27 June 2019
Porto, Portugal

Auditorium
Vítor Santos

TECNIMAR um laboratório no oceano atlântico

eit RawMaterials
Connecting matters

IN THE BLACK

EXPLORATION, EXTRACTION AND CONSTRUCTION OPPORTUNITIES FOR UNDERWATER TECHNOLOGY

Chairman **Stef Kapusniak**

INESCTEC
www.inesctec.pt

EIT RawMaterials is supported by the EIT, a body of the European Union
www.eitrawmaterials.eu

Venue

The Meeting IN THE BLACK|2019 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
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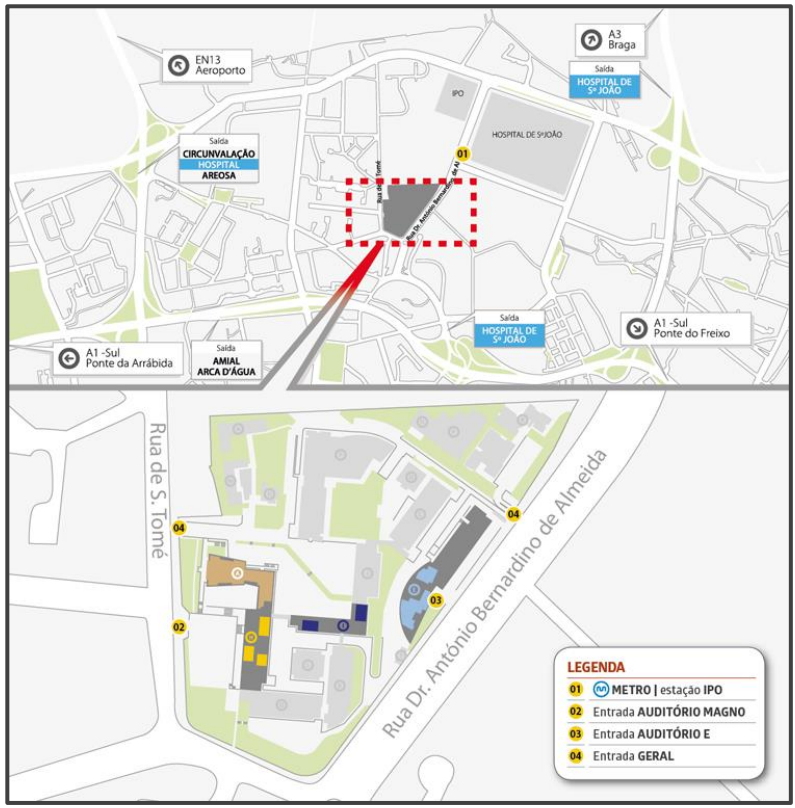

(Source:www.isep.ipp.pt/ISEP/Location)

For more details and information visit:

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

www.strongmar.eu

Please click on:

Events
- Thematic Workshop
  - In the Black 2019

Welcome Messages

CHAIRMAN

Last year's fantastic "In the Black" event attracted key presenters from around the world. Some of the EU projects involved last time have since been completed. For some of these, progress has continued post-project with key innovative solutions moving further up the Technology Readiness scale and attracting wider interest from industry. Some of these solutions and technologies are being exhibited in the morning and consequently we will have a shortened formal presentation schedule this year. However, the schedule still includes worldwide representation and I am sure the quality of presentations will be as high as it was last year. There are new speakers and new industrial attendees. The theme has changed from a deep-sea focus to include near-shore and inland submerged mining. Some of the technologies demonstrated are also useful for connected non-mining activities – such as offshore energy - and the presentations therefore extend into parts of the downstream value chain where the minerals are eventually used.

