

05 — 06
July 2018
Porto,
Portugal

ISEP
AUDITORIUM E
School
of Engineering
of Porto



STRONG
MAR



EIT RawMaterials
Connecting matters

IN THE BLACK

DEEP SEA MINING CHALLENGES THEMATIC WORKSHOP



www.inesctec.pt



www.udg.edu



EIT RawMaterials is supported by the EIT,
a body of the European Union

www.eitrawmaterials.eu

THE STRONGMAR PROJECT IS FUNDED BY THE
EUROPEAN COMMISSION UNDER THE HORIZON
RESEARCH AND INNOVATION PROGRAMME FOR RESEARCH AND
INNOVATION (H2020-NW-2015-088475)



www.strongmar.eu



Venue

The Thematic Workshop **IN THE BLACK | Deep Sea Mining Challenges** will take place at *ISEP (School of Engineering of Porto) – Auditorium Vítor Santos (old Auditorium E)*.



ISEP and Auditorium Vítor Santos (old Auditorium E).

INSTITUTO SUPERIOR DE ENGENHARIA DO PORTO

Rua Dr. António Bernardino de Almeida, 431

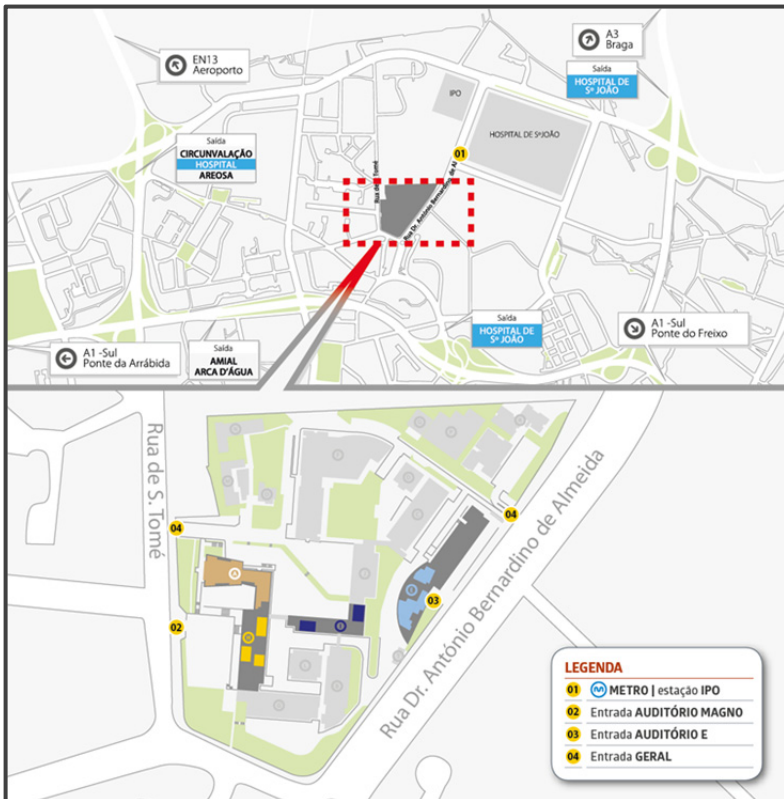
4249-015 Porto

Portugal

📞 228340546

✉ ana.c.pires@inesctec.pt / aplima@inesctec.pt

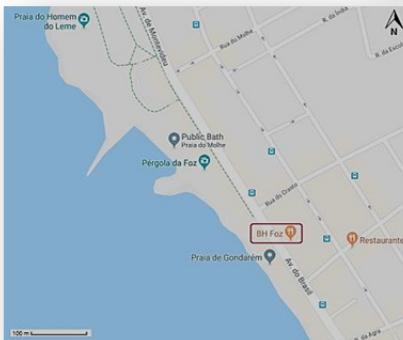
📍 41.1787° N, 8.6077° W



(Source: www.isep.ipp.pt/ISEP/Location)

Workshop Dinner

The **IN THE BLACK Workshop dinner** will take place at **restaurant BH Foz**. The restaurant is on the seaside at Avenida do Brasil 498 with an extraordinary view of the beach. We will meet at the restaurant entrance at 7.30 pm.



+info: www.bhfoz.pt/#!/home

📍 41.1566° N, 8.6812° W



For more details and information visit:

[Download this programme booklet in *.pdf* format]

www.strongmar.eu

Please click on:

Events

↳ Thematic Workshop

↳ Robotics for underwater mining - from exploration to exploitation

Welcome Messages

CHAIRMAN

I'd like to thank each of you for attending this workshop and bringing your expertise to our gathering. We have participants from all around the world covering legal, environmental, exploration, extraction and processing aspects of offshore minerals.

Today's technology is opening up new frontiers for sustainable access to vital raw materials. Tomorrow's technology will undoubtedly open up further exciting opportunities. I encourage you all to actively participate and share the latest insights of academic and industrial research and innovation, alongside shared experiences of full scale offshore mineral exploration and extraction.

I thank INESCTEC, the University of Girona and the project STRONGMAR for providing this opportunity, funded by the European Institute of Innovation and Technology's Raw Materials sector. It is a matchmaking activity in support of sustainable business creation.

It is also a chance to experience and enjoy the unique artistic and cultural aspects of the host city – which is steeped in maritime history and tradition.

Stef Kapusniak - Chairman of the Thematic Workshop



Business Development
Manager
Mining
Soil Machine Dynamics Ltd
Newcastle-upon-Tyne
England, United Kingdom
stef.kapusniak@smd.co.uk

Prior to joining SMD, Stef worked in the surface and underground mining industry, mainly in Australia. He has previously held roles in Australia as Mine Manager, Technical Services Manager, Preparation Plant Manager, Principal Mining Engineer, Senior Mining Engineer and Senior Geotechnical Engineer for a variety of companies. During his Australian career he received a ministerial appointment to the West Australian Coal Mines Examination Board. He gained a BSc in Mining Engineering and a PhD in Rock Mechanics from the University of Nottingham in the early eighties and holds both underground and opencut Mine Manager's tickets. He has also managed large construction Joint Ventures in the transport sector in the UK. Notably, whilst working for SMD he was the Project Director for the design and build of the three deep-sea mining machines for Nautilus Minerals, machines designed to mine copper and gold from the seabed a mile below sea-level, in the Bismarck Sea, off Papua New Guinea. He is currently Technical Director of the EU-funded VAMOS project.

IN THE BLACK, will provide the opportunity to increase understanding of innovations and new trends in Deep Sea Mining and highlight opportunities for synergy; bringing together the EIT Raw Materials KIC (European Institute of Innovation & Technology - Knowledge and Innovation Community) within the Portuguese innovation and technology ecosystem.

The Geology, Biology, Environmental, Digital, Mining, Robotics and other Technological communities will meet "in the middle" of Raw Materials to discuss the next frontier for Deep Sea Mining. INESC TEC is joining forces with all the Partners of the Innovation Hub CLC East – EIT Raw Materials, StrongMar and iVAMOS! Projects to get an overview of actions, strategies and investigate potential collaborations, coupling science, technology and industrial applications. This investment, on a World, European, national and regional scale, in the Raw Materials arena will be beneficial to us all, fostering the integration of education, business and research. It will also provide insights from different experiences and approaches, enabling mineral resources exploration and safe exploitation to move forward.

I am grateful to our Chairman who was able to establish all the necessary bridges to bring us an excellent Programme with Speakers from all around the world and with a variety of expertise and backgrounds. His experience in underwater mining technology will guarantee an exceptional host during the sessions, ensuring high standards for this Thematic Workshop.

Immerse yourself *IN THE BLACK* and together we can cross the next frontier for mineral exploration and exploitation!

Eduardo Silva - Coordinator of CRAS | INESC TEC



Coordinator of the Centre for Robotics and Autonomous Systems (CRAS) and Professor INESC TEC and ISEP

Porto

Portugal

eduardo.silva@inesctec.pt

Eduardo Silva is the Coordinator of the Centre for Robotics and Autonomous Systems (CRAS) at INESC TEC and Professor at the School of Engineering (ISEP) of the Porto Polytechnic Institute (IPP). He has a PhD in Electrical and Computer Engineering from the University of Porto. His main research areas are marine robotics, control architectures, perception and navigation for autonomous robots. He has participated in more than 14 research projects, including iVAMOS! and UNEXMIN EU projects. He has more than 60 publications in the area of the Field Robotics.

ORGANISING TEAM

The Deep Sea Mining (DSM) challenges that are ahead of us need more and more events like this Thematic Workshop hosted by the Centre for Robotics and Autonomous Systems from INESC TEC. All the participants including speakers with different backgrounds and expertise are going to discuss real DSM experiences, underwater technology developments and propose innovative solutions. We hope that all of you become “*IN THE BLACK*” state of mind!

As researchers in INESC TEC, we believe that an integrative cooperation between all partners working in DSM is always beneficial. INESC TEC is an EIT Raw Materials partner from the Innovation Hub CLC West, and is currently the leader of the Thematic Group concerning DSM. This thematic field is part of the EIT Raw Materials and our Innovative Hub strategy, to strengthen this emerging area. This event will certainly be a great opportunity to expand our network.

