IQUA

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Editor: Catherine Dalton

1. Introduction

Dear All,

I became a member of the RIA Geography committee in November 2004 and now have additionally been co-opted as a member of the RIA Geosciences committee. I hope to represent the interests of IQUA on both committees.

Catherine Dalton

2. IQUA Fieldmeeting 2005

There will be no annual fieldmeeting this year, due to the QRA / IQUA fieldtrip April 5-9th 2005.

3. IQUA Spring Meeting & AGM 2005

The IQUA AGM took place on Saturday, March 12th, in the Museum building, TCD. In general, it was thought that IQUA had a successful year. Special thanks are due to Michael Philcox who organised both the autumn symposium and the spring meeting this year.

IQUA held a very successful joint fieldtrip with the IAH to North Mayo late last year (see NS 33). It was noted that this is the second year without a fieldguide and it is hoped to redress this in the coming years.

The autumn symposium "Atlantic Coastal and Offshore Quaternary: Deposits, Sea-Level Changes and Archaeology" also went very well. There was an excellent attendance for the second year in a row, with 75 – 80 in the audience at any one time.

A smaller audience was in attendance for the Spring Meeting and AGM 2005. Fraser Mitchell questioned how we could make the Spring meeting more popular, especially among young researchers and postgraduates. It was suggested that the meeting next year be led by postgraduates.

The treasurer's report reflected the successful year. Lapsed members were encouraged to re-subscribe and the corporate members were encouraged to pay two years in advance. The guide books sales are also well up on previous years. There are presently 85 paid members.

A suggestion was made to re-instate a prize for the best postgraduate talk at the Spring meeting. This will be discussed at the next committee meeting.

Proposals for the 2005 Autumn Symposium included 'Reconstructing Changing Climates'. Susan Hegarty (UCD) and Freea Itzstein-Davey (TCD) have offered to organise the event. A provisional date of 25th of November has been suggested.

IQUA Committee

Both Pete Coxon (Chair) and Susan Hegarty (Secretary) have served their four-year term in office. Nominations were sought first for chair. Michael Philcox proposed Steve McCarron for Chair. The nomination was seconded by Susan Hegarty. Steve was appointed Chair. Nominations for secretary were subsequently looked for. Steve McCarron nominated Robin Edwards. Pete Coxon seconded. Robin was appointed secretary.

The committee, as of the end of the AGM was:

Steve Mc Carron (Chair)
Michael Philcox (Treasurer)

Robin Edwards (Secretary)
Catherine Dalton (Newsletter editor)
Paul Dunlop (Publicity officer)
Tony Brooks (Postgrad representative)
Mike Simms
Susan Hegarty

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AGM Abstracts

Geophysical insights on the geomorphology and palaeo-landscape of the River Shannon at Clonmacnoise and offshore west of Kerry Head

G. Duffy[1], C. Brown[1] and K. Barton[2]
[1] Department of Earth and Ocean Sciences, NUI, Galway.
[2] Landscape Geophysical Services, James St., Claremorris, Co. Mayo.
E-mail: gavin.duffy@nuigalway.ie

10 years ago the remains of a wooden structure traversing the River Shannon at Clonmacnoise was discovered by underwater archaeologists. They have interpreted it as an Early Medieval bridge crossing dated at 800AD. This discovery led to a project to investigate the usefulness of high resolution waterborne geophysics for the purposes of underwater archaeology. The acoustic techniques of side scan sonar, swath sonar bathymetry and sub-bottom profiler (Chirp) were employed. The techniques have enabled the classification of river bed sediments. A profile of esker morphology and the highly variable karst topography upon which it lies has been constructed. We have identified the presence of gas, possibly due to the decay of organic material at depths < 10m.

The detailed bathymetry map identifies the current regime in the Shannon today and goes some way to explaining the differential preservation of the wooden post remains. Presented is a possible explanation as to why there appears to be 'missing' posts in the middle of the river. A palaeo-landscape reconstruction using detailed seismic and bathymetric information suggests that the posts may never have been there in the first place. The analysis of fluvial processes has implications for recognising where the archaeological record has been preserved and where it has been destroyed.

In May 2004, the GSI mapped roughly 1200sq km off the Shannon Estuary as part of it Irish National Seabed Survey programme. The bathymetry data shows the location of palaeo-coastlines and bedrock features that could only have been sculpted by fluvial features. There is an obvious lack of surface sediment despite the fact that this area lies offshore from Irelands largest sediment carrying river, indicating perhaps that strong northerly currents carry sediment northwards. The magnetic data indicates the presence of an igneous body in the west which dips underneath the landward Carboniferous sediments. This body appears to outcrop in the far north west of the survey area. Its morphology and fracture patterns indicate it may be granitic.

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Cainozoic development of the Proteaceae in south-western Australia

Freea Itzstein-Davey
Geography Department, Trinity College, Dublin

South-western Australia is a globally significant hotspot of plant species diversity, with high endemism and many rare plant species. Proteaceae (*Banksia* family) is a major component of the south-western Australian flora, though little is known about how its diversity developed. This prompted an integrated study to investigate changes in the abundance and diversity of Proteaceae, in south-western Australia, by concurrently studying three sediment sequences of different ages over the Cainozoic and a modern pollen rain study.

Modern pollen-vegetation relationships in the two Proteaceae species rich nodes of the northern and southern sandplains were quantified. It was found that Proteaceous genera can contribute up to 50% of the total pollen rain. The vegetation and environmental setting during three pivotal periods of the Cainozoic: Holocene, Pliocene and Eocene, were investigated.

Eocene sediment from Lake Lefroy confirmed the presence of a *Nothofagus* dominated rainforest in the Middle to Late Eocene. At this time Proteaceae species were at least as diverse as today, if not more so, contributing up to a maximum of 42% of the total pollen rain. This study also identified that Proteaceae species representation varies across small lateral distances. Thus as samples varied spatially and temporally, single core samples are not sufficient to identify spatial patterns in Proteaceae or other low pollen producing taxa.

Some 7.91 cm of laminated Pliocene sediment from Yallalie, south-western Australia, was also examined. It covers 84 years of record and confirmed other regional reports that south-western Australia was covered by a rich vegetation mosaic consisting of heathy and wet rainforest elements. Although Proteaceae species were a consistent component of the pollen counts, diversity and abundance (maximum of 5%) was low throughout the studied section.

A 2 m core was retrieved from Two Mile Lake, near the Stirling Ranges, provided an early

Holocene vegetation history. Geochemical and palynological evidence recorded little change, suggesting the environment of deposition was relatively uniform. Proteaceae species were noted throughout the core, though in low numbers, at a maximum of 3.5 % of the total pollen rain.

Findings of this research indicate that Proteaceae species were an important and consistent component of vegetation in south-western Australia over the Cainozoic. It is likely that both changing pollination mechanisms and changes in associated vegetation are important in determining the dispersal of Proteaceaous pollen. By understanding how the vegetation has changed and developed in south-western Australia, present vegetation can be managed to include intra-specific variation and ensure the majority of species are conserved for present and future generations to enjoy.

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The Curraheen Lobe, Slievemish - giant debris flow or what?

Michael Philcox
Geology Department, Trinity College, Dublin

The Curraheen River flows north out of the Slievemish mountain front 4 mls SW of Tralee. It is here at the apex of a large fan-shaped sediment body, termed the "Curraheen Lobe", which is c.1.5 km across (E-W), has a steep arcuate front some 30-40 m high, and resembles from below a terminal moraine. However, behind the arcuate front the surface continues to rise, more gently and with a corrugated form, to the apex. The surface is littered with angular blocks commonly >4 m across, composed of red sandstone and distinctive, quartz-rich conglomerate. The few river-bank exposures (<5 m deep) show angular to edge-rounded, matrix-supported boulders within unsorted pebbly sand and silt. The deposit can probably be classified as a rock glacier, though its precise mode of formation is as yet unclear. Its composition resembles a till or debris flow. However, the overall morphology is not till-like, and the size of the deposit is large for a debris flow. Matrix-support for the boulders is compatible with some types of rock glacier.