I'd like to thank each of you for attending this workshop and bringing your expertise to our gathering. I'd also like to thank TEC4SEA and the European Institute of Innovation and Technology's Raw Materials sector for supporting this event and INESC TEC for organising and hosting it. The momentum continues on both the technical front and associated enabling strategies… *"Connecting matters"!*

Stef Kapusniak - Chairman of the Meeting

Business Development Manager Mining
Soil Machine Dynamics Ltd
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stef.kapusniak@smd.co.uk

Prior to joining SMD, Stef previously managed inland mines in Australia. 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 and Utilities sectors 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 was also the Technical Director of the highly successful EU-funded ¡VAMOS! project – which demonstrated the application and viability of submerged inland underwater mining and key technology advances in positioning, navigation and awareness systems for underwater turbid environments.

IN THE BLACK'19, 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. 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, once again, 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 Meeting.

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
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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 ¡VAMOS! and UNEXMIN EU projects. He has more than 60 publications in the area of the Field Robotics.

ORGANISING TEAM

IN THE BLACK'19, focusing this year on Exploration, Extraction and Construction Opportunities for Underwater Technology, is expected to generate renewed momentum to the EIT Raw Materials Community.

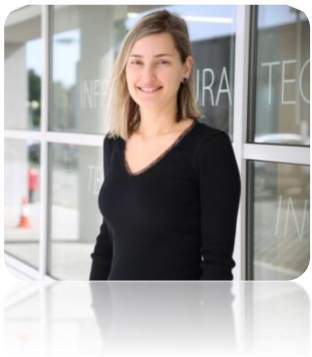
All the participants including speakers with different backgrounds and expertise are going to discuss real experiences, underwater technology developments and propose innovative solutions. We hope that all of you become "*IN THE BLACK*" state of mind!

As researchers in INESC TEC, we believe that an integrative cooperation between all partners working in Deep Sea Mining (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 and a unique opportunity to share knowledge, science and technology.

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

Enjoy the Meeting and our beautiful city!

The Organising Team of the Meeting



Ana Paula Lima
Project Manager, PhD
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Ana Cristina Pires
Post-Doc Researcher, PhD, MEng
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Programme

Schedule

Start	End	Session		Speaker	Title
27th June / Thursday					
10:30	13:30	Registration + Icebreaker (Robotics Laboratory)			
11:00	12:00	Visit to Robotics Laboratory and Demos			
12:00	**13:30**	**Lunch & Networking (Robotics Laboratory)**			
13:30	13:45	OS	Opening Session	Chairman: **Stef Kapusniak** [SMD]	
13:45	14:00			**Karen Hanghøj** [CEO EIT RawMaterials]	*Reflections on Raw Materials Demand and Supply in Europe*
14:00	14:25	S1	Session 1	**Stephen Wilson** [Soil Machine Dynamics Ltd, SMD]	*SMD's new sensor development for power cables*
14:25	14:50			**Laurens de Jonge** [Royal IHC]	*Blue Nodules - Integrated Technology Approach*
14:50	15:15			**Maria Judge** [Geological Survey of Ireland, GSI]	*Capturing marine mineral information for European sea regions*
15:15	15:40			**Martin Peters** [LafargeHolcim]	*Adaption of underwater mining technology for chalk extraction*
15:40	16:00	Coffee break			
16:00	16:45	S2	Session 2	**Robert Denovan** [DENITH ENGINEERING SA (PTY) LTD]	*Underwater Diamond Mining. Where from…. Where to?*
16:45	17:15			**Rudy Helmons** [Delft University of Technology, TUDelft]	*Blue Harvesting: Development and Testing of a Hydraulic Nodule Collector while minimizing its Environmental Impact*
17:15	17:45			**John Pidgeon** [BMT Group Australia]	*You want to dig where? How terrestrial mine mapping and modelling can be adapted for underwater applications*
				Sytze Van Heteren [Geological Survey of the Netherlands, TNO]	*The Code of Sand: using voxels models for decision support in sustainable marine aggregate extraction*
17:40	18:00	Coffee break			
18:00	19:00	RT	Round Table	*Moderator:* **Stef Kapusniak** [SMD]	
19:00	19:10	ES	End Session	**Eduardo Silva** [INESC TEC / ISEP]	
19:10	19:20			**Michel Vanavermaete** [Innovation Hub Director CLC West, EIT Raw Materials]	
19:20		***** SUNSET PARTY [ROBOTICS LABORATORY] *****			

