In the last few years there has been a tremendous increase in the amount of high-resolution surveying on the United Kingdom Continental Shelf (UKCS) which is underpinning the sustainable development of the UKCS. This interdisciplinary conference has been planned to highlight the science and understanding which is revolutionising our understanding of the sea bed and shallow geology. The conference and follow-up scientific journal will provide a showcase for this research and will bring together government, academia and the commercial sector to share techniques and understanding. This is a joint event with MAREMAP partners: British Geological Survey (BGS), Scottish Association for Marine Science (SAMS) and the National Oceanography Centre (NOC).

The RSE, BGS, SAMS and NOC wish to acknowledge the support of: Gardline Geosurvey Ltd, Kongsberg Maritime Ltd., Teledyne RESON and the Marine Studies Group of the Geological Society of London.
Evening Public Lecture

Wednesday 20 November (Free event, registration required)

17.30  Registration
18.00  Tsunami Hazards - Learning from Recent Events
       Professor David Tappin
       Tsunami Scientist, University College London and British Geological Survey
19.00  Q & A
19.20  Vote of Thanks
19.30  Drinks Reception for all attendees
20.00  Close

Conference Programme

Thursday 21 November

09.30  Registration with tea/coffee
10.00  RSE Welcome
       Sir John Arbuthnott MRIA PRSE
       President, Royal Society of Edinburgh
10.10  SESSION 1 - Coastal Geology and Geomorphology
       Introduction by Chair: Robert Gatliff
       Director, Energy & Marine Geoscience, BGS
10.15  Pushing the boundaries: Integrating swath bathymetry and topographic
       laserscan data in mapping the UK’s coastal zone
       Dr Keith Westhead
       Marine & Coastal Geologist, BGS
10.40  Q & A
10.45  The Rise and Fall of Organic and Metal Contamination in Thames Estuary
       Sediments
       Dr Christopher Vane
       Head of Organic Geochemistry, BGS
11.10  Q & A
11.15  Tea/coffee
11.45  SESSON 2 - Sediment Mobility on the Shelf  
Introduction by Chair: Dr John Howe  
Head of the Biogeochemistry and Earth Science Department, SAMS

11.50  Building on moving substrates in the North Sea  
Dr Ken Games  
Geophysical Director, Gardline Geosurvey Limited

12.15  Q & A

12.20  Shifting sands: A review of sandbank evolution on the UK Continental Shelf  
Dr Justin Dix  
Head of Geology and Geophysics  
Senior Lecturer, Marine Geophysics and Geoarchaeology,  
School of Ocean and Earth Science, University of Southampton

12.45  Q & A

12.50  Q & A from Morning Sessions

13.00  Lunch  
Attendees will have the opportunity to view poster displays

14.00  SESSION 3 - Quaternary Geology and Geomorphology  
Introduction by Chair: Dr Russell Wynn  
Head of Marine Geoscience and Chief Scientist, Marine Autonomous and Robotics Systems (MARS), NOC, University of Southampton

14.05  Ice sheet decay around northern Scotland recorded in seabed geomorphology  
Dr Tom Bradwell  
Quaternary Geologist, BGS

14.30  Q & A

14.35  Geology and Geomorphology of the Firth of Lorn  
Dr John Howe  
Marine geologist and Head of the Biogeochemistry and Earth Science Department, SAMS

15.00  Q & A

15.05  Shallow Geology and Marine Renewables  
Dave Long  
Team Leader of Marine Geohazards, BGS

15.30  Q & A
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<td>16.00</td>
<td>SESSION 4 - Putting the Seabed to Work - News From the Deep</td>
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<td>Introduction by Chair: Alan Stevenson</td>
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<td>Marine Geology Team Leader, BGS</td>
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<td>New Techniques for Mapping Submarine Geohazards and Marine Protected Areas in the Deep Ocean</td>
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Speaker Biographies

Dr Tom Bradwell  
*Quaternary Geologist, BGS*

Dr Tom Bradwell works at the British Geological Survey as a Quaternary geologist exploring both the onshore and offshore realms. Tom trained as a geologist at the University of Liverpool and gained his PhD at the University of Edinburgh in 2001. He has 15 years experience conducting research on glaciers and formerly glaciated landscapes. Tom has been a Team Leader and Project Leader at BGS and is currently involved in a number of exciting projects examining the Ice Age (Quaternary) history of the UK, the Continental Shelf and the wider region.

