European Innovation Partnership on Raw Materials

Application for a Raw Materials Commitment

**Environmentally Responsible Deep-sea Mining**

Acronym: ERDEM

Links to the Strategic Implementation Plan:

- **I. Technology Pillar**
  - I.B Priority Area: Technologies for primary and secondary raw materials’ production
    - Action area n° I.3: Innovative extraction of raw materials
      - 4) Deep-sea mining

- **II. Non-Technology Pillar**
  - II.A Priority Area: Improving Europe's raw materials framework conditions
    - Action area n° II.1: Minerals Policy Framework
      - 10) Explore feasibility of rules for the exploitation of sub-surface and deep sea resources
  - II.C Priority Area: Knowledge
    - Action area n° II.8: EU Raw Materials Knowledge Base
      - 3) Raw materials intelligence - methods, tools and analysis
      - 5) Collaboration with the rest of the world on raw materials information
      - 6) Improvement of data collection

- **III. International Cooperation Pillar**
  - III. International Cooperation Pillar
    - Action area n° III.1: Technology
      - 1) Exploit synergies in R&D with regard to exploration, extraction and processing

Objectives of the commitment:

ERDEM will embrace pro-active engagement of scientists, social scientists, policy makers and industry to collaboratively develop a Framework for Sustainable Deep Sea Mining. This will comprise innovative technologies and integrated management practices outputting renewed environmental impact assessment method and updated standards and legal instruments to achieve economically viable, environmentally sound and socially acceptable exploration and extraction of EU’s mineral resources. ERDEM promotes international cooperation in R&D on best practice sharing with Japan.

ERDEM aspires to develop a novel set of solutions for exploration, extraction and in-situ pre-processing of deep-sea ores and integrated robotic and sensor technologies to achieve lower cost...
and more efficient real time monitoring of environmental impact. It will assess the resilience of Deep Sea Ecosystems and of biodiversity to resource extraction activities and it will provide advanced understanding of deep sea mining associated geological processes

**Description of the activities:**

The vision is to link an ecosystem based approach in managing the exploitation of deep-sea resources and innovative technological monitoring capabilities with broader EU economical perspectives, targeting at enhancing EU industry competitiveness:

1. Develop and pilot a novel cost-effective, remote and immersive set of exploration and exploitation solutions allowing a tele-mining system concept.
   A new class of multipurpose mining system comprising robots and tools (jet-streams, grabbers, excavators, collectors and transporters) for low-impact larger-scale mining operations will be designed, prototyped and tested, based on functional specialization associated with a systemic cooperation which will provide teaming capabilities, necessary to operate in extreme hostile environments. The aim is to support remote mining and in-situ prospecting by deploying different sensing capabilities (e.g. fusion between vision, sonar and laser – green or blue- and chemical information in underwater environment) to provide situational awareness and for the continuous real-time evaluation of the produced ores.

2. Deliver a mobile, wireless environmental impact monitoring system.
   Develop, test and evaluate in real scenarios functional prototypes of integrated robotic and sensor technologies to achieve a lower cost and more efficient real time monitoring of environmental impact, via innovative adaptation of existing subsystems and by exploiting key technologies such as: wireless energy transfer; wireless communications; extended area geo-referencing; and environment sensors (acoustic, biogeochemical, and multi-parameter). Design, develop, integrate, and test solutions for extended area deep water geo-referencing of collected data required for mining environmental impact assessment.

3. Assess resilience of Deep Sea Ecosystems and of biodiversity to resource extraction activities, using new monitoring technologies. Assess the environmental impact of deep sea mineral resources mining, by studying the effects of extraction activities on the deep sea habitats. Advance the current knowledge on deep sea and sub-sea floors environments, by studying and analyzing environmental dynamics, population variability and connectivity of communities in deep sea habitats where such resources are found. Providing:
   - The expansion on the knowledge of natural variability in European deep sea ecosystems.
   - Extend methodological concepts developed for the management of coastal ecosystems to the deep-sea.
   - Standardise methods and tools and terminologies for impact assessment, monitoring and decision support.