Sessions
OS| Opening Session
S1|Opportunities for Underwater Technology Part I
S2|Opportunities for Underwater Technology Part II
RT ROUND TABLE|Next Frontiers


Sessions

OS	*Opening Session*

Reflections on Raw Materials Demand and Supply in Europe

Karen Hanghøj [CEO EIT RawMaterials]

Raw materials are critically important for society in general, and for the transition to a green economy in particular. They are key for achieving the goals set out in COP21 and for several of the United Nations Sustainable Development Goals. Metals, minerals and materials and their sustainable supply and consumption are important in the move towards a Circular Economy.

Emerging energy and mobility technologies create a strong demand for raw materials, and for some critical raw materials this demand will dramatically exceed current production in the next 10-15 years. Limited access to these materials might negatively impact the transition, thus reducing the competitiveness of European actors downstream.

To meet these challenges we need to design smarter solutions for the sustainable exploration, extraction, processing and use/repairing/recycling of raw materials from both primary and secondary sources. Furthermore, we must ensure that used materials and products find their way into new product lifecycles in an energetically and economically meaningful way.

EIT RawMaterials supports innovation in the raw materials sector and does so engaging partners from universities, research organisations and industry in joint innovation and education projects.

S1	*Opportunities for Underwater Technology Part I*

SMD's new sensor development for power cables

Stephen Wilson [Soil Machine Dynamics Ltd, SMD]

Stephen will provide an overview of SMD trenching evolution over the last 45 years with a focus on its dominance in offshore wind and power cable market solutions.

Stephen will then share the latest new technology development for cable detection, tracking and survey. This technology is launched on the 25th of June and so this event will be the first to have an in depth presentation of the technology, the key gaps in the market it addresses and the work that has been done to develop and prove this technology over the last 18 months.

Blue Nodules - Integrated Technology Approach

Laurens de Jonge [Royal IHC]

A Deep Sea Mining System consists of many components and sub-systems and their interfaces, which are run through and crossed by all the processes that eventually allow the system to function and operate. This total mining system operates in a very sensitive and vulnerable environment that needs monitoring and protection. Typically the components and subsystems are developed by specialized companies as they represent products that add to their commercial portfolio. On the other hand the processes are more often studied by academics and institutes as they represent opportunities for scientific research and increasing knowledge. This is also the case for the environmental aspects and impacts that are often at a distance in position and time from the actual mining system and operation. To bring together, align and balance out all these different aspects is not easy as it requires bridging gaps, step over preconceptions and know how to start talking and understanding each other's language.

Capturing marine mineral information for European sea regions

Maria Judge [Geological Survey of Ireland, GSI]

Answering the European Commission's call for better understanding of the marine environment has led to the establishment of a long-term marine data initiative called European Marine Observation and Data network, or EMODnet. This comprehensive network of marine agencies with environmental information on varied aspects of European sea regions was originally conceived in 2008. Spanning several topics including geology, bathymetry, sea habitat and human activities, the EMODnet consortium collaborates to standardise and harmonise regional marine information into open source data products. Spanning all relevant scientific fields, these are expected to be complete by 2020.

EMODnet's multidisciplinary approach aims to provide reliable and accurate information for the benefit of society, industry, research, policies and legislation. It underpins blue growth and sustainable economic development of the marine environment.

Developed by the Geological Survey of Ireland, the EMODnet Geology's Minerals topic includes twelve types of naturally occurring minerals, raw materials and hydrocarbons that are known to accumulate in seas surrounding Europe. With project partners from Russia to Iceland, Turkey to Portugal and all maritime countries in between, EMODnet Geology Minerals has accomplished broad-ranging systematic mapping of recorded marine minerals. Harmonised maps complete with key information from this mapping exercise are now available online. They highlight the variety of marine landscapes and relics of ancient environments scattered across our oceans, and illustrate the different types of mineral accumulations on and beneath the seabed. They provide baseline datasets for regional and localised studies of mineral accumulation—exemplified by the recently funded MINDeSEA project. This collaborative project aims to further characterise metalliferous mineral types, identify principal metallogenic provinces, develop mineral potential and prospectivity maps. MINDeSEA will also analyse the efficiency of the pan-European research approach to understanding seabed minerals research and modes of exploration.

