17 November 2022
Brussels, Belgium
Hybrid Event

TECHSEA

INESC BRUSSELS HUB

|CELEBRATING 5 YEARS|

IN THE BLACK

A NEW ERA OF OCEAN EXPLORATION

INESCTEC | inSITE LIBS Project Disruptive Innovation

eit RawMaterials Connecting matters

Co-funded by the European Union

Welcome Message

This year we are celebrating 5 editions of IN THE BLACK! During these 5 years we had the chance to experience major breakthroughs in Ocean Exploration, namely: the opportunities for underwater technologies; the challenges of deep-sea mining; the safety of people and the planet; and the impact assessment for future exploitation of underwater minerals.

Despite COVID19 and after remotely managing two of the workshops, is time to be face to face again with the IN THE BLACK community and strengthening our connections. IN THE BLACK'22 will also generate renewed momentum to the Raw Materials Community again.

This year the Workshop will be focused on "A NEW ERA OF OCEAN EXPLORATION". Learning from the Past, to live the Present and prepare the Future! Of course, strategic foresight also enables us to identify opportunities and amplifies our ability to seize them. IN THE BLACK is celebrating 5 years so we aim to redefine future enabling strategies. A handful of experts from all around the world – including renowned scientists from industry, technology, policy makers, and stakeholders - will come together under the same roof to talk you through state-of-art research across several fields of knowledge feeding into Ocean Exploration.

Do not miss the opportunity and register now! Join us in this general reflection and assessment about the ocean and its potential, the shortage of minerals in Europe, management strategies, deep-sea mining, marine policy, impact assessment and underwater technologies.

MEET OUR CHAIRMAN

Eduardo Silva - Coordinator of TEC4SEA|INESC TEC

Coordinator of the TEC4SEA platform at INESCTEC and Professor at ISEP, PhD, Meng *Research Fields:* Robotics, Autonomous Systems INESC TEC|CRAS [Centre for Robotics and Autonomous Systems] eduardo.silva@inesctec.pt

Eduardo Silva is the Coordinator of the TEC4SEA platform at INESC TEC. Previously he was the Coordinator of the Centre for Robotics and Autonomous Systems (CRAS) at INESC TEC until 2019. He is also a 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 20 research projects, including ¡VAMOS! and UNEXMIN EU projects, as well as UNEXUP and INSite Upscaling projects funded by EIT Raw Materials. He has more than 80 publications in Field Robotics.

MEET OUR TEAM

The Organising Team of the Workshop

Ana Paula Lima
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Programme

Schedule

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<tr><th>Start</th><th>End</th><th colspan="2">Session</th><th>Speaker</th><th>Title</th></tr>
<tr><td colspan="6">17th November / Thursday</td></tr>
<tr><td>09:30</td><td>09:45</td><td>OS</td><td>Opening Session</td><td colspan="2">Chairman: Eduardo Silva [TEC4SEA | INESCTEC]

Patrick Nadoll [Scientific Advisor, field of Exploration and Mining, EIT Raw Materials]
Deep-sea mining as a potential source of strategic raw materials</td></tr>
<tr><td rowspan="3">09:45</td><td rowspan="3">10:50</td><td rowspan="3">S1</td><td rowspan="3">Session 1</td><td>José Miguel Almeida
Coordinator CRAS|INESCTEC and ISEP</td><td>The Next Frontier for Underwater Technologies and Mining in the Deep Sea</td></tr>
<tr><td>Ulrich Schwarz-Schampera
Programme Management Officer, ISA</td><td>Deep-Sea resources: From exploration to exploitation, marine scientific research, environmental baselines, technological approaches</td></tr>
<tr><td>Noémie Wouters
Program Coordinator Marine Research, ISA</td><td>Science as a corner stone for sustainable exploitation of deep-sea minerals</td></tr>
<tr><td>10:50</td><td>11:10</td><td colspan="4">Coffee break</td></tr>
<tr><td rowspan="2">11:10</td><td rowspan="2">11:55</td><td rowspan="2">S2</td><td rowspan="2">Session 2</td><td>Sup Hong
Ocean System Engineering Research Division, KRISO</td><td>Towards Sustainable Mining Technology of Deep-Sea Minerals</td></tr>
<tr><td>Kris Van Nijen
Managing Director, DEME Group</td><td>Meeting increased metal demand in the most environmentally responsible manner</td></tr>
<tr><td>11:55</td><td>12:55</td><td>RT</td><td>Round Table</td><td colspan="2">Moderator: Eduardo Silva [TEC4SEA | INESCTEC]
- All the speakers</td></tr>
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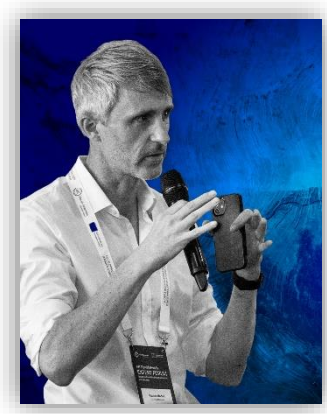
Sessions