At the foot of the Curraheen Lobe a quarry reveals coarse alluvial boulder gravel <5 m thick lying directly on Old Red Sandstone bedrock. The elevation and poor exposures of the top of the gravel indicate that it underlies and predates the lobe. Outside the lobe similar gravel is locally exposed in a large alluvial fan extending down to sea level 1 km away. The apex of this fan presumably coincides with that of the Curraheen Lobe, but it is not exposed.

On the beach reworked sandstone boulders partly cover an organic mud >1 m thick. This may have been deposited in a marsh behind a former storm beach on the edge of the alluvial fan, a probable precursor of the extensive existing back-barrier marsh. The organic mud is overlain by >60 cm of interlaminated fine, shelly gravel, sand and mud, probably deposited at the back of a sub-recent storm beach.

Within the mountains the steep-sided Curraheen valley has been cut deeply into massive-bedded red sandstone of the Kilmurry Formation (340 m thick; Pracht 1996). The upper part of the cliffs consists of the sub-horizontal Lough Slat Conglomerate Formation, which has a horseshoe-shaped outcrop around the valley. This is clearly the source of the abundant conglomerate blocks within and beyond the valley, but no prominent scar, that might be linked with an abnormally catastrophic event, has yet been identified.

The valley floor is crossed by a variety of debris deposits, including small recessional moraines and large blocky boulder ridges. Near the head of the valley one such ridge, >12 m high, extends obliquely down valley from the steep rock wall on the north side, but terminates before reaching the opposite cliff. It consists of large, clast-supported blocks of sandstone and conglomerate, most of which have been transported well out from their initial accumulation zone, possibly as prolonged rockfall onto moving ice. Up-valley from this boulder ridge bedrock rises smoothly into the backwall, and there is no ice-deepened bowl typical of corries. The various sediment bodies within the valley appear to be younger than the Curraheen Lobe, as they could not have survived its formation.

The Curraheen River system offers various avenues for future research into its long and complicated development.

Reference: Pracht, M., 1996. "The geology of Dingle Bay: a geological description to accompany the bedrock geology 1:100,000 map series, Sheet 20, Dingle Bay": Geological Survey of Ireland.

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Glaciofluvial discharge regimes of the Pleistocene River Slaney Valley --- retrodiction and correlation with glaciomarine events

Elizabeth McNicholas and Colman Gallagher
Geography Department, University College, Dublin

The Slaney Valley reflects high glaciofluvial discharges regimes. Discrete process zones are reflected in distinct sets of landforms and correlated sediments within the

valley. This research aims to identify and characterise these process zones using both sedimentological and topographic means. The process zones are indicative of dynamic ice margins and changing base levels, both isostatic and eustatic, during Oxygen Isotope Stage 2. The purpose is to understand Pleistocene glacial activity, denudation of Irish landmass and the transport of sediment to the Irish Sea basin.

The research is based on the observation, recording and analysis of glacigenic landforms and sediments. The landforms are to be used as surrogates in the interpretation and retrodiction of palaeoprocesses. Valley morphology was initially mapped from aerial photographs that provided estimates of palaeodischarge and maps for field work. In addition to this, a Digital Terrain Model will be created from Ordnance Survey height data, Geotiff and ortho-photos, digitised Quaternary data, Lidar data and mapped morphology from the field. Exposures will provide insight into the sedimentary sources and provide data required in the palaeohydrological reconstructions. The combination of the two data sets should create a coherent spatial model of the relationships between forms, sediments and palaeoprocesses in the Slaney Valley.

So far, using a Trimble roving GPS, glaciofluvial terraces, kettle holes and existing exposures have been mapped and the exposures logged. This work has allowed the identification of three distinctive reaches, each comprising a distinct glacigenic process zone. Reach one from Stratford to Baltinglass, is characterised by prolific erratics and well defined, high terraces. Reach two lies within the Tullow basin and is characterised by only one ill-defined glaciofluvial terrace and generally flat land. Aghade Bridge to Bunclody is the last reach, which is a deep forested gorge, where bedrock is close to the surface and erratics are located at high levels above the present river bed. Within reach one, Saundersgrove and Manger pits support Farrington and Mitchell's (1973) ice limit in phase two. Preliminary cross sections, systematically matched across valley from the DTM and field evidence, suggest maximum palaeodischarge of $22x103m^3s^{-1}$. However, hydrologically relevant longitudinal profiles and cross-sections will be estimated by plotting the thalweg depth from discrete, representative cross-sections in each process reach. Hence, key palaeochannel hydraulic and channel-geometry variables are being measured and will be used, along with sedimentology, to retrodict the key spatial elements of the palaeodischarge regime of the glaciofluvial Slaney.

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Ongoing projects in the Quaternary and Geotechnical section of the Geological Survey of Ireland

X. M. Pellicer, M. Sheehy
Quaternary and Geotechnical Section, Geological Survey of Ireland, Dublin, Ireland

The Quaternary and Geotechnical Section of the Geological Survey of Ireland is currently working on several projects involving Quaternary Geology mapping, the national geotechnical database of site investigation reports and associated map outputs, as well as the work of the Landslides Working Group

Quaternary Geology mapping is currently being carried out in areas of South County Westmeath, North County Offaly and County Louth. This process involves compilation of existing data/literature, satellite image and aerial photography interpretation, fieldwork (encompassing site description, drilling, sampling, and analysis) and compilation of acquired data into final product. A by-product of the quaternary mapping program is the production of depth to bedrock maps for the areas under investigation. The use of geostatistical analysis techniques is currently being tested with a view to improving this process.

The geotechnical borehole database now has a total of 4395 Reports containing over 50,000 borehole/trial pit/probe logs. Of these 3093 have been fully scanned into the GSI Document Management System (DMS). Data input into the Oracle database has now reached over 2600 reports containing over 31,000 borehole and trial pit logs. This digital database will permit a more efficient and rapid access to data. It is used extensively by consulting engineers and geologists, it allows for the development of a variety of map products for major urban areas, such as depth to bedrock contour maps. To date the location of over 8800 boreholes and trial pits in Dublin and other cities has been digitised.

The GSI Landslide Working Group has developed a database of landslide events in Ireland, now numbering just in excess of 100 events. These are mostly developed in peat. The Group is also examining the geotechnical parameters involved in slope failure. It is also considering the feasibility of landslide susceptibility mapping in Ireland. A pilot project in the Breifne area, covering parts of Co. Cavan, Leitrim and Sligo, is currently underway. An important part of the work is also to make recommendations for the integration of the landslide issue into the planning process.

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Vegetation response to climate change in Ireland and north-west Spain over the last 4500 years

Bettina Stefanini
Botany Department, Trinity College, Dublin
stefanb@tcd.ie

My research forms part of ACCROTELM, a three year project funded by the European Commission under the Fifth Framework Programme. ACCROTELM (Abrupt Climate Changes Recorded Over The European Land Mass) aims to quantify the extent and timing of climate change events of the late Holocene. High resolution multi-proxy analysis of well dated peat cores are used to try and establish climate change events from eight sites across Europe.

Ten partner institutions are generating climate-proxy records through the analyses of humification, micro and macrofossil, testate amoebae and bimolecular data. The data will be supported by detailed, wiggle-match dated chronologies.

