

Quaternary Newsletters are issued in February, June and November. Closing dates for submission of copy for the relevant Number are 1st February, 1st June and 1st November. Contributions, comprising relevant 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, Dr.W.G.Jardine, Department of Geology, University of Glasgow, GLASGOW, G12 8QA, U.K.

The Nature, Recognition and Stratigraphic Significance of Palaeosols.

A discussion meeting of the Quaternary Research Association on the above subject was held in the University of Reading on 6th January 1973. Authors' abstracts of the papers presented are given below.

1. Soil formation: past and present. C.P.Burnham, Wye College.

The interpretation of palaeosols must rest on a comprehensive understanding of how soil-forming processes operate in modern soils. Even distinguishing a soil from a sedimentary layer unaffected by soil formation demands a knowledge of the nature of the changes likely to be produced by exposure at the surface. It is also valuable to know approximately how quickly soil-forming processes operate.

Changes in the evolution of soil organic matter and the incidence of accelerated erosion can be rapid, as can be reduction of ferric oxide and other compounds and the formation of rusty mottles. Soluble salts can be quickly leached in suitable circumstances. Leaching of carbonates from a layer of significant thickness and the development of a podzol or a peaty gleyed podzol take several hundred years. The production of textural B horizons and of thick chemically-weathered layers may take 10,000 years or more. Conversely, some features take a very long time to disappear even if conditions no longer favour their formation, hard sesquioxidic concretions or ferricrete (laterite) being a good example.

In many parts of the world, including Britain, the present soil pattern is intricately variable; this is likely to have been true also in the past. To name a palaeosol on the basis of a single profile will be of limited value, unless something is known about lateral variation. A peaty soil in a hollow may be quite unrepresentative of the whole landscape. The guiding principle here must be to use the comprehensive knowledge we have of contemporary soils intelligently in the interpretation of our scanty clues about those of the past.

2. The nature and recognition of palaeosols. B.W.Avery, Soil Survey of England & Wales.

The INQUA Commission on palaeopedology (1969) defined a palaeosol as a soil that began forming on a landscape of the past. Palaeosols thus comprise (1) Buried soils, i.e. soil profiles or parts of soil profiles preserved beneath layers showing little or no pedological re-organization, and (2) Relict or polycyclic soils, in which horizons with distinctive properties attributed to pedogenesis in an earlier period occur at limited depths below existing land surfaces, within or directly below the zone now subject to pedological re-organization. However, buried soils of Flandrian age are not uncommon, and many British soils in Devensian deposits could be considered polycyclic insofar as their sub-surface horizons formed in a biotic environment unlike that of the present. Accordingly, usage of the term Palaeosol has commonly implied that the pedological features concerned originated in a pre-Holocene period.

The occurrence of palaeosols, particularly buried palaeosols, indicates that landscape development has involved successive phases of land-surface stability and instability. On this basis, Butler (1959) proposed a conceptual framework for soil studies in which recognition of 'ground-surfaces' by associated soil features is used to reconstruct the history of a landscape in terms of time intervals which he called K-cycles, each comprising an unstable and a stable phase. Laterally-traceable palaeosol layers have been similarly used as 'marker horizons' in

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elucidating the Quaternary history of formerly glaciated or periglacial areas, notably North America, on the basis that well developed palaeosols formed in interglacial periods.

Few pre-Devensian buried palaeosols have been identified in Britain, presumably because pre-existing soil profiles were generally destroyed by advancing ice, and because cryoturbation and solifluxion, rather than aeolian deposition, were dominant periglacial processes in each glacial episode. Polycyclic soils in which the more or less truncated or disturbed remains of an interglacial soil occur as part of the existing weathered mantle, often beneath a thin layer derived largely from loess, are apparently much more widespread, particularly in association with relatively stable land surfaces outside the limits of Devensian glaciation. The relict subsoil horizons generally have the characteristics of textural (argillic) B horizons and are usually distinguishable from similar horizons attributable to Holocene pedogenesis in similar materials by redder or stronger colours and more pronounced pedological organization, as evidenced by micromorphological studies. As elsewhere in western Europe, the most widely occurring horizons of this type probably originated in an Ipswichian (Eemian) phase of pedogenesis, but red (redder than 5 YR) or red-mottled loamy and clayey horizons found only in plateau deposits (above the Winter Hill terrace in the London basin) may have originated earlier.

