Bristol University as a dental student in 1918 and was a founder member of the University of Bristol Spelaeological Society. He spent much of his professional life in Malaya, as Professor of Dental Surgery 1929-1950. After retirement he returned to the Bristol area and was the leading member of the Spelaeological Society. In its proceedings Tratman was author of over 50 scientific papers on cave excavations, Palaeolithic to Roman archaeology, and geomorphology of the Mendip Hills, and of the Burren region of County Clare. In 1976, Bristol University honoured his contributions to science by awarding him a D.Sc. His passing is a great loss to local archaeology and to caving and especially to the Spelaeological Society.

K. Crabtree

INQUA COMMISSION ON GENESIS AND LITHOLOGY OF QUATERNARY DEPOSITS

The next meeting of the INQUA Commission on Genesis and Lithology of Quaternary Deposits will be held in Norway from the 6th - 13th August, 1979. It will be organized by a committee of Norwegian corresponding members of the Commission in cooperation with the Geological Survey of Norway.

The excursion will be concerned mainly with till and moraine morphology. Recent glaciers as well as localities with Pleistocene tills and other types of glacial deposits will be visited. As the excursion will pass through fjord and mountain areas, glacial erosion phenomena will be demonstrated.

For practical reasons the number of participants will be restricted to about 40 persons, preference being given to members of the Commission. Accompanying persons can be accommodated only if space permits.

The excursion route starts in Trondheim, goes first to the Dovrefjell area, then to Gudbrandsdalen and the Jotunheimen mountain area before proceeding to the Sognefjord and finally up to the Hardangerjøkulen area.

There will be an opportunity to present papers at a brief session to be arranged in Trondheim on Monday 6th August. Each talk will be limited to 20 minutes including 5 minutes discussion. Although only a few papers can be presented in this way, all participants are invited to submit a short abstract on scientific work of interest to the Commission.

The cost of the whole meeting from the morning of the 6th August in Trondheim, to lunch on 13th August at Finse, is estimated to be about N. kr. 1900 (US \$375). This includes registration fee, hotel accommodation, full board and transportation during the excursion.

All those interested should write to the Secretary, Sylvi Haldorsen, Department of Geology, Agricultural University of Norway, Box 21, N-1432 Ås-NLH, as soon as possible.

A SURVEY OF PEAT BOGS IN FRANCE.

Due to the recent accelerated destruction of peat bogs in France, the French Ministry of the Environment has initiated a review of important sites in conjunction with the National Council for the Protection of Nature, the Botanical Society of France, and the International Association of Phytosociology. Their intention is to provide a comprehensive inventory of the important sites in order that action can be taken for their future preservation. Anyone with information, or wishing to participate in the compilation of this inventory is asked to write to Jean de Chancel, L'Adjoint au Directeur, Service des Parcs et Reserves, Ministère de L'Environnement et du Cadre de Vie, 14 Bd du Général Leclerc, 92521 Neuilly sur Seine Cedex.

CALENDER OF MEETINGS

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| April 6th-10th 1979 | Quaternary Research Association annual field meeting and Annual General Meeting, Dublin. Final details are issued with the Circular issued with this Newsletter. Application forms are with the November 1978 Circular. |
| April 10th-14th 1979 | Quaternary Research Association short field meeting to Kerry. Further details can be obtained from Dr. W. P. Warren, Geological Survey of Ireland, 14 Hume St. Dublin, 2. |
| July 9th-14th 1979 | South African Society for Quaternary Research, Conference with field excursions. Principal theme: Hominid sites in southern Africa. Venue: Bernard Price Institute, University of Witwatersrand, Johannesburg. Details can be obtained from Prof. T. N. Huffman, Dept. of Archaeology, University of Witwatersrand, Johannesburg 2001. |

