2023 ANNUAL HERDMAN SYMPOSIUM

Looking Back and Looking Forward in Earth Science

50TH Anniversary Edition

Saturday, 11th February 2023

9:30 – 17:00

Wine reception at Mountford Hall (+18)

17:00 – 18:30

Itinerary

9:30	Welcome and registration
10:00	Introduction
10:10	Prof. John Wheeler - Crystal to crustal scale approaches to understanding how the Earth works
11:00	Prof. Jon Gluyas – Geo-energy in Energy Transition and Net Zero – a World Beyond Petroleum
11:50	Break
12:10	Panel Session: The Future of Earth Sciences
13:00	Lunch (GfGD bake sale)
14:00	Dr. Jenny Jenkins - Deep Earth Seismology: from blurry global pictures, to detailed images of core-mantle boundary structure
14:50	Dr. Natalie Farrell - Weakening Earth's crust: the role of laboratory-based experimental research in tackling urgent societal issues
15:40	Break
16:00	Dr. Philip Mannion - Why the long face? The evolutionary past and future of crocodiles on a changing planet.
17:00	Wine reception and networking event. **(18+)**

Herdman Symposium 2023

"Looking Back and Looking Forward in Earth Science"

We wanted to give our sponsors a massive thank you for their support and donations to help run this event.

Liverpool Geological Society

https://liverpoolgeologicalsociety.org/

The Liverpool Geological Society has been a consistent sponsor of the Herdman Symposium for many years, for which we, as a society, are very grateful.

LGS has been an active society of geology enthusiasts for over 160 years, hosting many meetings and talks given by researchers from across the country. For more information on this society and some of the talks they host, follow the link to their website.

Geotechnics

www.geotechnics.co.uk

We would also like to thank our newest sponsor this year, Geotechnics.

Geotechnics…. it's been in the name since 1983. We deal with the engineering and environmental interaction between earth materials and the built environment delivering first class site investigation services to like-minded clients; providing high quality data to reduce uncertainty in the ground and aid clients with geotechnical and geoenvironmental soil and monitoring parameters for foundation design, slope stability assessment, earthworks, dewatering, remediation and overall design works. Our Company values (Quality, People, Integrity), ethos and vision is everything to us. Our vision is simple - to be the very best at what we do and to ensure the experience of working with and for us is enjoyable for you and our clients. We aim to nurture and provide a workplace where everyone is involved, passionate and driven to deliver the very best quality site investigation services and data to serve the construction industry, wider community and the environment in which we operate and live.

With 4 offices and projects across the UK we are always looking for Geology, Geo-environmental analysis, Engineering Geology, Civil Engineering or similar graduates with drive, curiosity and integrity to join our Graduate Engineer Training Scheme. A two-year tailored programme that aims to apply and build upon your skills learnt at university and arm you with the necessary new skills, knowledge and experiences to make you the very best engineer you can be in the ground engineering industry. Along the way you will be looked after, trained, mentored and coached by some of the best in the industry to progress further along the Engineer route and on to Chartership. To find out more check out our dedicated graduate page at **geotechnics.co.uk/graduates.**

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"Looking Back and Looking Forward in Earth Science"

Prof. John Wheeler

University of Liverpool

John Wheeler studied Natural Sciences at Cambridge, followed by his PhD at Leeds, studying links between deformation and metamorphism in shear zones in the Lewisian Complex, Britain's oldest rocks. He then worked in a hydrocarbon industry consultancy for two years. He moved to Liverpool as an Independent Research Fellow studying how deeply buried rocks in the Alps became uncovered, and in 1990 became a lecturer.

Crystal to crustal scale approaches to understanding how the Earth works

My first memories of geology are from a time before plate tectonics was "discovered". My research now looks at atomic to crystal scale phenomena since these control all the larger scale processes that we experience including plate tectonics. I discuss examples from structural geology (the physics of how rocks change shape) and metamorphic geology (the chemistry of how rocks grow new minerals). Rocks are made of crystals, often interlocking, and they can deform without breaking. An electron microscope technique (Electron Backscatter Diffraction) measures the alignment of crystals, and the deformation within individual crystals. This gives information on linear atomic scale flaws (dislocations) which enable deformation. Mathematics provides the link between observed deformation and the dislocations.

In metamorphism, new mineral formation may involve the release of water. This can move around, carrying dissolved material a long way, and its presence helps trigger earthquakes. To understand this, we heat minerals and use X-rays to make 3D pictures of the evolving crystals and pores (holes filled with water). We use gypsum, a sulphate which is an "analogue" to silicate mineral behaviour. Gypsum, the new mineral bassanite and pores all have different shades of grey, but we use machine learning to reliably distinguish them.

