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17.00	**Panel discussion – Ken Johnson, Graham Shields-Zhou, Paul Pearson** Al Fraser (Chair), Imperial College London
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Speaker and Convenor Biographies

Prof Chris Stringer FRS

Chris Stringer is an international expert on human origins and evolution. He is a senior research scientist at the Natural History Museum, London and visiting Professor at Royal Holloway. His latest book "The Origin of Our Species " was published last year. Since 2001 he has led the Ancient Human Occupation of Britain (AHOB) project, which has united a wide range of researchers in the investigation of the history of humans in Britain in relation to climate and biogeographic change. His previous book "Homo britannicus" summarised the first 5 years' work of the project.

Dr Rob Dinnis

Rob Dinnis is a post-doctoral research assistant and curator of the AHOB project, based at the British Museum. His research interests include the Middle-Upper Palaeolithic transition, particularly in northern Europe, the palaeogeography of northern Europe, Upper Palaeolithic lithic technology, typology and function and the use of chronometric data in archaeological reconstructions.

Dr Kenneth Johnson

Ken Johnson is a palaeontologist and bioinformaticist specialising in fossil corals and the relationship of biodiversity to global change. Since 2005, he has been based at the Natural History Museum, London, having previously worked at the Natural History Museum of Los Angeles County, the Scripps Institute of Oceanography, Glasgow University, and the Smithsonian Tropical Research Institute. His study of the contrasting Cenozoic histories of Caribbean and SE Asian coral reefs shows how ecosystem responses to global environmental change are modulated by regional factors. Since 2010 he has coordinated the Throughflow Project, a Marie Curie Initial Training Network working to document the origins of the Southeast Asian Marine Biodiversity Maximum.

Vibor Novak

Vibor Novak is a post-graduate student at the Netherlands Centre for Biodiversity Naturalis. An Early Stage Researcher on the Throughflow project, his work focuses the stratigraphy and ecology of larger benthic foraminifera.

Dr Peter Bijl

Peter Bijl is a post-doctoral researcher at the Laboratory of Palaeobotany and Palynology of Utrecht University. His research includes investigation of the temperature reconstructions and dinoflagellate palaeoecology of warm-climate states and transient hyperthermal events. Although at an early stage of his career, Peter already has published internationally recognized research in the journal *Nature* and sailed as a ship-board micropalaeontologist on the 2010 Integrated Ocean Drilling Program Expedition 318 to the Wilkes Land Margin of Antarctica.

Dr Bridget Wade

Bridget Wade is a micropalaeontologist focusing on the history of the Cenozoic oceans. She uses microfossils and their chemistry to determine patterns of evolution and extinction, ancient marine temperatures, productivity levels, global ice volume and sea level fluctuations. Her research has been international in scope, involving fieldwork in Europe, Africa, the Caribbean/Gulf of Mexico, as well as participation on Ocean Drilling Program Leg 199 and Integrated Ocean Drilling Program (IODP) Expedition 321, both to the equatorial Pacific. She has occupied positions at both Rutgers University and Texas A&M University, and is currently a NERC Advanced Research Fellow at the University of Leeds. Bridget is the Chair of the Paleogene Planktonic Foraminifera Working Group, was awarded the Palaeontological Association Hodson Award in 2008 and The Micropalaeontological Society Alan Higgins Award in 2011.

Dr Mike Howe

Mike Howe is chief curator at the British Geological Survey, Keyworth with responsibility for the BGS palaeontology and biostratigraphy collections, probably the largest and most important collections of British fossils anywhere. At a time of diminishing curatorial resources, he has been proactive in ensuring not only that the collections are adequately curated and conserved but also that they are made more accessible to a wider range of users. To achieve this he has forged partnerships with geological curators in regional and university museums and recently obtained JISC funding for a collaborative online illustrated database of macrofossil type specimens. This major project will be launched at the meeting.

Prof. Wolfgang Kiessling

Wolfgang Kiessling is Professor of Evolutionary Paleoecology at the Museum für Naturkunde, Berlin. He is a world authority on the long-term, planetary record of reef ecosystems, biodiversity and evolution with a particular focus on the interplay between earth system change and biodiversity dynamics. To achieve this he has pioneered the use of large paleobiological and biological databases, especially the Paleobiology Database (PaleoDB, http://paleodb.org). He is editor of the journal *Biogeosciences* and a member of the PaleoDB advisory board.

Dr Paul Upchurch

Paul Upchurch is a leading researcher in the fields of dinosaur systematics, evolution and biogeography. His principle interests are focused on the gigantic long-necked sauropod dinosaurs, although his research includes the wider use of palaeontological data and database studies to determine macroevolutionary patterns and processes in Mesozoic vertebrates as a whole. Paul is a Reader in Palaeobiology at UCL.

Dr Mark Sutton

Mark Sutton is leading international expert on the computer-aided three-dimensional imaging, reconstruction and visualization of palaeontological material. His research encompasses a wide range of fossil groups but has been especially effective in the reconstruction and analysis of soft-bodied organisms recovered from fossil lagerstätte. The morphological details provided by these remarkable new techniques have reshaped the evolutionary histories and phylogenies of many groups. Mark is currently a senior lecturer at Imperial College.

Dr Richard Twitchett

Richard Twitchett is a Reader in Geology at Plymouth University. With a background in geology and biology, his expertise encompasses palaeoecology, stratigraphy, sedimentology and geochemistry. Richard is interested in understanding how the biosphere responded to the major environmental changes of the past and is a leading international expert on the Late Permian mass extinction event. He currently leads one of the four research projects that comprise the Natural Environmental Research Council (NERC) funded Co-evolution of Life and the Planet research program.

Richard Edmonds

Richard Edmonds is the Earth Science Manager within the Jurassic Coast World Heritage Site Team based in Dorset County Council. As such he plays a key role within the team covering most aspects of their work including education, interpretation and tourism. His core role, however, is conservation and management of the Earth science interests within the Site; considering planning applications and management plans or policy that may impact on the interests. The management of fossils and fossil collecting, including the refinement of national policy along the West Dorset coast forms a further aspect of the job and has been complemented recently by a major Heritage Lottery Funded project to bring new fossils and displays into the established museums along the coast.

