Instructions to authors

*Quaternary Newsletter* is issued in February, June and October. Articles, reviews, notices of forthcoming meetings, news of personal and joint research projects etc. are invited and should be sent to the Editor. Closing dates for submission of copy (news, notices, reports etc.) for the relevant numbers are 5th January, 1st May and 1st September. These dates will be strictly adhered to in order to expedite publication. **Articles must be submitted at least 6 weeks before these dates in order to be reviewed and revised in time for the next issue of QN, otherwise they may appear in a subsequent issue.**

Suggested word limits are as follows: obituaries (2000 words); articles (3000 words); reports on meetings (2000 words); reports on QRA grants (800 words); reviews (1000 words); letters to the Editor (500 words); abstracts (500 words). Authors submitting work as Word documents that include figures must send separate copies of the figures in .eps, .tif or .jpg format (minimum resolution of 300 dpi is required for accurate reproduction). Quaternary Research Fund and New Researchers Award Scheme reports should limit themselves to describing the results and significance of the actual research funded by QRA grants. The suggested format for these reports is as follows: (1) background and rationale (including a summary of how the grant facilitated the research), (2) results, (3) significance, (4) acknowledgments (if applicable). The reports should not (1) detail the aims and objectives of affiliated and larger projects (e.g. PhD topics), (2) outline future research and (3) cite lengthy reference lists. No more than one figure per report is necessary. Recipients of awards who have written reports are encouraged to submit full-length articles on related or larger research projects.

**NB:** Updated guidelines on the formatting of contributions are now available via the QRA webpage and from the editor.


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**COVER PHOTOGRAPH**
Hope’s Nose raised beach sequence, being visited by QRA ADM delegates (see QRA ADM report inside this issue) (photo credit Francis Ryan).
As promised in issue 144 (February 2018), in this edition we cast the spotlight on Glen Roy, as a site that fascinated Brian Sissons, and that he provided crucial insights into. This site was nominated for the QRA50 by Adrian Palmer.

Figure 1. Glen Roy from the flanks of Bohuntine Hill looking north with the Parallel Roads at 260 m, 325 m and 350 m clearly cut into the hillsides. (Photo: A. Palmer).

Here is a summary of the entry for Glen Roy and Glen Spean, from Silva and Phillips (2015, p38-39):
• Glen Roy is one of most iconic sites associated with the Glacial Theory, including visits by Charles Darwin, Louis Agassiz and William Buckland (and many decades later by armies of MSc students from Royal Holloway, University of London (Editor)).

• Agassiz and Buckland were the first to interpret the ‘Parallel Roads’ as shorelines of ice-dammed lakes.

• The Lock Lomond Stadial (LLS) age for the shorelines, and processes and rates of shoreline formation, were established within the research published by Brian Sissons (1997; 1978; 1979). In addition this work addressed the regional pattern of glacier retreat, lake drainage by jökulhlaup the role of tectonics in dislocating the shoreline.

• Further estimates for the timing and rate of shoreline formation have been provided by a varve chronology (Palmer, 2010) indicating that the lakes existed for 515 years.

• (Brian continued to puzzle over this site and in 2017 published a refined interpretation (Editor)).

• Glen Roy is unique site of European, and global, significance, for exploring the complex relationships between glacial, fluvial and lacustrine landforms and sediments, and these provide an exceptional opportunity to develop our understanding of the rate of landscape response to abrupt climate change.

References (and key sources for the site)


OBITUARIES

MARTIN J. AITKEN (1922 – 2017)

Martin Aitken is perhaps best known for his pioneering contributions to Archaeometry. Yet his work in magnetic dating and in luminescence dating, and his writing, reflect a physicist with strong interests in Geoscience. His contributions and influence are of enduring significance to Quaternary Research.

Martin was born in Stamford, Lincolnshire on the 11th March 1922, the second son of an engineering draughtsman. Both sets of grandparents were farmers in the Lincolnshire Fenlands, and he traced lowland Scots ancestry on his paternal side and Huguenot French connections on his maternal side. Educated from 1930 to 1941 at Stamford School, he was inspired by his Physics teacher, and won a Hankey Radio Bursary to Wadham College, Oxford, in 1941 to study Physics with Radio at the Clarendon Laboratory. In 1942 he joined the RAF Volunteer Reserve as Radar Officer serving in Ceylon (Sri Lanka), India, and Burma (Myanmar), until 1946. Returning to Oxford, he completed his Physics degree in 1949. In later life he remembered a summer vacation spent in Harwell helping to load uranium into the Graphite-moderated Low Energy Experimental Pile (GLEEP) which in 1947 became the first experimental nuclear reactor to operate in the UK and, indeed, in Western Europe. Martin’s doctoral research concerned the development of a 120 MeV electron-synchrotron in the Clarendon Laboratory, where he was responsible for the vacuum systems. This led to his first publication in 1953, a successful doctoral submission in 1954, and subsequent papers on photo-nuclear reactions using high energy bremsstrahlung quanta to promote proton and neutron emission from light elements.

Following a period as a research officer in the Clarendon Laboratory Martin was appointed Deputy Director of the Research Laboratory for Archaeology and the History of Art (RLAHA) in 1957, until retiring in 1989 as ad hominum Professor of Archaeometry. His awards include the 1992 Gemant Award of the American Institute of Physics (for pioneering the application of physics to Archaeology and art history), the 1997 Pomerance Science Medal of the Archaeological Institute of America, and an honorary doctorate in 2003 from the Université Blaise-Pascal in Clermont Ferrand. He was a Fellow of Institute of Physics, a Fellow of the Society of Antiquaries, a Member of the Royal Institution, and from 1983 a Fellow of the Royal Society.
He married Joan Killick in 1947, and having spent several decades living in the small village of Islip outside Oxford, in retirement they moved to the Auvergne region of France, living in a small and beautiful hamlet near Augerolles in the Puy-de-Dôme. Martin’s scientific writing and conference attendance continued for several years after retirement. His work was celebrated at a conference held in Clermont Ferrand in 2002 to mark his 80th birthday. There have been several appreciations of his work, both since his retirement and in the last year. Martin died in France aged 95 on 13th June 2017. Obituaries already published include those by his daughter Jessica in the Guardian, by Mark Pollard both in the Daily Telegraph and in Archaeometry, and by Nigel Spooner and Daniel Questiaux in Ancient TL. There are conference proceedings in progress in Archaeometry and within journal issues on luminescence dating, dedicated to his memory. These have highlighted his many contributions to the early development of magnetic prospection, to the development of magnetic dating, considered by some to have greater significance in the Geosciences than to Archaeology, and to the development of luminescence dating. Today luminescence dating flourishes as a primary tool for understanding the chronology and dynamics of Quaternary landscapes and environments. It is also one of the primary means of establishing the chronology of modern human evolution and dispersal, and it is finding new applications in thermo-chronology and the characterisation and dating of rock surfaces. Martin’s own interests in luminescence dating seem to have started from his interest in developing magnetic chronologies, originally based on remanent magnetic direction and later in exploring systems which register variations in magnetic field intensity. His early work in magnetic prospection aimed at locating suitable heated structures for establishing secular variation curves, clearly founded on his knowledge and interest in the physics of electromagnetic interactions and Earth systems. Thermoluminescence dating of kiln structures and ceramics offered the potential to establish a framework for linking these elements together. In the event, both the magnetic dating and luminescence research brought further complexity and opportunities in their wake.

Martin published more than 150 scientific papers covering the combination of method development and applications in both areas. His books: “Physics and Archaeology” originally published in 1961, and substantially revised in 1974, “Thermoluminescence Dating” in 1985, “Science Based dating Techniques in Archaeology” in 1990, and “An Introduction to Optical Dating: The Dating of Quaternary Sediments by the use of Photon-stimulated Luminescence” are all written with a clarity, precision and enthusiasm that characterised their author. Of these, his 1985 and 1987 books on luminescence dating and his 1990 book on science based dating techniques in Archaeology remain standard sources in dating laboratories and in Archaeology departments.

Martin was proud that he had supervised 23 of the 27 postgraduate students who went through RLAHA during his period there, many of whom went on to
leading academic or professional careers afterwards. He had a reputation as a demanding supervisor, but kept in touch with former students and supported their careers afterwards. He also had a talent for community building. Visitors to his laboratory were welcomed and encouraged. Both the International Archaeometry Symposium, and the International Luminescence and Electron Spin Resonance Dating conferences, which continue today with sizeable global participation, originated as informal meetings which Martin started in Oxford; one suspects simply to engage with people who shared his interests and enthusiasm for science.

In 1957 when Martin decided to leave mainstream research in high energy physics in favour of a small and relatively unheard of field, he made the change because of the opportunity to apply physics to a discipline in which he found a deepening interest, and where he felt that individual effort could still be effective. Many of us are very pleased that he did so.

D.S. expresses thanks to the Aitken family for sharing memories of Martin and to Ann Wintle for her proof-reading.

**Selected Publications**


Atti del VI Congresso Internazionale delle Scienze Preistoriche e Protostoriche II, Roma, 33-36.


JOHN BRIAN SISSONS (1926 – 2018)

The death of Brian Sissons on 20 January 2018 marked the end of an era. He laid the foundations of our current understanding of the geomorphology of Scotland, and his impact on Quaternary research extended much wider through his supervision of over 30 PhD candidates, many of whom pursued academic careers in UK universities and rose to become leaders in their fields.

Photo: Brian Sissons in Glen Roy in 2008, on a field course of RHUL Masters degree students.