OS|Opening Session
S1| Opportunities for Ocean Exploration and Underwater Technologies – Part 1
S2| Opportunities for Ocean Exploration and Underwater Technologies – Part 2
RT| The Next Frontiers
CS|Closing Session


Speakers & Talks

OP	*Opening Session*

Patrick Nadoll



Scientific Advisor, field of Exploration and Mining
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Patrick is an expert in responsible sourcing of strategic minerals and metals. He holds a PhD in geology from the University of Auckland, NZ and has over 15 years of experience working at the interface between the mining industry, government, and academia. In his current position as senior advisor for exploration and resource assessment at EIT RawMaterials, he focuses on stakeholder engagement, raw materials business intelligence, and innovative solutions for the exploration and mining sector.

Deep-sea mining as a potential source of strategic raw materials

Deep-sea mining is a highly divisive topic. On the one hand, a rich source of strategic raw materials; on the other hand, environmental concerns. In my talk, I will present opportunities and risks related to this topic and how research and innovation can help to gain a better understanding of the topic.

José Miguel Almeida

Researcher and Adjunct Professor
Coordinator at Centre for Robotics and Autonomous Systems (CRAS)
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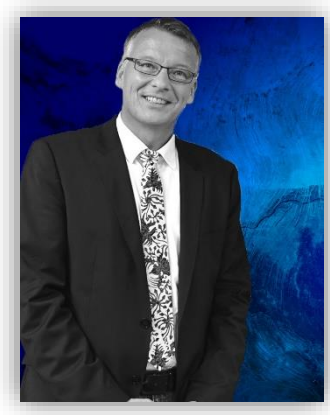
José Miguel Almeida is the Coordinator at INESCTEC's Centre for Robotics and Autonomous Systems. He is a Professor at the School of Engineering (ISEP) of the Porto Polytechnic Institute (IPP). His main research areas are navigation, sensing, perception and awareness for field robotics applications, focusing in marine, aerial and multi-robot systems, and design of innovative autonomous field robotics systems. He participated in a large number of European and national research projects, coordinating the INESCTEC team in several of them. In particular, he was the INESC TEC responsible for the Perception, Navigation and Awareness WP in the ¡VAMOS! H2020 Projects; the conception and design of the UX1 robots, the perception, navigation and awareness in UNEXMIN H2020 Projects and in the UNEXUP EIT RM project. He was involved in the design of several innovative autonomous robots, EVA, IRIS, UX1 and UX1Neo AUVs, 4 generations of Turtle Robotic Landers, Roaz ASV, Grifo and Grifo-X UAV. He is the author of 90+ scientific publications in conferences and journals with peer review. He has been involved in the design of several innovative autonomous robots of which EVA AUV, UX1 and UX1Neo AUVs, 4 generations of Turtle Robotic Landers, Roaz ASV, Grifo and Grifo-X UAV. are some examples. He is the author of more than 80 scientific publications in conferences and peer-reviewed journals.

The Next Frontier for Underwater Technologies and Mining in the Deep Sea

This presentation is about the positioning, navigation and awareness system developed for the Underwater Robotic Mining System of the !Vamosj 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 ¡VAMOS! 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. LIBS system upscaling and updating is being carried out in inSITE project funded by the EIT Raw Materials.