However the real challenge for us is to find common ground between all the fields involved in DSM. Therefore, we strongly believe that your presence and active participation will guarantee the success of the Workshop as it is a unique opportunity to share knowledge, science and technology.

We really hope that this Workshop about DSM triggers the development of future collaborations and projects, answers some questions and, perhaps... raises more.

Deep Sea Mining, definitely, cannot be at the bottom of the list Portugal and European priorities.

Enjoy the Workshop and our beautiful city!

The Organising Team of the Thematic Workshop



Ana Paula Lima
Project Manager, PhD
Research Fields: Biology, Natural Resources and Ecosystems
INESC TEC|CRAS [Centre for Robotics and Autonomous Systems]
aplima@inesctec.pt



Ana Cristina Pires
Post-Doc Researcher, PhD, MEng
Research Fields: Geosciences, Geotechnics and Mineral Resources
INESC TEC|CRAS [Centre for Robotics and Autonomous Systems]
ana.c.pires@inesctec.pt

Programme

Schedule Day 1

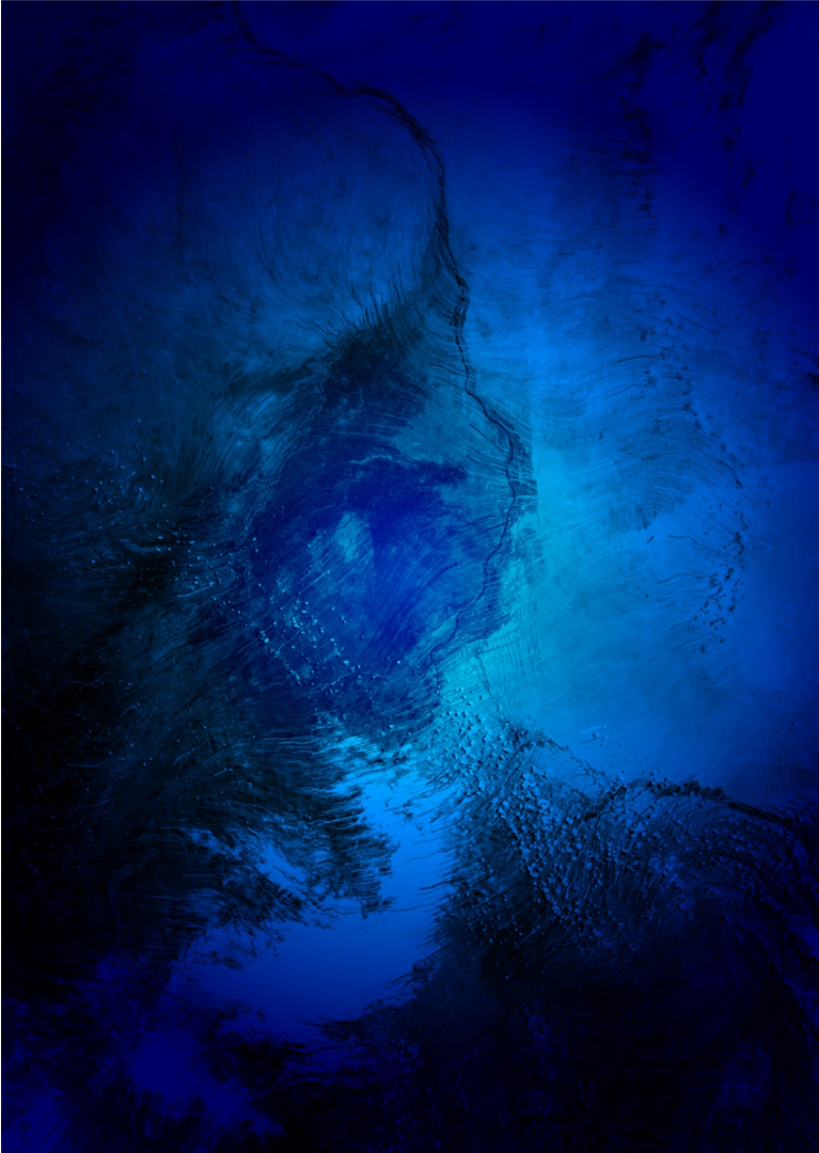
Start	End	Session	Speaker	Title
5th July / Thursday				
13:00	14:00	Registration + Icebreaker		
14:00	14:30	OS	Opening Session	Chairman: Stef Kapusniak SMD
14:30	15:00	S1	Session 1	Massimo Gasparon EIT Raw Materials <i>EITRawMaterials: a vision for a sustainable future</i>
15:00	15:30			John C. Wiltshire University of Hawaii <i>Future Developments for Risk Reduction in Deep Water Marine Mining</i>
15:30	16:00			Josep De La Puente Barcelona Supercomputing Center <i>Seismic and EM offshore imaging with HPC</i>
16:00	16:15	Coffee break		
16:15	16:45	S2	Session 2	Paulo Y.G. Sumida University of São Paulo <i>Cobalt crust exploration in the SW Atlantic: the need for baseline environmental studies</i>
16:45	17:15			Hiroyuki Yamamoto JAMSTEC <i>Technical issues on deep-sea EIA and environmental management</i>
17:15	17:45			Patrícia Conceição EMEPC <i>Seabed Mining in the Portuguese Continental Shelf: Are we there yet?</i>
20:00		Workshop Dinner		

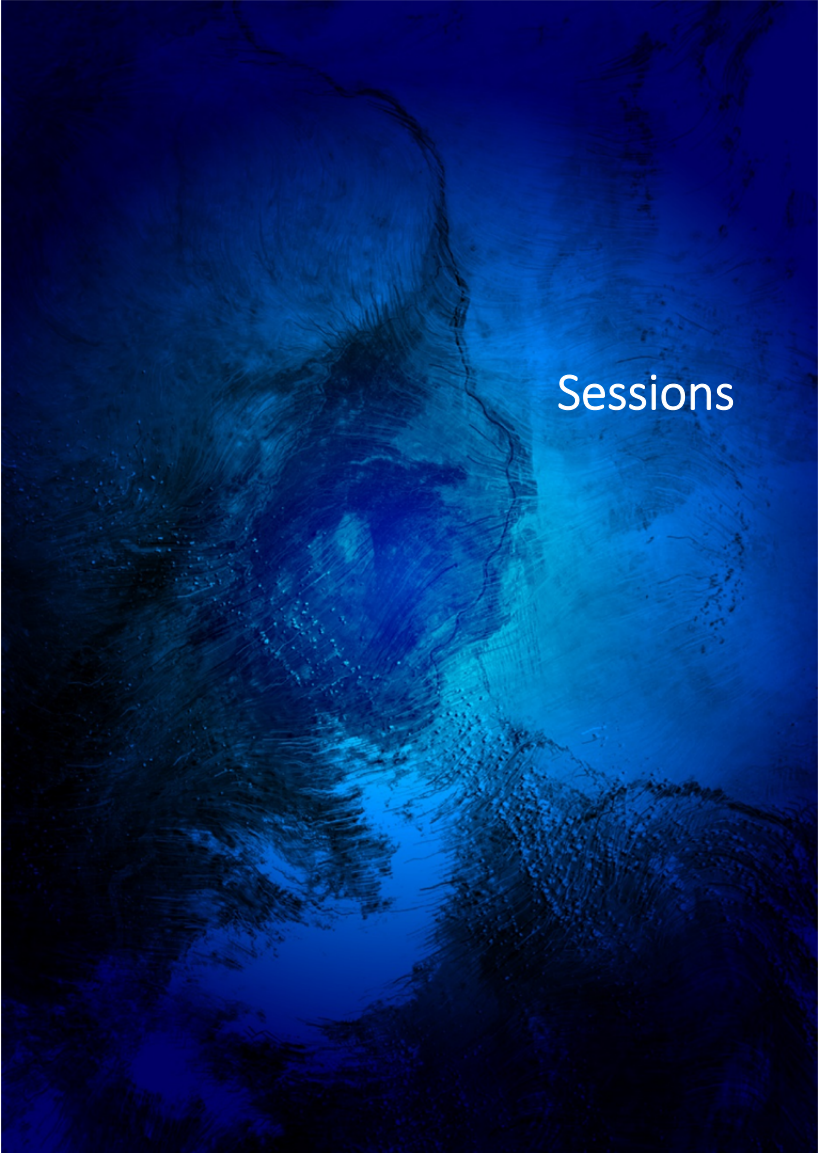
Sessions

- S1 | Shape the future with Mineral Raw Materials, Digital Data & Technologies
- S2 | Marine Georesources: from exploration to exploitation and impact assessment [Part I]
- S3 | Marine Georesources: from exploration to exploitation and impact assessment [Part II]
- S4 | “Living on the edge” of legal and regulatory framework in Deep Sea Mining
- S5 | Geotechnologies and Robotics for Underwater Mining [Part I]
- S6 | Geotechnologies and Robotics for Underwater Mining [Part II]
- RT ROUND TABLE | The Next Frontier for Mining in the Deep Sea

