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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 articles, 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 Street, London, W1P 1PA.

EXTENDED ABSTRACTS OF PAPERS ON:

THE LIMIT OF THE LAST GLACIATION IN ENGLAND

Papers read at a Symposium, held as part of the Biannual meeting of the Geological Societies of the British Isles, at Sheffield, September 19th - 23rd 1979.

This meeting also included a field meeting arranged jointly with the Geologists Association, to study evidence associated with the Last Glaciation in the Cheshire Lowlands, with particular reference to the sediments exposed at Chelford. This took place on Sunday, 23rd September under the leadership of Dr. P. Worsley.

THE LIMIT OF THE LAST GLACIATION IN ENGLAND: A CONSIDERATION OF ITS DEFINITION WITH SPECIAL REFERENCE TO THE WEST MIDLANDS, THE SOUTH-WEST PENNINES AND THE VALE OF YORK.

By E.A. Francis

The limit of the last glaciation may at first sight seem to be a topic which holds little potential for study, because this limit is relatively recent geologically and therefore may be thought to be self-evident. There are several reasons why we should not accept uncritically the limit as currently defined.

We cannot be sure that the limit has been mapped correctly: the position is everywhere an inferred position, and the evidence in most places leaves a considerable margin of error or zone of uncertainty. In some cases, error has been introduced by the interpretation of features as marking the position of a terminal glacial order, and further observations demonstrate that this is incorrect.

It is often instructive to examine the reasons why earlier workers sited a limit at particular positions. When these reasons are viewed in historical perspective they may be seen to be based upon models which were fashionable at the time, but may now no longer be adequate.

In 1977, the Quaternary Map of the United Kingdom was published for the Institute of Geological Sciences to coincide with the X INQUA Congress held at Birmingham. The Map depends upon information compiled from the work of the Institute of Geological Sciences and from various other sources. It includes, at a relatively large scale, the approximate southern limit of Devensian glaciation, which is broadly along the same course as any other versions depicted by Wright (1914 p.76), Penny (1964, p. 390) and Bowen (1978, p.37). However, these and other versions, when compared, show many differences of detail one from another and it is evident that though there is broad agreement about the general placing of the limit, its precise position at many places is by no means settled. This suggests that the examination of the criteria for the placing of the boundary in particular areas might be of interest, and consequently three of these are reviewed here: The West Midlands, the south-west Pennines, and the Vale of York.

In the West Midlands, the position of the limit to the west of Bridgnorth follows the valley of the Mor Brook where it was placed by Wills (1924), although he noted that "it is not known for certain how far south the ice-sheet extended". Extension would suggest that the limit was inferred from the supposed blocking of this valley, so that water was impounded and sand and gravel mounds were deposited. Further to the south-east and the other side of the Severn Valley, a "big concentration of boulders ....may be terminal in origin", and the limit was accordingly placed nearby. In this general area, it is therefore entirely hypothetical. Farther east, in and around Wolverhampton, the margin corresponds to that mapped by Morgan (1973) and is based largely upon the extent of the thin Wolverhampton Till, which exceptionally reaches over 9 m but hardly suggests the appellation Wolverhampton Moraine by Shotton et al (1977). Farther to the north-east, in the area north of Cannock Chase, the border is mapped as following approximately the course of the valley of the River Blithe. Patches of till in the area have been ascribed to a previous glaciation, and the placing of the line hereabouts seems to depend largely on the supposition that a few scattered 'glacial overflow channels' are close to the position of the margin.

In the south-west Pennines, north of Leek, the limit approximates to that drawn by Jowett and Charlesworth (1929). It is based on the inferred position of impounded marginal lakes, but the existence of these depends upon the recognition of overflow channels, some of which cannot be authenticated. No lake sediments or marginal features can be identified to support this placing of the limit. Indeed, ridges and mounds of glacial sand and gravel which exist in the area were not recognized by Jowett and Charlesworth and were not used by them in drawing either the limit or retreat stages of the ice. Thus, the limit in this area is entirely hypothetical and the hypothesis rests on an entirely insecure foundation.

In the Vale of York, the limit was formerly placed at the Escrick Moraine, but an earlier stage was identified by Edwards et al (1950) as lying at the Linton-Stutton Kame-Moraine, a discontinuous belt of sand and gravel interpreted as a marginal feature. This outer limit was accepted by Gaunt (1976) as a continuation of the margin of an extension which he inferred beyond the Escrick Moraine into the area between Scunthorpe and Doncaster. However, the internal structure of the Linton-Stutton Kame-Moraine demonstrates that they were formed as sub-glacial tunnel esker segments and consequently were not formed along a glacial margin.

The placing of the limit in the three areas examined is thus seen to be insecurely based and the need for critical re-examination is emphasized with the recognition that conclusions are in many cases not more than working hypotheses.

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TILL FACIES ASSOCIATED WITH THE DEVENSIAN GLACIAL MAXIMUM IN EASTERN ENGLAND

By J.A. Catt

In Devensian successions the radiocarbon method can be used to date some deposits directly and place limits on the age of others, but suitable organic materials occur only sporadically. Correlation between sites where deposits are dated by this or other methods is dependent upon the lithological features of the more widespread Quaternary deposits, principally those formed under cold conditions, such as glacial deposits and periglacial fluvial, slope and aeolian sediments. However, many of these deposits vary laterally in colour, particle size distribution, mineralogy and stone content as a result of differences in sediment provenance, conditions of deposition and post-depositional changes, such as weathering. Too little attention has been paid to the factors influencing this variability, and site-to-site correlation is consequently less certain than it might be, especially in areas of poor exposure.

Early studies of the glacial deposits in Lincolnshire and east Yorkshire indicated that some major lithological units are traceable for considerable distances. Using principally the almost continuous exposures along the Yorkshire coast, Wood and Rome (1868), Reid (1885) and Bisat (1940) established a sequence of tills differentiated by matrix colour and erratic suites. Bisat's major subdivisions on the Holderness coast were the Basement, Drab and Purple Clays (in ascending order). The Hessle Clay of inland Yorkshire exposures, which most workers have equated with the Hunstanton Brown Boulder Clay of Norfolk and the Hessle Clay of Lincolnshire, Bisat related to part of the Drab, mainly because both contain erratics of rhomb porphyry from southern Norway. However, Catt and Penny (1966) disagreed with Bisat's correlation, and accepted instead the concept of Wood and Rome that the Hessle Clay covers the whole area "like a cloth". On the Holderness coast, the dark brown (Munsell colour 7.5YR 3/2) Purple Clay is seen only between Hornsea and Easington. It has a knife-sharp junction with the dark greyish brown (10YR 3/2) Drab beneath, but grades more slowly upwards into the reddish brown (5YR 4/4) layer, about 5m thick, which Catt and Penny equated with the Hessle and Hunstanton Clays. Where the Purple is absent, as in coastal sections between Hornsea and Bridlington, the Drab similarly grades upwards into a reddish brown Hessle-like layer at the surface.

Catt and Penny (1966) showed that the Basement Till of Holderness was deposited during an earlier (pre-Ipswichian) glaciation than the Drab, Purple and Hessle Clays, and subsequent recognition of the same till above gravels containing a derived Hoxnian mammal fauna at Welton-le-Wold in Lincolnshire (Alabaster and Straw, 1976) showed that it must be related to the Wolstonian Stage of Mitchell et al. (1973). At Dimlington on the coast of south-east Holderness, the Drab, Purple and Hessle Clays total approximately 30m in thickness, and are separated from the Basement Till beneath by small silt and sand basins containing moss remains, which have been radiocarbon dated to 18,250 B.P. (Penny et al., 1969). Elsewhere in Holderness, the Drab, Purple and Hessle Clays are locally overlain by organic horizons up to approximately 13,000 years old, so these three clays were all deposited in the Late Devensian between about 18,000 and 13,000 B.P.

Catt and Penny also pointed out that many of the features of the Hessle Clay that Wood and Rome thought were diagnostic, could have originated by post-glacial soil development. Later, detailed mineralogical, granulometric and micromorphological studies of a profile of Hessle Clay over Purple at Tunstall (TA 314318) showed that pedogenesis since approximately 13,000 B.P. resulted in weathering of clay mica (illite) to expanding clay minerals, softening and disaggregation of sandstone, shale and igneous and metamorphic erratics, decalcification to 0.7m depth, and the weathering of several minerals in sand and silt fractions (Madgett and Catt, 1978). In particular, pyrite and siderite were oxidised to hydrated iron oxides (principally goethite and lepidocrocite) to 5m depth, and this change probably accounts for the slightly redder colour of the layer which Wood and Rome (1868) and Catt and Penny (1966) equated with the Hessle Clay inland and the Hunstanton Clay of north Norfolk. When allowances for all the pedological changes were made, it was clear that the complete profile could have been derived from the Purple Clay (Figure 1).

In addition, Madgett and Catt (1978) analysed many samples of the unweathered Drab and Purple Clays and of the redder surface layers (the Hessle and Hunstanton Clays) throughout east Yorkshire, Lincolnshire and north Norfolk. The unweathered Purple and Drab Clays of the Holderness coastal sections can be distinquished on silt (2-60 μm) content, on heavy mineral assemblages in fine sand (60-250 μm) and coarse silt (20-60 μm) fractions, and on the lithological grouping of 6-16 mm stones. After allowances were made for weathering changes and for local incorporation of loess into thin till near its feather-edge on the dipslope of the Yorkshire and Lincolnshire Wolds, it was clear that samples of Hessle Clay taken from an arcuate area adjacent to the coast of south-east Holderness resembled the Purple Clay, whereas those taken from all other areas (including north Norfolk and all parts of Lincolnshire) resembled the Drab. On this evidence, Madgett and Catt suggested that the Hunstanton Clay and the Hessle Clay of Lincolnshire, which Straw (1969) had divided into Lower and Upper Marsh Tills, are all equivalent to the Drab of Holderness. The Drab and Purple Clays were renamed the Skipsea and Withernsea Tills respectively, and the Hessle (merely a deep weathered mantle on whichever of these two tills occurs at the surface) was thus