Dr Justin Dix  
*Head of Geology and Geophysics, Senior Lecturer Marine Geophysics and Geoarchaeology, School of Ocean and Earth Science, University of Southampton*

Dr Justin Dix graduated with an Honours Degree in Geology from the University of Dundee in 1989, and subsequently a PhD, the use of high-resolution seismics for the reconstruction of Late Quaternary glacial environments, from the University of St Andrews. In 1993 joined Southampton University and as of 2013 is now Head of the Geology & Geophysics Research Group. His research interests involve the development and integration of geophysical, geological, and archaeological data in combination with physical and numerical models, for the investigation of a suite of scientific problems associated with the seabed and near surface sediments of the continental shelves.

Dr Ken Games  
*Geophysical Director, Gardline Geosurvey Ltd.*

Dr Ken Games joined Gardline in 1983 as Development Geophysicist. He set up the Seismic Processing Department in 1987 and has delivered Geophysics courses at Liverpool and UEA. He has made presentations in Ireland, Australia, Indonesia, America, Canada, Venezuela, Vietnam and Brazil. He became a Company Director in 1995 and a Chartered Geologist in 2002. He is a committee member of the Offshore Site Investigation Group of the Society of Underwater Technology (SUT); the Marine Studies Group of the Geological Society, and the OGP committee responsible for the publication of the Guidelines for the Conduct of Drilling Hazard Site Surveys and has published a total of 25 papers in a variety of journals.
Speaker Biographies

Robert Gatliiff  
*Director, Energy & Marine Geoscience, BGS*

Robert Gatliiff is a petroleum and marine geologist who has worked extensively on the United Kingdom Continental Shelf for BGS. He has contributed to the BGS offshore mapping and regional report series and worked extensively on the Atlantic Margin. He was appointed Head of Marine and Petroleum Geology in BGS in 2004 and has led the development of the BGS multibeam mapping capability, a new generation of subsea sampling technology and the European contribution to integrated ocean drilling program (IODP) operations.

Dr John Howe  
*Marine geologist and Head of the Biogeochemistry and Earth Science Department, SAMS*

Dr John Howe is a marine geologist and head of the Biogeochemistry and Earth Science Department at the Scottish Association for Marine Science (SAMS) in Oban. In 1994 John gained a PhD from the University of Southampton, working with the British Geological Survey in Edinburgh on the deep-sea sediments of the North Atlantic, followed by a post-doctoral position as a marine geologist with the British Antarctic Survey. Since joining SAMS in 1998, he has worked on marine sediment records of oceanic circulation and inshore surveys on the geomorphology of the UK shelf. He also contributes to marine geoscience undergraduate and postgraduate education as part of the University of the Highlands and Islands.

Dr Kerry Howell  
*Deep Sea Marine Ecologist, Plymouth University*

Dr Kerry Howell is head of the Deep Sea Conservation Research Unit at Plymouth University. She is an expert in deep-sea ecology, with research interests in conservation and sustainable management, design of high seas/deep-sea marine protected area networks, marine habitat classification, marine habitat mapping, predictive species modelling, population connectivity, deep-sea food webs and ecosystem impacts of deep-water fisheries. She has worked on biological seabed mapping for ten years, is a co-author of *The Marine Habitat Classification for Britain & Ireland* (v04.05), and has pioneered the use of predictive modelling techniques for mapping deep sea bed habitats.
**Speaker Biographies**

**Dave Long**  
*Team Leader of Marine Geohazards, BGS*

Dave Long is Marine Geohazards Team Leader at the British Geological Survey where he was involved in mapping the Quaternary offshore much of the UK. He has investigated shallow gas and sediment movement and other foundation-zone problems on the UK Continental Shelf and has focused his geohazard research on methane hydrates and submarine slides in deep-water areas, which are used to establish geological models for offshore developments. He has also worked on palaeo-tsunamis for nearly 25 years as means of risk assessment. Dave has been a long standing member of the Society of Underwater Technology (SUT) Offshore Site Investigation and Geotechnics Committee.

