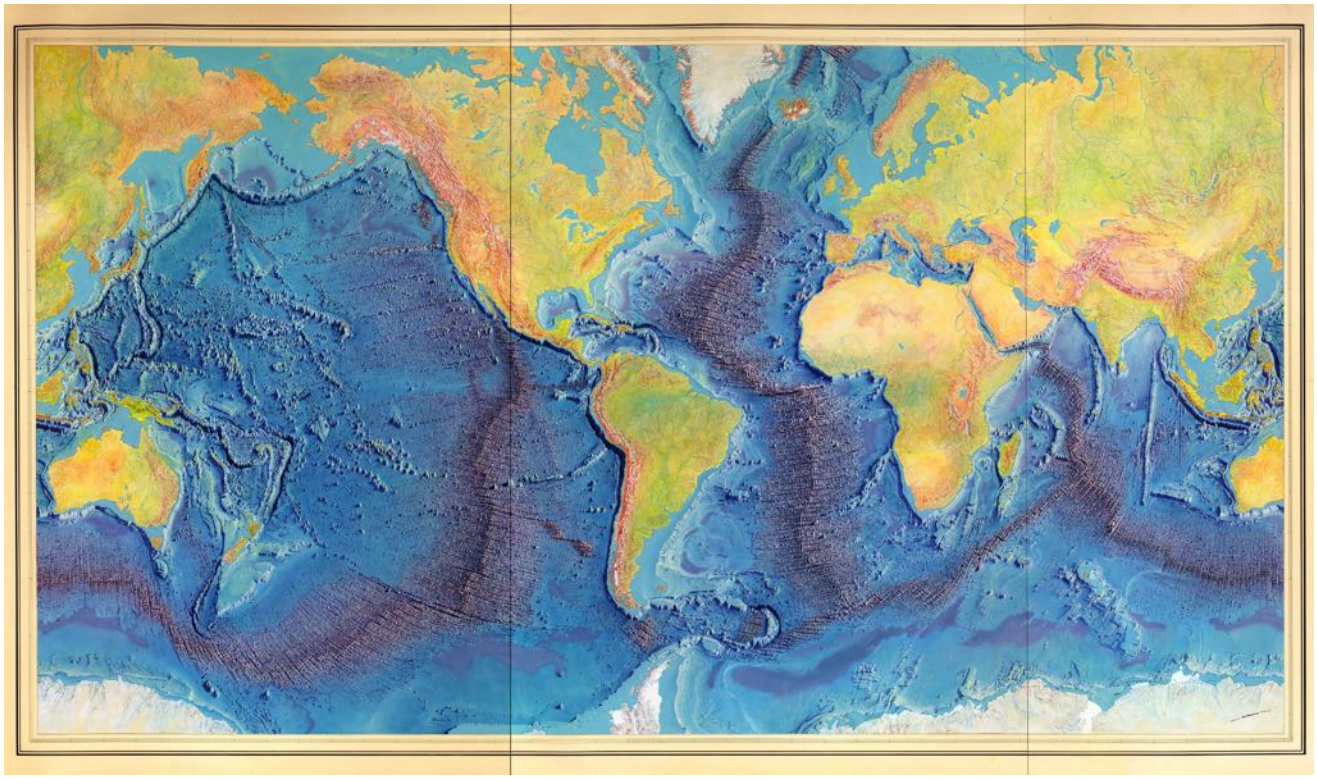
European Geoscience Union
GIFT – Geoscience Information for Teachers



GIFT 2025

EXPLORING THE SEA FLOOR

Vienna, Austria, 27-30 April 2025

Dear Teachers,

Welcome to the 2025 GIFT workshop!

For 2025 we return to Vienna for our 23rd GIFT workshop 'Exploring the Sea Floor' - in the middle of UNESCO's Ocean Decade.

The Sea Floor (a.k.a. the seabed, ocean floor & ocean bottom) is a complex and intriguing landscape, subject to many of the geological processes we experience on land. While its landscape continues to change, it is worth remembering that as of May 2023, 75% of the world's sea floor was yet to be mapped, in part because of its inaccessible and challenging nature (remember the lowest point in the ocean is much deeper than the highest point on land). Although out of sight for so long, the sea floor has the same general characteristics of the continental land with mountains, plains, channels, canyons, ridges, exposed rocks and sediment covered areas. The sea floor allows scientists to draw connections between volcanic, tectonic, hydrothermal, and biological systems in order to better understand the Earth's remarkable, evolving geography. Leading experts in many of these topics will join us at GIFT and share their knowledge with us across an exciting 2.5 days.

We will kick-off on Monday morning looking back at the history of seafloor explorations in the hands of **Angelo Camerlenghi** from OGS Trieste, Italy. Continuing our retrospective view, **Jason P. Morgan** will join us and highlight some aspects of the Expedition of 'F.A.M.O.U.S' (French American Midocean Undersea Study) that took place over 50 years ago and gave us the first glimpses of the deep ocean floor.

Without leaving our seats in Vienna, we will head to MARUM, an internationally recognised centre for marine research anchored at the University of Bremen where **Ulrike Prange** and colleagues will show us some of the inner workings of the Bremen Core Repository. Here, more than 192 km of cores from the Atlantic, Arctic Ocean, Baltic Sea, Mediterranean and Black Sea are stored.

Those cores are extracted at sea as part of ocean drilling investigations by IODP and others. **Sharon Katz Cooper** from the Lamont Doherty Earth Observatory in Columbia University, USA will update us on how teachers continue to engage with the IODP Schools of Rock which are educational workshops enabling teachers to become familiar with the International Ocean Discovery Program (IODP), scientific drilling and earth science through interactions with IODP scientists and Education/Outreach Officers.

Our final lecture of the Monday will be given by **Rouwen Lehné** and focus upon what we can learn from sea floor studies past and present around Iceland.

Day 2 begins with a focus upon hydrothermal vents. These 'hot springs' form on the ocean floor at locations where seawater meets magma. They have rich and diverse chemistries and are home to unusual organisms, often seen nowhere else on our planet. **Valérie Chavagnac** will speak first (via Zoom) about the geological aspects, before **Daphne Cuvelier** focusses our attention upon the unusual biodiversity of these vents.

After an interlude for more practical ideas, we shall discover what can be revealed about of our understanding of the mid-ocean ridge system when it makes a rare appearance above ground, with **Georges Ceuleneer** from CNRS in Toulouse taking us to Oman in the Middle East. It is then the turn of **Jean-Marc Lardeaux** from the University Cote d'Azur to take us higher and explore orogenesis (the process of mountain building that occurs when two tectonic plates collide).

Our final day focuses a little more on tectonics beginning with a look at subduction zones in the company of **João C. Duarte** from the University of Lisbon in Portugal. We will then welcome a second online presentation, with **Mathilde Cannat** joining us from the Institut de Physique du Globe de Paris to discuss the formation of oceanic crust and the tectonic and magmatic diversity of mid-ocean ridges.

GIFT 2025 will close with two presentations focussed upon different aspects of minerology of the sea floor. **Sabina Palinkas** will bring us insights from the Arctic Ocean and discuss sulfide mineralization along ultraslow spreading ridges before **Clifford Patten** closes our workshop with a reminder of what is buried below the sea floor; a buried treasure perhaps!

Following a tradition in the GIFT workshops, the presentations will be intermixed with practical hands-on activities and sharing of online tools and resources ably demonstrated by **András Zlinszky** and **Faustine Gendron,** members of the EC and our team of Geosciences Education Field Officers (GEFO).

And, of course, we will have presentations of 47 posters by those of you who wish to present to a wider group under the theme '*Discovering the oceans and sea floor in class.'* This poster session is a great Networking and sharing opportunity and its likely we will be joined by various scientists, participating at the General Assembly, who have an interest in education.

As every year, and prior to the workshop, GIFT participants are most welcome to a guided tour of the Vienna Museum of Natural History this year given by **Mathias Harzhauser**, **Oleg Mandic** and **Anna Weinmann** beginning at 16:00 hrs on Sunday afternoon (at the NHM).

And at the end of the GIFT 2025 workshop, do not forget to fill out the evaluation form. The success and direction of future workshops also depends on you and your valued feedback.

Ready to start?

The Education Committee of EGU

Acknowledgements

The GIFT-2025 workshop has been organised by the EGU Education Committee. EGU has supported the major hare of the expenses, but the workshop has also benefited from the help of

We would also like to thank all the speakers who have contributed to this educational workshop and their institutions.

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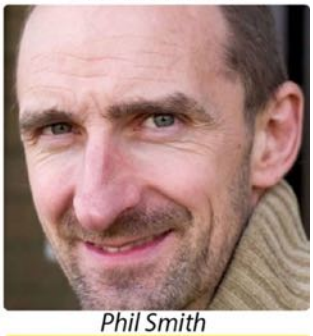

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Stavros Stathopoulos

Stephen Macko

Teresita Gravina

Programme

EUROPEAN GEOSCIENCES UNION – GENERAL ASSEMBLY

Geosciences Information for Teachers Workshop (GIFT) 2025

27-30 April 2025

'EXPLORING THE SEA FLOOR'

Sunday, 27 April 2025

16:00-18:00 **GUIDED TOUR OF THE NATURAL HISTORY MUSEUM VIENNA**

(Entrance: Maria-Theresien-Platz 1010 Vienna)

(optional) **WELCOME TO THE TEACHERS AND ATTENDEES OF GIFT**

Mathias Harzhauser, Oleg Mandic and Anna Weinmann

(Natural History Museum Vienna, Austria)

18:30-20:00 **ICE BREAKER PARTY AT AUSTRIA CENTER VIENNA (ACV)**

(optional) EGU General Assembly place

Bruno-Kreisky-Platz 1, 1220 Vienna

Monday, 28 April 2025

8:30-8:45 **OPENING GIFT25**

EGU and the Education Committee welcomes GIFT participants

Peter van der Beek (President of EGU)

Jean-Luc Berenguer (Chair of the Education Committee, EC)

TB1: Chair > **Jean-Luc Berenguer**

8:45-9:30 **THE MAJOR STAGES IN THE DISCOVERY OF THE SEA FLOOR (THE HISTORY OF SEA FLOOR EXPLORATION)**

Angelo Carmelenghi (OGS Trieste, Italy)

9:30-10:15 **THE FAMOUS DECADE: 1974-1984**

Jason Phipps Morgan (Institute of Marine Science, CSIC, Barcelona, Spain)

10:15-10:45: **AM COFFEE BREAK**

TB2: Chair > **Hélder Pereira**

10:45-11:15 **WELCOME TO THE BREMEN CORE REPOSITORY**

A virtual visit at MARUM - Center for Marine Environmental Sciences at the University of Bremen
Ulrike Prange (ESO Outreach Manager, Team Science Communication at MARUM)
Lecture by Zoom

11:15-11:35 **IODP SCHOOL OF ROCKS: AN ENDURING LEGACY FROM TWO DECADE OF IODP PROGRAMMING AND OPPORTUNITIES IN THE US AND BEYOND**

Sharon Katz Cooper (Lamont Doherty Earth Observatory, Columbia University, USA)

11:35-12:20 **ICELAND AND THE SURROUNDING SEA FLOOR: INSIGHTS INTO COMPLEX GEOLOGICAL SYSTEM FROM ITS ORIGINS TO THE PRESENT DAY**

Rouwen Lehné (Hessian Agency for Nature Conservation, Environment and Geology (HLNUG) Wiesbaden/Department Geology and Soil, Technische Universität Darmstadt, Germany)

12:15-12:30 **INSTRUCTIONS FOR THE POSTER SESSION & THE HANDS-ON SESSIONS**

12:30-14:00 **LUNCH BREAK**

TB3-TB4: **HANDS-ON ACTIVITIES (WS 1 and WS2)**
(2 groups alternating; 2 sessions x 1h30)

14:00-15:45 **WS 1: Exploring the ocean floor: Seeing plate tectonics below the waves**
Pete Loader[1], Pane Perunovski[1], Dragos Tataru[1], & Gina P. Correia[2] ([1]EGU Geoscience Education Field Officer, GEFO; [2]EGU Education Committee)

16:15-18:00 **WS 2: COPERNICUS BROWSER: AN OPEN ONLINE PLATFORM FOR TEACHING GEOGRAPHY WITH SATELLITE (SENTINEL 2) IMAGES**
András Zlinszky (Copernicus Data Space Ecosystem Sinergise Solutions GmbH, Hungary)

18:00-19:00 **TOUR OF THE EGU EXHIBITION**

19:00-20:00 **TOWNHALL MEETING**

(optional) **THE EDUCATIONAL ACTIVITIES ORGANISED WITHIN SEVERAL COMMITTEES AT EGU IN COOPERATION WITH OUTREACH AND EDI COMMITTEES. PRESENTATION OF THE EDUCATION COMMITTEE GOALS AND INITIATIVES**

Stavros Stathopoulos, Gina P. Correia, Giuliana Panieri, Teresita Gravina, Solmaz Mohadjer (EC members)

Tuesday, 29 April 2025

TB1: Chairs > Phil Smith

08:30-09:15 **THE DIVERSITY OF HYDROTHERMAL FLUID DISCHARGES AT THE SEAFLOOR ACCORDING TO THE GEOLOGICAL CONTEXT**

Valérie Chavagnac (Géosciences Environnement Toulouse, France)

Lecture by Zoom

09:15-10:00 **THE SEA FLOOR LIFE - BIODIVERSITY OF HYDROTHERMAL VENTS**

Daphne Cuvelier (Institute of Marine Sciences OKEANOS, University of the Azores, Portugal)