The recognition of palaeosols entails distinguishing effects of pedogenesis *in situ* from sedimentary discontinuities, and effects of Holocene pedogenesis from those of earlier phases in situations where they overlap. The basic requirements are adequate descriptions of sections and detailed comparative studies of the field relations of identifiable horizons. To further elucidate their nature and mode of origin, the most generally useful methods are particle-size and mineralogical analyses and thin-section studies.

Reference BUTLER, B.E. 1959. Periodic phenomena in landscapes as a basis for soil studies. C.S.I.R.O. (Aust.) Soil Publication No. 14.

3. Techniques applicable to the study of palaeosols. P.Bullock, Soil Survey of England & Wales.

It is important that for palaeosols a chronological order of events on a scale of absolute time should be established. Radiocarbon dating is the most important method of achieving this but, unfortunately, relatively few palaeosols lend themselves to dating in this way. Terrestrial materials such as charcoal and raised bog peat are the safest materials to date. Palaeosols influenced by a groundwater table may receive additions of fossil carbon and those influenced by downward leaching may receive fossil and very recent carbon, and in such cases radiocarbon dating is subject to errors. In soils formed over a long period, the organic matter they contain is likely to be a mixture of very old to very young components difficult, if not impossible, to separate for ^{14}C dating, and only a mean residence time for the organic matter can be measured. Other methods of isotopic dating e.g. K/Ar, Tritium (^3H) and Rb/Sr are not directly applicable to soils although Rb/Sr has interesting possibilities.

Relative dating of palaeosols, particularly organic soils, has been achieved by pollen analysis. Several authors have demonstrated that pollen can migrate in mineral soils and become stratified, and analysis of pollen in the different layers has provided a means of establishing the vegetation history during soil formation. Munaut (1967) used pollen analysis to distinguish old podzols with a Br_0 horizon in the Belgian Campine formed under forest (Atlantic period) from more recent podzols with a B_1 horizon formed under Calluna heath (sub-Atlantic period).

Chemical and mineralogical methods are used to provide confirmation of the presence of palaeosols and to reconstruct the soil forming-environment. Of the chemical methods, the most promising is that of amino acids (Goh, 1972).

Particle size analysis is an important means of detecting lithological discontinuities, and detailed studies of the mineralogy of the fine sand and coarse silt fractions help to establish the origin of the deposits and to distinguish those that have been pedologically reorganised. Micromorphology is the best method adapted to the study of soil-forming processes in palaeosols, and from a study of fabrics of present-day soils it is possible to deduce the soil-forming environment of palaeosols.

References GOH, K.M. 1972. Amino acid levels as indicators of palaeosols in New Zealand soil profiles. Geoderma, 7, 33-47.

MUNAUT, A.V. 1967. Thèse Acta geographica lovaniensia, 6, 191 pp.

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4. The distribution of iron oxides and hydroxides during the Pleistocene in soils of the West Mediterranean Basin and Atlantic France. N. Fedoroff, Départemento Geologie-Pedologie, Ecole Nationale Supérieure Agronomique, Grignon, France.

Many palaeosols are described simply according to the occurrence and distribution of iron oxides and hydroxides (e.g. sol rubefie, sol panache, sol marmorise, ferretto). The first part of the paper summarises present knowledge of iron oxides and hydroxides in soils, their distribution, and the climatic conditions to which their occurrence is related. The second part attempts to explain differences in the distribution of these iron compounds in the Pleistocene palaeosols of the West Mediterranean Basin and Atlantic France.

I Types of occurrence of iron oxides and hydroxides in soils

(a) Rubification is the development of red colours (Hues 5YR, 2.5YR, 10R, 7.5R of the Munsell Color Chart) as the result of partial crystallisation of amorphous iron oxides and hydroxides as hydrohematite. This is closely associated with clay particles, and in soils where the clay fraction is illuviated the red colours are often better developed in the argillans formed at depth by redeposition of clay than in the plasma of higher horizons where the hydrohematite originates.

Various studies have shown that a humid climate is necessary for rubification. In a cool climate it develops only in soils with a relatively warm pedocline, such as well-drained sandy soils; but in warmer climates finer-textured soils may be rubified. The rate of rubification depends on clay content and the nature of the iron-bearing minerals in the soil parent material. It is a slow process, taking perhaps thousands of years.