Dr Graham Shields-Zhou

Graham Shields-Zhou has a long research career in the isotope stratigraphy, climate and biogeochemistry of the Neoproterozoic, including extensive fieldwork in South China and western Mongolia. His career has been truly international, including positions at ETH Zurich, CNRS Strasbourg, the University of Ottawa, James Cook University, Townsville and the Universität Münster. Now he is a senior lecturer in the Department of Earth Sciences, UCL and is currently the lead co-ordinator of the Natural Environmental Research Council (NERC) Co-evolution of Life and the Planet research program. Graham is the secretary of the International Subcommission on Neoproterozoic Stratigraphy (ICNS) and was co-leader of the International Geoscience Programme (IGCP) Project 512: *Neoproterozoic ice ages*.

Prof Paul Pearson

Paul Pearson is world-leading expert on planktonic foraminifera and has contributed deeply to our understanding of ancient climate states. His research specializes in evolutionary and geochemical studies of planktonic foraminifera, including the development of new proxies for determining past seawater pH and atmospheric carbon dioxide levels. Paul has sailed on a number of Ocean Drilling Program expeditions, and more recently coordinated geological exploration and drilling programmes in coastal Tanzania (the Tanzanian Drilling Program) and Java (Indonesia).

Prof. Al Fraser

After more than 30 years experience with BP as a Petroleum Geologist/Exploration Manager, Alastair Fraser was recently appointed to the EGI Chair in Petroleum Geoscience at the Department of Earth Science and Engineering, Imperial College London. Al holds a BSc from Edinburgh University (1977) and a PhD from Glasgow University (1995), both in Geology. His career in petroleum exploration has taken him to most corners of the world including N. America, Europe, Africa, Middle East and the Far East. Following the BP

Amoco merger, he led the team that made the significant Plutonio discovery in Block 18, deepwater Angola. He is the author of many papers on the petroleum geology of extensional basins most notably on the North Sea Jurassic and northern England Carboniferous. He is co-editor of *Petroleum Geoscience* and is a member of the Council of the Geological Society of London.

Dr Jeremy Young

Jeremy Young is a researcher based at University College London, specializing in the study of Neogene and living coccolithophores, especially the integration of biological and palaeontological information. With Prof Peter Westbroek, Jeremy played a leading role in the pioneering multidisciplinary research on coccolithophores through the EUX and GEM projects and coordinated the EU CODENET project (Coccolithophorid Evolutionary Biodiversity and Ecology Network). He is currently working on the NERC-DEFRA Ocean Acidification project and is also a participant in the Throughflow and AHOB research programs.

Dr Tom Dunkley Jones

Tom Dunkley Jones is a micropalaeontologist and paleoceanograher specializing in the study of fossil coccolithophore algae. His research interests are focused on the warm-climate states of the Paleogene period and include the evolution, systematics and ecology of coccolithophores. Tom has also worked on the paleoceanography and paleoclimates of large climate perturbations, including the Eocene/Oligocene transition and the Paleocene-Eocene Thermal Maximum. He is currently a Royal Society Dorothy Hodgkin Research Fellow at the School of Geography Earth and Environmental Sciences, University of Birmingham. In 2010 he was awarded the Geological Society President's Award and in 2012 was appointed as a University of Birmingham Fellow.

Oral presentation abstracts

The Ancient Human Occupation of Britain (AHOB) Projects

Chris Stringer

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The Ancient Human Occupation of Britain (AHOB) research project began in October 2001, funded by the Leverhulme Trust. The project is now in its third phase and continues to investigate the timing and nature of human occupation of the British Isles during the Quaternary. However, its reach has now extended across Europe, with collaborations in countries such as Germany, Belgium, the Netherlands, France and Spain. AHOB brings together a range of specialists, including archaeologists, palaeontologists and earth scientists from universities and national museums, as well as a large body of Associates, who include further specialists and non-professionals: altogether over a hundred people have now formed part of the AHOB network.

When the project began, the earliest generally accepted evidence for the human settlement of Britain came from Boxgrove in Sussex, dated to MIS 13 (~500ka). However, field work in East Anglia has pushed the beginning of settlement to at least MIS 17 (~700ka: Pakefield), and then to at least MIS 21 (>800ka: Happisburgh 3). Nevertheless, studying old collections with new investigative techniques (such as isotope analysis, microscopes, scanning) has been just as important to the progress of AHOB as fieldwork to find new material. The central purpose of the research programme is to provide a detailed settlement history of Britain and neighbouring regions over the last million years, revealing aspects of the technology and behaviour of its Pleistocene inhabitants and exploring how and why these changed over time, reconstructing the environments in which they lived and the resources that these provided, and documenting the fauna that shared their landscape. By taking this broad sweep in time within a single region of Europe, AHOB aims to identify patterns of human social organisation, behaviour, technology, economies, habitat preferences and landscape use, against the backdrop of frequent ice-advance, sea-level change, and the effects on Britain of recurrent isolation from mainland Europe.

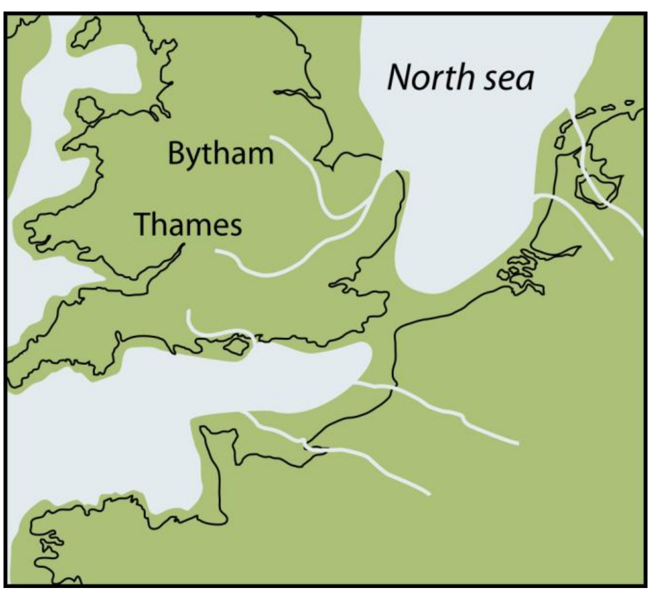

Figure 1. A reconstruction of the geography of Britain during the period of human occupation at Happisburgh Site 3 (AHOB).