My research project covers humification and microfossil analysis from the Irish and the Spanish sites. In humification alkali extracted humic acids are assessed through colorimetry to try and establish the rate of decay of organic materials within peat sediments. Microfossil analysis on the other hand focuses on changing patterns of pollen and other palynomorph deposition on mire surfaces through time. I am using it to reconstruct past vegetation changes on a local through regional scale. So far I have completed humification from both sites and am currently working on pollen analysis.

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The application of palaeoflower arranging to test palaeograzing hypotheses

Fraser J.G. Mitchell
Botany Department, Trinity College Dublin

Frans Vera has proposed a hypothesis that large herbivores maintained an open parkland type landscape in primeval times across lowland Europe. This hypothesis relies primarily on the interpretation of European pollen data which are dominated by high abundances of *Quercus* (oak) and *Corylus* (hazel). These trees cannot regenerate under dense shade and so their abundance is assumed to indicate a more a more open landscape that was maintained by large herbivores. If natural forest landscapes were indeed more open current forest conservation management policy across Europe would need to be reconsidered.

It is not possible to reconstruct large herbivore densities and so this hypothesis is tested by comparing relative proportions of *Quercus* and *Corylus* pollen from regions which supported large herbivores with data from Ireland, where large herbivores were excluded. Similarity between the two data sets indicates that large herbivores were not required to maintain these taxa in the primeval landscape.

Fine spatial resolution pollen data from small hollows in Europe and eastern USA provide another opportunity to explore the hypothesis. Data from moss polsters show that percentage arboreal pollen is a reliable indicator of canopy openness in these sites. The palaeoecological data demonstrate that open canopy forest has only ever been maintained by human exploitation

Large herbivores in Europe do not therefore appear to have maintained an open landscape in primeval times although evidence suggests that they would have influenced the species composition of the forest canopy.

Relevant references:

Vera, F.W.M. (2000) *Grazing ecology and forest history* CABI, Wallingford.

Mitchell, F.J.G. (2005) How open were European primeval forests? Hypothesis testing using palaeoecological data. *Journal of Ecology*, 93, 168-177.

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The Characteristics of Ribbed Moraine and Assessment of Theories for Their Genesis

Paul Dunlop
The University of Ulster, Department of Environmental Sciences, Cromore Road, Coleraine, Northern Ireland BT52 1SA.

Ribbed (Rogen) moraines are large subglacially formed transverse ridges that cover extensive areas of the beds of the former Laurentide, Fennoscandian and Irish ice sheets. Since the flow speeds and stability of ice sheets are known to be sensitive to conditions operating at the bed, a full understanding of the processes of ribbed moraine genesis are critical if we are to appreciate their role in ice sheet dynamics. Numerous hypotheses exist that seek to explain how ribbed moraine are formed: by shearing and stacking of subglacial sediments (e.g. Aylsworth and Shilts, 1989; Bouchard, 1989); as a consequence of subglacial megafloods (Fisher and Shaw, 1992); by fracturing and extension of frozen till sheets (Hättestrand, 1997) or by sediment deformation (Boulton, 1987; Hindmarsh, 1998a,b, 1999). However, given that their formation has never been observed, advances in knowledge have to rely on

abduction. That is, hypotheses, theories or models are generated that seek to best explain their characteristics (pattern, size, shape, internal composition etc). The most successful hypothesis will be the one that provides the most complete explanation of ribbed moraine characteristics. This approach is problematic given that ribbed moraine characteristics are poorly known. Scrutiny of the literature reveals that detailed observations are limited to small areas (normally < 1500 km^2) and with small sample sizes (i.e. probably <50 ridges). Generalisations drawn from this base cannot be regarded as being representative and thus remain an inadequate data source for testing the various hypotheses. This paper addresses this deficit by producing the first representative data set on ribbed moraine characteristics.

Various remote sensing and GIS techniques were used to record the morphological, morphometric and spatial characteristics of ribbed moraines in Ireland, Canada and Sweden, over a combined area of 81,000 km^2. This database of 36,000 individually mapped landforms demonstrates that many published accounts are somewhat misleading and unrepresentative, and that ribbed moraine morphology is more complex than was hitherto reported. For example it is shown that ribbed moraines often form independent of topographic influences, are not always curved down-ice, do not have accordant summits, can have both steep proximal and distal sides, have undulating crests and resemble waves, are not always anastomosing and do not necessarily fit neatly together like a jigsaw. Our database of ribbed moraine ridge length, width, height and wavelength is also presented and reveals they exist over a much larger scale range than was previously thought. These new data were used to test the various ribbed moraine theories. This led to the rejection of the topographic model of shear and stack and undermined the credibility of all other shear and stack hypotheses, the two-step hypothesis, the megaflood hypothesis and the thermal fracturing model of formation. Given that ribbed formation is not due to localised factors such as topography and on the basis that their patterns are repetitive, organised into dominant wavelength and are widespread it is strongly argued they are most likely the product of an instability mechanism that operates in the subglacial environment.

4. IQUA Autumn Symposium

The annual symposium for 2004 was held on the 26th November at the Geological Survey of Ireland and focused on the "Atlantic Coastal and Offshore Quaternary: Deposits, Sea-Level Changes and Archaeology". Until the recent mapping of the seabed by the Irish National Seabed Survey (INSS), very little was known about Ireland's Atlantic coastal and offshore region. However, the work of the INSS allied with recent advances in (*inter alia*) digital bathymetric mapping and sub bottom profiling has facilitated increased research in this area. Indeed, this topic is now at the forefront of Irish Quaternary studies and this was reflected by a good attendance at the symposium by both speakers and audience alike. Encouragingly, there was a strong postgraduate contingent, with representatives from Trinity, NUI and QUB discussing their ongoing research.

The conference was opened by Michael Geoghegan who discussed the current state of play with regards the work carried out by the INSS and the importance of this new bathymetric data to our understanding of the Quaternary in this region was aptly demonstrated through the talk that followed by David Hardy. The ensuing talks by Julian Carolan and Barbara Gylnn delivered case specific examples from Clew Bay with a focus on the late Quaternary glacial history and the geomorphological processes that have shaped the bathymetry of the Bay. The afternoon session had a heavy bias towards sea-level research with Melissa Harmon, Michael O'Connell, Joe Kelley, Tony Brooks and Joseph P. Kelly presenting evidence for late Devensian and Holocene relative sea-level change from both the north and west coast. In addition, Michael Gibbons' discussion on the inter-tidal landscapes of Mayo and Galway added an archaeological dimension to the symposium whilst Peter Haughton (on behalf of Lena Ovrebo) concluded the presentations with a discussion on offshore Quaternary deposits along the margins of the Rockall Trough off western Ireland.

Anthony Brooks, Geography Department, TCD.

Full abstracts for all the 2004 symposium presentations are below:

2004 Symposium Abstracts

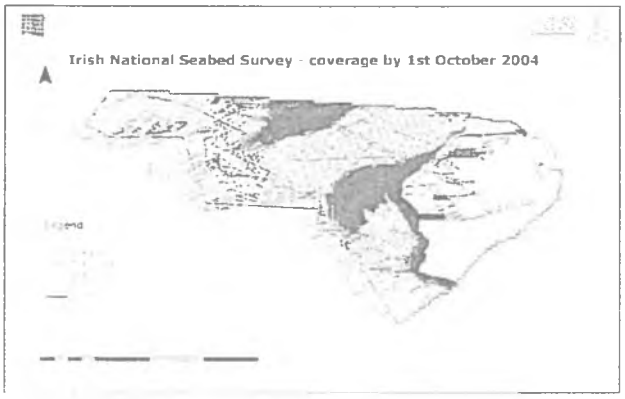
An Overview of the Irish National Seabed Survey, highlighting Recent-Quaternary features.