4. Deliver and contribute to advanced understanding of geological processes associated to the minerals’ extraction.
   - Provide baseline information about the geological environment and its dynamic behaviour through time by allowing proper evaluation of pressures and vulnerabilities in a context of exploration and exploitation of its resources.
   - Contribute to a better understanding of under-lying processes and their variability leading to submarine resources formation and the biogeochemical links that exist at the lithosphere-ocean interface with the deep biosphere.
   - Quantify the potential sphere of interference of mining activities to evaluate primary effects and secondary effects considering different technological approaches.
   - Develop and test new and advanced technologies and methods for investigating potential geological impacts.
   - Develop protocols for the quantification of geological impacts.
5. Develop a Holistic Governance Framework for Ocean Resources Sustainable Exploration and Extraction (GFORSE) including Governance, Legal instruments and Management Practices, Policy Recommendations and Standardization of tools and methods for assessing the environmental impact of such exploitation activities. GFORSE will involve stakeholders in an ecosystem approach and consolidate findings from all previous activities, in a web-based decision support system. Promote and support diffusion of the Framework, by bringing to the commitment new stakeholders and creating a solid basis for sustainable development on global scale and practicable for a broad range of cases across European member states. Promote international cooperation in R&D on best practice sharing with Japan.

**Description of the expected impacts:**

- Creation of concerted effort leading to increased European competitiveness in the raw materials and marine technology sector.
- Promote, by good governance, the investment into minerals sector.
- Enhanced knowledge on environmental impacts and processes of deep sea exploitation activities; improve the environmental management, including the EIA.
- Definition of boundary conditions for environmentally sustainable exploitation activities.
- New and improved knowledge on the measurement techniques for, and detailed characteristics of noise produced by mining operations; improved knowledge on the impacts of noise on deep sea ecosystems, and best practice guidance how to manage the noise footprint.
- New and improved knowledge on geological aspects of deep sea mineral sites describing the key physical parameters and characteristics and contextual settings. Focal topics include: Baseline studies, geomorphology, sediment distribution and sedimentation history, seabed and sub-seabed geochemical properties, habitat types and maps.
- Compiled overview maps of deep sea minerals distribution in Europe with quantitative resource potential estimates, adding to the transparency of EU raw materials information.
- Increase EU materials knowledge for different stakeholders.
- Create new jobs in mining and equipment manufacturing industries in many regions of the EU.
- Exploit the synergies in R&D with regards to exploration, extraction and processing including technological solutions for intelligent mining, safety and automation and create joint expert systems based on "lessons learnt" to replicate successes and avoid failures; strengthen international academic cooperation.

**Expected innovation outcomes:**
New products to the market  
New processes  
New services  
New technologies  
Societal innovation

**Comments:**

- Robots and tools prototypes allowing a remote and immersive tele-mining system concept.
- Improved tools for the rapid assessment of biological population structure and connectivity, essential for efficiently assessing biodiversity at genetic scale for mining sites and set-aside areas, delineating scale and direction of connectivity and identifying of source and sink populations.
- A web-enabled decision support system employing innovative techniques and technologies to model environmental decision making taking uncertainty into account: Holistic Governance Framework for Ocean Resources Sustainable Extraction.
• Autonomous deep-water environmental impact monitoring systems.
• Light-weight re-locatable monitoring network.
• Modular sensing systems for biogeochemical monitoring.
• Prototype for an enhanced acoustic monitoring network system for the characterisation of noise footprint of mining activities enabling the mitigation of noise effects and alert service.
• WEB Portal and Information Observatory.

