

Luminescence dating of sedimentation regimes in Scottish saltmarshes: can they keep pace with sea level rise?

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Saltmarshes, positioned between land and sea, are recognised as playing an important role in the coastal landscape. They reduce the effects of floods and storms, provide nurseries and habitat to a diverse marine fauna and flora and act as both store and sequester of carbon dioxide. But how do saltmarsh landforms respond to sea level rise and how much sediment reorganisation has already occurred in Scottish saltmarshes? Might climate change actually increase the resilience of saltmarsh habitats?

This research aims to establish whether or not saltmarsh sedimentation regimes on a paired set of saltmarshes, one realigned marsh and one adjacent natural marsh, can keep pace with sea level change and inform how the ecosystem services provided by such saltmarshes might be affected over time. Key to this is the ability to accurately place an age on sediments buried within the saltmarsh. Optically Stimulated Luminescence (OSL) profiling methods may provide accurate age profiling of recently buried saltmarsh sediments collected from Nigg Bay in Cromarty Firth whilst also acting as a potential process tracer in modern dynamic systems.

Recent studies have demonstrated the successful application of OSL dating in intertidal deposits to establish a chronology and reconstruct paleo-environmental landscape evolution in relation to sea-level changes (Fruergaard, Pejrup, Murray, & Andersen, 2015; Mauz, Baeteman, Bungenstock, & Plater, 2010); further OSL progress has also shown the potential to date young sediments but few have fully explored the bleaching of modern sediments (Cunningham et al. 2015; King et al. 2014).

OSL dating relies on the energy that has been trapped through time in sediment minerals (quartz and feldspars) during natural radioactive decay is released as luminescence (light) when exposed (bleached) in visible light, thus resetting the luminescence signal to zero. However depositional and bio-geomorphic processes influence wavelength and bleaching intensity. This is particularly relevant in tidal dominated environments where individual sediment components may have diverse transport and bleaching histories and different sensitivities to luminescence. In some cases, partial bleaching leads to potential overestimation of OSL ages.

This contemporary study of intertidal suspended sediments has the potential to explain how the current system behaves, if the deposits are well reset and when the bleaching may occur. The poster presents preliminary results of the luminescence sensitivity of the saltmarsh sediments in Nigg Bay and their ability to record a signal together with an assessment of the key factors influencing intertidal bleaching on saltmarshes.

Acknowledgements



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Adaptation to the Impacts of Climate Change in Scottish Island Communities

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Area being submitted to (delete as appropriate): 1) General science session

Preferred presentation medium (delete as appropriate): (ii) e-poster format.

Are you a student? (Delete as appropriate): Yes

The Scottish Islands are peripheral locations that are physically exposed to storms and coastal flooding; the frequency and magnitude of which are likely to be exacerbated under changing climatic conditions. Key questions remain about the motivations and priorities of small island communities for adapting to the impacts of climate change. The research reviews and develops theory on the scale of climate change adaptation measures, and considers the appropriateness of top down vs bottom up approaches, given the diversity of Scottish island contexts. Communities in South Uist (Outer Hebrides), Westray (Orkney) and Unst (Shetland) formed a multiple-case study approach. Empirical evidence was drawn from focus groups which explored local perspectives on priorities for climate change adaptation in the case study communities. The findings highlight local motivations behind adaptation priorities within each case study, and show significant variation across all cases, despite the communities being of similar population, demographic profile and island context. The research contributes to the debate on 'one-size-fits-all' adaptation planning. The findings support the argument that a uniform national approach to adaptation is not sufficient where local priorities differ significantly. The study develops deeper knowledge of the interface between community-based action and strategic policy in climate change governance processes and there is scope to apply a similar approach to understand adaptation planning priorities in other small island settings.

Interweaving narratives: reconstructing chronologies and impacts of windblown sand in prehistoric landscapes

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Islands and their coastlines have long been important landscapes for settlement, resource procurement and structuring social interaction. Such environments have also proven fruitful in exploring environmental change and its impacts on human activity. Manifestations of environmental change such as flooding, erosion and sand movement can have immediate and visible impacts on coastal activities and geomorphology. One notable impact is that of coastal sand movement and inundation, leading to marginalisation and abandonment of agricultural land.

The presence of sand horizons at coastal archaeological sites attests to significant movements in the prehistoric period across northwest Europe. However, the nature of impact and response in the prehistoric record is unclear, with environmental proxies often proving ill-defined. Archaeologists face the challenge of reconciling temporal scales provided by the environmental sciences with scales that are archaeologically-meaningful to explore human-environment relationships at deeper timescales.

