



Natural History Museum

Advancing the science to support deep-sea mining policy

Flett Theatre, Natural History Museum, Cromwell Road, London, SW7 5BD, Wednesday 22 April 2026



SMARTEX

smartexccz.org

Funding for the SMARTEX project is provided by the UK's Natural Environment Research Council



British Geological Survey



UNIVERSITY OF LIVERPOOL



Plymouth Marine Laboratory



SAMS Scottish Association for Marine Science



University of Southampton



SMARTEx is a UK Natural Environment Research Council (NERC) funded research project focused on understanding the ecosystems and biodiversity associated with polymetallic nodules in a vast 6 million km² region of the central Pacific Ocean, the Clarion Clipperton Zone. These nodules are of growing industrial interest for developing new sustainable technologies, yet they lie in remote abyssal environments that remain poorly understood.

The project has investigated how the deep-sea ecosystem in the Clarion Clipperton Zone functions, how its different components interact, and how resilient it may be to potential mining impacts. Researchers assessed how water, surface sediments, and deeper sediments are connected and evaluated nutrient and metal cycling processes essential for ecosystem health and potentially vulnerable to disturbance.

The structure of the seabed has been mapped and the physical nature of the sediments linked to biological patterns. The biological processes that lead to these patterns have been studied by detailing the life histories, reproduction and connectivity of the organisms present to understand how diverse, structured communities and food webs are maintained. The ecological functions that these organisms provide to maintain a healthy ecosystem have also been evaluated. The impact of mining and the recovery of these processes and patterns has been determined to assess the biological and functional consequences of disturbance in the deep sea.

Finally, mathematical models have been used to predict the consequences of mining across larger spatial and temporal scales. These insights will help assess environmental risk and support informed decision-making about the future of deep-sea mining.

Programme

1030 – 1100	Arrival	
1100 – 1110	Welcome	Prof. Sandy Knapp, Director of Research, Natural History Museum
1110 – 1310	Key science findings: The baseline	
	Introduction to SMARTEX	Prof. Daniel Jones, National Oceanography Centre
	Nodules	Dr Hannah Grant, British Geological Survey
	Ocean currents	Dr Andrew Dale, Dr Dmitry Aleynik, Scottish Association for Marine Science
	Dispersal	Dr Tim Szewczyk, Scottish Association for Marine Science
	Habitat spatial variability	Dr Loic van Audenhaege, National Oceanography Centre
	Questions	
	Habitat temporal variability	Callum Slade, Natural History Museum
	New species	Prof. Thomas Dahlgren, NORCE
	Genetic connectivity	Dr Belén Arias, Natural History Museum
	Reproductive physiology	Prof. Jon Copley, University of Southampton
	Ecotoxicology	Dr Mark Hartl, Heriot-Watt University
	Questions and discussion	
1310 – 1430	Lunch and exhibits	
1430 – 1630	Key science findings: Deep-sea mining impacts	
	Introduction to OMCO	Prof. Daniel Jones, National Oceanography Centre
	Sediment and organic matter	Dr Rachel Jeffreys, University of Liverpool
	Sediment disturbance	Dr Hannah Grant, British Geological Survey
	Ecosystem functioning	Prof. Andrew Sweetman, Scottish Association for Marine Science
	Foraminifera	Dr Bryan O'Malley, Eckerd College, Florida
	Questions	
	Megafauna	Bethany Fleming, University of Southampton
	Modelling	Dr Sophy Oliver, National Oceanography Centre
	Climate change	Dr Anieke Brombacher, National Oceanography Centre
	APEI network	Dr Molly James, Plymouth Marine Laboratory
	Wider context	Prof. Adrian Glover, Natural History Museum
	Questions	
1630 – 1715	Tea, cakes and exhibits	
1715 – 1815	Policy panel: The implications of the science findings	
1830 – 1930	Evening reception in Earth Galleries Hall	
1930 – 2100	Film: How Deep is Your Love	

Policy panel members



Emma Woods, Director of Policy & Partnerships at the Natural History Museum (panel chair)

Emma has spent her career using evidence to enrich policy, practice and public debate. With a background in biological and environmental sciences, her work has focused on the wellbeing of people and planet, most at recently the Royal Society and the UN Convention on Biological Diversity. Having set up the Natural History Museum's Policy Unit in 2022, she now leads teams responsible for policy, government relations and international partnerships. She aims to increase the Museum's sphere of influence in the UK and globally – on issues from protecting 30% of nature by 2030 to the future of deep-sea mining.