10:15-10:45: AM COFFEE BREAK

GROUP PHOTO IN FRONT OF ACV

TB2:

10:45-12:30 **HANDS-ON ACTIVITIES (WS 3 and WS 4)**

(2 groups alternating; 2 sessions x 45 minutes)

WS 3: Using maps to study the sea floor (paper and digital tools) with geomapapp. Presentation of the portal and exercises to calculate sea floor spreading rate (and/or plate motion) from the database

Francesca Funiciello and Teresita Gravina (EC members)

WS 4: From the sea floor to the classroom: how to engage secondary school students in oceanographic expeditions

Hélder Pereira and Faustine Gendron (Teachers at Sea)

12:30-14:00 LUNCH BREAK

TB3: Chair > **Jean-Luc Berenguer**

14:00-14:45 **EXPLORING THE DEEP OCEANIC LITHOSPHERE ON LAND: A FIELD TRIP IN THE OMAN OPHIOLITE**

Georges Ceuleneer (Observatoire Midi-Pyrénées, Géosciences Environnement Toulouse, CNRS, France)

15:00-15:45 **OCEAN CRUST IN THE MOUNTAINS (OPHIOLITHIC SERIES AND OROGENESIS)**

Jean-Marc Lardeaux (University Cote d'Azur, France)

15:45-16:15: AM COFFEE BREAK

TB4: Chairs > Annegret Schwarz, Gina Correia, Stephen Macko

16:15-18:00 **POSTER SESSION**

Teachers present and share school projects at EGU General Assembly

Discovering the oceans and sea floor in class

Convener: Annegret Schwarz

Co-Conveners: Gina Correia, Jean-Luc Berenguer, Stephen Macko

Members of the EGU Education Committee

18:00-19:00 **NETWORKING EVENT IN THE POSTER HALL**

Wednesday, 30 April 2025

TB1: Chairs > Francesca Cifelli & Francesca Funiciello

08:30-09:15 **WHEN SEA FLOOR DISAPPEARS IN THE SUBDUCTION ZONE - PLATE TECTONICS AND THE EVOLUTION OF SUBDUCTION ZONES**

João C. Duarte (University of Lisbon, Portugal)

09:15-10:00 **THE FORMATION OF OCEANIC CRUST AND THE TECTONIC AND MAGMATIC DIVERSITY OF MID-OCEAN RIDGES**

Mathilde Cannat (Institut de Physique du Globe de Paris, IPGP, France)

Lecture by ZOOM

10:00-10:15 **GIFT CERTIFICATES DISTRIBUTION**

10:15-10:45: **AM COFFEE BREAK**

TB2: Chairs > **Stavros Stathopoulos & Giuliana Panieri**

10:45-11:30 **FORMATION AND PRESERVATION OF SEA FLOOR MASSIVE SULFIDE MINERALIZATION ALONG ULTRASLOW SPREADING RIDGES: AN INSIGHT FROM THE ARCTIC OCEAN**

Sabina Strmic Palinkas (UiT The Arctic University of Norway and University of Bergen, Norway)

11:30- 12:15 **SEAFLOOR MINERAL RESOURCES**

Clifford Patten (Institute of Mineralogy and Petrology, Innsbruck University, Austria)

12:15 **GENERAL SESSION AND CONCLUDING REMARKS & GOOD BYE!**

Jean-Luc Berenguer & Stavros Stathopoulos (EC Committee)

GOOD BYE!

GUIDED TOUR OF THE NATURAL HISTORY MUSEUM VIENNA

Mathias Harzhauser, Oleg Mandic and Anna Weinmann

Natural History Museum Vienna

Mathias Harzhauser, on the right, Head of the Geological-Paleontological Department at the NHMW, and Professor at the University Graz (Austria) earned his degrees from the University of Vienna and has been employed by the NHM after his Master's thesis. He is interested in integrated stratigraphy and paleogeography of the Neogene Paratethys Sea and is a specialist for fossil gastropods. He is a corresponding member of the Austrian Academy of Sciences and is engaged in the popularization of science.

Oleg Mandic, on the left, is researcher and curator in the Geological-Paleontological Department at the NHMW and teaches at the University of Vienna (Austria). He is an expert for Eurasian Oligocene and Miocene stratigraphy and paleobiogeography and is a specialist for fossil bivalves. Oleg Mandic has worked at the NHMW since 2008 and is responsible for the collection of regional Tertiary geology.

Anna Weinmann is a micropaleontologist and earned her degree at the University of Bonn in Germany. She started her employment at the NHMW in 2020 and is the curator of the microfossil collection in the Geological-Paleontological Department. She specializes in fossil and recent foraminifera (single-celled organisms) including their biogeography and (paleo-)ecology.
at the NHMW since 2008 and is responsible for the collection of regional Tertiary geology.

Angelo Camerlenghi
Research Director
National Institute of Oceanography and
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Education

I studied Geology at the University of Milano, Italy from 1979 to 1984. Being curious about learning more about ocean science, and the geology of the Earth below the oceans, I moved to Texas A&M University in College Station, Texas in 1986 where I obtained a Master of Science (MSc) degree in Geological Oceanography in 1988. I returned to the University of Milano in 1988 to begin a Doctoral Program in Earth Science with a focus on Marine Geology. I obtained the PhD degree in 1991.

Career

My first job was part-time Student Technician at the Ocean Drilling Program, Texas A&M University, during my Master studies. I was hired in 1992 by the Osservatorio Geofisico Sperimentale, OGS in Trieste with five-year contract as post-doctoral researcher. I was hired permanently in 1997 as senior researcher, where I led the OGS Geophysical Interpretation research group. In 2024 I took the position of Research Professor of the Istitució Catalana de Recerca I Estudis Avançats at the University of Barcelona, Faculty of Geology. I moved back to OGS in 2012, where I took the position of Director of the Geophysics Research Section which I held until 2020. Since then, I have worked as Research Director.

Research interests

My research interests have changed throughout my career, always in the framework of Geological Oceanography. I have studied the geology and geophysics of continental margins, with special focus on polar depositional systems, the stability of submarine slopes and related geohazards, the geological setting and distribution of natural gas hydrates and mud volcanoes in the marine environment. In recent times I have studied the Mediterranean Salt Giant, marine bioacoustics, and offshore freshened groundwaters. Most of my research has been conducted in the framework of the international programs of scientific ocean drilling.

Publications and services

Most of the recent publications are on the understanding of the Messinian Salinity Crisis of the Mediterranean Sea. We have described the distribution of salt rocks in the subsurface of the Ionian Sea, the mechanisms of salt precipitation and the evidence for the largest flood known on Earth, the Zanclean megaflood that terminated the salinity crisis. I have also contributed to the development of a method to identify Milankovic cycles in seismic reflection data and the study of the effects of the sound produced by geophysical energy sources on marine fauna. Besides active research and teaching, I serve as an Italian Management Board member and vice-chair of the Joint Programming Initiative Healthy and Productive Seas and Oceans (JPI Oceans), and Chair of the ECORD Science Support and Advisory Committee (ESSAC). I am also an Italian Delegate in the Western Mediterranean Dialogue Forum (5+5) for Research and Innovation.

Awards and honors

In 1999 I obtained the Research Award *Felice Ippolito*, ex-aequo with Dr. F. Talarico, awarded by the Accademia Nazionale dei Lincei and by the Italian National Committee of Antarctic Research.

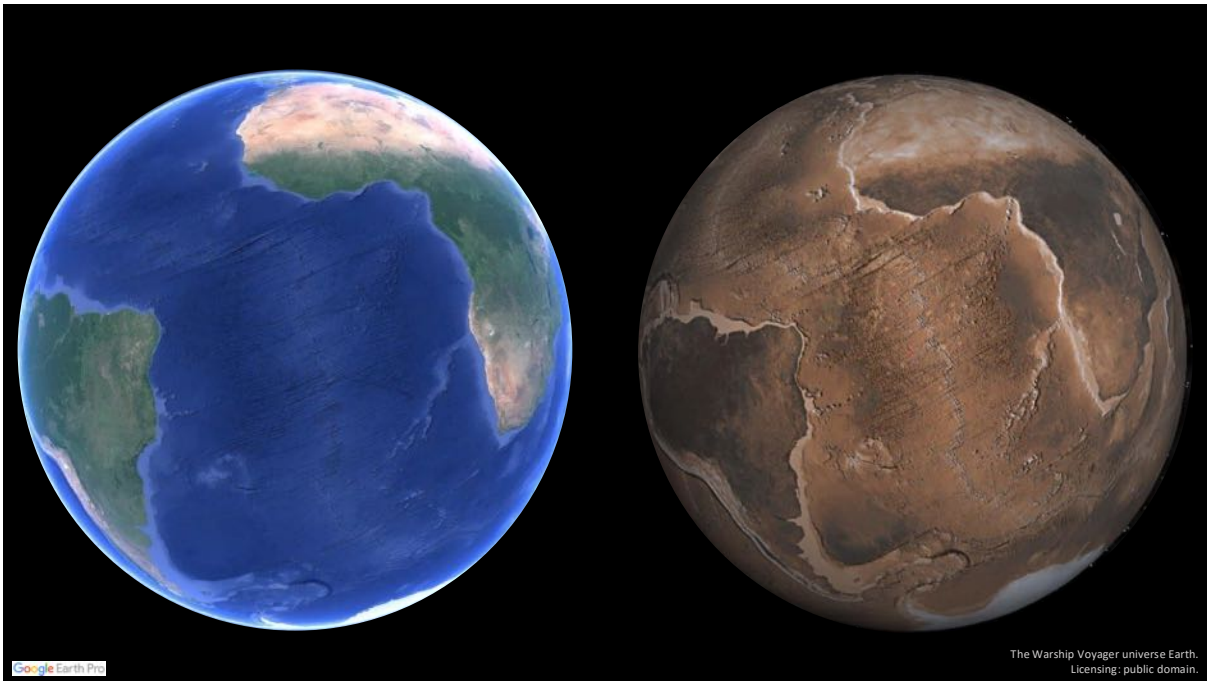
THE MAJOR STAGES IN THE DISCOVERY OF THE SEA FLOOR (THE HISTORY OF THE SEA FLOOR EXPLORATION)

Angelo Carmelenghi

OGS Trieste, Italy

The perception of the ocean is driven by the blue color, the element Water and the Life it contains. The lower boundary of the ocean is commonly perceived as the sea floor or seabed. However, this is not a boundary, it is a transition to another ocean hidden below the sea floor. This is the ocean of the past, that reveals the history of our planet, at least in the time frame constrained by the age of the oceans (Jurassic to Present; some researchers argue Triassic to present). The seawater trapped in the pore species of oceanic sediments, the grains composing the sediments, the volcanic and metamorphic rocks composing the seabed all compose chapters of the oceans' history book. The value of which has been recently enriched by the discovery of a deep microbial biosphere that extends down to ~2 km depth below the sea floor.

The scope of this lecture is to demonstrate the relevance of the sea floor and subseafloor in Ocean Science, and to review the discoveries of the sea floor and its subsurface which were enabled by the pairing between technological development and scientific curiosity in relatively recent times. Conceived as background for the following interventions, this lecture has the ambition of triggering the questions 'Why exploring the seabed and its subsurface? Is it really necessary? Are the sea floor and its subsurface relevant to the Blue Economy?'.



Jason P. Morgan
Research Professor
Institute of Marine Science, CSIC, Barcelona, Spain
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Education

B.S. Physics 1981, Ph.D. Earth Sciences 1985, Brown University
Ph.D. Thesis Title: Dynamics of Mid-Ocean Ridges

Career

Postdoctoral Green Scholar, IGPP-SIO; Assistant Professor, M.I.T.; Associate Professor&Professor, IGPP-SIO; Division Director and Assistant Director, GEOMAR Research Center (Kiel, Germany); Professor, Cornell U.; Professor and Head of Department, RHUL (UK); Chair Professor, SUSTech (Shenzhen China); Research Professor, ICM-CSIC (Barcelona, Spain)

Research interests

During my scientific career, I have remained extremely curious about how the Earth works, with a particular fascination for the dynamics of deformation and melting. I began by working on geodynamic models of mid-ocean ridge processes, then looked to the dynamics of mantle plumes and the asthenosphere that underlies Earth's tectonic plates and links ridges to deeper mantle convection. In Germany, my research focus swung to study plate subduction, including in particular the role of serpentinization in plate bending, while in the UK my research interests moved to trying to better understand the dynamics of continental rifting. I have spent 25 months at sea on 22 research cruises gathering marine observations at mid-ocean ridges, hotspots, and subduction zones.

Publications and services

I continue to teach and perform research on the geodynamics that underlies Earth's tectonism and volcanism. In 2024, I participated in a paper in Nature that explored Earth's ultra-slow spreading mid-ocean ridge in the Arctic Ocean.

Awards and honors

Cecil and Ida Green Scholar 1985, IGPP-SIO. Fellow, AGU, 1995. James B. Macelwane Award, AGU, 1995. Professeur, College de France, 1996. Royal Society Wolfson Merit Award, 2014. A.E.H. Love Award, EGU, 2016.

