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Editor: Dr D.T. Holyoak
Department of Geography and Geology
The College of St. Paul and St. Mary
The Park
Cheltenham, Glos. GL50 2RH

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COMPUTER PROGRAMS FOR DATABASE MANAGEMENT AND DISPLAY OF
QUATERNARY STRATIGRAPHIC DATA

Richard Everett and Ian Shennan

Recent advances in available computer software, for database management and graphics, and hardware, for cheap high quality graphical output, have allowed the development of a system to integrate the stages of data storage, retrieval, analysis and display of Quaternary stratigraphic data. The original ideas and programs were developed during research on sea-level changes in south-east England (Everett 1985) and the Fenland (Shennan 1980). The stimulus to integrate data sources for the Fenland using information stored at Durham with that being collated at Cambridge as part of the Fenland Project (Alderton 1984, Waller 1986) led to the establishment of a version of the programs on the computing facilities at Cambridge. Further modifications have been made to produce a series of transportable programs which can be integrated with commercially available packages.

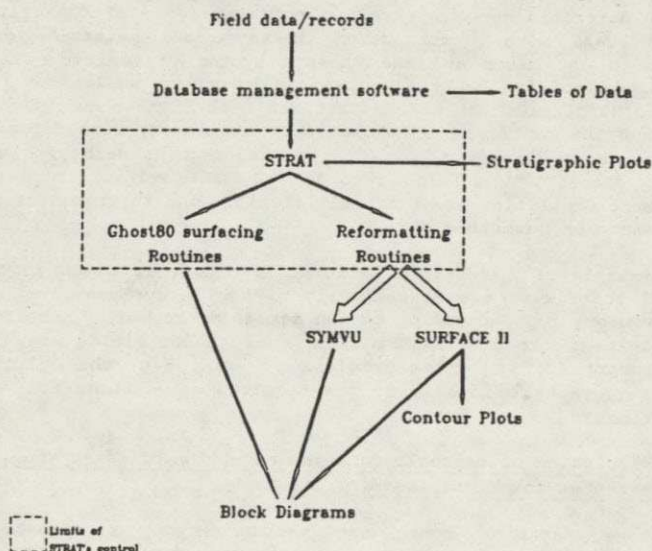


Fig. 1

The system is built around a stratigraphy-drawing program written by one of us (R.E.) but the full flexibility is gained by using other software. The basic operations (Fig. 1) that can be carried out are:

1. Data entry and storage of borehole information;
2. Manipulation of borehole data and selection of cases to be utilised further;
3. Graphical representation of selected borehole data as a series of transects using modified Troels-Smith (1955) notation and signatures;
4. Contouring of stratigraphic surfaces;
5. Block (or "3-dimensional") diagrams of stratigraphic surfaces.

1. Data entry and storage of borehole information

At the most basic level this need consist only of a file containing the attributes which are needed for operations 1-3 and the selection of those cases to be displayed could be carried out with a simple line or screen edit facility. However, the availability of database management software allows much more to be carried out, e.g. complicated conditional case selections, production of borehole lists or tables in user specified formats, transfer of data from one format type to another, etc. This flexibility is important where data are to be transported from one establishment to another. Such operations are becoming increasingly easy via electronic communications such as JANET (the Joint Academic NETWORK).

Database management software available will vary from establishment to establishment but the basic principles are similar. The example described here is based on our experience of dBaseIII run on an IBM PC-AT with a connection to an Amdahl mainframe computer. DBaseII, a BBC micro and the Phoenix system at Cambridge have also been used (working in conjunction with Martyn Waller). For each borehole 32 "fields" of information are used. The number that can be used, and the number of borehole records allowed, will depend on the software, e.g. dBaseII allows 65 thousand records each with up to 32 fields, dBaseIII 1 billion records and 128 fields. Such database management facilities are extremely flexible and the range of possible uses cannot be described here.

An example of a suitable database structure is given in Table 1. Some of the fields are specifically of use in our sea-level studies, e.g. sequence type according to the scheme described by Streif (1978), and height of the pre-Flandrian surface. Other fields are universal requirements for the other programs to work, e.g. the definition of the stratigraphy. Details of the required conventions are described in section 3.

2. Manipulation of borehole data and selection of cases and attributes to be utilised further

With a database management package such as dBaseIII these operations are integrated with data entry and storage. DBaseIII is used to extract those cases required for plotting, e.g. by defining the limit of an area of interest by giving the limiting grid references, and to feed in as input to other programs only those attributes, i.e. "fields" which are required.

