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DLP Speakers 2024

Cédric M. John
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Laura De Santis
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Jenny A. Gales
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Rosalind M. Coggon
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The ECORD Distinguished Lecturer Programme

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The ECORD Distinguished Lecturer Programme (DLP) is designed to bring the exciting scientific discoveries of IODP to the geosciences community in ECORD and non-ECORD countries. Distinguished Lecturers will give lecturers in each of the four main thematic areas of IODP Science Plan 2013-2023.
http://www.iodp.org/Science-Plan-for-2013-2023/

HOW TO HOST A LECTURE?

Apply via electronic mail to: ***essac@ogs.it***

The application should include:

1. a list with more than one choice of speaker (1st, 2nd, optionally 3rd choice) – this provides more flexibility in scheduling and increases your institution's chance of hosting a lecture; and
2. the name, address, telephone number and email address of a contact person in your institution for communications with the ESSAC Office and the lecturer.

The Distinguished Lecturer will then liaise directly with you to decide a suitable date. ECORD funding will cover the speaker's travel expenses; host institutions are asked in turn to provide local transportation, housing, and meals for the speaker. Only one lecture per institution will be funded. The schedule of the lecturers will be principally based on the applications received by **23 December 2023**, although later applications can also be considered.

ECORD Distinguished Lecturer Programme

Drilling Down the Data: A Deep Learning Dive into IODP Cores

Cédric M. John (Queen Mary University London, UK)

Climate & Ocean Change

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Earth Connections

The International Ocean Discovery Program (IODP) stands as a testament to human curiosity, having amassed a diverse collection of drilling cores which provide a window into geological processes. Core data is pivotal for understanding our planet's past, present, and future. Despite this richness, extracting meaningful insights from core description poses significant challenges due to the inherent complexity and variability of the data, the amount of existing material, and the subjectivity of the interpreter.

Focusing largely (but not exclusively) on carbonate rocks, characterized by their heterogeneity at all observational scales, I will discuss how my research group and I have pioneered the application of deep-learning computer vision to geological core interpretation. This technology transcends the traditional, tedious manual interpretations of cores, offering a rapid, and often more accurate, alternative for delineating depositional environments and sequence stratigraphy. Convolutional neural networks (CNNs) form the backbone of our approach, enabling us to process core data with unprecedented efficiency. I will show that these sophisticated models, when correctly trained and fed with substantial datasets, serve as invaluable tools for geologists, outpacing conventional methods in speed without compromising on precision.

Our early work was centred on transfer learning, an AI approach that adapts pre-existing models to new data. I will show that this remains one of the best way to train classification algorithms for geological dataset. But we also worked on generative algorithms that fill gaps in our sampling of core imagery: for instance, we use Generative Adversarial Networks (GANs) to transform the resistivity images from formation micro scanners into representations mirroring actual core photographs, thus enhancing the interpretability for geologists irrespective of their background in downhole tools.

We tackle the often-limiting factor of dataset size in two ways. First, we recourse to generative AI to oversample our training set. Second, we also explore semi-supervised learning techniques. I will demonstrate that we successfully train models on core deformation images from IODP with minimal labelled data, achieving accuracy on par with, if not exceeding, that of transfer learning models.

The arc of my talk will thus chart the course of deep learning's evolution from a mere auxiliary tool to a pivotal force in geological sciences. Results from my research group and the broader research community indicate a promising future where deep learning not only streamlines the interpretation process but also provides robust, systematic insights that could revolutionize our understanding of geological data.

ECORD Distinguished Lecturer Programme

Ice sheet and ocean interaction, paleoclimate and paleoceanographic record during past glacials and interglacials

Laura De Santis (National Institute of Oceanography and Applied Geophysics OGS Trieste, Italy)