Schedule Day 2

Start	End	Session		Speaker	Title
6th July / Friday					
08:30	09:00	Welcome Day 2			
09:00	09:30	S3	Session 3	Gary Van Eck De Beers Group	<i>The Nearshore Marine Mining Pipeline</i>
09:30	10:00			Dan Hamer Manafai International Trade	<i>Atlantis II Deposit, Red Sea – mineral resources from the sea floor</i>
10:00	10:30			Przemyslaw B. Kowalczyk NTNU	<i>Opportunities and challenges in processing of seafloor massive sulphides from the Loki's Castle area at the Arctic Mid-Ocean Ridge</i>
10:30	10:45	Coffee break			
10:45	11:15	S4	Session 4	Steve Potter Pinsent Masons	<i>The ISA's draft exploitation regulations of 30 May 2018 and the process to date – choppy waters ahead?</i>
11:15	11:45			Rui Ferreira CIIMAR	<i>Deep sea mining and law: an overview</i>
11:45	12:15	S5	Session 5	Deyan Draganov TU DELFT	<i>Mining prospecting with seismics: new opportunities through seismic interferometry</i>
12:15	12:45			Norbert Zajzon University of Miskolc	<i>Challenges and possible solutions of underwater „in-situ” material characterization</i>
12:45	14:15	Lunch			
14:15	14:45	S6	Session 6	Sunny Schoone RWTH Aachen University	<i>Use of acoustic emission for material flow chracterization in Deep Sea Mining at the RWTH Aachen University</i>
14:45	15:15			Pere Ridao Rodríguez University of Girona	<i>Cave Mapping Using SLAM</i>
15:15	15:45			José Miguel Almeida INESC TEC / ISEP	<i>Underwater perception technologies</i>
15:45	16:15	Coffee break			
16:15	17:30	RT	Round Table	<i>Moderator:</i> Filipe Castro (CIIMAR)	<i>The Next Frontier for Mining in the Deep Sea</i>
17:30	18:00	ES	End Session	Eduardo Silva INESC TEC / ISEP	
18:00	*** SUNSET PARTY [ROBOTICS LABORATORY] ***				





EITRawMaterials: a vision for a sustainable future

Massimo Gasparon [Programmes Director EIT Raw Materials]

EIT RawMaterials, initiated and funded by the EIT (European Institute of Innovation and Technology), a body of the European Union, is the largest and strongest consortium in the raw materials sector worldwide. Its vision is to develop raw materials into a major strength for Europe. Its mission is to boost competitiveness, growth and attractiveness of the European raw materials sector via radical innovation, new educational approaches and guided entrepreneurship.

EIT RawMaterials unites more than 120 partners from leading industry, universities and research institutions from more than 20 EU countries. Partners of EIT RawMaterials are active across the entire raw materials value chain; from exploration, mining and mineral processing to substitution, recycling and circular economy. They collaborate on finding new, innovative solutions to secure the supplies and improve the raw materials sector in Europe.

There are six regional Innovation Hubs in Belgium, Finland, France, Italy, Poland and Sweden, called Co-Location Centres (CLCs) that represent different regional ecosystems connecting industry, research and education.

EIT RawMaterials aims to significantly enhance innovation in the raw materials sector by sharing knowledge, facilitating matchmaking activities, developing innovative technologies and supporting business creation. EIT RawMaterials will generate a significant impact on European competitiveness and employment by driving and fostering innovation and empowering students, entrepreneurs and education partners driving towards the circular economy. This will result in the introduction of innovative and sustainable products, processes and services, as well as talented people that will deliver increased economic, environmental and social sustainability to the European society.

Future Developments for Risk Reduction in Deep Water Marine Mining

John C. Wiltshire [Department of Ocean and Resources Engineering, Hawaii Undersea Research Laboratory, University of Hawaii]

World population is growing, slated to reach 10 billion by 2050. The population is getting on average older and wealthier. It is using more resources at a time when grades of traditional land based mineral deposits are declining. The oceans cover 71% of the planet and contain high-grade mineral deposits. On the face of it, this would seem to make marine mining soon inevitable, yet none of the world's largest 20 mining companies has a major marine mining program. The reason is that when risk is calculated in the way mining companies evaluate new projects, most marine mining projects with the exception of diamonds, shallow water placers and sand and gravel are uneconomic. Risk must therefore be reduced by technology.

This starts with AUV exploration technology, automated mining systems and ships, advanced processing technologies and environmental surveys and mitigation. Work is progressing on each of these fronts and will be briefly described. Future marine mining will be dominated by smart, connected, highly adaptable, resilient new deep-sea technology.



Nautilus Minerals Sulfide Mining Ship Nearing Completion in March 2018

Seismic and EM offshore imaging with HPC

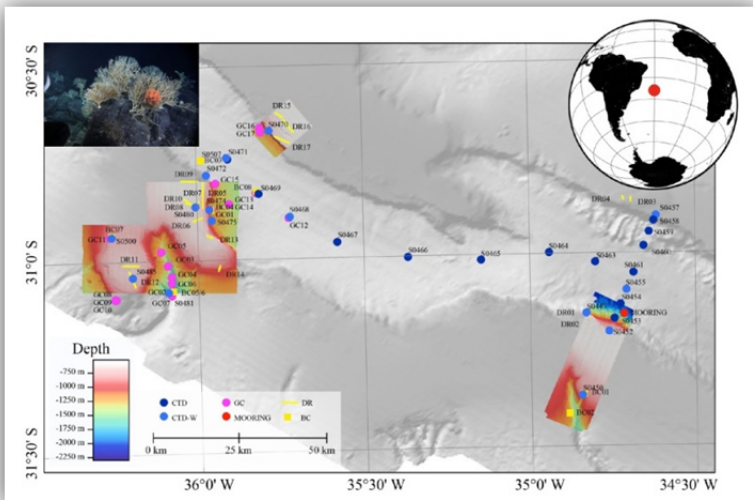
Josep De La Puente [CASE - Geosciences Applications, Barcelona Supercomputing Center]

The exploration of geological resources below the seabed is typically conducted with geophysical methods. These result from collecting gravitational, seismic or electromagnetic data. Modern processing techniques can transform such data into accurate 3D maps of the geological properties in the studied area. Key to the success of this "imaging" process are the algorithmics used to extract information from geophysical data. Such algorithms are often very intensive in terms of computational demands. I will present the state-of-the-art in high-performance computing (HPC) applied to geophysical exploration and exemplify the transformative impact in the exploration field that HPC has had in the past, and will likely have again in the near future.

Cobalt crust exploration in the SW Atlantic: the need for baseline environmental studies

Paulo Y.G. Sumida [Instituto Oceanográfico, University of São Paulo]

Recently, the Brazilian Government requested to the International Seabed Authority an area to explore cobalt-rich crusts at the summit of the Rio Grande Rise (SW Atlantic). However, recent expeditions to RGR, including one using manned submersible Shinkai 6500 revealed a rich fauna living in the area. While the search for minerals in the deep-sea promises to be a multi-billion dollar business, it is fundamental that baseline environmental research is undertaken to safeguard that vulnerable deep-sea ecosystems are protected from the damaging effects of mining. These ecosystems are particularly sensitive to impact mainly due to the slow recovery rates related to the biology of the organisms, like high longevity, slow growth rates and low fecundity. Some communities may take decades to centuries or even millennia to recover, if they do it at all. Therefore, political actions are required to create effective Marine Protected Areas to ensure a proper preservation of the biodiversity and ecosystem services of the deep oceans. The deep-sea is the largest environment on Earth and it is a common heritage of mankind.



Technical issues on deep-sea EIA and environmental management

Hiroyuki Yamamoto [Japan Agency for Marine-Earth Science and Technology|JAMSTEC]

The best practices of engineering and data analysis should be used wherever be able to reduce or mitigate ecological impacts. Deep-sea is a difficult target area for survey, and without suitable technology we could not access the primary data. Monitoring and observation is an essential technology to assess the situation of environments and to estimate the ecosystem robustness for impacts.

Biological/microbial community, biodiversity, or individual species have been used as indicator to determine the effect of environmental impacts. Data acquisition methods on such indicators have been changed past decade, introducing new technologies, e.g. metagenomics, flow-cytometry, and high-performance camera (for example stereo eye, holography, 8K super high vision). The tools for long-term observation using seafloor observatory and onboard pollution monitoring system are key technology of environmental management for seabed-mining. The data-acquisition techniques used in academic field should be modified for deep-sea environmental impact assessment (EIA) to achieve high performance survey under cost effective operation available for industry.

Within scientific communities, the coordination of data circulation through international relationship have been established, for example the Biological Information System for Marine Life (BISMaL), and the Ocean Biogeographic Information System (OBIS). Data-sharing system for the deep-sea EIA for seabed mining will be useful to perform comparative analysis and modelling to estimate potential of community resilience from impacts. The best practice of observation in deep-sea environments could also make the useful data-set for global issues on marine ecosystem through the data-sharing.

New technologies allow semi-automatic data gathering, e.g. metagenomic data, imaging data of biological indicators, and physicochemical parameters by in situ sensors. The process for identification of indicators and integration with habitat data in large amount of data are drastically changed using machine learning system. This movement will be improved data analysis on EIA.

Seabed Mining in the Portuguese Continental Shelf: Are we there yet?