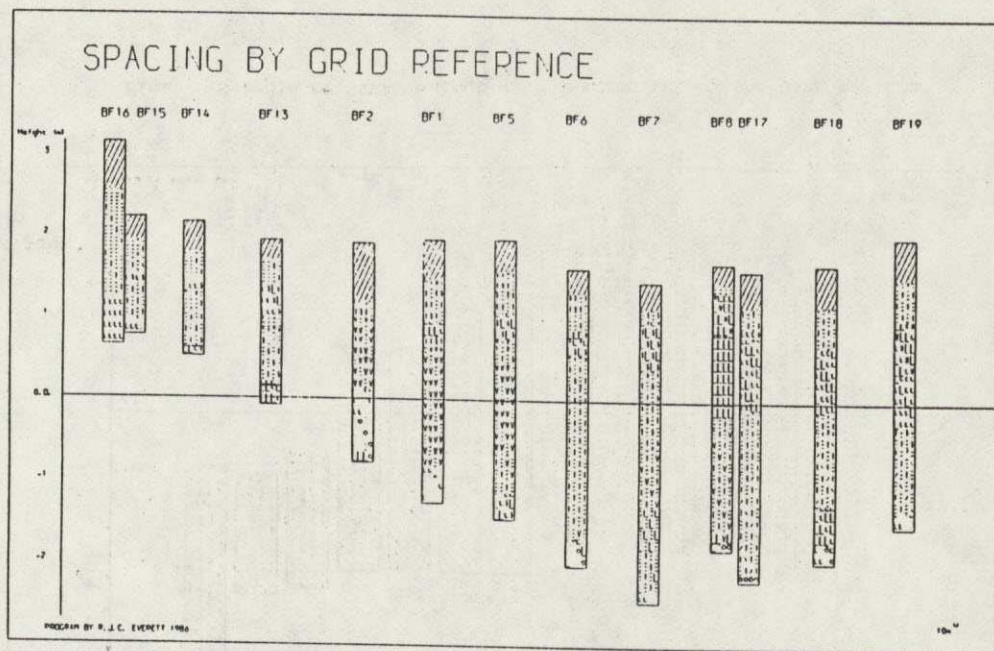
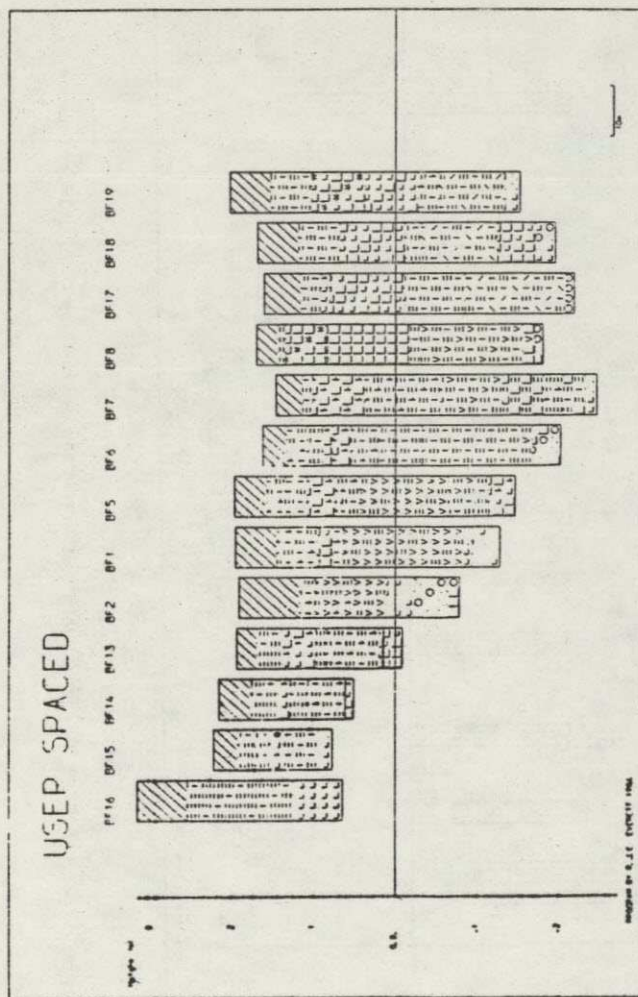


Fig. 2 Example of STRAT output with spacing defined by O.S. grid reference



3. Graphical representation of selected borehole data

The program STRAT was initially written in PascalVS (an IBM compiler conforming to the current ANSI ISO level(O) standard for the Pascal computer language and providing some extensions) and making use of the Ghost subroutine library (written in Fortran 66), but has since been modified to run with the later Ghost80 library. The stratigraphic diagrams that are produced use a modified version of the Troels-Smith (1955) graphical system, whereby within a borehole four symbols are drawn in a horizontal line, each one representing one of the four quarters which define the stratigraphic components identified in the field.

While the program runs the user is asked to choose various options interactively. Firstly the user must specify the type of datafile that is being used - database type (e.g. from dBaseIII) or the line/screen edited type. Of these the former type allows much greater flexibility within the program and is the type considered in detail here. The program counts the number of borehole records that are present within the datafile and asks the user whether the program is to spread them among a number of "transects" or whether the user wishes to specify the spread himself. The option asking the program to spread the boreholes is rather more effective with larger numbers of borehole records. The spacing of the bores along a transect may be based on Ordnance Survey grid references supplied within the borehole record (Fig. 2) or may be given interactively (Fig. 3) - boreholes with a wider scatter can be projected onto a straight line by the program given the grid references of start and finish points. In addition the program allows the reformatting of the borehole records for use with contouring and surfacing packages.

Within the program there is a certain degree of error trapping - any unknown stratigraphic descriptors (to the program that is) are plotted as a blank and error messages are written to the terminal. Any illegal value for the limes superior is also indicated, though a value of 5 is permitted to allow for cases where this may be unknown.

The program expects that the following data fields will be present within a borehole record submitted to it: REF, GRIDREF, OD, all thickness and stratigraphic fields, PREFLAND i.e. fields 1,2,4,6, to 26 in Table 1.

Limits are imposed by the program in the following respects: a maximum of 14 boreholes per transect, a maximum of 20 transects per run, and a maximum of 10 stratigraphic levels when the database type input file is used (20 with the line/screen edited type). Additionally not all of the component types described by Troels-Smith (1955) are supported - a full list of those which are, together with the symbols used is shown in Figure 4.

4. Contouring of stratigraphic surfaces

The stratigraphic boundary to be presented is selected and the relevant information from the database is extracted using dBaseIII. The essential attributes to extract are x,y coordinates (usually the

Table 1. An example of a dBaseIII datafile structure used within the Quaternary stratigraphic database management system.

Field	Field name	Type	Width	Dec
1	REF	Character	7	
2	GRIDREF	Character	10	
3	SITE	Character	31	
4	OD	Numeric	8	2
5	LIVERPOOL	Logical	1	
6	THICK1	Numeric	8	2
7	STRAT1	Character	12	
8	THICK2	Numeric	8	2
9	STRAT2	Character	12	
10	THICK3	Numeric	8	2
11	STRAT3	Character	12	
12	THICK4	Numeric	8	2
13	STRAT4	Character	12	
14	THICK5	Numeric	8	2
15	STRAT5	Character	12	
16	THICK6	Numeric	8	2
17	STRAT6	Character	12	
18	THICK7	Numeric	8	2
19	STRAT7	Character	12	
20	THICK8	Numeric	8	2
21	STRAT8	Character	12	
22	THICK9	Numeric	8	2
23	STRAT9	Character	12	
24	THICK10	Numeric	8	2
25	STRAT10	Character	12	
26	PREFLAND	Numeric	8	2
27	PROFILE	Character	3	
28	INFOSOURCE	Character	16	
29	OLDREF	Character	10	
30	RELIGRAD	Character	1	
31	C14	Character	40	
32	COMMENT	Character	80	

THICK1-10 indicates the thickness of each stratigraphic layer. STRAT1-10 defines the stratigraphic layer in modified Troels-Smith (1955) notation.