The West and East Antarctic ice sheets are the largest and oldest on Earth. Their fluctuations since the early Oligocene, triggered by orbital and greenhouse gas-induced climate variations influenced global sea level and ocean circulation until the Northern Hemisphere ice sheets developed in the Pliocene. Thereafter, the volume of the Antarctic ice sheets changed little compared to the Arctic ice sheets younger "sisters", which are much more sensitive to climate variability in the cooler and drier low-CO2 Quaternary world.
The sparse IODP sites from the continental margin suggest that some marine-based sectors of the Antarctic ice sheet likely retreated during the warmest Plio-Pleistocene interglacials, possibly under the influence of ocean warming and rising sea levels.
Observations that shed light on the maximum extent and retreat of the ice sheet over the continental shelf in the past, together with paleo environmental proxies are crucial for reconstructing changes in ice sheet volume and ice dynamics during glacial and interglacial periods. Estimates of ice sheet extent and environmental conditions in the past can be obtained by identifying the transition from subglacial to near-ice sediments, which coincides with the so-called “ice grounding zone”, i.e. the point at which the ice sheet detaches from its bedrock, begins to float and generally expands into ice shelves. These paleo-ice sheet reconstructions are then used to predict the rate and mechanism of the response of modern ice sheets to climate warming and the resulting global sea level rise.
This talk will present examples of sediments from the grounding zone of the ice sheet recovered during IODP Exp 374 and previous drilling projects in Antarctica. The correlation of sedimentary units with seismic profiles via the borehole logs allows the acoustic facies of these deposits to be characterised, which can be mapped spatially around the drilling sites and elsewhere in the area. This information is combined with paleoenvironmental and water depth information obtained from the sediments to reconstruct paleobathymetric maps that provide a fundamental basis for estimating the volume of the ice sheet and ice flow pathways as well as ice and ocean interaction in the past.

Climate & Ocean Change

ECORD Distinguished Lecturer Programme

The starring role of Scientific Ocean Drilling to discover the changing states of Earth's Climate during the past 66 million years

Thomas Westerhold (MARUM University Bremen, Germany)

Average global temperatures are rising due to anthropogenic emission of greenhouse gases. What will be the consequences? Has this happened before in Earth history? Did other climate states in the past exist with greenhouse gas concentrations like today or even higher? And if so, what was the main climate response to it? Those are just a few of the pressing questions we would like to know more about for our future. Sediment deposits at the bottom of the ocean are some of the only continuous archives recording changes in Earth's climate for the last ~100 million years. Ocean floor sediments are prime target for scientific ocean drilling giving access to material to reconstruct past environmental and climatic conditions essential for understanding earth system processes.

In this lecture I will take the audience on a journey following the motivation and milestones reconstructing Earth's global climate variability throughout the Cenozoic, the last 66 million years. Insight will be given to the key role of scientific ocean drilling and the international collaborative efforts associated with to enable the assembly of Earth fever curve of the past. Because resolving Earth's climate response to astronomical forcing is essential to understand past climate dynamics and the processes involved, the lecture in particular will focus on the development of the Cenozoic Global Reference benthic foraminifer carbon and oxygen Isotope Dataset, the CENOGRID. The curve is a major product of the IODP Science Plan Illuminating earth's past, present, and future. For the first time the record statistically disentangled four climate states of the Cenozoic: Hothouse, Warmhouse, Coolhouse, Icehouse. Depending on greenhouse gas concentrations and polar ice sheet volume Earth's climate showed a distinctive response, or fingerprint, to astronomical forcing during each of the climate states. We now know more accurately when it was warmer or colder and we also have a better understanding of the underlying dynamics behind past climate changes.

Climate & Ocean Change

ECORD Distinguished Lecturer Programme

Drilling volcanic rifted margins to understand large igneous provinces and associated global warming

Sverre Planke (University of Oslo, Norway)

Continental breakup is a rare, but fundamental Earth event driven by massive internal forces. The splitting of Europe from Greenland some 56 million years ago was likely triggered by hot material rising from the deep mantle, forming a large igneous province. The breakup magmatism was associated with a global warming and extinction event, the Paleocene-Eocene Thermal Maximum (PETM).

IODP Expedition 396 successfully drilled 20 holes on the mid-Norwegian continental margin to better understand continental breakup processes and to test the hypothesis that associated voluminous magmatism triggered the PETM. Hole locations were carefully selected on conventional and high-resolution 3D seismic data. In total, > 4 km of sediments and volcanic rocks were drilled, recovering 2 km of core. The expedition recovered the first sub-basalt rocks on the Norwegian margin, documenting the presence of granite and inter-basalt sandstones on the Kolga High. We also cored three different seaward dipping reflectors (SDR) facies units on the Vøring Margin, representing basaltic lava flows emplaced in sub-aerial, coastal, and deep marine environments, respectively. An Outer High named Eldhø, was sampled at the termination of the Inner SDR and recovered spectacular pillow basalt units. The PETM interval was cored at the ten Modgunn Arch and Mimir High holes. The Modgunn holes drilled into the upper part of a hydrothermal vent complex. High-resolution palynology and isotope geochemistry document that the hydrothermal venting took place near the start of the PETM, supporting the hypothesis that the global warming event was triggered by shallow-water eruption of greenhouse gases formed by heating of organic-rich sediments intruded by magmatic sills.