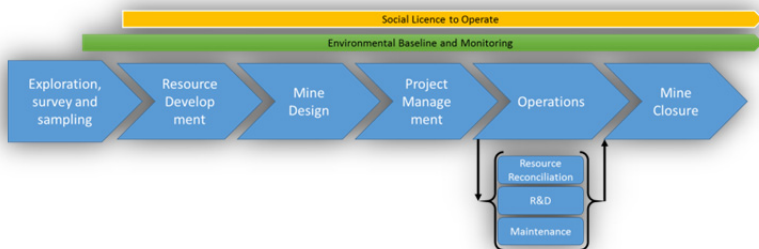
Patrícia Conceição [Task Group for the Extension of the Continental Shelf|EMEPC]

The Project for the Extension of the Continental Shelf results from the application of article 76 of the United Nations Convention on the Law of the Sea. Its implementation in Portugal was possible due to significant financial and technical efforts leading to a considerable increase of knowledge on the deep sea, mainly on its morphology, distribution and occurrence of natural resources. Currently, even though there are several known occurrences of mineral resources on the Portuguese continental shelf, the knowledge about the potential of our maritime area is still very limited. The need to increase the knowledge on the deep sea under the jurisdiction of Portugal will leverage technological development and innovation. This is paramount to access these vast areas typically located at depths greater than 3,000 meters. A lot more work is needed if Portugal wants to develop a strategy for its resources in the near future, which must also account for the protection of the marine environment. Even if seabed mining proves to be a sustainable activity, Portugal has a whole framework to develop before embracing this challenge.

The Nearshore Marine Mining Pipeline

Gary Van Eck [De Beers Group]

The first commercially viable marine diamond mining operations started off the Namibian coast in 1964, but stopped shortly thereafter. The current operations restarted in 1989 and today produce over one million carats of gem quality diamonds. The journey has not been easy, with significant strides made in the fields of exploration, subsea mining and environmental baseline management. The journey for deep sea mining, although able to leverage the benefits of modern day technology, will no doubt be as long and as challenging.



This presentation will take a brief look at the nearshore mining journey, how it has branched into other commodities, and what are some of the learnings and challenges for deep sea mining?

Atlantis II Deposit, Red Sea – mineral resources from the sea floor

Dan Hamer [Project Manager – Atlantis II, Manafai International Trade]

The Atlantis II Deposit is the world's largest sea floor massive sulphide and comprises metal-rich sediments in the Red Sea. It is located within the Exclusive Economic zones of Saudi Arabia and Sudan. The Deposit was discovered in 1963 and was initially evaluated during the 1970s and 1980s. This programme defined a $\leq 90\text{Mt}$ multi-metal resource (Zn-Cu-Ag-Au-Mn) and included successful pre-pilot mining and metallurgical processing. However, the Project was put on hold in 1984 due mainly to oversupply.

From 2008, there has been renewed interest in deep-sea mining. Accordingly, a Mining Licence over Atlantis II was granted to Manafai by the Saudi-Sudanese Red Sea Commission in 2010. A CIM compliant Inferred Resource ($\leq 80\text{Mt}$) was defined. In 2016, a programme of diversification (Saudi Vision 2030) was announced in Riyadh to reduce over-dependence on petroleum. As part of this initiative, Manafai plans to re-evaluate Atlantis II with a view to potential exploitation in a safe, environmentally sound, economically viable and socially responsible manner.

Atlantis II is an Anthropocene Hydrothermal-Sedimentary Deposit, accumulating in a fault-bounded basin within the axial trough of the Red Sea, containing brines $\pm 7x$ normal sea water salinities and at elevated temperatures ($\leq 66^\circ\text{C}$). The mineralised muds are unconsolidated and overlie basalt. They have precipitated from hydrothermal fluids exhaled from fissures associated with rifting. $\leq 25\text{m}$ of metal-rich sediments have accumulated within an area $> 57\text{km}^2$.

Coring has defined discrete mineralised zones. Due to technical difficulties encountered in soft sediments and brine-rich sea water at depths $\geq 2\text{km}$, coring to date failed to penetrate the full extent of the mineralised interval. Therefore, the Deposit is open at depth. Elevated grades are encountered in the SW portion of the basin. However, no intersections of a potentially high-grade feeder system (Cu-Au) have yet been achieved.

Manafai's programme has begun with a re-evaluation of the existing data. Additional geophysical work, including the acquisition of high resolution data will be followed by infill coring to upgrade the resource category. The programme will include further metallurgical and mineral processing test work; geotechnical and hydrological work; mine design and production planning.

Previous engineering studies envisaged extraction by hydraulic suction using remotely operating vehicles (ROVs) and transfer to surface via a vertical lifter and riser system to a production support vessel where preliminary processing and concentration could be carried out. $\leq 16,000\text{m}^3$ of metalliferous mud were successfully extracted in this manner in the 1970s and processed to yield zinc, copper and gold. The design of suitable remotely operating equipment capable of performing the required tasks at depth in hot brines, will be a crucial factor for operational success.

This system entails the return of seawater and tailings to the ocean which involves considerable environmental risk. The transfer of slurry via submarine pipeline direct from the mining site to a shore-based processing facility significantly reduces such risks and is also being considered. Shore-based processing would enable the recovery of additional economic minerals contained within the resource.

There is acute concern over the state of the oceans and the prospect of deep-sea mining adds to potential threats. The growth of self-determination and public awareness of rights in a connected world requires the informed consent of all stakeholders. The paucity of existing data is a limiting factor in the assessment of these mineral resources.

Manafai has established preliminary agreements with technical partners, research groups and environmental bodies. The Company intends to complete a Definitive Feasibility Study which will include a comprehensive Socio-economic and Environmental Impact Assessment.

Opportunities and challenges in processing of seafloor massive sulphides from the Loki's Castle area at the Arctic Mid-Ocean Ridge

Przemyslaw B. Kowalcuk [Norwegian University of Science and Technology|NTNU, Department of Geoscience and Petroleum]

Seafloor massive sulphides (SMS) can serve as a potential resource of metals such as Cu, Zn, Au and Ag. SMS rock samples from the Loki's Castle area at the Arctic Mid-Ocean Ridge are comprised of sulphide bearing minerals such as pyrite, chalcopyrite, isocubanite, galena, sphalerite, whereas the gangue consists mainly of barite and silica. Sphalerite, chalcopyrite and isocubanite show complex intergrowth textures on the nano to microscale.

Various mineral processing tests were conducted in order to recover copper, zinc and silver. It was shown that sensor-based sorting can be efficiently used for preconcentration of SMS rock samples. A significant amount of waste (i.e. barite and silica) was removed in the preconcentration stage with very low losses of copper and zinc to the waste fraction. The upgraded samples were sent to the next processing stages. The results showed that the complex mineralogy of the SMS material provided challenges to conventional mineral processing methods. Hydrometallurgical processing was applied as an alternative method for extraction of metals from SMS. Leaching experiments were conducted using solutions of different lixiviants, and it was shown that leaching of SMS together with manganese nodules would facilitate efficient recovery of metals from these resources.

S4

“Living on the edge” of legal and regulatory framework in Deep Sea Mining

The ISA's draft exploitation regulations of 30 May 2018 and the process to date – choppy waters ahead?

Steve Potter [Pinsent Masons MPillay LLP]

REVIEW OF ISA'S DRAFT EXPLOITATION REGULATIONS of 30 May 2018

On 30 May 2018, the ISA published a further revised (but 'unedited') draft of the exploitation regulations – which is the third such draft issued by the ISA. My presentation will focus on the extent to which key State and Contractor issues raised in formal submissions in December 2017 have been addressed in the revised draft and any additional key issues in the revised draft which are likely to cause significant issues for stakeholders moving forward, including those issues which are likely to impact significantly on the timing of implementation of the regulations.

ABSTRACT

Following the call for submissions in response to the ISA's August 2017 draft of the exploitation regulations, 55 responses from stakeholders were received and published by the ISA. My presentation will start by briefly looking at how the ISA has continued to engage with stakeholders to develop the regulatory framework governing DSM in the Area following since the publication of draft zero of the exploitation regulations in 2016, before focusing on a number of the December 2017 submissions, including those from the Africa Group, China and the Chinese sponsored contractors. My review of the formal submissions will include, amongst other things, commentary on:

- (i) the increased level of Stakeholder response (State Parties to UNCLOS, Sponsoring States, Privately owned Contractors, State Owned Contractors and NGOs);
- (ii) the quality of the submissions (particularly by States and Contractors);
- (iii) the key concerns raised by State and Contractor stakeholders and how those issues have been addressed in the 30 May draft exploitation regulations and what impact those issues are likely to have on the process of finalizing the regulations.

Deep sea mining and law: an overview

Rui Ferreira [CIIMAR]

Deep sea mining activities are seen by many as a new opportunity to address the growing human demand for mineral resources. Nevertheless, the risks posed by such operations to the marine environment are hard to tackle, due to gaps on scientific knowledge concerning deep sea ecosystems, habitats and dynamics, and due to the limitations of currently available technology for deep sea mining exploration and exploitation activities. In particular, technological progress needs to be articulated with scientific knowledge and with legal regulations, in order to effectively protect and preserve the marine environment from significant adverse effects. The presentation approaches the UNCLOS framework and part of the ISA Mining Code, in order to point out issues concerning environmental protection and legal regulation.