KEY TO STRATIGRAPHIC SYMBOLS USED

	Sc		Sh
	Tn		Tl
	Tb		Th (Clad.)
	Th (Phrag.)		Th (Vag.)
	Dh		Dl
	Ld		Lc
	Lf		Leo
	As		Ag
	Ga		Gs
	Gg		Test. (moll.)
	Charcoal		Component Missing

Fig. 4 STRAT component types and symbols

grid reference), and the z coordinate (the vertical component to be plotted, e.g. altitude of the surface, or depth, or thickness of the bed). It may be useful to extract the borehole reference number to check that the resultant diagram corresponds to the original data. DBaseIII was used to extract the x,y,z coordinates to produce a contour map using the SurfaceII package (Fig. 5). Other contouring packages of varying sophistication using similar inputs are SYMAP and ASPEX. An option is available within STRAT allowing the reformatting of database information for use with SurfaceII.

5. Block diagrams

These require the same data as for contouring, i.e. x,y,z coordinates. The packages that have been used so far to produce such diagrams are SurfaceII, SYMVU and Ghost80. An option exists within STRAT which allows surface plotting using the Ghost80 routines (Fig. 6), in addition to routines allowing the reformatting of the database information for use with SurfaceII and SYMVU.

Commercial software

DBaseII and dBaseIII are manufactured by Ashton-Tate and must be purchased through the usual suppliers. A licence agreement covers use of these packages after purchase. These are personal computer based systems. A link with a mainframe computer will be required for graph plotting and use of the other software. Mainframe database management software is available.

SurfaceII (Kansas Geological Survey), SYMAP, SYMVU and ASPEX (Computer Graphics Laboratory, Harvard) are mainframe software packages.

STRAT software

The STRAT program requires the installation on a mainframe computer of IBM PascalVS and Ghost80 (Fortran 66), or IBM PascalJB and Ghost80 (Fortran 77). Copies of the STRAT software can be obtained from one of us (I.S.) at the Department of Geography, Durham at minimal cost.

Acknowledgements

We would like to thank Martyn Waller, Cambridge, for help towards the development of these programs; and IBM United Kingdom Trust for sponsoring a project within the Department directed towards the use of the IBM PC in the teaching of Geography within which some aspects of this database and display system have been developed.

Richard Everett & Ian Shennan
Department of Geography
University of Durham
Durham DH1 3LE.

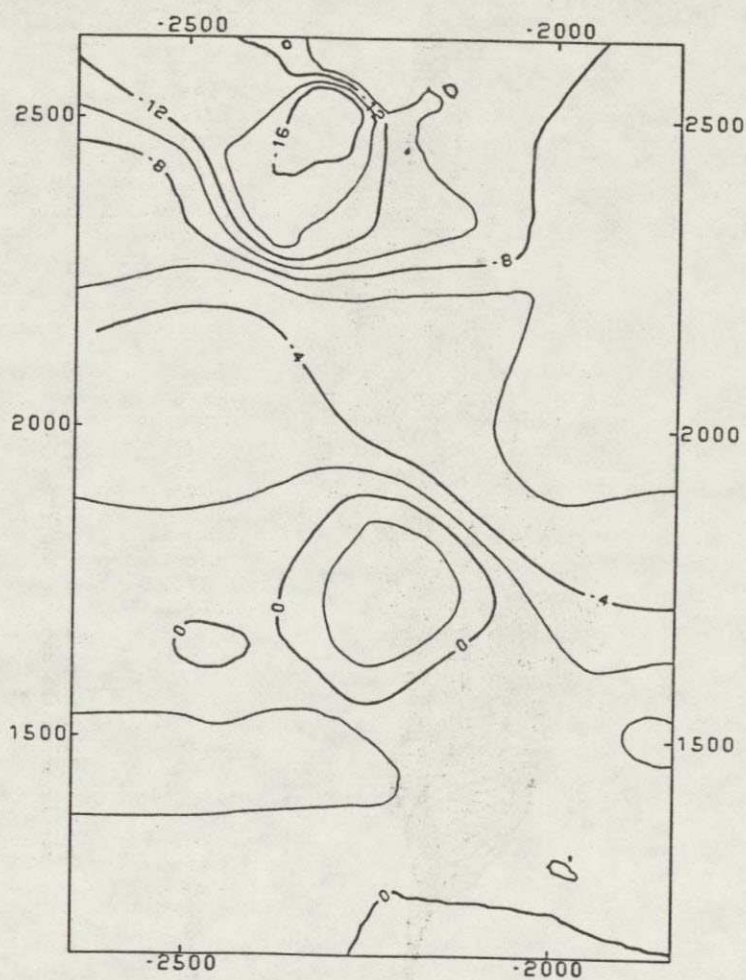


Fig. 5 An example of a contour map produced using Surface II

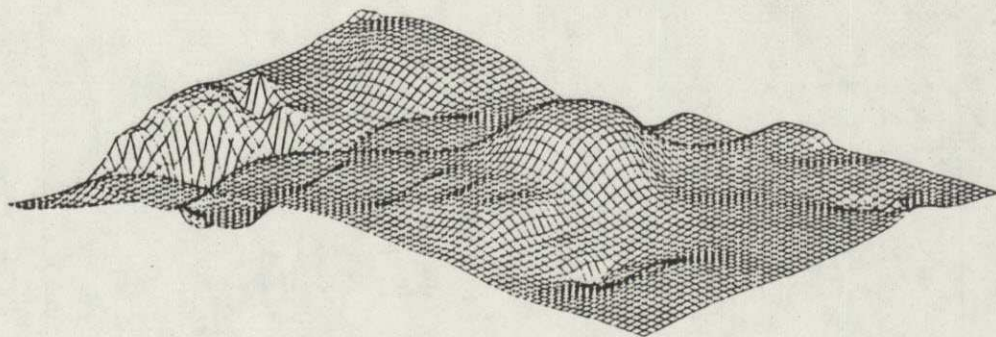


Fig. 6 A block diagram produced via the STRAT program, using the same data as portrayed in the contour map (Fig. 5)