Professor Adrian Glover, Merit Researcher at the Natural History Museum

Adrian is a zoologist, oceanographer and biodiversity scientist passionate about exploration and discovery in the remotest places on our planet. He holds a Merit Researcher position at the Natural History Museum, London where he leads the Deep-Sea Systematics and Ecology Group. He has over 20 years' experience leading deep-ocean and polar research in the remotest places on our planet including multiple expeditions with robotic and manned deep-sea submersibles. His research is focused on using the latest integrative taxonomic methods to describe new species, study their evolutionary origin, test general theories in biodiversity science and discover hidden value in their natural products.



Professor Anjali Goswami, Chief Scientific Adviser at the UK Department for Environment, Food and Rural Affairs

Anjali is a research leader in evolutionary biology and former Dean of Postgraduate Education at the Natural History Museum, London, an Honorary Professor in the Department of Genetics, Evolution and Environment at University College London, and Past President of the Linnean Society of London.

She received her B.Sc. from the University of Michigan in 1998 and her PhD from the University of Chicago 2005, followed by a US National Science Foundation fellowship held at the Natural History Museum and a JRF at King's College and lectureship in Earth Sciences at the University of Cambridge. Her expertise is in vertebrate evolution and development, particularly in the emerging area of evolutionary phenomics. She and her group develop and apply new approaches to capturing the complex three-dimensional shapes of organisms in order to reconstruct the evolution of biodiversity. Her work spans insects to dinosaurs, but her main interest is in the evolution of mammals. To fill key gaps in the palaeontological record, she has searched for

fossils from Svalbard to Madagascar, with her primary fieldwork being based in South India.

She is the recipient of the Linnean Society Bicentenary Medal, the Zoological Society of London Scientific Medal, the Hind Rattan Award, the Society of Vertebrate Paleontology Robert L. Carroll award, the Palaeontological Association President's Medal, and the Humanists UK Darwin Day Medal. She was elected to the fellowship of the Royal Society of London in 2024



Julian Jackson, Project Director, Ocean Governance, The Pew Charitable Trusts

Julian Jackson heads Pew's work to safeguard the marine environment by advocating for precaution in the development of a management regime for deep seabed mining at the International Seabed Authority. He also leads engagement in Europe on Pew's campaign to protect ocean life on the high seas. Julian was a civil servant with the U.K. government, working on international agriculture and biodiversity policies. He led the U.K.'s delegation to various international negotiations with the United Nations Food and Agriculture Organization and the Convention on Biological Diversity.



Professor Daniel Jones, Strategic Lead Biodiversity, National Oceanography Centre (panel overview)

Daniel has been at the National Oceanography Centre (NOC) for over 20 years. He specialises in understanding temporal and spatial patterns in marine ecosystems, including those impacted by anthropogenic disturbances. Much of his work is around biodiversity in some form and addresses everything from the fundamental science to policy development and environmental management. He leads the SMARTEX project and has been part of many other projects on the ecosystems of interest for deep-sea mining. He has carried out extensive offshore fieldwork globally, including to the Pacific Clarion Clipperton Zone and the Mid-Atlantic Ridge. He likes working on issues that bring together multidisciplinary expertise to try and understand and manage key scientific and societal issues.



Bruno Pozzi, Chef de Cabinet at the International Seabed Authority

Mr. Bruno Pozzi is the Deputy to the Secretary General and Chef de Cabinet of the International Seabed Authority. A career diplomat, Bruno has over 25 years of experience in international relations, diplomacy and politics and has worked across three different continents in a range of political, environmental and economic roles.

Prior to joining the International Seabed Authority, Bruno worked with the UN Environment Programme in Nairobi, as the Deputy Director of the Ecosystems Division. He also previously served as the UNEP Regional Director for Europe based in Geneva, covering the pan European region and the EU.