Brian was born in Batley, Yorkshire, and between 1937 and 1944 attended Batley Grammar School, where under the stimulus provided by his geography teacher (E.T.W. Robinson) he conceived an enduring interest in geomorphology. In 1944 he won an Open Exhibition to St Catharine’s College, Cambridge, but was conscripted to serve for three years as a radio operator in the Royal Navy, sailing in a depot ship to join the British Pacific Fleet. Returning to Cambridge in 1947, his enthusiasm for glacial geomorphology was fired by the lectures of W.V. Lewis, and he completed his undergraduate dissertation on aspects of the meltwater channels of south Yorkshire. He graduated with a First Class Honours
BA in 1950 and remained in Cambridge to complete a PhD on the denudation chronology of SW Yorkshire under the supervision of R.F. Peel. In 1953 he was appointed Assistant Lecturer in Geography at the University of Edinburgh.

Apart from a year as visiting Assistant Professor at McGill University (1957–58), Brian remained at Edinburgh until his early retirement in 1982, first as lecturer (1954–67), then as Reader (1967–82). During this period he published eighty papers, mostly devoted to aspects of the Quaternary geomorphology of Scotland; in all but a handful he was single or senior author. His book *The Evolution of Scotland’s Scenery* (1967) is a classic; it not only synthesised all earlier literature on the geomorphology of Scotland, but was written with flair, insight and prescience. It had a huge influence on the upcoming generation of geomorphologists in the UK, and even after 50 years is rewarding and stimulating reading. Its briefer successor *The Geomorphology of the British Isles: Scotland* (1976) provided an appropriate update, based mainly on Brian’s own research (and that of his PhD students) during the intervening years. A complete list of his publications prior to 1984 appears in a special issue of *Quaternary Science Reviews* that was compiled by several of his former postgraduate students to celebrate his retirement (Ballantyne and Gray, 1984).

Brian soon acquired a reputation (and in some quarters, notoriety) as a researcher of remarkable originality, uncompromising integrity and formidable intellect. His research was recognised by the award of DSc from the University of Edinburgh, the Clough Medal of the Edinburgh Geological Society, the Research Medal of the Royal Scottish Geographical Society and the Back Award of the Royal Geographical Society. He was made an honorary member of the QRA in 1990. That he was not promoted to a personal chair at Edinburgh in recognition of his outstanding research contribution appears to have been due to the narrow-minded opposition of certain of his senior colleagues rather than any failure to meet and indeed exceed the criteria for promotion.

Five main themes dominated Brian’s research: (i) reassessment of the significance of meltwater channels and related glacifluvial landforms (1958–63); (ii) deciphering the sequence of raised and buried shorelines and associated sea-level changes in eastern Scotland (1962–72), and reinterpretation of the age and origin of rock platforms in western Scotland (1974–82); (iii) research on the extent and chronology of the last Scottish Ice Sheet and associated readvances (1961–82); (iv) reconstruction of the extent and palaeoclimatic implications of the glaciers that occupied Scotland during the Loch Lomond (Younger Dryas) Stade (1967–82); and (v) investigation into aspects of landscape evolution associated with the damming of glacial lakes, particularly in Glen Roy and adjacent glens (Please see this edition’s Spotlight on a Site (Editor)).

Prior to Brian’s work, meltwater channels in Britain had been widely interpreted as overspill channels formed by outflow of ice-dammed lakes. In a series of eight
closely-argued papers, he established our current understanding of such features in terms of subglacial, ice-marginal, submarginal and proglacial drainage systems - interpretations that have remained unchallenged to the present. His work on the raised and buried shorelines in eastern Scotland, carried out in collaboration with his PhD students David Smith and Robin Cullingford, was equally game-changing. Prior to 1962 the literature on raised shorelines in Scotland was dominated by the concept of quasi-horizontal ‘100 foot’, ‘50 foot’, ‘25 foot’ and ’15 foot’ raised beaches. Detailed mapping and field survey (over 12,000 spot heights), supplemented by stratigraphic information from 3000 hand bores, commercial boreholes and some 70 radiocarbon dates of organic material from cores led him and his co-workers to reconstruct in unparalleled detail a remarkable sequence of 20 glacio-isostatically tilted shorelines (some buried as a result of later marine transgression) for Fife and the Forth and Tay valleys. This was seminal research; although shoreline sequences around the British Isles and their interpretation have been refined over the ensuing 50 years, the methodology and conceptual basis of the eastern Scotland shoreline model formed a paradigm for subsequent research. In conjunction with two other PhD students, Murray Gray and Alastair Dawson, Brian also turned his attention to the origins and significance of the low (<12 m OD) Main Rock Platform in western Scotland, concluding that this formed under periglacial conditions during the Loch Lomond Stade. From the westerly distribution of high rock platforms in western Scotland he inferred that during the retreat of the last ice sheet, the western limit of the ice sheet lay for a prolonged period amongst the Inner Hebrides, a conclusion recently vindicated by TCN dating of the timing of ice-sheet retreat in this region (Small et al., 2017).

Conflicting evidence bedevilled Brian’s interpretation of the dimensions of the last Scottish Ice Sheet. He acknowledged that the Fennoscandian Ice Sheet must have been confluent at some time with the Scottish Ice Sheet in the northern North Sea basin to account for northwesterly ice flow across Caithness and Orkney, but was persuaded that the balance of evidence was consistent with a restricted Late Devensian ice sheet, with ice-free enclaves in Caithness, Buchan and Orkney, and an ice margin terminating 60 km offshore in eastern Scotland (Sissons, 1981). This interpretation was subsequently developed by Donald Sutherland (1984) in a magisterial review of the available evidence and embodied in an influential paper by Bowen et al. (1986). TCN dating of supposedly ‘ice-free’ enclaves, mapping based on bathymetric data for the shelves adjacent to Scotland and the dated stratigraphy of trough-mouth fans beyond the shelf break has now demonstrated that the last Scottish Ice Sheet was much more extensive than Brian envisaged; but such techniques and data were unavailable in 1980, and he later acknowledged (at least verbally) that his views regarding the dimensions of the last ice sheet had been invalidated by new evidence. Somewhat ironically, his early advocacy (but later rejection) of evidence for a major readvance of the retreating ice-sheet margin in eastern Scotland (the Perth Readvance) has recently been revived, though the extent, significance and status of this event remain uncertain.
Reconstruction of the dimensions of the glaciers that re-occupied the Scottish Highlands and Hebrides during the Loch Lomond (Younger Dryas) Stade of \(~12.9–11.7\) ka engaged Brian from 1970 until his retirement. Starting with the Lochnagar area and SE Grampians, he mapped the glacial landforms of the Loch Lomond Readvance (LLR) across extensive parts of the Highlands, using a combination of aerial photograph interpretation and detailed fieldwork, sometimes walking over 40 km in a day to reach remote glens. His mapping alone was innovative: he was the first to appreciate, for example, the significance of Lateglacial periglacial features in limiting former glaciers. To test the age of his mapped ice limits he employed coring of enclosed hollows inside and outside these limits: cores recording a basal tripartite stratigraphy (minerogenic-organic-minerogenic) were interpreted as indicating that such sites lay outside the limits of the LLR; inside these limits, cores invariably revealed only Holocene organic material. Radiocarbon dating of organic material immediately above and below minerogenic horizons was employed to confirm this stratigraphic interpretation. Several of his PhD students (Roger Cornish, Murray Gray, Marie Robinson, Don Sutherland, Ken Thompson and Tim Wain-Hobson) extended the mapping of LLR limits elsewhere in Scotland, whilst others, notably John Lowe and Mike Walker, focused their research on the radiocarbon chronology and pollen stratigraphy of sites inside and outside the inferred readvance limits.

To Brian must also be conceded the credit for developing a novel methodology for interpreting the dimensions of palaeoglaciers (via calculation of former equilibrium altitudes) to infer aspects of former palaeoclimate. This innovation again was seminal: the approach he developed has been modified and replaced by semi-empirical computational modelling, but such refinements are rooted in the same principles that he and Don Sutherland established over 40 years ago. Some of his mapping, particularly in NW Scotland, has been shown to under-represent the dimensions of LLS glaciers; elsewhere it has been vindicated by later work. The culmination of his research in this field was the publication of a paper in *Nature* (Sissons, 1979) that depicts the trend of LLS equilibrium-line altitudes across Scotland, effectively demonstrating a steep W–E precipitation gradient attributable to scavenging of snowfall on the western side of the West Highland Ice Cap.

The ‘parallel roads’ and associated landforms of Glen Roy fascinated Brian (again readers are directed towards the Spotlight on a Site at the start of this edition of QN (Editor)). He mapped the associated ice limits, surveyed the lake shorelines in painstaking detail, presented a mechanism for frost-assisted shoreline formation and reconstructed the evolution of later lakes and, most strikingly of all, provided convincing evidence that the final drainage of the Roy-Spean lake took the form of a jökulhlaup: ‘…an enormous flood flowing along the route of the Spean gorge and thence along the Great Glen to reach the sea at Inverness’, where it deposited a 7 km\(^2\) fan of gravel offshore. He remained captivated by the events at Glen Roy.
to the end of his life, taking a keen interest in later developments and particularly in the interpretation of the varve sequence, publishing – after a gap of 34 years – two papers on these topics in a special issue of *Proceedings of the Geologists Association* that appeared last year (Sissons, 2017a; 2017b).

In retirement, Brian’s restless energy was directed into completely different channels. He designed kitchens, became fluent (from scratch) in Spanish, and wrote a three-volume novel (allegedly about a fictitious Scottish University Geography department) that sadly ‘was rejected by the referees’ as he complained, and never published. Until his eighties he set himself a target of walking 3000 miles a year. Only after the death of his wife and life-long companion Betty did he renew his interest in geomorphology, scrutinising recent papers and marking them with (often disapproving) comments.

