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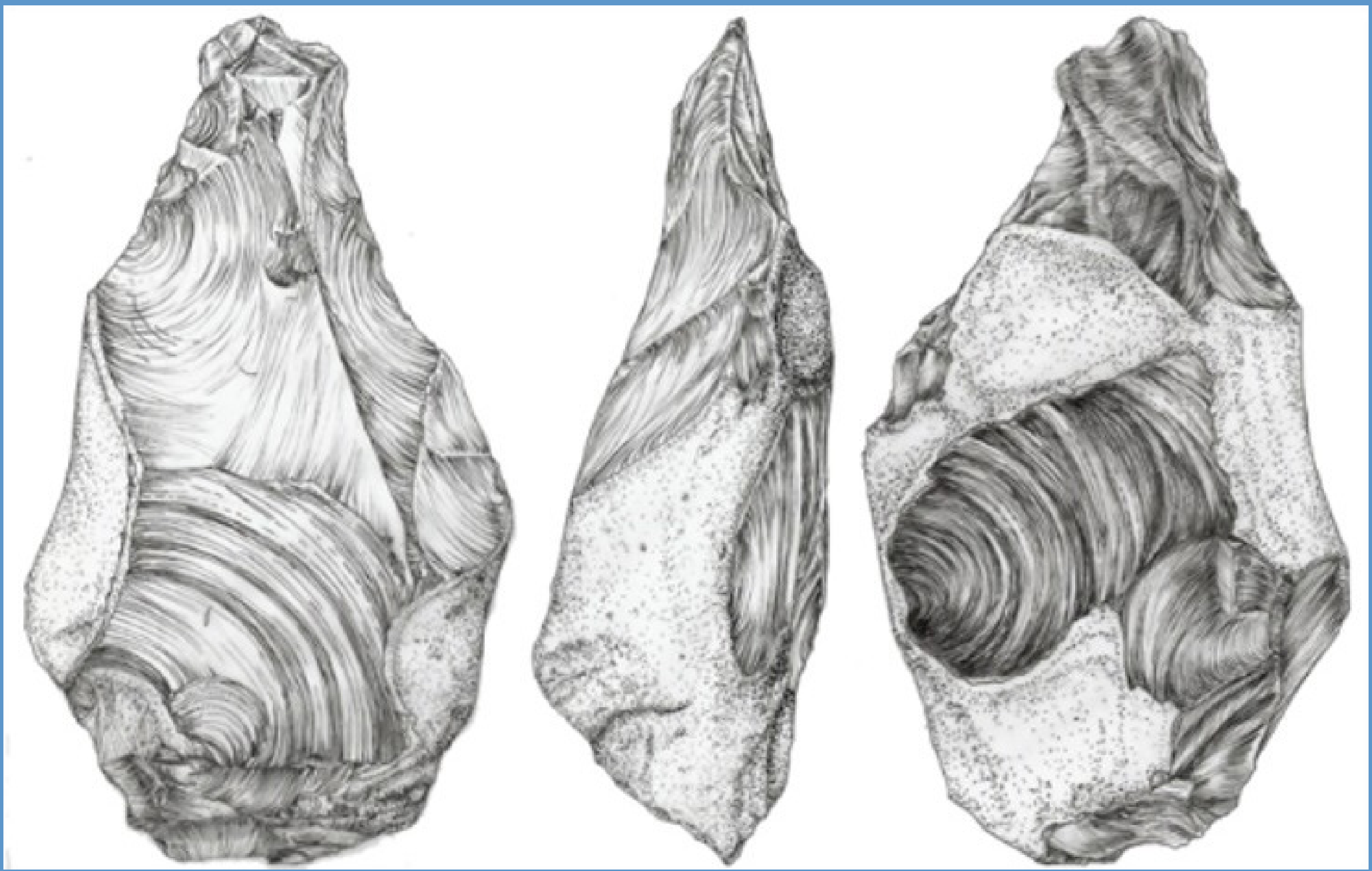

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QUATERNARY NEWSLETTER

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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 issues 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. Ph.D. 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 available on the QRA website or from the editor.

COVER PHOTOGRAPH

A hand-axe from Daking's Pit, Essex (image credit: Ellery Littlewood). Littlewood (this issue) describes the role of lithics in the British Quaternary record and importance of lithic illustration.

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STORIES IN STONE: THE ROLE OF LITHICS IN THE BRITISH QUATERNARY RECORD

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Introduction

Hominin presence as a part of a wider suite of evidence to reconstruct Quaternary environments is well established (e.g. Wymer, 1988; Bridgland, 2000, 2010; Hosfield, 2022; White, 2023). Despite this, the British Quaternary record features hominins sparingly as a 'record of coming and going' (De Groote et al., 2017), with slow multi-generation migration into Britain along 'dispersal corridors' of tolerable conditions and local extinction during cold stages (Dennell et al., 2011; Pettitt and White, 2012; Hosfield, 2022). Slow reoccupation after extinction was hampered by Britain fluctuating between being an island and being a peninsula of mainland Europe with changing climate cycles, crossed by major river systems that provided the canvas for multiple and varied ecosystems and, occasionally, barriers to their spread (Bridgland, 2000, 2010; White and Schreve, 2000). Furthermore, the evidence for hominin presence is often found, and can only be spatiotemporally understood, within the context of contemporaneous Quaternary deposits. In the British record, this is often in river terrace deposits (predominantly clast sizes of gravel and smaller) but also in finer-grained lacustrine material, cave systems, and, very occasionally, reworked into till (Bridgland, 2000, 2010; Wymer, 1988). The focus here will be on the first of those.

The relevance of hominins to wider Quaternary studies may be queried then, and rightly so: the British hominin record spans less than a million years and is primarily characterised by the stone tools (lithics) they used, with little in the way of fossil evidence. However, this record is also part of a story of a changing climate and landscape, with species adapting to conditions often towards the edge of their habitable zone, comprising species whose DNA is echoed in our own (Hosfield, 2022; Lockey et al., 2022).

Hominins in the Quaternary

Hominin evolution spans the initial evolutionary split from our last common ancestor with chimpanzees and evolution of a new genus – *Sahelanthropus tchadensis*, c.6-7 Ma BP – to the present singular surviving hominin: *Homo sapiens* (Figure 1; Brunet et al., 2002; Macchiarelli et al., 2020). Hominins of the genus *Homo* first evolved just prior to the start of the Quaternary (2.8 Ma BP) in the form of the heterogeneous *H. habilis* (arguably split into *H. habilis* and *H. rudolferensis*; Wood and Boyle, 2016; Prat, 2022). This lineage evolved and diversified throughout the Quaternary to encompass familiar hominins such as the Neanderthals (*H. neanderthalensis* or *H. sapiens neanderthalensis*), whose evidence constitutes a vital part of the British Quaternary hominin record. Furthermore, genome sequencing of modern humans, Neanderthals, and Denisovans (previously thought to be non-ancestral to each other) show shared genetic material and, therefore, evidence of interbreeding between these contemporaneous groups (Green et al., 2010; Ko, 2016).

The British fossil record of these species is sporadic at best: a tibia and teeth of *Homo heidelbergensis* found at Boxgrove (c.500 ka BP; Roberts et al., 1994), partial Neanderthal cranium from Swanscombe (c.400 ka BP; Key et al., 2020), and Neanderthal teeth from Pontnewydd Cave (c.225 ka BP; Compton and Stringer, 2015). Controversy over the represented species persists, with the Boxgrove remains having high degrees of morphological similarity with the Neanderthal remains from Sima de los Huesos (Atapuerca, Spain, c.430 ka BP), such that it has been argued that they cannot be said to be from a distinct species (Lockey et al., 2022). This is further complicated by high levels of diversity found in hominin remains from the same Marine Isotope Stage (MIS) at the prolific sites at Atapuerca, which were

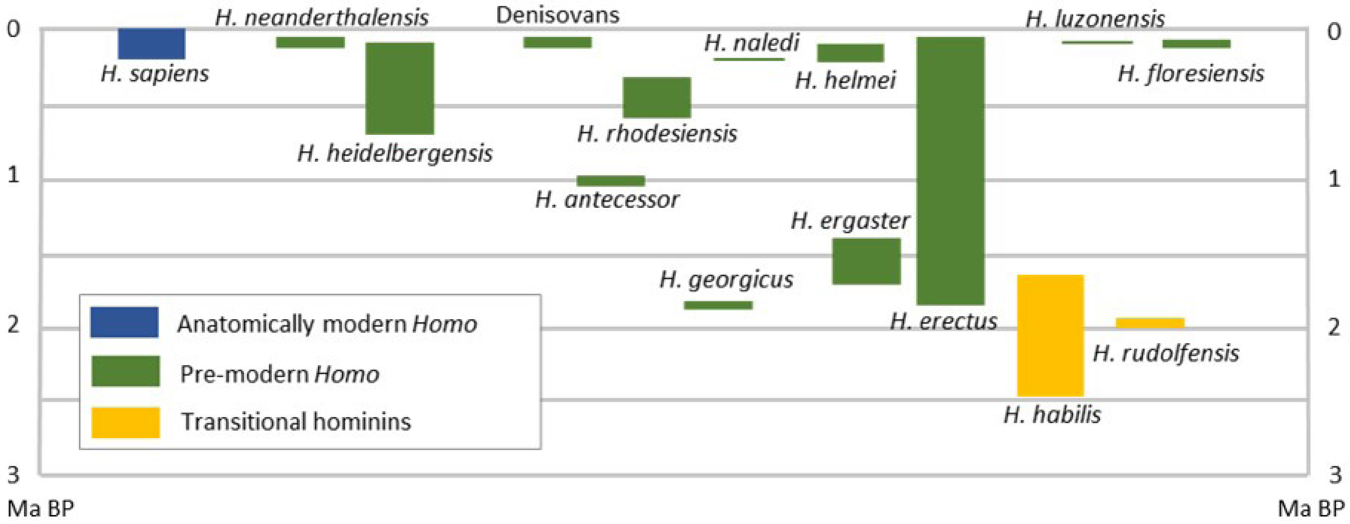


Figure 1. Hominin species of the genus *Homo* present in the Quaternary (based on specious taxonomy) after Wood and Boyle (2016) and Owen-Smith (2021).

initially classified as *H. heidelbergensis* (Arsuaga et al., 1997) but later reclassified as Neanderthal based on morphometric and genetic similarities (Arsuga et al., 2014; Meyer et al., 2016; Pablos et al., 2017). Rare hominin trace-fossil evidence also exists in the British record, in the footprints found on the foreshore at Happisburgh. Dated to c.950-700 ka BP, these are hypothesised to have been made by *Homo antecessor* based on temporally equivalent fossil evidence from Atapuerca, Spain (Ashton et al. 2014). As a result of the fragmentary fossil record, ongoing discourse around species differentiation, and uncertainty surrounding the migration pathways of hominins into Britain, the catch-all 'hominin' will be used here to refer to the makers of British Lower and Middle Palaeolithic tools.

Stories in stone

In the absence of a comprehensive fossil record, lithic presence, type, density, and assemblage nature is used to reconstruct hominin presence. The focus here is on Lower Palaeolithic hominins: those using early core and flake technologies (the 'Clactonian' industry) with later technological evolution of cores into bifacially worked hand-axes (the 'Acheulian' industry). Whilst lacking diagnostic artefacts and too small an assemblage to be classified as Clactonian, the oldest British lithics are flakes from Happisburgh Site 3 (MIS 21 or 25; Ashton et al., 2014). The Clactonian – aka Mode 1 (Clark, 1969) – is a non-hand-axe industry with a type locality at Clacton, Essex, first appearing in the British record during MIS 11 as a record of favourable climate (Oakley and Leakey, 1937). This technology centres around the production of flakes struck from cores to gain a sharp edge (and used as tools in their own right) or refined with secondary removals for use as more specialised tools (Pettitt and White, 2012). The cores could also be modified in a similar fashion, with the size, shape, and weight of the tool making them ideal for chopping wood and bone (Ashton et al., 1992). The evolution from Clactonian to Acheulean is non-linear with contemporary groups using different industries; this suggests migration into Britain by different hominin groups with varying material cultures, presumably reflective of their source populations (White and Schreve, 2000; White, 2015; Davis and Ashton, 2019).

The Acheulian – aka Mode 2 (Clark, 1969) – is defined by the presence of hand-axes and, except for the *bout coupé* (unique to MIS 4 - 3), is constrained to MIS 15 - 7 (Bridgland and White, 2014, 2015; White, 2015). The hand-axe is the tool that first placed humans in deep time via the 'stone that shattered the time barrier' (an *in situ* hand-axe) documented at St. Acheul, France, in 1859 (Gamble and Kruszynski, 2009). Compared to chopper cores, hand-axes had a larger number of uses and were more adaptable to a multitude of tasks, exemplified in the British record by the intra- and inter-group variation assigned to them by Roe (1968; Table 1). Bridgland and White (2014, 2015) utilised Roe's (1968) hand-axe groups, correlating them with distinct MIS (Table 1) via multi-proxy correlation to secure dating (White, 2015). Patterns in Roe's groups are also distinct to a sub-MIS in some cases: Group VI (including highly indicative twisted forms) are exclusively found in assemblages north of the Thames in MIS 11c, whilst Group II is found exclusively south of the Thames (White et al.,

Table 1. Correlation between Roe (1968) hand-axe groups and MIS, after Allen et al. (2022).

GROUP	 I I	 II	 III	 V	 VI	 VII
Marine Isotope Stage	9 - 8	11	9	15 - 13	11	13

2019). MIS 11b is a cold substage with local hominin extinction, however the MIS 11a spatial pattern of hand-axe occurrence is reversed: Group II to the north and Group VI to the south of the Thames (White et al., 2019). Assuming contemporary hand axe type represents distinct groups, characteristic typologies aid dating (to an MIS-level) and, furthermore, demonstrate the level to which large river systems represented a physical barrier to migration (White, 2015, 2023; Davis and Ashton, 2019). The MIS 11c record also demonstrates the speed of reoccupation following the inhospitable conditions of MIS 12, with the addition of Clactonian assemblages, suggesting dispersal corridors reopened rapidly, multiple hominin groups migrated along them, and that climate warmed to favourable conditions much more rapidly than in preceding warm stages (Dennel et al., 2011; Hosfield, 2022). However, this may also be suggestive of the evolution of adaptive skills within Eurasian hominins to address the 'over-wintering problem' (Hosfield, 2022).

These patterns are not without bias. Collection bias is endemic, with hand-axes often favoured over other lithics in historic excavations, poorly provenanced finds from sites, educational level (and financial rewards – see White, 2022) of those excavating, and a tendency towards sites with larger assemblages having multiple thorough excavations (Ashton and Lewis, 2002). Raw material also influences preservation; flint is more resistant than quartzite, leading to proportionally more flint preservation (Bridgland et al., 2014). Raw material availability is also a significant factor, with flint being dominant along migration routes into and within Britain (Bridgland, 1994). Uncertainty over assemblage age and provenance also comes via reworking, ascertained from the level of rolling an assemblage displays, common in 'fluvial jumbles' (White, 2023). There are also notable examples of mixed assemblages, such as that at High Lodge, Suffolk, which features rolled Group V and relatively mint Group VII (Bridgland and White, 2014).

Lithic illustration

From personal experience, interpreting lithics without an academic background in archaeology is a challenge. However, the precise illustration of the tools aided not only interpretation, but also understanding of how the tools were made and used. Photographs are often inadequate in showing all features and flake removals in materials with high shine (i.e. flint, the raw material for many British lithics) or matte (i.e. quartzite) surfaces. In the case of hand-axes (Figure 2) it is necessary to ensure illustration captures the maximum possible number of flake removals whilst not over-emphasising specific detail which would hinder the overall depiction of form, and therefore make allocation to a Roe Group (Table 1) impossible. With all illustration there lies the risk of over-emphasising detail that would assign a meaning to a non-knapped stone, as has plagued the history of the subject with misinterpretation of eoliths as lithics (White, 2023). An assemblage is not only hand-axes; flakes (Figure 3) should also be considered within Acheulian assemblages. Secondary usage of flakes also illustrates the ways tools were used to suit immediate need; Figure 4 illustrates a flake featuring subsequent retouch along the cutting edge (akin to chopper cores, described above) with pockmarks on one face indicative of secondary battering, not immediately visible in the photographed artefact.

The argument for 3D scans is applicable here, with ongoing projects seeking to digitise large collections of British lithics. Whilst these show more accurate and comprehensive renderings of lithics, illustration is currently a more accessible form of depiction that requires significantly less equipment or processing. Illustration is also a 'dying art' with limited professional practitioners and, even on a personal research level, is a beneficial tradition to continue.

Figure 2. Selected hand-axes from Daking's Pit, Essex, after Littlewood (2020) – not to scale. These hand axes range from 62 – 78 mm long. The largest hand-axe from this site measured just 128 mm long.

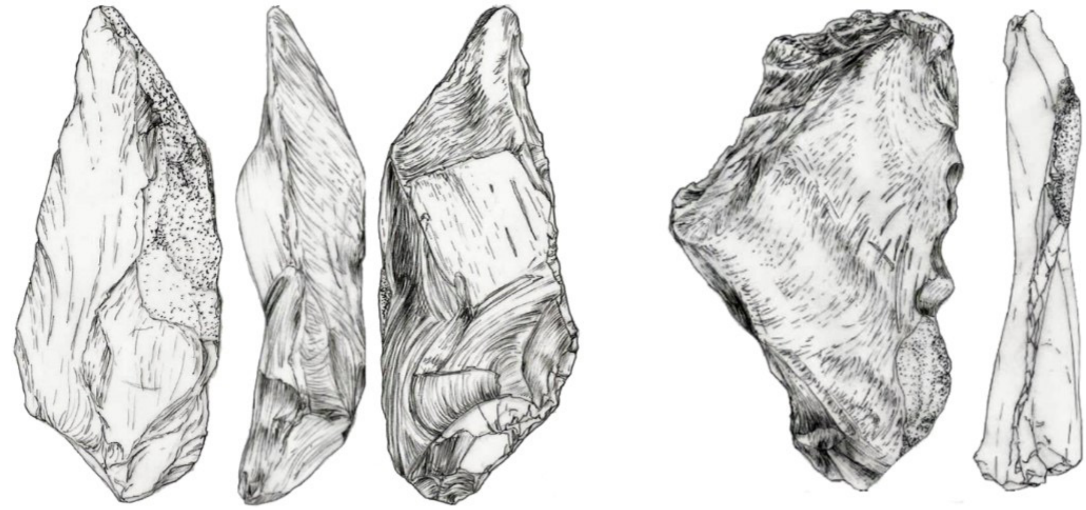
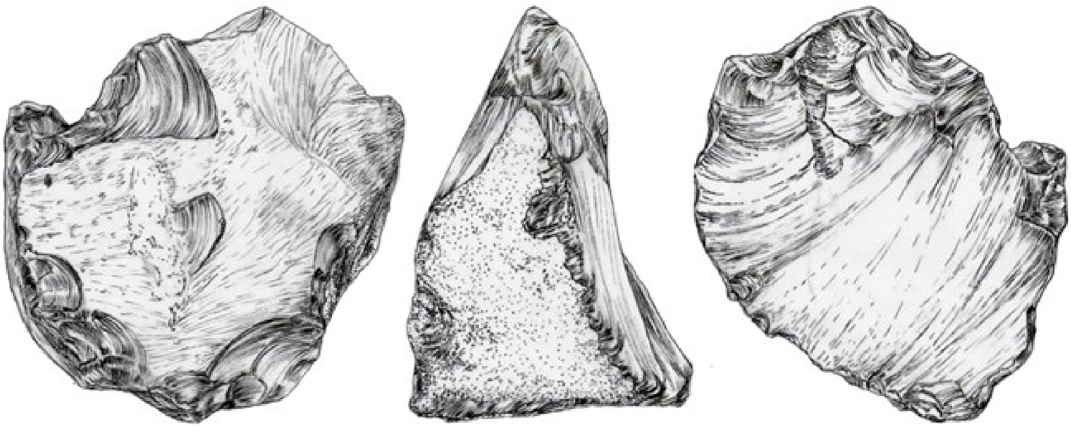


Figure 3. Selected flakes from Daking's Pit, Essex, after Littlewood (2020) – not to scale. These flakes are 72 mm long (left) and 56 mm long (right).