Prior to joining the UN, Bruno served in multiple high-level functions for the European Union in Kenya and Cote d'Ivoire, as well as for Belgium in South Africa, China and Japan.

Bruno's approach to multilateralism is shaped by three core convictions: first, that political and technical expertise are at the heart of multilateralism; second, that sustainable development, peace and prosperity cannot be achieved without a holistic approach that brings socio-economic and environmental considerations in development policies; and third, that economic transformation and innovation can, and must, be leveraged as key drivers of a sustainable future for all.



Christopher Williams, CEO UK Seabed Resources Ltd

Chris is the CEO of UK Seabed Resources Ltd, the holder of two UK-sponsored exploration licences for polymetallic nodules in the Clarion Clipperton Zone and a project partner in SMARTX. From 2015 to 2023 Chris managed Lockheed Martin's seabed minerals subsidiary, delivering a comprehensive mineral exploration programme through partnership with over a dozen world-leading academic institutions including NHM and NOC. Chris was previously the head of UK Government Affairs at Lockheed Martin. Until 2013 he was a professional civil servant working across a number of UK Government departments including the Cabinet Office. Chris has a master's degree in zoology from Cambridge University.

SMARTEX Publications

2026

Bribiesca-Contreras et al. **Drifting in the abyss: an in-situ observation of swimming in Psychropotes (Psychropotidae, Elaspodida, Holothuroidea)**. <https://doi.org/10.1007/s12526-025-01618-w>

Kaur et al. **Automated morphometric analysis and biomass estimation of marine nematodes using a conical frustum segmentation approach**. <https://doi.org/10.1016/j.ecoinf.2026.103728>

Van Audenhaege et al. **The role of habitat mosaics on biological communities at hydrothermal vents and their periphery**. <https://doi.org/10.1038/s41598-026-39544-x>

Swanborn et al. **Deep ocean seascape ecology: gaps and pathways for application**. <https://doi.org/10.1007/s10980-025-02283-x>

2025

Bribiesca-Contreras et al. **Hidden gems of the abyss: first species of azooxanthellate scleractinian coral (Scleractinia: Deltocyathidae) attached to polymetallic nodules in the eastern Pacific Ocean**. <https://doi.org/10.1093/zoolinnean/zlaf146>

Drennan et al. **On Anguillosyllis cf. hessleri Maciolek, 2020 – A species complex from the Clarion-Clipperton zone, abyssal central Pacific**. <https://doi.org/10.1016/j.dsr.2025.104453>

Fleming et al. **Influence of seabed heterogeneity on benthic megafaunal community patterns in abyssal nodule fields**. <https://doi.org/10.1525/elementa.2024.00049>

Jones et al. **Long-term impact and biological recovery in a deep-sea mining track**. <https://doi.org/10.1038/s41586-025-08921-3>

Mejía-Saenz et al. **Discovery of a mud-covering cephalopod evidences the complex life habits in the abyss**. *Ecology*, <https://doi.org/10.1002/ecy.70257>

Neal et al. **New species of Anguillosyllis Day, 1963 (Annelida, Syllidae) from polymetallic nodule exploration areas, eastern Clarion-Clipperton Zone, central Pacific Ocean**. *European Journal of Taxonomy*, <https://doi.org/10.5852/ejt.2025.1026.3105>

Simon-Lledó et al. **Marked Variability in Distance-Decay Patterns Suggests Contrasting Dispersal Ability in Abyssal Taxa**. <https://doi.org/10.1111/geb.13956>

2024

Hartl et al. **At-sea application of the comet assay to a deep-sea fish**. <https://doi.org/10.1016/j.dsr.2024.104298>

Stewart et al. **Biogeography and phylogeny of the scavenging amphipod genus Valettietta (Amphipoda: Alicelloidea), with descriptions of two new species from the abyssal Pacific Ocean**. <https://doi.org/10.1093/zoolinnean/zlae102>

Sweetman et al. **Evidence of dark oxygen production at the abyssal seafloor**. <https://doi.org/10.1038/s41561-024-01480-8>

2023

Bravo et al. **Toward an ecosystem-services based management approach for deep-ocean industries**. <https://doi.org/10.3389/fmars.2022.994632>

Fairbairn et al. **Bathysnap IV - Development of a new time-lapse photography free-fall benthic lander**. <https://doi.org/10.1109/OCEANSLimerick52467.2023.10244498>

Hitchin et al. **Thresholds in deep-seabed mining: A primer for their development**. <https://doi.org/10.1016/j.marpol.2023.105505>

Mejía-Saenz et al. **Rock outcrops enhance abyssal benthic biodiversity.**, Deep Sea Research Part I: Oceanographic Research Papers, 10.1016/j.dsr.2023.103999.