Michael Geoghegan and Eibhlín Doyle

In 1999 the Government allocated [illegible] over a seven-year period to fund the mapping of Ireland's designated waters. The management

of this significant project was assigned to the Geological Survey of Ireland. The area was initially divided into three zones. Zone 1 with water depths less than 50m, Zone 2 with water depths between water depths 50 and 200 and Zone 3 with water depths greater than 200m.

Zone 3 was surveyed initially. The area completed is approximately 410.000km^2 and has water depths up to 4,500m. This area was completed on schedule in 2002. Work on Zones 1 and 2 commenced in 2002, and are being surveyed together. Figure 1 shows the areas completed to date.



The main techniques used are multibeam echo sounding, single beam echo sounding, (EM120 and 1002), sub bottom profiling, gravity and magnetics. Side scan sonar and high resolution seismics have also been used for specific studies. In addition preliminary groundtruthing has been carried out and airborne laser techniques have been used in shallow water areas where the water clarity is good.

The results of this project have been far reaching, serving various sectors such as oil and gas exploration, marine aggregate, fishing, engineering, environmental and research.

A number of important features, related to glaciation, have been recognised, some of which are the subject of current research. On the Rockall and Porcupine banks iceberg scour marks and pockmark have been observed. Closer to shore glacial moraines have been identified. Submarine slides have been identified, e.g one which originates off the Rockall Bank and flows into the Rockall Trough and measuring 100km wide by 150km long. The age of this slide is unknown but examination of its features would indicate a recent age. It may be Holocene in age similar to other such slides in UK and Norwegian waters. More recent features include major sand waves related to the currents at work at present and the growth of the deep cold-water corals. The talk will illustrate many of these features and the techniques used to identify them.

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Discussion of ongoing work into the Quaternary and earlier geology of the Donegal Bay area.

David Harvey
Marine and Geophysics Section, Geological Survey of Ireland. Beggars' Bush, Haddington Rd. Dublin 4.
(E-mail. david.hardy@gsi.ie)

This presentation attempts to outline ongoing work, based on the interpretation of Irish National Seabed Survey, in the area around Donegal Bay.

In September 2002, the Marine Institute vessel Celtic Voyager, working on behalf of the GSI, collected a range of acoustic and geophysical datasets. The survey was primarily focused on the collection of Multibeam Echosounder data, however, 3.5kHz sub-bottom profiles and magnetic data were also collected for each line. In addition, some 60 bottom-samples were retrieved using a Van Veen grab.

The initial focus of this project was related to the possible existence of Tertiary channels in the area, however, the datasets available are more suited to a study of the Quaternary geology of the region.

Preliminary interpretation of the bathymetry and acoustic backscatter data identifies an inner and outer "basin", separated by a large North-South trending moraine (some 26 kilometres long, with an associated topographic height of ~25m). Several moraines of lesser dimensions can also be recognised. To the southwest of the area surveyed, significant exposures of bedrock occur, and a potential exists for correlation with the mapped onshore geology.

A working shallow stratigraphy for the area has been developed[1], and approximate sediment isopach and palaeotopography surfaces generated based on the 3.5kHz Profiler data.

Ongoing work aims to produce seabed classification maps, based on statistical backscatter analysis (see [2] for a description of the methods and technologies on which this based), in conjunction with the integration of all available datasets in a GIS environment. Planned future work aims to correlate the morphology and sedimentology observed, with data reported from onshore, in order to link the area with the "greater-picture" and potentially provide some dating constraints for the features observed.

[1] Marine Institute : Geolab End of Leg Report for Donegal Bay 2002 [GSI internal report].
[2] Preston, J.M. et al (2003) Sediment Classification Based

on Repetitive Bathymetry Surveys of an Offshore Disposal Site. *IEEE Oceans '03*. 69-75.

Acknowledgements
Data and funding for project provided by GSI.
Supervision by Dr. John Graham (TCD), Michael Geoghegan (GSI) and Dr. Eibhlin Doyle (GSI).

Fig. 1. 3D image of large moraine feature surveyed and associated "outwash plain". Image oriented to the North.

Fig. 2. Hillshade derived from Multibeam bathymetry, showing rock outcrops surveyed to the southwest of area and associated onshore geology (from GSI 100K Bedrock Series).

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Reconstructing the Late Quaternary evolution of Clew Bay: A journey through digital bathymetry, 'Chirp' sub-bottom profiling, Laser Airborne Depth Sounding (LADS) and computer mapping.

Julian Carolan
Department of Geography, Queens University Belfast.
e-mail: j.carolan@qub.ac.uk

The seafloor and subsurface shallow shelf environments within the formerly glaciated, bathymetrically complex, Clew Bay were mapped using a combination of: digital bathymetry, 235km of high-resolution (2-10kHz, 4 pulses/second) FM 'Chirp' sub-bottom reflection profiles and 175km^2 of Laser Airborne Depth Soundings (LADS). Key objectives of the study are: (1) to better understand the sedimentary processes, and (2) to reconstruct coastal/geomorphological evolution of the bay during the post-glacial sea-level rise. Integration of the bathymetric and sub-bottom data allows the relationship between seafloor topography and the underlying strata to be investigated. Data were integrated on a GIS platform where they can be successfully queried, visualised and manipulated spatially to reveal previously unknown relationships. The use of GIS permits the use of fragmentary geomorphological and geological evidence to allow a new approach to the reconstructing of Late Quaternary environments. Clew Bay can be sub-divided into eleven bathymetric units based on average water depths and geographic location. Three first-order Acoustic Facies Units (AFU-1, -2 & -3) and two second order units (AFU-2(B), -2(C)) are identified within the subsurface, which correlate with the surficial units SU-1, SU-2 & SU-3. Sedimentary facies within the system consist predominantly, of redistributed glacigenic deposits. Basement rock exposures being common throughout the study area while local trends in sediment thickness are strongly related to antecedent topography. Major submarine features of interest imaged within the study area include: two geographically distinct hummocky moraines, the smaller within the inner bay, and a second large composite multi-lobate, east-west trending series of ridges in the outer bay. A series of oval-shaped, bathymetric highs are identified as erosional remnants of drumlin forms, in various stages of preservation, which divide the inner bay into two major areas based on the dominant surficial and subsurface sedimentary units. The outlines of lag seafloor footprints have a distinct east west long axis trend. This trend is similar to the preferred orientation of the long axes of drumlins in the Clew Bay area and indicates the dominant flow direction of the Late Midlandian ice sheet. Modifications of the drumlins occurred during two distinct periods: 1. Ice re-advance, and 2. marine transgression. Drumlin orientation and morphometry suggest a statistically significant phase of secondary overprinting of these units with length- breadth ratios increasing toward the ice proximal end of the glacial depositional system. The results of this study indicate that relative sea-level changes in conjunction with local geological control had a profound effect on the deposition, erosion and preservation of sediment on the shelf of the inner bay throughout the Late Quaternary and that the shallow subsurface greatly influences many aspects of the present surficial morphology.

Suggested reading:

Eyles, N., Boyce, J.I., Halfman, J.D. & Koseglu, B., 2000 *Seismic stratigraphy of Waterton Lake, a sediment-*

starved glaciated basin in the Rocky Mountains of Alberta, Canada and Montana, USA. Sedimentary Geology. **130**, 283-311.