In the future Earth Science will be increasingly mathematical. Even if we do not undertake the actual mathematics, as Earth Scientists we should strive to understand the assumptions, strengths and weaknesses behind such approaches, and give guidance on how those influence the scientific conclusions.

DATE: SAT 11th February 2023

TIME: 10:10

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"Looking Back and Looking Forward in Earth Science"

Prof. Jon Gluyas

Durham University

Prof. Jon Gluyas has over 40 years' experience in industry and academia following a PhD in Sediment Geochemistry at Liverpool University. He began his career in the petroleum industry with BP working in exploration. Jon moved into academia at Durham University in as Chair in Geoenergy, Carbon Capture and Storage and he is now Executive Director of the Durham Energy Institute. Jon has spent 2/3 of his career pulling carbon out of the ground and the most recent 1/3 attempting to put carbon back in the ground.

Geo-energy in Energy Transition and Net Zero – a World Beyond Petroleum

For millennia, almost all humanity lived in abject poverty. That has changed, in the quarter millennium since the industrial revolution began, use of the energy released from combusting fossil fuels has enabled 80% of the now 8 billion people alive on Earth to escape from abject poverty. However, the consequences of burning coal, oil and gas some 20 million times faster than the rate at which the Earth stores reduced carbon is plain for all to see, a rapidly changing climate, warming atmosphere and acidified oceans.

There is no planet B. We must look after the one we have and yet development, especially for the 20% trapped in abject poverty is an imperative. The Earth will remain the major and possibly the only source of materials for development and much of the energy required to enable development. Here we look again at the Earth – its resources for sustainable, low to zero carbon energy, energy storage and waste disposal. Carbon storage and reuse, geothermal energy, and exploration for natural hydrogen as well as the critical resources of helium and lithium are all intimately linked. Industry is already beginning to exploit geothermal waters for lithium extraction and possibilities exist for monetising CO_2 as a geothermal power fluid, extracting helium from geothermal fluids and co-producing helium and natural hydrogen. Imagineering the future is a first step in realising the future – let's do some Imagineering!

DATE: SAT 11th February 2023

TIME: 11:00

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"Looking Back and Looking Forward in Earth Science"

Dr Jenny Jenkins

Durham University

Jenny Jenkins did her undergraduate degree in Geophysics with Geology at the University of Liverpool, followed by a PhD in deep Earth seismology at the University of Cambridge. She spent 3.5 years of burying seismometers in the wild Iceland highlands, using the data to image the underlying source of Iceland's volcanism. In 2021 she started as an Assistant Professor at Durham University where she now teaches on the geophysics course and continues her research exploring deep Earth structure using seismology.

Deep Earth Seismology: from blurry global pictures, to detailed images of core-mantle boundary structure

50 years ago, we already had a good understanding of the Earth's basic layered structure, and seismic imaging was just starting to provide the first blurry low-resolution pictures of the 3D structure of the planet's interior. Those early images opened up new questions about what structure exists in the deep mantle, and what role it plays in the dynamic processes that ultimately control things we directly experience at the surface. Since then, global seismic imaging methods have developed, the amount of seismic data has increased exponentially, and the computational power we now have means we can see deep structure in greater detail than ever before possible. But the closer we look, the more we find and the more questions it opens up about how the deep interior of our planet works…

In this talk I will focus on one of the most poorly understood structures found on the Earth's core-mantle boundary – ultra-low velocity zones (ULVZs). These are small but extreme structures that slow down earthquake waves almost ten times more than anything else we have found in the deep Earth, but we don't currently understand what they are or how they fit into the big picture of global convection. I'll show some of our latest seismic imaging results which provide high resolution images of these mysterious structures and discuss what they might reveal about what ULVZs physically represent. The future will need deep Earth scientists from across the disciplines of mineral physics, geodynamics, and geomagnetism to work together to understand what the detailed images seismologists are now producing can tell us about our planet and how it works.

DATE: SAT 11th February 2023

TIME: 14:00

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"Looking Back and Looking Forward in Earth Science"

Dr Natalie Farrell

University of Manchester

Dr Farrell gained her MESci at the University of Liverpool in 2007 and completed her PhD in rock mechanics at University of Aberdeen in 2016. She is currently a Leverhulme Research Fellow at the University of Manchester. Natalie's research measures and models the effects of faulting on the physical and microstructural properties of rocks to address both fundamental and applied geoscience problems. She has worked to promote the ways in which the scientific community can better support the co-existence of academic and family life.