THE FAMOUS DECADE: 1974-1984

Jason P. Morgan

Institute of Marine Sciences, CSIC, Barcelona, Spain

The project FAMOUS in 1974 was the first time that scientists explored how new tectonic plates are created at a mid-ocean spreading center. France and the US used their two deep-diving submarines, *Cyana* and *Alvin*, to bring researchers to the active seafloor volcanoes where new crust was created. To prepare for the submarine dives, for the first time researchers made a 3-D map of the local seafloor by using multiple expeditions to collect a densely spaced set of ship tracks that could profile the seafloor relief beneath each shiptrack ("Mowing the lawn" became a common name for this survey style.) It had become known that the mid-ocean spreading center in the Atlantic was a deep valley flanked by mountains about 30 km apart and 2 km high, but this was the first time that the along-axis volcanic and tectonic structures of a spreading center were revealed. (Note that by 1974, the surface of the Moon was already much better mapped than the floor of the oceans is known even now — the 3-6km ocean layer remains a formidable barrier to our investigation of the seafloor.) FAMOUS researchers discovered vast lava fields and crevasses, taking many pictures of the seafloor through the submarine windows and robot cameras towed just above the seafloor.

The discoveries in FAMOUS kick-started a decade of pioneering ridge research, as researchers started to explore the global system of mid-ocean spreading centers. In 1977, scientists exploring the Galapagos spreading center between the Cocos and Nazca Plates noticed a series of temperature spikes in their data – from 0°C to 400°C – over short distances. Warm springs in the seafloor were also seen that hosted amazingly strange communities of deep-sea life. By 1979, the first 'Black Smoker" hydrothermal vents were seen along the East Pacific Rise, the spreading center between the Pacific and Cocos Plates near the southern tip of Baja California — in a place where massive sulfide deposits had been seen on the seafloor the year before, but without active hydrothermal activity. The deep-sea ecosystem associated with these hydrothermal systems was found to be chemo-synthetic — it relies on Archaea that use the transformation of active chemical compounds, in particular, hydrogen sulfide, as an energy source, instead of light. (As an aside, the study of this type of extremophile Archaea played a big role in the development of practical gene-splicing technologies.)

A decade after FAMOUS, the basic elements of a mid-ocean spreading center and its unique ecosystem had been discovered. However, decades later many surprises, and large 'known unknowns' still remain as researchers use ever improving technologies to further explore this hugely inaccessible wonderland.

WELCOME TO THE BREMEN CORE REPOSITORY

A virtual visit at MARUM - Center for Marine Environmental

Sciences at the University of Bremen

Ulrike Prange

ESO Outreach Manager, Team Science Communication at MARUM

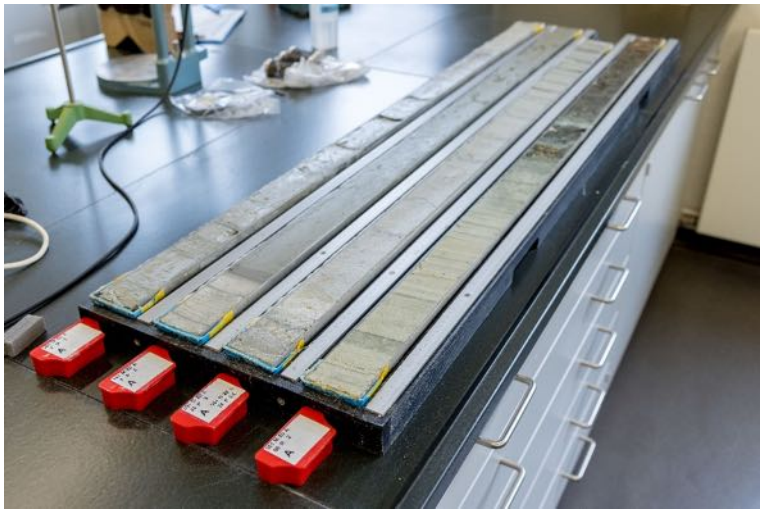
Bremen has become an integral part of the international Geosciences' research map due to the significance for scientific ocean drilling. The Hanseatic city has a reputation that is in no way inferior to that of College Station in Texas (USA) and Kochi (Japan). In these three places, cores from beneath the ocean floor are stored in refrigerated mighty halls. The cores have been retrieved during scientific international ocean drilling expeditions carried out since 1968.

Each of the repositories contains a unique collection of seafloor samples. The Bremen Core Repository at MARUM – Center for Marine Environmental Sciences of the University of Bremen is the largest of the three collections. Laid end to end, the core sections presently stored here would measure more than 192 kilometers. With planned upcoming expeditions in the new International Ocean Drilling Programme, short IODP³ that kicks off in 2025, this number will continue to grow.

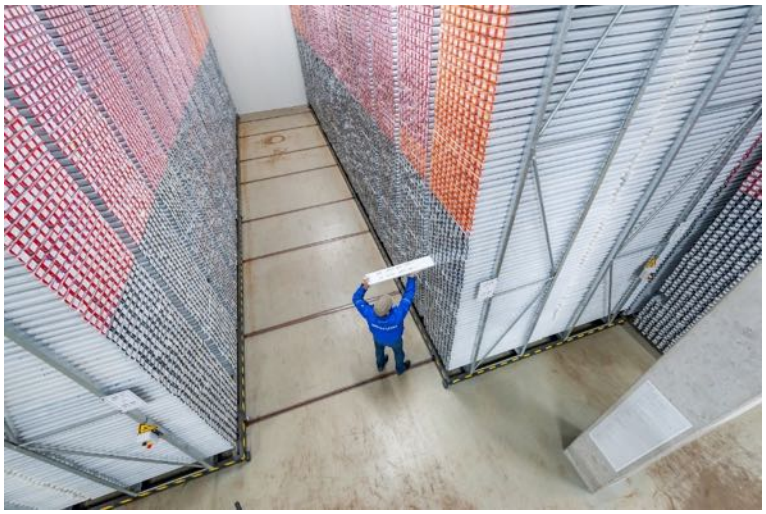
Each of the three core repositories archives and curates cores of a certain world ocean's region. In Kochi you may find cores of the Pacific (west of western boundary of Pacific plate); Indian Ocean (N of 60ºS), all of Kerguelan Plateau, and the Bering Sea. In College Station cores from the Pacific (Pacific plate east of western boundary); Caribbean Sea and Gulf of Mexico; Southern Oceans (S of 60º except Kerguelan Plateau) are stored. In Bremen are the cores from the Atlantic and Arctic Oceans (north of Bering Strait) the Mediterranean, Black, and Baltic Seas.

16 nations support the new International Ocean Drilling Programme, with two core members that are also organizing seagoing drilling expeditions.

We invite you to take a glimpse into our library that consists of sediments and hardrocks that illustrate Earth's history.



Sediment cores in the laboratory. Photo: MARUM – Center for Marine Environmental Sciences, University of Bremen; V. Diekamp



The core repository of the scientific Ocean Drilling Programs at MARUM in Bremen. Cores from the Atlantic and Arctic Oceans are stored here, as well as from the Mediterranean, the Black and the Baltic Seas. Photo: MARUM – Center for Marine Environmental Sciences, University of Bremen; V. Diekamp

MARUM-Team participating in the GIFT Workshop:

Dr. Holger Kuhlmann, Superintendent Bremen Core Repository (BCR) (host of remote visit to the BCR)

Ulrike Prange, ESO Outreach Manager, Team Science Communication at MARUM (organization)

Dr. Ulla Röhl, Senior Scientist, Head of the 'Bremen Core Repository' group at MARUM | ECORD Science Operator (ESO) Curation & Laboratory Manager | Scientific Ocean Drilling Programs Curator for Mission Specific Platform Expeditions and the BCR (representation at the workshop in Vienna)

Nils Strackbein, Team Science Communication at MARUM (technical realization)

More information:

On MARUM: www.marum.de

On the Bremen Core Repository: https://www.marum.de/en/Bremen-Core-Collection-Scientific-Ocean-Drilling-Programs.html

Possible questions/ aspects to discuss:

Where do the cores come from?
What is the background of the drilling programme?
Why are the cores stored at a temperature of 4 degrees Celsius?
How old is the oldest core?
How long can the drill cores be kept? (Can they go “bad”?)
Who has access? What is the process to access cores or samples?
How do you find a particular core in this huge hall?
Have there been any surprises?
What can you see with the naked eye?
Do you have a favorite core? [--> if so – it would be great if you could have it with you 😊]

Sharon Katz Cooper
Senior Outreach Manager
Lamont Doherty Earth Observatory
Columbia University, USA
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Education

- Princeton University, Princeton, NJ. Ecology and Evolutionary Biology (cum laude), certificates in Environmental Studies and Woodrow Wilson School of Public and International Affairs, AB.
- Yale University, New Haven, CT, Environmental Studies, MES.
- Graduate coursework in early childhood education, George Mason University Graduate School of Education.

Career

Senior Education & Outreach Officer, United States Science Support Program (USSSP) for the International Ocean Discovery Program (IODP), Lamont Doherty Earth Observatory/Columbia University (Oct. 2015 – present); and same role, Consortium for Ocean Leadership, (March 2007 – October 2015; cooperative agreement was re-competed and moved from COL to Columbia). I provide direction, programming and leadership in the education/outreach arena for the U.S. Science Support Program of the International Ocean Discovery Program, a marine geoscience research program with global operations.
Also, Director of several independently NSF-funded geoscience education initiatives.

Research interests

I am interested in best practices for effective professional development for educators, generating interest and persistence in university-level students to enter the fields of geoscience/oceanography, and inspiring the public about the relevance of science.

Publications and services

C. Nur Schuba, Patrick Fulton, Jamie Kirkpatrick, Shuichi Kodaira, Marianne Conin, Christine Regalla, Kohtaro Ujie, Maya Pincus, Sharon Cooper and Callan Bentley, *A Deep Dive into the Japan Trench,* Frontiers for Young Minds, section Earth Sciences, *in prep.*

Cooper, S., et al*. 2024. School of Rock: An Enduring Legacy from Two Decades of Professional Development on the JOIDES Resolution,* presentation at AGU December 2024.

Lewis, J.C., SK Cooper, L. White, S. Burrell, 2024*. Lessons Learned and Practices Reaffirmed by the STEM Student Experiences Aboard Ships (STEMSEAS) Project*, AGU 2024

Cooper, S., Bryant, R., Lewis, JC., Lewis, White, L. 2019. *Come Out to Sea – It Will Change Your Life!* Earth Educator's Rendezvous. Nashville, TN.

Cooper, S.K., and J.C. Lewis. 2017. STEMSEAS: A vehicle for the US academic fleet to serve undergraduates from diverse backgrounds. Oceanography 30(4):146–148.

Awards and honors

Winner, 2023 Neil Miner Award for exceptional contributions to the stimulation of interest in the Earth sciences, National Association of Geoscience Teachers.

IODP SCHOOL OF ROCK: AN ENDURING LEGACY FROM TWO DECADES OF IODP PROGRAMMING AND OPPORTUNITIES IN THE U.S. AND BEYOND

Sharon Katz Cooper

Columbia University, USA

Since 2004, the U.S. office of the International Ocean Discovery Program (IODP) has utilized the *JOIDES Resolution* (JR) and its related facilities and scientists to reach out to educators and the general public in efforts to raise awareness and knowledge about the interdisciplinary fields of the program, including climate and ecosystem evolution, palaeoceanography, the deep biosphere, sustainable georesources, deep crustal and tectonic processes, geodynamics and geohazards.

Over these past few decades, IODP has strived to not just push the bounds of scientific knowledge, but also make these findings accessible to the public. Towards these goals, the program has hosted the School of Rock (SOR) professional development program – focusing on the training and education of educators – as well as Onboard Outreach Officers (professional education and outreach personnel embedded into expedition science parties). Together, these two programs have generated a vast library of resources – developed through partnerships with shipboard educators and scientists – available to educators worldwide. Topics addressed range from seafloor spreading and plate tectonics, to microbiology and climate change. The materials are easy to filter (e.g. by grade level) to meet the needs of learners in varied settings.

School of Rock has also served as a fruitful generative vehicle for new ideas, including a community-driven, travelling informal exhibit program, and mechanisms for developing long-lasting relationships between K12 educators and university faculty. In this presentation, we will share highlights of the history of School of Rock, plans for the future of scientific ocean drilling education and outreach, and invite new collaborations.

Rouwen Lehné
Hessian Agency for Nature Conservation, Environment and Geology (HLNUG)
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Division Geological Fundamentals
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Education
Diploma Geology, Johannes Gutenberg-University Mainz, Germany
Ph.D. (Dr. rer. nat.) Geology, Johannes Gutenberg-University Mainz, Germany

Career
2014 – present: scientist at the Hessian Agency for Nature Conservation, Environment and Geology (HLNUG)
2007 – 2014: postdoctoral position at the Institute for Applied Geosciences at Darmstadt University of Technology
2005 – 2007: postdoctoral position at the Johannes Gutenberg-University Mainz
2014 – present: lecturer at Darmstadt University of Technology
2014: guest lecture (DAAD) at Tartu University, Estonia
2009 and 2010: guest lecture (DAAD) at the Canterbury University in Christchurch, New Zealand
2008: guest lecture (DAAD) at Tallinn Technical University, Estonia

Research interests
Recent geodynamic processes, radon, urban geology, geological 3D-modelling, data interoperability and Iceland

Publications and services
European Commission, Joint Research Centre – CINELLI, G., DE CORT, M. & TOLLEFSEN, T. (Eds.) (2020): European Atlas of Natural Radiation, Publication Office of the European Union, Luxembourg, 2019. ISBN 978-92-76-08259-0, doi:10.2760/520053, Catalogue number KJ-02-19-425-EN-C, EUR 19425 EN. Printed by Bietlot in Belgium 2019 – 190 pp.
Mair., J., Petermann, E., Lehné, R. & Henk, A. (2024): Can neotectonic faults influence soil air radon levels in the Upper Rhine Graben? An exploratory machine learning assessment. - Science of The Total Environment, Volume 956, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2024.177179.
Meinaß, H.P., Rein, L., Mair, J., Lehné, R., Hinderer, M. & Stein, E. (2024): Erkundung von Störungszonen im Kristallin mittels Geoelektrik und Radon-Bodenluftmessungen – ein Beispiel aus dem Bergsträßer Odenwald. - Z. Dt. Ges. Geowiss. (J. Appl. Reg. Geol.), 175 (4), p. 659–680, 10 figs., 4 tables, 5 electron. suppl.