- Summer 1979 Geologists Association 7-10 day meeting to study the Pleistocene sediments of East Anglia, under the leadership of P. Cambridge and others. Final details have not yet been issued.
- August 6th - 13th 1979 INQUA Commission on genesis and lithology of Quaternary deposits. To be held in Norway. Further details can be obtained from Sylvi Haldorsen, Department of Geology, Agricultural University of Norway, Box 21, N-1432 Ås-NLH. A brief outline is given with this Newsletter.
- September 13th-23rd 1979 Joint Quaternary Research Association/ British Geomorphological Research Group Study Course to the Alps to consider Glacial and Periglacial Features of High Alpine areas. Details are given in the Circular issued with this Newsletter and further details can be obtained from Dr. B. Whalley, Department of Geography, Queen's University, Belfast, BT7 1NN.
- September 17th-23rd 1979 International meeting on Holocene Sedimentation in the North Sea Basin. To be held at Texel, Netherlands. Details are given in the November 1978 Newsletter.
- September 19th-23rd 1979 Fourth Meeting of the Geological Societies of the British Isles. To be held at Sheffield. The Q.R.A. will contribute a series of lectures and a field meeting related to the topic of the Limits of the Last Glaciation in England on Friday 21st Sept. and Sunday 23rd Sept. respectively. Further details are given in the Circular issued with this Newsletter.
- September 24th-28th 1979 Quaternary Research Association Short Field Meeting to the Channel Islands under the leadership of Dr. D.H. Keen, Department of Geography, Lanchester Polytechnic, Priory Street, Coventry CV1 5FB. Further details are given in the Circular issued with this Newsletter.
- January 4th-5th 1980 Quaternary Research Association Discussion Meeting, Murchison House, Edinburgh. Offshore and Onshore Quaternary of North West Europe - the Scope for Correlation. Further details will be given in forthcoming Newsletters.
- April 6th-10th 1980 Quaternary Research Association Annual Field Meeting and Annual General Meeting, Glasgow. Further details will be given in forthcoming

Newsletters.

May, 1980

Quaternary Research Association Short Field Meeting to Inverness region. Further details will be given in forthcoming Newsletters.

September 18th-22nd 1980

Quaternary Research Association Short Field Meeting to West Cornwall. Further details will be given in forthcoming Newsletters.

Compiled and printed for circulation to Quaternary Research Association members and others by the Honorary Secretary to the Quaternary Research Association, Mr. J. Rose, Geography Department, Birkbeck College, London University, 7-15 Gresse St., London W1P 1PA, England.

QUATERNARY RESEARCH ASSOCIATION

PUBLICATION LIST

Quaternary Newsletter

No.	Date	Price to members	Price to non-members
1	September 1970	10p	40p
2	November 1970	"	"
3	February 1971	"	"
4	June 1971	Not available	
5	November 1971	"	
6	February 1972	"	
7	June 1972	"	
8	November 1972	"	
9	February 1973	"	
10	June 1973	30p	60p
11	November 1973	"	"
12	February 1974	"	"
13	June 1974	"	"
14	November 1974	40p	80p
15	February 1975	"	"
16	June 1975	"	"
17	November 1975	"	"
18	February 1976	"	"
19	June 1976	"	"
20	November 1976	"	"
21	February 1977	"	"
22	June 1977	"	"
23	November 1977	50p	£1.00
24	February 1978	"	"
25	June 1978	"	"
26	November 1978	"	"
27	February 1979	"	"

P. T. O.

Quaternary Research Association Field Guides

Title	Date	Editor/Compiler	Price to members	Price to non-members
Clacton	April 1973	J. Rose & C. Turner	£1.00	£2.00
Exeter	Easter 1974	A. Straw	£1.00	£2.00
Aberdeen + Quaternary Studies in North East Scotland	April 1975	A. M. D. Gemmell	£2.00	£4.00
Oxford Region	April 1976	D. Roe	£1.00	£2.00
Bristol	Easter 1977	K. Crabtree	£1.00	£2.00
Keele	April 1978	E. A. Francis	£2.00	£3.00
Vale of St. Albans	June 1978	J. Rose & P. L. Gibbard	£2.00	£3.00
Mallorca	December 1978	K. Crabtree, J. Cuerda, H. A. Osmaston, & J. Rose	£2.00	£3.00