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QN: abstracts

ERRATICS IN THE HISTORY OF GEOLOGY IN BRITAIN

The earliest records of erratics come through the folklore of placenames, there being Anglo-Saxon references to Hoarstones, Giant's Stones in Scotland and numerous place-name elements in Wales signifying the existence of large stones in unusual places. From time immemorial far-travelled rocks have been utilised, recognised and thus explained, so that there has often been confusion in historic times between an indication of natural, or of human origins.

As science developed after the 17th century, Whitehurst in the eighteenth century was to suggest that erratics resulted from volcanic explosions, while de Luc, in observing Alpine glaciers was to provide a solution which was later to help explain the origins of erratics in the British Isles. The early 19th century brought explanatory tidal waves, and later, icebergs for erratic dispersal. The theory of a flood - diluvialism - in its many forms, allowed erratics to be disseminated in geomorphic torrents.

From about 1825, Britain's geologists were carefully explaining the movement of Shap granite, Antrim Chalk and flint, and other distinctive rocks, over considerable distances with a growing appreciation of the similarity of these dispersals to those of present-day, or recent Alpine glaciers. This assisted the gradual acceptance of Agassiz's glacial theory, which in its turn helped stimulate the further collection of information on erratics.

Through-out the period 1840-1870, numerous articles were published by the Geological Society, and observations made by the Geological Survey all including in their general observations of potential glacial phenomena, erratics ranging from the massive to the miniscule.

Acting upon an initiative direct from Switzerland, David Milne-Home established a Committee for the Preservation of Erratic Blocks in 1871, under the aegis of the Royal Society of Edinburgh.

Two sets of questionnaires were circulated, one to ministers of rural parishes, the other to parochial schoolmasters, the former requesting information on boulders in excess of 50 tons, for the latter (for want of replies to the former), of 20 tons. The returns from these sheets formed the basis of printed reports running to about 550 pages of the Proceedings for the following decade. Within months of the Scottish initiative, the British Association began its own survey, but in this case boulders were of smaller size and the information was collected in more random fashion, in this case from field clubs and amateur naturalists.

Reports were published almost every year from 1873 to 1914, often comprising only summaries of lengthier accounts which appeared in local, or more rarely, national periodicals.

Although the Boulder Committees left a great legacy of data, quality is extremely variable; in Scotland virtually no petrographic information was given; that for England and Wales was limited by contemporary knowledge of identified exposures of country rock. Identifications by amateurs, and in some cases by professional geologists, tended to be partial and to relate to specific sightings based upon a personal knowledge of upland geology acquired during vacations. In Eastern England, for example, greenstone was at first attributed to Lakeland, subsequently, under Kendall's influence, some was ascribed to Norway. Later, in the 1920s, Sandford was to demonstrate that some was even Cornish (and, incidentally, to show that not all erratics need have arrived through glaciation).

Harmer's Map of erratics, published posthumously by Percy Kendall in 1923, remains the only summary of this massive and eclectic survey. Sadly, its distribution reflects the vagaries of its collectors, and an acceptance of any of its conclusions without an understanding of them would be unscientific. The golden age of naturalists as exemplified by this interest group was to be extinguished by the Great War and by the wholesale removal of the stones, through vigorous farming, road and house-building.

Whereas many useful papers have been produced on the subject since, some of which include more up-to-date source provenancing, a re-interpretation of the early collected information is long overdue,

and further systematic searches and a recording policy would be worthwhile stimulants to both geological education and the overall pursuit of systematic geology.

The writer would very much appreciate information as to the whereabouts of manuscript accounts and early lists of boulders or actual collections of stories, photographs or slides. Any assistance would be most gratefully acknowledged in future published work.

C.S. Briggs
'Pwllidrainllwyn'
Near Aberystwyth
Dyfed SY23 4SR.

QN: conference reports

INQUA COMMISSION ON THE GENESIS AND LITHOLOGY OF GLACIAL DEPOSITS: WORKING GROUP ON GLACIOTECTONICS (WGGT): REPORT ON FIELD MEETING AT MON, DENMARK 2 October 86 - 6 October 1986

This field meeting was organised by Professor A. Berthelsen and Dr. M. Houmark-Nielsen of the Institute of General Geology, Copenhagen University. The meeting was attended by more than 20, including the President of the Commission, Alexis Dreimanis, and Jan Lundquist, (Full Member of the Commission). Those attending had arrived from Western Europe (W. Germany, Holland, UK), Scandinavia (Denmark, Iceland, Sweden) Eastern Europe (Poland) and North America (Canada and USA). Some had attended meetings in the Netherlands, Germany and other parts of Denmark immediately prior to the Mon meeting. The United Kingdom was represented by Dr. P. Banham (University of London), Jane Hart (U.E.A.) and Dr. D. Croot (Plymouth Polytechnic).

The field meeting was subdivided into a number of site visits on the island of Mon, and paper-sessions at our accommodation in St. Danne. The programme was extremely full and probably due to the marvellous weather, ran like clockwork for the duration of the meeting.