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**Alan Stevenson**  
*Marine Geology Team Leader, BGS*

Alan Stevenson is Marine Geology Team Leader at the British Geological Survey (BGS) in Edinburgh and BGS Co-ordinator for the UK Marine Environmental Mapping Programme (MAREMAP). Alan is also Co-ordinator of the geological component of the European Commission’s European Marine Observation and Data Network (EMODnet), consisting of a network of 36 geoscience organisations from 30 countries, which finished its preparatory phase in 2012 and started full operations in 2013. He holds a number of committee roles, as Vice-Chair of the Association of European Geological Surveys Marine Geology Expert Group, Secretary of the Marine Studies Group of the Geological Society of London and Chair of the DEFRA Sea bed Mapping Working Group. Alan is also a member of the Scientific Organising Committee of the GeoHab Conference series (Geology and Biology of Marine Habitats). He is involved in the European Consortium for Ocean Research Drilling (ECORD) as Outreach Manager for the Science Operator and is a member of the programme’s strategy committee.

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**Dr Christopher Vane**  
*Head of Organic Geochemistry, BGS*

Christopher H. Vane received his MSc in Petroleum Geochemistry in 1993 and his PhD in Organic Geochemistry in 1997 from Fossil Fuels and Environmental Geochemistry at the University of Newcastle upon-Tyne. He then left UK shores to research fungal and bacterial transformations of biopolymers such as cellulose, lignin and tannin at the Center for Environmental Chemistry and Geochemistry, Pennsylvania State University, USA. In 2001, he joined the British Geological Survey (BGS) and established the Organic Geochemistry Laboratory which focuses, in part, on tracking the source and understanding the fate of persistent organic pollutants (POPs) in urbanised estuaries and coasts. Since then he has authored and co-authored over 50 peer-reviewed papers on subjects as diverse as the decay of animal fats in historical foot and mouth burial pits, tracking faecal matter in sediments, and measuring carbon stored in tropical termite nests.
Dr Keith Westhead
*Marine & Coastal Geologist, BGS*

Dr Keith Westhead is a marine & coastal geologist in the Marine Geology Team at the British Geological Survey, based in Edinburgh. Following PhD research at Liverpool University, on structural and metamorphic geology in Norway, he started his BGS career in 1990 in the land survey programme, being involved on a wide range of mapping and research projects across England and southern Scotland. In addition to this, he has also been involved in management of scientific information activities across BGS. His present interest is in developing new techniques for extending onshore surveying and modelling techniques into the offshore environment, to support and develop a range of research activities in the coastal zone.

Dr Russell Wynn
*Head of Marine Geoscience and Chief Scientist, Marine Autonomous and Robotics Systems (MARS), NOC, University of Southampton*

Dr Russell Wynn is Head of Marine Geoscience and MAREMAP co-ordinator at the National Oceanography Centre, Southampton. He has extensive experience in multi-disciplinary marine mapping and monitoring, exemplified by current roles as Chief Scientist of the NERC Marine Autonomous and Robotic Systems facility and Chairman of The Seabird Group of UK and Ireland. He is currently leading a diverse range of projects that includes mapping of giant submarine landslides off Morocco, deploying novel sensors on autonomous underwater vehicles (AUVs) for marine monitoring, and mapping distributions of endangered seabirds using miniature data loggers.

Professor David Tappin
*Tsunami Scientist, University College London and BGS*

Professor David Tappin is a marine geologist with 40 years experience of mapping the sea bed. He works for the British Geological Survey and is a Visiting Professor at University College, London. He has researched tsunamis for almost 15 years, beginning in 1998 with the devastating event in Papua New Guinea that killed 2,200 people. Since then, he has worked on numerous events, including the tsunamis in the Indian Ocean in 2004 and Japan in 2011. His present interest is in tsunamis generated from volcanic collapse and eruption.
Talk Abstracts

Tsunami Hazards - Learning from Recent Events
Professor David Tappin
Tsunami Scientist, University College London and British Geological Survey

During the past 10–15 years there have been a number of disastrous tsunamis that have led to the deaths of over 250,000 people. 220,000 people perished in the Indian Ocean tsunami of 2004, and in 2011 almost 20,000 people died in Japan. In Europe, the hazard from tsunami is small, although there were significant events 8,200 years ago and in 1755. All these events have led us to better understand tsunami hazard and how we can mitigate against it, and this talk will explain how these developments have come about.