In conclusion, scientific drilling has provided essential data to document how the Earth's internal processes have influenced the environment and life in deep time. To understand the environmental changes in the future, it is critical to keep on drilling the ocean basins to test new hypotheses and to discover our geological past.

Climate & Ocean Change

Earth Connections

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Deciphering Antarctic continental slope processes: new insights through ocean drilling

Jenny A. Gales (University of Plymouth,UK)

Antarctica's continental slopes hold invaluable insights for understanding past climate, ice-sheet dynamics, ocean circulation, erosional and depositional processes, and submarine geohazards over millennial timescales. Antarctica has been the recent focus for International Ocean Discovery Program (IODP) Expeditions 374, 379 and 382, recovering hundreds of meters of continental slope records. This lecture presents some of the multidisciplinary results from these recent expeditions arising from Antarctic continental slope records, particularly focusing on submarine geohazards. Antarctica's continental margins constitute an unknown geohazard risk, such as submarine landslide-generated tsunamis that pose threats to Southern Hemisphere populations and infrastructure. A major submarine landslide complex was drilled during IODP Expedition 374 on the eastern Ross Sea slope, identifying submarine landslide preconditioning factors and failure mechanisms. These recurrent submarine landslides were likely triggered by seismicity associated with glacioisostatic readjustment, leading to failure within preconditioned, climatically controlled weak layers and highlights risk of future slope failure across the region. We show multidisciplinary datasets that constrain the signature of down and along-slope processes and examine factors driving their timing, frequency, and impact. Deciphering these processes offers immense potential in understanding historical ocean circulation shifts, for example, when climates resembled 'worst-case' future climatic scenarios which could help understand anticipated changes in ice retreat and subsequent sea-level rise. These processes are also becoming increasing important economically as international interest in subsea internet cable connections to Antarctica grows. We discuss the implications of these findings in relation to Neogene and Quaternary West Antarctic Ice Sheet expansions to the shelf edge and finally discuss forthcoming research directions and opportunities.

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Biosphere Frontiers

The IODP South Atlantic transect: Low-temperature Ridge Flank Contributions to Global Biogeochemical Cycles and Archives of Changing Global Conditions

Rosalind M. Coggon (University of Southampton, UK)

Throughout its life the ocean crust is a key boundary between Earth's interior and the oceans/atmosphere. Hydrothermal circulation of seawater-derived fluids through the cooling and aging crust results in chemical exchange between Earth's interior and oceans and atmosphere, playing an important role in long-term biogeochemical cycles.

Hydrothermally altered ocean crust provides a time-integrated record of its geochemical exchange with seawater. Just as cooling crust preserves a signal of Earth's magnetic field and hence a record of plate tectonics, cores recovered by scientific ocean drilling have revealed that hydrothermal minerals that form from seawater-derived fluids across the ridge flank record the evolving chemistry of the overlying oceans – itself an integrator of a range of Earth processes. This led to a dramatic shift in appreciation of studies of hydrothermally altered ocean crust, as they enable us to both reconstruct past ocean chemistry and decipher the Earth processes responsible for variations in these records. I will present an overview of how scientific ocean drilling experiments across ridge flanks contribute to our understanding of the processes that control ridge flank hydrothermal exchanges, the role these exchanges play in global geochemical cycles, and the extent to which they record and respond to wider changes in the Earth system.

The South Atlantic Transect (IODP Expeditions 390C/395E/390/393) was designed to recover the upper crust and overlying sediments across the western flank of the slow-spreading Mid-Atlantic Ridge to investigate hydrothermal aging and microbiological evolution of the ocean crust, and the paleoceanographic evolution of the overlying South Atlantic. This lecture will include an overview of this multi-disciplinary drilling campaign, with a particular focus on how the recovered crustal cores have revealed that the extent and duration of ridge flank hydrothermal carbonate precipitation are influenced by crustal architecture, which is strongly influenced by spreading rate. Consequently, ridge flank hydrothermal contributions to the long-term planetary carbon cycle depend on the global length of slow-, intermediate-, and fast-spreading ridges and the age distribution of the ridge flanks, which have varied significantly throughout the Phanerozoic.