Awards and honors
2010 and 2014: Athene Award of Darmstadt University of Technology for Good Teaching
2009 – present: chair of the section Geoinformatics of the German Geological Society (FGI-DGGV, www.fgi-dggv.de)
2020 – present: chair of the work group 3D-modelling of the German state geological surveys
2022 – present: chair of the scientific advisory board of the Institute of Rock Structure and Mechanics of the Czech Academy of Sciences
2024 – present: co-chair of the European Expert Group Urban Geology (UGEG)

ICELAND AND THE SURROUNDING SEA FLOOR - INSIGHTS INTO A COMPLEX GEOLOGICAL SYSTEM FROM ITS ORIGINS TO THE PRESENT DAY

Dr. Rouwen Lehné

Hessian Agency for Nature Conservation, Environment and Geology (HLNUG)
Wiesbaden/Department Geology and Soil, Technische Universität Darmstadt, Germany

The Earth's oceans cover about 71% of the planet's surface and significantly shape our 'world view'. From a geological point of view, the term ocean floor describes the oceanic crust that was formed by magmatic processes. Sediments of varying thicknesses are deposited on this oceanic crust, giving the sea floor its visible morphology. This differentiation is important because the ocean floors in particular enable us to reconstruct the history of our planet and provided the evidence in the 1960s for the now generally accepted theory of plate tectonics. It was found that volcanic activity occurs along mid-ocean ridges and that the rocks that form there take on a magnetisation aligned with the Earth's current magnetic field. The resulting 'sea floor spreading' along the mid-ocean ridges, including the subduction of crustal material, has revolutionised our understanding of the Earth's history from a rather static status quo to continuous geodynamic processes.

Considering that the total length of all mid-ocean ridges is about 60,000 km, and that these undersea mountain ranges only rise to an average height of about 2,500 m below the sea level, the northern part of the Mid-Atlantic Ridge is a special feature. Here, in the transition area between the Reykjanes Ridge and the Kolbensey Ridge, the Mid-Atlantic Ridge rises up to the sea surface and beyond. The area of this mountain range that lies above sea level is known as Iceland.

Compared to other islands along the mid-ocean ridge, such as the Azores (2,351 km²) or Ascension (88 km²), Iceland is much larger, currently covering an area of approximately 103,000 km². The reason for this is the significantly higher production of melted rock, which is not only connected to the volcanism in the area of the mid-ocean ridge but also and especially to the so-called Iceland plume, i.e. a bulge in the Earth's mantle in which rock moves at higher temperatures towards the Earth's surface, thus providing additional material for the ongoing volcanism. The age of the Iceland plume is estimated to be about 65 million years, which means that its formation coincides with the opening of the North Atlantic. Accordingly, and in interaction with both the aforementioned sea floor spreading and the drift of the plates over this plume, the products of this plume volcanism can be found along a northwest-southeast oriented zone from the present-day western edge of Greenland, across Iceland and the Faroe Islands, to the western edge of Scotland. The submarine crust that was formed in this way rises significantly above the surrounding seabed and is referred to as the Greenland-Iceland-Faeroe Ridge.

Bathymetrically, the ridge forms a barrier that separates the Atlantic Ocean from the Norwegian Sea and the Greenland Sea. This gives the ridge an important role in connection with ocean currents and related climatic processes, both on a global and regional level. The shelf area created by the Greenland-Iceland-Faeroe Ridge around Iceland covers an area of more than 200,000 km² and, in addition to a very large abundance of fish, offers an excellent starting point for investigating the complex interaction between endogenous (spreading, volcanism, continental drift, isostasy) and exogenous (sea level changes, glaciation/deglaciation) processes. The lecture will present examples of interlocking processes and highlight the influence of the ocean floor around Iceland on the system as a whole.

Pete Loader

EGU Geoscience Education Field Officer for the UK
pete@earthlearningidea.co.uk

Pete Loader, FGS, BSc in Geology, is a retired secondary school geology teacher. He is the chair of A-Level geology examiners in the UK and a member of the Earthlearningidea team. He is a geoscience teacher trainer for the Earth Science Teachers' Association and a Fellow of the Geological Society of London. Since 2022 Pete has been the EGU Geoscience Education Field Officer for the UK.

Pane Perunovski

EGU Geoscience Education Field Officer for North Macedonia
pane.perunovski@ahss.edu.mk

Pane Perunovski, BSc in Geography, is a high school geography teacher. He is a member of the Steering Committee of the Macedonian Geographical Society and a regional coordinator for the geography competitions. He is a teacher trainer licensed by the Macedonian Geographical Society. At school he manages international student exchange programmes. Since 2024 he has been the EGU Geoscience Education Field Officer for North Macedonia.

Dragos Tataru

EGU Geoscience Education Field Officer for Romania
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Dragos Tataru, Geophysical researcher, and coordinator of Applied Geophysics, Prevention and Education Laboratory, National Institute for Earth Physics (NIEP) Romania. For the past ten years, he has led the educational, outreach, and training direction. Dragos has been the EGU Geoscience Education Officer from Romania since 2022.

Gina P. Correia

Member of the EGU Education Committee
gina_maria@sapo.pt

Gina P. Correia is an EurGeologist, has a MSc in Environmental Education, PhD in Geology, and has been a biology and geology teacher at a secondary school for over two decades. She is also a teacher trainer, integrates the research group 'Earth Dynamics' of the Earth and Space Research Centre, University of Coimbra, and is an EGU Education Committee member. She was Geoscience Education Field Officer from Portugal from 2019 to 2024.

EXPLORING THE OCEAN FLOOR: SEEING PLATE TECTONICS BELOW THE WAVES

Pete Loader[1], Pane Perunovski[1], Dragos Tataru[1], and Gina P. Correia[2]

[1]EGU Geoscience Education Field Officer (GEFO)

[2]EGU Education Committee

Ocean waters cover about 71% of the Earth's surface, but with only 25% of the seafloor explored in any detail, scientists claim to know more about the surface of the Moon and Mars than they do about the seafloor of our planet. And yet the plate tectonic revolution, which relies so much on evidence from the ocean floor, has flourished since the 1960's despite what is 'hidden' beneath the waves. In this interactive workshop, we will explore classroom simulations of those technologies used to map the ocean floor from above and below the ocean surface at different scales and resolutions. (Figure 1).

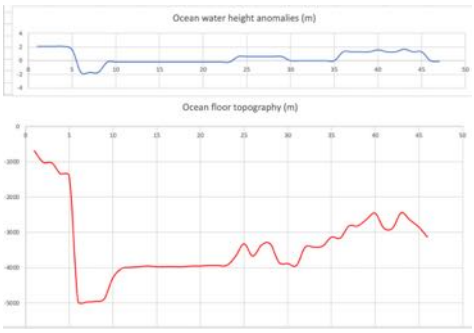

Figure 1: Laser quest data

Using resources from Earth Learning Ideas, we will demonstrate how these methods help scientists understand the ocean floor's plate tectonic structure and formation. We will model ancient and modern magnetic fields in the classroom (Figure 2) and simulate how evidence from palaeomagnetism enabled the mapping of magnetic stripes on the seafloor from which plate boundaries were inferred (Figure 3). Another activity will focus on simulating plate movement from hotspots data.

Figure 2: Human magnets

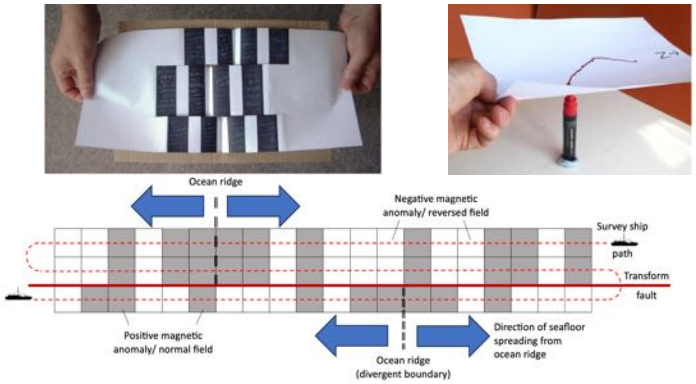

Figure 3: Magnetic stripes and hotspots on the seafloor

Participants will also explore other methods for simulating seafloor mapping, addressing resolution and sampling challenges using 3D-printed models of seafloor surfaces (Figure 4). They will also engage in interactive demonstrations of gravimeters and magnetometers, highlighting their principles and applications in geophysical exploration (Figure 5).

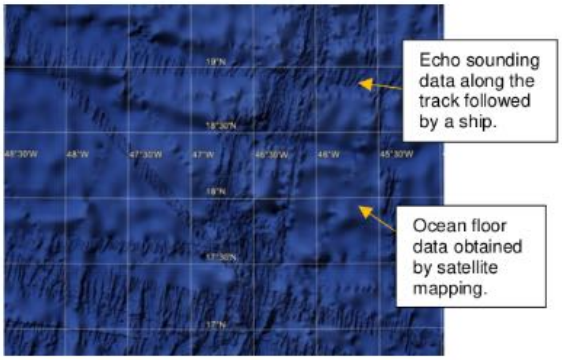

Figure 4: Topographic data at high and low resolution

Figure 5: Magnetometer and gravimeters in the classroom

The activities performed are available at the Earth Learning Idea website (https://www.earthlearningidea.com/), a free online repository where it is possible to find more than 450 activities, ready to use and translated in different languages. All are designed to develop the students' critical thinking and research skills, while developing their knowledge and understanding of Earth processes and products.

EGU Geoscience Education Field Officers (GEFO) are a team of geoscience teachers and researchers who provide professional development to schoolteachers with geoscience elements in their teaching curricula through interactive hands-on workshops. The team is supported by the European Geosciences Union Education Committee and is active in eleven countries around Europe. Please find more about the GEFO programme here: https://www.egu.eu/education/.

András Zlinszky
Community Evangelist
Copernicus Data Space Ecosystem
Sinergise Solutions GmbH
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Education

András Zlinszky graduated from Eötvös Loránd University in Budapest in 2007 as a biologist, specializing in Ecology. He obtained a second master's degree in Geoinformation Sciences from the Budapest University of Technology in 2011, and completed his PhD in conservation biology in 2013.

Career

Research scientist, Balaton Limnological Institute (2007-2019), Project Assistant, Dept. of Geodesy and Geoinformation, TU Vienna (2012-2014), post doctoral researcher, Section Ecoinformatics and Biodiversity, Aarhus University (2016-2017), Ecologist expert, Balaton Working Group, Hungarian National Water Authority (2017-2019), Remote Sensing expert, Ulysses Ltd (2019-2023), Ecologist, science communication expert, Szabadonbalaton (2016-2025).

Research interests

I am mainly interested in applying earth observation for science communication, but also for limnology, habitat mapping and urban planning. I like geology and geomorphology.

Publications and services

I participated as a science art curator at the Veszprém-Balaton European Capital of Culture (2023), I am a regular author of the Copernicus Data Space Ecosystem blog and gallery. I have more than 80 peer-reviewed journal publications, mainly in remote sensing.

Awards and honors

Best Paper of the Faculty Award, TU Vienna (2012); EGU OSPP (2010, 2014).

COPERNICUS BROWSER: AN OPEN ONLINE PLATFORM FOR TEACHING GEOGRAPHY WITH SATELLITE (SENTINEL 2) IMAGES

András Zlinszky

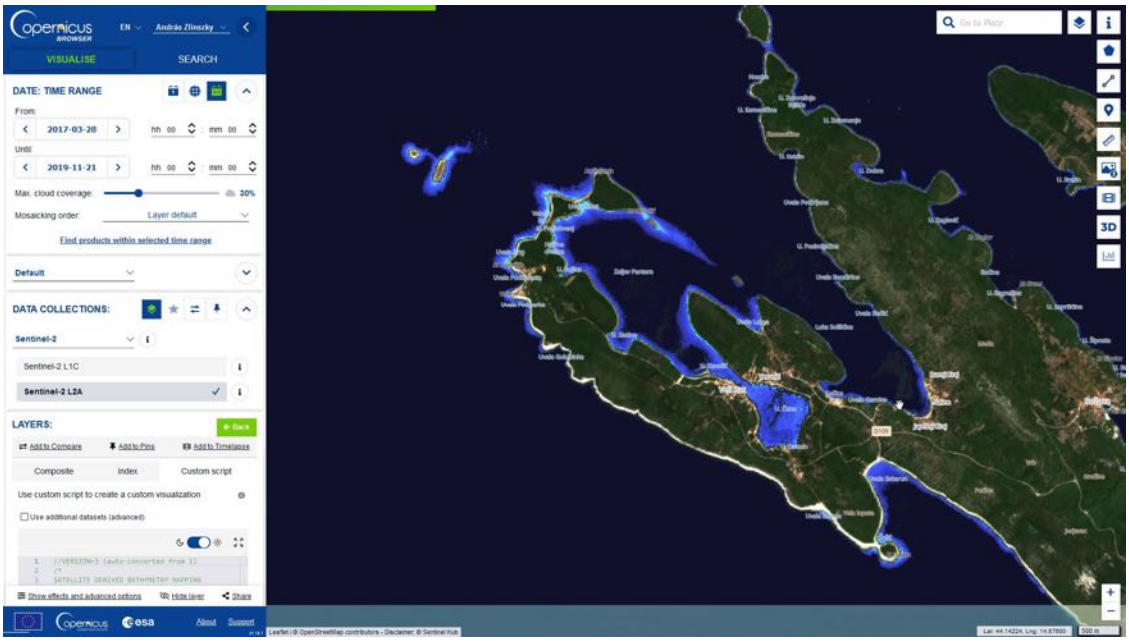
Copernicus Data Space Ecosystem Sinergise Solutions GmbH, Hungary

One of the main difficulties in teaching geosciences is the problem of conveying processes happening at spatial and time scales that students are unfamiliar with. Field visits are highly useful, but the scope of observation is limited to what is visible on the ground at that specific time. Aerial imagery is available from online providers, but vegetation and buildings often obscure relevant patterns, and the time of data collection may be uncertain. Meanwhile, satellite images are a highly intuitive source of information from local to continental spatial scale and from days to decades in time.