(b) Rusting is segregation of iron oxides and hydroxides as cutans, with some impregnation of the immediately adjacent soil matrix. It is commonest in sandy or loamy, highly hydromorphic soils. It has no climatic significance, as it occurs in both hot and cold climates. It develops quickly, perhaps after only a few weeks of anaerobic conditions.

(c) Mottling is an irregular mosaic of reddish, ochreous and whitish-grey patches. The reddish and ochreous colours result from iron oxide or hydroxide impregnation of clayey material; the whitish-grey patches have little or no free iron. The intensity of the mottling has no climatic significance, but is related to the nature of the parent material and occurrence of reducing conditions. Red patches do seem to be significant, however; a mean annual temperature exceeding 15° C, and long dry summers, seem to be necessary for the appearance of patches at least as red as 2.5YR.

It is difficult to distinguish the part played by clay translocation in causing mottling from that of poor soil drainage in a wet climate. Where clay translocation is weak (e.g. late Würm loess in the Paris Basin) the B horizon remains permeable, and no mottling occurs. However, in similar loess in the Ardennes, with a colder, wetter climate, clay translocation is much greater, and the B_t horizon has weak mottling; it also shows degradation in the form of tongues of the strongly clay-depleted A₂ horizon penetrating vertically from above. In central Russia, with a cold but relatively dry climate, soils on loess show intensive clay accumulation and some degradation tongues, but no mottling. On Riss loess in the Paris Basin, the soils show two distinct phases, an earlier one of strong illuviation but no degradation, and a later with degradation of the B_t horizon and some cryogenic features. The first probably dates from the Riss-Würm Interglacial, the second from the early Würm.

(d) Iron Concretions form when iron oxides and hydroxides impregnate an s-matrix densely enough to make it hard. The former fabric of the impregnated material is preserved, and the crystallites deposited in free spaces of the s-matrix do not displace particles as do, for example, crystals of secondary carbonate. Concretions form where 'reduced' ground waters are subject to oxidation, where groundwater flow is accelerated especially into the atmosphere, and where ground water is perched in the lower part of a permeable horizon by an impermeable layer beneath. They occur from the tropics to boreal regions, and have no climatic significance. Small soft concretions form in tens or hundreds of years, but larger concretions and ironpans, at least in the Paris Basin, are inherited from wetter periods.

II Stratigraphical significance of iron oxides and hydroxides in palaeosols

(a) Rubification giving 5YR colours has occurred in well-drained sandy soils in Atlantic France during the Holocene. During the Riss-Würm Interglacial in the same region it gave 2.5YR in sandy soils and 5YR in loess. Sandy soils of earlier periods have 10R colours.

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In Mediterranean France rubification probably occurs to-day in the wettest areas (e.g. plateau de Vaucluse), but in the drier lowlands of the West Mediterranean Basin there is no evidence for Holocene rubification (e.g. on Barcelona loess the hue is still 10YR). The rubification in the red soils of these areas occurred during wetter periods than the present, but it is impossible in most areas to date these periods.

(b) Mottling is generally absent from soils on the late Würm loesses of northern and south-western France; the loesses were deposited in dry conditions, and Holocene soil development prevented formation of an impermeable B_t horizon. However, the early Würm loesses of south-western France have ochreous and whitish-grey mottling, which probably developed during deposition in rather wet conditions. Interglacial soils on the Riss loesses are not mottled, except by subsequent soil development, probably in the early Würm.

Mottling occurs in most of the pre-Riss palaeosols of Atlantic France. It is difficult to use it chronologically, except that in the early Pleistocene and late Pliocene palaeosols the red patches are large, whereas those in middle Pleistocene palaeosols are smaller and occur in the centre of ochreous patches.

(c) Iron Concretions have no stratigraphical significance to a pedologist, but some Quaternary geologists (e.g. Bourdier) disagree. In the Paris Basin, the largest concretions seem to be inherited from a wet and cool period of the early Würm.

5. A study of palaeosols and palaeocatenas from West Runton (Norfolk) and Woodhall Spa (Lincolnshire). K.W.G.Valentine and J.B.Dalrymple, Department of Soil Science, University of Reading.

Field and laboratory results were reported for two possible palaeocatenas: one developed in Beestonian sands under Cromerian organic muds at West Runton, the other in fen margin sands and basal clays under a buried peat (radio-carbon dated 4,000 years B.P.) at Woodhall Spa in the north fens of Lincolnshire.