Regular workshops with published abstracts provide a forum to discuss the progress of the project, while hundreds of detailed research and site reports have been published as papers in academic journals. In addition a popular book Homo britannicus was published in 2006, and an academic volume The Ancient Human Occupation of Britain in 2010. The project's website http://www.ahobproject.org/ provides further information, and is also represented on Facebook.

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Chronology, climate and the appearance of modern humans in Western Europe

Rob Dinnis[1] and Tom Higham[2]

1. The British Museum (Prehistory and Europe), London. RDinnis@thebritishmuseum.ac.uk.
2. Deputy Director, Radiocarbon Accelerator Unit, Research Laboratory for Archaeology and the History of Art, Oxford.

Between 45,000 and 35,000 years ago, during a period of significant climatic fluctuation, European Neanderthals were replaced by modern humans. Several methodological developments over the last decade have begun to facilitate a much better reconstruction of this event. Key to this reconstruction is a reliable, high-resolution chronology, which is now possible via new techniques of radiocarbon dating and analysis of radiocarbon data. We also now have a clearer picture of climatic fluctuations during this time, seen in climatic proxies such as Greenland ice core records and via ongoing work on terrestrial climatic sequences. When applied to regions where the archaeological record is of sufficient quality, the combination of this chronological and climatic data allows human geographies to be observed. Western Europe – with numerous rich early modern human archaeological sites and with its long history of research – is one such region.

Here these methodological advances are explained and illustrated with reference to one particular question: how did Western Europe's very earliest modern humans adapt to shifting climates and environments? These new techniques will allow many other questions concerning the demise of the Neanderthals and the rise of modern humans to be approached. In conclusion, present and future work towards answering these is outlined.

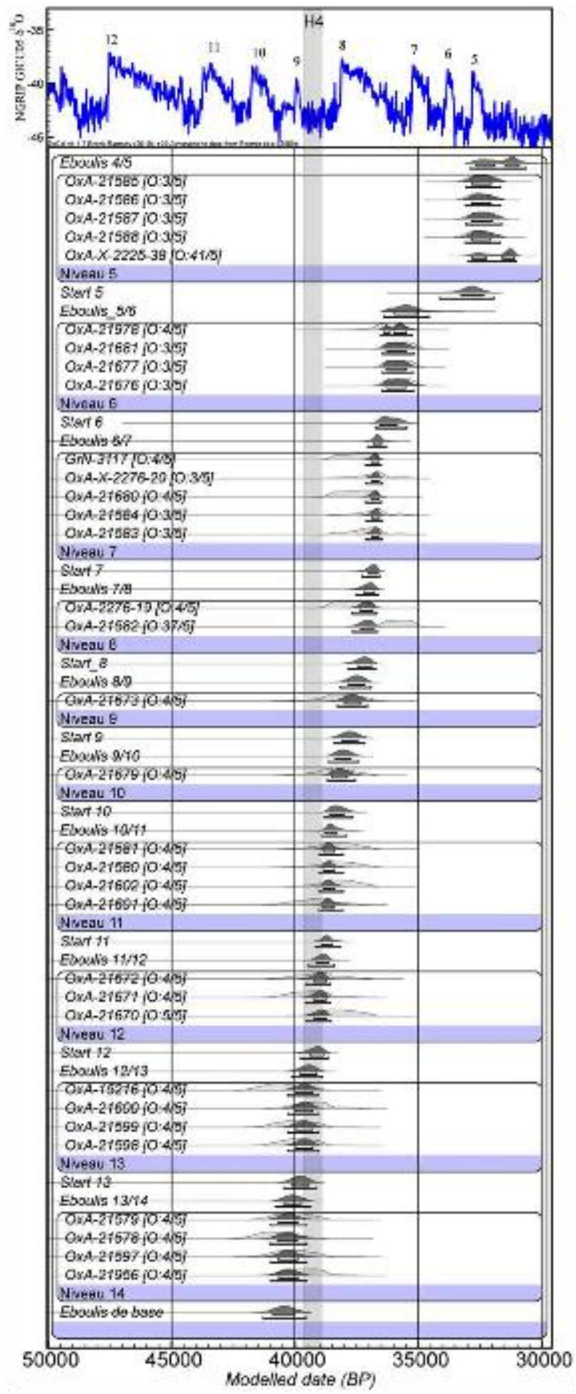

Figure 1. Bayesian-modelled radiocarbon dates for the Early Upper Palaeolithic stratigraphy of Abri Pataud, Dordogne, France.

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Thirty years of field-based Big Palaeontology on Cenozoic shallow marine ecosystems

Ken Johnson[1], Jon Todd[1], and Willem Renema[2]

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[2]NCB Naturalis, Leiden, The Netherlands

There is a long history of large-scale field-based palaeontology projects working towards understanding the Cenozoic history of tropical shallow marine biota of the Caribbean. We have been involved with three such projects since the 1980s. These include: 1) the Dominican Republic Project, studies on the Neogene facies of the Northern Dominican Republic organised by the Natural History Museum in Basel; 2) the Panama Palaeontology Project created by colleagues at the Smithsonian Tropical Research Institute in Panama; and 3) the Caribbean Coral Database, a long term study of reef-coral biodiversity largely based at the University of Iowa. These projects are all still underway, and are characterised by a significant variety of scientific aims ranging from description of faunas to understanding origins of present-day distributions, past episodes of biotic turnover, and the response of ancient ecosystems to environmental change. Geographic scope varies from one basin to regional, and taxonomic scope from single taxon to whole-biota studies. Project management and team composition also varies among the projects in response to constraints imposed by funding and availability of collaborators. The databases produced by these projects include at least 10,000 samples and greater than 1,000,000 macrofossil specimens from thousands of taxa. In some groups, a significant proportion of this diversity was previously unrecognized. Results were published in over 100 publications including dozens of taxonomic monographs. As implemented, each project has strengths and weaknesses, yet all made significant progress in our understanding of the Neogene biota of the Caribbean. Our experiences with these project have provided several insights into factors required for a successful large-scale project in palaeontology, including (1) the importance of long-term funding either through strong support of lead institutions or by funding agencies, (2) strong collaborative links among project partners, including strategies for managing intellectual property within the project to ensure that all partners receive professional compensation for their work, and (3) the critical importance of rigorous stratigraphic and taxonomic frameworks and integration of palaeoenvironmental interpretations from multiple data sources.

