Deep Ocean Exploration: is it a Gold Rush?

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On behalf of ¡Vamos! and Turtle teams
Growth Marine/Oceans Areas Use

- Shipping
- Offshore oil and gas
- Fisheries
- Cruise and coastal tourism
- Aquaculture
- Mining
- Dredging
- Submarine cables/pipelines
- Offshore wind energy
- Wave/tidal energy
- Ports/marinas
- Recreational/sport boating
- Desalination
- Carbon sequestration
- Navy/military use

Expanding
Kinds of use
Levels of activity
Duration
Intensity
Frequency
Location of activity
Geographical Extent
Frequency

Very Low Impact (<1.4)
Medium Impact (4.95–8.47)
High Impact (12–15.52)
Low Impact (1.4–4.95)
Medium High Impact (8.47–12)
Very High Impact (>15.52)
Ocean Use issues/solution/challenges

• Ocean industries require access and the social acceptance to use ocean space and resources.

• Many of the critical issues affecting access and social acceptance are cross-cutting.

• Sustaining ocean health and productivity requires responsible use and stewardship by all stakeholders.

• The best efforts by an entire industry sector, are not enough to secure the future health and productivity of the ocean.

• Ocean industries will benefit from collaboration with other sectors to develop synergies and economies of scale to address the issues and ensure access and social acceptance.
Deep Ocean Exploration Opportunities

- Deep Sea Offshore Oil&Gas
- Deep-Sea Biotechnology
- Deep Sea Mining
Motivation

- Increase of economical and scientific interest in the sea
- Research in marine robotic systems
- Portugal interest on the sea economy and exploration of its natural resources

Portuguese sea is:

- Large
- Deep
- Automate
- Go deeper
- Stay longer
- Do it safely
- Be sustainable
The Green Push to the Deep Sea Mining

A single Wind Turbine can contain 335 tones of steel, 4.7 of copper, 3 tones of aluminium and more than 300 kg of rare earths minerals.
Some of the “ins” and “outs” of conventional mining – from a safety and environmental perspectives
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Risks of water flowing into a mine…
Some of the “ins” and “outs” of conventional mining – from a safety and environmental perspectives

Other things can flow into a mine...
Some of the “ins” and “outs” of conventional mining – from a safety and environmental perspectives

Water flowing out of a mine can also be a risk...

What the @$%$&!
TEC4SEA is a unique and pioneer platform in Europe to support research, development, and test of marine robotics, telecommunications, and sensing technologies for monitoring and operating in the ocean environment.
VAMOS – Viable and Alternative Mine Operating System

Underwater mining technology
Awareness for precision mining, environment modelling in difficult conditions
H2020 Societal Changes 5 (Raw Materials) RIA
2015-2018

17 partners, 9 countries
9.2 M€

Partners: BMT, SMD (UK), INESC TEC, Damen Dredging (NED), Trelleborg (NED), Sandvik (AU)...

INESC TEC Role: Positioning, navigation and awareness system

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 642477.
Solara 1; Mining Area 0,1 Km$^2$ 1200m x 600m in 1500-1700m Water Depth.

3-dimensional image of proposed mining area at Solwara 1, looking north

Legend:
- Mineralised zone to be mined

Depth (m):
- 1500
- 1550
- 1600
- 1650
- 1700
¡VAMOS! Overview…
¡VAMOS! Underview…

HROV

Umbilical

LARV

Mining Prototype

Wireless short range high bandwidth communication

HROV Docking Station
Global PNA Data Flow…

Vessel Position and Navigation sensors (RTK GNSS, INS, USBL)
Machine Navigation Sensors (INS, optional DVL, USBL, pressure)
Environment Perception Sensors (Acoustic cameras, scanning sonars multibeam+pan&tilt, Cameras+laser projector)

Perception, Navigation and Awareness System

Time-stamped Position, Navigation and sensors raw data

Mine 3D mapping

Time-stamped, Relative 3D Point clouds

HMI

3D Map Info

Off-line Survey data from HROV

Real-time pre processed monitoring sensor data

HROV
Real Time Grade Control…

**Key challenge**
Enable real-time monitoring **boosting sensitivity** and establishing robust calibration protocols. *(double pulse configurations and gas assisted sampling)*
Advantages of Sea Floor mining

- High grades
- Highly scalable
- Low capital intensity
- No land clearance or people moved
- 40+ years offshore oil & gas

- Minimal waste
- Reusable equipment
- Competitive OPEX
- Increased worker safety
TURTLE Robotic Autonomous Deep Sea Lander

Developing technologies for sustainable and long term presence in the **deep ocean**
High performance structures for the deep sea with lower manufacturing cost
Energy efficient technologies of descent and ascent operations
Demonstrator to validate the robotic transport solution (fixed/mobile system) for deep sea monitoring (1000 m)

One of the 6 (out of 70) EDA approved dual-use projects
QREN (national) funds
2014-2015
Budget 1.3M €
Partners: **A. Silva Matos Metalomecânica**, Ply Engineering, INESC TEC, ISEP, Portuguese Navy
TURTLE – Technologies for long term presence in the deep sea
Launch and Recovery
TURTLE – Technologies for long term presence in the deep sea
some details of the operation
Concluding remarks

• INESC TEC has a commitment to create and promote technological knowledge based value for the sea economy

• Awareness at, and of, the sea, is a common issue in the ocean exploration and economic exploitation

• In the sea we want to
  – Stay longer
  – Do more
  – Go deeper
  – Do it safely
  – Do it sustainably

• With the increased interest in the sea, marine robotics, communications and sensors plays a relevant part for improved awareness.

• INESC TEC has been developing a strategy for robotic technology development leading to the exploration of the sea:
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