At West Runton the best developed soil was an apparent Iron Podzol, but heavy mineral analysis showed that the eluviated and illuviated horizons were derived from different sand types. Although the heavy minerals showed that weathering increased consistently up to just below the organic muds (like a soil profile) there was little evidence of soil biological activity having destroyed the geological bedding of the sand. Moreover, there was no logical catena-like change of pedological features along the section. Therefore, it is suggested that most of what appears as a soil has been produced by iron translocation by subsoil water percolating through the organic muds, although in one profile root channels and ice wedges were found.

At Woodhall Spa there was a catena-like change of soil morphology from an Iron Podzol to a Humic Gley, associated with the undulation of the sand surface. Pollen analysis was used in an attempt to show that the soils supported a vegetation distinct from the peat and had not been produced by subsoil percolation. Micromorphology proved to be the best technique for distinguishing pedological features from features inherited from geological sedimentation.

The principle feature that will distinguish a sandy palaeosol from a sedimentary deposit changed by diagenesis will be its logical change with landscape undulations, its catena-like properties.

INQUA Subcommittee, British National Committee for Geology.

As noted in Quaternary Newsletter No. 1 (September 1970), national matters that might arise in connection with the International Union for Quaternary Research (INQUA) are considered by a Subcommittee of the British National Committee for Geology. Recently changes in the composition of the Subcommittee arose due to the death of Professor D.L.Linton and resignation of Mr.B.W.Sparks. Currently, the members of the INQUA Subcommittee are:

Professor F.W.Shotton, F.R.S.	Department of Geology, University of Birmingham
(Chairman)	
Dr.W.W.Bishop	Dept. of Geology, Bedford College, London
Dr.D.Q.Bowen	Dept. of Geography, Univ. College, Aberystwyth
W.B.Evans	Institute of Geological Sciences, Leeds
E.A.Francis	Dept. of Geology, University of Keele
Sir Harry Godwin, F.R.S.	Dept. of Botany, University of Cambridge
Dr.W.G.Jardine	Dept. of Geology, University of Glasgow
Dr.P.A.Mellars	Dept. of Ancient History, Univ. of Sheffield
Dr.L.F.Penny	Dept. of Geology, University of Hull
Dr.R.G.West, F.R.S.	Dept. of Botany, University of Cambridge

Research News

As noted above, news of personal and joint research is invited for inclusion in Quaternary Newsletter. The following contribution was prepared by A. Horton, Institute of Geological Sciences, 5 Princes Gate, LONDON, SW7 1QN. The information is circulated by permission of the Director of the Institute of Geological Sciences.

The age of the Hoxnian Interglacial

In recent years the Institute of Geological Sciences has dated several organic samples derived from deposits which are thought to belong to the Hoxnian. Because of delay of publication in Radiocarbon these have been available only to a limited number of people. In view of the continuing controversy over the age of the Hoxnian, abstracts of these dates are given here.

- 1) IGS C14/10 (St 3067) >40,000

Plant remains washed from peat bed in core sample between 6.81 m and 6.88 m depth from Qinton No. 1 Borehole (52° 28' N Lat, 02° 00' W Long, Grid Ref. SO 9921 8471). Peat from part of sequence of organic sediments sandwiched between glacial deposits. Subm. by A. Horton. Contained insect fauna and plant remains indicate Hoxnian interglacial age.

- 1) Dunston Common series, Norfolk

Samples from borehole on Dunston Common near Norwich, Norfolk (52° 35' N Lat, 01° 17' E Long, Grid Ref. TG 2270 0267). Borehole proved 4.9 m of gravels deposited by River Tas, resting on greyish-blue, lignitic, laminated clays which were proved to a depth of 16.5 m without reaching the base. Coll. 1969 by A.R. Clayton and subm. by E.F.P. Nickless, Inst. Geol. Sciences.

- IGS - C14/73 (St 3681) >40,000

Bulk sample of lignitic clay from 8.5 m below terrace gravel.

- IGS - C14/74 (St 3683) >40,000

Bulk sample of lignitic clay from 11.6 m below terrace gravel.

General comment (E.F.P.N.): the glaciation which deposited Chalky Boulder Clay in the Norwich area has been assigned by West (1963) to the Anglian, by Straw (1965) to the Wolstonian, and by Woodland (1970) to the Devensian. The River Tas dissects Chalky Boulder Clay and glacial sand and gravel. Laminated deposits containing a Hoxnian flora (L. Phillips and R.G. West, personal communication) underlie river gravels at four sites in the Norwich area (Cox and Nickless, 1972) of which Dunston Common is one. Mapping and evidence from other boreholes indicate that the interglacial deposits rest on Chalky Boulder Clay. The determinations do not resolve the problem of the age of the Chalky Boulder Clay.