Pushing the boundaries: Integrating swath bathymetry and topographic laserscan data in mapping the UK’s coastal zone
Dr Keith Westhead
Marine & Coastal Geologist, BGS

The Defra-funded National Network of Regional Coastal Monitoring Programmes of England are using swath bathymetry and airborne LiDAR technology to survey the coast with increasing coverage, and this data has been brought together with that of the BGS and other organisations under the MAREMAP programme. This presentation shows how such data can be combined in innovative ways to generate high quality digital elevation surfaces extending seamlessly from onshore to offshore, which in turn enables new approaches to geological and geomorphological surveying across the coastal zone. A number of case studies from the Dorset Coast World Heritage Site are presented and the wider implications for improving the multi-disciplinary scientific evidence base in the complex coastal environment are discussed.

The Rise and Fall of Organic and Metal Contamination in Thames Estuary Sediments
Dr Christopher Vane
Head of Organic Geochemistry, BGS

The city of London has been discharging waste into the tidal portion of the Thames for over 1800 years. We show the distribution of persistent pollutants in Thames foreshore sediments (60 cores) covering a 102 km tidal stretch from Richmond to Maplin Sands. Total petroleum hydrocarbons (TPH) ranged from 34-7006 mg/kg, polyaromatic hydrocarbons (PAH) <1 to 338 mg/kg and polychlorinated biphenyls (PCB) ranged from 2 to 4491 µg/kg and the rise and fall of metals including total mercury (Hg) are tracked. These concentrations will then be discussed within the context of current action levels and sediment quality guidelines.

Building on moving substrates in the North Sea
Dr Ken Games
Geophysical Director, Gardline Geosurvey Limited

We discuss the effects of sand waves on seabed structures for the Oil and Gas and Windfarm Industries. Two case studies are presented. The first concerns a windfarm with a five-year gap between surveys. This revealed movements of sand waves of up to 155m in five years. Secondly, another windfarm development involved a re-survey, again over five years, but in this case post-turbine installation. This showed movements of sand waves of ~50m in five years. Observations of the scour effects on the turbines are discussed. Both sites revealed the presence of barchans. Whilst these features have been extensively studied on land, there are few examples of how they behave in the marine environment.
Shifting sands: A review of sandbank evolution on the UK Continental Shelf
Dr Justin Dix
Head of Geology and Geophysics, Senior Lecturer, Marine Geophysics and Geoarchaeology, School of Ocean and Earth Science, University of Southampton

The last decade has seen a step change in the volume of seabed bathymetry and sub-surface geophysical and geological investigation on the UK continental shelf, primarily driven by the offshore construction industry (e.g. the renewables sector), the minerals industry and the Civil Hydrography Programme. These new datasets combined with reprocessing of more traditional marine geophysical datasets allows us to re-visit fundamental questions associated with the Holocene evolution of the sedimentary environments of the UK shelf. This talk will focus in particular on a re-appraisal of our understanding of the controls on sandbank evolution.

Ice sheet decay around northern Scotland recorded in seabeam geomorphology
Dr Tom Bradwell
Quaternary Geologist, BGS

Shelf-wide echosounder bathymetry data (singlebeam and multibeam) are used to map the glacial geomorphology of a large area of seafloor around Northern Scotland, from west of Lewis to the Orkney Islands, and refine previous work. The new mapping reveals the detailed pattern of submarine glacial landforms, predominantly moraines, deposited by the ice sheet that covered Scotland and much of the continental shelf during the Late Pleistocene. The reconstructed ice sheet retreat pattern, based on geomorphological evidence, differs from previous work but highlights the crucial role played by topography and bathymetry in governing the dynamics of the former British–Irish Ice Sheet.