Interest in glaciotectonics has grown in the last few years, no doubt stimulated by the activity of the Work Group under the Presidency of Professor Berthelsen. The participants have a wide range of academic backgrounds: Quaternary stratigraphy and bio-stratigraphy, kineto-stratigraphy, present-day glaciotectonic deformation, Quaternary geology, soil mechanics, and hard-rock tectonics. (It is one of the groups aims arising from this meeting to enlarge the scope of interested parties). The titles of the papers

presented are listed below for your information. It is the intention of the group to have these published either as a special issue of an international journal, or a book, in 1987, edited by Dr. D. Croot.

- | | |
|--|---|
| BANHAM P.H. | The Recognition of Glacitectonic Structures
(Abstract) |
| HOUMARK-NIELSEN
M. | Glaciotectonic unconformities as marker-horizons
in Pleistocene stratigraphy and their evidence for
flow directions of former glaciers, with special
emphasis on modelling |
| BRYKCYNSKI
M. | Genetic relations between escarpments, glaci-
tectonics and agglomerations of flow tills in
the Plick Basin and Warsaw Basin, Central Poland |
| PETERSON K.S. &
SCHACK PEDERSEN
S.A. | Sand filled ice wedges in the moclay on the island
of Fur, Denmark |
| RUSZCZYNSKA-
SZENAJCH H. | The origin of glacial drift: Detachment, trasnport
deposition. |
| FENTON M.M. | A model for glacial tectonism Lake Wabamun area,
Alberta, Great Plains, North America: a first
approximation |
| DREDGE L.A. | Glacial deformation of rock and sediment, Magdalen
Islands, Eastern Canada: Evidence for major
glaciation in Gulf of St. Lawrence |
| FREESER V. | On the mechanics of joint development in
glacitectonically contorted clays |
| CROOT D.G. | Morphological, Structural and Mechanical Analysis
of Neo-glacial push-ridges in Iceland. |
| HART J.H. | Subglacial Glaciotectonic deformation beneath a small
surging glacier and a Quaternary Icesheet |
| van der WATEREN
D. | A modern Spitsbergen push moraine and a Saalian
push moraine in W. Germany |
| SCHACK PEDERSEN
S.A. | Geomorphology and glacial tectonics of the
Neogene deposits in East Peary Land, North Greenland |
| BERTHELSEN | A. Glaciotectonic structures in the cliffs of southern and
eastern Mon, Denmark. |

Some time was devoted in the final session to the administration and future aims of the work group. (The group automatically continues its work until the end of the next inter-Congress period). Following the resignation of Professor Berthelson and Dr. Houmark-Nielsen from the posts of President and Secretary respectively, Dr. Croot and Dr. J. Aber (Emporia State University, Kansas) were appointed in their places. (Dr. Croot as President, Dr. Aber as Secretary).

The Work Group established a number of future aims for the next inter-Congress period:

- (1) To establish links with a broader spectrum of specialists (glaciologists, rheologists, soil mechanics, sedimentologists), and to maintain those links via existing newsletters circulating amongst scientific committees.
- (2) To maintain and diversify a register of publications in fields directly and indirectly related to glaciotectonics.
- (3) To standardise the approach to glaciotectonic mapping, description and notation of sections, and production of data.
- (4) To compile regional maps of known glaciotectonic structures, with regional compilers: Quaternary: North America (J.Aber) W. Europe (Dick van der Wateren), Scandinavia (Michael Houmark Nielsen), Eastern Europe and USSR (Hanna Ruszczyńska Szenajch). Holocene (World-wide) D. Croot.
- (5) To organise at least one field meeting and workshop session in the next inter-Congress period.
- (6) To organise a major international expedition to an area of neo-glaciotectonics to produce detailed data on a wide range of aspects of the features, and produce a substantial volume of collected papers, to be presented at the next Congress.

A more detailed account of the history, achievements and future aims of the WGGT will be presented to the XIIth INQUA Congress in Ottawa in 1987, and circulated to members of the WGGT in the early part of 1987. Any member of the QRA who is interested in becoming a member of the WGGT is cordially invited to contact me at the address below, or Jim Aber in Kansas.

We will be particularly pleased to welcome those with backgrounds in the fields mentioned in (1) above!

David Croot
Department of Geographical Sciences
Plymouth Polytechnic
Drake Circus
PLYMOUTH
Devon

Martin, P.S. & Klein, R.G. (Editors) 1984 Quaternary Extinctions; a Prehistoric Revolution. Tucson, Arizona: University of Arizona Press. 892 pages. ISBN 0-8165-0812-7.

Episodes of 'mass extinction', which have occurred at various times in the geological record, are currently attracting much attention, accompanied by a great deal of controversy. The more sensible explanations range from climatic changes to asteroid impact and the drastic ecological effects of plate tectonics on the area of submerged continental shelf. The extinctions which took place in the later Quaternary/Pleistocene, in contrast to earlier events (for example at the end of the Permian or Cretaceous), have a particular appeal, because here the explanation seems almost (but not quite) within our grasp. The phenomenon provides one of the most intriguing and exciting unsolved mysteries in Quaternary palaeontology.

This fascinating book above all provides an extensive up to date coverage of the subject of late Quaternary extinctions, with a rather heavy bias towards North America. The senior author, Paul Martin (University of Arizona, Tucson), who has also done much work on the Quaternary of the American southwest, primarily in palaeobotany, is the driving force behind current interest in late Quaternary extinctions. He was also very much involved in the previous classic work on the subject - Martin, P.S. & Wright, H.E. 1967. Pleistocene Extinctions; the Search for a Cause. Yale: Yale University Press - which has been superseded by the present volume. Richard Klein (University of Chicago) is a well known archaeologist/palaeoanthropologist with considerable experience in the analysis of Quaternary mammal remains, primarily from palaeolithic sites in southern Africa.

