European Innovation Partnership on Raw Materials

Application for a Raw Materials Commitment

**Breakthrough Solutions for Seafloor Mineral Extraction and Processing in deep water environment**

**Acronym:**
SeaFlores

**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**

**Objectives of the commitment:**

Scientific explorations from the past decades have identified several types of seafloor mineral deposits including Seafloor Massive Sulphides (SMS). In Europe, Azores and Wallis and Futuna are shown to have the potential to contain SMS ores.

To enable commercial deep sea mining socially and environmentally acceptable, technologically achievable and economically viable methods need to be developed. The key innovation in this project is the generic design and in-situ demonstration activities of a cost-efficient and environmentally-acceptable deep sea mining pilot system. This project is complementary with ALBATROSS deep-sea exploration project led by Eramet.

Technology developed in this project will also reinforce Europe’s ambitions to be active in exploration areas outside Europe, thus increasing access to Raw Materials via new mining solutions and decreasing EU dependency on resource imports.

**Description of the activities:**

SeaFlores activities will consist of three different phases:
- **Phase 1:** Definition of mineral processing route and Feasibility study (FS) of the deep sea mining pilot,
- **Phase 2:** Pilot Plant detailed design, manufacturing and deployment on the basis of the FS results,
- **Phase 3:** Offshore demonstration activities in-situ.

It must be pointed out that Phase 1 can be covered by upcoming Horizon 2020 topic “SC5-1-2014/2015: New solutions for sustainable production of Raw Materials, item c) Deep mining on continent and in sea-bed” where the emphasis is on developing new highly-automated technological
sustainable solutions for deep mining in the sea bed in-situ and proving the concept and feasibility at the level of TRL 5-6. Activities described hereafter corresponds to this first phase (only).

The process designed to pre-concentrate the Copper / Zinc sulphides shall consider the variability of the ore. Depending on the mineral composition, the process shall be robust enough to remain stable through the changes or be stabilized up front by premixing ore feed. The initial data required in process design can be most reliably obtained from a pilot study. GTK's pilot plant includes a versatile selection of equipment for all unit processes. As each aspect of beneficiation is optimized, it is incorporated into an efficient overall process. Campaign results at pilot scale are typically sufficient to give an accurate idea of the concentration process yield and economic performance at full scale.

Complex sulphide ores contain more than one single valuable metal sulphide mineral each to be separated into its own individual concentrate. Generally, the ore is ground in two stages after which the ground pulp is subjected to conditioning followed by individual flotation stages to produce different concentrates that are then dewatered to optimum transport moisture. Outotec will provide the consortium with complete mineral processing solutions as Outotec has the expertise and capability for designing, supplying, and constructing mineral processing plant.

In order to achieve a viable, environmentally sound and cost-efficient technological solution, a FS will be performed to better define and optimize the mining pilot layout, topsides and associated subsea systems and methods including but not limited to:

- Vertical mining method,
- Free-flying mining method,
- Seabed based crushing and regulation unit,
- Riser and lifting method,
- Equipment launch and recovery method on surface,
- Ore Transhipment method from the mining ship to the ore carrier,
- The environmental impact assessment using “swarm” of Autonomous Underwater Vehicles (AUVs) for the real-time collection and synthesis of all data recovered during mining at sea.

The objective is to compare various design options, evaluate each of them against a number of technical, ecological and economic criteria and, finally, select the most feasible pilot layout. Environmental management plan that includes preliminary Environmental Impact Assessment (EIA) and risk management strategy will be delivered by Heriot-Watt. The aim will be to propose guidelines for the realization of the environmental baseline and the Environmental Impact Assessment and to compare them to the existing international regulations including the United Nations Convention on the Law of the Sea (UNCLOS), and relevant institutions such as the International Seabed Authority (ISA).

**Description of the expected impacts:**

Significantly improve Europe’s and also global marine resource base by unlocking deeper deposits in the EU, global sea-bed deposits using tested and evaluated innovative technologies. One of the pillars of the EU raw materials policy is to increase the attention to raw materials sources in Europe. A marine mining pilot-project would be a substantial contribution to ensuring a coherent approach to Horizon 2020 Blue Growth.

Create numerous new jobs in mining and equipment manufacturing industries in many regions of the EU, including remote and coastal areas. Many countries do not have economic deposits of base and precious metals on land. Mining and processing SMS deposits would provide these countries with a degree of self-sufficiency, lessening the need to import supplies of metals.

Push Europe to the forefront in the areas of extraction concepts, technologies and related services. Participation of major European mining players and several European technology providers ensures the efficient use of the project results. Therefore a sharing of issues will enable to elaborate a
common solution that automatically will be less expensive and time saving for all.

Reduce both the environmental impact of the mine operation and the risks to the population and natural life caused by potential failures. Environmental and social impacts still need to be properly assessed. For some environmental aspects, subsea mining will clearly be less harmful than corresponding land mining (less area disturbed, no overburden, less residues...).

Reduce energy and water consumption by the reduction of the volume of materials to be extracted from the mine. New opportunities will arise to incorporate energy efficient processes in the FS and minimise waste and emission to reduce the risk of polluting incidents.