Adaption of underwater mining technology for chalk extraction

Martin Peters [LafargeHolcim]

The Lägerdorf cement plant has currently two mining areas. Today's operation is done in dry conditions. To do so the natural groundwater table was successively lowered since many decades as mining progressed deeper. Consequently, a drawdown cone developed around the quarries. Due to the geological situation in and around the future mining area, lowering the groundwater table would influence some sensitive areas. Therefore the plant is forced to change the way of mining from dry to wet operation. Potential mining equipment for the chalk operation could be found in the deep see mining sector. To find a technical and economical feasible way of underwater chalk extraction will be the challenge for the next years.

S2 *Opportunities for Underwater Technology Part I*

Underwater Diamond Mining. Where from…. Where to?

Robert Denovan [DENITH ENGINEERING SA (PTY) LTD]

This paper gives an overview of the development of marine diamond mining systems over the last four decades and discusses the future potential for their use in other areas of mining.

Blue Harvesting: Development and Testing of a Hydraulic Nodule Collector while minimizing its Environmental Impact

Rudy Helmons [Delft University of Technology, TUDelft]

Deep sea mining is one of the new fields of industry that can aid in the supply of critical raw materials. Vast amounts of polymetallic nodules are found on the floor of the Clarion Clipperton Zone in the Pacific Ocean at typical water depths of 3 to 6 kilometers. The nodules are potato¬sized mineral formations, that lay on top of a clay or ooze¬like seabed.

To date, subsea harvesting equipment (or collectors) are known to generate large plumes of suspended particles which will have serious impacts on seabed life in the areas surrounding the mine sites and potentially for some kilometers distant to the mine sites. Currently, the preferred technology developed for harvesting nodules make use of hydraulic separation of nodules from the sediment and it is this process that creates the plume. This project focuses on the development and improvement of the collector by reducing its environmental impact and optimizing its production rate and efficiency.

Extensive simulations on the fluid dynamics of the collector as a whole, both inlet, processing and outlet of the water flow entraining nodules and sediment, will be analyzed and validated with lab and field tests. These results will be used to optimize the design of the system as a whole, to limit the production and dispersion of suspended sediment. Improvements of the design will be tested in the laboratory and in a fully operational environment, at an actual polymetallic nodule field at several kilometers water depth in the NE Atlantic Ocean in 2021.

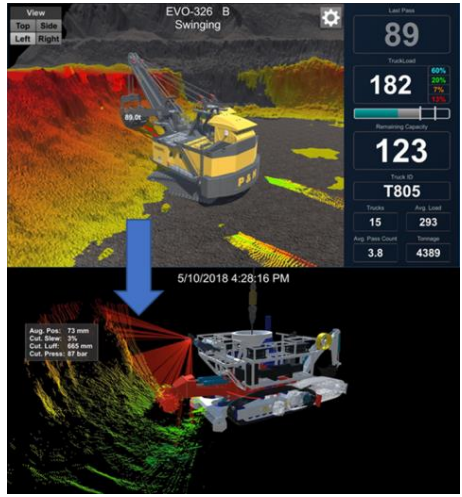
A standardized method for defining the spread of the plume over the seabed will be developed so that all collector devices may be able to be classified in future as to their environmental impact.

The Blue Harvesting project has received funding from EIT Raw Materials, under Framework Partnership Agreement No. [FPA 2016/EIT/EIT Raw Materials], Specific Grant Agreement No. [EIT/RAW MATERIALS/SGA2019/1], under project agreement 18138.

You want to dig where? How terrestrial mine mapping and modelling can be adapted for underwater applications.