Brian was not an easy man: he could be irascible and querulous, argumentative and disputatious. From his postgraduates, though, he commanded not merely enormous respect but also almost paradoxical affection. Over twenty of us attended his retirement dinner; even more his 80th birthday celebrations; and almost all his surviving postgraduates were present to celebrate his 90th birthday in June 2016. When I visited him in Inverness in January this year he was on good form, recounting scurrilous tales from the past and arguing about the Glen Roy varve sequence; five days later he died peacefully in his sleep. One of the leading figures in Quaternary science has left the stage. It was a great privilege to have known him.

**Selected Publications**


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JOHN CATT (1939 – 2017)

Born in Kent in 1939, John Catt went to school in Ashford and retained an interest in the county throughout his life, championing its wines and studying its loess. He gained his first degree and his PhD from the University of Hull, the latter under the supervision of Prof. Lewis Penny. This connection was later expressed in John’s work in setting up the QRA’s Lewis Penny Award and his membership of the Yorkshire Geological Society. John went on to work at Rothamsted Experimental Station at Harpenden, Hertfordshire, in 1963 as a Scientific Officer in the Pedology Department, rising to become Deputy Head of Rothamsted from 1988 to 1998. From Rothamsted he continued his research as an honorary professor in the Geography Department at UCL. He was also a visiting professor at Birkbeck College, the University of Reading and Hatfield Polytechnic (now University of Hertfordshire) and an honorary professor of the Czech University of Agriculture, Prague.

During his career John made significant scientific contributions to geology, pedology and agriculture. A flavour of his range of scientific endeavour is given in the selection of references to be published in a forthcoming edition of QN, drawn from the ~200 publications, reports and books that he wrote or

(photo credit Nick Pierpoint)
contributed to. He was always precise and succinct in his writing and diligent in his pursuit of scientific precision in methods, statistics and the written word. He edited and was a major contributor to 'Hertfordshire Geology and Landscape' which set an exceptionally high standard of scholarship and presentation.

He received many awards including a DSc from the University of Hull (1981), the John Phillips Medal from the Yorkshire Geological Society (2004), the 1875 Award for an outstanding contributor to natural history in Hertfordshire from the Hertfordshire Natural History Society (2013) and the Distinguished Service Award from the Geological Society (2015). He was awarded Honorary Memberships of the QRA (2002) and of the Hertfordshire Natural History Society (2017). He became Vice-President of the Geological Society in 1996.

He was an early member of the Quaternary Field Study Group, joining in 1965 and is mentioned in the first Quaternary Newsletter (1970) for recovering a mammalian bone, later identified as a metatarsal of *Bison* sp., from Beestonian gravels in a low cliff at West Runton. He took on various responsibilities within the QRA, joining the Committee in 1971, taking on the position of Secretary and Editor of the Quaternary Newsletter from 1974 to 1978, Vice-President 1984–7, Publications Secretary 1985–6, Chair of the Joint Association for Quaternary Research 2004–8. His last contribution was to edit, with Ian Candy, the History of the QRA, published in 2014, 40 years after he took on the editorship of QN, indicating his long period of service to the QRA.

John was keen to make geology more widely accessible, particularly that of Hertfordshire. For many years he was variously President and Field Meetings Secretary of the Hertfordshire Geological Society, organising a wide-ranging programme of lectures and field meetings in that county, throughout Britain and abroad. He also led many field meetings for visiting geological societies.

At a more personal level, numerous members of the QRA have very positive memories of John’s support. When PA was starting his PhD at Birkbeck he had a reserve about approaching the great and the good of the Association, but had a very helpful and productive meeting with John, who was very welcoming and ended with an invitation to get back to him if there were any further queries. DRB remembers an early PhD visit (1977–8) to John at Rothamsted when the loess of Essex demanded his scrutiny. Again the warmth and friendliness with which advice was proffered was memorable; DRB was also signed up to the QRA on the spot. AC draws attention to John’s support of work at the University of Hertfordshire, which manifested itself in many ways but was particularly evident when he was instrumental in arranging Rothamsted’s generous donation of a Pilcon drilling rig and associated tools to the University for research and consultancy purposes. Many such memories can be repeated throughout the membership of the QRA.
This is written as a Memory of John Catt: An Appreciation. A record of John’s papers, reports and books will appear as ‘John Catt, Scientific Contributions’ in a future edition of QN.

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Background and rationale

One of the most pressing questions in palaeoecology concerns the role of herbivores in creating and maintaining vegetation structure (e.g. Mitchell, 2005). The recognition of a new proxy for the presence of large herbivores, coprophilous fossil fungal spores preserved in sedimentary sequences that also contain pollen, established a link between herbivore presence and the vegetation community (e.g. Davis and Shafer, 2006; Baker et al., 2013). However, current research in this area is mostly qualitative and lacks a strong experimental basis. In particular, environmental and taphonomic factors influencing preservation and recovery of these spores are poorly understood. In October 2014, we designed field experiments to develop an experimental baseline for the interpretation of dung fungal spores from sedimentary records.

Methods

To experimentally quantify fungal spore density with animal density and to evaluate the influence of common taphonomic processes, pollen traps (modified from Tauber, 1974; Hicks and Hyvärinen, 1986) were placed in Chillingham Wild Cattle Park, Northumberland, UK. The sampling locations represent a range of moisture levels, vegetation types and grazing intensities (Table 1). The trap contents have been collected every six months from October 2014 to the present. Soil samples were taken from the same locations. The vegetation of the park was surveyed in 1979 and 2008 (Hall and Bunce, 2011; Bunce and Hall, 2013). In addition, in April 2017 a vegetation survey was carried out of the immediate surroundings of the pollen traps to enable a comparison between vegetation composition, pollen influx rate, preservation in the soil, and herbivore activity.

<table>
<thead>
<tr>
<th>Trap no.</th>
<th>Moisture level</th>
<th>Vegetation type</th>
<th>Grazing intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT1</td>
<td>Dry</td>
<td>Covered - deciduous</td>
<td>Low</td>
</tr>
<tr>
<td>CT2</td>
<td>Wet</td>
<td>Covered – deciduous</td>
<td>Low</td>
</tr>
<tr>
<td>CT3</td>
<td>Wet</td>
<td>Covered – deciduous</td>
<td>High</td>
</tr>
<tr>
<td>CT4</td>
<td>Dry</td>
<td>Covered - coniferous</td>
<td>High</td>
</tr>
<tr>
<td>CT5</td>
<td>Dry</td>
<td>Covered – coniferous</td>
<td>Low</td>
</tr>
<tr>
<td>CT6</td>
<td>Wet</td>
<td>Open</td>
<td>Medium</td>
</tr>
<tr>
<td>CT7</td>
<td>Dry</td>
<td>Open</td>
<td>Medium</td>
</tr>
<tr>
<td>CT8</td>
<td>Wet</td>
<td>Open</td>
<td>High</td>
</tr>
<tr>
<td>CT9</td>
<td>Dry</td>
<td>Open</td>
<td>High</td>
</tr>
<tr>
<td>CT10</td>
<td>Dry</td>
<td>Covered – deciduous</td>
<td>High</td>
</tr>
<tr>
<td>CT11</td>
<td>Dry</td>
<td>Open</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Table 1. Sampling locations and environmental variables for pollen traps at Chillingham Wild Cattle Park
Results

There is no clear relationship between pollen trap influx rates of pollen and dung fungal spores (Figure 1). As expected, pollen influx rates are much higher in summer than in winter. For dung fungal spores, an opposite trend is visible, although influx rates were low in the very wet winter of 2015-2016. Additionally, some samples contain large quantities of pollen from single species and these may need to be removed from the analysis as the addition of an anther to the sample may skew the results.

![Figure 1. Pollen trap influx rates of dung fungal spores and pollen (n spores/grains per cm² per 6 months)](image)

Pollen samples were compared with vegetation survey data using Redundancy Analysis (RDA using CANOCO Version 4.56, March 2009; Ter Braak and Smilauer, 2002) and Indices of Association (IoA; Davis 1984). Initial results show a reasonable correlation with local plant abundance (Table 2 and Figure 2) and ordination plots distinguish well between open and closed canopy sites. A preliminary RDA shows a strong correlation between vegetation composition and vegetation openness on axis 1, with the second axis being determined mainly by grazing intensity (Figure 2). The first two RDA axes explain 41.7% of the variation. The IoAs indicate a reasonable correlation of pollen type diversity with local plant abundance (Table 1).
Table 2. Metadata for Indices of Association on pollen presence in Chillingham pollen traps and plant presence around the sampling locations

<table>
<thead>
<tr>
<th>Metadata Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of plant species present</td>
<td>48</td>
</tr>
<tr>
<td>Number of pollen types present</td>
<td>46</td>
</tr>
<tr>
<td>Number in common across all sites</td>
<td>29</td>
</tr>
<tr>
<td>Number of plants with no pollen</td>
<td>19</td>
</tr>
<tr>
<td>Number of pollen with no plants</td>
<td>15</td>
</tr>
<tr>
<td>Number of strongly associated types (A &gt; 0.65)</td>
<td>5</td>
</tr>
<tr>
<td>Number of associated types (0.5 &lt; A &lt; 0.65)</td>
<td>5</td>
</tr>
<tr>
<td>Number of weakly associated types</td>
<td>16</td>
</tr>
<tr>
<td>No of underrepresented types (U = 0.0 and O &gt; A)</td>
<td>27</td>
</tr>
<tr>
<td>No of overrepresented types (O = 0.0 and U &gt; A)</td>
<td>22</td>
</tr>
</tbody>
</table>

Figure 2. Species-environment biplot of Redundancy Analysis of pollen types (summed across all years and seasons of collection) and environmental variables (tree cover and grazing) for Chillingham pollen traps.