Name of the coordinating organisation:
BMT Group Ltd
Country: United Kingdom
Entity profile: Private sector - large company
Role within the commitment:
BMT will be instrumental to ERDEM by developing the HGFORSE including Governance, Legal instruments and Management Practices, Policy Recommendations and Standardization of tools and methods for assessing the EI of minerals’ excavation in a deep sea environment. BMT’s extensive experience with local, state and federal government authorities, as well as community and stakeholder authorities, will be utilised to provide an acute appreciation of the constraints within which solutions for the specific activities need to be found. BMT will build on a vast experience in preparing Environmental Impact Assessments related to seismic surveys, drilling programs, new platforms, new pipelines, platform upgrades and modifications, subsea tie-backs, shore approaches and shoreline crossings.

Other partners:

Name of partner: Fugro EMU Limited
Country: United Kingdom
Entity profile: Private sector - large company
Role within the commitment:
Fugro Group is currently actively involved in R&D to provide environmental survey, monitoring and EIA for deep sea resource exploration as part of the MIDAS and other UK funded projects. Within the EIP, Fugro will build on this knowledge, further developing acoustic and optical sensors, increasing AUV capabilities, improving the efficacy of environmental survey and monitoring, and supporting the development of robust policy and legislation.

Name of partner: Soil Machine Dynamics Ltd (SMD)
Country: United Kingdom
Entity profile: Private sector - large company
Role within the commitment:
Direct involvement in the development and piloting of the remote and immersive set of exploration and exploitation solutions resulting in a multipurpose mining system. Will provide
assistance and advice to other activities and be the contact for multiple offshore operators that have relevant base knowledge that is not in the public domain.

**Name of partner:** Sandvik Mining and Construction G.m.b.H.
**Country:** Austria
**Entity profile:** Private sector - large company
**Role within the commitment:** Direct involvement in the development and piloting of the remote and immersive set of exploration and exploitation solutions resulting in a multipurpose mining system.

**Name of partner:** Damen Dredging Equipment BV
**Country:** Netherlands
**Entity profile:** Private sector - large company
**Role within the commitment:** Damen Dredging Equipment supplies tools and equipment that is normally used in the dredging industry, to excavate and transport sediments. Therefore we have expertise and facilities to develop and test products that will have a similar purpose in the proposed project. Also, with our knowledge on the process and the operation of these machines, we can advise the partners on certain aspects that are unfamiliar for them.

**Name of partner:** Instituto de Engenharia Sistemas e Computadores
**Country:** Portugal
**Entity profile:** Other
**Other:** Research Institute
**Role within the commitment:** Development of: • a new class of robots for low-impact larger-scale mining. • innovative sensing capabilities (e.g. fusion between vision, sonar and laser and chemical information in underwater environment) to produce overall quality of 4D data. • integrated robotic and sensor technologies to achieve a lower cost and more efficient real time monitoring of environmental impact.

**Name of partner:** University College Dublin
**Country:** Ireland
**Entity profile:** Academia
Role within the commitment:
The expansion on the knowledge of natural variability in European deep sea ecosystems, facilitating better management decisions

Name of partner:
Consorcio para el diseño, construcción, equipamiento y explotación de la Plataforma Oceánica de Canarias (PLOCAN)
Country:
Spain
Entity profile:
Governmental/public body
Role within the commitment:
PLOCAN will contribute to activities 2, 3 and 5 providing support and facilities for testing sensors and devices at test sites; compile and provide biogeochemical data from the Central Atlantic oceanic waters; apply for ship time and provide support for oceanic transects in Atlantic waters

Name of partner:
University of Bergen; Department of Earth Science
Country:
Norway
Entity profile:
Academia
Role within the commitment:
Contribute to activity 4 on advancing the understanding of geological processes associated with the deep sea minerals' extraction.