John Pidgeon [BMT Group Australia]

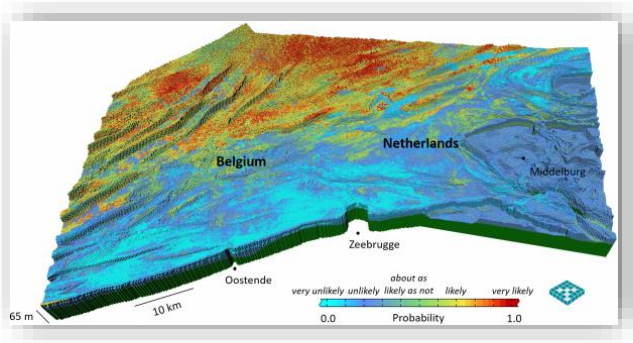
Drawing on his experience from the Vamos project and several years working on terrestrial mine mapping products, John discusses the challenges and opportunities of adapting these technologies for underwater applications.



The Code of Sand: using voxels models for decision support in sustainable marine aggregate extraction

Sytze Van Heteren [Geological Survey of the Netherlands, TNO]

Mineral and geological resources are non-renewable on time scales relevant for decision makers. The sustainable management of these invaluable resources requires a thorough and careful balancing of available quantity and quality versus rapidly changing societal and economical needs. The need for such an approach is recognized in the EU's Raw Materials Initiative, which highlights the optimization of the geological knowledge base as a key element in ensuring sustainable supplies from within the EU borders. Comprehensive knowledge on the distribution, composition and dynamics of geological resources is the backbone of long-term strategies for resource use in a rapidly changing world. As a world's first, a trans-border geological knowledge base is now available for the Belgian and southern Dutch part of the North Sea. It contains volumetric 3D pixel ('voxel') models of its subsurface, environmental impact models accounting for geological boundary conditions, a geological data portal, and a voxel-based decision support module on marine aggregate extraction. The newly developed tools assist in the preparation of long-term adaptive management strategies, and in scientifically underpinning new legally binding measures to optimize and maximize long-term exploitation of aggregate resources within sustainable environmental limits. Such measures feed into policy plans that are periodically evaluated and adapted (e.g. Marine Spatial Planning and the Marine Strategy Framework Directive, the environmental pillar of Europe's Maritime Policy).




Speakers *(in alphabetical order)*

John Pidgeon

Mechanical Engineer
BMT Group
Brisbane, Queensland
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John is an engineer working for the automation and robotics team for BMT based in Brisbane, Australia. He has experience in the simulation and visualisation of prototype machines and using virtual environments to assist operation. In this area, John has travelled to Europe to develop a simulation and visualisation tool for the European Commission project "Vamos" which is related to mining remotely in underwater environments. John has also worked on a variety of projects utilising automation and robotics across a diverse range of industries from mining to defence.

Karen Hanghøj

CEO, Managing Director
EIT RawMaterials
Europa Center
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Dr Karen Hanghøj is the CEO and Managing Director of EIT RawMaterials, a Knowledge and Innovation Community supported by the European Institute of Innovation and Technology, a body of the European Union.

Dr Karen Hanghøj holds a PhD in Geology from University of Copenhagen and has worked extensively with research on geological processes in the lower crust and mantle and their associated mineral deposits. Prior to joining EIT RawMaterials Karen was head of the Department of Petrology and Economic Geology at the Geological Survey for Denmark and Greenland (GEUS) and involved in several EU - funded mineral raw materials projects and networks.

Dr Karen Hanghøj is currently a member of the High-level Steering Group of the European Innovation Partnership (EIP) on Raw Materials, a stakeholder group advising the European Commission. She is also a member of advisory Boards for a range of Horizon 2020 projects such as MinFuture and ERAMIN2 as well as being a member of the UNFC Mineral Working Group and of advisory Board CAMM (Center for Advanced Mining and Metallurgy) of Luleå Technical University in Sweden.