S5

Geotechnologies and Robotics for Underwater Mining [Part I]

Mining prospecting with seismics: new opportunities through seismic interferometry

Deyan Draganov [TU Delft, Department of Geoscience and Engineering]

Exploration seismics is not traditionally used for mining prospecting despite having proven to provide the best imaging resolution for oil and gas exploration. This is because it is considered more time-consuming and expensive compared to traditionally used mining-prospecting methods. But the method is becoming more popular due to required higher resolution for smaller and/or deeper targets and lowered costs for acquisition and computational hardware and software. One contributor to the increased resolution and lower acquisition costs is a relatively new seismic method – seismic interferometry. Seismic interferometry allows retrieval of the response between two receivers as if one of them were a source. This method allows thus utilization of less sources in an actual field acquisition as later on seismic responses are retrieved at extra positions (of the receivers). Thus, the multiplicity of the seismic data and its illumination angles is increased for no extra field cost resulting in increased resolution. Seismic interferometry can also be used to remove undesired arrivals from the field data and enhance desired arrivals, thus again increasing the resolution. I will show examples of applications of seismic interferometry to shallow seismic data for removing undesired arrivals (e.g., surface waves) and enhancing desired ones (e.g., reflections).

Challenges and possible solutions of underwater “in-situ” material characterization

Norbert Zajzon [University of Miskolc, Institute of Mineralogy and Geology]

With the depletion of the conventional ore deposits on land, parallel to the continuously increasing demand of the society we need to improve our exploration, mining and extraction methods and look for new ways of resources to sustain the economy which still fulfil the environmental protection standards. One possible way is to search and mine underwater deposits, which can be high-grade and large compared to the currently explored and mined deposits on land.

There can be different types of underwater deposits as flooded open pits and underground mines, mines below the water table on land designed and operated without dewatering, and also off-shore deposits in shallow water and deep sea. Nearby many similarities these deposits have their unique characteristics and challenges which are even further complicated with the particular ore type. Deep sea deposits can be considered as one of the most difficult where the high pressure and deep location is an extra demand.

The further tasks need to be performed to successful mining: identifying the location of the deposit, proper evaluation of the deposit to decide mining, detailed production evaluation (ore block demarcation), ore extraction and transportation. For exploration and ore block demarcation material characterisation is inevitable (bulk chemical composition, trace element measurements and phase identification). What kind of measurement is need, it depends on the particular ore type, but to make the exploration and production economic these analytics must be quick and easily available. There can be two solutions for this demand related to deep sea mining: 1) sampling on site and analytics performed in a closely located laboratory (practically on a ship), 2) “in-situ” analytics underwater, where the deposit is located. Both ways of measurements carrying lot of difficulties which need to be solved for successful material characterisation.

For materials characterisation “in-situ” (e.g. performed inside drilling holes on the bottom of the sea), two main group of challenges exist: 1) the first is the physical difficulties and limitations like the shielding effect of water which outrules or strongly limits many otherwise very convenient analytical technics, and the high pressure versus the as thin analytical windows as possible of the instruments to minimize their absorption also; and 2) legal difficulties to make these methods accredited by current standards and introduce them into the very rigid mining codes (e.g. CRIRSCO or JORC) to make the measured data generally accepted by any mining companies. For this “in-situ” materials characterisation the most promising methods are optical (300–1000 nm) multi/hyperspectral methods, different UV-fluorescence techniques, Raman-spectroscopy, laser induced brake-down spectroscopy (LIBS), and X-ray fluorescence (XRF) techniques. Geophysical measurements are also a usefully technology for certain ore types where, density, magnetic-, or electric properties of the rocks are determined. This “in-situ” way would be a real break thru, which would completely reconfigure exploration so efforts in this direction should be made, but including its legal acceptance in mining realistically a long term target.

Much more realistic target in short term is to perform proper drill core sampling and the transport to surface the cores for research and production evaluation (ore block demarcations), parallel to setting up the suitable accredited laboratory in a ship to be able to move to the field to speed up the work and lower the costs.

Use of acoustic emission for material flow characterization in Deep Sea Mining at the RWTH Aachen University

Sunny Schoone [RWTH Aachen University, Advanced Mining Technologies|AMT]

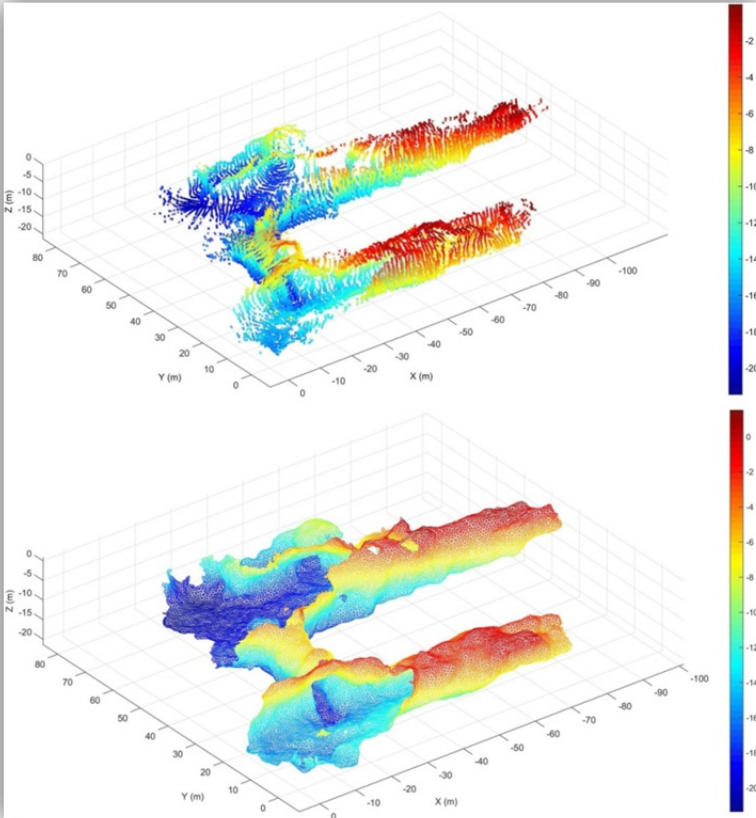
Since the founding of RWTH Aachen University, a long tradition in resource-related research has developed until today. As a result, the scientific and technical progress in the raw materials industry is in the focus of many research projects. This refers not only to land mining it also applies to the field of research of Deep Sea Mining. Currently at the RWTH Aachen University, five research institutes are working on the topic of Deep Sea Mining along the value chain. From the research in geology (Institute of Geology & Palaeontology (EMR)), on to the technological implementation (Institute for Advanced Mining Technologies (AMT); Unit of mineral Processing (AMR); Institute of Mineral Resources Engineering (MRE)) and finally to the metallurgy (Institute of Metallurgical Process Technology and Metal Recycling (IME)) many parts of the value chain are covered.

The Institute for Advanced Mining Technologies of RWTH Aachen University (AMT) has a long-established expertise in developing technologies for harsh mining environment, not only since recently the new chair Univ.-Prof. Dr.-Ing. E. Clausen was appointed. To extend the expertise of the AMT the focus of research increasingly shifted into the Deep Sea Mining sector. One core of Deep Sea Mining Projects is the development of an autonomous deep-sea mining vehicle. Furthermore is one of the core challenges to overcome the separation of valuable material from host rock at the source, in order to limit for one the environmental impact to a minimum level and increase efficiency at the same time. Another problem to face is the material transport to the surface. One way to achieve this is the employment of sensors, especially the acoustic emission (AE) technology. Previous investigations at the AMT have shown that material flow characterization is possible. Based on this, the use of AE for material flow characterization in a pipe circuit was tested in different scenarios. So far, various measurements on our self-designed and other special test benches have proven that AE is a feasible candidate for use in Deep Sea Mining activities. The results of this research will be presented in this talk.

Cave Mapping Using SLAM

Pere Ridao Rodríguez [University of Girona]

In this presentation, we detail the operations and discuss the results of an experiment conducted in the unstructured environment of an underwater cave complex using an autonomous underwater vehicle (AUV). For this experiment, the AUV was equipped with two acoustic sonar sensors to simultaneously map the caves' horizontal and vertical surfaces. Although the caves' spatial complexity required AUV guidance by a diver, this field deployment successfully demonstrates a scan-matching algorithm in a simultaneous localization and mapping framework that significantly reduces and bounds the localization error for fully autonomous navigation. These methods are generalizable for AUV exploration in confined underwater environments where surfacing or predeployment of localization equipment is not feasible, and they may provide a useful step toward AUV utilization as a response tool in confined underwater disaster areas.



Underwater perception technologies

José Miguel Almeida [INESC TEC | ISEP]

This presentation is about the positioning, navigation and awareness system developed for the Underwater Robotic Mining System of the !Vamos! project [www.vamos-project.eu]. Project !VAMOS!, that stands for Viable Alternative Mine Operating System, funded by the European Union's Horizon 2020 research and innovation programme, addresses the development of a prototype underwater mining system to extract raw materials from flooded open-pit mines. These inland mines have been considered depleted in the past because with previous mining techniques it was not economically viable anymore to continue operations. Today, with rising prices of certain rare ores it might become interesting again to re-open abandoned mines in order to access deeper seated minerals. However, conventional mining techniques require high treatment and dewatering costs. Moreover, from an environmental perspective, it is desirable that the water table of these flooded inland mines is not changed.