Efforts to cover as much ground as possible and to air a wide range of views have resulted in a rather awesome tome of nearly 900 pages, comprising 38 chapters by 47 authors. Initially, at least, one is inclined to be intimidated by the sheer volume of text and bewildering range of contributions. I would suggest that, having read the very brief introductory section 'A Word from the Editors', and Elaine Anderson's useful 'Who's Who in the Pleistocene; a Mammalian Bestiary' to then digest Chapter 17 'Prehistoric Overkill: the Global Model' by Paul Martin. The latter provides, amongst other things, an excellent overview of the phenomenon of late Quaternary extinctions on a global scale. Having mastered this (more or less), the reader can then work outwards to peruse more specialist chapters, in particular those discussing patterns of extinctions in different areas, before tackling the various hypotheses which have been put forward in explanation.

As pointed out by Martin the late Quaternary extinctions were unique in the geological record in that for the most part they affected only the so-called 'megafauna', i.e., according to Martin, terrestrial vertebrates (mainly mammals) with adult body weights in excess of 44 kg. This contrasts strongly with previous events, which

affected a wide range of organisms in different environments. For example those at the end of the Cretaceous, involved the loss of terrestrial reptiles (dinosaurs), flying reptiles (pterosaurs), marine reptiles (including ichthyosaurs and plesiosaurs) and the ammonites.

Although unusually high rates of extinction occurred during the later Quaternary over much of the globe, the phenomenon was undoubtedly much more marked in some continents than in others. For example North America appears to have lost about 73 per cent of its large mammal genera and Australia 94 per cent, whereas Europe lost 30 per cent and Africa with perhaps less than 5 per cent was scarcely affected. Moreover in some areas (e.g. North America) extinctions appear to have been relatively sudden, occurring within a timespan of a few thousand years or perhaps very much less, whereas in others (e.g. Europe) they seem to have been more gradual, staggered over tens of thousands of years. On the continents all major extinctions had taken place before 10,000 years P.P.

A large part of the book is concerned with the lively debate between: (a) those who believe that animals became extinct because they could not cope with the stress of environmental changes at the end of the Last Cold Stage; and (b), those who think that they were exterminated by human hunters (the 'overkill' hypothesis).

The chapter by Russell Graham and Ernest Lundelius, 'Coevolutionary Disequilibrium and Pleistocene Extinctions', provides an important development of the climatic argument. Based essentially on work in North America, these authors propose that the climatic changes at the end of the Pleistocene resulted in the breakdown of long-established ecological communities that had 'coevolved' over much of Pleistocene time. Animals, especially herbivorous 'megamammals', that were unable to adapt to the 'redefined niche differentiation' became extinct. A rather similar hypothesis put forward by Dale Guthrie, in his chapter 'Mosaics, Allelochemicals and Nutrients', explains extinctions in terms of fundamental changes towards the end of the Pleistocene which resulted in the replacement of supposed large-scale mosaic vegetation patterns ('plaids') in the late Pleistocene by vegetation zoned according to climate ('stripes') as it is today. The resulting marked reduction of habitat diversity, together with the late and postglacial spread of many plants with chemical 'antiherbivory' defences are thought to have selectively tipped the balance against certain large herbivores, such as mammoths, mastodons, ground sloths and horses in North America.

The obvious objection to this kind of hypothesis is that it asserts that there was something unique about the climatic changes which took place at the end of the Last Cold Stage, whereas we in Britain are used to the idea that the Flandrian is an (unfinished) interglacial period, of much the same character as previous interglacials. Earlier transitions from cold stages to interglacials, however, demonstrably were not accompanied by episodes of 'mass extinction'. A fundamentally different outlook is shared by several North American authors. For example Guthrie asserts that 'a growing body of evidence attests that the intensifying seasonality at the end of the last glacial was unique in both extent and in pace. Biotically the Holocene is not like other interglacials'. One suspects that such views are possible only because the palaeontology of interglacials in

North America is rather poorly known. Clearly, however, we need much more information on Pleistocene environmental changes for this and many other parts of the world before we can confirm or rule out this argument.

Paul Martin is the leading proponent of the alternative 'overkill' hypothesis and his chapter 'Prehistoric overkill; the Global Model', clearly expounds the ideas which he has developed over several decades. Briefly Martin aims to demonstrate that extinctions follow shortly after the arrival of humans in a particular zoogeographical region. He points to the extinctions which occurred in for example New Zealand (moas) and Madagascar (giant lemurs and others), which almost certainly resulted from overhunting by humans, the first of which arrived only within the last few hundred years. These events, however, may not be relevant to the main debate since they took place on islands in the face of relatively high human population densities sustained essentially by farming.

In North America spectacular extinctions appear to have occurred within a short period coinciding with the arrival of the Palaeoindian Clovis hunters (probably the first people to reach America) around 11,000 years ago. Conversely in Africa, where man originated, late Pleistocene extinctions were minimal, because humans and fauna had got used to one another much more gradually. In response to objections that remains of extinct animals were rarely found in association with artefacts, Martin some time ago put forward his celebrated 'blitzkrieg' hypothesis, which supposes that the impact on the fauna was so swift and devastating as to leave little evidence behind. Clearly, however, 'blitzkrieg' cannot account for the lesser, but still important extinctions, that happened in Europe, both because humans have been present in the region for a long time and because the animals disappeared over a long period. Even more seriously, the evidence from Australia seems to flatly contradict Martin's ideas, as it seems to indicate that humans and extinct fauna may have co-existed for some 30,000 years. In the latter case Martin questions the validity of the rather few radiocarbon dates so far obtained.

A supporter of 'overkill', but apparently not of 'blitzkrieg', Jerry McDonald in his chapter 'The Reordered North American Selection Regime and Late Quaternary Megafaunal Extinctions' argues convincingly that, in the period following the decay of the Wisconsinan Ice Sheet, biological productivity in North American showed an enormous increase and extinctions should not have resulted from such environmental changes. He is again struck by the coincidental timing of Clovis cultures and extinctions; a correlation reinforced by the presentation of much hard data in the contributions by Jim Mead, Jerry McDonald and Vance Haynes. Also very relevant here is the excellent chapter by Jared Diamond, 'Historic Extinctions: a Rosetta Stone for Understanding Prehistoric Extinctions'.