Name of partner:
BioID LTD
Country:
Ireland
Entity profile:
Private sector - SME
Role within the commitment:
Activity 5 • Creation of a document outlining best practices for Environmental Impact Assessment • Creation of a document outlining state of the art technologies in deep sea environmental monitoring Activity 1 • Consulting on minimising the environmental footprint of extraction platforms and the outfit of the extraction platform Activity 2 • Consulting on the development integrated robotic and sensor technologies to achieve a lower cost and more efficient real time monitoring of environmental impact Activity 3 • Development of a document outlining how to extend methodological concepts developed for the management of coastal ecosystems to the deep-sea. • Development of a document that standardises methods and tools and terminologies for impact assessment, monitoring and decision support. • Provide guidelines for conducting environmental impact assessment of deep sea resources’ mining, advancing ISA’s guidelines, via a process which will ensure stakeholder consensus.
**Name of partner:**
The Hellenic Centre for Marine Research (HCMR)

**Country:**
Greece

**Entity profile:**
Governmental/public body

**Role within the commitment:**
The Institute of Oceanography (IO) will collaborate and will contribute to: a. Assess the environmental impact of deep-sea mineral resources mining. The IO-HCMR has carried out numerous environmental impact assessments, i.e. mineral dumping, hydrocarbon exploration in E. Mediterranean, oil spills. b. Assess Deep Sea Ecosystems' Resilience and biodiversity to resource extraction activities. The IO-HCMR was recently finalised the strategic impact assessment regarding hydrocarbon extraction in the Greek EEZ. c. Advance the current knowledge on deep-sea and sub-sea floors environments and the associated geological processes, with special focus on mud volcanism and associated gas-hydrate resources in the Eastern Mediterranean. d. Develop a Framework for the sustainable exploitation of deep-sea resources, capitalising the great experienced gained through other scientific projects

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**Name of partner:**
Ocean Scientific International Ltd

**Country:**
United Kingdom

**Entity profile:**
Private sector - SME

**Role within the commitment:**
Contribute to the development, test and evaluation of the real time environmental impacts monitoring system.

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**Name of partner:**
La Palma Research S.L

**Country:**
Spain

**Entity profile:**
Private sector - SME

**Role within the commitment:**
La Palma Research S.L. will support ERDEM with its expertise in mapping emerging trends in deep-sea mining research. Such mapping will include the organisation of targeted workshops, the development of internet-based surveys and other activities that will mobilise the scientific community. These activities will support a „Horizon scanning and Research road mapping” subtask for ERDEM with the overall goal of identifying new research challenges, and linking these research challenges to existing research roadmaps, such as the one developed by ETPSMR (European Technology Platform on Sustainable Mineral Resources).

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**Name of partner:**
University College Cork
Country: Ireland
Entity profile: Academia
Role within the commitment: Assess plume fallout relative to background hydrothermal plume sedimentation to evaluate impact of mining and habitat disturbance. High resolution multibeam mapping (ROV or AUV based) to characterise site geomorphology and seabed rugosity which will feed into hydrodynamic plume models, enabling venting dynamics, down-core diagenetic geochemical overprinting and natural plume fallout to be constrained. Appraise the impact of creating artificial plumes as a deviation from historic hydrothermal plume sedimentation histories.

Name of partner: Technical University of Catalonia, BarcelonaTech, UPC
Country: Spain
Entity profile: Academia
Role within the commitment: - Use and adaptation of the LIDO network for real-time acoustic monitoring of deep-sea mining. - Development of classifiers and noise measurement modules to characterize the effects/impact of Deep-Sea mining on the environment. - Modeling of the noise foot-print of the Deep-Sea mining activities.

Name of partner: Centre for Geobiology
Country: Norway
Entity profile: Academia
Role within the commitment: Provide regional geological mapping and characterization of deposits through deep-sea resource exploration using state-of-art technology. Define new exploration targets using innovative approaches on the detection of local and distal footprints of ore-forming systems. Assess potential impact of seabed mining via plume dispersal studies, in-situ experiments and possible release of toxic elements into the seawater. Contribute to the understanding of geological processes capable of forming deep-sea deposits.