Significance

Early on in the project, it became clear that variation in weather conditions (e.g. a wet winter or a dry summer) has a clear impact on fungal spore influx rates (Van Asperen et al. in prep.). To obtain a dataset that is relevant to the interpretation of palaeoecological samples, it was therefore necessary to sample over a longer time period (cf. Giesecke et al., 2010). The vegetation data provide an important
validation that traps are functioning as expected, depicting a local pollen source area. In combination with the fact that dung fungal spores have short active dispersal distances, which do not normally exceed 1 m (Ingold and Hadland, 1959; Ingold, 1961; Yafetto et al., 2008; E. van Asperen, pers. obs.), this implies that the variation observed in dung fungal spore influx rates is due to environmental or taphonomic variables. Further research on the longer-term dataset aims to clarify the impact of a range of environmental factors on dung fungal influx, and hence potential preservation, and recovery, rates.

Acknowledgments

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References


RELATIVE SEA-LEVEL CONSTRAINTS FROM ISOLATION BASINS ON THE ISLE OF SKYE

Background and Rationale

Constraining Late- and post-glacial relative sea-level (RSL) change is important for understanding coastal evolution, patterns of deglaciation and glacio-isostatic adjustment (GIA). Data exists for Late- and post-glacial and Holocene RSL changes on the Isle of Skye, northwest Scotland; existing studies provide constraints from the litho- and biostratigraphy of raised features in coastal settings and isolation basins (Selby et al., 2000; Selby and Smith, 2007; 2015; Shennan et al., 2006). Model predictions of RSL change for the Isle of Skye suggest that it experienced RSL rises associated with Meltwater Pulse 1a and the mid-Holocene highstand (Bradley et al., 2011; Shennan et al., 2012). However, there are no data from the Isle of Skye validating this model output. The investigation of previously unstudied isolation basins on the Isle of Skye provides an opportunity to further constrain the magnitude and timing of RSL changes. The support of the Quaternary Research Fund enabled a week of fieldwork in September 2017 to survey and collect materials for analysis from two possible isolation basins close to Broadford, Isle of Skye (Figure 1A).

Results

Surveying and sediment coring confirm the basin topography of the underlying bedrock. The stratigraphy found broadly follows a typical isolation sequence of minerogenic silt-clay units overlain by organic limus units overlain by peat, with some intercalated units within the overlying peat (Figure 1B). The upper of the two basins has an exposed sill evident within the river; however, a sill could not be identified within the lower basin. Representative cores from both basins are undergoing proxy (diatom and foraminifera) analyses; preliminary foraminifera analysis from the basins indicate the marine nature of the lower minerogenic units. Combined with radiocarbon analyses of identified isolation contacts, new constraints of former RSL for the Isle of Skye will be generated.

Significance

The findings will contribute to an improved understanding of Late- and post-glacial environmental and RSL changes for the Isle of Skye and wider northwest Scotland region. In particular, the production of new RSL data for the Isle of Skye will help constrain the rate of RSL change following deglaciation. Such data is integral for the validation of GIA models and the contributing geophysical components (Bradley et al., 2011; Kuchar et al., 2012; Shennan et al., 2006).
Acknowledgements

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References


**Figure 1.** A) Location map of the study area with the upper (south) and lower (north) basins highlighted, and B) simplified stratigraphy of the upper basin from the core locations denoted in 1A. Aerial Imagery © Getmapping Plc


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Introduction

Peatlands are valued for the ecosystem services they provide: storing carbon, mediating the water cycle and preserving records of the past. Carbon storage in peat has attracted particular attention in recent years (e.g. Fenner and Freeman, 2011; Yu, et al., 2011). There are open questions around the evolution of the global peatland carbon store through the Late Quaternary and the role of peatlands in driving and responding to past climate change. The majority of global peat is in the northern Hemisphere, particularly across northern Eurasia and North America. However a non-trivial area of peat occurs in the high southern latitudes, with a peatland carbon stock estimated at 15GtC (Yu et al., 2011). This carbon pool is relatively poorly-studied.

Peat in the Falkland Islands

One of the larger Southern Hemisphere peatland regions is the Falkland Islands, an archipelago in the South Atlantic. Peat is known to be widespread in the Falklands but an understanding of peat development and carbon accumulation in this region is currently minimal. This report provides an initial summary of work undertaken in the Falklands in March 2017, partly funded by the QRA. Ten cores were taken from across East Falkland, the largest island in the archipelago. Two sites were sampled in the vicinity of Stanley, the island’s capital to the east of East Falkland. These sites had raised peat domes and vegetation dominated by Diddle Dee (*Empetrum rubrum*) and *Astelia pumila* with deep peats (>2.5m) (Figure 1). Even deeper peats were noted in eroding coastal sequences from Hooker’s Point on the Cape Pembroke Peninsula (~3.5m), subject of ongoing work by other researchers. Seven sites were cored in the southern plain of the main landmass of East Falkland and the Lafonia Peninsula (Figure 2). These sites all had vegetation dominated by White Grass (*Cortaderia pilosa*) with understorey vegetation including Teaberry (*Myrteola nummularia*) and Small Fern (*Blechnum penna-marinana*). None of these seven sites contained deep peat (generally less than a metre) and in two cases peat was of insufficient depth to be classified as peatland (less than 30cm). The deepest peats in this region appear to be valley fens. One site was sampled in the far northwest of the island at Cape Dolphin. This was the only site sampled with Tussac grass (*Poa flabellata*) vegetation, a habitat which was formerly much more widespread. Peat at the coring site was around 1.5m depth but eroding peat banks on the west coast of the Peninsula contain at least 4m of peat. One site was sampled to the north of the island in the vicinity of Hope Cottage Farm. This peat was relatively shallow with White Grass vegetation, but domes with *E. rubrum* were noted further east, almost certainly containing deeper peat. Smaller areas of other types of peatland were noted including small saltmarshes in the Swan Inlet area containing peat up to ~80cm depth.
General observations

From these reconnaissance coring undertaken it is clear that peat is widespread on East Falkland, but generally shallow. The deepest peats appear to be the (former) Tussac grassland peats in coastal regions and the *E. ruhrum* domes occurring particularly to the north and east of the island. From inspection of the stratigraphy, the *E. ruhrum* domes appear to contain the best macrofossil preservation and may therefore have the greatest potential for palaeoecological study. In most sites the peat is underlain by clays with the transition more or less abrupt. The timing of peatland development requires subsequent dating (results pending), although given the absence of recent glaciation may be considerably earlier than the global mean. The uppermost peat of several of the sites was noted to be decomposed and often dry. This may reflect changes due to land management but might also indicate the impacts of recent climate change: water tables were very low at the time of sampling. Future research will focus on understanding the dynamics of long-term carbon accumulation in a selection of the sites cored.

Figure 1. Diddle Dee (*Empetrum rubrum*) vegetation on relatively deep peat at Whalebone Cove near Stanley.
Figure 2. White Grass vegetation on shallow peat at Walker Creek in the east of the Lafonia Peninsula.

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NEW RESEARCHERS AWARD SCHEME

INVESTIGATING ANCIENT MAYA HUMAN-ENVIRONMENTAL INTERACTIONS IN THE BELIZE RIVER VALLEY

Background and Rationale

Current research on the relationship between prehispanic (Maya) populations and their environment in Central America is often used as a timely reminder of the possible consequences environmental negligence can have on thriving civilisations (Turner and Sabloff, 2012). Research examining the impact the Ancient Maya had on their environment is often polarised between opinions that the populations participated in intensive agricultural strategies resulting in environmental degradation (deforestation) (Diamond, 2005; Douglas et al., 2015; Shaw, 2003; Turner and Sabloff, 2012) and those who argue they partook in land-use strategies that promoted biodiversity and maintained ecosystem services (Ford, 2008, Ford and Nigh, 2015).

In Belize, the wealth of archaeological research provides a unique opportunity to investigate how the Ancient Maya civilisation may have managed the landscape. In the Belize River Valley, many rural archaeological sites have been researched for over 50 years (Aimers, 2007; Hoggarth et al., 2014). However, to date, no palaeoenvironmental research has been completed. The aim of this research is to provide a new palaeoecological reconstruction for the Belize River Valley region while also determining the extent in which the Ancient Maya used sustainable landscape management strategies in less densely populated areas.

Approach

The New Researcher’s Award funded travel to the Spanish Lookout region, located in the Belize River Valley. The area is currently occupied by the local Mennonite community and is intensively farmed for maize agriculture. Therefore, Spanish Lookout will provide a modern pollen analogue of intensive agriculture with which to compare to changing patterns of maize agriculture from the Classic Maya period until present.

The study site, Laguna Aguacate, is located within 5km of three archaeological sites (named Aguacate Uno, Dos, and Tres) that have been excavated (Figure 1). At present, no material has been analysed for dating, but archaeological layouts of the sites suggest an Early Classic occupation period (AD 250-600AD)(Koenig, 2014). Further south, the sites of Ruins of Truth, Barton Ramie and Baking Pot have been excavated with the latter providing a robust chronology suggesting a
Figure 1. Map of Spanish Lookout region. The study site, Laguna Aguacate, is closely surrounded by three archaeological sites. Further south, three additional minor archaeological sites are located to provide archaeological context for the Belize River Valley.
Middle Preclassic Occupation (1000-400BC) (Hoggarth et al., 2014) (Figure 1). Settlement research has suggested that at the aforementioned sites, the architectural layout shows they were minor centres, which is a classification that falls between small household settlements and large urban ceremonial centres (Bullard, 1960; Koenig, 2014; Hoggarth et al., 2014). Furthermore, all the archaeological sites mentioned thus far show evidence of continuous occupation throughout the Classic Maya Era (250-900AD)(Hoggarth et al., 2014; Koenig, 2014). This will provide a comparative chronology that can be used to link changes in landscape management practices to changes in internal/external factors such as political unrest or population change.