Geology and Geomorphology of the Firth of Lorn
Dr John Howe
Marine geologist and Head of the Biogeochemistry and Earth Science Department, SAMS

We present recently collected swath bathymetric data from the Firth of Lorn, western Scotland UK. 553km2 of data were collected during 2012 as part of the INIS Hydro program (Ireland, Northern Ireland and Scotland Hydrographic Survey). The inshore waters covered by this survey represent a priority area for the renewable industries, for shipping, tourism and encompass a number of Special Areas of Conservation (SAC) especially for rocky reef habitats. Surprisingly, given this interest, this project is the first comprehensive bathymetric survey in the area. This region of near shore continental shelf is revealed as predominantly bedrock-dominated seabed, characterised by a series of narrow, strongly fault-controlled troughs, part of the Great Glen Fault Zone complex. The region includes the Corryvreckan Whirlpool and Great Race tidal flows beneath which occur active sand waves and submarine dunes. Evidence for past glaciation is widespread and well preserved in the Firth of Lorn with preserved moraines and overdeepened basins common across the area. Initial geomorphological mapping shows that our understanding of the configuration and style of deglaciation in these sectors of the former British–Irish Ice Sheet can be greatly improved by the collection of these new high-resolution bathymetric datasets.

Shallow Geology and Marine Renewables
Dave Long
Team Leader of Marine Geohazards, BGS

Although 40 years of oil and gas development in the North Sea have contributed to our understanding of the shallow offshore geology the marine renewables industry is requiring a different type of information to plan its infrastructure. This reflects that these industries operate in different environments but also that they can occupy large areas. Limited ground-truthing requires consideration of the site’s geological history to evaluate the range of constraints to site development. Modern survey techniques such as multibeam mapping and the on-going development of 3D high resolution seismic will help to visualise sites and aid foundation design.
New Techniques for Mapping Submarine Geohazards and Marine Protected Areas in the Deep Ocean
Dr Russell Wynn
*Head of Marine Geoscience and Chief Scientist, Marine Autonomous and Robotics Systems (MARS), NOC, University of Southampton*

Autonomous platforms are revolutionising the way in which marine mapping and monitoring data are collected. They include propeller-driven autonomous underwater vehicles (AUVs), buoyancy-driven submarine gliders, and surface gliders that harvest wave and solar energy. This paper will showcase some of the recent scientific advances that have resulted from deployment of AUVs and gliders, including in hostile environments such as under ice or around deep-sea hydrothermal vents. A demonstration project for Defra will also be presented, highlighting how autonomous systems can collect data for evidence-based policy needs at lower cost and (in some cases) higher spatial and temporal resolution than conventional platforms.

Mapping the deep: the distribution of vulnerable marine ecosystems in the NE Atlantic
Dr Kerry Howell
*Deep Sea Marine Ecologist, Plymouth University*

Predictive species distribution modelling techniques provide estimates of vulnerable deep-sea habitat distribution and extent, an essential prerequisite for conservation management design and the assessment of conservation targets. However the resolution of the data used to build the model is likely to effect the estimates of both extent and distribution and ultimately the performance of the model. We use a real world scenario to investigate the effect of increased data resolution (decreased grid cell size) on the modelled maps, measured by: model performance, estimates of habitat extent, predicted spatial distribution, and assessment of % habitat protection in an MPA network. We develop Maxent models (maps) of the predicted distribution of three deep sea habitats (cold water coral reef, a deep-sea sponge aggregation and a xenophyophore aggregation) in UK and Irish waters, using terrain parameters derived from either GEBCO bathymetry (course scale grid) or multibeam bathymetry (fine scale grid).

Our results suggest that models built using fine scale multibeam data perform better than those built using course scale GEBCO data. Estimates of habitat extent are variable and there are differences in predicted distribution of habitat between models built on coarse-scale and fine-scale grids. Finally estimates of percentage area of each habitat protected by the existing MPA network were lower when based on a coarse grid compared to a fine grid. Implications for marine environmental management are discussed.
Conference Organising Committee

Professor Paul Bishop FRSE
Professor of Geography, University of Glasgow

Robert Gatliff
Director, Energy & Marine Geoscience, British Geological Survey

Dr John Howe
Marine geologist and Head of the Biogeochemistry and Earth Science Department
Scottish Association for Marine Science

Alan Stevenson
Marine Geology Team Leader, British Geological Survey

Dr Russell Wynn
Head of Marine Geoscience, National Oceanography Centre
University of Southampton
NOTES

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