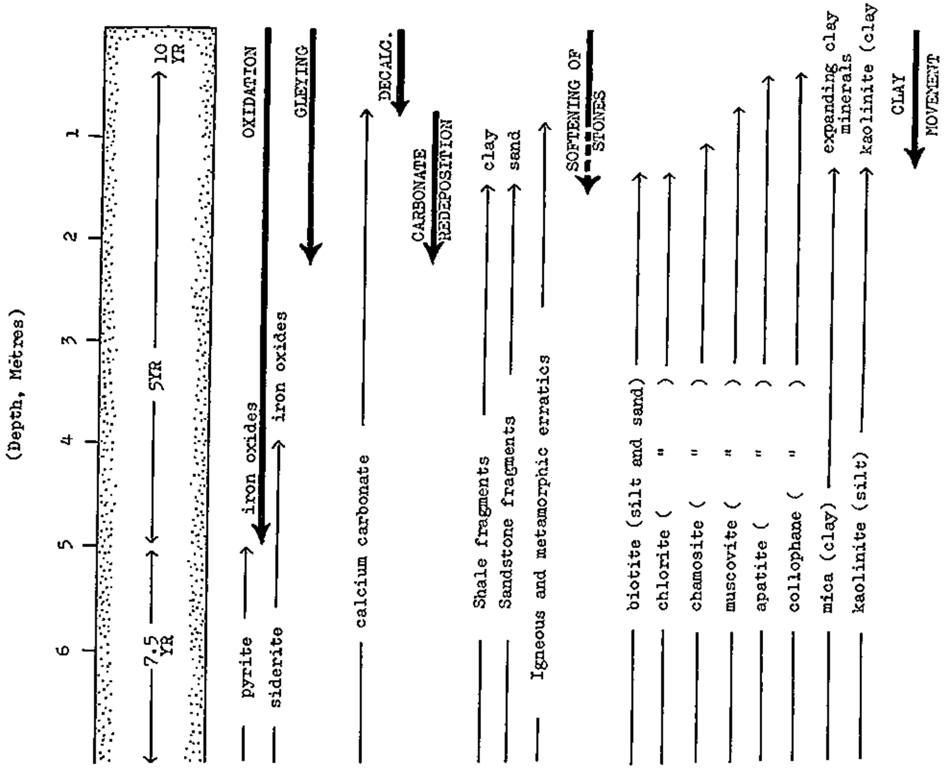

Figure 1. Changes due to postglacial soil development in a profile on Withernsea (= Purple) Till at Tunstall, Holderness.

invalidated as a stratigraphic unit. These conclusions in effect reinstated the earlier views of Bisat (1940), which were perhaps based partly on unpublished mineralogical work by Dr. J.D. Solomon. Unoxidised Devensian till is only rarely exposed in Lincolnshire, but where it is seen (e.g. at South Elkington, TF 285883) it is similar in colour, particle size distribution and stone content to the Drab (Skipsea) Till of the Holderness coast.

However, Straw (1979) questioned the correlation of the Devensian till in Lincolnshire with the Skipsea, pointing out that it conflicts with his previously published suggestion of two Devensian glaciations in Lincolnshire, one Early Devensian and one Late Devensian, separated by a lengthy interstadial period of erosion. To sustain this view, which was based largely on an assessment of geomorphological features in Lincolnshire, Straw presented a series of dubious stratigraphic and geomorphological arguments claiming to show that many parts of eastern England were glaciated in the Early Devensian, hinted that the Dimlington radiocarbon dates are somehow unreliable, and attempted to subordinate petrographic techniques of correlating Quaternary sediments to unspecified "traditional geological and geomorphological ones".

Straw's main geomorphological argument for two Devensian glaciations is based on contrasts in the constructional and erosional topography between the coastal areas of Devensian glacial deposition and those further inland extending (in Lincolnshire and Holderness) on to the Chalk dipslope. The two contrasted areas are separated by discontinuous ridges, such as the Hogsthorpe and Killingholme "moraines" in Lincolnshire, which Straw interprets as the Late Devensian end-moraine, even though the (Skipsea) till on either side is petrographically the same. In Holderness the topography is in fact more complex, with a series of at least 12 arcuate ridges increasing in amplitude eastwards, which are unlikely to represent successive Devensian advances each separated by an interstadial period of erosion. Some factors contributing to the east-west topographic contrast, such as Flandrian erosion and deposition along the Humber and Hull valleys and in the Lincolnshire fenlands, and smoothing by increased downslope movement of till on the steeper slopes associated with the westward-rising bedrock surface, clearly have no significance for glacial chronology. But, however real the original glacial topographic contrast might have been, we simply do not know exactly how the moraine-like ridges were formed, nor are we in a position to evaluate the many processes (in addition to time) responsible for such factors as differing slope angles and valley dimensions. Madgett and Catt (1978, p. 103) speculated that the ridges formed where the thickness of glacial deposits was locally increased by movement along low-angle shear planes in the ice, but other possible mechanisms within a single ice-sheet can be envisaged. The ridges are therefore very weak evidence for multiple glaciation, as it is far from certain that any of them can be regarded as true end-moraines.

Straw also found evidence for two Devensian glaciations in the Vale of York, the earlier being responsible for deposition of the Linton-Stutton gravels near Tadcaster, and for cutting of the Malton gorge. While there are reasons for believing that these and other erosional features on the margins of the Vale of York may pre-date the Late Devensian, at least in part, there is no reason whatever to attribute them specifically to an Early Devensian glaciation. The early (high-level) phase of Lake Humber, which Straw also attributed to the Early Devensian on geomorphological evidence, is however clearly dated by radiocarbon to the Late Devensian (Gaunt, 1974). Unless Straw is prepared to dismiss this date as easily as he does the Dimlington dates, his assertion that proglacial Lake Fenland (impounded by ice of his earlier Devensian stage) "must have co-existed and equalised with pro-glacial Lake Humber at its 30m level" presumably shows that Lake Fenland and the ice advance that impounded it were also Late Devensian.

As more direct evidence for the Early Devensian dating of Lake Fenland, Straw quoted the Middle Devensian age (Girling, 1974) of organic horizons lying beneath and in the lowermost levels of frost-disturbed gravels in the lower Bain valley, south Lincolnshire. The gravels are topographically lower and apparently younger than the Hemingby Terrace higher up the Bain valley, with which Straw correlated the Kirby Moor Sands, a delta-like spread thought to have been deposited at the margin of the 30m Lake Fenland. As the Kirby Moor Sands are older than the frost-disturbed Tattershall Gravels, which overlie Middle Devensian organic horizons, Straw concluded that they (and Lake Fenland) must be Early Devensian. However, the age range of the Tatterhsall Gravels is not indicated by the organic horizons, and it is quite possible that much of the gravels and the supposed Lake Fenland delta sands are both Late Devensian, a relatively short period of intense periglacial incision accounting for the height difference between the Hemingby Terrace and the upstream equivalent of the Tattershall Gravels.

A further erroneous stratigraphic argument offered by Straw concerns the "Marine Gravels" of Lincolnshire and the somewhat similar Kelsey Hill Gravels of central Holderness. Both were deposited as outwash from the Late Devensian ice, and contain a mixed fauna of warm and cold, marine and non-marine species, which despite their local abundance must be entirely derived from earlier sediments. Although some of the thermophilous species are probably Ipswichian, other elements of the fauna have a long age range and could be as old as Wolstonian. Therefore, the only chronological information that the fauna provides is that the outwash is post-Ipswichian. However, Straw seemed to believe that part of the fauna (he did not state which species) originated in a Middle Devensian Humber estuary, and on this basis apparently concluded that any till on which the gravels rest must be Early Devensian. Even if some species are from a Middle Devensian Humber estuary, the remainder of the argument defies logic, as derived fossils in one horizon place no age limits on an underlying deposit. There is consequently no stratigraphic or palaeontological reason to suppose that the till beneath the gravels is anything other than Late Devensian.

I heartily agree with Straw's sentiment that " all types of evidence should be carefully assessed to gain a reasoned interpretation" of Quaternary events. However, this does not mean that old ideas based on outmoded methods must be retained and amalgamated with new evidence in what would inevitably become increasingly complex and hypothetical reconstructions. The only way in which Straw's evidence for two Devensian glaciations in eastern England could be reconciled with the correlation based on till petrography offered by Madgett and Catt (1978) is if the two glaciations deposited petrographically identical tills. Although possible, this is a highly improbable coincidence, because petrographic methods satisfactorily distinguish the Skipsea and Withernsea Tills on the Holderness coast, both deposited within a few thousand (radiocarbon) years, and also adequately characterise other extensive till sheets in lowland Britain, such as the Lowestoft Till (Perrin et al., 1973) and Basement Till. Correlation of glacial deposits by petrographic techniques is much more likely to fail on account of lateral variability within formations than through widespread similarities between formations.

Because Devensian glacial deposits have now been dated by radiocarbon and other methods to the Late Devensian of Mitchell et al.. (1973) at several sites in various parts of Britain, and also in adjacent European countries, the onus is now surely upon those who believe also in an Early Devensian glaciation of these areas to demonstrate the truth of their claim. by identifying deposits that can be related to the period concerned by sound stratigraphic and dating methods. Geomorphological techniques of relative dating, such as the local identification of minor erosion episodes or the subjective assessment of freshness of topography, are far too imprecise for this task. Absolute methods or careful palaeontological studies, coupled with strict adherence to accepted stratigraphic principles, are the most likely means of precisely dating the Quaternary glaciations of Britain, but petrographic analysis of sediments can be useful in this as a stratigraphic tool helping to identify, distinguish and correlate deposits between dated series.

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RECONSTRUCTING ENVIRONMENTAL CONDITIONS IN THE PERIGLACIAL ZONE ASSOCIATED WITH THE LAST GLACIAL STAGE.

By P. Worsley.

An inspection of the beetle based July temperature curve estimates for the Last Glacial reveals a reasonably complete record when the various scattered biogenic exposures are correlated by radiocarbon dating back to some 45 ka. Prior to this, relatively little is precisely known about environmental conditions until roughly 120 ka, the assumed end of the 'Last Interglacial'. Not only is there a general lack of deposits which can be positively ascribed to the 45 - 120 ka timescale, but also a lack of ready means of establishing an absolute timescale. The Chelford, Cheshire succession appears to give the best guide to the pattern of environmental change within this problematic period. The paper constitutes a progress report on a still developing picture of palaeoenvironmental reconstruction during the earlier part of the Devensian prior to the advent of glaciation *per se.*

Since *circa* 1970 the Farm Wood site at Chelford has been obscured, but fortunately from 1973 onwards excellent new exposures have been available at Oakwood about 1 km to the SE. The working technique there differs from that previously adopted , namely the lagooning has been abandoned in favour of continually pumping the groundwater discharge and mechanically removing the sands. The result is a virtually complete exposure of the succession. Immediately beneath the arenaceous sequence is an impervious bed, which is unfortunately not well exposed because of its lack of any economic value. However, it is clear that this bed consists of either: a) weathered Mercian mudstone, or b) a diamicton which is in parts a till (Oakwood Till) and at other localities a massive silt. An excavation in the diamicton proved a thickness in excess of 3 m. Frequently the diamicton is overlain by a lag of erratic clasts, many of which are ventifacted, but ventifacts have also been recovered from within the diamicton. At the lowest point on the quarry floor, spoil from a drainage sump dug late in 1978 revealed organic clays and silts. Although the precise stratigraphic position of the organics has not been observed it can be inferred with reasonable confidence that they overlie the mudstone and diamicton and occupy a depression in them.

The organics have yielded both macro and micro plant remains, mollusca, a beetle fauna and one mammal bone. The biota are being examined by D.T. Holyoak, G.R. Coope and K.A. Moseley. The plant species are tolerant of cold climates and indicate pool and wet fen environments in an open treeless landscape. A cold period within the early Devensian is the simplest interpretation of the biogenics.