Therefore, the iVAMOS! project aims to develop a new remotely controlled underwater mining machine (MV), associated launch and recovery vessel (LARV) and support and survey autonomous/remote operated underwater vehicle (AUV/HROV), which provides a mining technique that is environmentally and economically more viable than the state-of-the-art.

This presentation will show the experience of INESC TEC in several projects concerning underwater technologies including real-time navigation to support mining operations, 3D mine models, mine surveys and the development of a maritime Laser-Induced Breakdown Spectroscopy (LIBS) system allowing the real-time grade control of the slurry.

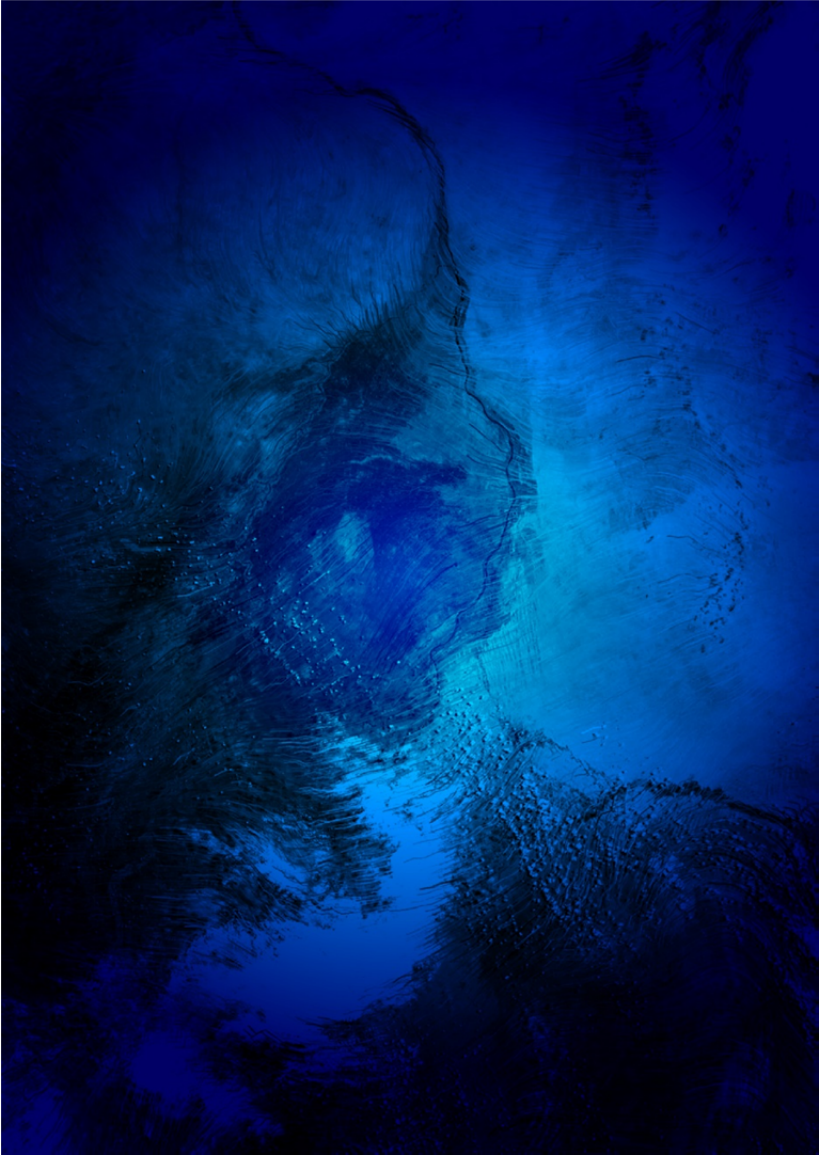


iVAMOS! Underwater mining machine, exploration iVAMOS! AUV [EVA] and real time monitoring interface in the control station.

ROUND TABLE	<i>The Next Frontier for Mining in the Deep Sea</i>
--------------------	---

The exploitation of mineral resources on deep-ocean beds, including those in the vicinity of sensitive-rich habitats such as hydrothermal vents is rapidly emerging as a plausible alternative. Yet, the scale and the nature of the challenges ahead, both from a technological and environmental perspective are mostly unknown at present. Hence, building upon currently available scientific information is crucial to develop new cost-effective technologies embedded into rigorous operating frameworks.

Filipe Castro [Moderator]



An abstract background featuring a deep blue color palette with visible, expressive brushstrokes. The strokes vary in intensity, from dark navy to bright cyan, creating a textured, painterly effect. The overall composition is centered and occupies most of the page.

Speakers *(in alphabetical order)*



Dan Hamer



Project Manager
Atlantis II, Manafai International Trade,
Riyadh, KSA
Saudi Arabia
d.hamer@manafai.com

Dan has more than thirty years of experience in mining and mineral exploration. He began his career as a geochemist with the British Antarctic Survey and joined the mining industry in 1984. He has held senior positions in production and managed mineral exploration programmes for gold and base metals from the generative stage through to bankable feasibility studies. He has worked for multi-national and state-owned mining corporations, mid-tier miner-explorers and junior exploration companies from Africa, Australia, Canada, China and Europe. He joined Manafai in 2017 as Atlantis II Project Manager and is based in Riyadh, Saudi Arabia. He is a Chartered Geologist and a Fellow of the Geological Society.



Deyan Draganov



Assistant Professor
Applied Geophysics and Petrophysics
Department of Geoscience & Engineering
TU Delft
The Netherlands
D.S.Draganov@tudelft.nl

Dr. Deyan Draganov holds a tenured Assistant Professor position in Applied Geophysics and Petrophysics at the Department of Geoscience and Engineering at Delft University of Technology (The Netherlands). He obtained his PhD (cum laude) in 2007. His expertise lies in the theory and application of seismic interferometry from ultrasonics, through near-surface and exploration scale to global scales. He uses interferometry for retrieval of reflections from active (e.g., ultrasonic transducers, hammer, vibrators, dynamite) and passive (ambient noise, microseismicity, local and global earthquakes) sources. The retrieved reflections are then processed using techniques from exploration seismics to obtain images and/or monitor changes in objects/subsurface. He also uses seismic interferometry to retrieve surface waves for their subsequent suppression from the original active-source data, thus improving the resolution of the active-source reflection data.

Together with Prof. K. Wapenaar, he is giving a two-day course on seismic interferometry as part of the continuing-education curriculum for professionals for the Society of Exploration Geophysicists (www.seg.org). Since 2004, Draganov's research has resulted in 45 published papers, one book publication, and two book chapters. Draganov's achievements in the field of seismic interferometry have been recognized by Best Student Paper Presentation from SEG (2004), Cagniard Award for poster presentation from the European Association of Geoscientists and Engineers or EAGE (2005), J. Clarence Karcher Award from SEG (2010), and Editor's Highlight paper in the Journal of Geophysical Research – Planets. Draganov was awarded a VENI grant in 2007 (08115) and a VIDI grant in 2012 (864.11.009). Since 2017, he is an Assistant Editor for Geophysics and was an Associate Editor for Geophysics since 2005.

URL: <https://www.tudelft.nl/citg/over-faculteit/afdelingen/geoscience-engineering/sections/applied-geophysics-petrophysics/staff/academic-staff/dr-ir-ds-deyan-draganov/>



Gary Van Eck



Offshore Portfolio Manager
Namdeb Diamond Corporation (Pty) Ltd
South Africa
Gary.VanEck@debeersgroup.com

Gary started off his professional life as a graduate mechanical engineer in the Defence industry. He subsequently obtained a Master's degree in Naval Architecture, and various project management qualifications, including the PMP[®]. Gary joined De Beers Marine as a project manager in 1999. He has successfully managed several mining projects, including the conversion, establishment and initial operation of the world's largest marine mining ship, the PEACE IN AFRICA. He was seconded as the Engineering & Portfolio Manager to AuruMar when it was created in 2010, and was later appointed General Manager. Under his leadership, AuruMar conducted exploration campaigns for offshore placer gold in various locations across the globe. This work culminated in the conclusion of a Preliminary Economic Assessment for the Nome Offshore Placer Gold field in Alaska in 2014. Gary is currently employed as the Offshore Portfolio Manager for Namdeb, and is responsible for establishing sustainable mining operations in Namdeb's offshore mineral concessions, as well as other wet mining projects for the De Beers Group. He resides in Cape Town, South Africa. He sometimes still stands at the edge of an open pit mine and wonders how a naval architect landed up there!



Hiroyuki Yamamoto



Senior Scientist
R&D Center for Submarine Resources
Japan Agency for Marine-Earth Science
and Technology - JAMSTEC
kyama@jamstec.go.jp

Hiroyuki Yamamoto is a senior scientist of R&D Center for Submarine Resources, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), and serves on a leading scientist of research unit for EIA technology in Project for Development of New-Generation Research Protocol for Submarine Resources, Cross-Ministerial Strategic Innovation Promotion Program of Japan. The research field is marine science and ecological microbiology.