**Preliminary Results**

Two short cores were retrieved from Laguna Aguacate in July 2017 using a piston and tube. The sediments were cored to 66cm with an additional 15cm overlap between the cores. Sediment composition was a combination of marl and clays and brief examination of the material showed good preservation of pollen. Additional loss of ignition and high-resolution charcoal analysis will be completed alongside a high-resolution pollen analysis.

**Significance**

This project will provide the first palaeoenvironmental data to demonstrate how the ancient Maya manipulated the landscape to support lower density population centres in the Belize River Valley. Minor sites offer an important opportunity to examine ancient land use in a setting that is not heavily influenced by the large-scale deforestation that resulted from monumental building, as seen in pollen records from temple sites (Bhattacharya et al., 2011; Mueller et al., 2010). This research will attempt to interpret the extent in which the forest was cleared to support agricultural means, while also examining the role of economically important species as indicators of cultivation by tracking changes in their abundance in the fossil pollen evidence. Such examples can be seen in the cultivation of palm in the archaeological site of Lamanai, Belize(Rushton, 2014). The combination of these factors will enhance our understanding of how the Ancient Maya interacted with their landscape by moving the focus away from the major ceremonial centres that often link deforestation signals to periods of demographic decline.

**Acknowledgements**

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THE SPATIAL VARIATION OF SUPRGLACIAL DEBRIS CHARACTERISTICS AND THEIR INFLUENCE ON GLACIER MELT ON ANNAPURNA SOUTH GLACIER, NEPAL.

Background and rationale

Supraglacial debris, which occurs on a large number of Himalayan glaciers, influences sub-debris glacier melt rates by modulating the pathway of atmospheric radiation to the ice surface (Benn et al., 2012). However, this debris cover tends to be highly heterogeneous at the glacier scale (Nicholson and Benn, 2013) and the spatial variation of properties such as debris thickness, aerodynamic roughness, grain size, and thermal conductivity and how they interrelate, are still poorly understood. This is due in part to the lack of field observations in these typically remote and high altitude regions (Nicholson and Benn, 2013). This limits our ability to investigate the relationship between debris and glacier melt rates and accurately model debris-covered glacier mass changes at larger scales. Annapurna South Glacier (ASG) is a debris-covered glacier in the Nepalese Himalayas. Between October 2016 and November 2017, debris thickness, aerodynamic roughness, grain size, air and debris temperatures and sub-debris ablation rates were measured across the ablation zone of ASG, to investigate the spatial variability of debris characteristics and their influence on sub-debris melt rates.

The New Research Workers’ Award helped to fund the 2017 field season which was vital for extending a short, week-long pilot study from the first field season into a comprehensive year-long dataset of air and debris temperature and sub-debris melt rates, and increased the spatial coverage of debris property measurements including aerodynamic roughness.

Preliminary results

Supraglacial debris thickness, grain size, aerodynamic roughness and glacier sub-debris ablation rates were spatially variable across the ablation zone of ASG. Debris thicknesses ranged from 0.15 to 0.72 m, and ablation rates ranged from 0.66 ± 0.01 to 1.58 ± 0.01 m a⁻¹. Stakes with the thickest debris had lower ablation rates. Grain size distribution across the study area was heterogeneous but there was a slight trend in decreasing grain size with increasing distance down-glacier. Air temperatures (Ta) and ice surface temperatures (Ti) began to consistently exceed 0 °C on ASG from 2nd May 2017 and Ta and debris surface temperatures (Ts) were strongly correlated (Figure 1). Debris surface temperatures varied across the study area. Debris effective thermal conductivity during the monsoon ranged from 1.03 to 1.30 W m⁻¹ K⁻¹. Debris temperatures through the debris were relatively warm, even during winter. Average annual stake displacement between Nov 2016 and Nov 2017 was 16 m a⁻¹, with faster velocities further down-glacier. This is surprisingly fast compared with other debris-covered Himalayan glaciers, which have tended to stagnate (Quincey et al., 2009).
Figure 1. Air (Ta), debris surface (Ts) and ice surface (Ti) temperatures measured on ASG between November 2016 and October 2017 using iButton temperature sensors.
Significance

This work contributes to the small but growing database of field observations on Himalayan debris-covered glaciers and provides some of the first measurements of supraglacial debris properties, temperatures and glacier melt rates in the Annapurna-Manaslu region of Nepal, which hosts ~300 debris-covered and debris-free glaciers but is largely unstudied. The data will help quantify the spatial patterns of supraglacial debris characteristics across ASG, investigate the response of debris to radiation during the year, and reveal the relationships between debris properties and melt rates.

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References


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A NEW CHRONOLOGY FOR THE MIDDLE STONE AGE SITE OF FLORISBAD, SOUTH AFRICA, USING LUMINESCENCE DATING

Background and rationale

The African Middle Stone Age (MSA) is an important period for examining behavioural patterns and technological changes that are commonly considered ‘modern’ (Lombard, 2012). Luminescence dating has become increasingly important for dating the MSA in Africa, and there is increasing interest in early MSA sites. An archaic *Homo sapiens* from Morroco was recently dated to c. 315 ka by luminescence dating (Richter et al., 2017). The other site in Africa at which an archaic *Homo sapiens* of a similar age was discovered is Florisbad in South Africa (Grün et al., 1996), which is an open-air spring site in the central part of the Free State Province of South Africa (28°46’S, 26°04’E).

The sequence at Florisbad underwent a chronological study over twenty years ago which employed electron-spin resonance (ESR) and optically stimulated luminescence (OSL) dating (Grün et al., 1996). However, assessing the dates is difficult because there is no accompanying data to support the ages, very little detail regarding the methods that were used, and most of the ages are displayed on a composite diagram which makes it difficult to get a sense of stratigraphic context. Furthermore, only part of the sequence was dated.

It is timely to revisit the Florisbad chronology due to significant developments in luminescence dating, including the development of the single-aliquot regenerative-dose (SAR) protocol (Murray and Wintle, 2000; Murray and Wintle, 2003). Tightening the chronology will allow a better understanding of the sedimentary context of the Florisbad cranium, better support the technological record, and support the new palaeoenvironmental reconstruction of the site (Toffolo et al., 2017).

Methods

There are a number of excavations at Florisbad (Figure 1). Pit 3 was one of three test pits cut to bedrock during the 1980s and 1990s in order to have a better understanding of the stratigraphic sequence and to establish a chronology for the site. A suite of samples from this pit were collected for luminescence dating in the 1990’s but the majority were never analysed. These samples have been the initial focus of this project and are currently undergoing luminescence measurements and analyses, but additional samples were required to provide a full chronological framework for the site.
The QRA New Research Workers’ Award supported fieldwork at Florisbad in September 2017, financing flights to South Africa and the hire of a car to travel to the site. During fieldwork, a new suite of samples was taken from the Dreyer Section and the Western Eye Section within the Main Excavation, which was the focus of early investigations at Florisbad in the 1930s and 1950s. These two sections were chosen because there is a lack of chronological information for them. In particular, there is doubt regarding the chronology of the Pleistocene/Holocene transition and the correlation of this period between excavation areas.

Figure 1. Photographs of the Main Excavation a) looking south, and b) looking north. The location where the cranium was found is just a few metres off to the east of photograph b.
In addition, the Florisbad cranium was found in the Main Excavation near to these sections. Samples were taken for luminescence dating using opaque sample tubes, with corresponding dosimetry samples collected in clear sample bags. In-field gamma spectrometry measurements were also taken for dosimetry, in the same spot as the luminescence sample once it was removed from the section.

**Significance and further work**

Luminescence dating of these samples and those collected in the 1990’s will allow the testing of correlations made by Toffolo *et al.* (2017) between the Main Excavation and Pit 3. Several different luminescence signals will be used to generate ages in order to assess the reliability of the results. These different luminescence approaches include multiple- and single-grain quartz OSL, and thermally transferred optically stimulated luminescence (TT-OSL). The latter signal is important as it has the potential to extend the age range of luminescence dating beyond quartz OSL dating (c. >150 ka) (Adamiec *et al.*, 2014).

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RECONSTRUCTING THE DEGLACIAL HISTORY OF ANVERS PALAEO-ICE STREAM TROUGH, WESTERN ANTARCTIC PENINSULA

Background and rationale

Our understanding of the future of Antarctic ice streams and marine-terminating glaciers is currently limited by the period over which we have been observing their behaviour. Palaeo-ice stream reconstructions allow us to investigate the key drivers of ice stream retreat over extended timescales (Bentley et al., 2014). Sediments deposited during past glacial cycles provide an important archive of long-term changes to the cryosphere, including the rate and style of deglaciation. A dependable deglacial chronology allows retreat behaviour to be compared to sea level and atmospheric and/or oceanic temperature curves (e.g. Smith et al., 2011). This may allow the key drivers of retreat to be identified, providing important analogues for the future of Antarctic ice streams and glaciers in a warming world.