Laurens de Jonge

Manager Marine and Deep Sea Mining
Royal IHC
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LJ.deJonge@royalihc.com

Core specialism:

- Dredging and subsea mining, design and operational experience
- Design and feasibility studies for Subsea Mining projects and components
- Integration of mining, design, engineering and operational aspects of complex mining projects

Education: M.Sc. Mechanical Engineering 1999 – Delft University of Technology (Faculty of Mechanical Engineering)

Laurens de Jonge graduated in 1999 for his M.Sc in Mechanical Engineering at Delft University of Technology. After graduation he worked as R&D technician and crawler operator in offshore diamond mining for NAMCO in South Africa and Namibia. In 2002 he started working for Royal IHC as R&D project manager with specialism in subsea mining, dredging consultancy and dynamic modelling. From 2004 he managed engineering, manufacturing and service projects of offshore swivel stacks and dredging installations for the new-build dredging vessels. In 2008 his career turned back to Marine Mining when Royal IHC started a Deep Sea Mining department. Laurens was responsible for very challenging and innovative projects like the development and build of a 2km aluminium fallpipe and design and feasibility studies for the mining of subsea resources. The development of Deep Sea Mining was boosted by two EU funded innovation projects: Blue Mining (2014-2018) and Blue Nodules (2016-2020). Laurens was responsible for submission and is now Project and Technical Coordinator of these projects. In his capacity as Manager Marine Mining, Laurens is responsible for the development of the Marine and Deep Sea Mining market for Royal IHC. This does not only involve the direct technical development and business relations, but includes involvement in the whole Mining Value Chain, legislation as well as the Social License to operate.

Maria Judge

Consultant Marine Geologist
Geological Survey of Ireland (GSI)
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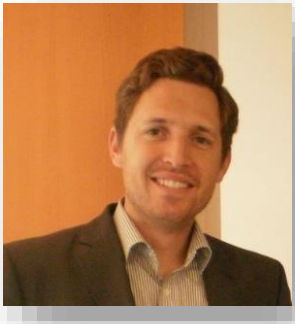
Maria is a consultant marine geologist. She began her career in mineral exploration. Since then, she has participated in hydrothermal vent exploration and discovery, and continues research in complex deep sea mineral accumulation. For the past six years, Maria has led the mineral theme of the EMODnet Geology project. She is also a lead participant in a GeoERA project that will develop the topic of metallogeny and geological potential for strategic and critical raw materials in European seas (MINDeSEA).

Martin Peters



Project Engineer Plant Engineering
Holcim (Deutschland) GmbH
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Born 19.05.1982
Studied at RWTH Aachen University

- M. Sc. Mineral Resources Engineer
- Working for Holcim Germany as
- Project manager for raw material projects, main project is the long term raw material supply by permitting a new mining area

Robert Denovan

Director, Design Engineer
Denith Engineering SA (PTY) LTD
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Robert was trained in the aircraft industry in England and emigrated to South Africa in the late sixties. In 1979 he founded an engineering company in Cape Town designing and supplying for the mining industry. He has been involved in the marine diamond mining business for the last 40 years and amongst other projects was the lead engineer on the concept, design and supply of the first mining crawlers and the launch and recovery systems for the Namibian Minerals Corporation (Namco) and De Beers. His company has designed and supplied bespoke equipment to the majority of the marine diamond mining sampling and mining vessels operating on the West Coast as well as undertaking many projects, worldwide, in the offshore energy and construction sectors.

Rudy Helmons

Assistant Professor
Dredging Engineering
Delft University of Technology
Faculty of Mechanical, Maritime and Material Engineering (3mE)
Department of Marine and Transport Technology (M&TT)
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In 2011, Rudy Helmons received his Master of Science in Mechanical Engineering from Eindhoven University of Technology in the Netherlands. His Master of Science thesis comprises the development of Computational Fluid Dynamics for vertical hydraulic transportation of solids, in collaboration with Royal IHC. After completing his master's degree, Rudy started his academic career at Delft University of Technology in the Netherlands, where he started his PhD research in the Dredging Engineering group. His research entails the cutting of rock for dredging, drilling and deep-sea mining applications. In order to do this, he developed a numerical model that combines both rock mechanics and fluid mechanics in order to simulate the fracturing and damage of fluid saturated rock. In 2015, he got awarded with the IADC Young Author Award. Rudy defended his thesis in 2017 and obtained his PhD with Cum Laude. After his PhD he continued his research at Delft University. Currently, Rudy is employed there as Assistant Professor for Subsea Engineering and Deep-Sea Mining. He is also the project coordinator of the EIT Raw Materials Upscaling project 'Blue Harvesting'. His main research interests are related to seabed interactions, e.g. excavation processes for sand, clay and rock, and the dispersion of turbidity plumes.