Hewitt, A.T. & Mosher, D.C., 2001. *Late Quaternary stratigraphy and seafloor geology of eastern Juan de Fuca Strait. British Columbia and Washington.* Marine Geology, **177**, 295-16.

Knebel, H.J. & Pope, L.J., 2000. *Sea-floor environments within Long Island Sound: A regional overview.* Journal of Coastal Research, **16**(3), 533-550.

Locker, S.D., Albert, C.H. & Brooks, G.R., 2003. *Regional stratigraphic framework linking continental shelf and coastal sedimentary deposits of west-central Florida.* Marine Geology, **200**, 351-378.

Todd, B.J., Fader, G.B.J., Courtney, R.C. & Pickrill, R.A., 1999. *Quaternaty geology and surficial sediment processes. Browns Bank, Scolian Shelf, based on multibeam bathymetry.* Marine Geology, **162**, 165-214.

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What shaped the seabed? Seabed processes off the north coast of Clare Island, Clew Bay.

Barbara Glynn, Colin Brown and Shane Rooney.
Department of Earth and Ocean Sciences, National University of Ireland, Galway.

Marine geologists have over the last number of years become increasingly involved in the application of acoustic remote sensing in offshore geological mapping. This is a direct result of significant advances in the resolution and accuracy of seabed mapping technologies, primarily swath acoustic systems and an improved understanding of complex seabed processes (Pratson & Edwards 1996, Todd *et al.* 1999, Bates & Byham 2001). Mapping the inshore zone has many additional important applications e.g., bathymetry as an aid to navigation; the identification of seabed bottom type; siting of offshore engineering developments; location of potentially economic sand and gravel deposits; pipeline and cable locations; environmental habitat studies; underwater archaeological studies and many more (Parsons *et al* 2004).

Swath bathymetry and backscatter data have been collected simultaneously using interferometric sonar over an area of 37 km^2 in Clew Bay. The sonar is a phase discrimination system, operating at a centre frequency of 234 kHz. It has a maximum swath width of 300 m and can give 100% seabed coverage in waters up to 100 m in depth. The bathymetric resolution can be as good as 0.075 m. A high-resolution bathymetric map of the area has been created for interpretation in terms of geological processes and has been integrated into a Digital Terrain Model. Backscatter is a measure of strength of the echo returned from an object or patch of seabed. Bathymetry and backscatter have been used to characterise the seabed geology and can be correlated with the onshore geology. A statistical analysis of backscatter amplitude has allowed for the generation of an acoustic facies map describing the distribution of sediment on the seabed. The analysis minimises subjective and qualitative interpretations of the acoustic images.

The geology reflects Clew Bay's extensive glacial history and until now, certain glacial erosion and depositional features in the area were unmapped. A terminal moraine marking major ice limits during the Last Glaciation (Midlandian) is present as described onshore by McCabe and Clarke 2003. Other features include submerged drumlins, submarine glacial erosion channels, Clare Island's palaeocoastline, the extension of highly faulted rock units offshore and major geological contacts. The sediments in the area have been sampled and corroborate interpretation of the backscatter.

Bates, C.R. & Byham, P.W., 2001. Bathymetric Sidescan Techniques for Near Shore Surveying. The Hydrographic Journal. No. 100 April 2001. pp. 13-18

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Relative Sea-Level Observations and Their Implications for Glacial Rebound Modelling in Ireland

Anthony Brooks
Trinity College, Dublin

All records of Irish Sea level since the Last Glacial Maximum (LGM) reflect the interplay of both glacio-isostatic and eustatic components. This isostatic signature is derived from the lithospheric response to local, regional and extra-regional ice cover but most significantly, the location of the Irish land mass near the periphery of the former British Ice Sheet margin meant spatial variation in ice loading thus substantial differences in glacio-isostatic adjustment (GIA) histories. In the North of the region fluctuations in the strength of the eustatic signal relative to isostatic uplift since the LGM has led to highly non-monotonic curves of Late Devensian and Holocene relative sea level (RSL) (e.g. Lambeck,

1996: Carter. 1982): Conversely in the South, the dominance of the eustatic signal over that of the isostatic component since the end of the Late Glacial up until the Late Holocene has imparted a dominant positive sea level tendency on RSL curves from the region (e.g. Lambeck. 1996, Sinnott. 1999).

In addition to providing valuable information in their own right. RSL data are powerful tools in the wider study of glaciation, climate change and Earth structure. Their intimate link with GIA and eustatic sea level means that they contain within them information regarding former ice extent. thickness and melting history. as well as data pertaining to the physical structure of the Earth and its response to loading. This information can be distilled through the combination of RSL data and geophysical modelling. Importantly. the location of Ireland beyond the margins of the main accumulations of Wu¨rm–Wisconsin–Devensian ice sheets. mark it out as an especially sensitive area for such modelling attempts.

The general theory pertaining to the application of geophysical models for the prediction of RSL change. and their validation *via* the use of radiocarbon-dated Sea-level Index Points (SLI's) is presented in Lambeck (1996) and Peltier *et al.* (2002). In brief. the modelling approach involves the combination of an ice model predicting the thickness. distribution and melting history of terrestrial ice. and an earth model predicting the Earth's deformation under varying loads of ice and meltwater. In the past. several attempts at glacial rebound modelling have been made for Ireland. The most notable of these are the efforts of Lambeck. (1996) and Lambeck and Purcell. (2001) although significantly. their ice model estimates are conditioned by an earth model which is said to be inconsistent with the high quality RSL data from the UK (Shennan *et al.*, 2002: Peltier *et* al.. 2002: Peltier. 1998). The most recent ice model estimates for Ireland can be found in the modelling attempts of Shennan *et al.*. (2002) although whilst this can be seen as the most up to date and accurate estimate of ice cover over Britain. the reluctance of the authors to employ any of the Irish RSL data calls into question the validity of their inferred ice sheet topography: (Indeed. preliminary model runs suggest an increase in ice thickness is required. at least over the north of the country.)

The model employed in this investigation is based upon the same methods employed by Peltier *et al.* (2002) and is used in preference to the model previously employed by Lambeck (1996) in Ireland. Principal differences are 1: The use of a 90 km lithospheric thickness (as opposed to 65 km) in accordance with recent geophysical and modelling data (DeLaughter *et al.*. 1999: Peltier *et al.*. 2002) and 2: The adoption of a calendar year chronology (based on the calibration of radiocarbon dates) in preference to a ^{14}C chronology to circumvent problems linked with *a posteriori* correction (Peltier *et al.*. 2002).

In the past decade, significant findings in the field have delivered new constraints on the timing and magnitude of late Devensian ice build up and decay: The work of Bowen *et al.*. (2002) has delivered a suite of cosmogenic dates which provide much firmer chronological control on the evolution of Devensian ice cover whilst the work of McCabe *et al.*. (1998): McCabe and Clark. (1998) and McCabe. (1996) has significantly augmented our knowledge of ice sheet evolution subsequent to the LGM. Furthermore. sea level data delivered by Sinnott. (1999). Devoy *et al.*. (2004) and Cooper *et al.*. (2002) has significantly improved our understanding of patterns of GIA which are directly linked with former crustal loading. The above suggests that now is a fitting time to consider a new ice model for Ireland in the light of these more recent advances.