In this workshop, we will demonstrate Copernicus Browser, a free and easy to use online interface to public satellite data that works on any web browser. From the first steps of exploring our neighbourhood, through viewing current geological processes such as coastal change, glacier melt and volcanic eruptions, students can be guided all the way to providing quantitative answers to assignment questions. The platform also enables generation of comparisons and timelapses, pins and stories, 3D perspective views, and direct sharing of scenes. Therefore, it is a revolutionary tool both for teachers wishing to create maps and images explaining specific processes and the students themselves for interactive learning.

The course will cover the basics of satellite image interpretation, explore various advanced data sources such as cloudless mosaic imagery, and guide participants through the process of identifying geographic features of interest, generating content for education and sharing results in formats that students can explore on their own devices. Examples will be provided for satellite imagery supporting various sub-disciplines of geosciences, but also other topics such as physics and history. Use cases such as fact-checking news stories, generating quizzes, exploring the sea floor, providing information on local environmental processes and understanding natural hazards will be shown.

No previous knowledge of remote sensing or geoinformation sciences is necessary. Participants will be able to interact with Copernicus Browser on their own devices and gain experience that can be directly applied for primary or secondary school level teaching.



Valérie Chavagnac

CNRS research director

Géosciences Environnement Toulouse

CNRS UMR5563/UPS/IRD/CNES

Valerie.chavagnac@get.omp.eu

Education

After two years of studies in physic, mathematic and electronic, I shifted my education to earth sciences. I followed general courses about earth evolution, geodynamic, geochemistry and sedimentology at several French universitie, i.e. Paris XI in Paris, Joseph Fourier in Grenoble and Rennes 1 in Rennes. My favorite disciplines are geochemistry, isotope geochemistry and earth evolution. I did my Ph.D. research in a joint Ph.D. between the University of Rennes 1 (France) and University of Bern (Switzerland) looking at the behavior and reliability of dating isotopic systems during metamorphism. I shifted my research interests to marine geosciences after my first post-doctoral contract.

Career

1998 – 2000 : Post-doctoral Associate, Massachussetts Institute of Technology (USA)
2000 – 2004 : Independent Research Fellow, National Oceanographic Center Southampton (UK)
2005 – 2007 : Senior Research Fellow, National Oceanographic Center Southampton (UK)
2007 – 2018 : CNRS Research Scientist, Géosciences Environnement Toulouse (FR)
2018 – present : CNRS Research Director, Géosciences Environnement Toulouse (FR)

Research interests

My main research activity is dedicated to understanding the processes involved in hydrothermal circulation at mid-ocean ridges and the fate and impact of hydrothermal chemical fluxes on the hydrosphere and associated marine ecosystems. The challenge of exploring versus exploiting mineral or other resources at the seabed is a real societal challenge that requires knowledge of the marine environment and its health state. My research is overall interdisciplinary whereby working with geochemist, geologist, biologist, geophysicist and technologist help us to obtain a better understanding of various processes taking at the seabed affecting to different degrees marine ecosystems.

Publications and services

The main scientific outcomes are summarized in the following publications:

- Artigue L., Chavagnac V., Destrigneville C., Godfroy A., François D., Lesongeur F., 2025. Fluid Chemistry Evolution in Deep-Sea Hydrothermal Environments: Unraveling Mineral-Fluid-Microorganism Interactions through Continuous Culture Experiment. Deep-Sea Research Part I, doi: 10.3389/j.dsr.2025.104456.
- Matabos M., Barreyre T., Juniper S.K., Cannat M., Kelley D., Alfaro-Lucas J.M., Chavagnac V., et al., 2022. Integrating Multidisciplinary Observations in Vent Environments (IMOVE), 10 years of observatories at vents: progress, future directions and recommendations. *Frontiers in Marine Science,* 10.3389/fmars.2022.866422.
- Gretchen L. Früh-Green, Deborah S. Kelley, Marvin D. Lilley, Mathilde Cannat, Valérie Chavagnac, John A. Baross, 2022. Diversity of magmatism, hydrothermal processes and microbial interactions at mid-ocean ridges. Nature Reviews, 10.1038/s43017-022-00364-y.

THE DIVERSITY OF HYDROTHERMAL FLUID DISCHARGES

AT THE SEAFLOOR ACCORDING TO GEOLOGICAL CONTEXT

Valérie Chavagnac

Géosciences Environnement Toulouse - CNRS UMR5563/UPS/IRD/CNES

Fluid circulation within the oceanic lithosphere covers a wide range of high and low temperature phenomena in basaltic to peridotitic substratum in accretionary and subduction geological contexts. From the magma chamber to the hydrosphere, seawater transformed into hydrothermal fluid modifies the physico-chemical properties of the oceanic crust, develops environmental conditions enabling microbial diversity and extreme ecosystems to thrive and has an impact on the chemical composition of the ocean. During this talk, I will present the diversity of hydrothermal fluid emissions worldwide, provide some key chemical tracers that characterize them, and illustrate how these hydrothermal fluxes can modify the hydrosphere.

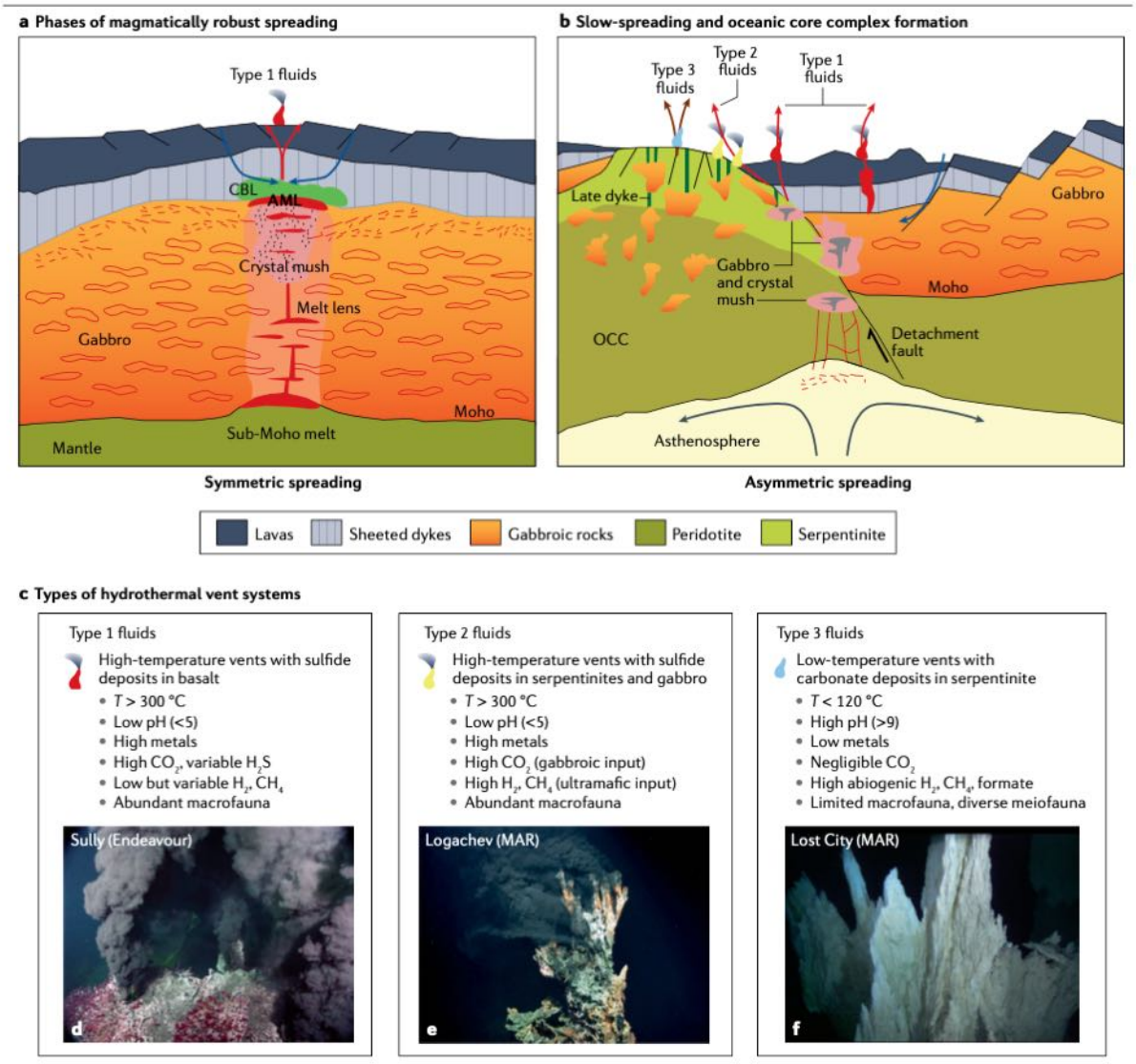


Figure: Variations in magmatism, structure and hydrothermal systems with varying spreading rates. Früh-Green et al. (2022).

Daphne Cuvelier
Researcher
Institute for Marine sciences-OKEANOS,
University of the Azores
daphne.v.cuvelier@uac.pt

Education

I am originally from Belgium, where I studied Latin-Mathematics for the first 4 years in secondary school/high school and Mathematics-Sciences for the last two years. I went on to study Biology at the University of Ghent and carried out my PhD at the University of the Azores, which I concluded early 2011. I also did a post-doc at Ifremer (France) among other postdoctoral scholarships and activities.

Career

Currently, I have a 6-year researcher contract by the national Portuguese Foundation for Science and Technology (FCT) that I started in August of last year (2024).

Research interests

My research interests revolve around the community dynamics occurring in the deep sea. Mostly based on imagery, I study how deep-sea communities change over time and what could drive these changes. Ecosystems in question are hydrothermal vents, but also abyssal nodule fields and other (chemosynthetic) habitats (e.g. whale falls). This kind of knowledge is indispensable to comprehend the deep-sea ecosystems, their interconnectivity as well as their influence on the surrounding habitats. These insights are fundamental in the current era of deep-sea exploration with increased interest to go and exploit the deep-sea mineral resources.

Publications and services

My latest publications were more related to the abyssal polymetallic nodule fields, with the use of AI on biological assessments of these ecosystems threatened by deep-sea mining [1], as well as impacts of human presence and activity [2,3]. Fundamental research on what drives spatial variation in the abyss [4] and an open access morphospecies catalogue also represent significant contributions to the field. Latest publications related to hydrothermal vents represented unique contributions on the knowledge on temporal variations, revealed circadian rhythms in the deep sea and analysed first data from the deep-sea observatories [5, 6].

1. Cuvelier D et al. (2024) Front. Mar. Sci. 11:1366078. doi: 10.3389/fmars.2024.1366078
2. Cuvelier D et al. (2023). Mar. Env. Res. 185. Doi: 10.1016/j.marenvres.2023. 105899.
3. Cuvelier D et al. (2022). Mar. Pollut. Bull. 184. doi : 10.1016/j.marpolbul.2022.114162.
4. Simon-Lledó E, et al. 2023. Nat. Ecol. Evol. doi: 10.1038/s41559023-02122-9
5. Cuvelier D et al. (2017). Biogeosciences, 14(12), 2955. Doi :10.5194/bg-14-2955-2017
6. Cuvelier D et al. (2014). PLoS ONE 9(5). doi:10.1371/journal.pone.0096924.

THE SEA FLOOR LIFE - BIODIVERSITY OF HYDROTHERMAL VENTS

Daphne Cuvelier

Institute of Marine Sciences OKEANOS, University of the Azores, Portugal

Hydrothermal vents are unique and isolated ecosystems, situated in the complete dark of the deep sea. In the absence of sunlight and under high pressure, the fauna that thrives here is very specific, depending on chemosynthesis for their survival, creating real hotspots in biomass. During this talk we will dive to these hydrothermal vents, firstly addressing their biodiversity on a global scale. In a second stage, we will go into more detail on the hydrothermal vents of the Mid-Atlantic Ridge, highlighting the importance of these study sites, some of which in Portuguese waters, and the uniqueness of the still ongoing studies. Relationships between fauna and environment will be addressed, as well as their connectivity on a regional scale and how important this is for conservation.