This project utilises sediment cores recovered from the Anvers-Hugo Trough (AHT), western Antarctic Peninsula shelf (Figure 1) and aims to investigate the deglacial history of the Anvers-Hugo Ice Stream (AHIS), including the timescales of, and processes that form, depositional features such as grounding zone wedges. The cores under investigation have a known geomorphic context, with three pairs of sediment cores recovered from the stoss and lee sides of three grounding zone wedges; asymmetrical sediment accumulation features. To date there have been limited studies that investigate the timescales over which grounding zone wedges are formed (Bart et al., 2017); however, their presence is often associated with still stands during episodic grounding line retreat (Batchelor and Dowdeswell, 2015; Dowdeswell and Fugelli, 2012).

Previous studies have collected and dated sediments deposited during the retreat of the AHIS following the Last Glacial Maximum (e.g. Pudsey et al., 1994). Despite this, the timing of ice stream retreat within the AHT remains poorly constrained, as the scarcity of preserved biogenic calcium carbonate within Antarctic sediments makes radiocarbon dating challenging. Past studies have often dated the Acid Insoluble fraction of the Organic Matter (AIOM) of the sediments, which involves the combustion and dating of all of the AIOM within a bulk sediment sample (Andrews et al., 1999). The dates obtained from this method are often older than biogenic calcium carbonate sampled from the same horizon, as AIOM samples can be contaminated by allochthonous fossil organic carbon (Andrews et al., 1999).
Over July and August 2017, I visited Professor Brad Rosenheim at the University of South Florida, where I utilised Ramped Pyrolysis (RP) $^{14}$C dating to date sediments sampled from the AHT sediment cores. RP $^{14}$C dating minimises the effect of contamination by fossil carbon through combusting sediments at gradually increasing temperatures. This allows for the separation of the more thermochemically reactive younger constituents from the reworked more stable older constituents (Rosenheim et al., 2008; 2013). Initial results indicate that

**Figure 1.** (a) Map of the Antarctic Peninsula including the AHT. White dashed lines indicate the division of the trough into an Outer Trough (OT), Mid-Trough (MT) and Inner-Trough (IT) region. JR284 sediment cores are shown in green. (b) AHT with JR284 core locations and highlighted grounding zone wedges, MSGLs and iceberg scour marks. Cores selected for Ramped Pyrolysis $^{14}$C dating are shown in white. (c) Bathymetric cross sections of the AHT trough with the location of grounding zone wedges 1-3 and core locations.
grounded ice within the Anvers-Hugo Trough retreated rapidly across the mid to inner shelf. One implication of this is that the grounding zone wedges developed over limited time-scales.

Overall, this was an incredibly valuable experience, allowing me to learn a method at the cutting edge of radiocarbon dating and collaborate with world-leading scientists. I would like to thank the Quaternary Research Association for supporting this data acquisition and institute visit through the New Research Workers’ Award.

Acknowledgments

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IMPROVING MANGROVE PROXIES FOR RECONSTRUCTING SEA LEVEL

Background and rationale

Studying past sea-level changes is important for many fields of Earth-system science; understanding past ice-volume fluctuations, providing empirical evidence for sea level and palaeoclimate models, and calculating the background signal upon which historical and current sea-level trends are evaluated (Lambeck et al., 2014). Mangroves accumulate sedimentary deposits close to mean sea level, and provide important archives of past sea-level changes in low-latitude locations. However, mangrove sediments currently make poor sea-level proxies because of problems with microfossil preservation and radiocarbon dating. A better understanding of mangrove environments is needed to provide sub-metre scale reconstructions of recent sea-level changes from these environments.

Methods

For my PhD research, I am seeking to identify features of mangrove sediments that can increase the precision of sea-level reconstructions. The mangrove-fringed island of Mahé, Seychelles in the Indian Ocean is an ideal setting for this study; the mangroves are easily accessible, the tidal range is small (~2 metres) and mangrove species are zoned by elevation (e.g. Woodroffe et al., 2015a). A primary objective is to further investigate mangrove sedimentological sea-level proxies, using grainsize analysis and by monitoring sediment accumulation rates in a mangrove forest. These analyses will be compared with palynological sea-level proxies, and potentially with new organic geochemical sea-level proxies.

A second objective is to identify what components in mangrove sediments are best suited for radiocarbon dating. While most mangrove sediments accumulate in situ and can provide consistent and reliable radiocarbon dates (e.g. Chappell and Grindrod, 1984), many age determinations come from material that will be considerably younger than its equivalent stratigraphic depth. Previous studies have shown that bulk sediment radiocarbon dates can be unreliable down-core (Larcombe et al., 1995) and an alternative approach is to date individual organic components within the sediment (Woodroffe et al., 2015b). My research will further develop a method to isolate the pollen fractions from sediment for radiocarbon dating, following methods outlined in Vandergoes and Prior (2003), and similar work by Woodroffe et al. (2015b) who analysed organic concentrates in mangrove sediments.

Information from these mangrove proxy and chronological analyses will be used to interpret cores collected in a mangrove environment, to reconstruct late Holocene relative sea-level changes at Mahé, Seychelles. Ultimately, we hope the findings
of this study will be applied to palaeo-mangrove sediments in other low-latitude locations, and will allow us to more accurately than ever before reconstruct sea-level changes from mangroves during the Late Holocene.

**Results and Significance**

In July 2017, a team of three (myself, my supervisor and a field assistant) travelled to Seychelles to collect surface sediment, short-cores and modern leaf samples at two mangrove sites on the western side of Mahé island. Additionally, we deployed a series of pollen traps and sediment marker horizons, to quantify annual pollen flux and sediment accumulation rates (respectively). These traps and markers will be collected and analysed during a second field trip in July 2018. Currently, the modern surface sediment samples are being analysed in the laboratory in the Geography Department at Durham. Data from particle size analysis, pollen assemblages, biomarker distributions and compound-specific stable isotopes are being collected, and will be assessed for their suitability as sea-level proxies.

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MAMMUTHUS IN EUROPE – EARLY EVOLUTION AND ORIGIN

Background and rationale

The prime aim of my PhD research is to complete an accurate phylogeny of Plio-Pleistocene Elephantidae, the modern elephants and close extinct relatives (including the mammoths). Courtesy of support from the Quaternary Research Association New Research Worker’s Award, I was able to visit two important regional museum collections in the Auvergne, France for understanding the early evolution of mammoths in Europe: the Musée de Paléontologie Christian Guth in Chilhac, and the Musée Crozatier in Le Puy-en-Velay. Together, these French regional museums curate several rare and exceptionally well-preserved crania of the early mammoths *M. meridionalis* and *M. trogontherii*, showing important diagnostic morphological features.

Results

Of particular interest is *M. meridionalis*, the earliest Eurasian mammoth that is represented by numerous fossil samples well-controlled for stratigraphic provenance. However, the taxonomy of the *M. meridionalis* complex has been a cause for uncertainty. The type collection for this form from the Early Pleistocene of the Upper Valdarno in northern Italy (curated at the Museo Di Storia Naturale in Florence) is characterised by a high, rearward-tilting skull roof (Lister *et al.*, 2005). By contrast, skull remains from Chilhac in the Musée de Paléontologie Christian Guth possess lower, less prominent vertex. Alexeeva and Garutt (1965) erected a separate species, *Archidiskodon gromovi*, based on a highly complete early mammoth skull from Khapry in the Russian Black Sea region, which resembles the Auvergne sample. The Auvergne and Khapry materials pre-date those from the Upper Valdarno, but the samples do not differ in the morphology of the third molars, one of important diagnostic criteria in understanding mammoth systematics (Lister *et al.*, 2005). Azzaroli (1966; 1977) deemed the morphological distinction between the Valdarno and the French-Russian type samples of *M. meridionalis*-grade mammoths to be evolutionarily significant. He suggested that the low-skull domed morphotype with triangular vertex from the Haute-Loire and the Russian North Caucasus is closely affiliated with the ancestry of subsequent mammoth species in the Northern Hemisphere; whereas the Italian skulls appear morphologically too highly derived and should be precluded from the ancestry of subsequent mammoth species (Azzaroli, 1977).

My extensive first-hand examinations of the *meridionalis*-grade mammoths curated in Florence and Chilhac conclude that the two skull morphotypes apparently show no sympatry (contra Palombo and Ferretti, 2005), thus supporting the
hypotheses of Alexeeva and Garutt (1965) and Azzaroli (1966; 1977) that formal taxonomic distinction of these early mammoths from Europe may be warranted. A preliminary cladistic analysis of elephantids presented at the International Conference of Mammoths and Their Relatives in Taiwan last September also lends support to this distinctions, as the Italian and French morphotypes did not nest as sister terminals (Zhang et al., 2017). The preliminary cladogram presented at the Mammoth Conference still awaits further validation work, particularly accounting for intraspecific variability of cranial characters using specimens from the extant elephant species as a ground-truthing basis. My further work will also attempt to fully quantify cranial variations in mammoths by employing a landmark-based 2D geometric morphometric approach, to discern patterns difficult to delineate based on human observations.

**Acknowledgements**

I sincerely thank the Quaternary Research Association for awarding me the New Research Worker’s Award, to support my research visit to the Auvergne; Séverine Pégon (Chilhac) and Emmanuel Magne (Musée Crozatier) for facilitating access to specimens. I further extend my gratitudes to the Geological Society of London and the Jeremy Willson Charitable Trust for supporting my travel to Florence. Gratitudes also go to Mark Puttick and Marco Ferretti for their contributions in generating preliminary phylogenetic analysis. I am extremely grateful to my supervisors Mike Benton, Adrian Lister and Wang Yuan for advice and encouragement. My travel to Taiwan to attend the ICMR in Taiwan and to undertake examination of specimens was kindly supported by the ICMR 2017 Traveling Support, the Palaeontological Association, and the University of Bristol Bob Savage Memorial Fund.