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Late Holocene Relative Sea-Level Changes Recorded in County Donegal Saltmarshes: Initial Results

Melissa Harman
School of Geography, Queen's University, Belfast, BT9 6DN, U.K
m.harman@qub.ac.uk

Late Holocene relative sea-level (RSL) change remains predominantly unknown across Ulster, yet this is perhaps the most important time for making predictions regarding the direction and speed of future RSL. Although tide gauge records can be used to indicate RSL changes in the last century, the period previous to this remains unknown. The north of Ireland is a key area for studying this period of RSL change, due to the dual impacts of the Scottish and Irish ice sheets and resultant isostatic and eustatic effects following the melting of these ice masses. An east-west variation in RSL is expected as areas closer to the centre of the Scottish Ice Sheet experience a greater isostatic uplift following the melting of this ice mass, over-riding a rise in eustasy to create an net RSL fall, whereas those areas further west are likely to exhibit an overall RSL rise. However, this trend is likely to decrease over the length of the Holocene as the rate of isostatic uplift decreases. A PhD research project attempting to reconstruct RSL variation for this important period of approximately the last 2000 to 3000 years includes two saltmarsh sites from County Donegal: Strath's Farm, near Malin, and Maas, near Ardara.

Saltmarshes have proven to hold a high-resolution record of RSL change in research based in both North America and Great Britain, through the study of microfossils preserved in their sediment with attached chronologies. The location of saltmarshes at the land-sea interface is ideal for recording RSL change and the low-energy environment of this bio-zone promotes the preservation of microfossils. However, this source of data has not yet been exploited in Ulster and is utilised here as a first attempt at reconstructing the geologically recent RSL record to expand the knowledge of the RSL history of Ulster.

Both foraminifera and diatoms are studied to create a multi-proxy record, with contemporary (surface) assemblages determined and compared to various environmental variables (pH, conductivity, loss on ignition/Carbon content, particle size analysis, vegetation type and cover, altitude and tidal influence) in order to create a modern dataset from which transfer functions from the local to the regional scale can be developed. These transfer functions are then applied to fossil (core) assemblages. Chronologies are provided by ^{14}C dating accompanied by ^{210}Pb and ^{137}Cs analysis for recent records. Surface analysis at Maas and core assemblages from Maas and Strath's Farm are described and discussed, with a consideration of the benefits and difficulties of using the saltmarsh microfossil record of RSL in Ireland. For example, the specific difficulties of poor fossil foraminifera preservation at both sites and the linkage between the stratigraphic record and microfossil assemblages are considered and RSL changes on the millennial scale at Maas are described.

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Sea-level change in Galway Bay during the later Holocene

Michael O'Connell
Palaeoenvironmental Research Unit, Department of Botany, NUI, Galway
www.nuigalway.ie/pru

Most of the investigations carried out to date on Holocene sea-level change in Irish coastal areas have centred on the northern and southern coasts with relatively few studies in the mid-western part of the coastal line. The relative neglect of the mid-western coast is surprising given it location between two areas with contrasting Holocene sea-level histories. This part of the coastline has also many favourable opportunities, in the form of partially submerged peats and fossil timbers, for such investigations. In this paper, results of palaeoecological investigations (^{14}C dating, pollen, dendrochonology, wood identifications, etc.) carried out at various times over the past several years on coastal peats and fossil timbers on the northern shore of Galway Bay, between Salthill and Barna, will be presented. Information gleaned from multidisciplinary investigations of sediments taken from the present-day brackish lake, An Loch Mór, on Inis Oírr, will also be considered (cf. TIMECHS project). On the basis of these investigations, relative sea-level movements in the late Holocene for the Galway Bay area will be reconstructed.

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The Exotic World of the Western Shore: Dog Whelk, Stone Boats and Barking Pans. Observations on the Emerging Archaeological Landscape in the Inter-tidal Zone with special reference to the Galway and Mayo Coasts.

Michael Gibbons
Member of the Archaeological Committee of the Heritage Council
Member of the Institute of Irish Archaeologists.

The recent discovery of eroding field walls in the intertidal peat at the northern end of Inishkea North highlights once again the archaeological potential of this environment for settlement studies. The recognition of landscape features, as distinct from individual monuments, is, however, nothing new. A large intertidal-zone field system was first mapped on Trá Mór, Aran, in the Middle of the 19th century.

In the past decade Ireland has jumped from quite a low base in this field to a pre-eminent position with award winning and pioneering studies of both Strangford Lough and the Shannon Estuary. An initial trawl through the published material together with a limited field survey programme has highlighted the huge wealth of sites and monuments throughout this zone on the West Connacht Coast at a time when it is undergoing unprecedented change. The sites and monuments being identified fall into a number of categories, ranging from settlement and ritual/mythical through to military, industrial and communications related remains.

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Sea-level lowstand off Northern Ireland: new cores and seismic reflection data

Joseph P. Kelly1, Andrew Cooper2, Derek Jackson2, and Daniel Belknap1
1 University of Maine, Department of Earth Sciences Orono, ME 04469-5370
2 University of Ulster, School of the Environment, Coastal Studies Group Coleraine, Northern Ireland

Although numerical models have estimated the depth of the late Quaternary sea-level lowstand off Northern Ireland at around -10 m, there are few or no data to support this. We earlier reported on seismic reflection profiles seaward of beaches near Port Rush that suggested a lowstand around ~30 m based on shoreline notches in rock and till and the stratigraphy shallower than ~30 m. We interpreted a Quaternary section of glacial-marine mud over till and rock. This was overlain by sand with several prominent reflectors we speculated might be peat deposits. In Belfast Lough seismic reflection data depict an acoustically transparent unit resting unconformably over glacial-marine mud out to the ~30 m isobath.

In the summer of 2004 we collected 13 underwater vibracores in these areas to confirm our earlier interpretations. The cores from the sandy shorefaces were short. Only one core encountered the inferred peat reflector, and it contained coarse gravel. All other cores contained massive fine sand, up to 1.6 m thick. On this basis we consider the reflectors earlier interpreted as peat to be gravel similar to coarse deposits which occur on the modern beaches. The 4 cores from Belfast Lough penetrated up to 2.5 m of red glacial-marine clay overlain by shell-rich, muddy sand. The contact between the clays and muddy sands is abrupt and marked by up to 5 cm of sand and rip-up clasts of clay in the overlying unit. We interpret this as a low-energy beach sand overlain by a tidal flat deposit that grades into deeper subtidal materials. On the basis of these cores it appears that the lowstand did occur around ~30 m depth. Radiocarbon dates have not yet returned on shells from the inferred beach and overlying material.

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Temporal and spatial variations in Late Quaternary slope sedimentation along the margins of the Rockall Trough, offshore western Ireland.

Ovrebo, L.K., Haughton, P.D.W. & Shannon, P.M.
Department of Geology, University College Dublin, Belfield, Dublin 4, Ireland.

The Rockall Trough, offshore western Ireland, is a 1000 km long, 250 km wide, NNE-SSW trending bathymetric depression with water depths ranging from 300 to >3000 m. The trough is underlain by the Rockall Basin, which formed as a consequence of protracted Late Palaeozoic to early Cenozoic continental rifting. In the Early Neogene, deep-water circulation and drift sedimentation was initiated. Late Neogene to Quaternary deposition on the slopes flanking the trough was controlled by climatic changes and sea-level fluctuations that accompanied the onset of Antarctic glaciation. Previous work has focused on the Feni Drift along the west margin and the NE Rockall Trough (north of 56ºN) and has shown that bottom current activity combined with downslope remobilisation were the main depositional processes (e.g. Armishaw et al., 2000; Howe et al., 1994; Kidd & Hill, 1986; Stoker, 1997). Little work has, however, been undertaken on the eastern margin south of 56ºN and it is therefore the focus of the present study.