Overlying the previously described strata is the main succession of extremely well-sorted cross-stratified sands which give a palaeocurrent flow from the E and SE to the W and NW. The basal sands are reddish brown, but soon pass upwards into white sands. Towards the top of the sequence they revert to a pink colour. This succession indicates a significant period of fluvial deposition, but the presence of scattered ventifacts suggests concurrent wind activity. Although not common, ice vein and ice wedge casts are found within the sand succession giving support to the supposition that permafrost was present in the sub-surface for much of the time whilst the sands accumulated. Essentially in the middle of the sands occur the interstadial beds almost exclusively within a major palaeochannel system which trends SE - NW apparently conformable with the trend of the thickest sands. The coincidence of palaeochannel trend and low on the sand base seems to be fortuitous. At the margins of the palaeochannel, excellent exposures have revealed a complex sequence of palaeochannel infil. Within the fill sequence wedge structures and deep horizontal notches at the base of undercut channel banks are interpreted as ice-wedge casts and fossilized thermo-erosional niches, further evidence for the presence of permafrost. Tree stumps in the position of life have been observed on the channel floor and on the channel banks, but the majority are clearly clastic. Some of the smaller channels appear to have been completely infilled with organic detritus much of which may be more or less <u>in situ</u>. Beyond the palaeochannel limits a buried land surface has been detected throughout the quarry, usually marked by a pebble lag bed, large ice vein and wedge casts and traces of a very thin organic bed which is sometimes associated with <u>in situ</u> rootlets. The complex sequence of cut and fill events within the palaeochannel was seemingly accompanied by stability on the low relief landscape beyond the channel banks. After the complete infilling of the channels, deposition recommenced across the entire area but, as already noted, with an increase in sand impurity.

The top of the Chelford Sands are channelled and infilled by sands of the Stockport Formation derived from glacial sources, thus marking the transition from a prolonged period of periglacial fluvial deposition to a glacigenic environment. To date no stratigraphic evidence is available to give a chronological fix to the uppermost phase of Chelford Sand deposition other than the data which relates to the general age of the ice advance.

THE CLIMATE OF ENGLAND DURING THE DEVENSIAN GLACIAL MAXIMUM: EVIDENCE FROM COLEOPTERA

By G.R. Coope

It is always difficult to use fossil biological information to interpret the physical environmental conditions of the past when these are near to the limits of toleration of biological systems. In other words, when conditions of polar desert are approached, the relevant palaeontological signal diminishes to zero and "background noise", for example far-travelled or derived pollen grains, is correspondingly raised. Fortunately fossil Coleoptera do not seem to be subject to long distance transport nor to derivation from earlier deposits. They also survive under extremely cold conditions that most macrophytes find intolerable. Under such circumstances the beetles food webs may be traced ultimately to mosses, algae and lichens as the primary producers in the ecosystem. A number of species of coleoptera are obligate inhabitants of such harsh environments whilst others merely tolerant of a wide spectrum of conditions that happens to include those of extreme cold. In theory at least, fossil coleoptera should provide species associations that are diagnostic of physical conditions near to the low temperature tolerance limits of most organisms.

A rich and varied assemblage of coleoptera (just over 150 names species) dates from the latter part of the Upton Warren Interstadial Complex namely from 40,000 BP to 25,000 BP just prior to the expansion of glacier ice into lowland England at the Devensian glacial maximum. These faunas have been well documented already (Coope 1975) and will be briefly summarized here. The abundance, at this time, of beetle species that are today not normally found living below the tree line, strongly suggests that average July temperatures could not have been much above 10°C and the considerable diversity of species indicates that these temperatures were not much below this figure. The occurrence throughout this period of species with eastern asiatic ranges at the present day, often individually in profusion, implies climatic continentality and winter temperatures may well have been -25°C or even lower. Thus average annual temperatures during the latter part of the Upton Warren Interstadial Complex were probably about -6°C or -7°C. It is likely that a climatic regime such as this would have been adequately cold to sustain lowland glaciers in England. There is, however, no evidence for the existence of such glaciers and their absence might best be accounted for by inadequate precipitation.

Four insect assemblages are known which on the basis of radiocarbon dates, can be attributed to the period of maximum ice advance: Lea Valley (21,530 ± 480 BP) (data unpublished), Barnwell Station (19,500 ± 650 BP) (Coope, 1968), Dimlington (18,240 ± 250 BP) (Penny, Coope and Catt, 1969) and Glen Ballyre, Isle of Man, (18,900 ± 330 BP) (Shotton and Williams, 1971). The specific diversity of all these faunas is much smaller than during the Upton Warren period: only about 20 named species. Furthermore there is a complete absence of the more extremely eastern species. The presence of obligate low temperature species suggests that the average July temperatures were 10°C or lower and the impoverishment of these assemblages hint at rather lower figures than this. Even so, we are not dealing with polar desert conditions though it must be borne in mind that episodes of such severe climate would have left no palaeontological clues. The lack of asiatic species may indicate a diminished continentality of climate with high precipitation to nourish the glaciers in their extension into central England.

With the retreat of the glaciers from England the beetle faunas continue to indicate more or less tundra conditions until the sudden climatic amelioration at about 13,000 BP (Coope and Brophy, 1972). The presence in these insect assemblages of asiatic species (usually rather rare) may hint at a return to rather more continental conditions with the intriguing possibility that the retreat of the ice from lowland England was due, not to an improvement in the thermal environment but rather to inadequacies in precipitation.

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ABSTRACTS OF PAPERS READ AT A DISCUSSION MEETING ON:

OFFSHORE AND ONSHORE QUATERNARY OF NORTHWEST EUROPE - THE SCOPE FOR CORRELATION

This meeting was held at the Institute of Geological Sciences, Murchison House, Edinburgh on January 4th and 5th 1980. Also included is the abstract of a short paper given at the meeting outlining the results of recent Quaternary research.

THE EXTENT OF THE LAST SCOTTISH ICE-SHEET

By J.B. Sissons

Evidence relating to the extent of the last (Late Devensian) ice-sheet was critically discussed, particular attention being given to the limitations of some radiocarbon dates and incorrect inferences based on radiocarbon dates. It was suggested that the last Scottish and Scandinavian ice-sheets were not confluent and that Orkney and NE Caithness may not have been covered by the last Scottish ice-sheet. Ice-sheet growth and decay were considered in relation to possible positions of the oceanic and atmospheric polar fronts: implications are that much the greater part of ice-sheet decay resulted from inadequate snowfall and that the maximal limits of the last ice-sheet may not have been synchronous. Ice-sheet calving may have resulted in an independent ice mass over the Outer Hebrides. It was suggested that most of the bed of the Central North Sea became land during the Late Devensian and that a large delta existed in the eastern part of the area. It was also suggested that the buried and infilled channels of this eastern area, which are normally interpreted as tunnel valleys, are shallow delta channels whose present depth is due to delta subsidence.

THE LIMITS OF THE LAST GLACIATION IN IRELAND

By G. F. Mitchell

The relatively conservative limits of the last glaciation in Ireland as set out on Sheet 21 'Glacial Landforms' in the Atlas of Ireland, recently published by the Royal Irish Academy are, on the whole, accepted.

The more speculative limits as set out by Francis Synge in 'Quaternary Glaciation in Ireland' in the Quaternary Newsletter, No. 28, June 1979, are discussed. The ability of floating shelf ice to "thrust shelly clays on to the coast", or to pick up chalk from the sea floor, is queried.

The views of Armel Coudé on the 'Formations superficielles et dernière grande glaciation en Irlande Occidentale' (CNRS Centre de Geomorphologie de Caen, Bull. No. 22, November 1977) is also discussed.

QUATERNARY GEOLOGY OF THE NORWEGIAN CONTINENTAL SHELF

By K. Rokoengen

As a part of the regional geological mapping programme of the Norwegian Continental Shelf Institute (IKU) about 30,000 km of sparker profiling and sampling from 300 localities have been carried out. The work has been concentrated in the area between 62°N and 72°N, but mapping in the North Sea is also in progress.

Crystalline rocks with rough topography extend up to 50 km offshore from mainland Norway, beyond which they are overlain by sedimentary rocks of Mesozoic and Tertiary age. The thickness of Quaternary deposits ranges from a patchy cover to more than 300 m and averages about 100 m. The deposits consist of top sand, soft sensitive clay and glacial drift divided into several seismostratigraphic units. The oldest and most extensive unit is deeply eroded and is assumed to be older than 20,000 years. The younger units occur as complex linear belts running mainly parallel to the present coastline and were probably deposited during the last deglaciation between 13,000 and 11,000 years B.P.

Features possibly representing submerged beaches have been mapped. Two levels off Troms, North Norway have isobases parallel to the coast and gradients of about 2 and 2.3 m/km out from the coast. In the northern part of the North Sea a submerged beach fringing the North Sea Plateau has been traced for more than 100 km at water depths between 130 m (south) and 160 m (north), and tentatively dated to 12,000 years B.P. The age of both glacial deposits and submerged beaches is surprisingly low compared with investigations on land in Norway, but further work will hopefully give better correlation.

WHERE THE MARINE AND TERRESTRIAL RECORDS OVERLAP: SOME OBSERVATIONS ON THE POTENTIAL OF OLD SEA CAVES IN INTERGLACIAL STUDIES

By A.J. Sutcliffe

At a time when it has been shown from the deep sea record that more climatic fluctuations occurred during the Quaternary than can yet be recognised from the terrestrial evidence, the question of correlating terrestrial and marine events attracts ever increasing attention. For the time being, however, many problems still remain to be resolved.

A field of study which seems to have a good potential in relation to events round about the time of the last interglacial (this term being used in its broadest sense) is offered by some old sea caves, such as those of Gower, where raised beach, terrestrial and travertine deposits with rich mammalian and molluscan faunas occur interbedded together.

An important finding in Gower is that two low lying raised beaches, separated by a time interval of unknown duration, can be distinguished. Although these beaches can be clearly separated here, their altitudinal difference is so small that at other localities where the exposures are less good equivalent beaches may be indistinguishable.

In many old publications the height of raised beach deposits has been described as "above O.D." or "above sea level" which (in consequence of variations of tidal amplitude from one region to another; and the great altitudinal range of the various elements of any single beach) can be nearly meaningless to the reader. The speaker implores raised beach workers to be more precise about what they are describing and, as a non-specialist in this field himself, invites those who are specialists to lay down some guide lines for field workers recording beach deposits.

THE USE OF DINOFLAGELLATE CYSTS IN STUDIES OF THE QUATERNARY CLIMATIC HISTORY

By R. Harland

Fossil dinoflagellate cysts were first seen in pre-Quaternary rocks by Ehrenberg as early as 1836. It was, however, not until the work of Evitt (1961) that the modern interest in dinoflagellate cysts began and their usefulness in biostratigraphy and its applications to the petroleum industry was realised. In contrast indigenous dinoflagellate cysts were first recognised in Recent marine sediments by Muller (1959) and in Quaternary sediments by Rossignol (1962). The link between fossil and Recent dinoflagellates was completed with the discovery of living dinoflagellate cysts (Evitt and Davidson 1964) with their incubation to motile dinoflagellates (Wall 1965).