Weakening Earth's crust: the role of laboratory-based experimental research in tackling urgent societal issues

Controlled experiments with a focus on looking at laboratory-produced microstructures have vastly improved our knowledge of natural rock deformation and are critical to our understanding of hazards including earthquakes, landslides, leakage/contamination during fluid extraction/injection activities in the subsurface.

National commitments to decarbonise by 2035 demand that fluid injection activities (e.g., geothermal energy extraction, carbon capture and storage, hydrogen storage) are accelerated. However, as observed with the induced earthquake damage at Gronginen (Holland) and in Pohang (South Korea), activities involving extraction or injection of fluids can alter both the subsurface stress-state and chemical equilibrium, and thereby change the mechanical properties of rocks. Therefore, accurate predictions of rock behaviour (strength, fluid flow) in these dynamic mechanical-chemical settings are critical to ensure these activities are conducted safely, productively, and sustainably.

Focusing on geological processes in the shallow crust (< 5 km) where most human activities are conducted/planned, this talk will 1) discuss seminal scientific contributions from over 50 years' of laboratory rock deformation and share how empirically defined relationships between mechanical and microstructural rock properties from these studies have informed human energy extraction and 2) present data from recent rock deformation projects which include varied fluid chemistry (wastewater, supersaturated carbon dioxide, nuclear waste) with mechanical deformation to better predict the response saturated of minerals to stress-state changes associated with fluid injection.

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TIME: 14:50

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"Looking Back and Looking Forward in Earth Science"

Dr Philip Mannion

University College London

Dr Mannion studied at the University of Liverpool from 2001-2005, followed by a PhD at UCL studying the diversity of sauropod dinosaurs. He spent six years at Imperial College London, including receiving a Royal Society University Research Fellowship, before taking up a permanent academic position at UCL. His current research focuses on the evolutionary history of terrestrial vertebrates over the last 250 million years, including the role of climate on shaping past life, and how the fossil record can inform the current biodiversity crisis.

Why the long face? The evolutionary past and future of crocodiles on a changing planet

The 25 extant species of crocodylians (crocodiles, alligators, caimans, gharials) are environmentally sensitive and restricted to the tropics. Almost 50% of crocodylian species are identified as being threatened with extinction by the IUCN Red List. Given that birds are the closest living relatives of crocodylians, but that this divergence occurred 250 million years ago, we therefore stand to lose a disproportionate amount of evolutionary history from the vertebrate tree of life. The fossil record of crocodylians and their extinct relatives reveals a much richer evolutionary history, with the group characterised by a far broader latitudinal distribution in its past, extending into polar regions. Extinct members include fully marine species with flippers, herbivores, species that inhabited semi-arid environments with elongate limbs adapted for running, and 12-metre-long giants. The advent of large online fossil occurrence databases, as well as increasingly sophisticated analytical methods, provides us with an unparalleled view of the rise and fall of crocodylian diversity, including the impact of Earth's long-term cooling trend over the last 30 million years. This past record not only reveals their evolutionary history, but can also be used to improve predictions of the future of crocodylians in response to the ongoing climate emergency. Predictions are usually based on the present-day distribution of a species, but a species might not occupy all areas that are climatically suitable for it due to past anthropogenic disturbances. Combining fossil, archaeological, historical, and present-day data for the Chinese alligator, one of the world's most Critically Endangered reptiles, changes projected suitable habitat area, with implications for conservation and rewilding.

DATE: SAT 11th February 2023

TIME: 16:00

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We will be hosting a bake sale during the afternoon to raise money for Geology for Global Development (GfGD).

Geology For Global Development.

https://www.gfgd.org/

GfGD is a charitable organisation that is involved in projects both internationally and in the UK, with the aim to support the implementation of the UN sustainable development goals.

GfGD develop and support programmes to improve lives and livelihoods in the Global South, through access to geological science. Current projects include providing hydrogeology and water management training materials to NGOs in eastern Africa, alongside funding research projects into how to improve current water programmes in place. They also worked with partners in the UK and India to deliver training on natural hazards, disaster risk reduction, and climate change to approximately 100 students and teachers from 11 schools in Ladakh. This programme was part of a major international conference on sustainable development.

GfGD groups in universities highlight the importance of the earth sciences in international development, inspiring students to take an active role in achieving the UN Sustainable Development Goals. The groups are led by GfGD Ambassadors and are involved in a range of activities throughout the year, from raising awareness about GfGD, to inviting speakers to give talks, putting on film screenings and organising fundraisers.