Figure 4. Secondary use wear on the face of a retouched flake from Daking's Pit, Essex, showing evidence of retouching and secondary use, after Littlewood (2020). This flake has dimensions w:53 mm, l: 37 mm, d: 53 mm.



Conclusions

The British hominin fossil record is extremely fragmentary yet fits into the wider European pattern of hominin evolution and migration. In the absence of a robust fossil record, lithics can be used to reconstruct hominin presence and population dynamics on the basis of material culture as a proxy for distinct groups. Lithics themselves can also be used as a proxy to support and augment other relative and absolute dating methods along the lines of Roe's (1968) groups assigned to MIS (Bridgland and White, 2014, 2015). This is seen on a sub-stage level in MIS 11 with the position of hand-axes of different Roe goups either side of the Thames, interpreted as a physical barrier for further migration, as a proxy for distinct hominin groups. Depiction of lithics is also relevant, with lithic illustration being an important mechanism by which non-archaeologists can gain a better understanding of how lithics were made and used by Palaeolithic hominins, as well as an accessible means of communicating lithic (and, by extension, assemblage) features. These ideas can be applied further in interdisciplinary studies within the broader field of geoarchaeology. On a very human level, this allows a window into the world of people somewhat alien to us, yet whose DNA persists in our own and who were perhaps not that different to us after all: existing and subsisting in the climate, landscape, and circumstances to which they were born.

Acknowledgements

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COMBINING LONG-TERM ACCUMULATION RATES AND FLUX TOWER DATA TO INVESTIGATE PEATLAND CARBON STORES IN THE FALKLAND ISLANDS

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Introduction

Peatlands in the Falkland Islands are very different to those found in northern temperate regions and include vegetation and soil properties quite unlike the blanket peat, fens and raised bogs that are more familiar to Northern Hemisphere scientists. The climate of the archipelago is dry with only 400-800 mm precipitation annually (Otley et al., 2008), but despite this, peatlands cover around 38% of the islands and together with peaty-soils store approximately 900 Mt of carbon (Burton, 2016; Evans et al., 2020; Carter et al., 2023). Inland, peatlands are dominated by whitegrass (*Cortaderia pilosa*) and diddle dee (*Empetrum rubrum*) within a landscape that has been substantially altered by historical grazing. Along the coastlines tussac grass (*Poa flabellata*) peatlands provide both substantial carbon stores and important habitats for coastal and marine wildlife (Smith and Karlsson, 2017). These include the *"extraordinary"* Beauchêne Island where long-term carbon accumulation rates are amongst the highest ever recorded for any type of ecosystem (Smith and Clymo, 1984; Payne et al., 2019). The processes leading to widespread peat formation under such dry climatic conditions continue to confound scientists. Very simply, why is the peat here? Is the peat-forming vegetation particularly recalcitrant (Scaife et al., 2019)? Does exceptionally low hydraulic conductivity restrict water loss? Does peat still accumulate today or did the widespread peatlands form in the past under a very different climate and in the absence of livestock grazing (Otley et al., 2008)?

Natural history in the Falkland Islands has been considered for more than 200 years. A young, and slightly perturbed, Charles Darwin visited the islands in 1833 and 1834 and was – geology aside – largely unimpressed, describing *"an undulating land with a desolate and wretched aspect …"*. Subsequently, however, renowned botanists and islanders alike have been taken in by the curious landforms and treeless landscape (Hooker, 1842). They also provided cautionary forecasts that continue to be relevant today. For example, in 1841-3 the first British Governor-Lieutenant, Richard Clement Moody noted that tussac was *"much injured by grazing; for all animals, especially pigs, tear it up to get at the sweet nutty-flavoured roots"* (Ross, 1847). This excessive grazing has led to a reduction of more than 80% in the extent of tussac since European arrival in 1764 CE (Strange et al., 1988). Understanding the differing threats to peatlands, and the processes that led to their formation, is more important than ever if the UK and its overseas territories are to reach net zero by 2050 CE. Undisturbed until the mid-18th century, peatlands in the Falklands are now highly modified by historical and ongoing grazing activity, drying, burning and peat cutting for fuel, and are likely to be threatened by further climatic drying as the Southern Hemisphere westerly winds move southward. There are, however, substantial opportunities to halt, and possibly reverse, this damage. Appreciation of the natural biodiversity is growing alongside the realisation that peatland restoration could provide substantial benefits to both the environment and the local economy (Evans et al., 2020). Here, we describe some of the first steps in a feasibility study for a carbon credit scheme with the long-term aim of financing peatland restoration in the islands. This Department for Environment,

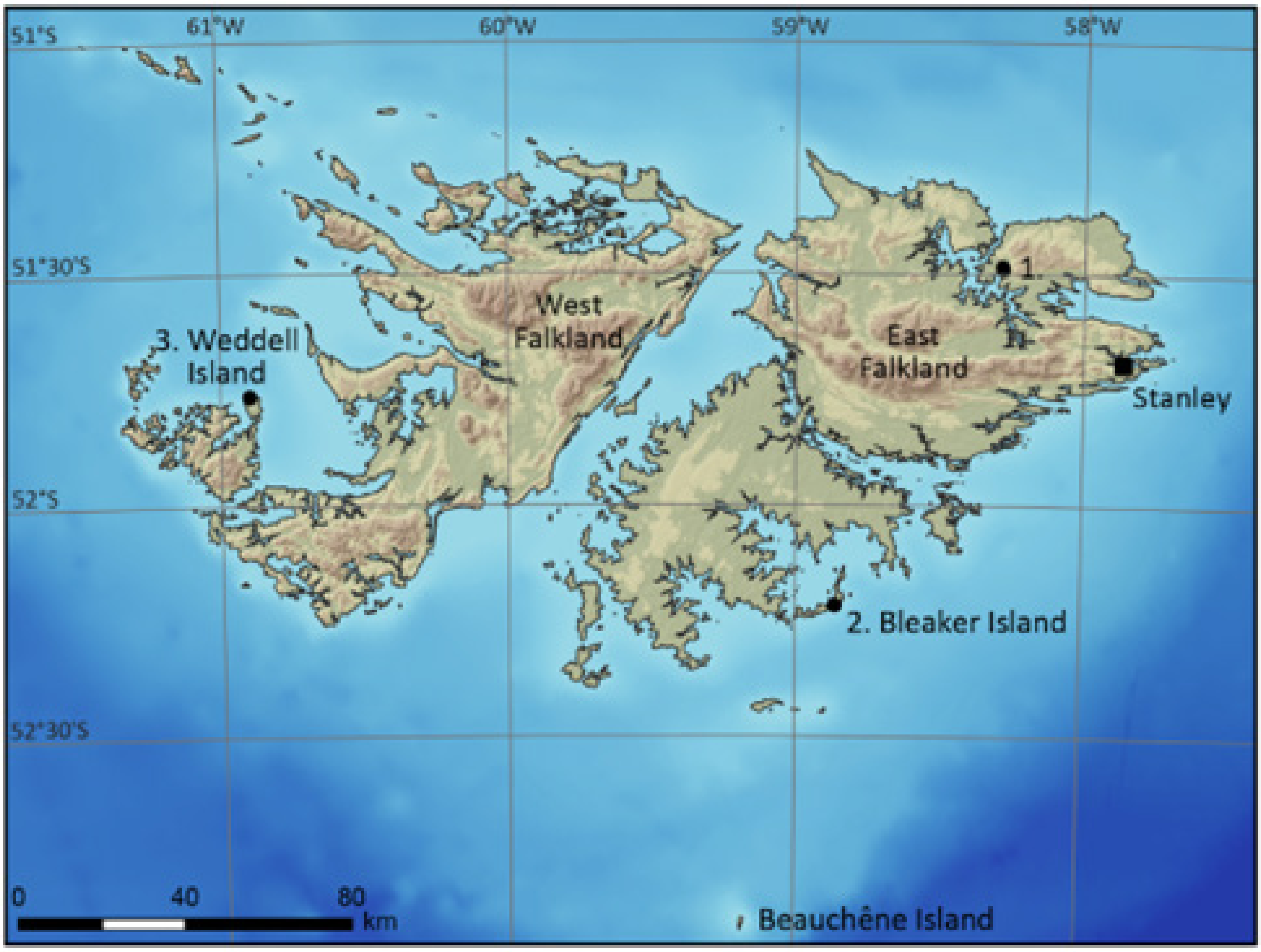

Figure 1. The position of the Falkland Islands and study sites. (1) Ricon Grande/Horseshoe Bay. (2) Bleaker Island. (3) Weddell Island.

Food and Rural Affairs (DEFRA)- and Falkland Islands Government-funded project includes teams from Falklands Conservation (FC), the UK Centre for Ecology and Hydrology (UKCEH), the South Atlantic Environmental Research Institute (SAERI) and the British Antarctic Survey (BAS).

Combining long-term accumulation rates and flux measurements

The feasibility study represents a novel combination of biometeorological and paleoenvironmental techniques. In February 2004, a team of FC, UKCEH and BAS researchers installed flux towers at four different sites and retrieved representative peat-cores from the areas most important to the biometeorological instruments (Fig. 1). Some of the challenges faced by the 2024 team haven't changed since Darwin's first visits during the early 19th century and much of the flux tower wiring faces an uncertain future given the enthusiastic attention of local wildlife. Striated Caracaras (*Phalcoboenus australis*; Johnny Rooks) were a concern in the 1830s and remain so today (Fig. 2): *"...It was necessary to keep a good look out to prevent the leather being torn from the rigging ... These birds are very mischievous and inquisitive; they will pick up almost anything ... a large black glazed hat was carried nearly a mile ..."* (Darwin, 1839). The researchers are, however, hopeful that suitable preventative measures and good local support will prove successful in keeping the Caracaras at bay.

Peat-cores will allow long-term peatland carbon accumulation rates to be quantified, providing natural baselines that predate historical disturbance. These data will establish the limits of carbon sequestration if peatlands can be restored to functionally resemble their pre-disturbance state. In contrast, flux towers take continual measurements of weather conditions, soil moisture and, importantly, the exchange of gaseous carbon fluxes between the peat and atmosphere. The selected study sites address two principal themes. (1) The first provides data that investigate how differing grazing pressures affect peatland carbon flux. In East

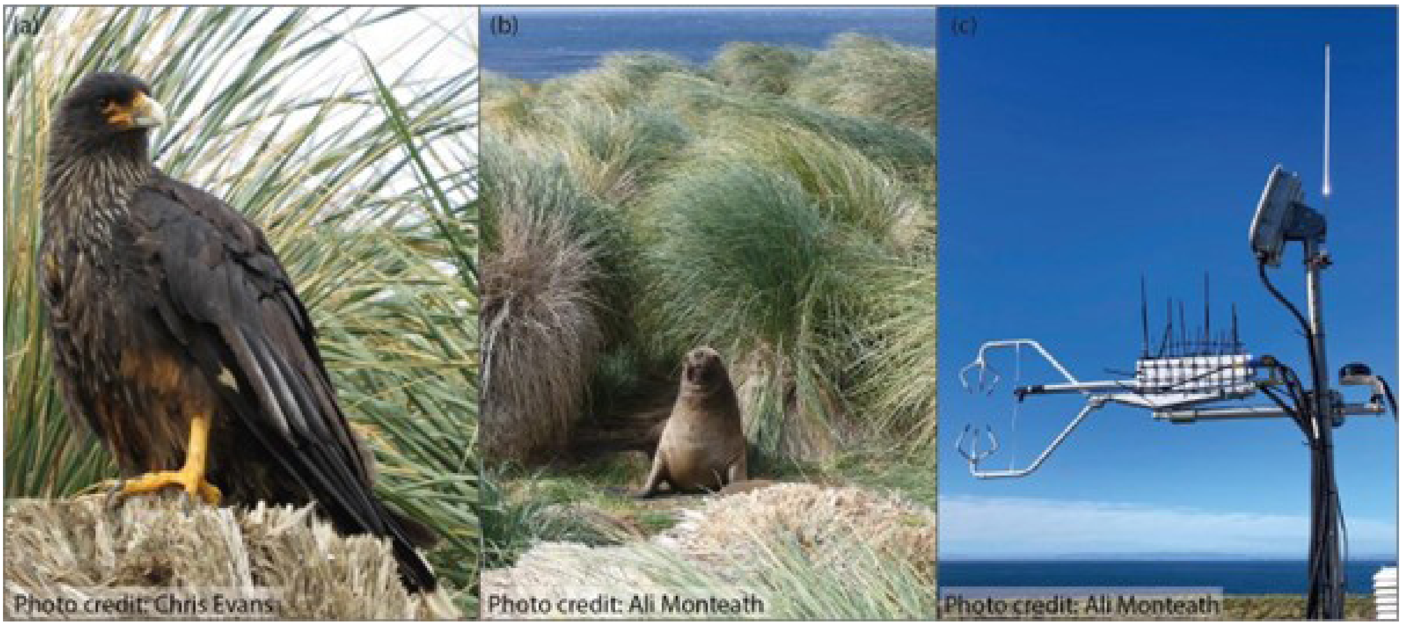

Figure 2. (a,b) Flux tower threatening wildlife. (c) Wildlife defences

Falkland, a property boundary divides a blanket peatland and different sheep-stocking practices have led to the development of contrasting vegetation communities within a uniform climate space (Fig. 3). To the north, rotational stocking has promoted a whitegrass (*Cortaderia pilosa*) dominated assemblage with patches of bog moss (*Sphagnum* spp.) and rushes (*Rostkovia magellanica*). To the south, set stocking has led to diddle-dee (*Empetrum rubrum*) dominance and drier surface conditions. Understanding whether either of these peatlands continues to sequester carbon, and if differing grazing pressures are influential, will help to determine land use guidance within the proposed carbon offsetting scheme. (2) The second theme is focused around tussac grass restoration. This unique plant is endemic to the South Atlantic and can reach three meters in height – providing a refuge for a range of marine/coastal wildlife (Fig. 2). In turn, nutrient loading from these animals promotes rapid accumulation of exceptionally dense peat. Flux towers were installed in areas of tussac restoration and regeneration on Weddell Island and Bleaker Island. These instruments will measure the potential carbon sequestration benefits from restoration as well as linking flux data with meteorological conditions and vegetation health. At the time of installation an area of dieback appeared to be closely associated with peat depth and presumably water, or nutrient, stress.

Figure 3. The Ricon Grande (left) and Horseshoe Bay (right) fence line.

Throughout the next two years the project team will continue to monitor the flux tower measurements and combine these data with long-term carbon accumulation data. Data will be made available through the South Atlantic Environmental Research Institute data-portal.

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Quaternary Newsletter
Article

COMMENT ON "AN IGNEOUS ERRATIC AT LIMESLADE, GOWER, AND THE GLACIATION OF THE BRISTOL CHANNEL" BY BRIAN JOHN

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In his article in Quaternary Newsletter 162 (pp. 4-14), *An Igneous erratic at Limeslade, Gower, and the glaciation of the Bristol Channel*, John (2024) reports the observation of a large unspotted dolerite erratic boulder on the foreshore at Limeslade, SE Gower. He provides petrographical observations and data, some attributed to others, to explore whether this boulder can be provenanced to igneous sources in the Mynydd Preseli region of northern Pembrokeshire. He concludes, "tentatively", that on the basis of this evidence the boulder cannot have derived from a Mynydd Preseli source and explores other possible igneous sources across Wales. Having been unable to establish any clear provenance for the boulder, he then discusses possible transport mechanisms, concluding that the boulder is most likely an erratic transported by the Irish Sea Glacier *[sic]*; = Irish Sea Ice Stream (Scourse et al., 2021).

Given the ambiguity over the provenance of the boulder, he then, rather extraordinarily, states *"The discovery of this erratic in the SE corner of the Gower Peninsula has a profound bearing on the debate concerning the entrainment and transport of Preseli "bluestones" from West Wales towards Stonehenge."* (p. 10). Indeed, the motivation behind the article is clear in that John's exploration of transport mechanisms starts first by discounting human transport rather than the more parsimonious explanation of glaciation. This provides the starting point for a lengthy rehearsal of the Stonehenge bluestone transport debate involving a polemic against the advocates of human transport (e.g. Parker Pearson et al., 2021) and support for glacial transport to Salisbury Plain: *"...once the glacial transport hypothesis is taken seriously, Stonehenge loses much of its aura and marketing potential!"* (p.11).

We respond here to the following issues raised in the article: 1. hand specimen descriptions, thin section descriptions and provenance, 2. geochemistry and petrogenesis and 3. glaciation and glacial transport in the Bristol Channel region.

Hand specimen descriptions, thin section descriptions and provenance

John makes reference to potential provenances for the Limeslade boulder, but the commentary provided leads to more questions than answers. He is certainly correct in stating that the boulder cannot have been derived from anywhere in the local vicinity, given the geology of the Gower Peninsula. John reports that Dr Katie Preece, from Swansea University, had examined a detached flake from the bottom surface of the boulder, noting that it is *"made of greenish unspotted dolerite or micro-gabbro with crystals of feldspar and pyroxene"* (p.5). John reports that *"The rock's colour is very similar to that of fresh unspotted dolerite surfaces in the western part of Mynydd Preseli in Pembrokeshire."* (p.5). Whilst that is true, it similarly applies to almost all dolerite/gabbros exposed across the whole of the north Pembrokeshire area. He then goes on to say that the rock is similar to *"another rock sample from Foel Eryr on Mynydd Preseli"* (p.5) and then that *"When the surface texture is compared visually with that of unspotted dolerites in Cilgwyn, near Newport, there is remarkable similarity"* (p.5), here, rather misleadingly suggesting two specific locations while comparisons which could be made with almost any dolerite in north Pembrokeshire. Matching of dolerites/microgabbros at the outcrop

scale across north Pembrokeshire is just not possible on visual similarities alone and to suggest so is misleading.
John then goes on to quote Professor Peter Kokelaar as saying that *"the banding perpendicular to the 'columnar' length is fairly typical of some coarsely jointed sills I have mapped between Fishguard and St David's Head"* (p.5), which is a fair observation. However, John then states that *"One such sill occurs at Ogof Golchfa, near Porthclais (SM 740236), and the similarities in hand specimen are again striking"* (p.5-6). However, not only does Ogof Golchfa not lie between Fishguard and St David's Head, it is not a dolerite but rather a porphyritic microtonalite (British Geological Survey, 1992, Sheet 209, 1:50 000). Having identified at least three outcrops that show 'similarities', John then admits - despite stating earlier that *"The boulder surface is remarkably fresh…"* (p.5) - that *"However, visual comparisons (especially for weathered surfaces) can cause confusion..".* This is indeed true.