Building on the success of these previous projects, THROUGHFLOW is a consortium of European universities, industrial partners, and the Indonesian Geological Agency funded as a Marie Curie Initial Training Network. The primary scientific aim of THROUGHFLOW is to document the biotic and environmental history of shallow marine ecosystems of Southeast Asia. In the present day, Southeast Asia contains global centre of diversity for shallow marine biota, yet the timing and factors responsible for the origins and continued maintenance of this biodiversity hotspot remain obscure. Existing collections are inadequate to document the biodiversity and more importantly are inadequate to reconstruct the changing environmental and ecological conditions that allowed high diversity to persist. The THROUGHFLOW team includes earth systems modelers, geochemists, palaeoceanographers, palaeontologists, sedimentologists, and stratigraphers. In the past year, THROUGHFLOW has deployed two field parties, totaling 1117 researcher-days, to study the Miocene shallow marine facies of East Kalimantan, Indonesia. Over 160 exposures were studied, and eight tons of samples were collected. Preliminary results confirm high diversity in various shallow marine habitats during the Miocene. For reef facies, there was a switch from assemblages constructed by tabular to platy colonies to facies dominated by branching and small free-living forms. This change might coincide with rapid cooling during the Middle Miocene, or might result from regional environmental change associated with tectonic evolution of the Indonesian Throughflow.

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Environmental reconstruction of a Langhian patch reef (East Kalimantan, Indonesia)

Vibor Novak[1], Nadiezhda Santodomingo[2], Anja Roesler[3], Emanuela Di Martino[2], Juan Carlos Braga[3], Paul D Taylor[2], Kenneth Johnson[2], Willem Renema[1]

1. Department of Geology, Netherlands Centre for Biodiversity Naturalis, The Netherlands.
2. Palaeontology Department, Natural History Museum, London.
3. Department of Stratigraphy and Paleontology, University of Granada, Spain.

The development of isolated patch reefs within siliciclastic sediments epitomise the Miocene carbonate deposits of East Kalimantan, Indonesia. A team of Marie Curie Early Stage Researchers and Principal Investigators from the THROUGHFLOW project collaborated in reconstructing a mixed system, delta-front patch-reef. Based on a multi-taxon analysis of the fossil assemblages, we described the palaeoenvironment and biodiversity of this well-preserved Langhian patch reef.

The studied outcrop is located near Bontang, East Kalimantan, at the NE margin of the Kutai Basin, sedimentary complex dominated by siliciclastic deposition. Fieldwork was undertaken in two steps: 1) characterisation of lithology and geometry of reef deposits, and 2) sampling of fossil assemblages. Lithological units were identified by detailed logging of eight transects along the outcrop in order to detect lateral changes. Microfacies analyses of thin sections included carbonate lithological classification and skeletal component logging, on which relative abundances of LBF, algae, and corals were estimated for each sample, allowing broad palaeoenvironmental separation. The resulting biodiversity data was analysed jointly with the sedimentological information.

Based on the fossil content and lithological characteristics described from thin sections and bulk samples, five different facies types (FT1-5) were defined in nine units. By integrating the results from each fossil group we constructed a facies model suggesting deposition in water depths of 20-50m. We observed facies changes up-section starting with calcarenite sediments (FT1) followed by bioclastic packstone with larger benthic foraminifera and calcareous algae (FT2). Abundant thin platy corals and bryozoans occurred in a fine-grained muddy matrix (FT3) gradually passing into a thick-platy coral framestone (FT4). Reappearance of the bioclastic packstone (FT2) characterizes the next facies change, followed by the muddy matrix facies with thin platy corals (FT3). The demise of reef growth is marked by siliciclastic deposits (FT5) capping the carbonate units. The main factor controlling reef growth is proposed to be variation in turbidity of the water column, most likely as a result of changes in terrestrial runoff from a large river. Multi-taxon fossil assemblage analysis has allowed the formulation of a reference model for equatorial patch-reef systems of this type. In the next phase of THROUGHFLOW we will test the generality of this model by comparing multiple reefs identified during two fieldwork seasons in East Kalimantan.

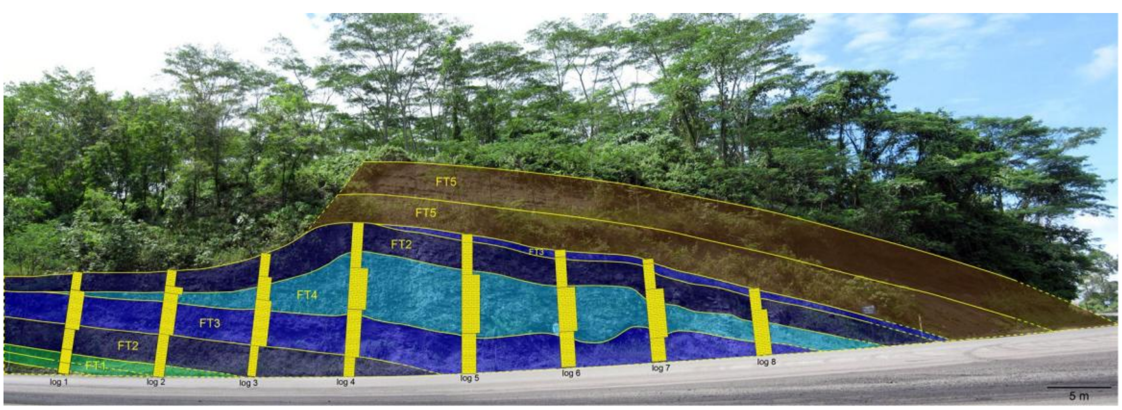

Figure 1: Photomosaic of the logged section with lithologic units, log positions and facies types (FT).

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Tracing Eocene-Miocene Southern Ocean climate and oceanography using dinoflagellate cyst assemblages from the Wilkes Land margin, Antarctica (IODP Leg 318)

Peter Bijl[1], Alexander J.P. Houben[1], Francesca Sangiorgi[1], Alexander Ebbing[1], Jörg Pross[2], Appy Sluijs[1] and Henk Brinkhuis[1, 3]

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2. Paleoenvironmental Dynamics Group, Institute of Geosciences, Frankfurt University, Germany
3. NIOZ Royal Netherlands Institute of Sea Research, Texel, The Netherlands

IODP Leg 318 recovered an unprecedented, well-dated Cenozoic sedimentary record from the Wilkes Land Margin of Antarctica. Much of the record lacks carbonate and silicate microfossils but well-preserved assemblages of organic-walled dinoflagellate cysts (dinocysts) allow for the reconstruction of major climatological and oceanographic changes.