**Expected innovation outcomes:**
New technologies

**Comments:**

Although marine mining of sand and gravel in shallow waters are mature industries, no sustained operations have taken place for the commercial recovery of SMS or any other minerals in water depths greater than 400 meters. To date Nautilus Minerals is leading the way in this field with its Solwara 1 project in Papua New Guinea in 1,700m of water. Solwara 1 offshore system project represents very relevant State-of-the-art. It must be highlighted, however, that Solwara 1 is located in the Bismarck Sea, a protected sea with no significant wave height. Hence, the benign nature of Solwara 1 makes this site selection very attractive for first-of-a-kind technological development but would not be capable of mining in any type of harsh environments. To meet proper operability and universality, this project proposes to design an offshore system architecture able to be deployed anywhere.

**Name of the coordinating organisation:**
Technip

**Country:**
France

**Entity profile:**
Private sector - large company

**Role within the commitment:**

Consortium leading entity will be Technip France. Technip will perform the complete multidiscipline interfaces management and coordination. After determination of the key technical parameters, Technip will also design the Riser and Lifting System. The objectives of these studies are to confirm the technical feasibility of a riser and lifting method and define the most proper SMS pumping system for the generic field development.

**Other partners:**

**Name of partner:**
ERAMET SA

**Country:**
France

**Entity profile:**
Private sector - large company

**Role within the commitment:**

ERAMET SA is involved in SMS Exploration project in Wallis and Futuna as leader of the EIP project proposed as “ALBATROSS”. ERAMET will ensure that all information useful for
Seaflores can be collected during exploration campaigns and is effectively communicated. ERAMET intends to participate to the specification phase, to build the business plan and to validate the industrial solution as final operator of the pilot.

**Name of partner:**
IFREMER
**Country:**
France
**Entity profile:**
Governmental/public body
**Role within the commitment:**
Ifremer will bring here its scientific knowledge of the processes for assessing: i) the characteristics of the potential sites; ii) the engineering properties; iii) the protocols for environmental assessment of potential exploitation. Ifremer propose to study new developments in autonomous sensing with fix and mobile autonomous or supervised platforms for environmental survey and monitoring, during drilling and production phases.

**Name of partner:**
OUTOTEC
**Country:**
Finland
**Entity profile:**
Private sector - large company
**Role within the commitment:**
Partner, technology provider for mineral processing. Outotec will provide its industrial expertise in mineral processing (crushing and grinding, flotation, thickening and clarifying, filtering), process control and automation. Outotec’s analytical and mineral processing laboratories are utilized as well as GTK’s (Geological Survey of Finland) pilot facilities.

**Name of partner:**
DCNS
**Country:**
France
**Entity profile:**
Private sector - large company
**Role within the commitment:**
DCNS will design, qualify and operate a long-term monitoring system. The system features a swarm of several AUV with high endurance. The number of AUVs to be deployed at sea will be adapted to the area to be monitored. The system will eventually mix DCNS’ designed AUVs and any other-designed AUVs. The operation of the swarm will be performed from a dedicated command & control system for the synthesis of all the data collected.

**Name of partner:**
Geological Survey of Finland (GTK)
**Country:**
Finland
GTK will concentrate on the development of beneficiation technologies for deep sea ores in cooperation with Outotec. GTK Mintec’s research includes everything from mineralogical research and laboratory-scale beneficiation tests to continuous test runs at the pilot-scale.

**Name of partner:**
Seatools B.V.
**Country:**
Netherlands
**Entity profile:**
Private sector - SME
**Role within the commitment:**
Design and manufacturing of Subsea Equipment

**Name of partner:**
Kenz Figee Group
**Country:**
Netherlands
**Entity profile:**
Private sector - SME
**Role within the commitment:**
Design and manufacturing of Launch and Recovery System

**Name of partner:**
C Spencer Ltd
**Country:**
United Kingdom
**Entity profile:**
Private sector - large company
**Role within the commitment:**
Design and manufacturing services related to the installed sub sea mined material recovery equipment, particularly those areas governing fluid management, valving design and wear predictions.

**Name of partner:**
BAUER Maschinen GmbH / Industrial
**Country:**
Germany
**Entity profile:**
Private sector - large company
**Role within the commitment:**
The role of BAUER Maschinen in this project is to design a cutting head able to penetrate and
break the deposit that will operate under deep-sea conditions. Because of the very high pressure, a more ductile behaviour of the rock is expected and will influence the cutting head design. Bauer’s task also involves the design of a pressure appliance system, a frame able to work under deep-sea conditions that maintains the breaking conditions and the progression speed into the deposit and that support all subparts of the mining system.

**Name of partner:**
MMD Mineral Sizing (Europe) Ltd.

**Country:**
United Kingdom

**Entity profile:**
Private sector - SME

**Role within the commitment:**
MMD Mineral Sizing (Europe) Ltd. is part of the UK-based MMD Group of Companies which is specialized in the design and manufacture of mineral sizing (crushing) equipment. MMD has been involved with the subsea mining project in partnership with Technip as well as other entities for the last few years during which research and development work has been carried out to evaluate sizer crushing performance in conditions similar to those found in deep sea.

**Name of partner:**
Heriot-Watt University

**Country:**
United Kingdom

**Entity profile:**
Governmental/public body

**Role within the commitment:**
The role will be to evaluate the potential environmental impact generated by the Pilot. Minimizing this impact is a critical component of this project and the evaluation of the impact will follow the different development steps of the Feasibility Study. For each component of the mining activity, environmental impact criteria will be investigated in order to qualify and quantify the potential responses of biotic structures and functions.

**Existing EU contribution:**
No

**Period to implement the commitment:**
Thursday, 13 June, 2019