A further section provides information on the boulder in the form of a summary of the petrography of thin sections from the boulder. Why this is separate from the earlier descriptions is unclear, but is confusing. The information is basic, reporting that it contains clinopyroxene and plagioclase in ophitic intergrowth, lacking any detail of alteration of the rock, other than that the pyroxene is incipiently uralitized, the plagioclase is partially argillized, and a vague comment – quoting Dr Steve Parry - about *"overprinting by opaque material (presumably oxides of Fe and/or Ti)"* (p.7). There is no mention of the presence of particular secondary minerals, which in altered basic igneous rocks in north Pembrokeshire comprise variable amounts of chlorite, titanite, epidote, clinozoisite, prehnite, pumpellyite and actinolite. The distribution of the last three phases is linked to subtle variations in whole rock Mg/(Mg+Fe) contents in the sub-greenschist to greenschist facies boundary region, as present in the Mynydd Preseli area and reported by Bevins and Robinson (1993), and these offer significant potential for provenancing. John states *"Dr Parry suggests that there is nothing about the petrology or geochemistry which is exceptional or particularly noteworthy. Micro-gabbro intrusions of this general type are not unusual in the Lower Palaeozoic successions of Wales…but at present it would be unwise to suggest a specific age or provenance."* (p.8). This is fine, given the cursory examination of the boulder by John and colleagues but then John, on the basis of no evidence, states that *"it can be tentatively suggested that the Limeslade boulder has not come from a Mynydd Preseli outcrop"* (p.8). However, he then admits that *"there are scores of outcrops in NW Pembrokeshire (including the St Davids Peninsula, Pen Caer and the Eastern Cleddau catchment) where narrow strips of microgabbro or coarse dolerite with a greenish tinge are exposed at the surface"* (p.8-9), again mentioning erroneously the microtonalite outcrop at Ogof Golchfa.

There is reference to alteration of Preseli dolerite; "Preseli unspotted dolerite is also found in hand axes, and the Implement Petrology Group has classified it as *"group XIIIb"* (p.8), followed by *"The group comprises altered sub-ophitic dolerite, originally with clinopyroxene-plagioclase-titanomagnetite-ilmenite-apatite intergrowths. Alteration is widespread and secondary minerals include muscovite, chlorite, epidote, clinozoisite, actinolite, quartz, pyrite, titanite, pumpellyite and prehnite (Ixer and Bevins, 2018)."* (p.8). However, Ixer and Bevins (2018) were describing Group XIII spotted dolerite, known as 'preselite'. The non-spotted and spotted dolerites are petrographically significantly different.

To add to the confusion, John then goes on to state that *"more distant sources of dolerite, for example in the Cader Idris region, in Llyn, and in Snowdonia have in the past been considered as possible sources for the Stonehenge unspotted dolerite assemblage but dismissed on the grounds that they are physically not well matched"* (p.9) quoting Kokelaar et al. (1984), Williams-Thorpe et al., (2006) and Bevins et al. (2014). Quite why these potential areas of Wales are brought into the equation is puzzling, as none of them would likely be a potential source for the Limeslade boulder. What is meant by *"physically not well matched"* (p.9) is not clear, whilst the choice of reference citations here is odd. Kokelaar et al. (1984) make no reference to the origin of the Stonehenge bluestones, whilst Bevins et al. (2014) discuss the source of the spotted and non-spotted dolerite bluestones, focussing on specific outcrops in the Mynydd Preseli. Reference to Wiliams-Thorpe et al. (2006) is also confusing and no reason for its citation is offered.

Recent petrographical descriptions of igneous rocks in southwest Wales have commonly employed total petrography using polished thin sections, especially if petrography is to be allied to geochemistry, as has been advocated by Ixer et al. (2004). Total petrography allows for the identification of opaque and semi-opaque minerals, in addition to making minor phases more apparent and accessible to technical (e.g. SEM, microprobe) detailed characterisation. The descriptions in John are based on transmitted light microscopy only, and hence miss the opportunities provided by total petrography.

As reported by John, the petrography of the Limeslade boulder thin sections offers no evidence for a provenance for the boulder.

Geochemistry and petrogenesis

John attempts to compare the composition of the Limeslade erratic with XRF and pXRF analytical data from other sources. This analysis is deeply problematic.

First, no details whatsoever are given of the analytical methodology used by Darvill and Parry. It is not known what Parry's affiliation is, but presumably they have access to a pXRF. Different models of pXRF instrument operate differently, and it is essential that operating conditions and some reference material data are presented so that analytical quality can be assessed. In lacking any traceability data, the results presented by John have no meaning and cannot be compared externally. Using an 8 mm diameter analytical spot, Pearce et al. (2022) show that between 15-20 pXRF analyses are required to give a meaningful analysis of Preseli dolerites. If the pXRF used by Darvill and Parry has a smaller (e.g. 1 mm or 3 mm diameter) analytical spot as used on some other brands of instrument, many tens of analyses will need to be performed across a medium to coarse grained doleritic rock to obtain a representative analysis (this being related to grain size vs. spot size considerations). Bevins et al. (2022) presented a wide range of reference material analyses for the pXRF used in their studies, with analysis of an in-house standard during each analytical run to check day-to-day calibration. Here, John presents no reference material data for the Darvill and Parry analyses.

John describes *"The geochemical compositions of three [our emphasis] "control samples" of spotted dolerite from Carn Meini"* (Table 1, p.6) and then uses the average of these to compare the data with other published analyses. We do not know if this is three single analyses or whether it is the average of many analyses from three samples. If it is the former, this is a totally inadequate number of analyses for such comparisons; the latter is only valid if each analysis is an average of many repeat determinations (several tens) from each sample (see above). The comparison can then only be made if reference material data are presented to show the accuracy of the data presented by John. John goes on to state that because the tabulated data are *"ppm measurements...means that* ***direct comparisons are not possible with****...past geochemistry...which presented oxide percentage weights for the major elements and ppm measurements for the trace elements."* (p. 6). Conversion between wt % oxide and ppm is a simple calculation, described in many basic geochemistry texts and online, routinely undertaken by undergraduates, thus comparison is entirely possible.

John compares Ni concentrations for three Carn Meini analyses from Darvill and Parry (average 99 ppm, no standard deviation given) and compares these with data from Pearce et al. (2022) (average 42.5 ± 11.6 ppm). John quotes no standard deviation for the Pearce data, nor the fact that only 88 of the 165 analyses performed by Pearce et al. (2022) were above the Limit of Detection - LoD - thus the true concentration will be notably lower than the reported average of 42.5 ppm were all the analyses <LoD to be known/included (this is discussed in detail in Pearce et al., 2022). John states that *"Not one of the 165 readings was over 90 ppm, raising the possibility of calibration or instrumental error"* (p.6-7), presumably meaning errors in the Pearce data, subsequently adding *"environmental, procedural and human errors"* (p.7) were also likely factors causing the difference. John, notably, fails to compare the bulk sample XRF analyses from Carn Meini of Thorpe et al. (1991) (29 ppm, included in John's Table 1, p.6) and Bevins et al. (2014) (35 ± 7.2 ppm, excluded from Table 1), both of which are entirely consistent with the pXRF Ni data from Pearce et al. (2022), and far lower than the Darvill and Parry reported concentration. For Rb, Darvill and Parry determined Rb at 5.7 ppm, Thorpe et al. (1991) recorded 19 ppm, Bevins et al. (2014) 14 ± 5.6 ppm and Pearce et al. (2022) 9.7 ± 3.2 ppm. Once again, the Darvill and Parry data looks out of place (here, too low) when compared with bulk data. The Bevins et al. XRF and the Pearce et al. pXRF data overlap at ± 1 standard deviation, and whilst the pXRF data look slightly low compared to the bulk-sample laboratory XRF, this could be related to surface leaching of Rb (Potts et al., 2006), which may have had a more extreme impact on the Darvill and Parry data. John fails to make these comparisons. What John's argument in fact shows here - ignoring the uncertainties of the analytical methods used - is that the Darvill and Parry pXRF data are too high for

Ni and possibly too low for Rb. Preconceptions drive the preferred narrative here - that the Darvill and Parry data are correct, and the Pearce et al. data are de facto wrong - despite clear and contradictory information which has been ignored.

John displays his ignorance of geological and geochemical processes related to sill formation. The various crags of Carn Meini and Carn Gyfrwy are all mapped as part of one sill (see Burt et al. (2012) and the map in Bevins et al., 2014). Sills inflate by the injection of magma between layers of rock (typically sediments), extending laterally (for long distances, often kilometres) and vertically (typically tens/ several tens of metres) as more magma is injected. They may show vertical compositional variation related to flow injection processes, and as they cool from the outer surfaces, further vertical compositional variations may form related to differential cooling rates, the order of crystallisation and crystal settling (Bhattacharji, 1967; Merriman et al., 1986; Marsh, 1989; Gibson and Jones, 1991; Gibb and Henderson, 1992; Latypov and Chistyakova, 2009; Marsh, 2013; Holness et al., 2017). Thus, to capture the range of compositional variation displayed in a sill, vertical profiles are required and this approach was followed by Pearce et al. (2022) in their pXRF assays of the Preseli sills. John, contrary to this extensive body of literature, contends that the variations between the Darvill and Parry, and Pearce et al. data, are because

- *"these discrepancies (and the wide scatter of plotted points on bivariate graphs) is that Carn Meini is not a single tor but an association of tors"* (p. 7). The source of the geochemical data providing the scatter to which John is referring to here is not clear, but if it is their data it merely relates to the fact there are so few analyses.
- *"Samples have been taken by researchers from many different locations in this assemblage of tors, revealing great heterogeneity within the parent igneous mass"* (p. 7) although it is not stated who performed these analyses. If it is Bevins et al. (2104) and Thorpe et al. (1991), then their data are consistent with the pXRF data of Pearce et al. (2022), and their analyses do not show the wide variation John claims.
- John claims these other sources of data *"contradicts the claim made by Pearce et al (2022) that there is homogeneity in the Carn Meini intrusion, based on the fact that there are near constant concentrations of Ni, Zr and Ba"* (p. 7) but we have shown above the similarity in the analytical data (e.g. Ni, above), so John's claimed contradiction is false.
- John also claims incorrectly *"That [the claimed homogeneity] takes no account of substantial lateral variations across the intrusion which are visible to the naked eye"*. (p. 7). The analyses of Carn Meini by Thorpe, Bevins and Pearce (described above) show comparable concentrations from diverse sample locations, so what this variation is that John claims is not clear. It is clear, however, that some analytes do not compare with the pXRF data from Darvill and Parry. How geochemical variation can be visible to the naked eye is a mystery.

John does however admit *"There is inadequate data for the creation of scatter diagrams or bivariate graphs involving the Limeslade boulder ppm readings"* (p. 7): he is correct in stating the Limeslade data are inadequate: were it plotted alongside the Carn Meini data from Thorpe et al. (1991), Bevins et al. (2014) and Pearce et al. (2022) with the Darvill and Parry Carn Meini *"control sample"* data, the shortcomings would be self-evident.

Glaciation and glacial transport in the Bristol Channel region

That this boulder was transported by glacial ice, at some point during the Pleistocene, is highly likely, as suggested by John. Whether this was by ice rafting at a time of high relative sea level, or by grounded ice – either by the Irish Sea Ice Stream (Scourse et al., 2021) or reworked into a local Welsh ice cap, is impossible to determine given it is not stratified. The Limeslade erratic is not a singular occurrence. It is but one of many hundreds of erratic boulders found in the modern intertidal zone across southern Britain and Ireland that, as pointed out by John, have been difficult to explain by ice rafting because of the necessity of generating high relative sea-level at a time of low eustatic sea level during glacial stages. Scourse (2024) recently provided a mechanism for their emplacement by ice rafting arising from the asynchrony between Early and Middle Devensian regional ice sheet development and global sea level. John argues that this is *"not supported by the field evidence"* (p.10) on the basis that in Cardigan Bay only one glacial episode – the Last Glacial Maximum during the Late Devensian at 26 ka BP - is present following the Ipswichian interglacial raised beach. However, as pointed out by Scourse (2024), 1. recent geochronological evidence from the raised beaches of the region is challenging the notion that these are all of interglacial status and 2. that the bounding periglacial sequences can be of very different age depending on the extent of postglacial coastal erosion (see Figure 3 in Scourse, 2024).

John questions whether high level erratics can be explained by ice-rafting. Some may be, as is probably the case of the uplifted sequences along the Sussex coastal plain (Scourse, 2024). It is true that *"Large erratics on the coasts of Devon and Cornwall are not restricted to the intertidal zone"* (p.10) but the vast majority are. Some may well be related to grounded ice, or glaciolacustrine conditions caused by impounding by glacial ice, as in the case of North Devon. As to why *"it is a mystery why glacial transport should be questioned, given that glacial deposits are on the Isles of Scilly, on Lundy Island…and south of Barnstaple"* (p.10), there is actually no mystery. The evidence for glaciation from these three localities is unequivocal, whereas further afield in SW England, apart from the evidence for cold-based plateau icefields on Dartmoor (Evans et al., 2012), the evidence is equivocal.

John's conclusion that *"On balance, the Limeslade is most likely a glacially transported erratic, carried southeastwards by the ice of the Irish Sea Glacier (sic) during one of the Quaternary glacial episodes"* (p. 10) is as likely as it is ice-rafted. The occurrence of boulders from Pembrokeshire transported by glacier southeastwards across South Wales towards the Severn Estuary has been known for well over a century (reviewed in Scourse, 1997). There is, however, no geochronological or other evidence to support John's contention that this ice advance occurred during the Anglian glaciation, nor is there any evidence to extrapolate this transport route eastwards from the western Mendips towards Stonehenge, as shown in Fig. 7 (p.9).

The Limeslade erratic is in no way exceptional. It is simply another giant erratic on the foreshore of southern Britain. There is no evidence presented by John to shed light on its provenance; rather, the narrative represents a curious journey of local sources to a broad, Wales-wide journey of potential sources of the Stonehenge bluestones, which has no relevance to the identification of the boulder on the foreshore, at Limeslade on Gower, and which logically, on the basis of previously published works, was derived from north Pembrokeshire. This article merely represents a disingenuous cover to justify a rehearsal of the now well-worn and increasingly tedious debate concerning transport of the Stonehenge bluestones.

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INTERNATIONAL ACCOLADE FOR THE PARALLEL ROADS OF GLEN ROY

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Introduction

The Parallel Roads of Glen Roy in the Highlands of Scotland are an iconic suite of glacial lake shorelines which underpinned the development of the Glacial Theory in the 19th century. They are recognised by the International Union of Geological Sciences (IUGS) as a locality of international significance in the 'History of Geosciences' category in the list of the *Second 100 IUGS Geological Heritage Sites* announced on 27 August at the 37th International Geological Congress in Busan, South Korea (Gordon et al., 2024).

Glen Roy

Glen Roy and neighbouring Glen Spean have stimulated geological debate from the early-nineteenth century to the present day (Palmer & Lowe, 2017; Rudwick, 2017; Sissons, 2017). Particular highlights are three shorelines, or 'Parallel Roads', present along the flanks of Glen Roy at altitudes of 260 m, 325 m and 350 m above sea level, and now recognised to have formed during the Loch Lomond Stade (≈Younger Dryas, ~12.9–11.7 ka) (Palmer & Lowe 2017; Palmer

Figure 1. The Parallel Roads form three prominent shorelines on the flanks of Glen Roy. (Photo © A.P. Palmer).

2021) (Fig. 1). The lakes were dammed by glaciers as they advanced and retreated, their surface levels being determined by those of overspill cols.

Louis Agassiz visited Glen Roy in 1840 and, from comparison with similar landforms around modern glaciers in Switzerland, concluded that the Parallel Roads represented the shorelines of former ice-dammed lakes (Agassiz, 1840) and not, as previously believed (e.g. by Charles Darwin and Charles Lyell), marine shorelines formed during a great submergence, although Darwin did later recognise that his marine hypothesis was a "gigantic blunder" on his part. The Parallel Roads provided convincing evidence for the former existence of glaciers in an area where none exist today, thus supporting Agassiz' theory of continental glaciation during a geologically recent Ice Age.

Since the 1840s, research on the landforms, sediments and chronology of the area has played a major role in understanding the complexity, rapidity and trajectory of landscape evolution and environmental change at the end of the last glaciation (Palmer & Lowe, 2017). In the last 50 years, research on the landforms and sediments of the two valleys, including the Turret fan (Fig. 2) has generated further refinements to the model of landscape evolution (e.g. Sissons, 1978; Peacock, 1986; Boston & Lukas, 2017). Further understanding of the complexity, rapidity and trajectory of environmental change at the end of the last glaciation has been enabled through the establishment of shoreline age through cosmogenic nuclide exposure dating (Fabel et al., 2010) and the analysis of annually resolved lake sediment (varve) records to understand glacier dynamics at decadal scales using high precision chronologies (Palmer et al., 2020).

The national importance of Glen Roy as a geoheritage site has been acknowledged since the 1950s through Site of Special Scientific Interest and National Nature Reserve designations (Brazier et al., 2017).

IUGS Geological Heritage Sites

In 2021, under the International Geoscience Program of UNESCO, the IUGS initiated a rolling programme to establish a worldwide inventory of geological heritage of international value coordinated by the International Commission on Geoheritage (IUGS-ICG) and based on a set of global standards. An IUGS Geological Heritage Site is defined as "a key place with geological elements and/or processes of international scientific relevance, used as a reference, and/or with a substantial contribution to the development of geological sciences through history" (Hilario et al., 2022). A list and justification of the first 100 sites was presented at a meeting in Zumaia, Basque Coast UNESCO Global Geopark (Spain), in October 2022, and published in book form (Hilario et al., 2022) and online (https://iugs-geoheritage.org/designations/). The nomination and evaluation process involved over 200 specialists from almost 40 countries and

Figure 2. The 350m and 325m shorelines and the Turret fan bluff. (Photo © C.K. Ballantyne).

ten international organisations. The meeting also adopted the IUGS Zumaia declaration (https://iugs-geoheritage.org/the-iugs-zumaia-declaration/, which includes recognizing geological heritage as part of the values that humanity must protect for future generations.