Early Eocene dinocyst assemblages are dominated by cosmopolitan taxa, indicating warm, ice-free conditions, while middle Eocene assemblages are characterized by taxa coevally prevalent in the southwest Pacific Ocean. This suggests that a connection developed between the Australo-Antarctic Gulf and the Pacific Ocean, signifying a shallow-water opening of the Tasmanian Gateway around 50 Ma.

In the earliest Oligocene (33.6 Ma), the typically highly diverse dinocyst assemblages of the Eocene are replaced by low-diversity assemblages, consisting of heterotrophic taxa that are similar to those dominating modern Antarctic sea-ice systems. Late Oligocene and Miocene dinocyst assemblages are highly variable suggesting alternations between high-productive and low-productive surface-water regimes. These shifts may be linked to glacial advances/retreats and/or shifts in oceanic fronts.

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Tanzania Drilling Project

Bridget Wade[1], Paul Pearson[2], Joyce Singano[3], Brian Huber[4], Ken Macleod[5], Chris Nicholas[6], Paul Bown[7] and the TDP Team

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2. School of Earth, Ocean and Planetary Sciences, Cardiff University.
3. Tanzania Petroleum Development Corporation, Dar-es-Salaam, Tanzania
4. Department of Paleobiology, Smithsonian National Museum of Natural History, Washington, DC, USA
5. Department of Geology, University of Missouri-Columbia, USA
6. Department of Geology, Trinity College, Dublin, Ireland
7. Department of Earth Sciences, University College London.

The 'Tanzania Drilling Project' (TDP) is an informal name for a programme of shallow coring in marine sediments that are now exposed on land in the coastal basins of Tanzania. The main objective is to provide palaeoclimate and micropalaeontological records. In successive field seasons from 2002-2009, over 40 holes were drilled using small truck-mounted rigs, recovering sediments from Aptian to Oligocene age. The main funding stream was through a series standard research grants from Natural Environment Research Council (UK) and National Science Foundation (USA), with additional support from the Tanzania Petroleum Development Corporation, Enterprise Ireland, and individuals (e.g. via fellowship research funding). TDP has involved scientists from the UK, USA, Tanzania, Ireland and Netherlands. Over 30 peer-reviewed papers have been published so far.

The Paleogene and Cretaceous succession of Tanzania is renowned for its superb microfossil preservation which is related to the clay-rich facies and shallow maximum burial depths. This, and the long stratigraphic continuity, makes the area important for quantitative use of palaeoclimate proxies (e.g. from planktonic and benthic foraminifera) and also for palaeontological research (taxonomy and evolution). Critical stratigraphic intervals such as the Cenomanian-Turonian, Paleocene – Eocene and Eocene – Oligocene have been the focus of much of the work. Oxygen isotope and biomarker studies have resulted in an exceptional long tropical palaeotemperature history. Several new species of foraminifera have been described and much use has been made of the well-preserved material in taxonomic atlases. Study of the calcareous nannoplankton has revealed a very high diversity of previously undescribed forms, including many fragile taxa and holococcoliths that do not ordinarily preserve.

Figure 1. Cribrohantkenina inflata *(planktonic foraminifera) from the upper Eocene of TDP Site 12.*

The TDP is providing the springboard for further planned work in the area. A full drilling proposal has been submitted to the Integrated Ocean Drilling Program for the recovery of equivalent strata offshore for which a detailed seismic site survey has already been undertaken.

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GB/3D Type fossils online

Mike Howe

Chief Curator, British Geological Survey (mhowe@bgs.ac.uk)

The International Code on Zoological Nomenclature and the International Code of Nomenclature for algae, fungi and plants require that every species or subspecies of organism, whether living or fossil, should have a type or reference specimen to define its characteristic features. These specimens are held in museums and collections around the world and must be available for study. Many of the UK fossil species were defined over a century ago, and with time, the type specimens may have deteriorated or been lost, causing major problems. The project, funded by JISC, aims to develop a single database of the type specimens held in British collections, of macrofossil species and subspecies found in the UK, including links to photographs (including "anaglyph" stereo pairs) and a selection of 3D digital models.

The British Geological Survey, partnered by National Museum Cardiff, the Sedgwick Museum of Earth Sciences (Cambridge University), the Oxford University Museum of Natural History, and the Geological Curators' Group will develop a collaborative database of British type specimens. It will build on existing databases, exploring the use of schemas such as *ABCDEFG* and dictionaries such as the *Lexicon* and the *Rock Classification Scheme (RCS)* for the transmission and sharing of data. The Geological Curators' Group will extend the partnership to local museums and other organisations holding type fossils.

The results will be made available through a single searchable web database. It will include links to view or download high quality images, stereo pairs (anaglyphs) and digital models. Images will generally be in JPEG2000 format, and digital models as .PLY and 3Dpdf formats. It will also include the ability to store and download other data types, as diverse as X-ray images, and links to or scans of original papers.

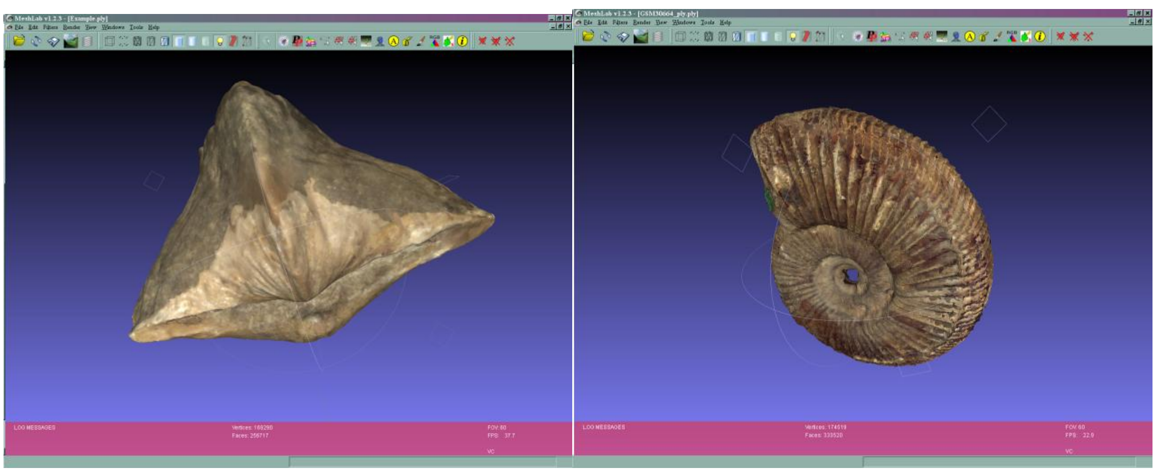

Figure 1. Examples of digital fossil models viewed in MeshLab™ v.1.2.3, a free, open-source, 3D mesh processing software program.