- 1) IGS C14/94 (St 3846) Stanway By-pass, Essex 28,170 ± 170
26,220 B.C.
32,500 ± 1240
IGS C14/95 (St 3864) Stanway By-pass, Essex 30,550 B.C.
1080

Peat from cutting (51° 53' N Lat, 00° 48' E Long, Grid Ref. TL 9257 2425) Coll. 1971 and subm. by C.R. Bristow, Inst. Geol. Sciences. Comment (F.C. Cox): stratigraphic and palynological evidence favours correlation with the Hoxnian. The stratigraphically-younger specimen (IGS - C14/95) yielded an older date. It is therefore concluded that the samples have been contaminated by humic solutions.

- 1) IGS C14/107 (St 3815) Swanscombe, Kent >40,000

Material consisted of complete shells from a life assemblage of Potamidia littoralis Cuvier from sand lens in Lower Loam, 0.10 m above junction with Lower Gravel, north-west face of trench B5 (51° 26' N Lat, 00° 18' E Long, Grid Ref. TQ 5986 7428), 1971 excavations at Barnfield Pit (Conway 1971). Coll. 1971 and subm. by B.W. Conway, Inst. Geol. Sciences. Comment (B.W.C.): Lower Loam widely accepted as Hoxnian (Ovey 1964) and specifically correlated with early temperate sub-stage of Hoxnian interglacial (Kernay 1971) occurring within insolation half cycle 6W to which an age of 200,000 to 220,000 years B.P. has been assigned (Evans 1971). As expected, the infinite date is not at variance with this.

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- (e) IGS C14/108 (St 3830) Hoxne Brick Pit, Suffolk 26,930 \pm 975
24,980 B.C.

Peat from Main Cutting, Layer 2, archaeological excavation (52° 21' N Lat, 01° 12' E Long, Grid Ref. TM 175 767). Coll. 1971 and subm. by C.R.Bristow, Inst. Geol. Sciences. Comment (F.C.Cox): radiometric age much younger than expected. Stratigraphy and other C14 dates (Bristow and Cox 1973) suggest sample should be beyond limit of radiocarbon dating and hence it is assumed to have been contaminated by humic solutions.

- (f) IGS C14/125 (St 3872) Woodston, Peterborough > 40,000

Wood from gravel bed near base of Woodston Series at depth 2.4 m in drainage trench at Woodston, Peterborough (52° 53' N Lat, 00° 16' W Long, Grid Ref. TL 1799 9608). Coll. 1971 and subm. by A. Horton, Inst. Geol. Sciences. Comment (A.H.): date accords with interglacial age deduced from flora.

- (g) IGS C14/129 (St 3874) > 40,000

Peat from a 0.69 m thick bed at 12.8 m below ground level in IGS borehole, Nar Valley (52° 42' N Lat, 00° 26' E Long, Grid Ref. TF 6502 1419) close to a former course of the River Nar. Coll. 1971 and subm. by R.W.Gallois, Inst. Geol. Sciences. Comment (R.W.G.): part of the Nar Valley Freshwater Beds; the infinite date is not incompatible with the presumed Hoxnian age of these deposits (Stevens, 1958).

- (h) IGS EK/4 (SRR 60) Sel Ayre, Shetland 36,800 + 1950
- 1560
34,850 B.C.

Peat of suspected Hoxnian interglacial age from eroded cliff face at c. 6.1 m below present cliff top, Sel Ayre, west Shetland, Scotland (60° 15' N Lat, 01° 41' W Long, Grid Ref. HO 176 541). Coll. 1971 and subm. by W. Mykura, Inst. Geol. Sciences. Comment (W.M.): Pollen content of peat, examined by H.J.Birks, has strong analytical similarities with peat from Fugla Ness (SRR 59).

- (i) IGS EK/5 (SRR 59) Fugla Ness, Shetland 40,000 + 2000
- 1600
38,150 B.C.