A total of 63 gravity cores have been studied from four sites along both margins of the Rockall Trough: i) the West Porcupine Bank at the southeast entrance to the trough (52 - 53ºN); ii) the North Porcupine Bank (~54º); iii) the East Rockall Trough along the Erris High(~55º25'N); and iv) theWest Rockall Trough slope (~56ºN). The core data have been integrated with high-resolution bathymetry data, side scan imagery and shallow seismic, allowing the study of

temporal and spatial variations in slope sedimentation. This has allowed the creation of a series of 3D stratigraphic models that distinguish between local and regional controls on the sedimentation at different points on the slope. The Porcupine Bank slope is particularly instructive as it has a section of stable slope where the late Quaternary succession can be traced across an area of 1500 km^2. The cores penetrate deposits revealing possibly up to 500 kyr of deposition, with an alternation of bottom current reworked planktonic oozes and siliciclastic muds and sandy muds with ice-rafted debris. Facies variations across the slope demonstrate both regional changes in current strength leading to extensive erosion surfaces (associated with climatic oscillations), and enhancements and decelerations of bottom currents linked to local seabed topography (e.g. slope gradient, canyons and carbonate mounds).

Cores from the other study areas recover only last glacial to Holocene stratigraphy. These sites can be compared and contrasted with the west Porcupine Bank. This comparison showed that the margins of the Rockall Trough failed repeatedly during the last glacial when bottom current activity was subdued, whereas during the Holocene the slopes were more stable and along-slope bottom currents were the dominating margin shaping process.

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Geophysical insights on the palaeo-landscape of the River Shannon at Clonmacnoise and lessons for the medieval engineer.

G. Duffy[1], C. Brown[1] and K. Barton[2]

[1] Department of Earth and Ocean Sciences, NUI, Galway.

[2] Landscape Geophysical Services, James St., Claremorris, Co. Mayo.

E-mail: gavin.duffy@nuigalway.ie

Clonmacnoise is located on the intersection between two of the country's largest natural transport routes: a narrow winding esker running from Dublin to Galway called the Eiscir Riada, and the River Shannon which runs roughly north - south from Cavan to Limerick. It was not a surprise when local divers discovered 10 years ago the remains of a wooden structure traversing the Shannon at Clonmacnoise. This was interpreted by archaeologists as an Early Medieval bridge crossing, dating from 800AD. This discovery led to a project to investigate the usefulness of high resolution waterborne geophysics for the purposes of underwater archaeology. The acoustic techniques of side scan sonar, swath sonar bathymetry and sub-bottom profiler (Chirp) were employed as well as a magnetometer for metal detection. The techniques had moderate success as artifact finders e.g. being capable of identifying some of the previously discovered log boats, but the vertical orientation and negligible acoustic impedance of the water laden wooden posts prevented their detection by any of the techniques. It has been possible to classify the river bed sediments by combining all the acoustic data. A profile of esker morphology and the highly variable karst topography upon which it lies has been constructed.

The detailed acoustic bathymetry map identifies the current regime in the Shannon today and goes some way to explaining the differential preservation of the wooden post remains. We have also identified the presence of localised gas, possibly due to the decay of organic material at depths < 10m. This affects the strength of the sediments around the posts and may also have influenced their preservation. Archaeologists have been puzzled by a 20m gap in the posts traversing the river and have assumed that some 3 pairs of posts have been removed by passing boat traffic despite the lack of evidence of their remains elsewhere on the riverbed. With the aid of detailed seismic and bathymetric information, this work has allowed us to infer sediment transport processes in the vicinity of Clonmacnoise. It suggests that the posts were never there in the first place. An attempt has been made to reconstruct the extent of the main river channel around 800AD by projecting the meander upstream to the north. The location of this palaeo-channel determines the current regime and depth profile of the river bed at the time the bridge was constructed.

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Geological significance of swath bathymetry and backscatter in Lough Corrib and Clew Bay

Glynn, B[1,2], C Brown[1,2] and S Rooney[2]

[1] Environmental Change Institute, National University of Ireland, Galway, Galway.

[2] Department of Earth and Ocean Sciences, National University of Ireland, Galway, Galway.

Swath bathymetry and backscatter data have been collected simultaneously using interferometric sonar over an area of 37 km^2 in Clew Bay and 40 km^2 in Lough Corrib, western Ireland. The sonar is a phase discrimination system, operating at a centre frequency of 234 kHz. It has a maximum swath width of 300 m and can give 100% seabed coverage in waters up to 100 m in depth. The bathymetric resolution can be as good as 0.075 m. High-resolution bathymetric maps of both areas have been created for interpretation in terms of geological processes and have been integrated into a Digital Terrain Model. Backscatter is a measure of strength of the echo returned from an object or patch of seabed. Bathymetry and backscatter have been used to characterise the seabed and lakebed geology and can be correlated with the onshore geology. A statistical analysis of backscatter amplitude has allowed for the generation of an acoustic facies map describing the distribution of sediment on the seabed/lakebed. The analysis minimises subjective and qualitative interpretations of the acoustic images.

The geology reflects Clew Bay's extensive glacial history. A terminal moraine marking major ice limits during the Last Glaciation (Midlandian) is present. Other features include submerged drumlins, submarine palaeo-river channels, palaeocoastline, the extension of highly faulted rock units offshore and major geological contacts. In Lough Corrib, a NE-SW trending deep channel has been found. This channel appears to be part of a splaying fault system, in accordance with other faults mapped in the area. The sediments in both areas have been sampled and corroborate interpretation of the backscatter.

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2004 Autumn Symposium Posters

Glynn, B., Brown, C. & Rooney, S.
Geological significance of swath bathymetry and backscatter in Lough Corrib and Clew Bay

Duffy, G., Brown, C. & Barton, K.
Geophysical insights on the palaeo landscape of the River Shannon at Clonmacnoise and lessons for the medieval engineer

Eibhlín Doyle
Shallow seismic results for NW of Donegal

Eibhlín Doyle
Major Slide into Rockall Basin

David Hardy
INSS and Ancient Landscapes

5. Upcoming Events

Joint IQUA/QRA Fieldmeeting to Western Ireland. 5-10th April 2005.

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2005 Autumn Symposium: 'Reconstructing Changing Climates'. A provisional date of 25th of November has been suggested.

6. Postgraduate Research

Glaciation, deformation and till porosity: County Laois, Ireland

Aoibheann A Kilfeather
Department of Geography, Queen Mary, University of London

The Quaternary geology of the Irish midlands is largely unknown. The first aim of this thesis is to describe the results of Quaternary geological mapping, by the author, of County Laois in the midlands of Ireland, with special emphasis on the tills. The second aim is to examine bulk porosity and pore shape, size and connectivity in tills. A review of the literature describing tills and their structures reveals that there has been little research into till porosity.

The methods used in this thesis include conventional mapping techniques with particle size analysis and stone counts. Methodologies have been developed in this research to examine till pores microscopically using thin section microstructure analysis, scanning electron microscopy (SEM), experimental pore cast production and x-ray computed tomography. Porosity is quantified using digital image analysis of thin section images from the petrographic microscope and SEM. These methods were applied to a selection of tills with diverse properties.

The mapping results have substantially increased the Quaternary data set, and our understanding of glacier dynamics during the last glaciation, for the Irish midlands. Two ice lobes, which moved over a deforming till bed, covered County Laois: one advanced from the northwest and the other from the west. During retreat the lobes deposited complex suites of flow tills and glaciofluvial sediments.

Micromorphological techniques have allowed porosity to be related to other till microstructures. Most of the microstructures examined, including the pores, are indicative of either plastic or brittle subglacial deformation and the type and extent of till deformation has been found to affect bulk porosity, pore type and pore connectivity.

Viewing tills as deforming glacier beds has led to better understanding of till structures, including porosity. The methods and results presented in this thesis may be applied to tills in other glaciated and formerly glaciated regions.