This contribution aims to review the state of knowledge of the nature, life history and distribution of Recent dinoflagellates and their cysts and their potential in the elucidation of the Quaternary climatic record in the marine realm. Examples will be given of some of the work completed to date with especial emphasis on the North Sea area. It is believed that the study of dinoflagellate cysts offers an exciting new tool in the reconstruction of the Quaternary climatic record.

RAISED SHORELINES AND WEICHSELIAN ICE-SHEET DECAY IN THE SOUTHERN SCOTTISH INNER HEBRIDES

By A.G. Dawson

Two high lateglacial shorelines are developed along the coastline of Jura and NE Islay. Both shorelines decline in altitude from NE - SW away from the centre of glacio-isostatic uplift and possess regional gradients of 0.55 m/km and 0.61 m/km. The gradients are compared with lateglacial shoreline gradients from E. Scotland; in particular with that of the Main Perth Shoreline (0.43 m/km). The shoreline gradients from Jura and Islay are discussed with respect to a radio-carbon date of 16,470 ± 300 B.P. from I.G.S. borehole 71/9 located between Colonsay and NW Jura. The shoreline gradients from Islay and Jura in conjunction with the radio-carbon date suggest that the Weichselian ice-sheet melted rapidly after the supposed glacial maximum c. 17,000 B.P. The results suggest also that large areas of the Scottish Inner Hebrides were deglaciated prior to the formation of the Main Perth Shoreline in E. Scotland.

DEVENSIAN DEPOSITS AT BRIMPTON, BERKSHIRE

By I. D. Bryant and D. T. Holyoak

A working gravel pit near Brimpton (SU 565654) exposes a 12 m thick gravel sequence beneath a topographic flat which lies just above the modern floodplain, between the River Kennet and its tributary the Enborne. The flint gravels were apparently deposited by a braided stream and contain lenses of finer material which have yielded pollen, plant macrofossils and Mollusca.

Ongoing study of these fossils and the stratigraphy suggests at least two Devensian interstadials and three stadials are represented. The lower interstadial is tentatively correlated with the Chelford Interstadial by *Pinus-Betula-Picea* pollen spectra. The deposits of the upper interstadial have *Gramineae-Pinus-Betula* pollen spectra and thermophilous Mollusca. They are capped by a considerable thickness of gravel that appears to be of mid-Devensian age.

The following paper is an extended version of a contribution given at the Edinburgh Discussion Meeting.

SHELL STRUCTURE AND AMINO ACID RACEMIZATION

By D. T. Holyoak

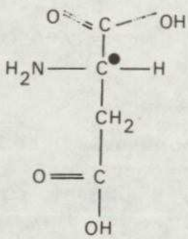
The possibility of using diagenetic changes in amino acids from fossils as a technique for dating Quaternary deposits has attracted considerable interest. Almost all of the research published so far has been carried out in the U.S.A. (Hare, 1969; Mitterer, 1974), including data from British Pleistocene deposits reported recently (Andrews *et al.*, 1979; Miller *at al.*, 1979). The present article attempts to provide a basic introduction to the technique and to review briefly its potential and the problems in its application. The nature and occurrence of amino acids are described, the occurrence of different (isomeric) forms of amino acids is summarised and interconversion of these forms in fossil material is described and explained. The slow rates of these interconversions appear to offer the possibility of 'amino-acid dating' of deposits. It is argued that shells of non-marine Mollusca are the most promising material for the determination of amino acids in British deposits. Relevant aspects of the structure of shells of several species are summarised.

At present the technique would appear to have considerable promise for obtaining relative ages of suitable fossils, but absolute dating presents considerable difficulties. Relative ages can be obtained for the period accessible to radiocarbon dating and back to the early Pleistocene, from samples of 0.1 g or less.

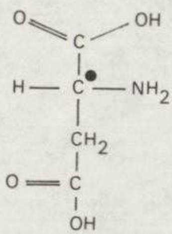
Introduction

Amino acids are the chemical units which are joined together to form proteins. Proteins make up a considerable proportion of the dry weight of most living organisms; they are involved in most physiological processes (as enzymes) and are often also important structural components. Proteins play an essential part in such biological mineralisation processes as the formation of shell and bone, forming organic matrices which are surrounded by the mineral phase. Mineralised proteins are more or less protected by the surrounding mineral, so that they are less susceptible to degradation than other proteins and are consequently of widespread occurrence in more or less altered forms in fossils.

About twenty kinds of amino acids occur commonly in fresh proteins, although others are often present in sediments and fossils as derivatives of the original kinds. Carbon atoms bonded to four different constituent groups (known as asymmetric carbon atoms) are present in 19 of the 20 common amino acids. These asymmetric carbon atoms allow occurrence of different arrangements of constituent groups within the molecule. The different arrangements have generally similar chemical and physical properties and are known as stereoisomers. Molecules that are stereoisomers differ only in the spatial arrangement of constituent groups. Fourteen of the 20 common amino acids have a single asymmetric carbon atom, allowing occurrence of two stereo-isomers (known as diastereomers), such as with aspartic acid:



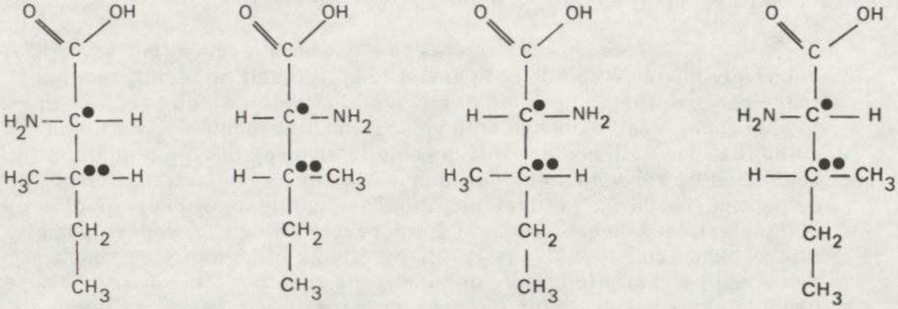
L - aspartic acid



D - aspartic acid

The stereoisomers of these 14 amino acids having a single asymmetric carbon (marked • above) are also known as enantiomers because they are mirror images. The L- and D- forms are designated by analogy with glyceraldehyde, the simplest sugar that has an asymmetric carbon. Hydroxyproline has a second asymmetric carbon, but it is bonded in a ring structure and does not allow occurrence of additional isomers.

The four remaining common amino acids each have two asymmetric carbon atoms. In three of them four different isomers can occur (the fourth, cystine, has only three isomers because the molecule has two similar halves with one asymmetric carbon in each). Taking isoleucine as an example of this type, it can be seen that two enantiomers analogous to those of aspartic acid are due to the configuration about one asymmetric carbon (●), while an additional enantiometic equivalent of each of these (known as an allo-form) is due to the configuration about the second asymmetric carbon (●●):



L-isoleucine D-isoleucine D-alloisoleucine L-alloisoleucine

The DNA base sequences of the genetic code are translated into the amino acid sequences which form the primary structure of proteins by means of enzyme systems. In most higher organisms the enzyme systems select only one stereoisomer of each of the amino acids having asymmetric carbon atoms. With those amino acids having a single asymmetric carbon the D-form is not used, with those having two asymmetric carbons the allo-forms are not used. However, some antibiotics, bacteria, worms and insects are known to contain D- amino acid enantiomers (Bodansky and Perlman, 1969; Merster, 1965).

Pure solutions of a single amino acid stereoisomer exhibit optical activity, that is they can rotate the plane of plane-polarised light when examined in a polarimeter. (The direction of rotation is nowadays conventionally designated + or -, and bears no direct relation to the structure denoted by D and L). Pure solutions of amino acids extracted under appropriate conditions from most fresh proteins show optical activity in accordance with the presence of only one stereoisomer. Amino acids synthesised in the laboratory consist instead of an equal mixture of L- and D- forms designated a racemate, which lacks optical activity. Similarly, those amino acids with two asymmetric carbons show optical activity when obtained from fresh proteins where allo- forms are lacking, but lack optical activity when synthesised in the laboratory because the natural and allo- forms are then present (although not in equal proportions).

Different stereoisomers of an amino acid are equally or nearly equally stable, but energy needs to be applied to interconvert them. The rate of such interconversion is slow at environmental temperature but increases logarithmically with increasing temperature. With the amino acids having a single asymmetric carbon, the L- amino acids from proteins gradually racemize until equal proportions of L- and D- forms exist (subsequent interconversions have no net effect). With amino acids having two asymmetric carbons a net conversion (known as epimerisation) of the naturally occurring form to a mixture of natural allo- forms occurs, up to an equilibrium ratio related to differences in stability of the forms (with isoleucine, D-allo/L-iso = 1.3-1.4 at equilibrium).

This account applies to most amino acids, but several are relatively unstable and do not persist long in fossil material; some of these react to form inorganic amino acids at rates which are slow enough to show progressive change on a geological time-scale. Additional complications with some or all diagenetic changes of amino acids may be caused by slower rates of epimerisation or racemization of protein or peptide-bound than of free amino acids, catalysis of racemization or epimerisation by racemase and epimerase enzymes present in some micro-organisms (cf. Evans 1972), by effects of humidity on reaction rates and by catalytic effects of cupric and possibly other ions. These problems are set aside for the present but will be considered later.

Amino acid "dating"

From a naive model of the racemization and epimerisation reactions it would appear that D/L and allo/iso ratios of amino acids should increase progressively according to the age of fossil proteins, provided that the input of thermal energy had been constant and the reactions had followed first-order thermodynamics. Hence, knowledge of ratios for two amino acids from the same fossil would allow the age term and a thermal term to be calculated from simultaneous equations. Alternatively, the ratio for a single amino acid from a site of radiometrically estimated age could be used to calculate a term for the thermal effects, which could in turn be used to solve equations for age in adjacent sites.

The assumption of constant input of thermal energy is obviously unsound in geological contexts but the thermal history of fossils in deposits within a narrowly defined geographical region is likely to have been similar. Thus amino acid ratios would be expected to provide at least a relative age-scale. If it is assumed that first-order thermodynamics are obeyed by each of two separate reactions throughout the temperature range experienced by the proteins, then simultaneous equations could be used to estimate the absolute age from two ratios. However, there is evidence that isoleucine epimerisation only follows first-order thermodynamics over part of the range of ratios.

Assumptions are minimised if ratios are used only to detect older reworked fossils occurring in the same deposits as fossils contemporary with deposition. In view of the differing activation energies of the different racemization reactions the technique should be most powerful in regions that have suffered least climatic change, or over periods when climatic change has been small. Taking this rather parsimonious view of the usefulness of the technique, it is still evident that it could be of considerable importance in Pleistocene biostratigraphy as for instance in the study of early-Devensian molluscan faunas, where the uncertain extent of occurrence of reworked interglacial shells has so far prevented proper study. However, even this application requires that contamination and other potential sources of error can be ignored. Radiometric dates and stratigraphical evidence could provide independent checks whichever procedure was adopted.