Francesca Funiciello
Laboratory of Experimental Tectonics

Dept. of Sciences, Univ. “Roma TRE, Rome, Italy

francesca.funiciello@uniroma3.it

Education/Career: **1999-2002**: Ph.D. in Geophysics ETH-Institut für Geophysik, Zürich (Switzerland); **2003–2006**: Post-doc at Dept. of Geology, Università Roma Tre; **2006**: Winner of the European Young Investigator (EURYI) Award 2006 (European Science Foundation) with the project “Convergent margins and seismogenesis: defining the risk of great earthquakes by using statistical data and modelling”. **2006- 2011**: Researcher at the Dept. of Geology, Università Roma Tre as EURYI Awardee. **2011-present**: Researcher and then Professor at the Dept. of Sciences, Università Roma Tre.

Research Interests
Vision: Understanding subduction process and mantle convection from long-term to short-term (seismic cycle) deformation.
Topics: Dynamics/kinematics/tectonics of subduction zones. Subduction seismicity. Mantle convection. Rheology.
Tools: Laboratory and numerical modelling; geophysical data analysis; Material Rheology.

Publications and Services: 91, ISI-h index: 39 (January 2025)

Services:

a) Referee of NSF (National Science Foundation, USA), EC (European Commission), MIUR/MUR (Italy), NWO (the Netherlands), NRDI (Hungary), ANR (France), NSF (Switzerland) projects; **b)** referee of scientific journals; **c)** Editor of a special volume 'Frontiers in Earth Sciences' titled “Subduction Zones Geodynamics” edited by Springer (2009); **d)** Topical Editor of Solid Earth (EGU journal;2011-2016 with 1 special volume organized on subduction zones); **e)** Editor of the special volume “Subduction Zones” in the journal Solid Earth; **f)** 2016-2018: member of the Editorial Board for the Reference Module in Earth Systems and Environmental Sciences of Elsevier. **g)** 2019-2020: member of the Editorial Board for the Encyclopedia of Elsevier; **j)** Editor of the book “Simulating Geological Processes in the Laboratory - An Introduction to Analogue Modelling” (Springer) that is in progress; g) 2024-2027: Editor in Chief of the Third Edition of the Treatise on Geophysics (Elsevier). **k)** Organizer of Subduction Zones Conference 2007. Montpellier (France); **l)** Convener of EGU (European Geophysical Union) and AGU (American Geophysical Union) sessions; **m)** Collaboration to realize the scientific movie, “Face of Earth”, produced by “The American Geological Institute”, “Evergreen Films” and “Discovery Communication” for Discovery Channel. **n)** Italian responsible of Educational Education Committee of the European Geosciences Union (EGU). **o)** Erasmus coordinator; **p)** 2016-present: Coordinator of the Italian Network of Experimental Infrastructures; **q)** 2010-2018: Co-chair of the EPOS WG 16 (Laboratories). R) Participant in 37 national and international projects, 6 as PI and 8 as local PI.

Awards
2022: Marie Tharp medal of the EGU Tectonics and Structural Geology Division
2018: Burov Award (International Lithosphere Program).
2009: Burgen Scholar Award 2009 (Accademia Europaea) for high international scientific value studies. ***2009***: Top reviewer Geophysical Research Letters (AGU).
2009: Winner of the “Twenty Italians Who Are Changing Italy” Award (Corriere della Sera National Magazine).
2006: Winner of the EURYI 2006 (European Young Investigator) Award of the “European Heads of Research Councils” and the “European Science Foundation”. Award: 821.000 euro. format EURYI merged in the EC IDEAS program.

Teresita Gravina

Upper secondary Natural Science Teacher

Liceo Diaz, Caserta,

Italy

teresita.gravina@scuola.istruzione.it

EDUCATION

2013 - **BSc** (First Class Honors Degree) Environmental Science University Luigi Vanvitelli, Caserta

2006 - **PhD** in Earth Science, University Federico II of Naples, Department of Earth Sciences and Department of Chemical Engineering

2001 - **BSc** (First Class Honors Degree) Earth Science, University Federico II of Naples

CAREER

2007-today Natural Science Teacher in Italian upper secondary school

RESEARCH INTERESTS

Teresita Gravina is a natural science teacher at Liceo Diaz in Caserta (Italy) and Teacher training. At the moment she is involved in a research project aiming to address and overcome the critical issues related to the teaching of Earth Sciences in secondary education in Italy. The study seeks to analyze the current state of Earth Sciences education by examining pedagogical approaches, curriculum design, and student engagement.

PUBLICATIONS AND SERVICES

Gravina, T., & Iannace, A. From Textbook-Based Instruction to Skills-Enhanced Activities: Transforming Earth Science Education in Italian Upper Secondary Schools. AGU24.

Gravina, T., & Iannace, A. (2024). Revitalizing Earth Science Education in Italian Upper Secondary Schools: Crafting New Educational Materials Aligned with National Guidelines (No. EGU24-7797). Copernicus Meetings.

Gravina, T., Occhipinti, S., Boccardi, V., & Fantini, F. (2018). The Italian Earth's Science Olympiad: a reflection on results of first edition. *RENDICONTI ONLINE DELLA SOCIETÀ GEOLOGICA ITALIANA*, *45*, 23-30.

USING MAPS TO STUDY THE SEA FLOOR (PAPER AND DIGITAL TOOLS) WITH GEOMAPAPP

PRESENTATION OF THE PORTAL AND EXERCISES TO CALCULATE SEA FLOOR SPREADING RATE (AND/OR PLATE MOTION) FROM THE DATABASE

Francesca Funiciello and Teresita Gravina (EC members)

EC members

This workshop introduces GeoMapApp (https://www.geomapapp.org/), an advanced geospatial visualization and analysis tool, to middle and high school educators. GeoMapApp offers an interactive platform for exploring a wide range of topographic, geological, and oceanographic datasets, providing valuable support for the teaching of Earth Sciences.

The session will focus on the pedagogical applications of GeoMapApp, demonstrating how it can be used to engage students with real-world data, enhance spatial analysis skills, and promote inquiry-based learning. Participants will receive an overview of the software's key features, including mapping tools, data overlays, and visualization techniques, with practical examples relevant to topics such as plate tectonics, climate change, and natural hazards. Hands-on activities will allow attendees to explore and apply these tools in an educational context. To ensure a productive experience, participants are strongly encouraged to download and install GeoMapApp from www.geomapapp.org prior to the workshop.

Standing near the bronze elephant in front of the entrance of the Natural History Museum in Vienna, Austria

Hélder Pereira, on the left, is a teacher of Biology and Geology at the Escola Secundária de Loulé (Algarve, Portugal). He has a degree in Biology and Geology, and a MSc in Nature Conservation and Management (Geological Heritage and Geoconservation) from the University of Algarve, Portugal. Currently he is a predoctoral researcher at the University of Coimbra, Portugal. His research is focused on the study of the stratigraphy and vertebrate fauna from the Lower Cretaceous of the Algarve Basin (Southern Portugal).

https://www.cienciavitae.pt/portal/en/E518-B03F-B4DD

Faustine Gendron, on the right, is a teacher of Biology and Geology at the Maison d'Education de la Légion d'honneur de Saint Denis (Paris, France). She has a degree of Biology and Geology from the Sciences University of Nantes, France. She is also a teacher former in biology, geology, and sciences pedagogy and didactics in Sorbonne University (Paris, France). Moreover, she is secretary for the CAPES of biology and geology in Paris (France), and a jury member for the CNAL Mayotte, France.

Faustine Gendron

FROM THE SEAFLOOR TO THE CLASSROOM: HOW TO ENGAGE SECONDARY SCHOOL STUDENTS IN OCEANOGRAPHIC EXPEDITIONS

Faustine Gendron[1] & Hélder Pereira[2]

[1] *Lycée des Maisons d'Education de la Légion d'honneur, Saint Denis, France*

[2] *Escola Secundária de Loulé, Algarve, Portugal*

Some educational programmes (e.g., EGU "Teachers at Sea" and IODP "School of Rock") allow Earth Science teachers to take part in oceanographic expeditions and become familiar with the science that goes on aboard research vessels equipped with cutting-edge technology.

During these campaigns, teachers are fully immersed in the experience of an oceanographic expedition, interacting with the crew regularly and learning firsthand the science behind it. This presents a unique opportunity to engage students in the process of how science really works and promotes direct interaction with scientists via ship-to-shore communication in real time.

In this session, we will share some of our experiences at sea on board research vessels involved in scientific ocean drilling programmes and other missions during which sediment and fluid samples were collected from the seafloor. We will demonstrate why these programmes provide a unique environment for learning and teaching, including examples of how you can use authentic scientific data in your classroom.

Hopefully, after attending it, you will be able to develop activities for teaching geoscience and related disciplines, using real scientific data. This will allow you to involve your students in oceanographic expeditions and increase their understanding about our planet.

Useful links:

https://amocint-pt.blogspot.com/

https://edumed.unice.fr/data-center/oceano/supermouv.php

https://joidesresolution.org/for-educators/classroom-activities/

Georges Ceuleneer
Director of Research
Centre National de la Recherche Scientifique (CNRS)
Géosciences Environnement Toulouse
Observatoire Midi-Pyrénées
France
georges.ceuleneer@get.omp.eu

Education

I graduated in Geology at the Université Libre de Bruxelles in 1981. I got a Master in Geology and Geophysics at the Université de Paris-XI and a PhD in Geology at the Université de Nantes in 1986. My PhD was devoted to the study of the Oman ophiolite. The main objectives were to map the asthenospheric flow pattern beneath a former oceanic ridge recorded in the plastic flow structures of the mantle peridotites and to constrain the mechanisms of obduction of ophiolites.

Career

After my PhD, I got a post-doc scholarship from the European Space Agency to model numerically the convection in the partially molten mantle and its impact on the Earth's gravity field and topography. My host institution was the Centre National d'Etudes Spatiales in Toulouse. In 1988, I got a permanent researcher position at CNRS in Montpellier and moved back to Toulouse in 1992.

Research Interests

My research is primarily focused on the construction of the oceanic lithosphere, on magma migration in the mantle and lower oceanic crust and on the impact of the resulting melt-rock-hydrothermal fluids interactions on the global geochemical budget of the Earth. My approach combines field work in ophiolites (Oman, California, Europe) with observations and sampling along present-day oceanic ridges using dredging, drilling (JOIDES Resolution) and dives with submersibles (Nautile and Shinkaï-6500).

Publications and services

In our recent publications, my students and I have brought robust pieces of evidence supporting the existence in the mantle of what we named a "pioneer melt", rich in water and alkalic elements. Being highly corrosive for mantle minerals this melt triggers the initiation of highly permeable porous flow channels. We have shown how some lithological heterogeneities are preferentially dissolved by the pioneer melt, and thus impact the trajectory of magma in the mantle by porous flow. During these last ten years I have chaired the IODP-France office in charge of the management of the French participation to the International Ocean Discovery Program (IODP). I have been member of the Science Advisory Board of the French Oceanographic Fleet.

Awards and honors

In 2003, I got the Furon medal of the Société Géologique de France attributed for major contributions to the understanding of deep Earth processes. In 2020, I received an award from the Sultan Qaboos University of Oman for my contribution to the organization of an international conference devoted to the Oman ophiolite.

EXPLORING THE DEEP OCEANIC LITHOSPHERE ON LAND:

A FIELD TRIP IN THE OMAN OPHIOLITE

Georges Ceuleneer

Observatoire Midi-Pyrénées, Géosciences Environnement Toulouse, CNRS, France

The Oman ophiolite is an ideal target for exploring the deep oceanic crust and underlying lithospheric mantle, and understanding what is happening there. This land-based field approach is complementary to the study of active oceanic spreading centers where we only have patchy information on these geological units. The exceptional nature of the Oman ophiolite comes from the combination of several factors: its immense size (400 x 80 km) making it possible to understand different spatial scales of the processes active below oceanic spreading centers, encompassing several ridge segments, the arid climate making it possible to carry out continuous observations, and the fact that it was little affected by tectonic events post-dating its formation as the Arabia-Eurasia convergence has not yet degenerated into continental collision in this sector of the Alpine chain.

The Oman ophiolite is also a fantastic educational tool. In this lecture, I will show how the simple observation of outcrops allows to make understandable difficult concepts like partial melting of the mantle, melt migration, magma chamber dynamics, hydrothermal alteration and tectonics (cf. Fig. 1). I will also talk about recent results that have allowed a better understanding of the role played by interfaces, like the Moho, on the exchanges between the solid earth and the outer envelopes of our planet. These processes regulate global geochemical cycles and, hence the parameters that govern the climate at geological time scales, allowed the emergence of life in the primitive oceans. They also condition the availability of resources, particularly renewable and green which we, hopefully, will manage to compensate the dramatic depletion of fossil resources that the earth has been suffering for more than a century.