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Palaeobiology in the Age of Biodiversity Informatics

Wolfgang Kiessling

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The decline of biodiversity at global scales fostered the establishment of several national and international biodiversity initiatives and research centres, which increasingly explore large data repositories for assessing changes of biodiversity and its drivers. International initiatives such as the Global Biodiversity Information Facility (GBIF, www.gbif.org) managed to mobilise and make accessible more than 300 million records of primary observational and collection data. To make full use of such datasets for biodiversity research, the new field of biodiversity informatics has emerged and the next generation of biodiversity researchers is trained in the analysis and synthesis of large datasets.

There are good reasons why palaeontology needs to be integrated into modern biodiversity research: On short palaeo time scales (Holocene, Pleistocene) the fossil record can be used to identify ecological consequences of rapid climate change and to define natural baselines before anthropogenic influence, whereas on long time scales (Phanerozoic) paleontological data can elucidate how biodiversity is regulated at multiple spatio-temporal scales and assess the evolutionary consequences of climate change and extreme physico-chemical perturbations. Better funding for palaeontology projects is likely if a full integration is achieved.

Although the advantages of palaeo data are increasingly recognized by biodiversity researchers, a full integration is still lacking, probably because: (a) The fossil record suffers from being incomplete and (b) there are still too few data readily available to address big questions at relevant scales.

The Paleobiology Database (PaleoDB, www.paleodb.org) showcases how a community-wide effort can succeed in circumventing obstacles and manage to make palaeo data visible and accessible for biodiversity analysis and synthesis at multiple levels. The secret of PaleoDB's success (285 contributors, 1 million occurrences, 150 official publications) is that it was and is science-driven, receives de-centralized funding and it is managed by idealistic palaeobiologists. The PaleoDB was founded in 2000 (one year before GBIF) with the aim to answer a simple scientific question: Are the diversity curves derived from simple range data correct or are those flawed by taking the incomplete fossil record at face value? The community has realized that to answer this question we need to go beyond simple range data and apply sampling-standardization on occurrence and abundance data. Even before this goal had been accomplished (Alroy et al., 2008, Science **321**, 97) it became obvious that many more questions can be answered with the PaleoDB. I highlight just a few examples: (a) What are the ecological impacts of rapid climate warming? (b) In which settings is biodiversity preferentially generated and destroyed? (c) What is the impact of chemical change in the oceans on skeletal mineralogy and mass extinctions?

Further prerequisites to develop palaeodiversity studies into big science are: (a) a changing attitude of palaeontologists towards data sharing, (b) a better training of young palaeontologists in modern quantitative methods, (c) the active participation of palaeontologists in biodiversity initiatives, and (d) the mobilisation of museum collection data over the internet.

NOTES

Latitudinal variation in Cretaceous vertebrate biodiversity

Paul Upchurch[1], Roger B. J. Benson[1], and Philip D. Mannion[2,3]

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2. Museum für Naturkunde, Berlin, Germany.
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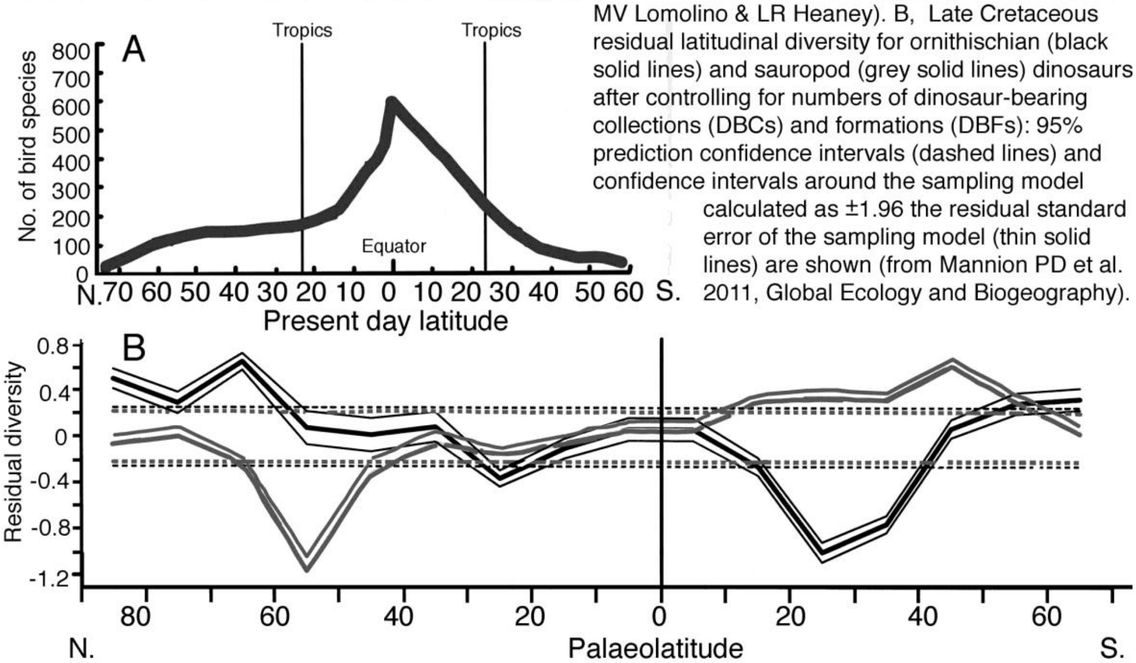
At present, the biodiversity (species richness) of terrestrial and marine organisms is positively correlated with decreasing latitude (Fig. 1A). This 'latitudinal biodiversity gradient' (LBG) is the dominant first order macroecological pattern on Earth and has potentially existed since 500 million years ago. Recently, however, analyses of the LBGs of several ancient terrestrial groups (Cretaceous dinosaurs [Fig. 1B], Palaeocene mammals, Cenozoic insects) have found distribution patterns that depart radically from the present day norm. Data from the fossil record therefore lies at the heart of current research into the climatic and evolutionary factors that shape LBGs.