Studies of fossil amino acids have concentrated on the epimerisation of L-isoleucine to D-alloisoleucine because the reaction is slower than most and the isomers can be separated by ion-exchange chromatography. Other L- and D- amino acids cannot be distinguished in this way unless some enzyme-catalysed reaction is ued to form new compounds which can be separated (and comparison should be made with the study of aspartic acid racemization by Bada and Protsch 1973). The routine study of several ratios from the same fossils is much to be desired as this would greatly strengthen the theoretical basis of the technique.

Techniques for separating and assaying amino acid mixtures by use of ion-exchange columns, ninhydrin staining and a spectrophotometer are now routine practice in many biochemical laboratories. Automated amino acid analysers with facilities for recording and intergrating data are available, and these need little modification for dealing with the smaller quantities from fossil proteins. In particular, the analysis of submicrogram quantities is facilitated by smaller bore ion-exchange columns and other tubing than in usual practice, and a system of pressure elution is needed instead of one relying on gravity. Analsyis of small quantities also necessitates purification of all reagents used and careful precautions to minimise and monitor laboratory contamination. An apparatus for use in the field has been designed and successfully demonstrated in the Arctic by Dr. P.E. Hare, but such a convenient device cannot easily be applied to any other than the isoleucine reaction.

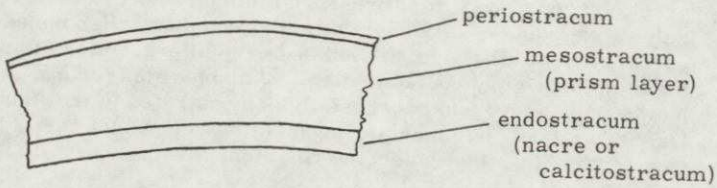
Published studies of ratios in mammalian bone and shells of a variety of species of Mollusca have demonstrated large differences in rates of isoleucine epimerisation between different types of material In addition, different parts of individual shells of *Mercenaria* spp. and *Corbicula fluminalis* appear to behave differently. Hence it is of obvious importance for analyses to be conducted on well defined parts of specimens whose taxonomic identity is sure. For geological applications it is equally vital that the stratigraphical origin of specimens is known and so far as possible understood in relation to other information from the site. Handling of specimens must be avoided and also much of the over-drying of samples which is routine practice amongst workers on Pleistocene Mollusca. Some of these problems will probably conspire to prevent amino acid studies achieving the wide and convenient applicability attained by radiocarbon dating.

The need to investigate ratios from material that is closely specified taxonomically imposes considerable restraints on the choice of material, if as wide as possible a range of sites is to be studied. The scarcity of well stratified bones of particular species suggests shells are more useful. No other Pleistocene fossils having much protein within a mineral matrix are nearly as widespread and plentiful. General considerations also suggest that shells should be specially useful: the protein content (conchiolin) is apparently of not much variety, it is an integral part of a compact and nearly impervious material, and the calcium carbonate of the shell should provide a significant pH buffering effect. These factors should afford considerable protection to the proteins from several kinds of degradation and contamination.

Shell Structure

Study of the ultrastructure of shells of several of the most common Mollusca occurring fossil in English Pleistocene deposits was begun at Reading in 1978. Florkin (1969) pointed out that in comparing the compositions of fossil proteins and the corresponding proteins of living organisms it is important to rule out the possibility of contamination by epizoans and parasites by thorough control with the electron microscope. Studies on shell structure are important for amino acid studies for recognising these and other forms of contamination and in allowing work to be carried out on well defined parts of shells that are as uniform as possible, both in ultrastructure and chemistry.

Shells of Gastropoda and Bivalvia are similar in having a three-layered structure:



The periostracum is not calcified in the species studied and it is commonly lost from fossil shells. It is readily removed along with surface dirt, by heating in dilute oxalic acid. In most Gastropoda the other two shell layers consist of around 90 per cent calcium carbonate which is originally deposited as aragonite, but which undergoes slow diagenesis to calcite. S.E.M. analysis of the location of dye on stained shell fragments shows that aragonite diagenesis is rather irregular, resulting in many calcite paramorphs of aragonite as well as calcite crystals of typical shape. The factors controlling aragonite diagenesis in shells deserve further investigation because the diagenesis is much slower than that of synthetic aragonite.

Organic matter, consisting of several different proteins together termed conchiolin in association with mucopolysaccharides occurs within individual aragonite crystals (cf. Watabe 1965) and in much larger quantities amongst crystals arranged to form lamellae or prisms and between lamellae. Diagenesis of aragonite leaves the general arrangement of organic matter intact but it is not known how intracrystalline material behaves.

Investigation of fragments of fossil shells with stereomicroscopes and the S.E.M. has often revealed cracks between the layers of the endostracum and between endostracum and mesostracum (prism layer). The endostracum also appears to be more pervious to a variety of dyes in aqueous solution than does the mesostracum, which can usually only be stained on exposed surfaces. For these reasons attention has been concentrated on cleaned fragments of the mesostracum, although amino acid studies have tended to use the endostracum or whole shells.

With some fossil material fragments of mesostracum were shown by S.E.M. study to be finely pitted or cracked. This material may be unsuitable for amino acid investigation because contamination with amino acids present in groundwater could occur. However, most fragments of fossil mesostracum did not show pitting or cracks. This better material could not be stained internally with dyes in aqueous solution and weighing experiments with soaked and dried fragments suggested that little water was absorbed into any other than the surface layers. Difficulty was experienced in cleaning away surface layers uniformly because a variety of chelating agents tended to attack the shell irregularly; work on this is continuing.

Problems and Conclusions

Returning to the possible complications in amino acid analysis mentioned above, a number of comments can be made with reference to fragments of fossil shell mesostracum. Restriction of analyses to fragments of mesostracum which have been shown to have good physical preservation is of obvious importance. In addition, the chemical pretreatment should allow separate assay of free amino acids and peptide-bound amino acids as the latter are likely to have less varied histories and they are known to racemize more slowly. Study of modern material of various origins is essential to establish which amino acid isomers are present initially. Micro-organisms and their racemase and epimerase enzymes would not be expected to penetrate far into the mesostracum as dyes of much lower molecular weight are unable to do so in hot aqueous solutions, but more study is needed. Contamination by cupric and other reactive metallic ions would be expected to result in production of compounds which could be detected by atomic-absorption spectroscopy, but further experimental work is desirable. Possible effects of humidity on rates of amino acid diagenesis are difficult to assess, but preliminary results suggest there is little water movement into intact mesostracum.

Difficulties in the assumption that first-order reaction kinetics can account for the diagenesis reactions remain. There is no evidence that heating experiments properly reproduce changes that occur at lower temperatures on a geological time-scale, although this is fundamental to some published studies. The very different activation energies of the various reactions anyway prevent any single heating experiment from duplicating the ratios in a particular fossil during a single run. Detailed investigation of changes in several amino acids in the same material may eventually shed light on this problem.

In the meantime, the prospect of obtaining meaningful absolute dates is most unsure, although there seems a good prospect of obtaining useful relative ages. Certainly, some published results look promising (Miller et al., 1979; Mitterer, 1974). At any event, the present state of the art should allow more detailed study of fossil molluscan assemblages by allowing recognition of reworked shells.

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RIMSMOOR, DORSET: POLLEN RECORD FROM LATE BOREAL TO PRESENT IN EIGHTEEN METRES OF PEAT

By P. V. Waton

In a depression in the Dorset heathlands peat has accumulated to a depth of about 18 m since the early Flandrian. The bog, Rimsmoor, is south-west of Bere Regis and is currently being analysed pollen analytically by the writer in the Department of Geography at the University of Southampton as part of a thesis on chalkland palaeoecology.

Geomorphologically, the feature is a doline, briefly mentioned by Sperling *et al* (1977). It consists of a single conical depression 30-40 m in diameter with a shallow extension to the south making the present *Sphagnum* covered surface about 80 m north to south and 35 m east to west. The presence of peat and almost total absence of lake deposits infers that the doline has subsided gradually over time. Pollen preservation appears to be good to excellent throughout and although cutting has resulted in the loss of the upper 1-2 m of peat, it is known that remnants of the uncut surface remain.

Although radiocarbon dating has yet to be undertaken and despite the chiefly local origin of the pollen, the outline diagram constructed at the time of writing (late December 1979) suggests uninterrupted accumulation of peat from the middle or late Boreal period to the present day. The Boreal-Atlantic Transition is present at about 16.5 m and the decline of *Ulmus* well marked at 11.5 m, giving a depth of 5 m of Atlantic peat. A number of clearance phases are evident: it seems that there was almost total regeneration of the forest cover after the elm decline until more permanent clearances assumed to be in the Bronze Age, as suggested by unpublished palaeoecological data from the Poole Basin and New Forest and a number of round barrows on the adjacent heath. *Tilia* also shows a marked decline at about 7.5 m. Additionally, pre-Neolithic disturbance of the vegetation seems to have occurred during the Atlantic period here as elsewhere in the Poole Basin (Haskins, 1978).

The potential for the site undoubtedly rests on the high resolution of clearance events that will be discernible because of the extraordinarily high accumulation rate of about 1 cm in 5 years. Close counts will be made of selected horizons showing particular fluctuations and it is hoped that a more detailed report will be ready for publication by mid 1980.

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REPORT ON A SHORT FIELD MEETING IN GUERNSEY AND JERSEY
24th - 28th September 1979

By D. H. Keen

Eleven members and guests of the Q.R.A. attended this meeting which was led by Dr. D.H. Keen and also had contributions from Dr. R.L. Jones and Dr. P. Callow. The main focus of the meeting was on the islands' raised beaches and their associated periglacial and organic deposits. A visit was also made to the Palaeolithic site of La Cotte de St. Brelade.

Day 1

The meeting began in Guernsey. The first stop was in the road cutting at St. Martin's Church (WV325765) where up to 2 m of loess is exposed. The section exhibits faint banding through the thickness of the loess due to small grain size differences between the bands. J.P. Lautridou (Caen) was of the opinion that these bands represented contemporaneous soils, forming during deposition of the loess, a view supported by D. Cope.

The second stop was at the Doyle Column (WV 339753) and a descent of the cliff was made to examine the smooth shore platform cut on meta-sediment in the Icart gneiss, and the head, sandrock and raised beach resting on this platform. A traverse along the section to St. Martin's Point, was made and the calcareous loessic head at this locality was examined. The calcareous nature of the loess was emphasised by the large tabular concretions in the section, and also by the preservation of mollusca of a typical loess fauna of Pupilla muscorum, Trichia hispida and Succinea pfeifferi schumacheri. Columella columella previously recorded from this locality was not found on this occasion. This assemblage allows little doubt that the deposits at St. Martin's Point accumulated in a cold, dry climate.