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REPORTS

2018 QRA ANNUAL DISCUSSION MEETING DATA-MODEL INTER-COMPARISON

University of Plymouth, 3\textsuperscript{rd} to 6\textsuperscript{th} January 2018

In January 2018 the QRA Annual Discussion Meeting was held at the University of Plymouth, with three days of talks themed around data-model inter-comparison (3\textsuperscript{rd} to 5\textsuperscript{th} January) followed by a field trip to Kent’s Cavern and Hope’s Nose raised beach (6\textsuperscript{th} January). The meeting was co-ordinated by Caroline Clason and Stephanie Mills, with support from staff and postgraduates from the School of Geography, Earth, and Environmental Sciences at the University of Plymouth. The meeting was attended by 82 delegates from across the UK as well as Switzerland, Sweden and Canada, and a total of 42 talks and 28 posters were presented.

The central theme of the meeting was ‘data-model inter-comparison’, with an aim to highlight recent advances in both data-driven and model-driven approaches to questions of climatology, ecology, geomorphology, glaciology, hydrology, sea-level change, landscape evolution and archaeology. To encompass the full breadth of Quaternary science sub-disciplines, talks were arranged in five thematic sessions: ‘Long-term landscape evolution and palaeohydrology’, ‘Long-term ecology and human-environment interactions’, ‘Palaeoclimate reconstruction and data-model inter-comparison’, ‘Glacial modelling and geomorphology’ and ‘Global patterns of sea level change’. Each session was opened by an invited keynote speaker, each highly-respected in their fields: Susan Ivy Ochs (ETH Zürich), Marie-José Gaillard (Linnaeus University), Marie-France Loutre (PAGES), Chris Clark (University of Sheffield) and Roland Gehrels (University of York).

The presentations began with a session on ‘Long-term landscape evolution and palaeohydrology’, chaired by Matt Telfer (University of Plymouth) (Figure 1). Susan Ivy Ochs (ETH Zürich) gave a keynote talk on ‘Juxtaposing field evidence, isotopic dating results and ice-sheet models for the Late Glacial Maximum in the Alps’, which included striking examples of adventurous Alpine fieldwork. Ed Rhodes (University of Sheffield) then spoke about ‘New Developments in IRSL dating of high energy fluvial deposits’, followed by two archaeologically-themed talks. Laura Basell (Queen’s University Belfast) gave a talk entitled ‘Hominins in the Tundra: Human Occupation and Landform Evolution at Doniford on the North Somerset Coast, UK’, showing the complexity of archaeological records in areas subject to cold climate erosion. Ella Egberts (Bournemouth University) continued this theme by presenting OSL-dated terrace deposits from the Hampshire
Avon, and the implications for the timing of hominin presence in Britain. This session continued after lunch with Martin Stokes (University of Plymouth) who asked ‘Are Alluvial Fan Sedimentation and Erosion Patterns Controlled by African Humid Period Climate Dynamics?’ with a study from the Cape Verde Islands. Rebecca Briant (Birkbeck, University of London) then spoke about metrics for model-field data comparison in landscape evolution modelling, using a case study from the Welland catchment (eastern England). Abi Stone (University of Manchester) gave a fascinating introduction to the utility of portable luminescence readers, themed around her work on reconstructing southern African landscape evolution in dunefields. The final talk of the day was given by John Cooper (Swansea University) who spoke on ‘Discovering Tir Gŵyr (The Lost Caves and Submerged Lands of Gower)’.

Figure 1. Matt Telfer (University of Plymouth) chairing the first session of the 2018 QRA Annual Discussion Meeting

The first day was concluded with a poster session, presenting a range of fascinating research spanning the full range of Quaternary science sub-disciplines. Twenty-eight individual contributions were made to this session, with postgraduate delegates making up 43% of presenters. This is in contrast to the proportion of oral presentations given by postgraduates (24%), highlighting the importance of poster sessions for those early in research careers (Figure 2).
The second day began with a session of talks on ‘Long-term ecology and human-environment interactions’, chaired by Nicki Whitehouse (University of Plymouth). Marie-José Gaillard (Linnaeus University) gave the session keynote talk on the PAGES LandCover6k project, which aims to use pollen-based land cover reconstructions to improve climate models for the Holocene, with a particular focus on Anthropogenic land cover change. This was followed by Yiman Fang (University of Hull) who presented work on new approaches to estimating pollen productivity and pollen-vegetation relationships, to reconstruct past land cover in southeast China. Jane Bunting (University of Hull) then gave an overview of the ‘Multiple Scenario Approach’ to reconstructing land cover from pollen records, and Ralph Fyfe (University of Plymouth) spoke about ‘Burning and grazing as drivers of moorland vegetation over millennial time scales’, highlighting the utility of palaeoecological information for informing land management practices. After a coffee break, Michael Grant (University of Southampton) gave a talk on European beech (Fagus sylvatica) at its northern limits, and the discrepancies between

Figure 2. Victoria Naylor (University of Exeter) presenting her work on rocky coastline evolution in Torbay, Devon
palaeoecological data and palaeoclimatic models. **Jessie Woodbridge** (University of Plymouth) provided an overview of ‘Mediterranean vegetation and landscape change through the Holocene’, with preliminary analyses suggesting a potential link between vegetation and changes in human culture and population. This was followed by a trio of talks on work using palaeoentomological datasets. **David Smith** (University of Birmingham) asked ‘Is the development of farmed landscapes in the late Holocene a case of econiche replacement and ecosystems engineering?’, noting a loss of biodiversity in Britain from the Neolithic onwards. **Kim Davies** (University of Plymouth) presented findings from the ‘Celtic Connections and Crannogs’ project, with preliminary analyses suggesting lacustrine assemblage turnover and ecological state change following crannog development, based on a range of biological proxies. The session was concluded by **Nick Schafstall** (Czech University of Life Sciences) who presented preliminary findings from the analysis of sub-fossil Coleoptera from Norway spruce forests in the High Tatra Mountains, Slovakia.

The third session of the conference began after lunch, with talks under the theme of ‘**Palaeoclimate reconstruction and data-model inter-comparison**’, chaired by **Danny McCarroll** (Swansea University). The keynote for this session was sponsored by Wiley (publishers of *Journal of Quaternary Science*) and given by **Marie-France Loutre** (PAGES) who gave ‘A brief tour in the world of complementarity between data and models’, highlighting the value of combining data-based and model-based approaches in palaeoclimatology. **Nicki Whitehouse** (University of Plymouth) then presented on behalf of **Margaret Georgina Milne** (AFBI) on recent updates to the coleopteran Mutual Climatic Range method. This was followed by **Neil Roberts** (University of Plymouth) who spoke about the potential roles of the African monsoon and Mediterranean precipitation regimes in the greening of the northern Sahara during the Early Holocene. **Rachel Avery** (University of Southampton) then gave a talk on new insights into the deglaciation of the Lake District, using varve sequences from Windermere, UK. **James Scourse** (University of Exeter) began talks following the coffee break, speaking about ‘Annually-resolved North Atlantic marine climate over the Last Millenium: the ULTRAseries’ and reconstructing past climates using shells of the long-lived marine bivalve, *Arctica islandica*. **Francis Rowney** (University of Plymouth) presented new research on the Mid-Brunhes Transition and interglacial climates in Britain, suggesting the potential importance of reconstructing hydroclimatic variables in future research. Then followed three dendroclimatological talks, beginning with **Neil Loader** (Swansea University), who spoke about new developments in the dating of tree-rings using stable oxygen isotope ratios. **Mary Gagen** (Swansea University) gave a talk outlining the potential for stable carbon isotopes from tree-rings to be used as a ‘palaeocloud’ proxy. **Giles Young** (Swansea University) closed the second day of talks with a presentation on the utility of stable isotopes from oak tree rings to reconstruct summer temperatures and precipitation in the British Isles. The conference dinner was held on the evening of day two in the
impressive setting of the National Marine Aquarium on Plymouth’s Sutton Harbour. Delegates in attendance were introduced to some of the aquarium’s inhabitants before enjoying dinner under the shark tank.

Day three of the meeting began with a session on ‘Glacial modelling and geomorphology’ and was chaired by Anne Le Brocq (University of Exeter). Chris Clark (University of Sheffield) provided an excellent keynote talk for this session, posing the question ‘you can lead a horse to water but when will he drink?’ Chris presented a review of how data-model interactions have evolved in palaeoglaciology over the last few decades, and highlighted the approach taken by BRITICE-CHRONO in reconstructing the last British-Irish Ice Sheet. Niall Gandy (University of Leeds) offered the first of two talks from researchers at the University of Leeds, on ‘Modelling the Retreat of the Minch Palaeo Ice Stream, NW Scotland’, followed by Lauren Gregoire who spoke on the importance of exploring spatio-temporal uncertainty in climate data for simulating the past evolution of ice sheets. Jonathan Cripps (Simon Fraser University) provided the last talk before coffee with an overview of a data-model comparison for reconstructing the deglaciation of the Cordilleran Ice Sheet in British Columbia, including the role of ice-dammed lakes and outburst floods.