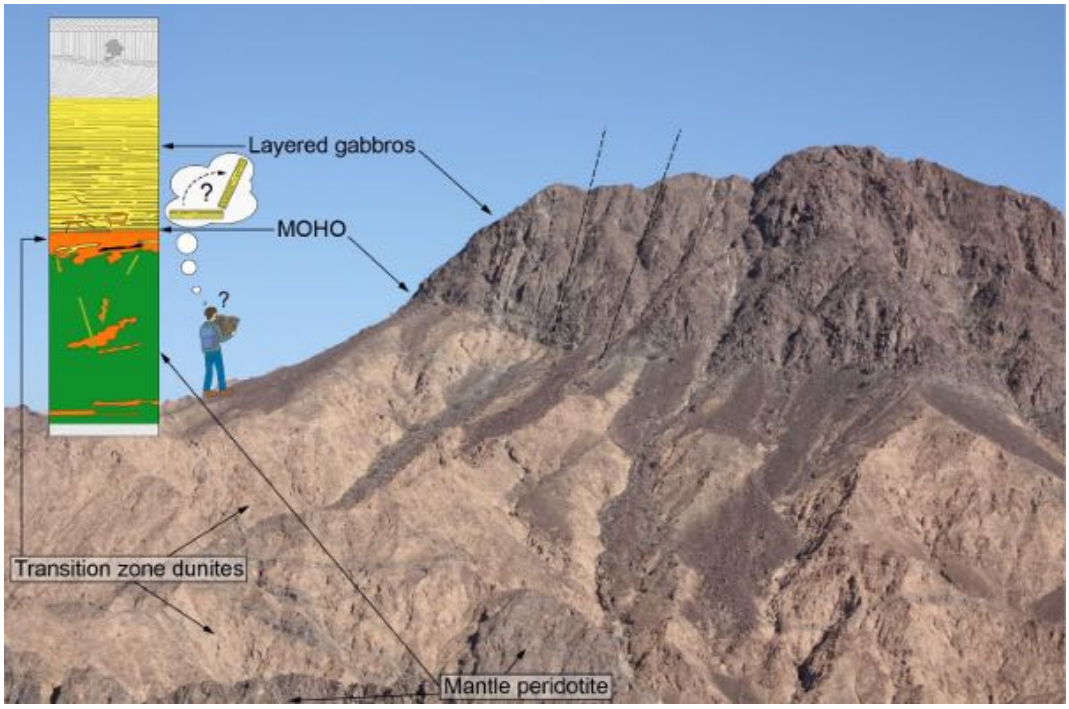


Fig. 1. It may happen that field observations do not match the schematic representation of the oceanic lithosphere published in textbooks. The Oman ophiolite is full of such examples that allow students to develop their critical thinking ... and researchers to break certain paradigms.

Jean-Marc Lardeaux

Emeritus Professor at the Exceptional Class

Université Côte d'Azur. Earth Sciences Department, UMR Géoazur (France).

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Education

1981: PhD Thesis in Geology, Paris 6 University.
1992: HDR (Habilitation à Diriger des Recherches), ENS (Ecole Normale Supérieure) Lyon and Lyon I University.

Career

Emeritus Professor at the Exceptional Class of Université Côte d'Azur since 2024.
Full Professor (Exceptional Class), University of Nice Sophia-Antipolis 2002-2023.
Full Professor, Lyon 1 University, 1993- 2002.
Associate Professor, ENS Lyon and Lyon 1 University, 1989-1993.
Lecturer, Lyon 1 University, 1982-1989.

Research interests

I specialise in the metamorphic evolution of plate convergence zones (subduction and collision zones), natural resources, including geothermal systems. My fields of investigation range from the Alps to the Antilles arc, through the Variscan range in Europe and Morocco, Brazil, Madagascar, Norway, and the Himalayas.

Publications and services

I have authored more than 150 publications in international scientific journals. I am an author of several textbooks, and have contributed my scientific expertise to numerous national and international educational programs. As a professor since 1993 at the University of Lyon I, I was appointed at the University Nice-Sophia Antipolis in 2003. I have been a member of the Scientific Council of this university since 2005 and Vice-President between 2007 and 2011. In addition, I was President of the National Council of Universities between 1995 and 1999, an expert evaluator at the European Commission of Brussels between 1999 and 2002, Vice-President of the Scientific Council of the Bureau of Geological and Mining Research (BRGM) between 2000 and 2006. Between 2002 and 2007, I chaired the Scientific Commission "Sciences of the Earth" of the National Institute of Sciences of the Universe (INSU-CNRS). I was President of the National Committee for "Carte Géologique de la France" (BRGM) in the period 1999-2012, and I chaired the Scientific Committee of the National Project "Référentiel Géologique de la France" between 2013 and 2018. Furthermore, I have been a Thesis Advisor of 32 PhD students since 1985.

Awards and honors

1998: Fellow of the Charles University (Praha) and Czech Academy of Sciences, BORICKY Medal.
1990: Fellow of the Geological Society of Italy.
2009: Prix VIQUESNEL of the French Geological Society.

OCEAN CRUST IN THE MOUNTAINS (OPHIOLITHIC SERIES AND OROGENESIS)

Jean-Marc Lardeaux

UMR Géoazur, Université Côte d'Azur, Nice Sophia-Antipolis (France)

Since pioneering works of Suess (1875), Franchi et al. (1908) and Argand (1911), it is recognized that most orogenic domains result from the closure of one or more oceanic domains. The memory of the oceans that have disappeared is represented by the so-called ophiolithic series, which offer examples of oceanic lithosphere fragments, more or less transformed, during subduction/collision processes leading to the construction of mountain belts.

In this contribution we review and discuss the diversity of mineralogical and structural transformations suffered by the constituents of the oceanic crust from the data available today for the Alpine chain, the European Variscan belt and the Caribbean domain. First, we show that, within the same orogenic system, rare ophiolites are poorly transformed and preserve their oceanic characteristics whereas the most abundant ophiolites have been largely transformed during orogenesis. Secondly, we portray the progressive metamorphic and tectonic evolutions of ophiolites during subduction and continental collision.

Based on this dataset we address some fundamental geodynamic problems still debated in mountain belts, for example the sizes of ophiolithic units that have recorded the same tectono- metamorphic history (i.e. coherent P-T-t/deformation trajectories), the conflicting models that account for the exhumation of subducted ophiolites as well as the types of known evolutions for ophiolites generated in back arc basins during orogenesis.

Preserved meta-basalts in alpine ophiolite

Eclogitized meta-basalts in alpine ophiolite

João C. Duarte

Assistant Professor

IDL - University of Lisbon, Portugal

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Education

Degree in Geology from the University of Lisbon in 2005, MSc. in Geological Cartography at the University of Évora in 2007, and PhD in Geodynamics at the University of Lisbon in 2012.

Career

Post-doc and Researcher at Monash University between 2011 and 2015.

Researcher at IDL between 2015 and 2019. Assistant Professor at the Geology Department of the Faculty of Sciences of the University of Lisbon since 2019.

He is currently the deputy Director of IDL and coordinates the Ph.D. degree in Geology and MSc degree in Teaching of Biology and Geology.

Research interests

Plate tectonics and its links with the other spheres of the Earth system. Planetary tectonics and the origin of life. Subduction zones and subduction initiation. Analogue and numerical models.

Publications and services

He has recently published several articles on the dynamics of subduction zones and subduction initiation, in particular, in the subduction systems presently developing in the Atlantic: the Gibraltar, Scotia and Lesser Antilles arcs, and he has published on the sources of the 1755 Great Lisbon Earthquake and scenarios for the formation of the next supercontinent.

He is the incoming President of the EGU's Tectonics and Structural Geology Division, the Section Lead Editor at Communications Earth & Environment, and a Fellow of the Lisbon Academy of Sciences. He has edited four books, the most recent of which is Dynamics of Plate Tectonics and Mantle Convection.

Awards and honors

He was awarded the 2017 Arne Richter Award for Outstanding Early Career Scientists of the European Geosciences Union (EGU); the Discovery Early Career Researcher Award (DECRA) from the Australian Research Council in 2015, and the IPGP Foreign Student Award for outstanding PhD research from the Institute de Physique du Globe de Paris in 2011.

WHEN SEAFLOOR DISAPPEARS IN THE SUBDUCTION ZONE

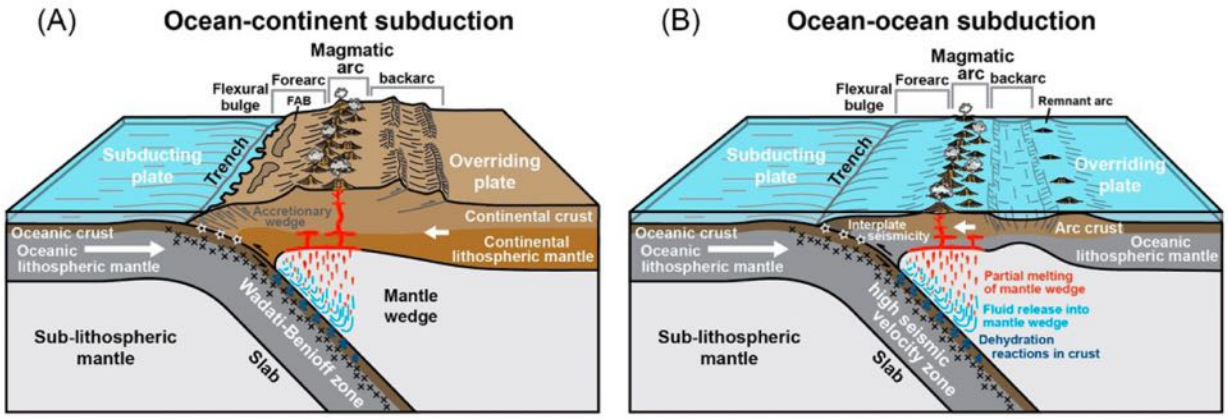
PLATE TECTONICS AND THE EVOLUTION OF SUBDUCTION ZONES

João C. Duarte

Instituto Dom Luiz (IDL), Faculty of Sciences of the University of Lisbon, Portugal

Subduction zones are the main driver of modern-style plate tectonics on Earth. They power mantle convection, drive the supercontinent cycle and are an essential part of several biogeochemical cycles. By driving the movement of continents, they allow biological speciation and are responsible for the recycling of many elements in the mantle.

Subduction is the process by which a plate sinks in the asthenosphere due to its weight, and subduction zones are the locations where this occurs. At the Earth's surface, they are marked by deep trenches. They are also a cause of high-magnitude seismicity and some of the most destructive volcanoes on Earth. In this presentation, we will review what a subduction zone is and why they form. We will explore what drives subduction, how it drives plate tectonics and its fundamental role in the Earth system.



Two types of subduction zones: ocean-continent and ocean-ocean (from Schellart, in Duarte 2023).

Mathilde Cannat

Emeritus CNRS researcher
Institut de Physique du Globe de Paris (IPGP)
France

cannat@ipgp.fr

Education

1990. Habilitation à Diriger des Recherches, University of West Brittany, Brest.
1983. PhD University of Nantes, France.

Career

2024- Emeritus CNRS researcher, Institut de Physique du Globe, Paris.
2019 senior CNRS researcher (DRCE1), Institut de Physique du Globe, Paris.
2009 senior CNRS researcher (DR1), Institut de Physique du Globe, Paris.
2001 senior CNRS researcher (DR2), Institut de Physique du Globe, Paris.
1996 senior CNRS researcher (DR2), University of Paris VI.
1986 junior CNRS researcher (CR2), University of West Brittany, Brest.
1984-1986 post-doctoral scholar (supervisor, J. Dewey), Durham University, UK.

Research interests

Structure of the oceanic lithosphere; tectonic, magmatic and hydrothermal processes at mid-ocean ridges; slow-spreading ridges; exhumation and serpentinization of mantle rocks in extensional domains; monitoring of deep-sea environments.

Publications and services

I am the author and co-author of nearly 180 papers, and in the past 20 years I have focused on two main projects: the first is targeted at an anomalously low melt supply region of the global mid-ocean ridge system, in the eastern part of the Southwest Indian Ridge, and the second is the Lucky Strike observatory for the monitoring of hydrothermal circulations and associated ecosystems, at the Mid Atlantic ridge. In addition to my direct involvement as a researcher, I have helped develop this last project at a broader, community scale, that eventually led to this observatory becoming part of the EMSO (European Multidisciplinary Seafloor and Water Column Observatory) research infrastructure.

Awards and honors

2023 Arthur Holmes Union EGU medal
2023 Murchison Medal of the Geological Society of London
2019 Stephan Muller medal, EGU Tectonics Division
2014 Elected fellow of the American Geophysical Union
2009 Silver Medal of CNRS (Centre National de la Recherche Scientifique)
2007 Furon Award of the Société Géologique de France

THE FORMATION OF OCEANIC CRUST AND THE TECTONIC AND MAGMATIC DIVERSITY OF MID-OCEAN RIDGES

Mathilde Cannat

Institut de Physique du Globe de Paris, IPGP, France

Plate divergence at mid-ocean ridges results from a combination of three main processes: magma emplacement, faulting and hydrothermal circulation. Melt fluxes at fast and most intermediate spreading ridges are high enough that the axial lithosphere remains thin, or at least thinner than the cumulative melt thickness. In this configuration, magma emplacement fully accommodates plate divergence. This is not the case for slow and ultraslow ridges, where melt fluxes are lower, resulting in colder axial geotherms and an axial lithosphere that is generally thicker than the cumulative melt thickness. In this configuration, faults accommodate a significant part of the plate divergence, while magma may be emplaced at a range of depths, over the full thickness of the axial lithosphere.

This creates the conditions for the exhumation of mantle-derived peridotites and the formation of a "composite" oceanic crust, made of variably serpentinized peridotites and magmatic rocks. Melt fluxes, and probably melt emplacement depths, are also highly variable at slow-ultraslow ridges. This allows for complex interactions between magma and faults, and between magma and hydrothermal circulation, resulting in spatially and temporally variable spreading modes (i.e. the combination of tectonic, magmatic and hydrothermal processes that determines the composition and structure of the oceanic lithosphere).