In the final section, two chapters by Larry Marshall and Don Grayson, are valuable overviews, summarizing the opinions of the other authors and weighing the evidence. Although their contributions are both stimulating and meticulously thought out, I feel that they are too concerned with the ideas of particular personalities and 'the structure of the debate', rather than stressing the overwhelming need for more information.

I personally suspect that the answer to this intriguing question will prove to be considerably more complex even than it now appears. It is abundantly clear when contributors disagree on fundamental facts, that so much of the current controversy stems from our still very imperfect knowledge of such factors as Quaternary environmental changes and the absence of a detailed and reliable chronology of extinctions for all parts of the world. Surely at present the major requirement is not for more refined hypotheses or debate, but for a great deal more basic data, including records of later Quaternary vertebrates (extant as well as extinct forms) in good stratigraphic context and/or dated by radiocarbon (preferably both). Only then will it be possible to build up an accurate global picture of the pattern of extinctions in space and time. From this, hopefully, one can go on to develop and test hypotheses by observing how this pattern correlates with climatic/vegetational changes on the one hand, and the archaeological record on the other.

In addition to its main purpose of covering Pleistocene extinctions, the book provides invaluable reviews of late Pleistocene faunas over much of the globe. Particularly informative are the contributions by: Richard Klein (African faunas); Peter Murray, Duncan Merilees and David Horton (Australian faunas); Robert Dewar (subfossil fauna of Madagascar) and Michael Trotter and Beverley McCulloch (extinction of moas in New Zealand). The chapter by N.K. Vereschagin and G.F. Baryshnikov, although frustratingly brief concerning the all important basic data is a useful summary of late Pleistocene faunas and extinctions in the Soviet Union. However, a major criticism of the book is that, apart from the summaries in Martin's chapter and a report on a single site in Venezuela, there is no coverage of either Europe or South America, although the faunas of both areas are of considerable relevance to the whole extinctions question.

For anyone interested in either Quaternary vertebrates or palaeolithic archaeology, who can afford it, this volume is a must for the bookshelf. Hopefully it should be available also in many libraries. This intriguing subject deserves wider attention. Quite apart from its intrinsic interest we might do well to find out what caused 'mass extinction' on what is geologically speaking our own doorstep.

A.J. Stuart
Castle Museum
Norwich
NR1 3JU

QN: obituary

ANTHONY KNOWLES, 2nd September 1933 - 1st October 1986

After enjoying a game of badminton with a colleague, Tony Knowles tragically collapsed and died. Those regular participants in Q.R.A. activities will in recent years, be familiar with a rather quiet but nonetheless genial and enthusiastic member of the Association. Indeed less than three weeks before his passing he attended the joint Q.R.A. British Geomorphological Research Group meeting which had as its theme 'Rivers and River Terraces'. Subsequently he talked of this pioneering British Quaternary geomorphological meeting in euphoric terms regarding it as a major development. This is not surprising since Tony's main academic interest lay in Quaternary geomorphology.

Tony rather unusually possessed two bachelor honours degrees. The first of these was a B.Sc.(Econ) in Applied Economics from the London School of Economics where he graduated in 1954 and he immediately followed this with a Graduate Certificate in Education from the University of Manchester. After National Service he taught in Ashton under Lyne for four years prior to moving to the College of Commerce at Newcastle-upon-Tyne as a lecturer. However, his stay in the north east was brief since he then made the profound decision to become a student again and thereby develop his growing interest in physical geography. Hence in 1962 he entered the Department of Geography in the University of Manchester.

As a mature student, Tony made a major contribution to activities in the department and was constantly enquiring of a research student's lot. At that time Quaternary oriented studies were taking root (in 1964 the Q.R.A. was effectively founded) and upon graduation in 1965 Tony elected to undertake a part-time higher degree initially whilst teaching at Stockport School. Under the guidance of Dr. R.H. (Chuff) Johnson, he commenced on the former landslips in the Namurian county east of Oldham and in 1973 was awarded an M.A. for his resultant thesis. His stay in Stockport was short, for in 1966 he joined the newly established Madeley College of Education (3 km west of Keele University) as a Lecturer in Geography. The other important event in 1966 was his marriage to Elaine Ackroyd, also a Manchester graduate, who was to give him unfailing support whilst he fitted research time into his lecturing, teaching and domestic duties.

As a north Staffordshire resident Tony turned his enquiring mind to the geomorphology of his adopted home area and, following the completion of his M.A. he registered for a part-time Ph.D. at Manchester. In 1978 Madeley was absorbed into the North Staffordshire Polytechnic and he moved his work place to Stoke and was made a Senior Lecturer in the Department of Geography and Recreational Studies. With the support of his new department his Ph.D. study made progress and was in the last phases of write-up when his life was so suddenly terminated. A scrap of satisfaction can be gleaned from his contribution to the book on the 'Geomorphology of north-west England' since this distils the essence of his latest research and illuminates the kind of work being pursued on the dry valley and dell networks on

the Permo-Triassic of western north Staffordshire. This fascinating landscape was beginning to yield its secrets under the tenacious and penetrating attention which he gave to it.

Tony exemplified an important component of the Q.R.A. membership, that of a dedicated active researcher without easy access to major equipment, facilities, and field support but one who by sheer drive, perseverance and intellectual capability was able to make thoroughly worthwhile contributions to knowledge despite logistical difficulties. Amazingly this was achieved without any detriment to his 'bread and butter' duties as lecturer and teacher trainer. Indeed, his packed funeral service was almost exclusively drawn from those associated with his non-research contributions to life. They mourned the loss of a much loved friend, a person who set an example towards which most aspire but fail.

Bibliography

1985a. The relationship of periglacially disturbed ground phenomena and associated sediments to supposed former pro-glacial lakes near Baldwins Gate, north-west Staffordshire, England. North Staffordshire Journal of Field Studies, 21, 37-56.

1985b. The Quaternary History of North Staffordshire, in R.H. Johnson, ed., The Geomorphology of North-West England, Manchester (Manchester University Press), 222-236.