Stephen Wilson

Strategic Business & Development Manager
Soil Machine Dynamics Ltd
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England, United Kingdom
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In 2004 Stephen joined, what was then Narec and is now the Offshore Renewable Energy Catapult. Over the last 14 years he has been involved in testing, developments and installation services for manufacturers & offshore contractors for offshore wind, wave, tidal and oil and gas companies. Working for such companies as DeepOcean and Matrix Composites & Engineering, Stephen has gain valuable insights and understanding of the changes in the energy markets over this period.
Stephen's current role is to identify, assess and develop new investment & developments for SMD's subsea and hazardous environment remote robotic solutions business. SMD are leaders in the design and manufacture of trenching equipment for power cable protection. With over 45 years of experience, SMD is still innovating to meet with the market needs.

Sytze Van Heteren

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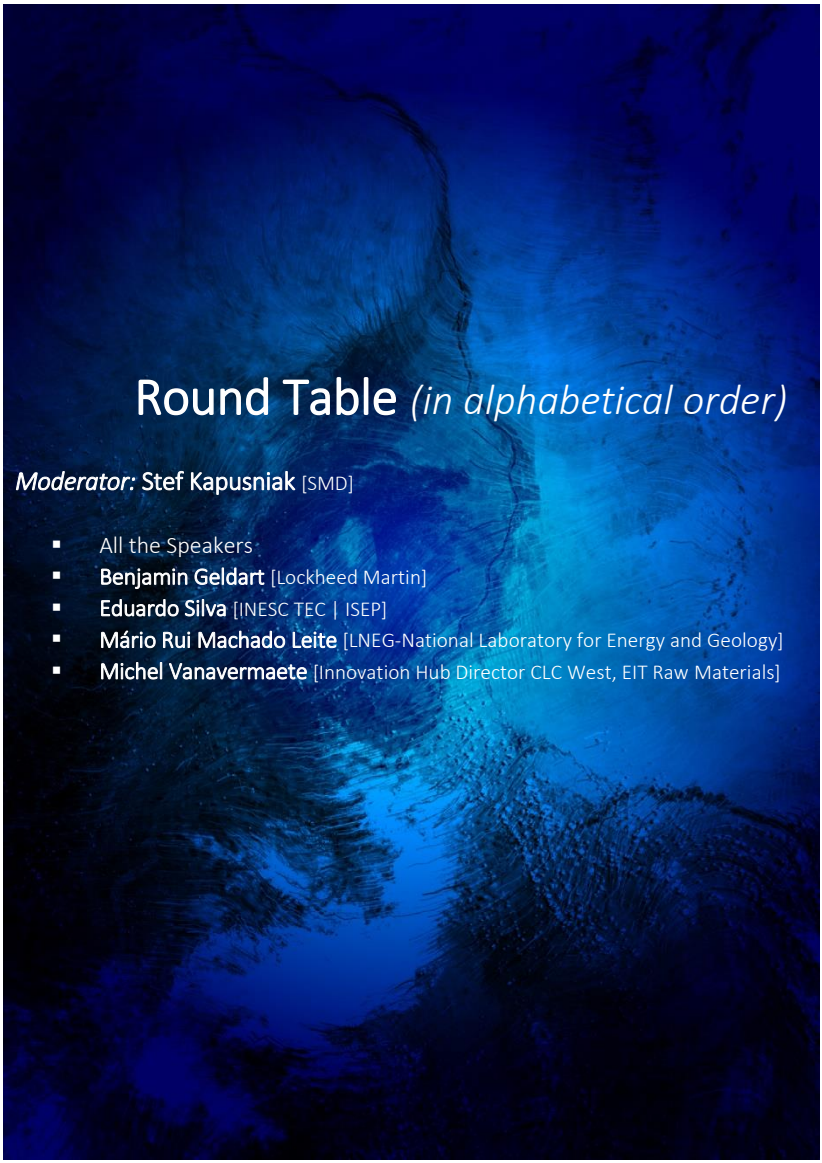
Dr. Sytze van Heteren is a coastal and marine geologist at the Geological Survey of the Netherlands (part of TNO, the Netherlands Organisation for Applied Scientific Research). Trained at Vrije Universiteit Amsterdam (MSc) and Boston University (PhD), he has more than 25 years of experience conducting and supervising coastal and marine projects in the Netherlands and abroad. Currently, he coordinates the marine geological mapping program (shallow subsurface) of the Survey. He chairs the EuroGeoSurveys Marine Geology Expert Group, which harmonizes pan-European marine mapping, and is a member of the Programme Committee of the Netherlands Centre for Coastal Research NCK.