Neal et al. **Taxonomy, phylogeny, and biodiversity of Lumbrineridae (Annelida, Polychaeta) from the Central Pacific Clarion-Clipperton Zone.** <https://doi.org/10.3897/zookeys.1172.100483>

Rabone et al. **How many metazoan species live in the world's largest mineral exploration region?** <https://doi.org/10.1016/j.cub.2023.04.052>

Rabone et al. **A review of the International Seabed Authority database DeepData from a biological perspective: challenges and opportunities in the UN Ocean Decade.** <https://doi.org/10.1093/database/baad013>

Simon-Lledó et al. **Carbonate compensation depth drives abyssal biogeography in the northeast Pacific.** <https://doi.org/10.1038/s41559-023-02122-9>

Simon-Lledó et al. **Mass falls of crustacean carcasses link surface waters and the deep seafloor.** <https://doi.org/10.1002/ecy.3898>

Stewart et al. **Biodiversity, biogeography, and connectivity of polychaetes in the world's largest marine minerals exploration frontier.** <https://doi.org/10.1111/ddi.13690>

Uhlenkott et al. **Habitat heterogeneity enhances megafaunal biodiversity at bathymetric elevations in the Clarion Clipperton Fracture Zone.** <https://doi.org/10.1007/s12526-023-01346-z>

Washburn et al. **Seamount mining test provides evidence of ecological impacts beyond deposition.** <https://doi.org/10.1016/j.cub.2023.06.032>

Wiklund et al. **Checklist of newly-vouchered annelid taxa from the Clarion-Clipperton Zone, central Pacific Ocean, based on morphology and genetic delimitation.** <https://doi.org/10.3897/BDJ.11.e86921>

2022

Hoving et al. **The abyssal voyage of the argonauts: Deep-sea in situ observations reveal the contribution of cephalopod egg cases to the carbon pump.** <https://doi.org/10.1016/j.dsr.2022.103719>

Neal et al. **Abyssal fauna of polymetallic nodule exploration areas, eastern Clarion-Clipperton Zone, central Pacific Ocean: Amphinomidae and Euphosinidae (Annelida, Amphinomida).** <https://doi.org/10.3897/zookeys.1137.86150>

Stratmann et al. **Habitat types and megabenthos composition from three sponge-dominated high-Arctic seamounts.** <https://doi.org/10.1038/s41598-022-25240-z>

Uhlenkott et al. **Investigating the benthic megafauna in the eastern Clarion Clipperton Fracture Zone (north-east Pacific) based on distribution models predicted with random forest.** <https://doi.org/10.1038/s41598-022-12323-0>

Weaver et al. **Assessing plume impacts caused by polymetallic nodule mining vehicles.** <https://doi.org/10.1016/j.marpol.2022.105011>

2021

Bribiesca-Contreras et al. **Biogeography and Connectivity Across Habitat Types and Geographical Scales in Pacific Abyssal Scavenging Amphipods.** <https://doi.org/10.3389/fmars.2021.705237>

Drazen et al. **Regional Variation in Communities of Demersal Fishes and Scavengers Across the CCZ and Pacific Ocean.** <https://doi.org/10.3389/fmars.2021.630616>

Hollingsworth et al. **Spatial Variability of Abyssal Nitrifying Microbes in the North-Eastern Clarion-Clipperton Zone.** <https://doi.org/10.3389/fmars.2021.663420>

Jones et al. **Environment, ecology, and potential effectiveness of an area protected from deep-sea mining (Clarion Clipperton Zone, abyssal Pacific).** <https://doi.org/10.1016/j.pcean.2021.102653>