Ulrich Schwarz-Schampera



Programme Management Officer
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Dr. Ulrich Schwarz-Schampera is Programme Management Officer for Mining Geology at the International Seabed Authority in Kingston, Jamaica since 2020. He studied Geology/Paleontology and Mineralogy at the Universities of Clausthal and Aachen, Germany and received his PhD on the trace metal association in volcanic-hosted massive sulphide deposits (Canada, Portugal) and hydrothermal vent fields in the Soutwest Pacific from the Freiberg University of Mining and Technology. Dr. Schwarz-Schampera was hired 2003 by the Ore Deposit Research Department of the Federal Institute for Geosciences and Natural Resources. The focus were terrestrial ore deposits of strategic metals and minerals. Part of the work included the cooperation with the IAEA/OECD uranium group as Germany`s delegate and authorship of the ‚Red Book' on Uranium (2003-2010). Continued marine research in the Southwest and Central Pacific (sulphides, nodules, crusts) was concluded in the initiative for prospecting and exploration for polymetallic massive sulphide (PMS) in the Indian Ocean within the UNCLOS legal framework and with the International Seabed Authority in 2011. Since then, Dr. Schwarz-Schampera was managing the PMS exploration in the Indian Ocean, organizing and running cruises and associated metallogenic and environmental workings and reporting duties. At BGR, he was leading the Department for Ore Deposits and Analytical Fingerprinting between 2014 and 2020. Dr. Schwarz-Schampera is working on marine projects since 1991 and has marine experiences from 27 research cruises and related research and exploration projects, thereof 12 as chief scientist. He also joined and led scientific and exploration projects on terrestrial ore deposits and prospects in Canada, Portugal, South Africa, Madagascar, Burkina Faso, Germany.

Deep-Sea resources: From exploration to exploitation, marine scientific research, environmental baselines, technological approaches

Recent interest in deep-sea minerals including polymetallic nodules, polymetallic sulphides and cobalt-rich ferromanganese crusts is driven by a substantial increase in commodity prices due to forecasts of future demands for metal resources. Factors behind this increase include population growth, the rapidly expanding economies of countries with large populations, market concentrations and the development of low-carbon footprint technologies such as wind turbines, photovoltaic cells, and batteries for electric cars as possible answers to climate change. These new technologies require a wider range of base and trace metals, which are considered economically strategic to meet current and future demand and which are concentrated in seabed minerals. The exploration for deep-sea resources, marine scientific research and related environmental baseline studies has advanced enormously since the beginning in the late 1970s. It produced very profound scientific understanding with respect to marine minerals, mineral enrichment processes, biodiversity and seabed and water column characteristics as well as scientific collaboration on a global scale and for the benefit of humankind. Currently, ISA signed 31 contracts for resource exploration in the Area. The enrichment of seabed minerals to deposit scales requires very specific geological and environmental conditions. Cobalt-rich ferromanganese crusts and polymetallic massive sulphides form local, 3-dimensional deposits extending for 100 to 1,000m whereas polymetallic nodule deposits may occupy few thousands of sq.km for feasible operations. Mineral resources need to occur in such form, grade, quality, quantity that definition of well-defined prospects for eventual economic extraction is possible. Their characteristics are measured with

confidence to support detailed mine planning, and proven mineral reserves require innovative approaches towards intelligent and remotely operated mining technology, infrastructure, legal, economic, environmental and other factors to represent valuable resource prospects. Technologies are now developed to potentially proceed to environmentally sound and regulated exploitation using state-of-the-art automation, artificial intelligence, and machine learning for mineral recovery.

Noémie Wouters

PhD, MBA
Program Coordinator Marine Research
International Seabed Authority (ISA)
nwouters@isa.org.jm