Figure 1. A, A graph showing how the biodiversity of living terrestrial birds varies with latitude (modified from Turner JRG & Hawkins BA 2004, In Frontiers of Biogeography: New Directions in the Geography of Nature (eds MV Lomolino & LR Heaney). B, Late Cretaceous residual latitudinal diversity for ornithischian (black solid lines) and sauropod (grey solid lines) dinosaurs after controlling for numbers of dinosaur-bearing collections (DBCs) and formations (DBFs): 95% prediction confidence intervals (dashed lines) and confidence intervals around the sampling model calculated as ±1.96 the residual standard error of the sampling model (thin solid lines) are shown (from Mannion PD et al. 2011, Global Ecology and Biogeography).



Peaks and troughs in latitudinal species richness reflect genuine diversity signals and/or latitudinal variation in sampling. Large data sets are required in order to tease apart biodiversity signals from sampling artefacts, enable comparisons between different organisms, and enhance the temporal and spatial resolutions of reconstructed LBGs. Our project is building a comprehensive data set on the occurrences of Cretaceous tetrapods, hosted by The Paleobiology Database (PBDB). At present, this data set comprises approximately 8700 occurrences of over 1600 Cretaceous tetrapods, but many groups (such as Lissamphibia and Squamata require substantial updating). Corrections for uneven sampling of the fossil record have been applied using subsampling, residual diversity approaches, and Share-holder Quorum subsampling, and the results of these various analyses are in broad agreement. Analyses of the dinosaur component of this data set indicate that the LBGs of Cretaceous terrestrial taxa differ from those of the Present. Cretaceous dinosaurs had peak diversities in temperate rather than tropical latitudes (Fig. 1B). This pattern might be explained by higher global temperatures during the Cretaceous, which produced shallower thermal gradients from the equator to the poles. Other factors, such as land area (that are overwhelmed by climatic effects at the present), might have been more dominant during the Cretaceous, prompting the development of temperate diversity peaks. However, the observation that different clades have diversity peaks at different temperate latitudes (Fig. 1B) suggests that ecological and evolutionary factors also played a role in the finer details of these distributions. Work in this field is still in its early stages: future analyses should be able to tease apart other signals such as body size effects and differences in the LBGs of aquatic and terrestrial organisms.

NOTES

Virtual Palaeontology

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"Virtual Palaeontology" involves the study of fossils as three-dimensional computer models. While idealised reconstructions can be made digitally (in a manner analogous to the production of an idealised physical model or artist's sketch), the real power of the approach lies in the direct digitisation of specimens. A powerful and disparate array of techniques now exists to accomplish this, each with different merits and limitations. Techniques include surface-based approaches (e.g. laser-scanning and photogrammetry), as well as more broadly applicable tomographic ('slice-based') approaches; the latter include physical serial-sectioning, optical sectioning, X-ray 'scanning ' (CT, μCT/XMT, SXRMT), magnetic resonance imaging, neutron tomography, and more besides. Virtual specimens have many advantages over real specimens. They can be rotated, viewed, manipulated, sectioned and dissected at will, without risk of damage. They retain associations between poorly connected or disjoint pieces without any requirement for physical strength. They can also be easily copied and disseminated for collaborative study, publication, or teaching, and can be augmented with interpretative mark-up. Virtual fossils can be used as the basis for quantitative analyses of function, such as finite element stress analysis and computational fluid dynamics. Finally, specimens exist that cannot be satisfactorily physically isolated (e.g. fossils of the Herefordshire Lagerstätte); these can only be studied virtually.

Virtual Palaeontology has its roots in early 20th Century serial-sectioning work, whose results were on occasion rendered as wax or cardboard models. Towards the end of the 20th Century larger fossils, especially vertebrates, began to be studied using medical CT scanners. The 21st Century, however, has seen a huge expansion in these techniques. This has been driven by increases in the availability of computing power and software for effective reconstruction and manipulation of models, and by the increasing availability of new data-collection techniques, most notably micro-CT (μCT or XMT) and Synchrotron X-ray Microtomography (SXRMT). Not all fossils are preserved in three dimensions, but where even partial three-dimensionality exists, virtual palaeontology has rapidly become established as the optimal approach for the study of rare and important fossils; it is rapidly becoming important for 'run-of-the-mill' work as well. Barriers to broader use still exist however. These include perceptions of the techniques as difficult, limited availability of certain types of data-capture hardware, unwillingness to share data, and the lack of suitable data-interchange formats. Weakening or overcoming these remaining obstacles will facilitate further uptake of this powerful new way of working, providing palaeontologists with new opportunities for advancing the science in the 21st Century.

Figure 1: Xylokorys chledophilia*, 30mm in length; virtual fossil reconstructed from serial sections. Silurian, Herefordshire, England.*

NOTES

Coevolution of Life and the Planet

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One of the major concerns of scientists, governments and individuals is the influence that the activities of one species – *Homo sapiens* - are having on the Earth's atmosphere, oceans, climate and biota at the present. Our species is by no means the first to have wielded such an influence on the planet, however, and when the full history of life on Earth is considered in its entirety there are numerous examples of similar planetary-level changes being caused by the appearance and activities of different, disparate organisms.

Arguably the most significant was the oxygenation of Earth's atmosphere that began some 2500 million years ago, and which was the direct result of the activities of photosynthetic microbes. The evolution and spread of vascular plants in the Devonian may have led to enhanced weathering, the drawdown of atmospheric CO_2 levels, and global cooling, amongst other potential effects. It has been suggested that initial colonisation of the land by bryophytes earlier in the Palaeozoic may have had similar consequences, causing the glaciations in the Ordovician. Animals too have influenced the evolution of the geosphere. The appearance of burrowing animals near the base of the Cambrian, and their expansion into greater depths in the Carboniferous, would have had a profound effect on nutrient cycling and productivity within the oceans. Termites are presently the second largest natural source of methane – a source that would not have existed prior to their appearance in the Mesozoic.