Stop 3 was at Moulin Huet (WV 329752) where the multiple nature of the shore platform was demonstrated and the large thickness of head filling the west side of the bay was examined. It was pointed out that no consistent stratigraphy could be recognised in the head in the islands although H.C.L. James and J.P. Lautridou stated that this was not the case in either Cornwall or Normandy. The party then visited the Moulin Huet Cave on the east side of the bay. Considerable argument took place about the exact nature of the deposition of the two raised beach remnants in the cave, one at about 8 m above mean sea level on a bench at the back of the cave, and the other at 11-12 m in the cave roof. The party was equally divided between those who assumed a single phase of cave fill up to the highest level, and subsequent removal of most of the deposits by a later high sea level, and those who suggested two phases of high sea level with the lower beach deposited first and the upper beach second. The latter invoked a break in marine conditions to explain angular deposits in the back of the cave thought by some to be head and by others to be merely pieces of the collapsed cave roof. Both groups agreed that it was difficult to fit either observed sequence into the conventional stratigraphy of a Ipswichian sea level reaching only 8 m. Suggestions of Pre-Ipswichian sea levels at about 8 m and 12 m were advanced to account for the two beaches in the cave. Evidence for at least two separate sea levels around 8 m were also indicated by the rock platforms and wave notches immediately outside the cave entrance. The party then proceeded to Les Vardes (WV 317825) in the north of the island where despite recent quarry working small amounts of beach conglomerate can still be observed on the hilltop at about 25 m above mean sea level. A possible correlation of this deposit with the Hoxnian sequence at Slindon, Sussex was suggested but in view of the doubt surrounding altitudinal correlation of this kind no clear proof of age could be offered. Several members of the party preferred a lower sea level for the Hoxnian and dated Les Vardes to an age much earlier in the Middle Pleistocene.

The final stop on the first day was at l'Eree (WV 248785) where excellent exposures of the 8 m beach were examined. At this locality, facing due west, up to 20% of the raised beach consists of "foreign" stones primarily flint, but also grés armoricaine, jasper and volcanics probably from Normandy or sea floor outcrops (Keen, 1978). A humified layer in the base of the loessic head over the raised beach was interpreted as a palaeosol, perhaps of early Devensian age, by D. Cope and J.P. Lautridou.

Day 2

The first stop on the second day was at Pleinheaume (WV 318817) where the sediments of the "18 m" beach were examined. General agreement was expressed that this beach was probably of a different age to the deposits at Les Vardes, and of the coastal 8 m localities, both of which are separated from the Pleinheaume exposure by low cliffs cut in l'Ancresse granodiorite. An age in terms of the conventional Pleistocene stratigraphy could not be arrived at however.

The second stop highlighted the problems involved in correlation or designation of raised beaches by their height. The party entered the quarry at Chouet (WV 333841) and examined the excellent exposures of 8 m raised beach in the south and west faces of the quarry. The beach here is a coarse storm beach of large pebbles and cobbles and has a height range of over 10 m from its highest to its lowest point, thus overlapping the proposed separation between the 8 m and 18 m raised beaches. Again, as at l'Eree, the beach here is rich in foreign stones, presumably driven on to the present area of the island from submarine sources as the sea rose to its maximum height in 8 m raised beach times.

The third stop was at Rousse, (WV 323832) across the Grand Havre from Chouet. Here the 8 m beach extends into modern tidal limits almost to mean sea-level. This beach is similar in foreign stone content to that at Chouet, and is probably of similar age, but formed in the marine regression from the highest level. Some participants suggested that this beach may be a cemented Flandrian deposit and not a raised beach at all, but the stratigraphy described by Elhai (1963) in which he notes a head layer over the cemented beach in a section now obscured by dumped concrete, ruled this out.

The final stops of the day were around Paradis in the north east of Guernsey where, despite fragmentary sections, the relationship of the 18 m to 8 m beach was demonstrated.

The party then crossed to Jersey by hydrofoil.

Day 3

The first stop in Jersey was at South Hill, St. Helier (WV 651477) where sediments of a raised beach at about 35 m above sea level were examined from a distance due to their position at the top of a quarry face. As as Les Vardes the age of this beach is uncertain, perhaps Hoxnian, but probably earlier.

The second stop was at Bonne Nuit Bay (WV 642559) on the north coast of the island where the extensive sections of head were examined. Lines of beach pebbles in the base of the head were generally agreed to be a reworked raised beach. Fine grained beds of grey silt at the base of the head were likened to similar minero-organic material in the base of the head in Lower Normandy which have yielded pollen of interstadial or early glacial character.

The third stop was at Fliquet (WV 713535) where a gully in the shore platform is filled with silty peat. R.L. Jones described the pollen and coleoptera sequence (Coope, Jones and Keen, in press) from the deposit. Despite considerable excavation on the foreshore, no clear idea could be obtained of the relationship between the peat and head exposed on the north side of the gully. However, the compressed condition of many of the inclusions (wood fragments especially) in the peat allow little doubt that a large weight of head originally covered the peat. The pollen and coleoptera from the peat both clearly indicate a cooling climate but it is impossible to correlate this episode, whether interstadial or late interglacial, with any known phase in the Devensian or earlier glaciations.

The party then drove along the coast to La Motte, pausing at La Rocque (WV 707465) to examine the 3 km wide degraded rock platform off SE Jersey.

At La Motte (WV 674462) sections in loess were examined. At the top the sections were completely decalcified and exhibited Limon á doublet banded texture. At the base the loess was calcareous and contained nodules of cemented loess with Pupilla muscorum and Succinea sp.

The final stop on the third day was in the cutting of the former Jersey Eastern Railway in St. Helier (WV 654484) where beach gravels with a base at 18 m above mean sea level occupy a gully in the side of the cutting.

Day 4

The first stop on the last day of the meeting was at Benest's supermarket (WV 629501). The first scientific stop was at Belcroute Bay (WV 607482) where a section of rock platform, head, raised beach, sandrock and head was examined. This sequence was held to indicate a marine episode followed by a periglacial phase, an interglacial marine phase, and finally a further period of periglacial conditions. A cliff fall allowed access to the top of the section where further layers of decalcified loess were examined resting on the head. There was some discussion over the age of the raised beach gravel and thus of the two heads. D.H. Keen advanced a conventional dating scheme with the lower head being pre-Ipswichian, the raised beach Ipswichian and the head Devensian. J.P. Lautridou, (on evidence from palaeosol development in Upper Normandy) preferred a "Saalian" date for the upper head, thus pushing the raised beach and lower head back in the Middle or lower part of the Upper Pleistocene.

The party then drove over the top of the headland to Portelet (WV 600471) where a similar sequence was examined. Some doubt was expressed by several members of the party about the in situ nature of the boulder beach in this section. C.P. Green in particular was strongly of the opinion that the beach was slumped down slope, although he agreed that this did not affect the general stratigraphy of the site.

The third stop was La Cotte de St. Brelade (WV 594475). The deposits of the cave, although now encased in concrete to protect them from weathering and vandalism, are still partially accessible and were described by P. Callow who took part in excavations in the cave from 1968-74 (McBurney & Callow, 1971).

The deposits in the rock shelter are a complicated series of loessic heads rich in bones of cold climate mammals and palaeolithic artefacts. Two main complexes of these cold climate deposits are dated to the late "Saale" and early Devensian, and are separated by thin silts lacking archaeological material which are dated to the Ipswichian. The two series of loessic heads were also separated by a vertical erosion surface probably cut by the Ipswichian high sea level entering the bottom of the cave.

The party then traversed the cliff section south of La Cotte to examine the head and raised beaches in these bays. D.H. Keen described how in this case the lines of beach pebbles in the head were moved downslope as the pebble lines were discontinuous in the head and there was no clear erosion surface at the base. This explanation was strongly contested by several members of the party who thought this was involving special pleading compared with the situation at Portelet. On this note of dissent the meeting ended and the party dispersed from the airport and docks all heavily laden with the duty proceeds of the last mornings first stop!

References

Coope, G.R., Jones, R.L. and Keen, D.H., 1980. The palaeoecology and age of peat at Fliquet Bay, Jersey, Channel Islands. Journal of Biogeography 7, 1 (in press).

Elhai, H., 1963. La Normandie occidentale entre la Seine et la Golfe norman-breton, etude morphologique. Bordeaux.

Keen, D.H., 1978. The Pleistocene deposits of the Channel Islands I.G.S. Rep 78/26.

MacBurney, C.B.M. and Callow, P., 1971. The Cambridge excavations at La Cotte de Saint Brelade, Jersey. Proceedings of the Prehistoric Society, 37, 167-207.

QUATERNARY STUDIES IN WALES

A GAZETTEER OF CURRENT QUATERNARY RESEARCH IN WALES

Compiled by J. Ince and S. Lowe

As research students working on Quaternary projects in Wales, it has become apparent over recent years that a considerable amount of work is being undertaken in the area. In the general interests of research and in the belief that fellow members of the Association would welcome a list of current research activities in the region, it was decided to compile a short gazetteer on current Quaternary research in Wales.

Most of the information included in this Gazetteer is a response to letters circulated to individuals known to be concerned with Quaternary studies in Wales, which outlined our proposals and requested details of current research. This was followed in June 1979 by a note in Quaternary Newsletter No. 28 which was circulated to all members. In general our request was very well received and we would like to thank everyone who replied. Although the list is inevitably incomplete we hope that it will be of use to members of the Association, and could provide a basis for a more detailed survey in the future if such proves necessary.

BALL, D.F., Institute of Geological Sciences, Keyworth, Nottingham.
Assessment of sand and gravel resources in the Mold area of Clwyd (SJ 16/26/36) for the Industrial Mineral Assessment Unit of the I.G.S. Boreholes are being drilled to a maximum depth of 25 m on a 1 km grid spacing for collection of gravel and till samples and subsequent particle size analysis. Two assessment reports in the Wrexham area have recently been completed (cover areas SJ 25/35 and SJ 24/34). All data produced from these surveys is confidential until publication (Wrexham reports - 1980, Mold reports 1980/81).

BARCLAY, W.J. Institute of Geological Sciences, 5 Princes Gate, London, SW7 1QN.

Revision of Quaternary geology of 1:50.000 sheet 232 (Abergavenny)

BLOEMENDAL, J., Department of Geography, Roxby Building, University of Liverpool.

Measurement of magnetic susceptibility and related parameters on 130 sediment cones obtained on a carefully surveyed grid system from Llyn Goddionduan, North Wales (SH/753583). Correlation of the cores is being attempted to investigate spatial and temporal variations in the pattern of sedimentation and the provision of a C^{14} and Cs^{137}-based chronology should permit the estimation of the total influx of sediment to the lake during defined time intervals. Pollen analysis and chemical analyses are being used to aid the interpretation of magnetic and other sedimentological changes.

BOULTON, G.S., School of Environmental Sciences, University of East Anglia, Norwich.

Younger Dryas glaciation of Wales (Snowdonia, Arenigs, Rhinogs, Cader Idris, Black Mountains, Brecon Beacons).

BRIDGES, E.M., Geography Department, University College of Swansea, Swansea, SA2 8PP.

Pedology, mineralogy and chemistry of "indurated minerals" in the soils of south Wales.

BROWN, E.H., Department of Geography, University College, Gower Street, London, WC1E 6BT.

The glacial geomorphology of Wales in general, currently with particular reference to north-east Wales.

CHAMBERS, F.M., Department of Geography, University of Keele, Keele, Staffs.

(i) Aspects of vegetational history and blanket peat initiation in upland south Wales.