UK sites among the *First 100 IUGS Geological Heritage Sites* include Hutton's Unconformity at Siccar Point (Scotland), a key locality in the history of geoscience where James Hutton demonstrated the existence of 'deep time', the Giant's Causeway and Causeway Coast (Northern Ireland) and the Moine Thrust Zone (Scotland). Geomorphology and Quaternary sites include Uluru (Australia), the Grand Canyon (USA), the Quaternary Glacial Varves of Ragunda (Sweden), Funafuti Atoll (Tuvalu) and volcanoes such as the Quaternary Phlegrean Fields Volcanic Complex (Italy), the Holocene Puy-de-Dôme and Petit-Puy-de-Dôme Volcanoes (France), Capelinhos Volcano (Portugal) and Taburiente Volcanic Caldera (La Palma, Spain).

As well as The Parallel Roads of Glen Roy, notable geomorphology and Quaternary sites in the Second 100 list include the Combined Esmark Moraine and Otto Tank's moraine (Norway), the Granite Landforms of Dartmoor (England), the Mer de Glace (France), Yosemite Valley (USA), Vatnajökull (Iceland) and Hornsund Fjord (Norway) (Hilario et al., 2024).

The nomination process is likely to start in 2025 for the Third 100 sites, and further details will be available on the IUGS website – https://iugs-geoheritage.org. There is an opportunity for QRA members to consider whether additional sites in the UK might merit nomination, for example some of those listed in the *UK Top Quaternary Sites* (Silva & Phillips, 2015).

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QN Quaternary Newsletter Report QRA Quaternary Research Association

SUMMATIVE REPORT ON ‘EXPLORING POLAR ENVIRONMENTS’ DAY 2023

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Motivation for the event

Representation of BIPOC (black, indigenous people of colour), women, and other minority people in geoscience is severely lacking, most significantly in polar sciences. For example, 16% of the UK population are BIPOC, yet only 3% of polar scientists are BIPOC (British Antarctic Survey, 2022). Polar sciences have a poor history of inclusivity, with field research being entirely dominated by white males until as late as 1980, when the first British female scientist conducted research in Antarctica (British Antarctic Survey, 2022).

Increased diversity can benefit scientific advancements through expanding perspectives and approaches to problem solving (Bernard and Cooperdock, 2018; Medin and Lee, 2012). Yet, underrepresentation is apparent at all stages of academic research, from undergraduate level to research staff to professorial level (Ghosh, 2021). Addressing this lack of diversity begins at a grass-roots level, by increasing participation of underrepresented groups in environmental and polar sciences at secondary school and undergraduate level and encouraging them to pursue further education in these areas.

In November 2023, Drs Bethan Davies and Roseanna Mayfield led an ‘Exploring Polar Environments’ event at Newcastle University. This day, targeting school children from diverse local schools, was designed to promote greater equality, diversity, and inclusion in polar sciences, and expand on the significant work carried out by the British Antarctic Survey, Polar Regions Department of the UK Foreign, Commonwealth and Development Office, and Polar community, including UK Polar Network. A previous event was held at Royal Holloway University of London in March 2022 (Jenkins et al., 2022). We wanted to build on this success by hosting an event to engage with secondary schools in the North East.

The schools

The event was attended by over 200 pupils (years 9, 10, and 11) from nine local secondary school schools in NE England. These year groups were selected to target pupils at a stage where they make pivotal decisions about their future careers. Schools with the highest proportion of pupils from BAME backgrounds and >50% pupils on free school meals were prioritised.

The event

Location and partners
The 2023 ‘Exploring Polar Environments’ Day was hosted at Newcastle University and The Great North Museum: Hancock, in collaboration with Durham University and University of Northumbria. In addition, the event was supported by the British Antarctic Survey (BAS), British Geological Survey (BGS), Centre for Polar Observation and Modelling (CPOM), Environmental Systems Research Institute (ESRI), Quaternary Research Association (QRA), Royal Geographical Society (RGS), Royal Holloway University of London, University of Liverpool, University of St Andrews, and UK Polar network (UKPN). The day was selected to coincide with Polar Pride Day (18th November 2023).

Volunteers
The day was supported by over 70 unpaid volunteers from Newcastle, Durham, Northumbria, and Royal Holloway universities, The Great North Museum: Hancock, BAS, BGS, CPOM, ESRI, and UKPN. The event was a genuine collaboration between institutions and organisations, brought together by their

Figure 1. Advert sent to schools and collaborators, and used to attract volunteers.

specialisms and passion for polar sciences. Volunteers ranged in career stage from undergraduate to senior professor, with a large number of postgraduate and early career researchers participating.

Structure of the day

The Polar Environments Day was structured around four central pillars:

- campus tour
- panel discussion on polar fieldwork
- panel discussion on polar careers
- interactive exhibition.

Campus tour

Local (undergraduate and postgraduate) students guided school groups around the Newcastle University main concourse, providing a personalised insight into university life. The tour showcased the Students Union, theatre, cafés, historical buildings, sculptures and artwork, gardens, and lecture buildings. The purpose of the tour was to provide deeper insight into university as a concept, demonstrate the availability of extracurricular opportunities, and may have been the students first experience of a university.

Panel events

The event held panels focusing on careers and fieldwork. Panellists were carefully selected based upon career stage, pathways, and experience (Table 1). For example, some of our career panellists have worked aboard, in industry, grew up in an Arctic community or the North East, or followed an Academic Summer School pathway to access university. Fieldwork panellists have experience working across both poles, including in Greenland, Scandinavia, Svalbard, Iceland, and Antarctic.

Table 1. Panellists selected to discuss career pathways and working as a field scientist.

Careers panel			
Chair	**Prof Rachel Carr**	Professor of Glaciology	Newcastle University
Panel	**Dr Ingrid Medby**	Senior Lecturer in Human Geography	Newcastle University
	Dr Christine Batchelor	Lecturer in Physical Geography	Newcastle University
	Dr Inès Otosaka	Lecturer in Physical Geography	Northumbria University
	Dr Grace Nield	Post Doctoral Research Associate	Durham University
	Dr Devin Harrison	Marine Geoscientist	British Geological Survey
Fieldwork panel			
Chair	**Dr Stewart Jamieson**	Professor of Geography	Durham University
Panel	**Dr Stephen Roberts**	Quaternary Geologist	British Antarctic Survey
	Dr Caroline Clason	Assistant Professor of Physical Geography	Durham University

Dr David Small	Assistant Professor (Research)	Durham University
Dr Sammie Buzzard	Director for Knowledge Exchange	CPOM, Northumbria University
Dr TJ Young and Ms Emma Cameron	Lecturer in Physical Geography and PhD Student	University of St Andrews. (Contributed remotely from Antarctica).

Exhibition
An interactive exhibition was held in The Great North Museum: Hancock to offer pupils the opportunity to complete hands-on experiments with experienced scientists and ask questions (Figure 2). Stalls covered a wide range of topics including melting ice, palaeoecology, biomarker trace fossils, biological adaptations, indigenous communities, and the role of satellites, artificial intelligence, and machine learning in polar research. BAS provided a tent and field clothing offering the pupils to experience the practicalities of fieldwork in cold areas. There were stalls on menstruation health in the field, and celebrating past explorers and current LGBTQIA+ people in polar research.

Figure 2. Photographs from the exhibition halls. **A.** Addy Pope from ESRI talks about Geographical Information Systems. **B.** Dr Emma Pearson (Newcastle University) tells pupils about ancient chemical fossils of poo found in lake mud. **C.** Dr Owen King (Newcastle University) shows pupils images of melting mountain glaciers. **D.** Dr Louise Callard (Newcastle) introduces school groups to microscopic marine organisms and plant pollen which can be used to understand past climate and environmental change. **E.** Dr Ellie Honan (Durham/ BAS) shows pupils menstruation options which can be used in remote field settings. **F.** Dan Gordon (The Great North Museum: Hancock) talks about biological adaptions to living in cold regions.

Goody bags
As a souvenir of the day, each pupil received a "goody" bag with free educational materials and "goodies" from our supporting organisations. Goodies included pens, notepads, postcards, stickers, QRA and polar pride pin badges, bags, microfibre cloths, webcam covers, information leaflets, and water bottles (Figure 3). We included a detailed programme to provide the pupils with a written record of the day and help them recall their favourite parts.

School teachers received "goody" bags and a USB memory drive with educational and teaching resources designed for key stage 4/5 Geography students, and information on studying Geography at university and enrichment days at The Great North Museum: Hancock.

Catering
We provided free break time snacks and packed lunch for all attendees. This was one of our largest

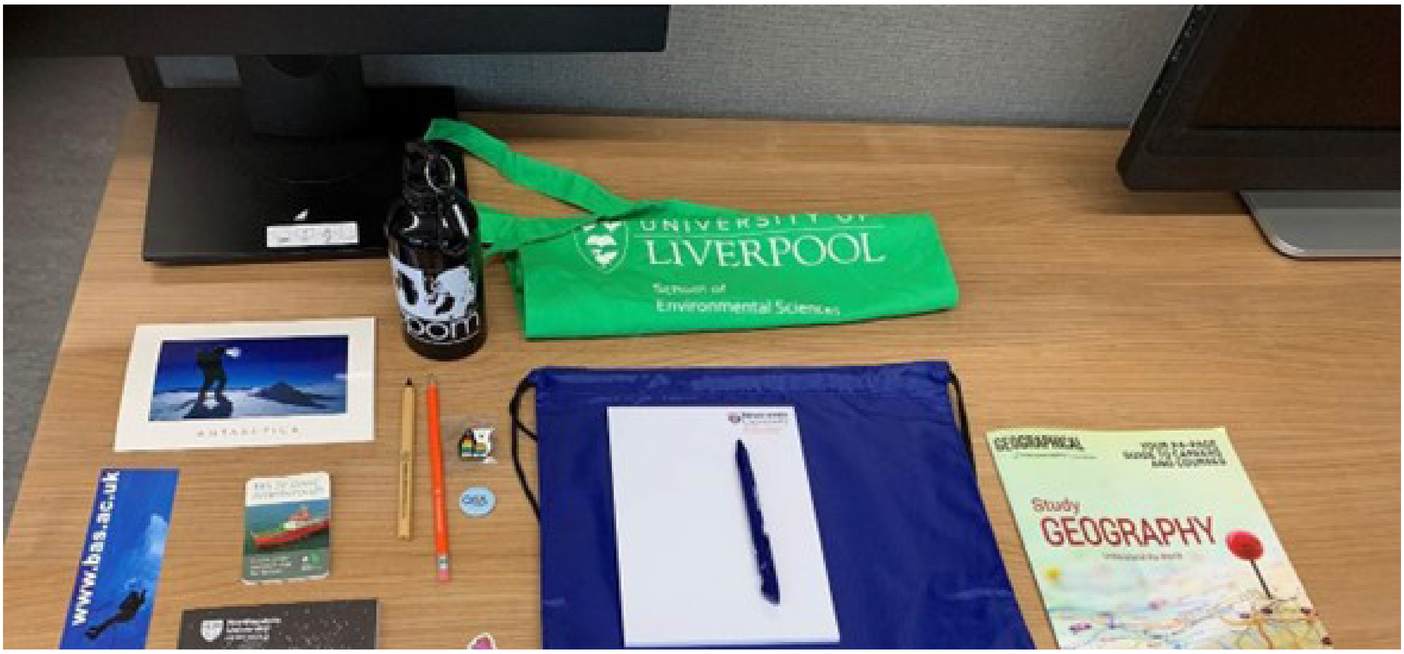

Figure 3. A selection of the materials included in the "goody" bags.

expenditures; however, it was important to us as organisers as schools in the NE of England have the highest rate (29.1%) of pupils eligible for free school meals (Adams, 2022) and a large proportion (1 in 4) of school-aged students are living in poverty yet are not eligible for free school meals (Children North East, 2022). We felt supporting student attendance through lunch was essential, as we were concerned a high percentage of attending pupils would otherwise miss their free school meal, be hungry, or not attend.

Feedback on the event

Feedback indicated that 71.3% of pupils and teachers rated the day as 4 or 5 out of 5. The exhibition/museum, careers information, campus tour, talking to scientists, and free gifts were very popular with the pupils. Teachers asked for the event to be run again. Unfortunately, the least popular aspect of the day was the lunches.

The pupils particularly enjoyed the unique opportunity to interact with scientists and explore the interactive stalls (68 pupils, 39.3%, listed the exhibition as their favourite part). Pupils particularly enjoyed the "interactive" nature of the exhibition, the "range of displays/activities", and how "friendly" the scientists were. A wide range of stalls were listed as favourites, including the BAS tent, bird and fish life, origami, cool images, polar gear, "the guy with a screen who makes maps", microscopes, drones, and artefacts. Thus, indicating we succeeded in providing a wide range of activities to capture their interests.

Learning about careers was a common response in the feedback. Pupils commented: "the panellists were kind and engaged with the crowd", they appreciated the "honesty and openness of the panel", and enjoyed learning about "why they became polar explorers" and "all the careers in geography". Comments on "the opportunity to ask questions and get the answers" came up for all aspects of the day, and there were numerous references to the helpfulness of the university student guides.

Funding and expenditure

We received £10,000 funding to support this event: with £9000 from the three local universities and £1000 from the QRA. Funding was used to provide accommodation and transport costs for visiting keynote speakers, transporting BAS equipment, pay an administrative assistant to organise the event, and provide catering on the day. The funding from the QRA was used to support school attendance (e.g., transport costs).

Acknowledgements

This event could not have occurred without the immense support of very many people. Special thanks go to Dr Bethan Davies for all her work in making the day a success. Thank you to the QRA, Newcastle University, Durham University, University of Northumbria, and the Centre for Polar Observation and Modelling for their generous funding and support. Thank you to all the organisations who provided "goodies" for the goody bags. Specific thanks to the Newcastle University technical team for all their support in the organisation and running of the event. Thank you to the Newcastle University conference team, The Great North Museum: Hancock team, Inclusive Newcastle team, the widening participation teams at Newcastle, Durham and Northumbria universities, and every one of the volunteers who so generously gave their time, energy and commitment to make the event a success.

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GLACIAL GEOMORPHOLOGY AND QUATERNARY PALAEOGLACIOLOGY OF SOUTHEAST ALBERTA AND SOUTHWEST SASKATCHEWAN, CANADA

15-18 August 2024

Field Trip Leaders: David Evans (Durham University, UK), Emrys Phillips (British Geological Survey, UK), Nigel Atkinson (Alberta, Geological Survey, Canada), Sophie Norris (University of Victoria, Canada)

Report: Christopher M Darvill, The University of Manchester
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Introduction

A joint Field Meeting – the first to be co-sponsored by the QRA (UK) and CANQUA (Canada) – was held in August 2024 in association with the British Glacial Landsystems Working Group (GLWG) ahead of the biennial CANQUA conference in Regina, Saskatchewan. The meeting brought together 24 QRA and CANQUA members (Figure 1) from academic institutions and government surveys interested in four primary themes:

1. Palaeoglaciological reconstruction of the Southwest Laurentide Ice Sheet,
2. Glacial sedimentology and stratigraphy of ice sheet tills and glaciotectonites and their relationships to preglacial topography,
3. Ice sheet subglacial and marginal landform genesis,
4. Engineering geology applications of deposits and structures pertaining to ice sheet beds and dynamic margins.

The group assembled in Regina on the morning of Thursday 15 August for a 4-day trip through the prairies of Southwest Saskatchewan and Southeast Alberta. This report draws on field notes, photographs from the group, and additional information in the excellent accompanying field guide:

Evans D.J.A. (ed.) 2024. *Glacial geomorphology and Quaternary palaeoglaciology of SE Alberta and SW Saskatchewan, Canada – Field Guide.* Quaternary Research Association, London.

Day 1: Thursday 15 August 2024

The first day began with a long drive northwest from Regina through the plains of Southern Saskatchewan. South of the railway town of Unity is the southernmost limit of a crevasse-squeeze ridge corridor deposited by the former Maskwa Ice Stream flowing south-southeast. Just inboard of the Handel Moraine is a large hill-hole pair, the hole now occupied by Muddy Lake. The group stopped at a section through the hill, which **David Evans** described as a thrust mass that has been streamlined by overriding ice, with flutings and crag-and-tails on its surface. Complete, freely available LiDAR imagery for the provinces of Saskatchewan and Alberta became invaluable for picking out otherwise subtle glacial geomorphological features in the vast open landscape. The group discussed the geomorphology of the Maskwa Ice Stream complex and spent a little time working away at the eroded road section through the glaciotectonised hill. For some, this was their first encounter with the geological units of the Western Canadian Sedimentary Basin, with a change in perspective required to appreciate that these pale, soft-looking outcrops were in fact bedrock.

Continuing west into Alberta, a second, late-afternoon stop was made in the Neutral Hills to look at a section through a thrust block moraine. The Neutral Hills Uplands are major glaciotectonic thrust masses that are clear on satellite imagery and on the ground, rising above the prairies in conspicuous, closely spaced, parallel ridges. The hills join others to the east and west and are interpreted as the crests of folds and thrust blocks of bedrock glaciotectonised and thrusted along with pre-deposited sediments. With the guidance of **Emrys Phillips**, the group found good evidence of

Figure 1. Group photo at Mud Buttes: (1) Jennifer Organ, (2) Michelle Hanson, (3) Dan Utting, (4) Alec Aitken, (5) Abigail Burt, (6) Christopher Darvill, (7) John Gosse, (8) Nickolas Mesich, (9) Martin Ross, (10) Alicia Böhme, (11) Dave Evans, (12) Tyler Hodder, (13) Mederic Lorry, (14) Grant Hagedorn, (15) Michelle Gauthier, (16) Nigel Atkinson, (17) David Huntley, (18) Pierre Francus, (19) Emrys Phillips, (20) Brent Ward, (21) Jessi Steinke, (22) Sophie Norris, (23) Heather Campbell. Photo by Tessa Fenoughty-Evans.

folded and thrusted sediments in the section. This was also an opportunity for **David Evans** to introduce the rounded, ridge-rimmed depressions that litter the summit of the thrust masses, sometimes containing isolated ponds. Similar in morphology to kettle-holes, an alternative hypothesis is that they mark the escape points of over-pressurised groundwater following a reduction in glacier pressure after thrusting (Evans et al., 2019). 'Dave's doughnuts' quickly became a theme for the rest of the trip, both due to the extraordinary abundance of these landforms across this formerly glaciated terrain and obligatory pit-stops at Tim Horton's, Canada's iconic coffee-and-doughnuts chain. The first day finished in the small but welcoming village of Consort.

Day 2: Friday 16 August 2024

The second day started with a short drive south down the road from Consort to a small exposure cut into a pitted surface of low-amplitude hummocks with very faint flutings and meltwater channels. The pitting shows where buried glacier ice subsequently melted out, some of which was bulldozed south-southwest to form a large, pitted end moraine made up of multiple push ridges, recording the same ice readvance as the Neutral Hills Uplands. **Emrys Phillips** talked the group through sediments within the section. Laminated sands, silts and clay-rich diamictons from proglacial glaciolacustrine deposition have been injected from below by burst-out structures, leaving quite spectacular branched features filled with gravelly diamicton. At the top of the section, a matrix-supported diamicton with strong clast alignment is a subglacial traction till emplaced by the same ice advance that deposited the fluted surface. The sedimentologists in the group likely could have spent all day here had it not been for the promise of the next, most spectacular stop of the trip.