1986. Lake Madeley: A Review of the Pleistocene proglacial lake concept in the context of the glacial geomorphology of the Madeley area of North Staffordshire. Occasional Papers in Geography, no.8, North Staffordshire Polytechnic, Stoke on Trent.

Professor Peter Worsley
Department of Geography
University of Nottingham.

QN: notices

REGISTER OF MEMBERS' INTERESTS

In order to help with requests for information from organisations such as the B.B.C. and commercial firms the Q.R.A. Executive Committee is establishing a list of interests of those members willing to assist with such enquiries. If you are willing to help please send very brief details of interests to Dr. D.H. Keen, Q.R.A. Secretary.

NORTH OF ENGLAND SOILS DISCUSSION GROUP

The Annual Field Meeting will be based in Manchester from 7-9 September 1987 and consider "Soil erosion in the South Pennines". Details from: P.J.A. Howard, I.T.E. Merlewood Research Station, Grange-over-Sands, Cumbria, LA11 6JU.

SECOND INTERNATIONAL SYMPOSIUM ON RADIOCARBON DATING AND ARCHAEOLOGY

Will be held at the University of Groningen, The Netherlands from 7th-11th September 1987; details from: Conference Secretariat, Biological Archaeological Institute, Poststraat 6, 9712 ER Groningen, The Netherlands.

FINAL FIELD MEETING OF IGCP 200 UK WORKING GROUP

Will be held in the Lincolnshire Fenlands from 18th-20th September 1987. The meeting will be concerned primarily with the methods of investigation and reconstruction of Fenland environments influenced by changes in sea level. Details from: Dr. Ian Shennan, Department of Geography, University of Durham, Durham DH1 3LE.

5TH INTERNATIONAL FLINT SYMPOSIUM

Will be held in Bordeaux, France from 27th September-2nd October 1987. This symposium includes a Quaternary section. Details from: Michel Lenoir, Secretary 5th International Flint Symposium, Institut de Quaternaire, Université de Bordeaux I, 33405 Talence, France.

THE QUATERNARY GEOLOGY OF NORTH-EASTERN ESSEX

The Geologists' Association will hold an Excursion to Essex on 22nd-24th May 1987, concentrating on Middle Pleistocene deposits in the northern coastal district of Essex. For details send S.A.E. to Dr. D.R. Bridgland at 188 Tonbridge Road, East Peckham, Tonbridge, Kent TN12 5JR.

INTERNATIONAL SYMPOSIUM ON ENGINEERING GEOLOGY

An "International Symposium on Engineering Geology as related to the study, preservation and protection of ancient works, monuments and historical sites" will be held at Athens, Greece from 19-23 September, 1988. Details from Greek Committee of Engineering Geology, 1988 Symposium Secretariat, P.O. Box 19140, GR-11710 Athens, Greece.

INTERNATIONAL WORKING MEETING ON SOIL MICROMORPHOLOGY

The International Society for Soil Science Subcommittee B Micromorphology Working Group will meet at San Antonio, Texas from 10-15 July 1988. Chairman of the Organising Committee is L.P. Wilding, Dept. of Soil and Crop Sciences, Texas A. & M. University, College Station, TX 77843, U.S.A. Liaison with the Q.R.A. is Vance Holliday, Dept. of Geography, Science Hall, University of Wisconsin, Madison, WI 53706, U.S.A.

CALENDAR OF MEETINGS

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

23rd-24th Symposium on the Thermal Waters of Bath at Royal Society,
March 1987 London (see Newsletter 50, p. 51).

26th-30th Late Cenozoic Palaeoenvironments and Geology of the
April Arctic, Workshop to be held in Norway (see Newsletter 49,
1987 p. 49).

3rd-8th Penrose Conference on Glacial Facies Models, in Ontario,
May 1987 Canada (see Newsletter 50, p. 52).

18th-26th IGCP/INQUA Symposium on 'Lake, mire and river history
May 1987 in south Sweden (see Newsletter 50, p. 52).

22nd-24th Geologists' Association Excursion to NE. Essex (see notice
May 1987 above).

25th-27th Symposium on Coastal Lowlands: Geology and Geotechnology,
May 1987 at the Hague, Netherlands (see Newsletter 48, p. 44).

31st July- XIIth INQUA Congress, Ottawa, Canada (see Newsletters 48,
9th August p. 44; 49, p. 48; 50, pp. 48-51).
1987

7th-9th North of England Soils Discussion Group Annual Field
September meeting, Manchester (see notice above).
1987

7th-11th Second International Symposium on Radiocarbon dating and
September Archaeology at Groningen, The Netherlands (see notice
1987 above).

18th-20th IGCP 200 UK Working Group Final Field Meeting in the
September Lincolnshire Fenslands (see notice above).
1987

20th-25th Spanish Association for the Study of the Quaternary
September (A.E.Q.U.A.) VIIth Meeting at Santander, Spain (see
1987 Newsletter 50, p. 52).

27th-29th BGRG Meeting in Oxford (see Newsletter 49, p. 49).
September
1987

27th Sept. 5th International Flint Symposium at Bordeaux, France (see
-2nd Oct. notice above).
1987

- 8th-11th Symposium on the Geomorphology of Southern Africa,
April University of Transkei, Southern Africa (see Newsletter
1988 50, p. 52).
- 22nd-25th Geological Association of Canada, Mineralogical
May 1988 Association of Canada, Canadian Association of Petroleum
 Geologists, Joint Meeting at St. John's, Newfoundland (see
 Newsletter 49, p. 48).
- 10th-15th International Working Meeting on Soil Micromorphology, at
July 1988 San Antonio, Texas, U.S.A. (see notice above).
- 19th-23rd International Symposium on Engineering Geology, at Athens,
September Greece (see notice above).
1988
- 9th-19th 28th International Geological Congress to be held at
July 1989 Washington, D.C., U.S.A. (see Newsletter 48, p. 44).

QUATERNARY NEWSLETTER

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