Wood from suspected Hoxnian interglacial peat bed on coast of Fugla Ness, north Shetland, Scotland (60° 36' N Lat, 01° 25' W Long, Grid Ref. HU 311 913). Coll. 1971 and subm. by W. Mykura, Inst. Geol. Sciences. Comment (W.M.): section described by Chapelhowe (1965) and pollen analysis by Birks and Ransom (1969). Age shows general agreement with dates from same deposit given by Page (1972). Pollen content comparable to Sel Ayre (SRR 60) and two peats appear to be of comparable age. Both assemblages have strong Hoxnian affinities, but as there are no other interglacial deposits in the region, correlation is very tentative.

Quaternary Publications.

- (a) In February 1973, Oliver and Boyd published a new book in the series GEOMORPHOLOGY TEXTS. This is Number 5, entitled Glacial and Fluvio-glacial Landforms. The author is Dr. R. J. Price of the Department of Geography, University of Glasgow. The book has 221 pages of text, 95 text-figures, including numerous photographs and aerial photographs, and a 12-page bibliography. The price is £5.00.
- (b) A number of recent Reports of the Institute of Geological Sciences (of Great Britain) are devoted wholly or partly to Quaternary deposits:
- No. 72/1 A description of the geology of the Hunterston Peninsula, Ayrshire. A. Davies.
 - No. 72/2 The Pleistocene history of the Barnstaple area. E.A.Edmonds.
 - No. 72/4 An interglacial deposit near Austerfield, southern Yorkshire. G.D.Gaunt, G.R.Coope, P.J.Osborne and J.W.Franks.
 - No. 72/6 The sand and gravel resources of the country around Witham, Essex. Description of 1 : 25 000 resource sheet TL 81. H.J.E.Haggard.
 - No. 72/8 The use and resources of moulding sand in Northern Ireland. R.A.Cld.

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Recent Reports of the I.G.S. (contd.)

- No. 72/9 The sand and gravel resources of the area south and west of Woodbridge, Suffolk; Description of 1 : 25 000 resource sheet TM 24. R.Allender and S.E.Hollyer.
- No. 72/10 I.G.S. marine drilling with n.v. Whitehorn in Scottish waters 1970-71. J.A.Chesher, C.E.Deegan, D.A.Ardus, P.E.Binns and N.G.T.Fannin.
- (c) Proceedings of the 2nd Guelph Symposium on Geomorphology, comprising a 285-page paperback entitled Research Methods in Pleistocene Geomorphology, priced £5.00, may be obtained from GEO ABSTRACTS LTD., University of East Anglia, Norwich, NOR 88C. Information about the third Guelph Symposium, planned for May 1973, and with the theme 'Research methods in Arctic and Alpine geomorphology' is also to be obtained from Geo Abstracts Ltd.

The contents of Research Methods in Pleistocene Geomorphology are:

- Field Experiments on Freezing and Thawing at 3,350 m in the Rocky Mountains of Colorado, U.S.A. A.E.Corte, Argentina.
- The Ground Thermal Regime in Cold Regions. P.J.Williams and W.C.Nickling, University of Ottawa.
- The Nature and Use of Till Fabrics. S.Harris, University of Calgary.
- The Effect of Lithology upon Texture of Tills. A.Dreimanis and U.J.Vagners, University of Western Ontario.
- Clay Mineralogy of Glacial Tills in Eastern Durham, England. P.Beaumont, University of Durham.
- Computer Applications in the Analysis of Heavy Mineral Data from Tills. H.Gwyn and P.G.Sutterlin, University of Western Ontario.
- Application of Linear Discriminant Analysis to the Investigation of Tills. R.May, University of Western Ontario.
- Uses of Q-Mode Factor Analysis in the Interpretation of Glacial Deposits. A.Falconer, University of Guelph.
- Multivariate Analysis of Quaternary Deposits Using Nominal Scale Data: Ordination and Information and Graph Theoretic Models. J.T.Andrews, Institute of Arctic and Alpine Research.
- The Use of Trend-Surface Mapping in the Interpretation of Quaternary Deposits. O.Slaymaker and M.Church, University of British Columbia.
- Discussion: Quaternary Geomorphology. J.G.Fyles, Geological Survey of Canada.
- The Adaptation of the Continuous Particle Electrophoresis System for the Quantitative Analysis of Clay Minerals. L.C.Hodgson and J.B.Reynolds, University of Guelph.
- Dating Cave Calcite Deposits by the Uranium Disequilibrium Method: Some Preliminary Results from Crowsnest Pass, Alberta. D.C.Ford, P.T.Thompson and H.P.Schwartz, McMaster University.
- Cartographie Géomorphologique Détaillée en Morphologie Glaciaire (Secteur de Bury, Comté de Compton, Québec). J.M.Dubois, University of Ottawa.
- Comparaison des Résultats de Deux Parcelles Expérimentales d'Erosion en 1969-70 à Sherbrooke, Québec. P.Clement and P.Gadbois, Université de Québec.
- Preliminary Observations on Downslope Movement of Soil During the Fall in the Chinook Belt of Alberta. S.A.Harris, University of Calgary.