(ii) Reconstruction of past environments in the area of Cefn Graeanog,Hut Group II (excavated by Gwynedd Archaeological Trust) using palynology and radiocarbon dating.

CLOUTMAN, E.W., Department of Plant Science, University College, P.O. Box 78, Cardiff, CF1 1XL.

Origins of blanket peat and history of upland vegetation in the Black Mountains.

COOPE, G.R., Department of Geological Sciences, University of Birmingham, P.O. Box 363, Birmingham, B15 2TT.

The interpretation of environmental changes based on evidence provided by fossil insects from various Lateglacial sites in North and Central Wales. Further work is in progress on the climatic significance of the coleopteron assemblage from Glanllynnau.

CURRANT, A., SUTCLIFFE, A.J., STRINGER, C.B. Department of Palaeontology, British Museum (Natural History), Cromwell Road, London, SW7 5BD.

Excavation of Quaternary deposits of the Gower Caves at Minchin Hole and Bacon Hole, West Glamorgan. Studies presently concentrating on enlarging the collection of faunal material from some of the less rich beds and obtaining better relative and absolute dating to aid in correlation of Gower sites and further afield.

DAVIES, H., 12 Whitegates Crescent, Willaston, Wirral, Merseyside, L64 2UX.

Character and origin of "Irish Sea Till" in the North East Wales borderland, especially coastal areas.

DERBYSHIRE, E. Department of Geography, University of Keele, Keele, Staffordshire, ST5 5BG.

Late-glacial geomorphology, sedimentology and stratigraphy of the Peris-Padarn rock basins, North Wales. Investigations include study of rhythmites, sands, gravels and macrofossils and pollen from peat strata as revealed in 4 inch cores and in field exposures.

DONALD, A.P., Department of Geography, St. David's University College, Lampeter.

Reconstruction of the Lateglacial and Postglacial environmental history of south-west Wales. Pollen analytical methods are being combined with chemical and sedimentological analyses to provide a synthesis of vegetation, climate and soils during the period in question. Sites being investigated include a coastal mid/Late Flandrian profile, together with several kettlehole sites containing older deposits.

DRESSER, P.Q., Department of Plant Science, University College, P.O. Box 78, Cardiff, CF1 1XL.

Radiocarbon dating of Postglacial sites with some work in association with archaeological trusts.

EDWARDS, M., The Botany School, Downing Street, Cambridge, CB2 3EA.

(i) Elucidation of the historical ecology of oakwoods in southern Gwynedd using pollen analytical methods. Some of the sites are within national nature reserves and are of great botanical importance.

(ii) Pollen analysis of a core from Dolfriog near Beddgelert to provide a record of regional vegetation since the Late Devensian.

FIELDING, M., Department of Geography, University College of Swansea, Singleton Park, Swansea, West Glamorgan, SA2 8PP.

Glaciation of the middle and upper Wye drainage basin north of Hereford, with emphasis on (i) Late Devensian ice levels and gradients; (ii) glacial drainage channel morphometry; (iii) sedimentary characteristics of fluvio-glacial deposits, in particular those associated with kames and kame terraces. Research may be extended into the lower Tywi valley and the areas immediately north of Carmarthen Bay.

FISHWICK, A., 76 Oakthwaite Road, Windermere, Cumbria.
Glaciations of the Conway catchment, North Wales (i)deciphering the patterns of ice movement in the Conway catchment and relating these to potential ice sources; (ii) interpretation of the multiple till sequences on the North Wales coast (from boreholes/coastal exposures) between Llanfairfechan and Colwyn Bay.

FRANCIS, E.A., Department of Geology, University of Keele, Keele, Staffordshire, ST5 5BG.
Nature and origin of the glacial sediments and landforms in the borderland area, on the margins of the Welsh uplands and the Cheshire basin (N.E. Welsh borderland defined as : East Clwyd, extending from the Wrexham area through Ellesmere to Shrewsbury and beyond).

GRAY, J.M., Department of Geography, Queen Mary College, University of London, Mile End Road, London, E1 4NS.
(i) Mapping of cwm moraines in Snowdonia, North Wales at 1:10000 scale and reconstruction of Loch Lomond Stadial (Younger Dryas) glaciers and snow patches. (ii) Small-scale forms of erosion on glaciated bedrock surfaces in Snowdonia, particularly striae, friction cracks and p-forms in the Llydaw, Llyn Peris and Marchlyn Mawr areas, (with Dr. J.J. Lowe, City of London Polytechnic).

GREATREX, A., 42 Westlands Avenue, Newcastle, Staffs, ST5 2PX.
Palaeo-ecology of lacustrine hydroseres : site at Llyn Creiniog, near Llansannen, Denbighshire. Study of late Devensian and more especially Postglacial lake sediments by analysis of plant macrofossils (primarily) with supporting stratigraphy and pollen analysis.

GREEN, H.S., National Museum of Wales, Cardiff, CF1 3NP.
Director of excavations at Pontnewydd Cave, Clwyd, as part of a programme of research into the "Earliest Human Settlement of Wales". Collaboraters in the project include:

COLLCUTT, S., Donald Baden-Powell Quaternary Research Centre, 60 Banbury Road, Oxford.
Cave sediments.

BULL, P.A., School of Geography, Mansfield Road, University of Oxford.
Cave sediments

CURRANT, A., Department of Palaeontology, British Museum (Natural History), Cromwell Road, London, SW7 5BD.
Vertebrate assemblages.

EMBLETON, C., Department of Geography, Kings College, Strand, London, WC2R 2LS.
Local geomorphology

BEVINS, R., Department of Geology, National Museum of Wales, Cardiff, CF1 3NP.
Petrology.

The main elements of the programme are: (i) Completion of the Pontnewydd excavation, including excavation at the newly discovered cave of Cae Gronw. (ii) Limited excavation at Longhole, Gower, to establish the date of the probable Middle Palaeolithic occupation.

(iii) Limited excavation at the undisturbed Ogof y Pebyll near Bridgend to determine whether important archaeological deposits exist. (iv) Excavation of Longbury Bank (Little Hoyle), Tenby, where a sequence from Middle Palaeolithic to Upper Palaeolithic probably exists. (v) The publication of earlier unpublished and incompletely published work on Welsh caves of all periods of the Stone Age.

HARRIS, C., Geography Section, Department of Geology, University College, PO Box 78, Cardiff, CF1 1XL.
(i) Quaternary sediments and stratigraphy in the South Wales coalfield. (ii) The micromorphology of solifluction deposits in the South Wales coalfield and the Brecon Beacons.

HELM, D.G., Department of Geology, Goldsmith's College, University of London, New Cross, London, SE14.
Sedimentological analyses on probable glacifluvial deposits of the Menai Straits that outcrop between Penmon and Llaniog. Relationships between cliff sections and foreshore areas are under investigation and maps are being prepared and current direction data collated. Work done in conjunction with B. Roberts, Department of Geology, Birkbeck College, University of London.

HILLMAN, G., Department of Plant Science, University College, P.O. Box 78, Cardiff, CF1 1XL.
Studies of plant macrofossils from archaeological sites in association with archaeological trusts.

HOULDER, C.H., RCAHM(Wales), Edleston House, Queen's Road, Aberystwyth, Dyfed, SY23 2HP.
(i) Collection of all types of information relating to the presence of man in Quaternary contexts, particularly in connection with sites having potential for the discovery of structural remains. Information is presently being compiled to form an archive for consultation by the general public and by organisations for research and conservation projects: maintained by the National Monuments Record of the Welsh Ancient Monuments Commission. (ii) The Stone Age in Cardiganshire (This subject is to be a chapter in the projected County History, sponsored by the Ceredigian Antiquarian Society). (iii) The Stone Age in Brecknock. An intensive study of the period in all its aspects, centering on the use of caves for habitation or burial. (To form a section in the forthcoming Inventory of Ancient Monuments (Volume I) of the Royal Commission on Ancient and Historical Monuments in Wales).

INCE, J., Geography Section, City of London Polytechnic, Calcutta House Precinct, Old Castle Street, London, E1 7NT.
Pollen analysis and radiocarbon dating of Lateglacial and early Flandrian deposits in Snowdonia, North Wales. The aim of the project has been threefold: (i) To trace vegetational and environmental developments in the Snowdonia area throughout the Lateglacial and early Flandrian period and to compare successional developments between sites at different altitudes. (ii) To obtain C^{14} dates on significant lithostratigraphic and biostratigraphic boundaries so as to establish a skeletal chronology for Lateglacial environmental

changes in the area. (iii) To establish Younger Dryas ice limits using pollen analysis from sites inside and outside moraines and, by obtaining radiocarbon dates from organic material in basal sediments, the age of deglaciation of the Younger Dryas ice.

JACKSON, D.I., Institute of Geological Sciences, 5 Princes Gate, London, SW7 1QN.
Glacial and post-glacial geology of South Wales in general and middle reaches of Usk and Ebbw valleys in particular.

JOHN, B.S., Greencroft Books, Trefelin, Cilgwyn, Newport, Dyfed, SA42 0QN.
Quaternary geomorphology of North Pembrokeshire; Devensian drift distribution in East Pembrokeshire and South Pembrokeshire with a view to establishing a reliable Last Glaciation limit for the southern part of the "Irish Sea Glacier".

JOHN, D., The Geography Department, Saint David's University College, Lampeter, Dyfed.
The Quaternary history of the area around Milford Haven with particular reference to raised marine features and associated deposits. This will involve geological and geomorphological mapping and standard sedimentological analyses.

KARABIYIKOGLU, M., M.T.A. Enstitusu, Jeoloji Dairesi Baskanligi, Sedimentoloji Servisi, Ankara, Turkey.
Glacial geology and geomorphology of Halkyn Mountain, North-East Wales.

LAING, F.C., 52 The Drive, Chorley Wood, Herts., WD3 4EB.
Study of Flandrian vegetational history as revealed by pollen-stratigraphic investigations at Llyn Gwernan (SH 703158) Gwynedd.

LOWE, S., Department of Geography, Queen Mary College, University of London, Mile End Road, London, E1 4NS.
Palaeoenvironmental reconstruction of the Lateglacial in North Wales. Research includes: (i) Detailed geomorphological mapping at a 1:10,000 scale, of features believed to be related to the Loch Lomond Stadial (Younger Dryas glaciation). The area of mapping includes southern Snowdonia, the Rhinogs, Arenigs, Berwyns, Arons and Cader Idris upland areas. (ii) Pollen analytical studies on sediments of Lateglacial and early Postglacial age from Llyn Gwernan (SH 703158) in the Cader Idris area and Pontllwyni (SH 828838) in the Arenig area.

MOORE, J.W., 33 Hillary Crescent, Walton-on-Thames, Surrey, KT12 2DE.
The form and origin of ground ice mound ramparts on the Llyn Peninsula.

MOORE, P.D., Botany Department, King's College, 68 Half Moon Lane, London, SE24 9JF.