Noémie Wouters is a marine scientist by heart and training, and she complemented her scientific training with business and managerial experience. She is graduated magna cum laude as a Master in Marine and Lacustrine sciences from Ghent University in 2006. She obtained her PhD at the University of Lisbon, Portugal in 2014. Her research focussed on the effectiveness of marine resilience assessment tools. She was lucky to be co-supervised by a Brussels-based biomimicry consulting company. She contributed to marine policy making through her appointment at the at the European Marine Board. It was enriching to participate in Blueinvest sessions of the European Commission focussing on unlocking investment for the Blue Economy and acting as an evaluator in the EASME-EMFF Expert group was particularly interesting. She returned to her alma mater Ghent University in 2015 as liaison officer to launch and initiate Blue Growth activities and projects. In 2016 the first edition of the pluridisciplinary UGent Blue Growth Summer school kicked off and the initiative continues to thrive. In 2018, she was appointed CEO of Bluebridge. Located at the Ostend Science Park, Bluebridge is the Blue Economy innovation centre of the University of Ghent. It is a beehive for blue economy entrepreneurs, scientists, policy makers and the industry. A milestone during her time at Bluebridge was the organisation of a strategic think-tank on the demand of critical minerals in collaboration with a contractor and Ghent University. While exercising her CEO responsibility, she graduated as an executive MBA with honours at the Vlerick Business School, Belgium. Her thesis addressed green hydrogen to reach net zero emissions and hurdles and opportunities for Belgium to become a front runner. This work was carried out in cooperation with a major ocean and overseas Belgian/multinational operator. She is honoured to have joined the International Seabed Authority, as Programme Coordinator Marine Scientific Research and she look forward contributing to the further implementation of the Marine Scientific Action Plan.

Science as a corner stone for sustainable exploitation of deep-sea minerals

The International Seabed Authority is the organization through which States Parties to UNCLOS organize and control all mineral-resources-related activities in the Area for the benefit of humankind. In so doing, ISA has the mandate to ensure the effective protection of the marine environment from harmful effects that may arise

from deep-seabed related activities as well as to promote marine scientific research in the Area. Effective protection and sustainable use of the ocean rely on a thorough understanding of the state of the marine environment and oceans characteristics, and ISA provides a critical platform for knowledge generation on the deep-sea ecosystems and ocean s water columns. In 2020, the Assembly of ISA endorsed the ISA Action Plan on Marine Scientific Research (MSR) in support of the UN Decade of Ocean Science for Sustainable Development. Six strategic priorities were put forward to materialize the contribution of ISA to the implementation of the Decade. This presentation will inform the audience in detail on the strategic research priorities and will highlight key activities developed under each one of them. Finally new research topics that ISA is exploring to contribute to will be shared.

S2 *Opportunities for Ocean Exploration and Underwater Technologies – Part 2*

Sup Hong

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Dr. Sup Hong is a Principal researcher at KRISO (Korea Research Institute of Ships & Ocean Engineering), majored in Naval Architecture and Offshore Engineering at Seoul National University receiving Bachelors (1983) and Masters (1985) degrees. He holds a Doctorate for offshore engineering from Technical University of Aachen (1992). Since 1993, he is working in the research field of offshore and deep-sea engineering at KRISO. The main research topic is focused on mining technology of deep-seabed minerals. He has managed the long-term project of development of deep-seabed mining technology for polymetallic nodules (1994-2015). The representative achievements for that period are the development of simulation-based design technology of underwater mining system (1994-2000), the development of self-propelled test collector and sea trials (2009-2010), the development of pilot mining robot 'MineRo' and sea tests (2012-2013) and the development and sea tests of pilot lifting system (2014-2015). The technological achievements led honours as recipients of Presidential Award of Jangbogo Grand Prix (2014) from Korea Government and The Moor Medal for Excellence in Engineering for the Advancement of Marine Minerals (2018) from IMMS (International Marine Minerals Society).

Towards Sustainable Mining Technology of Deep-Sea Minerals

The geological and geotechnical characteristics of deep-sea minerals are unique in the aspect of sustainable mining. The topographical features of PMN, PMS and CRC are diverse and dissimilar; 2D, 3D, and 2D on 3D seafloor surface, respectively. The mining procedure consists of collecting and lifting under water, separation on board and tailing discharge into water column, and storage and offloading, which are conducted in

sequence. The collecting of minerals has to be performed in an eco-friendly manner; harvesting or excavating with high energy efficiency and minimum seafloor disturbances. The lifting should minimize the by-products, i.e. seawater and sediments. The mining platform must provide mandatory functions and spaces; DP, LARS of collector, RALS, ore-water separation, tailing treatment and discharging, power supply and control, storage of parts and equipment, cargo holds, and offloading facility, etc. Key of sustainable mining is preferentially focused on collector's functions and performance. The collector's mechanism must assure operational efficiency and stability based on an apt mobility. Robotics of collector is on the way of from conventional Remote Control to Automation, Adaptive Control based on MMI (Man-Machine Interface), and eventually to Autonomous Control. A relevant way will be chosen to the features of minerals; automatic control for PMN, adaptive control by MMI for PMS and/or CRC. AI-based autonomous control could be adopted, if once countable and sufficiently big DB is successfully established.