Name of partner: CHRISAR SOFTWARE TECHNOLOGIES
Country: France
Entity profile: Private sector - SME
Role within the commitment:
To advise in design and preparation of all acoustic aspects offering experience, knowledge and understanding in cetacean and acoustic domains. Including:
- acoustic measurement to supervise and control anthropic noise levels,
- definition of detection/behavioural/physiological criteria and thresholds of cetacean species,
- definition of environmental acoustic parameters,
- propagation performances,
- Identification of a security perimeter and definition of a « code of conduct » to minimalize acoustic disturbance

Name of partner:
Aarhus University
Country:
Denmark
Entity profile:
Academia
Role within the commitment:
Providing expertise in benthic ecology, benthic hydrodynamics, ecosystem modelling, deep-sea habitats. AU will contribute to expand knowledge of structure and variability of European deep-sea ecosystems and habitats with a focus on seamounts and continental margins. AU will also contribute to evaluate methods and tools for impact assessments, monitoring and deep-sea ecosystem management.

Name of partner:
Geological survey of Slovenia (GeoZS)
Country:
Slovenia
Entity profile:
Governmental/public body
Role within the commitment:
GeoZS will contribute mainly to the activities listed in point 4 of the work plan: "Deliver advanced understanding of geological processes associated to the minerals’ extraction." We will especially focus geological studies of past deep-sea environments, which are now found on the surface. Such environments are much more suitable for the detailed research, since they are easily accessible. There are many such areas in EU, and we will mainly focus studies on ophiolites, and sulphidic mineralisation connected with them. Ophiolites are part of the ancient oceanic crust and upper mantle, now emplaced on the continental crust during various plate-tectonic processes, mainly with closure, collision, subduction and obduction of the former oceanic domains (Neotethys and Alpine Tethys). We will focus on their upper part of the sequence - extrusive rocks (pillow lavas) at the seawater contact and pelagic cherty sediments on the top of the sequence. We will use background knowledge, as well as perform net focused studies for the consortium to address needs for other points of work plan with relevant data, as hardness, spectrographic footprints of different minerals in ophiolites, provide samples to test new equipment etc. Having our knowledge with construction of decision support systems and neural networks, GeoZS can participate at point 3, where new decision support systems for environmental impact assessment are foreseen, as well as having our knowledge and expertise about impact of (terrestrial) mining to the environment and many experiences in policy making on national and international level, GeoZS can also contribute to the point 5 of the work plan.
TÉCNICAS Y MONTAJES SUBACUÁTICOS S.L.

Country: Spain
Entity profile: Academia
Role within the commitment: R&D, Design and development of subsea technologies and machinery

Name of partner: Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
Country: Japan
Entity profile: Governmental/public body
Role within the commitment: Data sharing on deep-sea environments and biodiversity and knowledge for EIA, and the cooperation for research cruise. Explore synergies with the "Submarine Resources Research Project" with regards to exploration, extraction and processing to replicate successes and avoid failures. Strengthen academic collaboration.

Name of partner: Montanuniversitaet Leoben
Country: Austria
Entity profile: Academia
Role within the commitment: Montanuniversitaet Leoben is a mining, metallurgical and material science oriented university working along the value chain from primary and secondary resources to materials and products; special competence in mining/mineral extraction is on excavation engineering (mechanical and blast induced excavation) rock mechanics and mine planning; expertise will be provided to the consortium in the fields of rock excavation on the sea bed, on remote mining and on the development of concepts for sub-sea in-situ mining.

Name of partner: Marine Minerals Ltd
Country: United Kingdom
Entity profile: Private sector - SME
Role within the commitment: Marine Minerals will provide the tin recovery site in Cornwall as a test environment for the intelligent mining system that will be developed within ERDEM. Marine Minerals will also transfer their knowledge and experience on EIA regarding seabed mining.
**Name of partner:**
"Zentrum für Telematik" (ZFT)

**Country:**
Germany

**Entity profile:**
Private sector - SME

**Role within the commitment:**
Contribute to the remote intelligent mining system and the wireless environmental impact monitoring system by providing competencies on like remote actuation, cross-linking, pre-processing (e.g. filtering or compression) and fusion of sensor data as well as the evaluation of sensor systems.

**Existing EU contribution:**
No

**Period to implement the commitment:**
Sunday, 1 June, 2014 to Friday, 31 May, 2019

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