John Wiltshire



Director
Hawaii Undersea Research Laboratory
(HURL)
Associate Chairman
Department of Ocean and Resources
Engineering
University of Hawaii
johnw@soest.hawaii.edu

Dr. John C. Wiltshire graduated in 1976 with a B.Sc. in geology from Carleton University in Ottawa, Canada. He worked as an exploration geologist in the oil and mining industries for Noranda Mines, Chevron and Petro-Canada. Dr. Wiltshire earned a Ph.D. in Geological Oceanography from the University of Hawaii in 1983. He then became Ocean Resources Manager for the State of Hawaii in the Department of Business, Economic Development and Tourism. In this position, Dr. Wiltshire interfaced with the growing marine business and energy sector in Hawaii representing many of Hawaii's small marine companies in trade initiatives to China and Japan. In 1986, he joined the Hawaii Undersea Research Laboratory (HURL), he is now Director of HURL. He is also Associate Chairman of the University of Hawaii's Department of Ocean and Resources Engineering. He is the Editor-in-Chief of the peer-reviewed journal Marine Georesources and Geotechnology. He teaches four courses at the University of Hawaii in the areas of energy and mineral resources. He is a fellow of the Marine Technology Society (MTS) and was General Chairman of the 1500-person MTS 'Oceans' conference in 2011. Wiltshire has authored over 100 papers on marine minerals, marine technology, energy and sustainable development. He serves as president of the international consulting group TCI-Hawaii.



Josep De La Puente



Group Manager
CASE - Geosciences Applications
Barcelona Supercomputing Center
Spain
josep.delapuate@bsc.es

A Physics graduate from the Universitat de Barcelona. He holds a PhD in Natural Sciences from the Ludwig Maximillians Universität Munich, obtained at the Earth Sciences Departments. He is a specialist in Computational Geophysics, including seismic/EM modelling and inversion. In particular he works in developing and deploying geophysical imaging software for high-performance computing platforms.



José Miguel Almeida



Senior Researcher
Center for Robotics and Autonomous
Systems
INESC TEC and ISEP
Portugal
jma@inesctec.pt

José Miguel Almeida is a professor at the School of Engineering (ISEP) of the Porto Polytechnic Institute (IPP). His main research area is sensing, perception and navigation in mobile multi-robot systems. He is a principal investigator or researcher in several research projects funded by entities such as Portuguese Science and Technology Foundation (FCT), Portuguese Innovation Agency (Adi/ANI) or NATO SfS programme. In particular, he is the INESC TEC responsible for the Navigation task in the iVAMOS! project (H2020).



Massimo Gasparon



Programmes Director

EIT Raw Materials

Germany

massimo.gasparon@eitrawmaterials.eu

Academic qualifications:

- 1994 PhD in Geology, University of Tasmania (“Origin and evolution of mafic volcanics of Sumatra (Indonesia): their mantle sources, and the roles of subducted oceanic sediments and crustal contamination”).
- 1989 BSc (Honours) in Geology, University of Firenze, Italy (“Volcanologic and petrologic study of the Debre Zeyt area, Ethiopia”. First class “summa cum laude”)

Employment history (post-PhD):

- 2018-current Programmes Director, EIT RawMaterials
- 2017 Education Officer, EIT RawMaterials NCLC (Luleå)
- 2008 – 2016 Professor, Earth Sciences, The University of Queensland
- 2002 – 2007 Senior Lecturer, Earth Sciences, The University of Queensland
- 1998 – 2001 Lecturer, Earth Sciences, The University of Queensland
- 1995 – 1997 Associate Lecturer, Earth Sciences, The University of Queensland
- 1994 CNR-NATO Postdoctoral Fellow, Vrije Universiteit Amsterdam, The Netherlands

Awards

- 2011 The University of Queensland Teaching Excellence Award
- 2006 Carrick Institute for Learning and Teaching in Higher Education - Citation for Outstanding Contributions to Student Learning
- 2003 “Visit Europe” award (Australian Academy of Science)
- 2001 Young Scientist Award (Australian Research Council)
- 2001, 2005 Fellow, Alexander von Humboldt Foundation (Germany)

Society membership

- American Geophysical Union, International Mine Water Association, Geological Society of Australia, Australasian Institute for Mining and Metallurgy



Norbert Zajzon



Associate Professor
Institute of Mineralogy – Geology
Faculty of Earth Sciences and Engineering
University of Miskolc
Hungary
nzajzon@uni-miskolc.hu

Norbert Zajzon completed his studies about mineralogy, geochemistry and solid mineral resources at the Eötvös Loránd University (MSc 2001, PhD 2006), Budapest, Hungary. His research subject was instrumental mineralogy and geochemistry related to global environmental crises. Until now he is dedicated to numerous analytical techniques in the geoscience field.

He is currently an associate professor at the Institute of Mineralogy and Geology, University of Miskolc (Miskolc, Hungary), teaching instrumental mineralogy, ore deposits and astronomy and planetology and head of the microprobe laboratory (<http://www.geology.uni-miskolc.hu/index.php/en/staff/13-munkatarsak/438-dr-norbert-zajzon>). He is also the coordinator of the currently running UNEXMIN project (www.unexmin.eu) which is a European Union funded Horizon 2020 project, aims to develop an autonomous underwater robotic explorer (UX-1) to 500 m water depth, capable to 3D map and deliver geo-scientific information by non-invasive methods from abandoned, flooded underground mines.



Patrícia Conceição



Marine Geologist
Task Group for the Extension of the
Continental Shelf
EMEPC
Portugal
patriciaconceicao73@gmail.com

Patrícia Conceição is a marine geologist in the Task Group for the Extension of the Continental Shelf (EMEPC), working in deep sea mineral resources and in the Portuguese Continental Shelf Project outreach. She worked in the University of Lisbon and in Codes - ARC Centre of excellence in Ore deposits of University of Tasmania, Australia. In 2008 she became part of the team which prepared and delivered the Portuguese Continental Shelf Submission, and is now interacting with the Commission on the Limits of the Continental Shelf, during its evaluation.



Paulo Sumida



Associate Professor
Oceanographic Institute
University of São Paulo
Brazil

psumida@usp.br

Paulo Sumida obtained a PhD in 1998 from the University of Southampton (National Oceanography Centre, UK) and worked as a post-doctoral fellow at the University of Hawaii in 1999-2000. In 2000, he joined the University of São Paulo and is currently an Associate Professor of Biological Oceanography. Sumida works on the ecology of deep-sea benthic organisms of reducing environments, deep-water coral reefs and polymetallic nodule and crusts. He participated in over 40 oceanographic cruises and dived in many research submersibles (Alvin, Johnson-Sea-Link, Shinkai 6500, Deep Rover) down to 4200 m depth, having also worked in many ROV missions. His research has been undertaken in different ocean basins, such as the North and South Atlantic, Gulf of Mexico, Northeast and Northwest Pacific and Southern Ocean.



Pere Ridao Rodríguez



Associate Professor
Department of Computer Engineering
University of Girona
Spain

pere.ridao.rodriguez@gmail.com

Pere Ridao received the Ph.D. degree in computer engineering in 2001 from the University of Girona, Spain. Since 1997, he has participated in 19 research projects (10 European and 9 National), he is author of more than 100 publications, and he has directed 5 PhDs thesis (5 more under direction) and 13 MS Thesis. His research activity focuses on designing and developing Autonomous Underwater Vehicles for 3D Mapping and Intervention. He is the director of the Computer Vision and Robotics Research Institute (VICOROB) and the head of the Underwater Robotics Research Center (CIRS) and an Associate professor with the Department of Computer Engineering of the University of Girona and a co-founder of Iqua Robotics SL, an University of Girona spin-off company.



Przemyslaw B. Kowalczuk



Assistant Professor
Wroclaw University of Technology
Poland

Researcher
Norwegian University of Science and Technology
Norway
przemyslaw.kowalczuk@ntnu.no

Przemyslaw B. Kowalczuk is an assistant professor of mineral engineering and physicochemistry of surfaces at the Wroclaw University of Technology (Wroclaw, Poland), and researcher at the Norwegian University of Science and Technology (Trondheim, Norway). His scientific interest is development of new technologies and ideas in mineral processing and engineering, applied interfacial and colloid sciences as well as chemical metallurgy. Currently, he has been working on mineral processing options for deep-sea minerals.



Rui Ferreira



Research Assistant
Law of the Sea Research Group
CIIMAR
rferreiralaw@gmail.com

Rui Ferreira holds a degree in Law by the Faculty of Law of the University of Porto (2013) and a Master's degree in Business and Contract Law by the School of Law of the University of Minho (2016). He is currently a research assistant within the Law of the Sea Research Group of CIIMAR. Rui is currently working on the CORAL/N2020 project, performing research on currently existing legal frameworks applicable to deep-sea mining activities.