This research is cataloguing and characterising episodes of coastal sand movement in the prehistoric period using the Northern and Western Isles of Scotland as a case region. A mixed-methods approach has been taken to this research, combining archaeological evidence with geoarchaeology and historical analogy. The project utilises geophysical survey and luminescence dating to investigate the nature, source and chronology of sand movement on archaeological sites. This poster will present the results from fieldwork at the multiperiod site of Pool, Sanday and will demonstrate that a consideration of environmental change impacts in the past can enrich our understanding of present and future coastal change.

Modelling changes in the coastal geomorphology of Unst, Shetland and the implications for understanding Norse/Medieval harbour changes in the Scandinavian North Atlantic

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Preferred presentation medium: e-poster format

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The Norse settlement of the North Atlantic relied upon a network of harbours that played key roles in the development of North European economies through the late Middle Ages. Many of these harbours were abandoned, the reasons for which are unclear. A crucial geomorphological characteristic of a successful harbour is *structural equilibrium*. A harbour must have physical stability for boats to use it safely season to season, year on year. Should the harbour be located on a changeable coastline (or one that becomes changeable) it may become unviable. In the early Norse period, sandy beaches were favoured as landing places due to their physical safety when compared to rocky coastlines.

We assess geomorphological change on the island of Unst, Shetland, a coastline used by the Norse. Unst offers a complex coastline of deep fjords and headland bays and thus significant differences in forces acting upon the coastline. Evidence exists for instability in the beaches used by the Norse that could have been driven by the changes in climate conditions from the Medieval Climatic Anomaly to the Little Ice Age and the present day. We model coastlines using the sediment dynamics model MIKE21. Model results agree well with the location of existing sandy beaches on Unst, but model runs with modern environmental drivers also build beaches where none currently exist. Blown sand deposits were formed in the 12th-13th century, consistent with High Medieval settlement times and the onset of the Little Ice Age, suggesting that some Norse landing sites began destabilising at this time.

Recovery time of beaches destroyed by storm action was also investigated. Theoretical modelling of idealised headland embayments, supported by empirical data from bathymetric charts, reveals a strong relationship between beach location and offshore slope. A threshold average gradient of approximately 0.025 promotes sandy beach formation on coastlines with a shallower slope under both calm and persistent stormy conditions. Beaches do not tend to form on steeper coastlines under persistent stormy conditions. This has wide implications for the structural equilibrium of coastlines used by Norse seafarers, and further implications for modern day coastline management.

Investigating the speciation and mineralogy of iron in colloids and nanoparticles of Scotland's coastal waters: method development.

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Area being submitted to: 3) Marine Biogeochemistry

Preferred presentation medium: (ii) e-poster format

Are you a student?: Yes

The biogeochemical iron cycle exerts significant control on the carbon cycle. Iron is a limiting nutrient in large areas of the world's oceans and its bioavailability controls CO₂ uptake by marine photosynthesizing microorganisms¹. In their review of the iron cycle, Raiswell and Canfield (2012) highlight the importance of resolving the nature and composition of Fe colloids and nanoparticulates in the dissolved fraction in order to improve understanding of their role in biogeochemical cycles.

The poster outlines the development of methods to facilitate the investigation of the submicron particulate Fe fraction. This fraction is very dilute in seawater, and is often classed within the "dissolved" fraction as it is smaller than the conventional 0.45 μm cut-off. The small colloids and nanoparticles¹ in this submicron fraction are well suited to characterisation by Mössbauer spectroscopy, specifically the speciation, mineralogy and morphology of iron particles.

Conventional Mössbauer spectroscopy requires concentration of ~10 mg/cm² of Fe on a minimum area of ~1 cm². In coastal waters, where the "dissolved" Fe fraction is very dilute, achieving this is simply not practicable and can be coupled with lengthy measurement times². We can address these limitations by using synchrotron-based Mössbauer-related applications at the European Synchrotron Radiation Facility, Grenoble, which require a reduced sample amount compared to conventional Mössbauer spectroscopy³. The ⁵⁷Fe Synchrotron Mössbauer Source (SMS) uses a micron-sized diameter beam and high luminosity, allowing investigation of microscopic samples with a high data quality output in significantly reduced measurement times². Before applying for beamtime at the ESRF, we need to develop a method to isolate the submicron colloidal fraction of Fe-bearing particles and concentrate it in a small volume, optimum for Mössbauer spectroscopy.

An initial sampling campaign was carried out in Loch Etive and its main tributaries. We filtered 2 L water samples through a 0.45 μm filter membrane, followed by tangential flow filtration (100 kDa), and the resultant retentate was freeze dried. Measurement by ICP-MS of Fe concentrations in the dissolved (<0.4 μm) and "truly" dissolved (<5 kDa) fractions supports the low Fe concentrations in the colloidal fraction, demonstrating the need for increased sample volumes. Therefore, development of these concentration techniques will be achieved using river waters known to be iron rich. The poster will explore these methods and investigate the anticipated challenges of their further development for higher salinity waters.