Mud Buttes is a remarkable location, well worth a visit for both tourists and Quaternary geologists alike (Figure 2). It is a textbook example of glaciotectonism with surprisingly little research since the pioneering work of George Slater in the 1920's (Slater, 1927), and comprises a large, 2 km long cupola hill, with large exposures revealing intensely folded and thrusted Cretaceous sandstones, siltstones and mudstones, and an upper layer of subglacial traction till. **David Evans** and **Nigel Atkinson** began with an interesting overview of the history of research at the site and landscape-scale context before the group descended into the floor of the butte where **Emrys Phillips** took over to highlight deformation structures on a tour of the spectacular exposures. Fortunately, it was a hot, dry day, as the bedrock is notoriously slippery when wet. Once again, it would have been possible to spend hours at Mud Buttes and – while Phillips et al. (2017) recently updated the work of Slater, particularly focussing on the structural architecture through the glacitectonic thrust complex – it was acknowledged there remained scope for a great deal more research.

Figure 2. Mud Buttes offers a spectacular example of glaciotectonised sediments. Photo by Michelle Hanson.

Figure 3. Lunch overlooking Mud Buttes, discussing muddy boots. Photo by Tessa Fenoughty-Evans.

Figure 4. An introduction to the Empress Group sediments on the banks of the South Saskatchewan River. Photo by Michelle Hanson.

There was much discussion of the site over lunch, sitting overlooking the folds of bedrock (Figure 3) but it was soon time to continue south. A pause at a quarry exposure allowed the group to look through a raft of 'rubble terrain': small, often rectilinear hills that have clearly been displaced from nearby depressions on routes that match local flutings. Most of these blocks are assumed to be bedrock, but this stop highlighted an example composed of normally faulted, rhythmically bedded sands and gravels. Many in the group delighted in the opportunity to clean the section and examine the transition to the upper horizontally bedded sandy gravels, deformed by an upper cap of matrix-supported diamicton. **David Evans** noted that the lower sands and gravels likely originated in an ice-walled lake plain, subsequently over-run by ice.

A long drive south took the group over the South Saskatchewan River, with a stop to look at the river cliffs (Figure 4). **Nigel Atkinson** talked through the regional geology and introduced the Empress Group formation, which made up much of the opposite riverbank. This somewhat 'catch-all' formation became a subject of intense and lively discussion for the rest of the trip. The Palaeogene to early Quaternary Empress Group sediments were initially regarded as preglacial but are increasingly thought to include glaciolacustrine and fluvial deposits between tills. The field trip was generally concerned with glacial activity since the Last Glacial Maximum, but this discussion highlighted both the general lack of glacial geochronology across the region and gaps in understanding of prior glacial episodes. The Empress Group was topped by a diamicton that filled hanging valleys along the river, making for impressive viewing as the journey continued south through Alberta for a night in the city of Medicine Hat.

Day 3: Saturday 17 August 2024

The first stop of Day 3 was at Bain Bluff, with a spectacular view over the meandering South Saskatchewan River (Figure 5). A steep descent down the eastern cliff allowed the group to observe sediment sections through the tills and glaciolacustrine sediments of moraine ridges deposited by the Maskwa Ice Stream lobe above Empress Group sediments

Figure 5. Bain Bluff, overlooking an impressive meander of the South Saskatchewan River. Watch out for snakes. Photo by Christopher Darvill.

first observed the day before. This section correlates with others along the river that have filled preglacial buried valleys (Ó Cofaigh et al., 2010), including the evocatively-named Evilsmelling Bluff. **David Evans** talked through the sediments on show, the chronostratigraphy that indicates the tills all likely date to the last glacial cycle, and the impressive landslide features that are now casting sediments towards the river on the outer bank of a spectacular meander. Here, the group were joined by the landowners and their son and granddaughter, who were as keen to learn about the geological history of the valley as everyone else. Such was the impressive view that a nearby rattlesnake was almost missed, curled-up and well-camouflaged within the scrub and cacti. Sturdy footwear and trousers are strongly advised at all sites (plus a keen-eyed landowner to spot nearby hazards).

The trip continued southwest to Foremost to look at spillways, particularly Smith Coulee where **Dan Utting** (Alberta Geological Survey, Canada) talked about the development and drainage of megaponds along the southern margin of the Laurentide Ice Sheet. The spillways are sizeable. For example, the Etzicom Coulee that drained Glacial Lake Lethbridge is up to 500 m wide and 60 m deep, following the lobate margin of the Central Alberta Ice Stream (Utting and Atkinson, 2019). **David Evans** talked the group through the classic four-stage spillway development model of Kehew & Lord (1986), geomorphic evidence of which is preserved in Etzicom Coulee and other spillways in the area. A nearby road cut allowed the group a view of heavily deformed mudstone and sandstone bedrock. Here, **Emrys Phillips** talked through the folding and erosional scour, interpreted as a glacial tectonite composed of thrust-stacked rafts. The implication is that bedrock mega-rafts may have ploughed through the underlying surface, mirroring surface megaflutings, megagrooves, hill-groove pairs and rubble flutings around Smith Coulee.

The final stop of the day was in the delightful Cypress Hills Provincial Park at the impressive Reesor Lake viewpoint (Figure 6). Here, **Nigel Atkinson** explained the monadnock terrain on display: quartzite gravel sheets that are the last remnants of vast Tertiary fluvial deposits, now seemingly raised above the prairies after subsequent Tertiary and Pleistocene uplift and erosion removed the surrounding peneplain. The monadnock escaped glaciation, with the viewpoint offering a spectacular view of a moraine wrapping around the flat-topped, wooded hillside above Reesor Lake.

Figure 6. Looking out over monadnock terrain in the Cypress Hills Provincial Park.
Photo by Christopher Darvill.

Here, **Sophie Norris** also talked the group through the till stratigraphy of the southwest Laurentide Ice Sheet, with borehole data providing the basis for a stratigraphic model of diamicton emplacement relating to palaeo-ice stream activity across the region (Norris et al., 2018). With just enough fuel to make it (cue much discussion of the most fuel-efficient means of driving), the night was spent in Maple Creek.

Day 4: Sunday 18 August 2024

The final day of the trip started with a cruise along the Trans-Canada Highway, with good opportunities for doughnut spotting en route (both geomorphological and baked). The day's stop was at the Claybank brick plant at the northeastern foot of the Dirt Hills (Figure 7). Like the Neutral Hills, this topography marks the readvance of ice during overall retreat of the Southwest Laurentide Ice Sheet. Alec Aitken (University of Saskatchewan, Canada) gave a brief but informative overview of the geology of the area, including the Cretaceous Bearpaw and Eastend Formations that are found within the Dirt Hills alongside glacial Empress, Sutherland and Saskatoon Group deposits. **Emrys Phillips** then outlined the thrust-slab model that the group could see exposed in the Claybank quarry sections. One of the units, the heavily folded Whitemud Formation, was the target of the former Claybank plant for making fire-resistant bricks during 1914-1989. Hence the National Historic Site is today popular with both heritage tourists and glacial geomorphologists. From here, the group made the short trip back to Regina to begin the CANQUA 2024 Biennial meeting.

Final remarks

The field guide published to accompany the trip is a valuable addition to the QRA library (Evans, 2024). It is a useful resource for glacial geologists travelling in the area and offers a comprehensive summary of palaeo-ice stream geomorphology and sedimentology more generally. Those considering following the route should note the guide summarises key sites, but not as part of a scheduled tour. It is possible to follow the route presented in this report, but considerable driving is required, and some sites are on private land requiring permissions. An alternative to the lengthy

Figure 7. Walking towards exposures through the Whitemud Formation at Claybank National Historic Site. Photo by Christopher Darvill.

roundtrip might be to start in Regina, Calgary or Edmonton and visit many of the sites on a one-way trip west or east to reduce the travel overall.

The fieldtrip was masterfully led by **David Evans**, **Nigel Atkinson**, **Emrys Phillips** and **Sophie Norris**, including many hours of driving by this team (Figure 8). Their sustained energy and enthusiasm at each stop were remarkable and made for a thoroughly engaging and enjoyable trip. In addition, Michelle Hanson (Saskatchewan Geological Survey, Canada) and **Maria Velez Caicedo** (University of Regina, Canada) provided excellent logistical support prior to and during the trip, and **Tessa Fenoughty-Evans** (UK contingent) ensured everyone knew where to be, what they needed and how long it would be until the next stop (invaluable in ensuring a smooth running and inclusive journey). This was a thought-provoking fieldtrip, the welcoming nature of which echoed the ethos of both CANQUA and the QRA. It will hopefully inspire further collaborations between these two national organisations in the future.

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Figure 8. Fieldtrip leadership team at Reesor Lake. From left to right: Nigel Atkinson, Sophie Norris, David Evans and Emrys Phillips. Photo by Michelle Hanson.

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QN Quaternary Newsletter Report QRA Quaternary Research Association

NEW SEDIMENTOLOGICAL INVESTIGATIONS HELP UNRAVEL COMPLEXITIES IN THE DEGLACIATION OF NORTHEAST IRELAND

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Background and Rationale

Northeast Ireland lay under a major ice divide at the confluence of the Malin Sea and Irish Sea ice streams in the centre of the last British-Irish Ice Sheet (BIIS). During deglaciation (Fig. 1d), British and Irish sectors unzipped over this region c. 20-19 ka BP (Benetti et al., 2021; Clark, et al., 2022), isolating separate ice centres over Scotland and Donegal (Wilson et al., 2019; Ely et al., 2024). During this process, the Armoy Moraine – a c. 50 km wide complex ridge (Shaw and Carter, 1980) – was formed along the north Antrim coast by a major outlet, allowing ice-dammed lakes in the Lower Bann valley and north Antrim Hills to form contemporaneously (Creighton, 1974; Warren, 1990; Knight, 2004). Little is known about the nature and drivers of retreat of this outlet and the subsequent separation of the BIIS down the North Channel.

However, recent digital mapping and scouting of the region (Clark et al., 2024) sheds light on a previously unexamined complex style of retreat. Further investigations into this behaviour may therefore uncover hitherto unexplored drivers and impacts of the BIIS unzipping over northeast Ireland. Towards achieving this aim, we employed sedimentological methods on exposures along the north Antrim Coast to complement a new high-resolution geomorphological map.

Methodology and Results

Runkerry Beach is situated 16.5 km north of the central Armoy Moraine ridge and 3.2 km north of a previously unidentified series of recessional moraines (Fig. 1a). From a single exposure, Dardis (1990b) previously described ice-distal till deposited in a glaciomarine setting overlain by beach cobbles, similar in age to the deposits at Portballintrae <1 km to the west (Dardis, 1990a; McCabe et al., 1994). Upon examining a *c.* 760 m long transect of the exposed short cliff sequences at Runkerry, we uncovered a much more varied suite of sediments, and 14 key exposures were logged in detail.

Crudely stratified and planar bedded gravels from the southeastern section of Runkerry (Fig. 1b points 1-4) are interpreted as hyperconcentrated flow deposits (Fig. 2a) found in sub-aqueous ice-proximal settings (see Todd, 1989; Mulder and Alexander, 2001). At the northwest and central sections of Runkerry (Fig. 1b points 4-14), the short exposures tell a story of subglacial till formation (Fig. 2b) and deformation under high stress during retreat with occasional supra-/ extra-glacial inputs (Fig. 2c). Two contrasting till facies are identified, implying a shift in ice-bed interface dynamics. Glaciofluvial sand and gravel outwash deposition then followed over much of Runkerry.

In the northeast of Co. Antrim, Watertop Farm lies near the head of the Carey Valley (Fig. 1a) which hosts a series of Gilbert-type glaciolacustrine deltas formed in an ice-dammed lake (Warren, 1990), as well as glaciofluvial terraces that formed after its disappearance (McCabe and Eyles, 1988). The nature of ice withdrawal from this region has been staunchly debated (e.g. Dwerryhouse, 1923; Charlesworth, 1938; Hill and Prior, 1968; McCabe and Eyles, 1988; Warren, 1990), but the upper reaches of the valley above c. 130 m OD (metres above Ordnance Datum, Belfast) have always evaded further study. We hypothesised newly mapped subdued morainic and glaciofluvial deposits in the region of Watertop Farm (Fig. 1c) could provide vital context for understanding the morphostratigraphy of the Carey Valley landforms, as well as the nature of ice withdrawal from the Antrim Hills into the North Channel.
At Watertop Farm 1 (Fig. 1c) located behind a subtle moraine crest, matrix-supported, edge-rounded

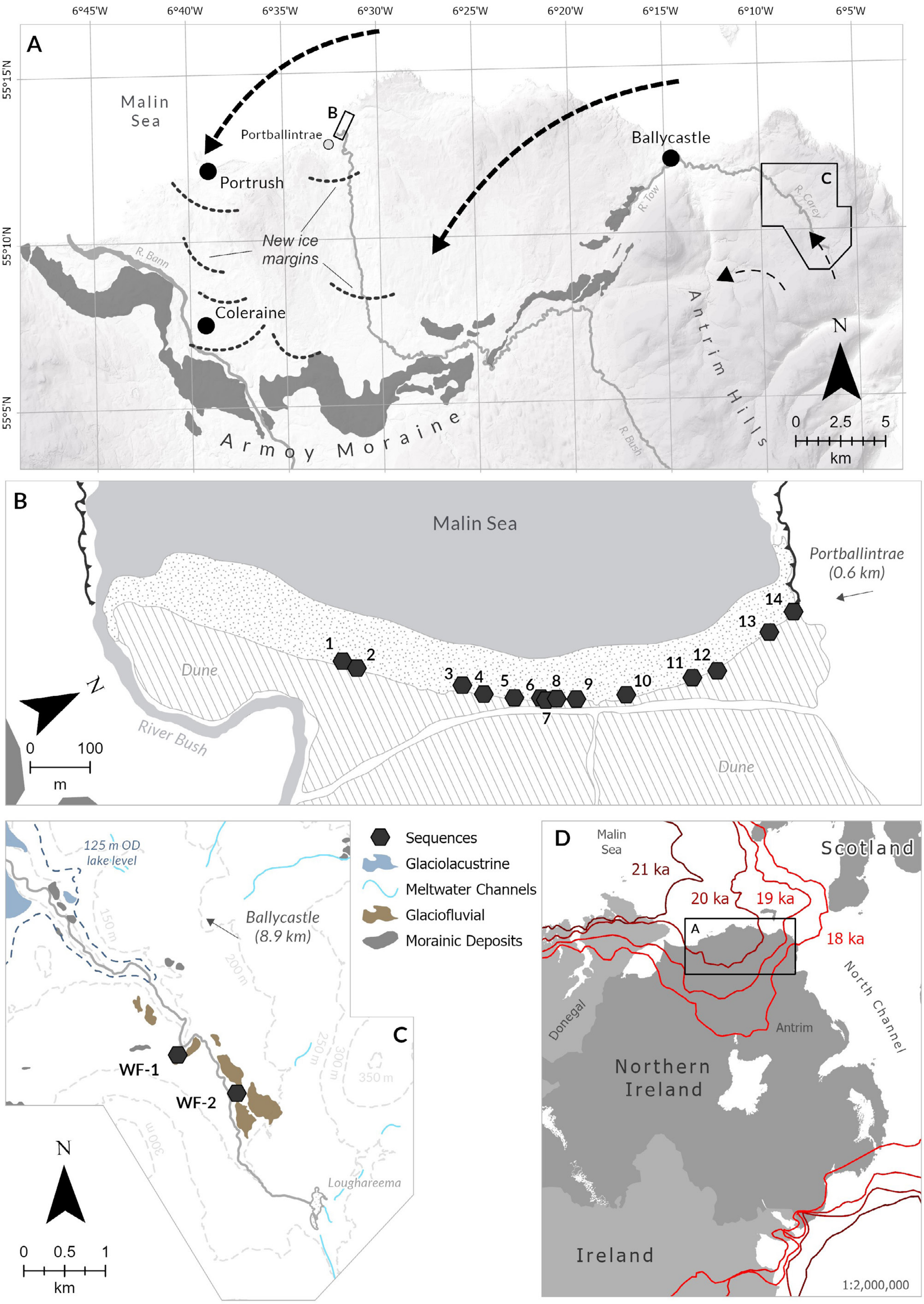

Figure 1. a) Map of the study region along the north coast of Northern Ireland with generalised ice flow directions indicated by dashed arrows; **b)** Runkerry Beach and the location of 14 exposures identified and logged; **c)** the upper reaches of the Carey Valley with the locations of the sections at Watertop Farm, including key digitally mapped glacial landforms; **d)** optimum empirical BIIS reconstruction limits from 21-18 ka BP from Clark et al. (2022) and location of panel A.

gravels of mostly weathered basalt (52%) and schist (28%) with lenses of coarse gravels overlying medium sands are suggestive of a low- to intermediate-energy ice-distal braided (glacio-)fluvial system. Stratified sandy gravels and poorly-sorted gravels overlying greyish brown clast-rich glacial till at Watertop Farm 2, by contrast, likely represent a more ice-proximal glaciofluvial system with a more ephemeral meltwater discharge regime.

Significance

These results will have important implications for characterising and unravelling the complex nature of deglaciation in northeast Ireland. At Runkerry Beach, our results point to an active and dynamic retreat after the formation of the Armoy Moraine, likely punctuated by standstill events even as ice recedes from the present coastline. This interpretation expands upon and potentially challenges the proposed surge-like (re)advance theory resulting in a down wasting ice lobe (Knight, 2004).

Finally, evidence from Watertop Farm suggests a valley glacier experienced an active retreat in the upper reaches of the Carey Valley *c.* 170 m OD. At this elevation and with this style of retreat, it is most plausible that the glacier was attached to thick ice in the North Channel rather than a small local centre in the Antrim Hills. Our results therefore help demonstrate that the survival and decay of ice in northeast Antrim was predominantly influenced by the thinning and detachment of North Channel ice during the unzipping of the BIIS.