In this presentation, I review these concepts, discuss the extent to which they have been tested by experiments and modelling, and point to a few remaining questions.

Sabina Strmic Palinkas

Professor

UiT The Arctic University of Norway

Department of Geosciences

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Education

- PhD in Geosciences, University of Zagreb, Croatia (2009)
- MSc in Geology, University of Zagreb, Croatia (2004)

Career

- Professor of Geochemistry and Ore geology, UiT The Arctic University of Norway (Since 2022)
- Professor II of Geochemistry, University of Bergen, Norway (Since 2024)
- Associate Professor II of Geochemistry, University of Bergen (2018-2023)
- Associate Professor of Ore Geology/Mineral Resources, UiT The Arctic University of Norway (2015-2022)
- Assistant Professor of Geochemistry, University of Zagreb, Croatia (2010-2015)
- Research Fellow, University of Auckland, New Zealand (2012-2013)

Research interests

My main research interest is focused on geochemistry of ore deposits, including mineral chemistry, fluid and melt inclusions, stable isotope geochemistry, and thermodynamic modeling. I have been involved in studies of a wide spectrum of magmatic and hydrothermal deposits in SE Europe; Brazil and New Zealand. Recently I am mostly working on recent submarine hydrothermal systems along the Arctic Mid-Ocean Ridges and volcanogenic massive sulfide, orogenic gold and sediment hosted Cu deposits in Norway. I also have interests in environmental geochemistry, particularly in physicochemical processes that control stability of ore and gangue minerals in submarine tailings.

Publications (selected)

Strmic Palinkas, S. et al. (2024) Metallogenic model of the Lykling ophiolite-hosted lode Au deposit, Scandinavian Caledonides: Insight from fluid inclusions, mineral chemistry and stable isotope geochemistry. Ore Geology Reviews, 106227.

Hoff, M. et al. (2024) Biogeochemical impact of historical submarine mine tailings on benthic ecosystems in the Repparfjord (Northern Norway). Science of the total environment, 924, 171468.

Strmic Palinkas, S. et al. (2024) Trace Element and Sulfur Isotope Signatures of Volcanogenic Massive Sulfide (VMS) Mineralization: A Case Study from the Sunnhordland Area in SW Norway. Minerals, 14(4), 384.

Heckmann, P. et al. (2023) An experimental study of the effect of water and chlorine on plagioclase nucleation and growth in mafic magmas: application to mafic pegmatites. European Journal of Mineralogy, 35(6), 1111-1124.

Sahlström, F. et al. (2023) Mineralogical distribution and genetic aspects of cobalt at the active Fåvne and Loki's Castle seafloor massive sulfide deposits, Arctic Mid-Ocean Ridges. Ore Geology Reviews, 153, 105261.

FORMATION AND PRESERVATION OF SEA FLOOR MASSIVE SULFIDE MINERALIZATION ALONG ULTRASLOW SPREADING RIDGES: AN INSIGHT FROM THE ARCTIC OCEAN

Sabina Strmic Palinkas

UiT The Arctic University of Norway and University of Bergen, Norway

"First off, I'll mention that at the bottom of the sea there are veins of zinc, iron, silver, and gold that I would quite certainly be capable of mining." This sentence from Jules Verne's famous novel "Twenty thousand leagues under the sea" was written back in 1870. It was written more than 100 years before minerals that contain Zn, Ag and Au have been found on the sea floor by Jack Corliss and his team. Since this discovery in late 1970s, submarine hydrothermal vent fields have been attracting scientists all over the world as some of the most spectacular places on our planet where geological, chemical and biological processes occur simultaneously (Figure 1).

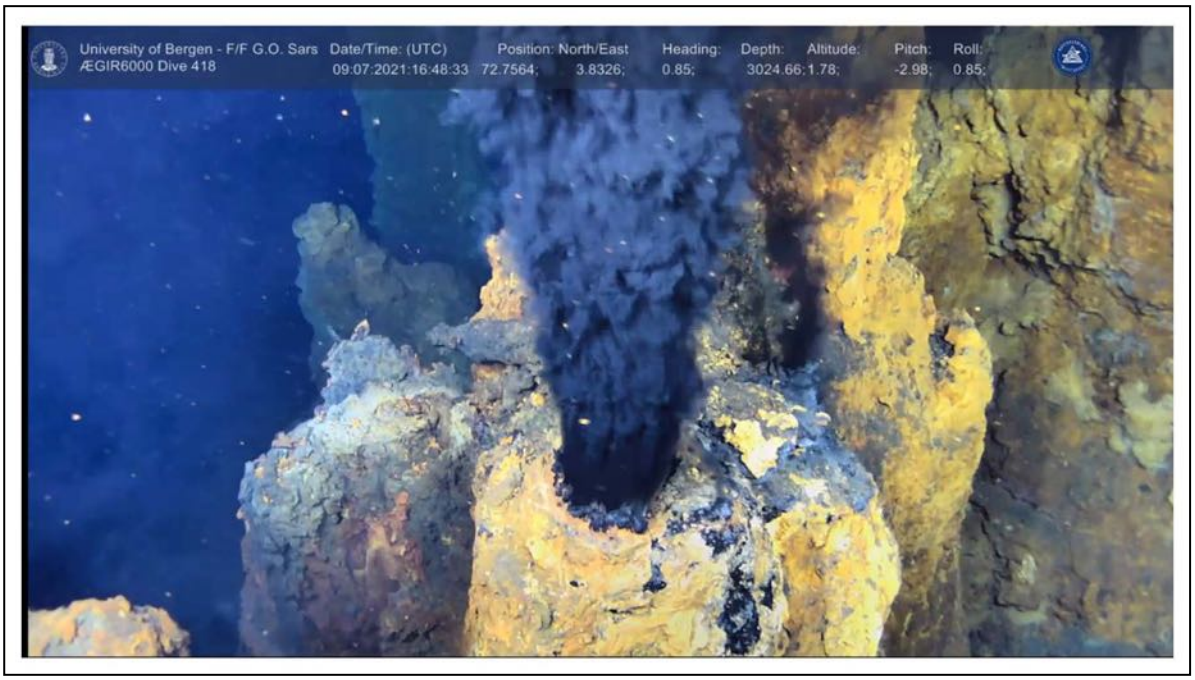


Figure 1. Fåvne hydrothermal vent field, Arctic Mid-Ocean Ridges (*Source: Centre for Deep Sea Research, UiB*)

The Arctic Mid-Ocean Ridges (AMOR), an oceanic ridge system located north of the Arctic circle (66°N), consists of six slow to ultraslow spreading segments associated with abundant hydrothermal activity and, therefore, represent a natural laboratory to study recent hydrothermal ore-forming processes that drive formation and preservation of seafloor massive sulfide (SMS) mineralization.

Active hydrothermal systems found along AMOR show a great variability in terms of their mineral assemblages and metal contents.

This talk will bring an overview of geological, mineralogical and geochemical characteristics of active and extinct Arctic SMS deposits, including new data from Aurora, the northernmost known hydrothermal system. The discussion will be focused to geological factors that control deposition and preservation of mineral phases rich in economically important metals (such as Cu, Zn, Co, Au and Ag) as well as in potentially toxic elements (such as Tl, As and Hg).

Clifford Patten

Assistant Professor

Institute of Mineralogy and Petrology,
Innsbruck University

clifford.patten@uibk.ac.at

Education

2012/16 Ph.D. in Earth Sciences, Stockholm University, Sweden
2009/12 M.Sc. in Earth Sciences, Université du Québec à Chicoutimi (UQAC), Canada
2005/07 B.Sc. in Earth Sciences, Université Toulouse III, France

Career

2023/- Assistant Professor in economic geology, Institute Mineralogy and Petrography, Innsbruck University, Austria
2017/23 Assistant Professor in economic geology, Institute of Applied Geosciences, Karlsruhe Institute for Technology, Karlsruhe, Germany

Research interests

Throughout my research I have developed a profound interest in the geochemical cycles of metals in the earth's crust and their relation to the formation of magmatic-hydrothermal ore deposits. To understand the formation of ore deposits it is necessary to investigate metal behavior at a large scale, from source to sink. Mineral resources are at the heart of the energy transition and are essential for addressing climate change; they are, however, getting harder to access.

Selected Publications

Patten, C. G. C., Junge, M., Coltat, R., Jesus, A. P., Beranoaguire, A., Tropper, P., & Alt, J. (2024). Sulfur and metal mobilization during the life cycle of an oceanic core complex: Implications for seafloor massive sulfide deposits formation at slow and ultra-slow spreading ridges. Lithos, 490, 107843.

Patten, C. G. C., Hector, S., Kilias, S., Ulrich, M., Peillod, A., Beranoaguirre, A., ... & Kolb, J. (2024). Transfer of sulfur and chalcophile metals via sulfide-volatile compound drops in the Christiana-Santorini-Kolumbo volcanic field. Nature Communications, 15(1), 4968.

Patten C.G.C., Coltat R., Junge M., Peillod A., Ulrich M., Manatschal G., Kolb J. (2022) Ultramafic-hosted volcanogenic massive sulfide deposits: an overlooked sub-class of VMS deposit forming in complex tectonic environments. Earth Science Reviews, v. 224, 103891.

Patten C.G.C., Pitcairn I.K., Teagle D., Harris M. (2016) Mobility of Au and related elements during the hydrothermal alteration of the oceanic crust: implications for the sources of metals in VMS deposits. *Mineralium Deposita*, v. 51, p. 179–200

Selected Awards

2023 SGA Young Scientist Award
2013 European Consortium for Oceanic Research Drilling Research Grant, EU
2009 Lucien Bouchard Excellence Bursary, UQAC, Canada

SEAFLOOR MINERAL RESOURCES

Clifford Patten

Innsbruck University, Austria

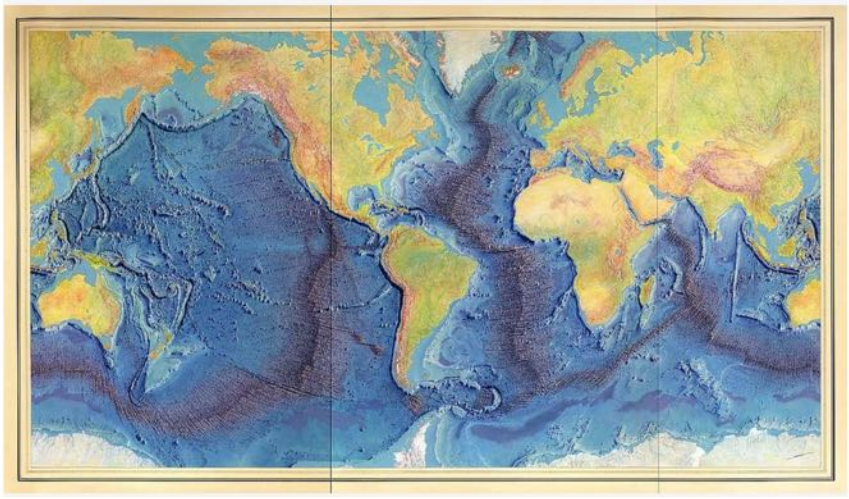
The energy transition to low carbon emission energies for addressing climate change deeply modifies our needs for mineral resources in terms of sheer amounts and commodities. Although improvement of a circular economy by efficient resource management and recycling allows reducing our needs for raw materials, it is still necessary to access primary ores. This drive for new mineral resources has led to increasing interest into the vast seafloor mineral resources, starting new societal and environmental challenges. Access to these mineral resources depends on many stakeholders, public or private, operating at both national and international levels. The seafloor, although still only partly known, is incredibly diverse and, as such, hosts very different types of ore deposits enriched in a wide range of commodities.

Ore deposits on the seafloor can be grouped into three large groups which occur in different seafloor environments: 1) seafloor massive sulfides, 2) Mn-nodules and Mn-crust and 3) continental shelf-related deposits. Seafloor massive sulfide deposits form in numerous oceanic crust environments such as mid-oceanic ridges, island arcs and back-arc basins. They are associated with extensive hydrothermal fluid circulation within the oceanic crust and form large sulfide accumulation at or near the seafloor, often with the well-known black smokers forming on top. These deposits are variably enriched in Cu, Zn, Pb, Au and other trace metals depending on their seafloor tectonic environment.

Manganese nodules and Mn-crusts are present in very distinct seafloor environments. Manganese nodules mainly form in deep abyssal plains, such as the Clarion Clipperton Zone in the Pacific Ocean. Manganese nodules grow by hydrogenetic and diagenetic processes on the seafloor where low sedimentation rate occurs; forming vast fields at the bottom of the ocean. The nodules are enriched in Mn, Fe, Co, Ni, Cu and rare earth elements, some particularly useful for the battery industry. The Mn-crust, on the other hand, form on the flanks of volcanic seamounts, noticeably present in the western Pacific Ocean. Similarly to Mn-nodules, they form by hydrogenetic processes in sediment poor environments. They are also enriched in Mn, Fe, Co, Ni, Cu and rare earth elements.

Finally, detrital mineral resources, such as sand, gravel and heavy minerals, such as diamonds and cassiterite, are extracted from sediments present on the continental shelf. The continental crust itself, below the continental shelf sediments, also host potential mineral resources similar to those found on land.

Image on the front page:



Manuscript painting of Heezen-Tharp "World ocean floor" map by Berann
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