Acknowledgements: This is a MASTS-funded PhD project (GSS30). Preliminary work was supported by a SAGES PECRE grant to C.S., and a MASTS Visiting Fellowship award (VF41) to K.C. Thank you to Dr David Green, SAMS, Scottish Marine Institute, for his invaluable help and use of the tangential flow filtration unit.

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Biodiversity, Ecosystem Functioning and Value of Restored Saltmarshes in the Eden Estuary, Fife

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Area being submitted to (delete as appropriate): 1) General science session;

Preferred presentation medium (delete as appropriate): (i) oral.

Are you a student? (Delete as appropriate): Yes

Saltmarshes are important ecologically and economically, providing a wide range of valuable ecosystem functions and services to mankind. They are internationally and nationally recognised as regions of high biodiversity and productivity, acting as rich feeding and breeding grounds for birds and fish. Their ability to dissipate wave energy makes them a valuable form of coastal defence, a property which is becoming increasingly important due to climate change and sea level rise. They are important attractions within the recreation and tourism industries due to their aesthetic properties and wildlife.

Despite their value saltmarshes are in decline worldwide due to pressures from human development and climate change. To restore and better manage these important habitats requires an improved knowledge of their ecology and ecosystem functioning.

In the Eden Estuary, Fife, the local marsh species *Bolboschoenus maritimus* has been successfully transplanted from natural beds to un-vegetated sites. The transplanted sites have demonstrated comparable sediment accumulation to natural stands (Maynard et al., 2011), however, restoration of other measures of ecosystem functioning have not yet been assessed.

New saltmarsh sites established between 2003 and 2013 were compared to natural saltmarsh and mudflats to examine whether ecosystem functions were being restored at the transplanted sites.

Measurements of sediment stability, surface sediment and biofilm characteristics were collected monthly between March 2012 and March 2013 from natural stands and transplanted sites. Macrofaunal community structure and diversity, plant height and density were collected bi-monthly between November 2011 and March 2013. An additional sample for all variables was made in March 2014 to enable a 3 year comparison in addition to the 13 month comparison.

Plant height and density, important for habitat provisioning and coastal protection, were

comparable between transplanted and natural marsh a decade after transplantation. Initial analysis of macrofaunal community structure appears to be developing along the same trajectory but taking longer to attain comparable measures. In general, no significant differences were found between sediment stability, surface sediment and biofilm characteristics.

In addition to assessing the ecological success of transplanting the saltmarshes, the value that people place on the saltmarshes as a form of coastal flood defence was estimated. A choice experiment was used to place a monetary value on these saltmarshes as a form of coastal defence. Participants selected their preferred management scenario considering different types of coastal flood defences (sea wall, saltmarsh, combined or none) and where the defences would be located (property, farmland or golf courses). Each management scenario involving an increase in coastal flood protection had a cost in terms of increased council tax associated with it.

Willingness to pay for coastal flood defences ranged from  100 to  212 per household. Locals' preferences for the type of the defences indicated a preference for combined, followed by soft and finally hard defences being used. Protection for property over the alternate land types was preferred.

Improved understanding of our ability to restore saltmarshes and the time expected for ecosystem functions and services to be restored enables managers to plan better for the future management of an area. Combining this knowledge with the economic valuation of these services and locals' preferences enables managers and policy makers to make more informed and cost-effective decisions.

References

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Mapping the Marine Planning Science Network in Scotland

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Area being submitted to (delete as appropriate): 5) Science in the Clyde

Are you a student? (Delete as appropriate): No

The goal of our project is the creation of an accessible, interactive map describing the diverse marine planning science network within Scotland, which allows users to explore the individuals and institutions making up the marine planning science network. . By using the search bar, selecting pre-determined categories, or clicking on a point on the map, users are able to focus on particular geographical areas, institutions, and people, seeing past and current projects, as well as areas of interest.

As the user focuses their search, profiles of individuals and institutions will be displayed, containing information such as: the name of the individual/institution, contact details, their role and responsibilities within the marine planning network, areas of expertise, areas of interest, geographical areas studied, current and previous projects. When clicked, the user's preferred email account will open and they will be able to email the individual or institution directly.

As well as a geographical map, the user will be presented with an interactive node map representing the relationships individuals and institutions have with one another. Nodes will be clustered together and coloured to represent individuals with close connections. The node map will allow the user to explore existing relationships within the MASTS network, recognise common connections, and identify potential synergies and collaboration opportunities. The node map will act as both a visual representation of the knowledge network, and as a tool that will promote communication, interdisciplinary research, and co-ordination within the network.