NOTICE

European Quaternary scientists travelling via North America to the INQUA Congress in New Zealand in December 1973 are invited to visit the Department of Earth Sciences at University of Waterloo, Canada, during a stopover at Toronto. Anyone interested should contact Professor Paul F. Karrow, Department of Earth Sciences, University of Waterloo, WATERLOO, Ontario, CANADA.

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Calendar of Meetings.1973

- 6 Geologists' Association. In the Rooms of the British Academy, Burlington House, Piccadilly, LONDON W.1. at 6 p.m.: Dr.D.Q.Bowen. 'The Pleistocene succession of the Irish Sea: an orthodox view'.
- 11 - 13 The Systematics Association. Symposium on 'The changing flora and fauna of Britain'. University of Leicester. Details from Dr. Paul Parker, Botanical Laboratories, University of Leicester, University Road, LEICESTER, LE1 7RH.
- 13 - 17 Quaternary Research Association. Annual Field Meeting and Annual General Meeting, Clacton-on-Sea, Essex. Local Secretary: Dr. C. Turner, c/o Sub-Department of Quaternary Research, The Botany School, University of Cambridge, Downing Street, Cambridge, CE2 3EA. (Meeting fully booked).
- 5 Quaternary Research Association. Afternoon visit to the Michin Hole excavations, Gower, South Wales. Details from Dr.D.Q.Bowen, Department of Geography, University College of Wales, Penglais, ABERYSTWYTH, Cards., SY23 3DA. See also Q.R.A. Circular, February 1973.
- 25 - 27 Quaternary Research Association. Short weekend field meeting, Isle of Arran. Local Secretary: Dr.A.M.D.Gemmell, Department of Geography, University of Keele, KEELE, Staffs., ST5 5BG. Itinerary in Q.R.A. Circular, February 1973.
- 22 & 23 British Association for the Advancement of Science. Section E (Geography). 22nd August: Presidential address by Prof. K.Walton, 'A Geographer's View of the Sea', and related papers. 23rd August: Geology and Geomorphology of the Thames Estuary.
- 2 - 14 Quaternary Research Association. Overseas Field Meeting: The Quaternary of the Alpine Foreland. Excursion Secretary: Dr.D.D.Bartley, Department of Plant Sciences, University of Leeds, LEEDS, LS2 9JT.
- 20 - 23 Joint meeting of British Geological Societies, Department of Geology, University of Manchester. Includes Geologists' Association symposium on The Pleistocene History of the Irish Sea. Details in next Quaternary Newsletter.
- 2 - 10 9th Congress of INQUA, Christchurch, New Zealand, with pre-Congress and post-Congress field excursions in New Zealand and Australia.
- 1974
- 20 - 24 First Symposium on the Geological Action of Drift Ice. Quebec City, Canada. Information from: Jean-Claude Dionne, Environnement Canada, C.P. 3800, Sainte-Foy, Quebec, CANADA.

SPECIAL NOTICE

Special Report No. 4 of the Geological Society of London is expected to be A correlation of Quaternary deposits in the British Isles, by G.F.Mitchell, L.F.Penny, F.W.Shotton and R.C.West, containing regional correlation charts and the report of the Quaternary Era Subcommittee of the Geological Society of London. It is planned to have the Report published by mid-April 1973, so that copies will be available for purchase at the Annual Field Meeting of the Quaternary Research Association at Clacton-on-Sea, 13th to 17th April 1973.

When published, the Report will be available from Scottish Academic Press Ltd., 25 Perth Street, EDINBURGH EH3 5DW. Further details will be included in Quaternary Newsletter No. 10 (June 1973).

Compiled and duplicated, for circulation to Q.R.A. members and others, by Dr.W.C.Jardine, Honorary Secretary, Quaternary Research Association, Department of Geology, University of Glasgow, GLASGOW, G12 8QQ, Scotland, U.K.