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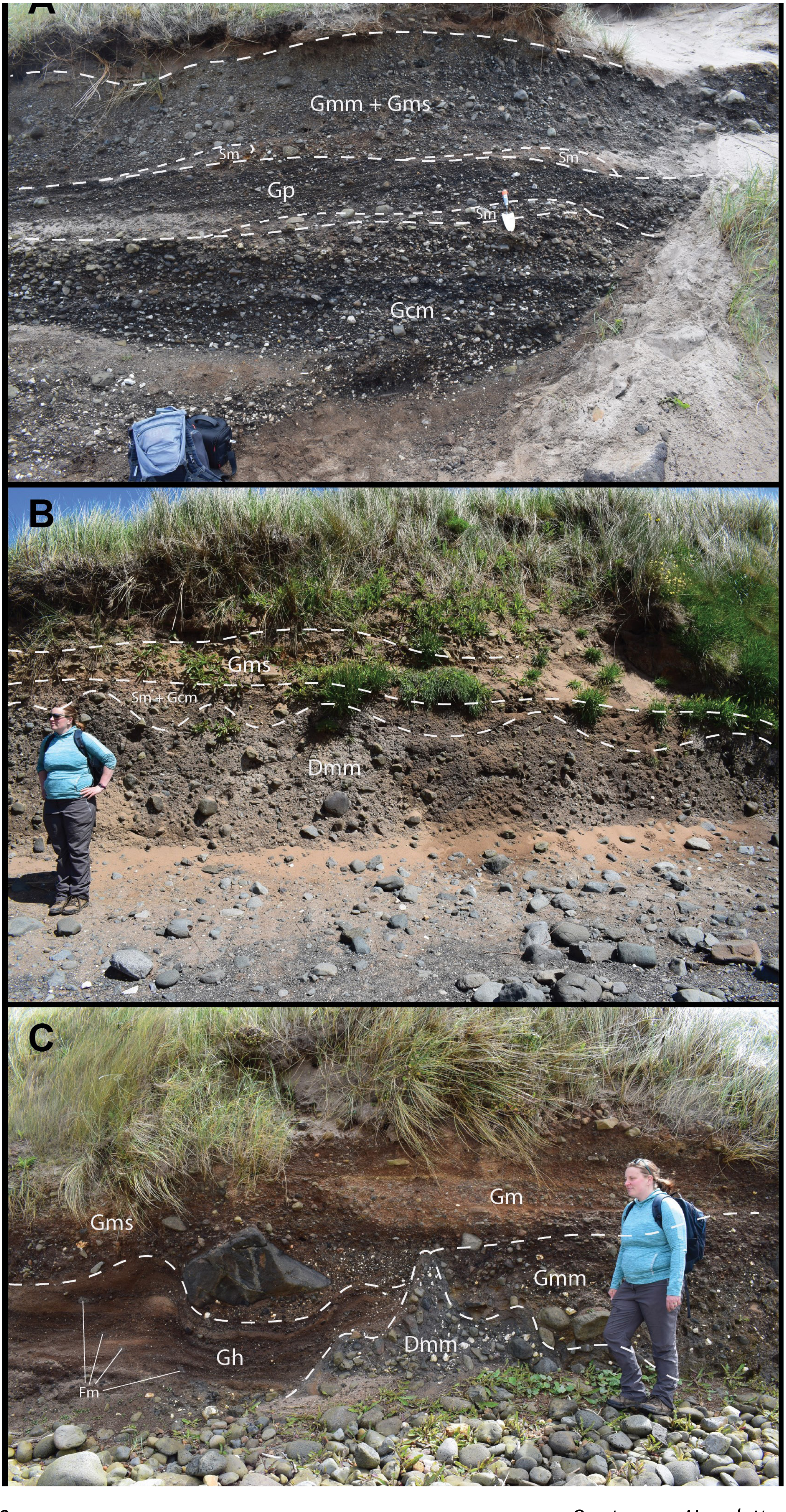

Figure 2. a) Runkerry Beach sequence 14: dark reddish-brown subglacial till (Dmm) overlain by glaciofluvial sands (Sm) and gravels (Gcm, Gms); b) Runkerry Beach sequence 4: large oversized basalt boulder deforming sub-aqueous gravels (Gh) with fine-grained rip-up clasts (Fm) overlying dark greyish-brown chalky till (Dmm); c) Runkerry Beach sequence 1: hyperconcentrated flow (Gcm, Sm, Gp), glaciofluvial (Gmm, Gms), and sand dune (Sm) sequence.

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Quaternary Newsletter
Report
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EVALUATING THE PALAEOECOLOGICAL POTENTIAL OF WETLAND DEPOSITS IN AN UPLAND AREA (SERRA DO GERÊS), NORTHWEST PORTUGAL

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Introduction

Restoration of biodiversity and ecosystems is fundamental in controlling climate change and mitigating damaging impacts of land-use (Strassburg et al., 2020). By looking into the past, palaeoecology provides an important context which allows comparing and contrasting past landscapes and ecosystems with present ones. The climate crisis we presently face brings several challenges and sensitive areas are impacted more severely. In Europe, upland landscapes are a specific type of landscape that has evolved in a long-term relationship with human communities. In spite of the long story of settlement, today these regions are often considered to be peripheral (Cavaco, 2005). That very same peripherality that contributed to the development of specific environments now threatens them, in the form of population exodus, extinction of the traditional way of life, of climate change and its impacts, exposing the fragility of these landscapes (Honrado et al, 2016). Driven by climate change, shifts in land-uses resulting from land abandonment and/or commercial forestry can have catastrophic consequences not least by increasing ecosystems vulnerability to wildfires.

Rational

If we can understand the different past ecological processes which supported the existence and maintenance of robust ecosystems perhaps these can be restored/maintained in the present. Equally fundamental is to comprehend how climate and humans influenced and shaped past processes, past dynamics and their respective roles as drivers of change. Change and disturbance are an integral part of natural ecosystems. To understand how human activities in the past related to these cycles could be fundamental to addressing the challenges faced in the present (Connor et al. 2019). It is therefore necessary that analysis of Holocene change in Europeans uplands must consider anthropic drivers. Furthermore, we need to understand, at the local scale, the past dynamics of a landscape and their drivers to be able to make logical management decisions.

Location and Methods

The study area is located in the Terras de Bouro Municipality, NW Portugal. Sampling locations are situated within the Gerês mountain and border the Parque Nacional Peneda Geres.

Figure 1. Study area location.

The aim is the establishment of a skeleton multiproxy palaeoecological sequence, enabling the evaluation of these deposits potential to contribute to the

Figure 2. Castro da Calcedonia (July 2023).

vegetation history, patterns of landscape change and land-use in this area. Following on from the results of surface sample analysis from collected in 2021 at the Castro da Calcedonia (Sá Ferreira, 2022) the proposed work in 2023 was to collect a sediment core from this location to establish the viability of the palaeoecological record. Unfortunately, at the time of sampling (July 2023) the site was completely dry and it was not possible recover a sediment core.

A survey was then carried in the surrounding areas to locate suitable sampling locations in the vicinity and in direct relation to the path of the Via XVIII. Two locations were identified, and sediment cores were retrieved using a Russian corer. Surface samples were also collected to establish pollen source area. The cores were subsampled for palaeoecological analysis and 14C dating. Samples for palaeoecological analysis were processed at National University Ireland Galway using standard laboratory techniques as per Faegri and Iversen (1989) and Moore et al. (1991). Chã de Vilar pollen percentages were calculated and plotted in Excel. Campo do Gerês data percentages were calculated and plotted using Tilia (Grimm, 2011).

Figure 3. Sampling at Chã de Vilar.

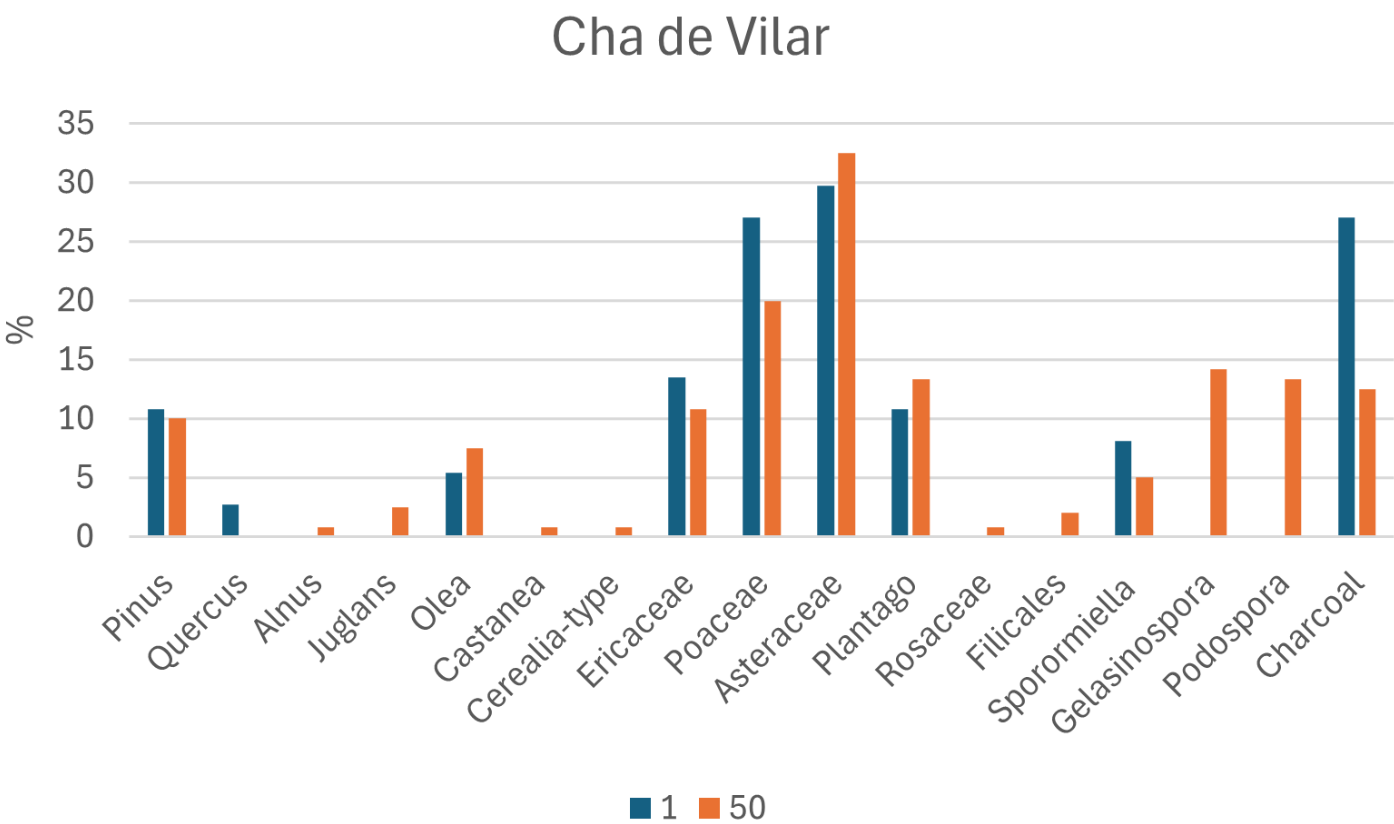

Figure 4. Chã de Vilar pollen percentages at 1cm and 5cm.

Sites

The Chã de Vilar site (41°42'19.8"N 8°17'33.1"W) is located in a small accumulation basin at the base of a gentle slope. The surrounding vegetation is composed of shrubs (Ericaceae and *Ulex* spp.) and ferns, mainly *Pteridium aquilinum*. A 50cm sediment core was collected at this site. It is possible that this deposit is deeper than the depth cored as the surface was compacted and was challenging to operate the Russian corer in order to maintain its integrity (Fig.3). This site is located at the start of the mile *XVIII* of the Roman Road *XVIII -Bracara Augusta* to *Asturica Augusta*. It corresponds to the area of a Roman settlement with some authors suggesting that this might be the location of the *Mansio Salaniana* mentioned in the Antonine Itinerary (Fontes et al, 2020). Owing to the shortness if the sedimentary profile only two samples were analysed for this site and results are presented in a graphic (Fig.4).

The sediment was very minerogenic and the analysed pollen was mostly degraded possibly due to

Figure 5. Campo do Gerês deposit.

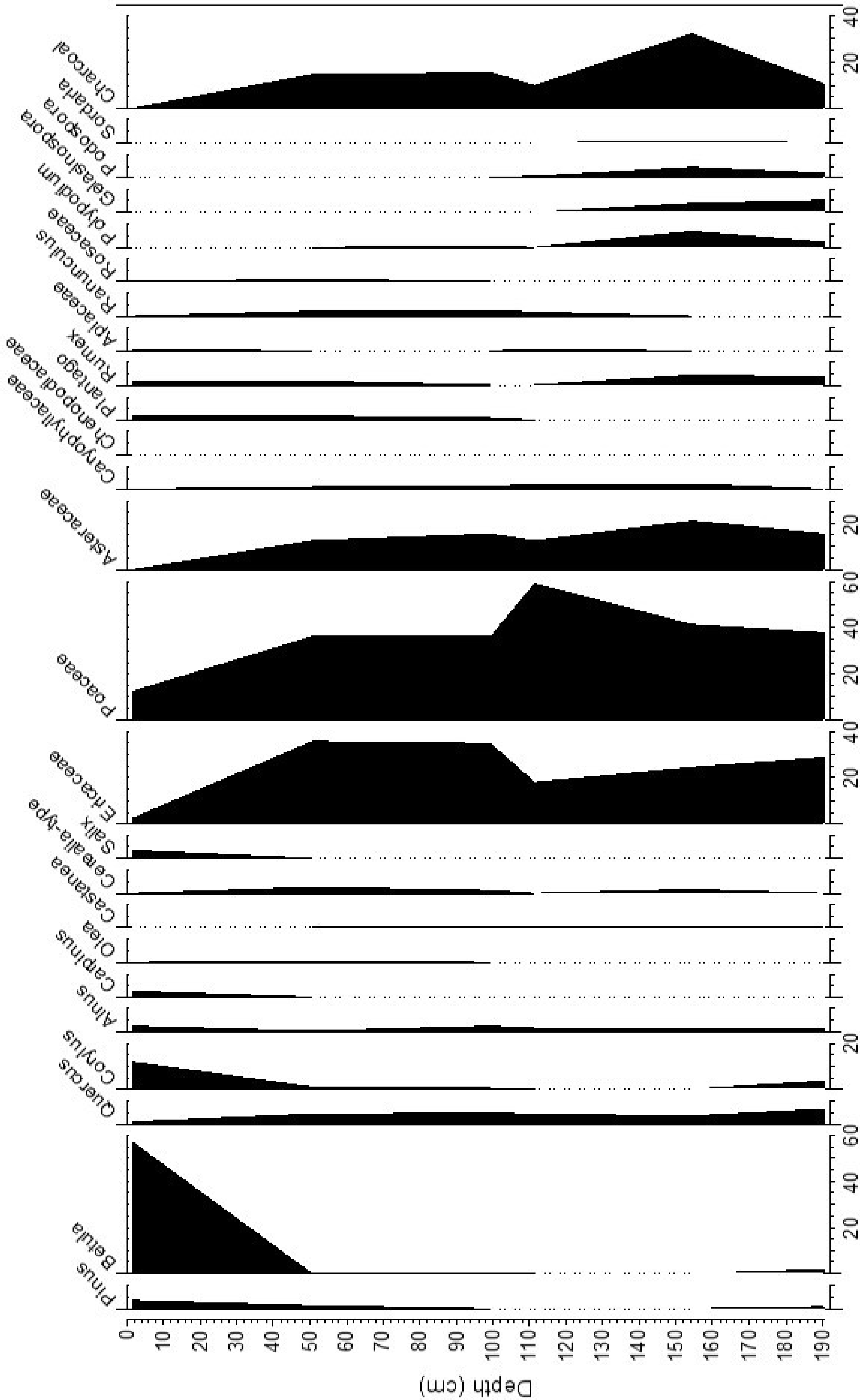

Figure 6. Campo do Gerês multiproxy diagram.

taphonomic processes. Cultivars are present in both the surface and 50cm samples although only *Olea* is present in the former. This suggests that the Relevant Pollen Area is probably located to the West/Southwest of the deposit and includes the Casal village area, 700 meters from the sampling site. Coprophilous fungi were more abundant at 50cm than at present with only *Sporormiella* spp. recorded in the top sample. There is cattle grazing in the area and a small herd was grazing the site when sampling was conducted. The samples to not suggest any significant landscape variation between 50cm and the present-day surface. This could indicate that sediment accumulation at the site is quite fast due to erosion, and the base of the column is chronologically close to the present day. Or could suggest that, due to the compaction of the soil, the deposit could yield a deeper sediment sequence if a different corer is used, or work takes place at a different time of the year.

Campo do Gerês

The Campo do Gerês deposit is located in a small hollow close to a small stream (41°44'56.9"N 8°12'11.2"W) and it is surrounded by small trees and shrubs namely birch (*Betula* spp)., alder (*Alnus* spp.) and willow (*Salix* spp.).

A 190cm sediment sequence was collected here (Fig.5). This site is in close articulation to the *Via XVIII*, c. 500m to the West, the Sagrado roman settlement 1km to NE, and Mata da Albergaria 2km also to NE. The existing local vegetation is well represented in the surface sample although *Pinus* and cultivars must originate from the Pollen Source Area probably on the North/Northeast where the present-day settlements are located.

Cultivation is recorded throughout the sequence with arable crops being prevalent between 100cm and 10cm. Mid sequence (~100cm) there is a shift from the dominance of Poaceae to Ericaceae which appears to coincide with the rise in *Cerealia*-type and the contraction of coprophilous fungi. It could indicate an abandonment of grazing areas in the locality and a move towards a more specialised form of farming.

Conclusions

Even though data is limited both sites show potential to yield information on the vegetation dynamics and landscape change in this region. This is extremely significant considering the scarcity of palaeoecological studies in northern Portugal. These could contribute to elucidate long-term vegetation shifts and their drivers, providing crucial data to inform present and future land management policies. Funding will be sought to date the beginning of accumulation at both locations and further survey and sampling will be undertaken in the region to locate new wetland areas and evaluate their potential for future palaeoecological studies.

Acknowledgments

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QUATERNARY NEWSLETTER AWARDS - THE DETECTION OF TOXIC CYANOBACTERIAL METABOLITES (MICROCYSTINS) IN LAKE SEDIMENTS & THEIR APPLICATIONS FOR UNDERSTANDING THE DRIVERS OF PALAEO CYANOBACTERIAL BLOOM EVENTS

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Background and rationale

Harmful cyanobacterial bloom occurrences in freshwater lakes are increasing globally (Huisman et al., 2018). This has created heightened public and scientific concern due to their toxic secondary metabolites which can have devastating impacts on biota and compromise freshwater availability (Dawson, 1998). Recent advances in metabolomic techniques for the extraction and quantification of these toxic compounds from sediments has created new opportunities to use cyanotoxins as a proxy in palaeolimnological study (e.g. Efting et al., 2011; Zastepa et al., 2017; Waters et al., 2021). This can be complemented with more established proxies (e.g. diatoms, sedimentary pigments, and C/N ratio) to explore the drivers of past toxigenic bloom events (Waters et al., 2021).