Steve Potter



Based Partner of International Law
Pinsent Masons MPillay LLP
Oil & Gas
Singapore
steven.potter@pinsentmasons.com

Steve is a Singapore based partner of international law firm Pinsent Masons. He has over 20 years' experience advising on mining and oil and gas projects globally. He is only one of a handful of lawyers in private practice with experience advising clients on the International Seabed Authority's Mining Code and advised Keppel Corporation on its subsidiary, Ocean Minerals Singapore's, successful application to the International Seabed Authority for an exploration contract for polymetallic nodules in the Clarion Clipperton Zone.

More recently, Steve has advised a number of stakeholders, including Contractors and Government, on their responses to draft zero of the ISA's exploitation regulations. He is a regular commentator on deep seabed mining related matters and his recent DSM speaking engagements include:

- At the invitation of International Seabed Authority Secretary General Michael Lodge, presenting as part of the ISA's panel on the development of the exploitation code at the 41st Annual Conference of the Center for Oceans Law and Policy in Yogyakarta, Indonesia (May 2017);
- Presenting at the 3rd annual Offshore and Deep Sea Mining Conference in London on Singapore's new deep seabed mining legislation governing activities of Singapore sponsored entities in the deep seabed beyond national jurisdiction (November 2016); and
- Presenting at UMC 2016 in Incheon Korea on likely key Contractor issues in respect of draft zero of the exploitation regulations (October 2016).

Qualifications

LLB (Hons) English and French law, University of Kent, Canterbury
Diploma in Legal Practice – College of Law, York
Admitted to practice in England and Wales and Australia (Victoria)

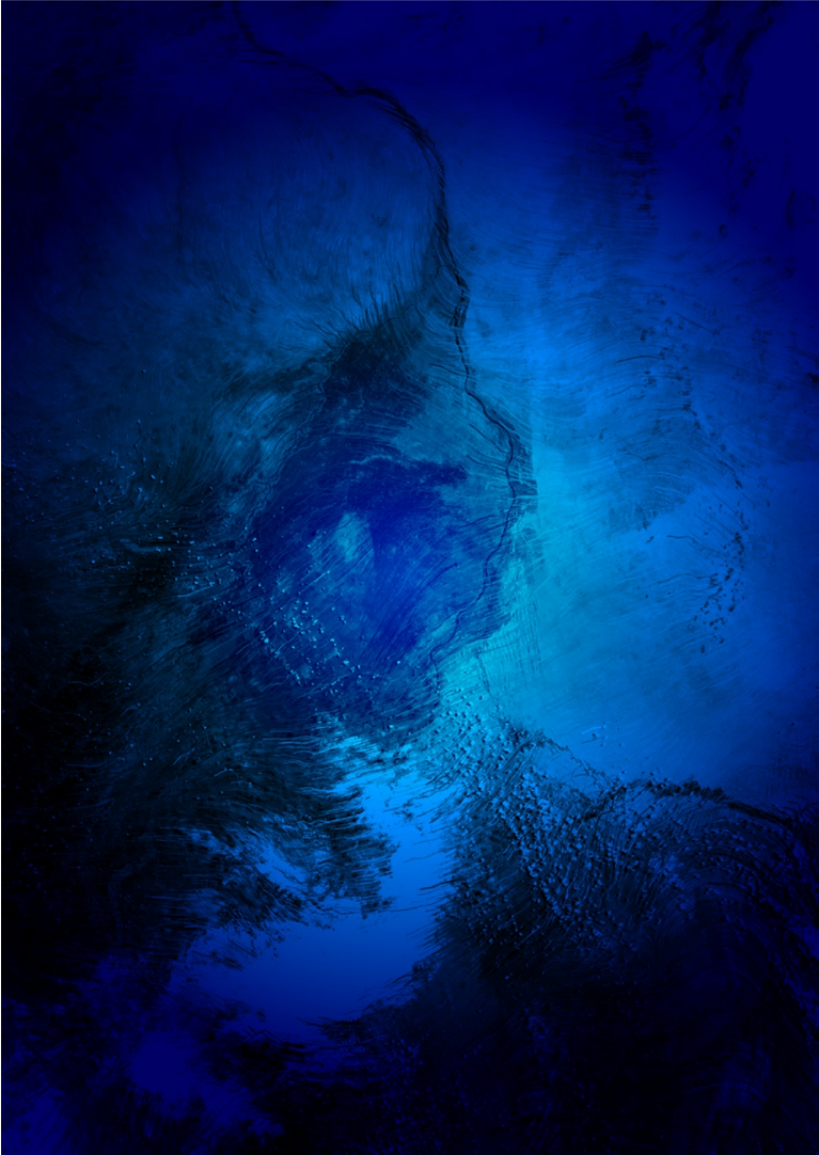


Sunny Schoone



Research Assistant
RWTH Aachen University
Institute for Advanced Mining
Technologies|AMT
Germany
sschoone@amt.rwth-aachen.de

After finishing his studies of Mineral Resources Engineering with a M.Sc. degree Sunny Schoone started as a scientific research assistant and PhD candidate at the Institute for Advanced Mining Technologies (AMT) at RWTH Aachen University. Regarding his research Sunny Schoone is engaged in various projects dealing with the development of sensor technology for the automation of mining machinery. These range from a material flow In-Line characterization by using different types of sensor systems such as acoustic emission and thermal imaging to material recognition during rock cutting extraction. His focus of work is the progress in mine automation on land and in deep-sea environments.



The background of the slide is a dark blue, abstract image that appears to be a stylized map of Europe, with the continent's outline and internal borders visible in a lighter blue hue. The overall texture is grainy and artistic.

Round Table *(in alphabetical order)*

Moderator: Filipe Castro [CIIMAR]

- Chairman **Stef Kapusniak**
- All the Speakers
- **Eduardo Silva** [INESC TEC | ISEP]
- **Nuno Lourenço** [The Portuguese Institute for Sea and Atmosphere, IPMA]
- **Teresa Ponce Leão** [LNEG-National Laboratory for Energy and Geology]



Filipe Castro



Interdisciplinary Centre of Marine and
Environmental Research
CIIMAR
filipe.castro@ciimar.up.pt

Filipe Castro has a broad background in Biology, with specific training and expertise in molecular biology, evolution and environmental sciences. He has participated as PI or co-Investigator multiple funded grants and produced over 90 peer-reviewed publications. Filipe Castro is a member of the Board of Directors of CIIMAR and an invited Auxiliary Professor at the FCUP.



Nuno Lourenço



The Portuguese Institute for Sea
and Atmosphere
IPMA
nuno.lourenco@ipma.pt

Board of Directors of IPMA. PhD in Marine Sciences, University of Algarve focused on the tectonophysics of the Azores Region. One year experience in Oil industry consultancy. Participated in 24 deep sea scientific cruises being chief scientist in 6 of them. He is author or co-author of 26 scientific publications in peer reviewed journals and more than 100 communications in international meetings. He holds a position as professor at the Algarve University. During 7 years he was attached to the Portuguese Task Group for the Extension of the Continental Shelf, where he led the R&D office. In this scope he coordinated the Deep water ROV LUSO operationalization project, the marine Biodiversity Information System and the geoscientific component of the Portuguese submission to the UN for the extension of the continental Shelf in the framework of the United Nations Convention on the Law of the Sea (UNCLOS). He participated in several international consultancy projects (State to state) in the scope of UNCLOS. He participated in several public administration workgroups concerning fisheries and offshore aquaculture. He has been actively engaged in the drafting of National Ocean Strategy 2014-2020 and action plan and the European Union Strategy for the Atlantic Basin. He is National Delegate to H2020SC2 Programming Committee and ICES. He is actually engaged in the strategic board of the Blue Med Initiative, and Atlantic Seabed International Mapping Expert Work Group and is project manager for the acquisition of a regional oceanic vessel, financed by the European Economic Area grants.



Teresa Ponce Leão



National Laboratory for Energy and Geology
LNEG
teresa.leao@lneg.pt

Ph.D. in Electrical and Computer Engineering, University of Porto (FEUP), is Professor at FEUP and a senior researcher at INESC Porto.
President of the Board of the National Laboratory of Energy and Geology (LNEG).
President of the EuroGeoSurveys.
Founding Member of the European Energy Research Alliance (EERA) and Member of the Executive Committee of EERA.
Member of the Board of Directors of WavEC – Offshore Renewables
Vice President of ESEIA (European Sustainable Energy Innovation Alliance).
Member and rapporteur of the Advisory Group for Energy Education and Training.
Member of the Integrated Roadmap H2020 and H2020 Advisory Group on European Research Infrastructures, including e-Infrastructures.
President and Member of board of the Portuguese Association for the Electric Vehicle.
Member of the CERT at the International Energy Agency.
Member of high level steering group of European Innovation partnership on Raw Material.



Organizers

INESC TEC
University of Girona (UdG)
EIT Raw Materials



INESCTEC
TECHNOLOGY & SCIENCE
ASSOCIATE LABORATORY
PORTUGAL



**STRONG
MAR**

Universitat
de Girona



RawMaterials
Connecting matters



EIT RawMaterials is supported by the EIT,
a body of the European Union

www.eitrawmaterials.eu

The STRONGMAR project
is funded by the
European Commission
under the H2020 EU
Framework Programme
for Research and
Innovation (H2020-
TWINN-2015, 692427).

www.strongmar.eu