The planet, in its turn, has also affected the evolution of life. Movement of the plates and eruptions of large igneous provinces have directly led to the evolution, and often extinction, of major groups of animals and plants. The most significant biotic crisis of the Phanerozoic, the Late Permian mass extinction event, was caused ultimately by climate change driven by the emplacement and eruption of the Siberian Trap large igneous province. Changes to terrestrial vegetation in the wake of the extinctions and global warming also led to changes in the rates of soil erosion and nutrient delivery to the oceans, further impacting on the oceans. The subsequent Mesozoic witnessed a number of smaller but similar crises that shaped the early evolution of many groups of organisms that dominate the planet today. Groups that are critical to the present day global carbon cycle, such as the calcareous nannoplankton and planktonic foraminifera, evolved during the Mesozoic. It has been hypothesized that the origin of the planktonic foraminifera is a direct result of climate-induced environmental changes associated with the early Toarcian biotic crisis. Furthering our understanding of the complex coevolution of our planet and the life that inhabits it is a major UK-funded initiative that has implications far beyond the science of palaeontology.

NOTES

The Dorset and East Devon Coast World Heritage Site

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The Dorset and East Devon Coast, now popularly known as the Jurassic Coast, was accepted onto the UNESCO World Heritage List in December 2001. The site has qualified under Criteria vii and its Outstanding Universal Value is due to the virtually complete record through the entire Mesozoic coupled with the diversity of fossils and the remarkable range of active erosional processes at work. The main threat to the site is through the construction of coastal defenses where the erosion that maintains the site actually threatens people, property and infrastructure. The balance between the need to protect the World Heritage Site by allowing it to erode and to protect the built environment from that erosion is an ongoing challenge. Fossil collecting is the other principal conservation challenge. Many of the most famous localities, such as West Dorset are rapidly eroding and the fossils are at constant risk of being damaged or destroyed by the very processes that expose them. Local collectors, both amateur and professional have demonstrated their value over the last 200 years by rescuing these fossils and as a result, the World Heritage Site embraces collectors and collecting within the management of the site. Finally, areas such as Charmouth and Lyme Regis represent a wonderful opportunity to excite a new generation of geologists and palaeontologists as it has done for generations before.

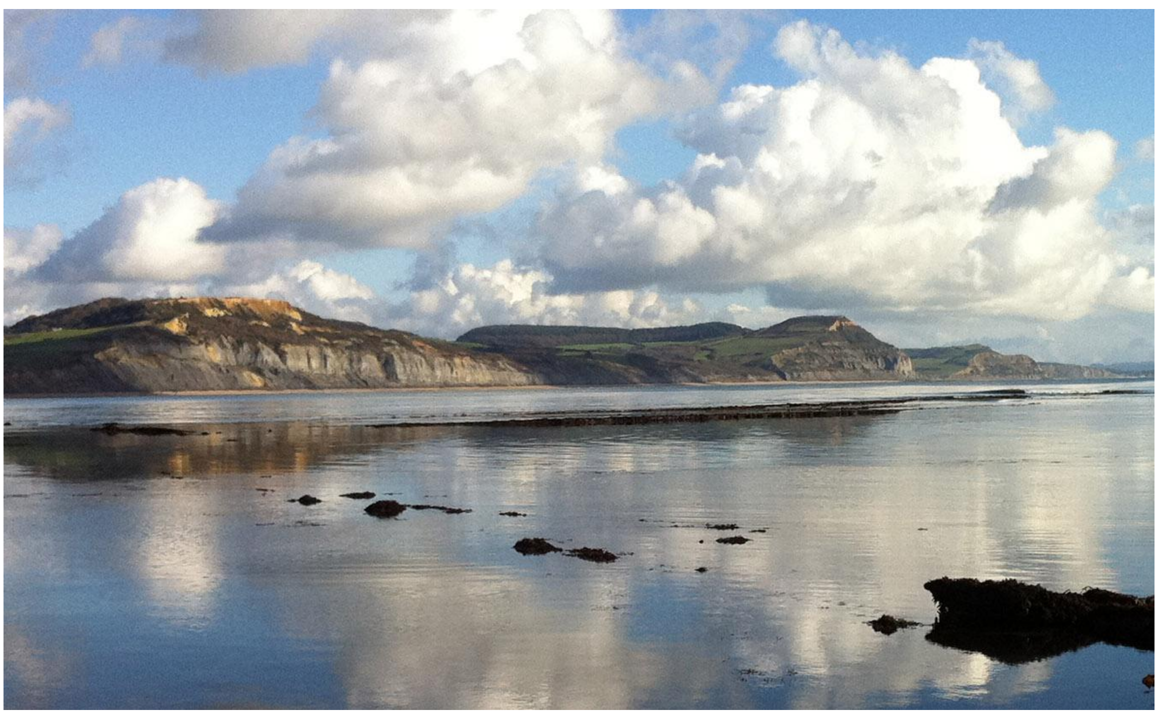

Figure 1. The Jurassic Coast, looking east from Lyme Regis

NOTES

Burlington House
Fire Safety Information

If you hear the Alarm

Alarm Bells are situated throughout the building and will ring continuously for an evacuation. Do not stop to collect your personal belongings.

Leave the building via the nearest and safest exit or the exit that you are advised to by the Fire Marshall on that floor.

Fire Exits from the Geological Society Conference Rooms

Lower Library:
Exit via main reception onto Piccadilly, or via staff entrance onto the courtyard.
Lecture Theatre
Exit at front of theatre (by screen) onto Courtyard or via side door out to Piccadilly entrance or via the doors that link to the Lower Library and to the staff entrance.
Main Piccadilly Entrance
Straight out door and walk around to the Courtyard.

Close the doors when leaving a room. **DO NOT SWITCH OFF THE LIGHTS**.

Assemble in the Courtyard in front of the Royal Academy, outside the Royal Astronomical Society.

Please do not re-enter the building except when you are advised that it is safe to do so by the Fire Brigade.

First Aid

All accidents should be reported to Reception and First Aid assistance will be provided if necessary.

Facilities

The ladies toilets are situated in the basement at the bottom of the staircase outside the Lecture Theatre.

The Gents toilets are situated on the ground floor in the corridor leading to the Arthur Holmes Room.

The cloakroom is located along the corridor to the Arthur Holmes Room.

Ground Floor Plan of the Geological Society, Burlington House, Piccadilly