The QRA New Research Workers' Grant (NRWA) was used to (1) attend and present my PhD research at the Interdisciplinary Freshwater Harmful Algal Bloom Workshop (IFHAB), held in Montréal in May 2023; and (2) receive training in the extraction of microcystin congeners (microcystin-LA, LR, RR, and [Dha[7]] LR) from sediment samples at the Natural Products Chemistry Research Group, Carleton University Ottawa, Ontario, Canada. Attending the IFHAB workshop provided me with my first opportunity to present my postgraduate research, which led to several useful interactions with globally leading researchers in the field of harmful cyanobacteria blooms and cyanotoxins. Following the workshop, during my visit to Carleton University, I received training in sediment-bound microcystin extraction protocols, running several samples I collected as part of my PhD fieldwork in New Brunswick Canada (Figure 1). In total three sediment cores and a suite of sediment-water interface samples from lakes in New Brunswick were extracted and quantified in collaboration with the Natural Products Chemistry Research Group. The results from the sediment core analysis are currently being prepared as a manuscript exploring the influence of historic land use and climate change on toxigenic lake cyanobacteria responses. Here we present liquid-chromatography mass spectrometry (LC-MS/MS) inferred microcystins from the sediment-water interface samples collected in New Brunswick, September 2021. These samples were collected to appraise the microcystin concentrations at the sediment-water interface from a suite of lakes (Figure 2) with both histories of known toxigenic cyanobacteria bloom events (i.e. Chamcook Lake, Harvey Lake, and Wheaton Lake) and from those which had no known events (i.e. Little Chamcook Lake, Limeburners Lake, Gibson Lake, Snowshoe Lake, and Welch Lake).

Results

Cyanotoxins, as total microcystins (MCs), were detected in three of the eight sampled lakes (Figure 2; Table 1): Chamcook Lake, Harvey Lake, and Wheaton Lake. These three lakes have a known history of bloom events, with Harvey and Wheaton Lakes experiencing bloom events only weeks prior to sediment collection. In every sample in which MCs were detected, microcystin-LR (MC-LR) was

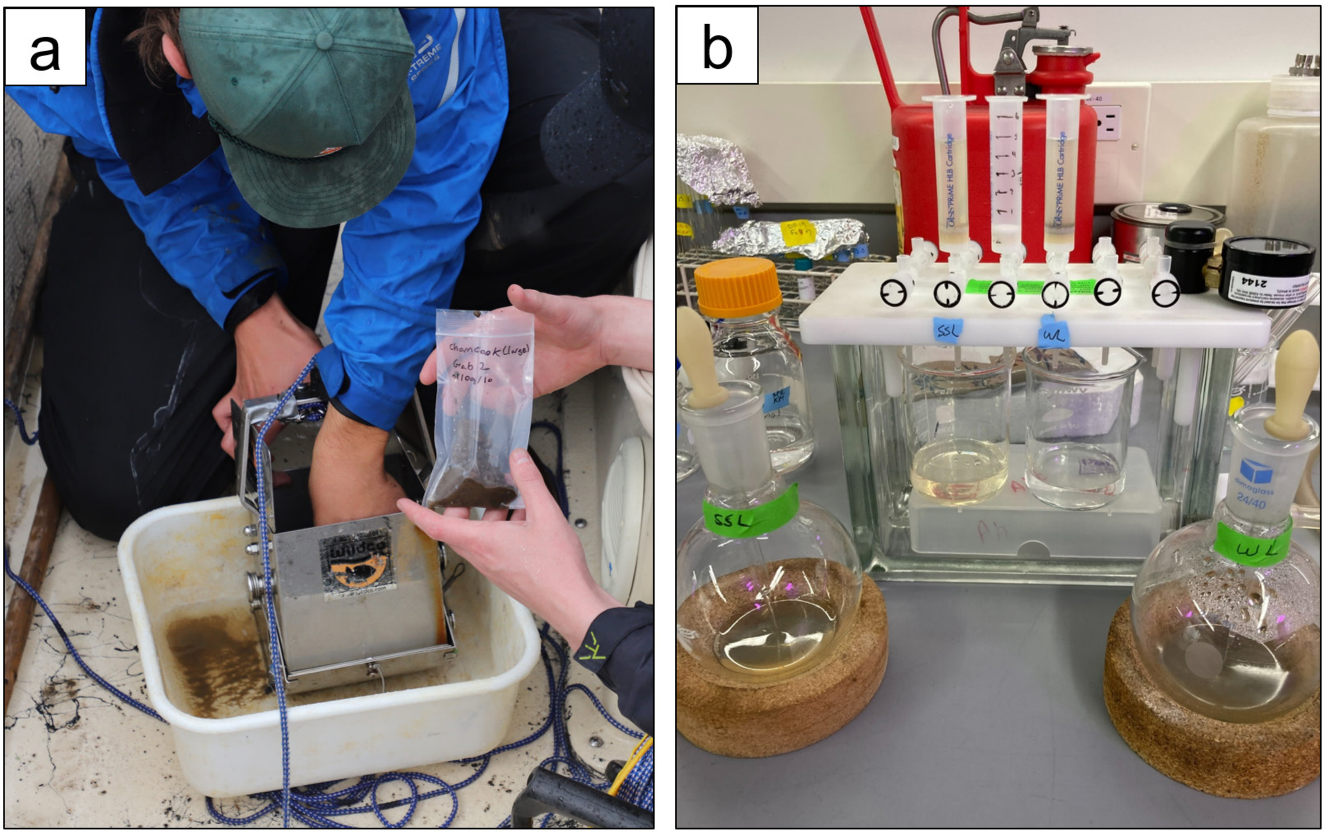

Figure 1. (a) Field work collecting sediment-water interface samples from Chamcook Lake, New Brunswick in September 2021; and (b) part of the microcystin extraction protocol using Hydrophilic-Lipophilic-Balanced (HLB) SPE cartridges (Oasis HLB 150 mg, 6 cc, 30 µm; Waters) to aid isolating sediment-bound microcystin congeners.

present. Harvey Lake had the highest concentrations of toxins detected with a range from 61.6 – 335.4 ng/g total microcystins (average = 151.7). In Harvey Lake MC-LR was detected in each sample tested, whereas microcystin-RR (MC-RR) was only detected in half. Microcystins were only present in one sample collected from Wheaton Lake, with MC-LR and MC-RR detected (total MCs = 112.5 ng/g). In Chamcook Lake only MC-LA was detected in one of the two samples collected at a concentration of 61.1 ng/g. Microcystins were not present or below limits of detection in Little Chamcook Lake, Limeburners Lake, Gibson Lake, Snowshoe Lake, and Welch Lake, all of which had no known past toxigenic bloom events.

Significance

With harmful cyanobacterial blooms increasing globally, understanding the drivers in their occurrence has become more critical than ever. The extraction and quantification of sediment-bound microcystin

Lake Name	Sample number	MC LA	MC LR	Dha7 LR	MC RR	Total MC (ng)
Chamcook Lake	G1	<LOD	**61.1**	<LOD	<LOD	**61.1**
	G2	<LOD	<LOD	<LOD	<LOD	-
Gibson Lake		<LOD	<LOD	<LOD	<LOD	-
Harvey Lake	G1	<LOD	**79.4**	<LOD	**33.6**	**113.0**
	G2	<LOD	**96.8**	<LOD	<LOD	**96.8**
	G3	<LOD	**61.6**	<LOD	<LOD	**61.6**
	G4	<LOD	**258.0**	<LOD	**77.5**	**335.4**
Limeburners Lake		<LOD	<LOD	<LOD	<LOD	-
Little Chamcook Lake	G1	<LOD	<LOD	<LOD	<LOD	-
	G2	<LOD	<LOD	<LOD	<LOD	-
Snowshoe Lake		<LOD	<LOD	<LOD	<LOD	-
Welsh Lake		<LOD	<LOD	<LOD	<LOD	-
Wheaton Lake	G1	<LOD	<LOD	<LOD	<LOD	-
	G2	<LOD	**75.9**	<LOD	**36.7**	**112.5**

Table 1. Microcystin Congeners (LA, LR, RR, and [Dha^7] LR) detected at each of the lake sites.

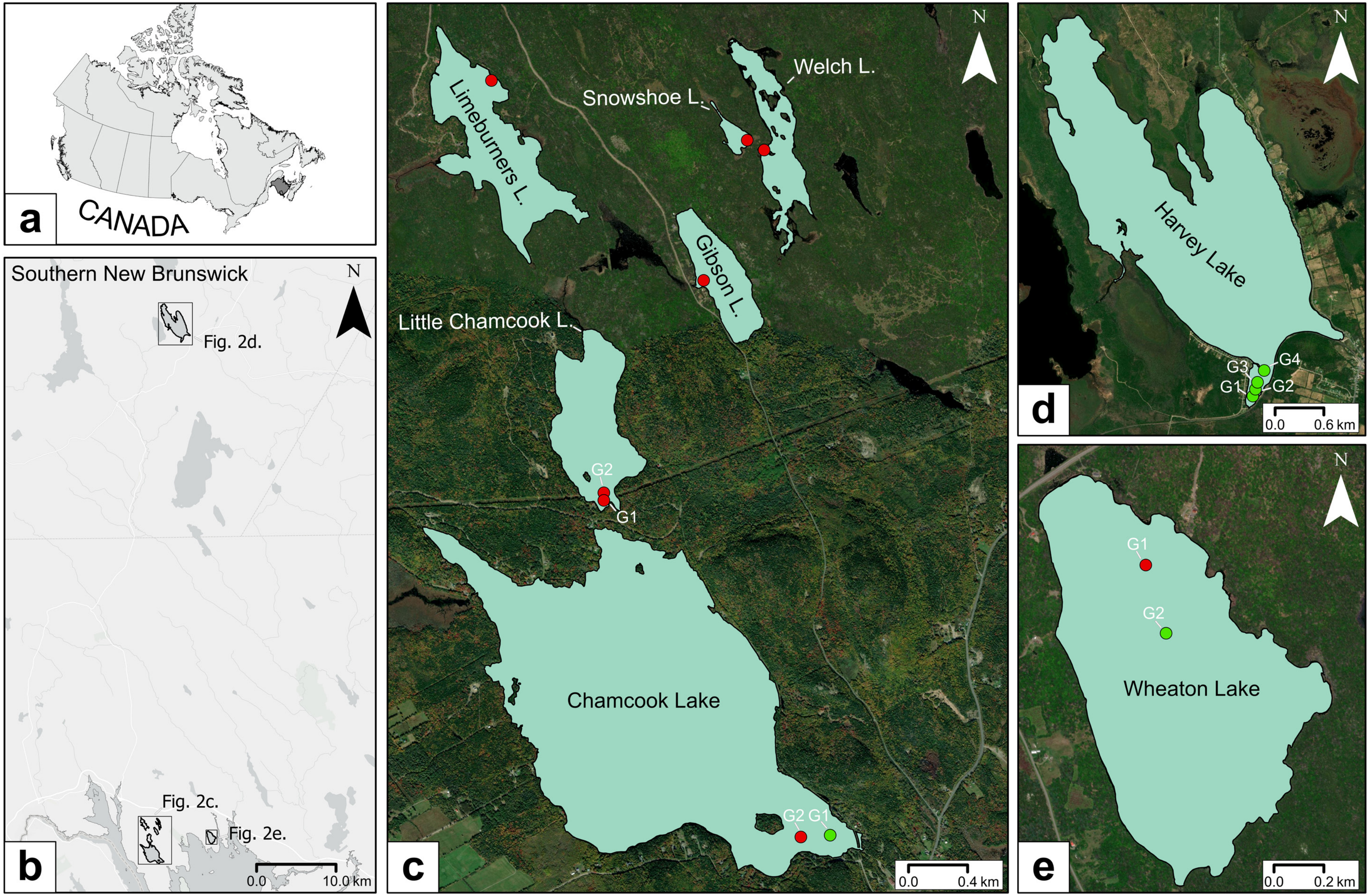

Figure 2: Map of the study area, including; **(a)** overview of Canada; (b) overview of southern New Brunswick including map extents c, d, and e; **(c)** sediment sample locations for Chamcook Lake, Little Chamcook Lake, Limeburners Lake, Gibson Lake, Snowshoe Lake, and Welch Lake; **(d)** sediment sample locations for Harvey Lake; **(e)** sediment sample locations for Wheaton Lake. Sample locations denoted by a green circle had microcystins present, whereas those shown in red were not present or below limits of detection.

congeners has enabled the reconstruction of past temporal toxigenic cyanobacteria events from lake sedimentary core records, providing important context on the timing and magnitude of these events, critical for establishing restoration targets and the effective implementation of management strategies.

The small number of samples run during my training provides some additional insights into the application of microcystins as a sediment core proxy. The results presented here demonstrate that the concentration and the diversity of toxins detected can vary significantly over short distances. For example, between Harvey Lake sample 3 (G3) and sample 4 (G4) (~100 m) toxin concentrations increased by approximately five times, whilst the diversity of toxins also increased. This may suggest that the location of core collection may significantly influence the toxin record preserved.

Acknowledgements

I wish to thank the QRA for enabling me to attend the IFHAB workshop and to receive this training. Thank you to Prof. David McMullin and his students for their warm welcome and assistance with laboratory training whilst hosting me in his group. Thank you to Prof. Tim Patterson and his group for hosting me in his laboratory during my visit to Carleton University and assistance in the field with sediment sampling.

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Quaternary Newsletter
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PRELIMINARY RADIOCARBON RESULTS FROM JARROW'S ANGLO-SAXON MONASTIC GUEST HOUSE

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The Anglo-Saxon monastery of Jarrow was originally excavated during the twentieth century by Professor Dame Rosemary Cramp and has national significance as the home of the Venerable Bede. Currently there is no definitive model for how monasteries during this period were provisioned, or how they exploited the landscapes around them. A PhD project between Newcastle University, Durham University, and Jarrow Hall is currently investigating the landscape management of the site through faunal analysis and isotope work. Funding was kindly given by the society for 3 radiocarbon dates to identify contexts linked to the Anglo-Saxon monastery or the Late Saxon period.

Samples were identified from the Guest House, also known as Building D. A published stratigraphic diagram (Cramp, 2005) was used to select three contexts that had a stratigraphic relationship (2868, 2863, 2857), allowing for a Bayesian model to be constructed for the building. This area was chosen for sampling as it may have been associated with high-status individuals and other visitors to the monastery. Understanding these contexts would give an insight into how these individuals contributed to the provisioning of the monastery and whether this differed from areas dedicated to use by the monks.

A cattle bone was selected from each of the contexts. As cattle are a domestic species, the deposition was likely linked to human activity and therefore more accurately date the contexts they are deposited within. The three samples were sent to the 14CHRONO centre in Belfast for dating. None showed any sign of contamination and had good levels of collagen preservation.

All samples dated from the Saxon period, with the earliest date being modelled to 675-776calAD, the middle to 682-801calAD, and the latest to 689-822calAD (2 sigma). The wide range was not unexpected in this period, and still clearly puts the use of the structure within the monastic period. The latest date came from context 2857 which covers the collapse of Building D. This suggests that the building collapsed while the monastery is still believed to have been active. Further radiocarbon dates are being carried out on contexts above this level to test the dating of the building and the accuracy of the model.

Following this successful radiocarbon dating, assigning contexts to the monastic period, funding has been secured for isotope analysis of teeth from Jarrow. This will entail around ten teeth undergoing incremental strontium and oxygen analysis to establish potential grazing locations or seasonal vertical transhumance. Five of these samples are from Building D, directly benefiting from this radiocarbon dating awarded through this grant. It ensures that when results are being analysed, changes in animal husbandry and movement throughout the monastery's history may be accurately identified. This will further deepen our understanding of monastic landscape use and provisioning.

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Quaternary Newsletter
Obituary
Quaternary Research Association

OBITUARY – ALLAN STRAW (1931 - 2024)

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The passing of Allan Straw deprives the QRA of its last surviving 'founding father'. He had been a co-leader of a Yorkshire Geological Society field meeting in north Lincolnshire in September 1962, when the idea of founding a Quaternary field studies group arose during lunch time discussions (Worsley, 2014). Allan always regarded himself as a geographer, by instinct, training and application but was nevertheless always comfortable in the company of geologists. Strangely, he never had any formal geological training and this absence undoubtedly influenced the kind of geomorphologist he became.

Allan was a proud Lincolnshire 'Yellowbelly', being born in Cleethorpes, Lincolnshire, on January 4, 1931, the first son of Lilly Straw née Smith and Frank Straw, a primary/junior school master. He had two younger brothers, Malcom (1938-2022) and Ian (1942-). After initially living successively in Cleethorpes and Barton upon Humber, for the decade from 1939, he spent his formulative teenage years living in the rural environment of Donington-on-Bain, a small village nestling below the westward facing escarpment of the Lincolnshire Wolds. This followed from his father's appointment as deputy head of the local council school. Thus, as a 'country boy' he spent the war years and its immediate aftermath somewhat isolated from events on the global stage, but this nurtured a deep appreciation of environment and landscape. For his secondary education, Allan commuted some 12 km eastwards to attend the King Edward IV Grammar School in Louth (founded in 1276). He entered the sixth form at an early age and spent three years there and in his final year became head boy. Through the respect from and strong support of his geography teacher Ralph Parkinson, he developed an interest in the physical aspects of the subject. It was with Parkinson's encouragement, his parents bought him what he then regarded as his 'bible', a copy of the first edition (1944) of Arthur Holmes's 'Principles of Physical Geology', which he retained throughout his life. He excelled at cricket and football and even had a successful trial for Grimsby Town Football Club! With good timing, in the summer of 1949 his father was appointed head of the junior school at Langworth 10 km north-east of Lincoln, just as he matriculated from Louth Grammar School. Like many sixth formers, this was time to move on and leave home.

Initially, National Service called, and in September he enlisted with the RAF. After basic training he was posted inside the Last Glacial Maximum ice limit at RAF Linton-on-Ouse, north west of York for almost two years. Upon discharge in 1951, he then entered the University of Nottingham to read for a BA degree in Geography. His tutor was the distinguished geomorphologist Cuchlaine A. M. King (1922-2019), who fostered his growing interest in the subject and by example the necessity of personal field investigation and mapping. Somewhat surprisingly, his dissertation was on the River Ancholme drainage history and land use but family connections at the Humber outfall were influential in its formulation. It formed the basis of his first publication (Straw, 1955).

Whilst a Nottingham undergraduate, he met Beryl M. Goodwin, a 'country girl', who was reading economics and politics. Beryl hailed from a North Somerton farm located close to the eroding Norfolk coast at Scratby, and visits there naturally encouraged him to examine the local exposures of chalky tills. They married in 1955 and subsequently they had a daughter followed by two sons. Beryl predeceased Allan in 2008.

After graduating with first class honours in 1954, Allan was appointed to a salaried three-year Junior Research Fellowship in Geography by the University of Sheffield. He lamented that, despite having a distinguished academic staff, the departmental physical facilities were very rudimentary, despite having Professor David Linton as the head of department. This unsatisfactory situation was not addressed until a purpose designed new building opened in 1970, although ironically, Allan resigned the following year.

As a member of Sheffield staff, he registered for a PhD on the 'Quaternary history of the Lincolnshire Wolds', with Linton as his notional 'overseer', but it was to be a decade before he finally submitted his thesis. This was due to two factors, first, a very heavy teaching load and second, his decision to give priority to the publication of research papers which, inevitably, were related to his thesis topic. However, the flow of these papers, based on his 1:25,000 scale field mapping of the entire Wolds, ensured his appointment as a tenured assistant lecturer in 1957 and subsequently he was promoted to lecturer and senior lecturer. He soon gained a reputation as an inspiring teacher and supervisor. One convert to Quaternary Science through his course on Pleistocene Geography was a geology undergraduate called Phillip Gibbard.