Kris Van Nijen

Managing Director
Global Sea Mineral Resources
DEME Group
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Kris has spent the last 20 years overseeing marine engineering projects across continents, and has a track record of successfully balancing economic, environmental and social considerations for sustainable growth. Today, he heads a team developing ultra-deep ocean technologies, focused on recovering critical metals needed for sustainable development and ultimately for the future benefit of humankind. Kris is an active participant and presenter in meetings with regional (EU) and international (UN) intergovernmental bodies charged with regulating the marine minerals sector. Kris has a MSc in engineering and a PhD in applied economics.

Meeting increased metal demand in the most environmentally responsible manner

The climate and biodiversity crises are coinciding with a massive increase in global population. Decarbonising a rapidly urbanising planet will require huge amounts of primary metal. This in turn will add to the carbon budget and impact biodiversity. Different solutions have different implications. Society needs to confront this reality so that these metals can be sourced in the most responsible way possible, for the benefit of us all. This presentation will look at GSR's deep seabed mining project from a geological, technological, environmental, economic, and regulatory perspective.

About inSITE

InSITE - Insitu ore grading system using LIBS in harsh environments

|*inSITE* is an upscaling project funded by EIT Raw Materials|

inSITE brings together a multidisciplinary research team with a renowned spectroscopy company to take to the market a new smart LIBS (Laser Induced Breakdown Spectroscopy) technology. LIBS is a powerful spectroscopy technique for element analysis with very promising features for real time assessment of composition. However, despite many systems already probing the market, its performance is only acceptable with simple samples and in controlled conditions. Its identification and quantification abilities rapidly decline with sample complexity and environmental roughness (e.g., underwater). To date no satisfactory system presents acceptable performance when facing complex mineral samples in harsh mining conditions.

Recently, however, our team has developed novel methods that allow LIBS technology to perform with improved performance even with complex mineral samples, thus enabling real time ore grading. This was achieved under the framework of Horizon 2020 VAMOS project [http://vamos-project.eu/], where the technology was validated in a relevant mining environment (TRL6). The technology is in production state and is ready to be improved to the market under the efforts of *inSITE* project.

The new LIBS technology will be suitable to perform accurately in harsh mining environments with analytical capabilities in three types of operation modes: prospection/qualitative, semi-quantitative and quantitative. The Smart-LIBS technology involves an improved concept which is based on novel chemometrics algorithms, coupled with a knowledge-database of spectra and analytical information of complex minerals. The technology can be incorporated in different hardware configurations enabling a new set of tools for smart mining, suitable for both exploration and exploitation stages.

Using patented calibration transfer methods, the technology can be incorporated in different hardware configurations enabling a new set of tools for smart mining, suitable for both exploration and exploitation stages. The project will deliver a new portable smart LIBS system suitable for in-situ identification and quantification of minerals, particularly suited for low atomic number elements, such as Lithium, where the regular technologies such as XRF do not work. In addition, exploratory works will prepare next generation of the product to work underwater, unveiling the new market of the mining activity.

The equipment has huge potential to improve the efficiency and reduce the costs and environmental footprint of mining operations. Furthermore, having such analytical capabilities in situ, is also an asset in many other fields of application and potential markets: geosciences research/services, oil and gas research and development fields.

MORE INFORMATION

ACRONYM: ***inSITE***
START: 1st January 2020
END: 31st December 2022
GLOBAL BUDGET: 1.937.146,00 €
LEAD PARTNER: INESCTEC
PRINCIPAL INVESTIGATOR: PEDRO JORGE
PROJECT MANAGER: ANA PIRES

PARTNERS INVOLVED

INESCTEC
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