(Doctor of Philosophy awarded end of 2004)

7. Postgraduate Notices

Undergraduate / Postgraduate Training

Arctic Research Experiences for Undergraduate Students. The Svalbard Research Experience for Undergraduates (REU) is offering exciting opportunities for students to participate in polar science research projects in Svalbard, Norway. http://www.mtholyoke.edu/proj/svalbard/welcome.shtml

HOLIVAR Training Course
"Quantitative climate reconstruction and data-model comparisons"
Monday June 27th to Friday July 7th, 2005
Location: Météo-France CIC, Toulouse, France
Full funding available for PhD students and young post-doctoral scientists affiliated with European institutions

This course is intended for PhD students and young post-doctoral scientists interested in multi- and interdisciplinary study of Holocene climate variability. Offered to both palaeoclimatologists and climate modellers it covers in a single two-week programme of lectures and practical exercises the key themes of the ESF-HOLIVAR programme in an integrated way. The content of the course this year will largely follow the courses presented in London in 2003 and Ghent in 2004, with a larger emphasis on quantitative methods of reconstruction. The course is structured in 7 topical modules, each consisting of a series of lectures on the state of the art by leading climate-change scientists, related practical exercises, and group discussion of major research issues.

Post-doctoral and PhD students affiliated with European institutions are invited to apply. Successful applicants receive full ESF-HOLIVAR funding to attend the course (travel, half-board accommodation and course fees). They will be expected to present a poster on their research, and contribute to a written summary of discussion themes and conclusions to be distributed at the end of the course. Application forms can be found on the HOLIVAR website at http://www.geog.ucl.ac.uk/ecrc/holivar/ or requested from Simon Brewer at brewer@cerege.fr.

8. Recent Publications

Hegarty, S. 2004 Limits of Midlandian glaciation in south-eastern Ireland. Irish Geography, 37: 60-76.

Knight, J. 2005. Formation of thrust structures in front of coastal landslides. Journal of Geology, 113 (1) 107-114.

Knight, J. 2005. Controls on the formation of coastal ventifacts. Geomorphology, 64 (3-4), 243-254.

FitzGerald, D.M. and Knight, J. (eds) 2005. High-Resolution Morphodynamics and Sedimentary Evolution of Estuaries. Springer, New York.

Knight, J. 2005. The Irish Sea Basin. In: Lewis, C.A. and Richards, A. (eds) The Glaciations of Wales. Logaston Press, Hereford, 177-188.

Knight, J. 2004. Subglacial depositional processes in the Port Askaig Formation (Neoproterozoic) of Ireland. EOS (Transactions of the American Geophysical Union), 85 (47), Fall Meeting Supplement, abstract C31B-0330.

Mitchell, F.J.G. 2005. How open were European primeval forests? Hypothesis testing using palaeoecological data. *Journal of Ecology*, 93, 168-177.

Mitchell, F.J.G. and Cooney, T. 2004. Vegetation history in the Killarney Valley. In: W. O'Brien (ed.) *Ross Island. Mining, metal and society in early Ireland*, pp. 481-493. Bronze Age Studies 6, Department of Archaeology, National University of Ireland, Galway.

Vaughan, A.P.M., Dowling, L.A., Mitchell, F.J.G., Lauritzen, S.-E., McCabe, A.M. and Coxon, P. (2004) Depositional and post-depositional history of warm stage deposits at Knocknacran, Co. Monaghan, Ireland: implications for preservation of last interglacial deposits. *Journal of Quaternary Science*, 19, 577-590.

9. News items

Colm O'Cofaigh – Trinity College Graduate 1991 has been awarded the Quaternary Research Association's 'Lewis Penny Medal' (details below). Colm completed a Masters degree also in TCD (On glacimarine sedimentation along the SE coast) and went on to do a PhD in Canada. He is now lecturing in the University of Durham.

The medal will be presented to Colm by the Association's President at the Annual General Meeting of the QRA that, by coincidence, is to be held in Galway on Thursday 7th April.

Lewis Penny Medal
Criteria for the award of the medal
The Medal and £100 prize money will be awarded to a young (normally less than 35 years old) or new research worker, who has been a member of the QRA for at least 3 years, and who has made a significant contribution to the Quaternary Stratigraphy of the British Isles and

its maritime environment. This is notionally taken to mean Britain, Ireland and surrounding offshore areas but adjacent areas of continental Europe that have relevance to the British Isles may also be taken into account. Quaternary Stratigraphy is considered here to include both Pleistocene and Holocene records and to be broad-based, encompassing lithostratigraphy, chronostratigraphy, biostratigraphy or other relevant fields.

Nominations
The candidate should be nominated by his or her Head of Department, Ph.D. or Postdoctoral supervisor or any other QRA member 'of standing' who is familiar with the candidate's work.

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Environmental Sciences Association of Ireland
http://www.esaiweb.org/
To any ESAI member who has not been contacted by ESAI in the last two months, please forward details to Sinead Macken (E-mail)jbres@indigo.ie at your earliest opportunity.
Anyone else can check out our new website at www.esaiweb.org

ESAI Bursary
The ESAI invites applications for a summer student bursary from undergraduate students in environmental sciences or environment-related disciplines to support their participation in active research during the summer of 2005. The student will be expected to work under the supervision of a member of academic staff on a project of direct interest to the Department/Centre in a recognised academic Institution on the island of Ireland.
http://www.esaiweb.org/bursar.htm

10. Forthcoming Conferences & Workshops

European Geosciences Union, Vienna, Austria, 24 - 29 April 2005
http://www.copernicus.org/EGU/ga/egu05/

International Workshop on Sub-aerially Exposed Continental Shelves Since the Middle Pleistocene Climatic Transistion 9-13 May 2005 Hong Kong
www.hku.hk/earthsci/other/des_fram.htm

Conference of Irish Geographers, 2005. National University of Ireland, Galway 6th-8th May 2005
http://www.nuigalway.ie/geography/confer05.html
BGRG Spring Field Meeting May 20-22 2005
http://wwww2.plymouth.ac.uk/BGRG

Rapid landscape change and human response in the arctic June 15-17, 2005, Whitehorse, Yukon, Canada
http://www.taiga.net/c-ciarn-north/yukon.html

International Field Conference and Workshop on Tephrochronology and Volcanism: *"Tephra Rush 2005"* Dawson City, Yukon Territory, Canada - July 31st to August 8th, 2005
http://conferences.eas.ualberta.ca/tephrarush2005/

Earth System Processes 2 (ESP2) meeting (8-11 Aug 05, Calgary, Canada), convened jointly by the Geological Society of America and the Geological Association of Canada,
http://www.geosociety.org/meetings/esp2/
(Special session entitled Sediment Dynamics and Fluid Flow across Continent-Ocean Margins which is convened by Jasper Knight, University of Exeter, UK, j.knight@exeter.ac.uk) and John F. Bratton (USGS, Wood's Hole, jbratton@usgs.gov).

Paleoclimate, Environmental Sustainability and Our Future. PAGES (Past Global Changes) 2nd Open Science Meeting (OSM) Beijing, China 10-12 August 2005. www.pages2005.org

International Conference on Glacial Sedimentary Processes and Products. University of Wales, Aberystwyth 22-27 August 2005
http://www.aber.ac.uk/visitors/glaciology/

Holivar2006 Open Science Meeting - Natural climate variability and global warming. Environmental Change Research Centre, University College London, UK 12th-15th June 2006. http://www.holivar2006.org/

10th International Paleolimnology Symposium, Duluth, Minnesota, USA June 25-29, 2006 (further details will be coming soon)

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