Julien Seguinot (ETH Zürich) kicked off the second part of the session, taking us to the European Alps for a comparison of the Parallel Ice Sheet Model against field-based reconstructions. Bethan Davies (Royal Holloway) then transported us to the Antarctic Peninsula, offering an insight into the ‘Holocene dynamics of Marguerite Trough Ice Stream and George VI Ice Shelf’ through analysis of new landform data and exposure ages. Two further talks on the Southern Hemisphere glaciation were presented before lunch. Firstly, Julian Martin (Royal Holloway) described geomorphological mapping and modelling for the Monte San Lorenzo Ice Cap in Patagonia for the reconstruction of ‘Late Pleistocene and Holocene glacier fluctuations’. This was followed by Tim Barrows (University of Exeter) who spoke on data-model comparison of the Franz Josef Glacier in New Zealand and reflected on the climatic conditions necessary to explain glacier evolution. The ‘Glacial modelling and geomorphology’ session continued with a further four talks after lunch. Lauren Knight (University of Portsmouth) began with a geomorphological and model-based reconstruction of cirque glaciation in the Wicklow Mountains, Ireland, citing the importance of snow blow and solar insolation. This was followed by Sven Lukas (Queen Mary) who reported on geomorphological and sedimentological observations of a rare upland drumlin in the Austrian Alps; a product of retreat of the Hornkees valley glacier during the last 200 years. Caroline Clason (University of Plymouth) took us to Arctic Sweden and presented on the storage and release of fallout radionuclides within glacial sediments as a legacy of the Chernobyl nuclear accident, and Harry Langford (Birkbeck) concluded the session with an exploration of a ‘subaqueous record of a shoreward prograding ice grounding line’ at the Cromer Ridge on the North Norfolk coast.
The fifth and final session of the meeting, chaired by Tim Daley (University of Plymouth), focussed on ‘Global patterns of sea level change’, and was headed by a highly topical keynote from Roland Gehrels (University of York). Roland spoke on the use of saltmarsh sediments for the reconstruction of sea-level changes, highlighting that the greatest rates of sea level rise over the last 3000 years have occurred within the 20th Century. This was followed by a talk on how ‘Natural internal variability can double rates of secular sea-level rise across multi-decadal timescales’ by Robert Barnett (University of Exeter), who highlighted the importance of accounting for internal variability to better understand the role of natural versus anthropogenic contributions. The final talk of the meeting was presented by Andy Emery (University of Leeds) who gave us an insight into Holocene sea level change and its impacts on stratigraphy and sedimentary processes at Dogger Bank in the Southern North Sea, as interpreted from cores and seismic mapping.

After three exciting days of presentations, a subset of delegates ventured out to Torquay for the meeting fieldtrip, where Kent’s Cavern was explored under the guidance of the owner of the cave, Nick Powe. Delegates learnt about the geology of the caves, with additional commentary by Tim Barrows (University of Exeter), as well as southern Britain during the last glacial cycle and the early foundations of archaeology. Excavation first took place in these world-famous caves in 1824, but it was only decades later that the fossils and artefacts found there were accepted to represent extinct fauna and ancient hominins, as this was contradictory to contemporary religious beliefs. After a hearty meal, the group ventured outside through the January weather on a walk to Hope’s Nose (Figure 3). The Torbay raised beach deposits are among the most fossiliferous of their kind on the south coast, and provide a cornerstone for Pleistocene palaeoenvironmental and stratigraphic studies in the South West. Packs of oysters and other marine mollusc remains gave plenty of clues about the glacial environment, however though many researchers (including Matt Telfer and Tim Barrows) have dated the shore platform and coastal cliffs nearby, so far this has been without conclusive results. At Hope’s Nose, MSc-by-Research student Victoria Naylor (University of Exeter) gave a brief introduction to her research on quantifying the rate of coastal rock evolution in North Torbay by using 36Cl exposure dating and structure-from-motion photogrammetry, using samples collected by her supervisor Tim Barrows. The fieldtrip showed the value of South West England for Quaternary research, as well as the beauty of the English Riviera in midwinter.

The local organising committee (some of whom are captured in Figure 4) were keen to promote gender equality throughout all aspects of the 2018 ADM, and actively set out to achieve this when assigning organisational roles, advertising the meeting, inviting keynote speakers, and when putting together the schedule of talks. Analysis of attendees and presenters at the meeting, carried out by Caroline Clason (University of Plymouth), shows that this was successful. Overall, 46% of
Figure 3. QRA delegates discussing the raised beach sequence at Hope’s Nose, Torquay, Devon.
delegates were female, with women comprising 56% of the organising committee, 60% of keynote speakers, 40% of session chairs, 44% of all talks presented and 61% of posters. Outside of the committee’s control, however, was the gender balance of the questions asked following oral presentations. A tally was kept of every question asked during the meeting, revealing that men asked 77% of the questions posed during the presentations. This is something that conference organisers have very little control over, but certainly highlights a need to ensure that female academics, and particularly those at early career stages, can feel confident enough to offer critique, advice, and opinion. The open and friendly environment of the QRA ADM seems like an ideal place to continue to promote gender parity in the future, in addition to supporting early career researchers.

Figure 4. Members of the local organising committee (left to right): Ralph Fyfe, Stephanie Mills and Caroline Clason (University of Plymouth).
The local organising committee would like to thank the QRA and Wiley for providing sponsorship to help bring international keynotes to Plymouth, and Van Walt and Niton UK for sponsorship which contributed towards discounted postgraduate registration. Last but not least, thanks go to all of the delegates, presenters and session chairs for travelling to the far south-west of the UK and helping to make the 2018 meeting a success.

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A workshop was held on chronology building in the coastal town of Campeche in the Mexican Yucatán Peninsula, a region with a fascinating climatic, palaeoenvironmental and archaeological history. Thirty-five participants from Mexico, the UK, the US and elsewhere discussed the importance of reliable chronologies, mostly those based on $^{210}\text{Pb}$ or $^{14}\text{C}$ dating and Bayesian age-depth models. Networking was a key component of the workshop, and here the funds so kindly provided by the QRA were put to great use for a dinner at a coastal seafood restaurant after our afternoon’s excursion to one of the region’s many sinkholes.

The workshop attracted 35 participants based in a range of countries, mostly Mexico (14; 6 institutes), the USA (12; 11 institutes) and the UK (2), but also from Sweden, Norway, Italy, Spain, Australia, Argentina and Canada (see photo). The participants presented a mix of career-stages, with 12 being either at PhD or postdoctoral level; 17 men and 18 women.

Prof Mark Brenner (UFL) and Dr Nuria Torrescano (Ecosur) gave introductions to the palaeoecology and archaeology of the Mayan region, after which introductions were given to radiocarbon dating (Dr Corina Solís UNAM and Dr Maarten Blaauw QUB), $^{210}\text{Pb}$ dating (Dr Ana Carolina Ruiz Fernandez UNAM), Bayesian statistics in chronology building (Dr Andrés Christen CIMAT), lake coring and sampling (Dr Amy Myrbo LacCore) and the Neotoma database for fossil data (Dr Simon Goring Univ. Wisconsin Madison). Other talks included new $^{210}\text{Pb}$ modelling methods (Marco Aquino Lopez QUB), Age-modelling using Artificial Intelligence (Dr Liz Bradley Colorado University) and dating strategies (Dr Maarten Blaauw). One morning was dedicated to talks by early-career researchers, after which the $^{14}\text{C}$ laboratories of UNAM and QUB awarded two sets of five free $^{14}\text{C}$ dates to the best presentations (Karla Zarisadai Rubio Sandoval UNAM and Alejandro Vela Ecosur).

Besides talks, lots of time was dedicated to hands-on data sessions on $^{210}\text{Pb}$ modelling (Dr Joan-Albert Sanchez-Cabeza UNAM), age-depth models such as clam, Bchron and Bacon (all official CRAN R packages), and extracting data from Neotoma using R. Experienced R users were assisting newer users and lots of datasets and ideas were shared.

Indeed, much emphasis was placed on networking. Breakfasts and lunches, as well as some of the dinners, were held at group tables. The fact that the group was based in one hotel (with a freezing-cold outdoor pool), and the hotel being based at walking distance from the coast and the idyllic city centre of Campeche, further facilitated networking. Specific networking and collaboration sessions
were held on speed-networking, approaches to successful collaborative research (Simon Goring), brainstorming sessions, an excursion, and a forum session in Spanish in order for participants who didn’t speak fluent English to discuss funding issues specific to Mexico and other Latin-American countries, and to facilitate plans for collaboration within Mexico and internationally (especially between the US and Mexico).

We received highly positive feedback from the participants about the scientific content of the workshop, but also about the gender, career and ethnicity balance, and the possibilities that were offered to stimulate networking and thinking about collaborative research proposals, as well as to work on and share data between participants. Many participants commended the friendly, open and collaborative atmosphere during the workshop. We therefore want to thank the QRA again for supporting the seafood dinner.

Figure 1. The glaring sun made the workshop participants squint and hurry back to their laptops shortly after this photo was taken.

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QUATERNARY RESEARCH ASSOCIATION

The Quaternary Research Association is an organisation comprising archaeologists, botanists, civil engineers, geographers, geologists, soil scientists, zoologists and others interested in research into the problems of the Quaternary. The majority of members reside in Great Britain, but membership also extends to most European countries, North America, Africa, Asia and Australasia. Membership (currently c. 1,200) is open to all interested in the objectives of the Association. The annual subscription is £20 with reduced rates (£10) for students and unwaged members and an Institutional rate of £35.

The main meetings of the Association are the Field Meetings, usually lasting 3–4 days, in April, May and/or September, a 2-3 day Discussion Meeting at the beginning of January. Short Study Courses on techniques used in Quaternary work are also occasionally held. The publications of the Association are the Quaternary Newsletter issued in February, June and October; the Journal of Quaternary Science published in association with Wiley; and the QRA Field Guide and Technical Guide Series.

The Association is run by an Executive Committee elected at an Annual General Meeting held during the Annual Discussion Meeting in January. Current officers of the Association are:

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