After attaining his doctorate, during 1964-5 he wrote his seminal 'Eastern England' contribution to the Methuen 'Geomorphology of Britain Isles' series of books. By this time, he had concluded that the Older Drift glaciation was produced by essentially north – south moving ice and that the Last Glaciation consisted of two separate advance phrases separated by a significant hiatus. Understandably, he was not impressed by the 14-year delay in publication due to the procrastination of his contributing editor! (Straw, 1979d).

Allan gained leave of absence from Sheffield in 1965, in order to take up a two-year visiting professorship at McMaster University, Hamilton, Ontario. This enabled him to work on aspects of the local geomorphology, especially the effects of Great Lakes glaciation on the Niagara escarpment (Straw, 1966b; 1968b; 1985b). A McMaster field teaching reconnaissance exercise along with colleagues to Cornwallis Island, gave him his only, albeit short, experience of a modern High Arctic permafrost environment. Later (1979 and 1983) he returned to Ontario as a summer time visitor at the University of Guelph and continued his research on the local deglaciation (Straw, 2008b; 2011).

A major change in his career path came with his appointment to a Chair in Geography at the University of Exeter in 1971 and later in 1983 he became the Reardon Smith Professor of Geography and Head of Department for the following decade until 1994. At Exeter Allan was highly regarded for his fair management of the department and the unstinting support he gave to colleagues. Putting the interests of others first did have an adverse effect on his research output in the south west of England and after retiring he regretted not having been able to do more whilst in post. After 37 years living in Exeter, Beryl and Allan moved to Petersfield, Hampshire for family reasons in 2008.

In his early retirement years, his family duties were given priority. It was the publication of the revised Geological Society of London Special Report on the Quaternary (Bowen ed., 1999) which triggered his return to active academic involvement and this he maintained until his death. Allan was rightly incensed by not having been consulted in the compilation of Chapter 2 on Eastern England and forcibly submitted his 'corrections' arising from 'a number of omissions, inconsistencies and inaccuracies' to the Quaternary Newsletter (Straw, 2000) . This also gave him the opportunity to state publicly for the first time that his Older Drift 'Wolstonian' glacial event was Marine Oxygen Isotope Stage 8 rather than Stage 12 (Anglian). Subsequently, in the light of weak dating evidence, he conceded that his 'Wragby Glaciation' 'could fall into any of the Stages 6, 8 or 10' (Straw 2005 p.34).

Arguably, Allan's most influential paper was Straw

(1983a). This was inspired by his need to address what he saw as the deficiencies in Perrin et al's (1979) all embracing Anglian glaciation model. His original manuscript was endorsed by Professor Fred Shotton and, aware that Fred could not serve as a referee, he still submitted it to the Philosophical Transactions of the Royal Society of London. Sadly, it was rejected outright. By chance, Quaternary Science Reviews had recently been launched and the founding editor, David Bowen, was on the look-out for submissions. On learning of Allan's rejected paper, he ensured its successful passage through the refereeing process.

One locality which will always be linked to Allan is the former aggregate quarry Welton-le-Wold just west of Louth. This is undoubtedly the most important Quaternary site in Lincolnshire even if its precise chronology remains an enigma. As part of his initial Wolds research, Allan had periodically monitored the quarry workings from 1954 into the early 1960s. Chris Alabaster, a pupil at his old school in Louth contacted him in 1969 with the news that fossil elephant bones had been found beneath the tills. Then, in the following year, Chris reported the discovery of an Acheulian handaxe from the same general horizon. Allan revisited the site and clarified the stratigraphy and also located a further two handaxes and a retouched flake. Alabaster & Straw (1976) gave the details and Wymer & Straw (1977) expanded the archaeology. Allan received a tip-off that a new investigation had been published by Aram et al. (2004). This was, in his words, a 'bombshell' , since he had no inkling of this despite the fact that some of his unpublished photographs had been used. Heavily influenced by Optically Stimulated Luminescence (OSL) age estimates, the new study argued for an Anglian age for the main glacial succession contra to Allan's long-standing 'Wolstonian' interpretation. This prompted Allen to produce a self-published booklet putting on record a detailed account of all aspects of the site geology (Straw, 2005) but significantly not mentioning Aram et al! Possibly due to the booklet being outside the mainstream publications and the later availability of a detailed account of the OSL data, Schwenninger et al (2007), two other Lincolnshire-based publications subsequently promoted the Aram et al chronology. To address this conundrum, Allan wrote a further Welton-le-Wold account, but on this occasion directly criticised the Aram et al suppositions, (Straw, 2015). Currently Allan's views expressed in this paper remain the latest word on Welton-le-Wold although astonishingly the government-funded 'Lincolnshire Heritage Explorer' web page on Welton-le-Wold currently gives a totally garbled inaccurate version of the truth!

Unlike contemporary practice where the emphasis is on collaborative research projects funded by major grants, Allan's work is characterised by individual endeavour in which he dealt with 'topics as they arose, were perceived or provoked'. Apart from his thesis work on the Lincolnshire Wolds, there was never a grand design. Field work was often a response to issues as they arose. Although he occasionally worked jointly with others, he preferred to work alone and be unrestricted in his conclusions. He was never afraid to defend his beliefs as a series of discussion papers in the Quaternary Newsletter testifies. Generally, he was reluctant to change his long-established views and recognised that he could be 'obstinate and arrogant' in their defence. For example, he could never admit that his two-glaciation hypothesis (Straw, 2008a) along the eastern flanks of the Wolds was unsustainable. Despite this, his concept of a 'Wolstonian Glaciation' in Lincolnshire received unexpected support from the Trent Valley Palaeolithic Project (Bridgland et al., 2014) which had undertaken some further work at Welton-le-Wold. This gave him extreme satisfaction especially when he was invited to join the authorship of the project's concluding synopsis (Straw, 2016b). Poignantly, his final paper, published earlier in this year, was titled 'Last thoughts on …..', appropriately a Lincolnshire focussed topic (Straw, 2024).

Acknowledgements

Nigel Straw has kindly given access to and permission to quote from his father's unfinished 23k word long scientific auto-biography - (Appendix 4 Geography and Research) - written c. 2002-3 for the Straw family. Several friends including Geoff Boulton, Dave Bridgland, Phil Gibbard and Jim Rose have suggested improvements to the manuscript. Others have assisted in ensuring accuracy of Allan's consolidated list of publications.

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OBITUARY – PROFESSOR EDWARD DERBYSHIRE (AUGUST 18, 1932 – JULY 9, 2024)

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This past July 9, the global Quaternary science community lost one of its most beloved Quaternary scientists, Professor Edward Derbyshire. Our friend, mentor, and role model, renowned Quaternary scientist and passionate educator Edward (known by many as simply Ed) Derbyshire, died peacefully at the age of 92 in Cheltenham, Gloucestershire. His contributions to understanding Quaternary climate change and landscape evolution profoundly impacted both the scientific community and society. Many of us fondly recall our transformative experiences with Edward in the field, at conferences, and in the classroom. All loved his dry humor and satire, particularly his play on words. He also shared his poetry with those of us most fortunate, a talent he modestly hid from many of his academic colleagues.

Born on August 18th, 1932, in Liverpool to Kathleen and Edward Derbyshire, Edward attended Holy Trinity Primary School until he was relocated to North Wales at the outbreak of the Second World War. After the war, Edward gained a place at Alleyne Grammar School in Stone in Staffordshire and then at the newly formed University College of North Staffordshire (UCNS), which later became Keele University. Edward studied English Literature and Geography in his first year at university before majoring in Geography with a subsidiary in Geology. In 1952, Edward was elected President of the university's Geographical Association and was the only British undergraduate to attend the XVIIth International Geographic Congress in Washington, D.C. At UCNS, Edward met Maryon Lloyd, who was also studying Geography. They were married in Essex in 1956, spent a lifetime of adventures together, and parented three boys.

Edward graduated from Keele in 1954 and gained a Diploma in Education. Then, as part of his National Service, Edward taught English and Geography to squaddies before ending up at NATO Headquarters in Fontainebleau, where he was based for 18 months. After completing his National Service, Edward moved to McGill University in Montreal, Canada, to undertake an MSc on fluvial erosion in central Quebec-Labrador. He then trained as a weatherman with the *Canadian Meteorological Service* and spent a year at the meteorological station in Schefferville in central Labrador. In 1958, Edward and Maryon returned to UCNS, where Edward became a Demonstrator in Geography.

In 1960, Edward moved his family to Australia to become a Lecturer at the University of New South Wales, and in 1962 became the first full-time Lecturer of Geography at Monash University in Melbourne. His initial research focused on the geomorphology and glaciations of Tasmania and Antarctica. As a Senior Lecturer at Monash, Edward was invited by the USGS in 1966 to work on cirque forms and moraines in the Dry Valleys of Antarctica, for which, in 1974, he was awarded the *Antarctic Service Medal* of the Royal Geographical Society. While at Monash, Edward worked toward his doctorate, focusing on the glacial geomorphology and climate of the Mountains of Western Tasmania, which he completed in 1968.

Edward and his family returned to the UK in 1967 to become a Lecturer at what by then was Keele University. Edward was quickly promoted to Senior Lecturer and, by 1974, promoted to Reader and was awarded a Chair as Professor of Geomorphology in 1984. His time at Keele was notable for the field trips he led to Norway and Iceland. In 1970, Edward worked with Geoffrey Boulton on a six-week expedition to Iceland, where he honed his research interests in glacial deposits. A sabbatical year in 1975-1976 took him back to Monash and Massey University in New Zealand, where he continued his glacial work.

A turning point in Edward's career started when he visited China in 1977 as a member of the UK Royal Society's delegation of geomorphologists. This was followed by a sabbatical in Lanzhou in 1980, where he had the opportunity to teach Chinese scientists, which ultimately helped bring modern science to a country that had essentially been cut off from the rest of the world for many decades. Early career and senior scientists flocked to hear him talk and to get

Edward with several of his Chinese colleagues on the Tibetan Plateau in the late 90s as part of a British Council-funded research exchange program.

advice on the latest ideas on Quaternary science and geomorphology, and he forged solid links with the Chinese Academy of Sciences. During these early visits, Edward became fascinated by the glaciation of Tibet and the thick loess successions of the Loess Plateau. His work with Professors Shi Yafeng and Li Jijun helped reconstruct the extent of Quaternary glaciation on the Tibetan Plateau, showing the lack of an ice sheet during glacials. Working with esteemed Chinese colleagues, including Professors Liu Donsheng and Wang Jingtai, they helped pioneer the use of the Chinese loess as the most important continental record for Quaternary paleoenvironmental change. He collaborated with other internationally renowned researchers on the loess successions, including Professors Slobodan Markovic, Jim Bowler, and Ian Smalley. His research also recognized the societal importance of loess and was funded for eight years to work on landslides on the Loess Plateau in Gansu Province.

Edward's teaching, research, and collaborations in China were among his most impactful contributions. Many have recognized his significant contributions to the Quaternary community in China at an individual level as he helped them develop their careers. As early as 1982, the Royal Geographical Society awarded Edward the Beck Award for his contributions to glacial geomorphology and research in China. His landslide work earned him the Varnes Medal of the International Consortium on Landslides, awarded by UNESCO and International Union of Geological Sciences (IUGS) largely due to his work on landslides in Chinese loess.

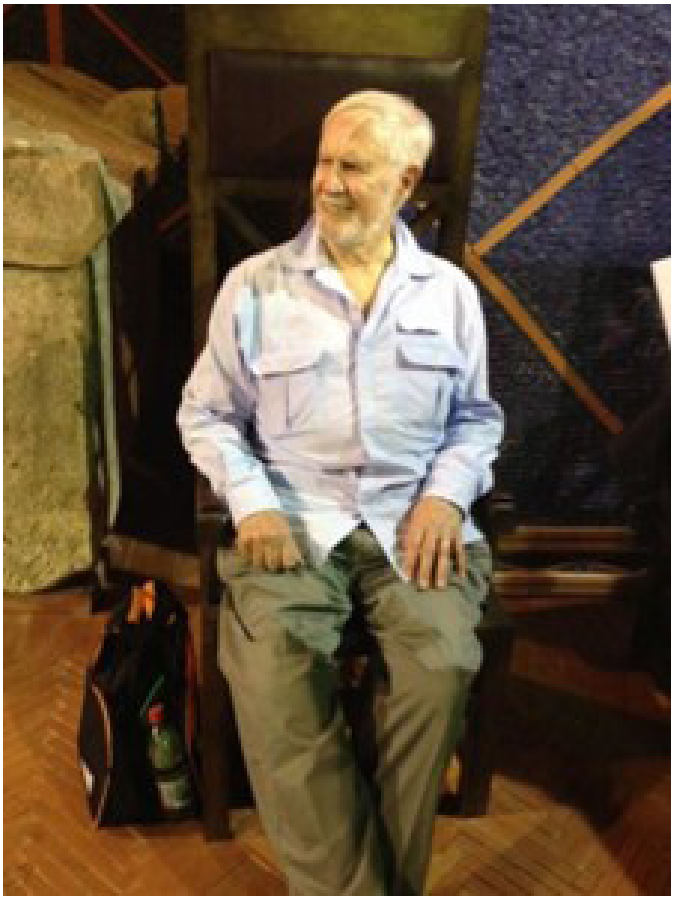
Just after Edward ended his sabbatical in China, he joined the International Karakoram Project, organized by the Royal Geographical Society, in the Hunza Valley of northern Pakistan. This helped him continue strengthening his links with Chinese colleagues and new ones with Pakistani scientists. It also started many years of work in the high mountain region of Central Asia, ranging from glaciation studies to mountain highway hazards. This involved numerous field excursions, including, one year, spending his

A tea break during fieldwork in Hunza in 1985 with his first University of Leicester doctoral student (sporting all-red attire).

Christmas and New Year in the frozen reaches of Baltistan.

Although Edward recalled to his family that his 18 years at Keele were his happiest, he was enticed to move to the University of Leicester in 1985 to become the Professorship and Head of the Department of Geography. This brought new challenges and opportunities to contribute to building a premier department. At Leicester, he continued his research and collaborations in Central Asia while helping to modernize his department. He notably collaborated across the university with geologists and engineers, in particular, developing the use of scanning electron microscopy methods to examine sediment fabric. Edward was amongst the first to publish papers on the newly emerging discipline of engineering geomorphology, although it was not called that until years later.

In 1990, Edward saw an opportunity to retire from formal academia at the tender age of 59 and become his "own boss". Yet, he remained as busy as ever over the next few decades. Soon after his retirement from Leicester, Edward jumped at an invitation from Professor Jim Rose to become a Visiting and then Emeritus Professor in the Department of Geography at Royal Holloway, University of London (RHUL). At RHUL, Edward contributed to the newly established MSc in Quaternary Science, designing and delivering a course in Quaternary Sedimentology. During this time, he served as the Secretary General of the International Union for Quaternary Research (INQUA; 1991–95), Chairman of the Scientific Board of the International Geological Correlation Program (IGCP) of UNESCO and IUGS from 1996 to 2001, Secretary of Foreign and External Affairs of the Geological Society of London from 2007 to 2010. In 2001, Edward was appointed to the Chairmanship of the Science Program Committee of the Proposed United Nations International Year of Planet Earth (IYPE) 2008. In this role, Edward successfully lobbied national delegates at the UN to declare 2008 the IYPE.



Edward's humor was always evident, as in this photograph that he had me take in Novi Sad at the "ED@80" Loessfest, joking that on that throne-like chair he was the king of loess, for at least that day.

Edward's work also extended into medical geology, and together with Professors Olle Selinus and Peter Bobrowsky, they led IGCP 454, focusing on medical geology. He was fundamental in helping to advance this new sub-discipline within Geology. One notable study area was the effect of aeolian (loess) dust on human health. His interest in arid lands continued and he contributed significantly to IGCP 349 (Desert Margins and Palaeomonsoons since 135 ky). Edward's work on loess extended into the Loessfest conferences, which he regularly attended. In his honor, the 2012 Loessfest in Novi Sad was called "ED@80" celebrating his achievements and his turning 80.

In his "retired" years, Edward and Maryon traveled the world and lived in Brighton, Bognor Regis, Gran Canaria, and Cheltenham. Edward contributed wherever he lived and traveled, as in Gran Canaria, where he worked on dust blowing from the Sahara. In his final years, Edward settled in Cheltenham, being close to his family and enjoying the occasional cruises around the Mediterranean and north of the Arctic Circle.

It goes without saying that throughout his career, Edward published numerous influential papers and presented his findings at conferences worldwide. In addition to his >200 research papers, Edward also published numerous books, including *Geomorphology and Climate* (1976), *Landslides in The Thick Loess Terrain of North-West China* (2000), *Essentials of Medical Geology* (2005), *Pollutants, Human Health and the Environment: A Risk Based Approach* (2012), *Geomorphological Processes* (2013), and *Essentials of Medical Geology* (2013). His work advanced the field of Quaternary science and served as a crucial resource for policymakers addressing climate-related challenges. Amongst his many honors, he was awarded lifetime membership of INQUA, the *James Harrison Outstanding Achievement Award* granted by the IUGS, and *Prix d'excellence pour les sciences de la Terr*a by the *Organization Mondiale de Mineralogy, Monaco.*

As a beloved professor, Ed inspired countless students with his engaging lectures and hands-on approach to learning. Ed made complex topics accessible and relevant, fostering a deep appreciation for the Earth's history among his students, peers, and the broader community. Like so many, I vividly remember many adventures with Ed during fieldwork in the mountains of Central Asia, first as one of his doctoral students and then as a research colleague. There are far too many stories to recall on paper, but we will continue to recount them in the years to come around campfires, at QRA and INQUA meetings, in the classroom, and during Burns Nights, where we will read some of Ed's poetry. For me, some of the stories include crawling through a subglacial meltwater channel in Karakoram on New Year's Day, cooling off in glacier meltwater after climbing thousands of feet up bare sediment sections in the burning mid-day sun, enjoying exotic foods at Chinese banquets, making tea by swinging a pot wildly in the air, driving hundreds of miles across the Tibetan Plateau in a jeep whose exhaust feeds directly into the passenger side of the cabin, and enjoying fine wine and great seafood at his home in the Gran Canaria.

We owe Ed so much individually and as a community, particularly as we address the most significant challenges humankind has faced in our history, namely climate and associated environmental change, a focus of Ed's distinguished career. Ed was a loving husband, father, and grandfather; our thoughts go to his family as they remember his life and contributions.

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 ~1000) is open to all interested in the objectives of the Association. The annual subscription is £30 with reduced rates (£15) for students, retired and unwaged members and an institutional rate of £60.

The main meetings of the Association are Field Meetings, usually lasting 3–4 days, in April, May and/or September, and a 2-3 day Annual Discussion Meeting held 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 January discussion meeting. Current officers of the Association are:

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