Round Table *(in alphabetical order)*

Moderator: Stef Kapusniak [SMD]

- All the Speakers
- **Benjamin Geldart** [Lockheed Martin]
- **Eduardo Silva** [INESC TEC | ISEP]
- **Mário Rui Machado Leite** [LNEG-National Laboratory for Energy and Geology]
- **Michel Vanavermaete** [Innovation Hub Director CLC West, EIT Raw Materials]

Benjamin Geldart

Technology Development Manager
UK Seabed Resources
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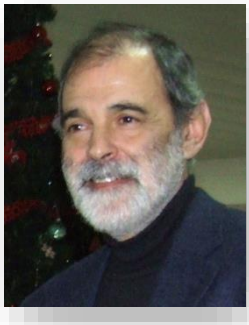
Ben Geldart is the Technology Development Manager at UK seabed Resources, a wholly owned subsidiary of the defence contractor Lockheed Martin.
In this diverse role which entails a blend of skills in programme management, business development, supply chain management and systems engineering, a future seabed mining system and mature development programme is being established to diversify and secure the supply of critical metals required for a low carbon future.

Through consultation and collaboration with industry experts and academia, innovative technology is being studied for utilisation, adaptation and in some cases bespoke solution development for our venture in order for the system to operate reliably and efficiently in isolated, extreme, subsea environments.

The seabed mining programme is truly as exciting & interesting as it is complex.
Prior to life in seabed mining, Ben worked as the project team lead on various UK defence contracts for complex vehicle development programmes as well as within the automotive industry as a tier 1 supplier of underbody production facilities into Jaguar - Land Rover
Ben has a Bachelor of Engineering (BEng) degree in aerospace engineering.

Mário Rui Machado Leite



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Mário Machado Leite is full Professor of Mineral Processing at the Mining Department, Faculty of Engineering, University of Porto, Portugal, since 1996 and member of LNEG (Geological Survey) Board of Directors, since 2009. His experience and personal interest are modeling of unit operations of mineral processing, mainly comminution and mineral liberation and flowsheet analysis.

Michel Vanavermaete

Innovation Hub Director CLC West
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Michel Vanavermaete has been appointed Innovation Hub Director (CLC West) as of May 2018. Michel has extensive experience in financing and public support to innovation and industrial R&D. After graduating with a degree in Information Technology in 1986, he started his career within an IT Start Up company developing Belgian accountancy and tax management systems. He continued is carrier as IT Director in a large US advertising and Communication company. In 1999, Michel joined the EUREKA Secretariat (mother organization of Joint EU-EUREKA Eurostars Innovative SME support programme), Contributing to its design, he was appointed as Director of the Eurostars Programme. With a long experience in managing public funding for innovation and the development of innovation strategy and innovation hubs in Companies, He also acquired expertise in support and selection of Start Ups.

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