Lateglacial and Flandrian vegetational history from late sediments at Llyn Mire (SO 016552)

PEAKE, D.S., Rosewall, Portley Wood Road, Whyteleafe, Surrey, CR3 0BP

(i) The River Alyn's pre-glacial course across the Horse-shoe anticline. Includes the extension of earlier mapping north-eastward to this area in conjunction with recent bore-hole evidence to examine the River Alyn's pre-glacial valley and its present relation to the solid floor of the adjacent Dee valley. (ii) Glacial diversions of three western tributaries of the River Alyn. Examination of open-cast coal workings in the area to supply further evidence for repeated southerly glacial diversions of the Terrig, Nant Brook and Cegidog, west of Hope Mountain.

POUNDER, E.J., 22 Friary Grange Park, Winterbourne, Bristol, BS17 1LZ.

Analysis of alluvial fans and river terraces in the Usk catchment, south Wales, with particular reference to their detailed surface form, mode of formation, and development since deglaciation. Attention is given to methods used for initiating terrace development and correlating terrace landforms.

PRICE, M., Botany Department, King's College, 68 Half Moon Lane, London, SE24 9JF.

Blanket peat origins and development on the Black Mountains (Talgarth area) in relation to Neolithic settlement.

ROWLANDS, B.M., The City of Liverpool College of Higher Education, Prescot Road, Liverpool, Merseyside, L34 1NP.

Glacial and post-glacial geomorphological evolution of the Arenig region and Vale of Clwyd.

SMITH, A.G., Department of Plant Science, University College, P.O. Box 78, Cardiff, CF1 1XL.

Palaeoecology and vegetational history of upland bog and archaeological sites in Mid and South Wales.

STEPHENS, N., Department of Geography, University College of Swansea, Singleton Park, Swansea, SA2 8PP.

Research in the South Wales area, especially the Gower Peninsula, in a survey in south-west Britain of the provenance of erratic boulders and pebbles found in: (i) Present beaches, or stranded on wave-cut platforms; (ii) Pre-Devensian beaches; (iii) Within head deposits. Comparisons will be made with the erratic content of glacial tills of various age. The tills considered will extend over a wider area, including the southern Irish Sea and part of the mainland of the Republic of Ireland.

TAYLOR, J.A., 23 Portman Avenue, London, SW14 8NX.

The form, origin and age of patterned ground in the Moelwyn range.

THOMAS, G.S.P., Department of Geography, University of Liverpool, Roxby Building, P.O. Box 147, Liverpool, L69 3BX.
(i) Glaciofluvial and glacio-lacustrine sedimentation, Upper Alyn Valley, Clwyd; (ii) Glacio-tectonic structures at Dinas Dinelle, Gwynedd; (iii) The terraces of the Upper Dovey, Powys.

WALKER, M.J.C., Department of Geography, St. David's University College, Lampeter, Dyfed, SA48 7ED.
Lateglacial and Early Postglacial environmental history of the Brecon Beacons - Fforest Faur area of central south Wales. The aim of the project is twofold: (i) To present a detailed picture of vegetation history and landscape evolution in the area during the Lateglacial and Early Postglacial; (ii) To use pollen stratigraphy in the establishment of a Late Devensian glacial chronology for the area. Sites under investigation are: a) Traeth Mawr (SO 967257) - Lateglacial profile; b) Craig Cerrig-gleisiad (SO 964220); c) Craig-y-fro (SO 972208). The latter two sites are Postglacial profiles within moraines believed to be Zone III in age. Five radiocarbon dates are being provided by NERC to complement palynological, sedimentological and chemical data from the profiles.

WATERS, R.A., Institute of Geological Sciences, 5 Princes Gate, London, SW7 1QN.
Revision of Quaternary geology of 1:50,000 sheet 263 (Cardiff).

WHITTINGTON, R.J., Department of Geology, Llandinam Building, Aberystwyth, Dyfed, SY23 3DB.
Geophysical studies of the Quaternary deposits of Cardigan Bay in particular and the S. Irish Sea and N.E. Celtic Sea in general.

WILTSHIRE, P., Botany Department, King's College, 68 Half Moon Lane, London, SE24 9JF.
Vegetational history of the Claerwen Valley as documented by blanket and valley peats. Especial emphasis on local variations within a relatively small area.

WRIGHT, M.D., 51 Caer Wenallt, Whitchurch, Cardiff, CF4 7HP.
Glacial and periglacial deposits of the South Wales coalfield area and their bearing on foundation engineering.

BOOK REVIEWS

Grid Sampling and Computer Mapping of the Ivybridge area, Devon. By R. Webster, T.R. Harrod, S.J. Staines and D.V. Hogan, 1979. Soil Survey Technical Monograph No. 12, 64 pp. Soil Survey Rothamsted Experimental Station, Harpended, Herts., AL5 2JQ. Price: £2.00.

This publication is the first offspring of a trial marriage between traditional soil survey practices and computer mapping and processing procedures. To the question whether the offspring is a success and more progeny encouraged, I think the answer is a qualified yes: some genetic engineering would improve the strain.

The argument for using computers rests on familiar bases: the speed of calculation, a wider range of analyses, and a greater body of processed information. With these aims in mind the Ivybridge area was studied as a pilot project. The report begins with an admirably terse and informative summary of the study area followed by a careful statement of methods used to collect and process the data. This detailed explanation of procedure is useful as it avoids any impression of sleight of hand.

SYMAP was their original choice of mapping package and perhaps a stimulus to the project's conception. However, the authors decided during the development of the project to use GRID CAMAP, a program devised at Edinburgh specifically for point data representation and available by remote job entry from a terminal. This system was available until January 1976, when the Edinburgh computer was replaced and the authors suffered the traumas of software susceptibility to hardware transplants. Thus the body of information included in the report is the produce of just over one year's work. Soil information is printed on a minimal base map showing small settlements, streams, roads and railway, which is useful for location but does tend to emphasise the difference in visual quality of conventional cartography and digital maps. The digital maps are produced from an extended line printer, and, as is typical of this scheme, the character set is rarely sufficiently informative to avoid constant reference to the key. As far as general users are concerned these maps are unlikely to be acceptable and finer line work may be a useful innovation. If they are to be available as digital data banks for on-line interrogation they may be more successful as potential users may be quite happy to exchange traditional visual impression for the point accuracy and manipulative qualities of this information.

For me the most important feature of this venture is that bijective mapping is retained; and in all cases numerical and locational information are both kept in a one to one corresondence of map and world. The first maps presented show single attributes such as vegetation, land use, slope, soil quality and type. Subsequent maps process the information. Many use particular combinations such as texture, depth and mottling in map 5.17 page 47. In this regard the provision of contingency tables relating to site occurrence by all class combinations would be useful. In certain cases each variable was dyadic, hence there are the possible combinations and 166 hypotheses of interaction for such a table. In these cases one map is not enough and some analysis, perhaps using GLIM developed at Rothampstead, would be helpful for interpreting 'working' maps and deciding what else is mapworthy. Indeed, there seems scope for the authors to be yet more ambitious, as what they have done is well tried and acceptable in other aspects of research and commerce.

P.W. Lewis

The Winters of the World. Edited by B.S. John, 1979, 256 pp. David and Charles, Newton Abbott.

This book is a popular, but up to date, review of the evidence for glaciation throughout the full span of Earth history. It consists of eight chapters of which the first two are concerned with the changing global configuration and the mechanisms of climatic change and are written by Brian John. The third is by Ed Derbyshire and explains the processes of glaciation and some basic aspects of Pleistocene stratigraphy. These are followed by a discussion of Precambrian glaciations by Grant Young, Ordovician glaciation by Rhodes Fairbridge, the Permo-Carboniferous glaciation by Brian John, and Cainozoic glaciation by John Andrews. It concludes with a chapter by the editor which attempts to identify the main patterns of climatic change and discusses the possiblility of predicting the climate of the near future.

In line with the popular approach the book is attractively designed with numerous diagrams and photographs (sometimes a surfeit of photographs seems to reflect a lack of substance), and written in a style that can be understood by the intellegent layman supported by the eighteen page glossary. However, the book is also written well and each of the authors clearly explains the state of understanding in his particular topic. The result is that the book exceeds its popular brief and provides a very useful review of the full range of glaciations through geological time. It thus provides a very convenient body of background information for those concerned with the study of glaciation during a restricted period of Earth history such as the Pleistocene. Whatever the readership, however, it is a book that can be read at leisure and enjoyed.

J. Rose.

FORTHCOMING PUBLICATIONS

Studies in the Lateglacial of North-west Europe. Edited by J.J. Lowe, J.M. Gray and J.E. Robinson. 1980, 215 pp. Pergamon. Price £17.00.

This volume brings together the papers read at the Quaternary Research Association Discussion Meeting held at University College, London on January 5th and 6th, 1979, to consider 'The Lateglacial Environment of the British Isles and possible correlation with North-west Europe'. The book is being offered to members of the Association at a special reduced rate of £9.95 plus postage, and a promational leaflet and order form are included with this issue of the Newsletter. Members may also be interested to note that 'Studies in the Scottish Lateglacial Environment' edited by Gray and Lowe is also being offered at a reduced rate. This time at the price of £7.95 compared with the full price of £11.50.

Quartery Journal of the French Association for the Study of the Quaternary.

In the past this journal has been published by AFEQ (Association Française pour l'Etude du Quaternaire) as an outlet for research on the French Quaternary for papers written in French. However, as the result of a recent decision the Association has decided to change the scope of the journal and produce it, in future, for an International readership with content related to methodology of Quaternary Research and aspects of the Pleistocene of Western Europe. Articles will be accepted in English, and Professor R.G. West has been invited to join the editorial board.

In view of this change the editors are inviting the submission of appropriate articles. These should be between 2 and 10 pages long (illustrations included) and should be sent to the President of AFEQ, Professor Jean Chaline, Université Pierre et Marie Curie, Laboratoire de Geologie 1, Tour 16, 4e étage, 4 place Jussieu, F.75230 Paris Cedex 05.

CALENDAR OF MEETINGS

March 28th-April 1st, 1980	Quaternary Research Association Annual Field Meeting and Annual General Meeting, Glasgow. Further details and a Registration Form are included in the February Circular. This meeting is now fully booked and any members still wishing to attend should write to Dr. R.J. Price, Department of Geography, University of Glasgow, Glasgow G12 8QQ, to have their name placed on the waiting list.
May 22nd-25th, 1980.	Quaternary Research Association Short Field Meeting in the Inverness Region under the leadership of Dr. J.S. Smith and F.M. Synge. Further details are given in the Circular issued with this Newsletter.
June 29th-July 6th, 1980.	V International Palynological Conference, Cambridge. Information can be obtained from Mrs. G.E. Drewry, Geology Dept., Sedgwick Museum, Downing Street, Cambridge, CB2 3EQ.
September 1st-11th, 1980.	INQUA Sub-Commission on shorelines of North West Europe. Field Excursion based on Oban, Glasgow, and Lancaster. Approximate price £220. Some places are still available. Further details can be obtained from Dr. W.G. Jardine, Department of Geology, University of Glasgow, Glasgow, G12 8QQ.
September 18th-21st, 1980.	Quaternary Research Association Short Field Meeting to West Cornwall under the leadership of Professor N. Stephens and P. Sims. Further details and a Registration Form are given in the Circular issued with this Newsletter.

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