European Multidisciplinary Seafloor and Water-Column Observatory: A New Challenge for RV’s

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Earth's interactions: hydrosphere, biosphere, lithosphere, atmosphere.

**Challenging Topics**
- Health of the Oceans; Ocean Circulation, warming and acidification
- Marine resources exploitation impact and sustainability
- Natural Hazards; Early warning of tsunami & earthquakes

EMSO is a Distributed European Research Infrastructure of fixed seafloor and water column observatories constituting a Large Scale infrastructure for long-term monitoring of marine environmental processes.
EMSO Nodes (11 nodes & 4 test sites)
10 Countries confirmed:
- Italy (coordinator) (JRU in progress)
- France (IFREMER, CNRS, IPGP)
- United Kingdom (NERC-NOCs)
- Germany (KDM)
- Spain (CSIC, PLOCAN)
- Portugal (IPMA)
- Greece (HCMR)
- Romania (GeoEcoMar)
- Ireland (MI)
- The Netherlands (NIOZ)

Planned participation:
- Norway (NRC)
- Turkey (TUBITAK)
- Sweden (UGOT)

Total implementation costs: 300 M€
Running costs: 20 M€/y
### Steps towards EMSO-ERIC

<table>
<thead>
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<th>Step</th>
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<tr>
<td>Italian Ministry Letter sent to the Funding Agencies</td>
<td>DONE</td>
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<td>MoU Signature process</td>
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<td>Interim Office establishment</td>
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<td>ERIC Official Application submission (step 1)</td>
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<td>by Permanent Representation of Italy to EU</td>
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<td>ERIC Application review process</td>
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#### 10 Signatory Countries:
- Italy, UK, Portugal, Romania, Greece, The Netherlands, Ireland, Germany, France, Spain

#### Foreseen:
- Norway, Turkey, Sweden (postponed)

### Timeline for Implementation

- **Year 1**
  - Arctic, Celtic/Porcupine, Azores Islands, Ligurian Sea, Western Ionian Sea, Hellenic Arc, PLOCAN, Marmara Sea, Black Sea
- **Year 2**
- **Year 3**
- **Year 4**
- **Year 5**
- **Year 6**
- **Year 7**
- **Year 8**
- **Year 9**
- **Year 10**

**PHASE 1**
- Arctic, Celtic/Porcupine, Azores Islands, Ligurian Sea, Western Ionian Sea, Hellenic Arc, PLOCAN, Marmara Sea, Black Sea

**PHASE 2**
- Norwegian Margin, Iberian Margin
Fixed-point observatories

In order to explore the time changing properties of the oceanic environment, sustained observations are essential at a sufficiently high frequency.

These provide the means to examine complex interrelations between processes and properties:

- Short-time scales (minutes, hours to days)
- Longer-time scales (up to decades)

A key attribute of many current fixed observatories is that they are real-time multidisciplinary interactive and some cover several environments from the top of the ocean to the seabed.
Rationale for the missions:

i) characterise ambient noise (marine mammal sounds, environmental/anthropogenic sources);

ii) study earthquake and tsunami generation in Iberian Margin & Western Ionian Sea

Detection algorithm runs in the Shore Station

**Payload:** seismological, geomagnetic, gravimetric, oceanographic, hydro-acoustic, bio-acoustic
Iberian margin

Erie nodes: present status

Geo-Hazard

Tsunami Early Warning system prototype
Seismometer, bottom pressure data;

Marine ecosystem & climate change: CTD, hydrophone, gravity meter, current meter, ADCP, turbidity meter, seismic, sea bottom pressure

First mission (2007-2008)
(NEAREST EC project)

November 2009 deployment

Second mission (2009-2011)
NEAREST - ESONET LIDO DM
GEOSTAR recovered in June 2011

June 2011 recovery
International Dimension

Ocean Networks Canada

DONET Japan

ECSSOS China

MACHO Taiwan

IMOS Australia

OOI United States
SCIENTIFIC RESEARCH OBJECTIVES

**Geosciences**
- Seismicity
- Gas hydrate stability
- Seabed fluid flow
- Submarine landslides
- Submarine volcanism
- Geo-hazard early warning

**Physical Oceanography**
- Ocean warming
- Deep-ocean circulation
- Benthic and water column interactions
- Marine forecasting

**Biogeochemistry**
- Ocean acidification & Solubility pump
- Biological pump
- Hypoxia
- Continental shelf pump
- Deep-ocean biogeochemical fluxes

**Marine Ecology**
- Climate forcing of ecosystems
- Molecules to microbes
- Fisheries
- Marine noise
- Deep biosphere
- Chemosynthetic ecology

Opportunities exists through **EMSO-ERIC** consortium
Key Socio-Economic Impacts (1/2)

**EMSO** addresses several Horizon 2020 challenges
Socio Economic Impact: incidence Sectors

Natural resources; Oil, Gas, Deep Sea mining, etc.
Environment; Civil protection, Marine mammals protection, Biodiversity
**Marine Technology**; Sensor, vehicles, Seafloor Observatories, seismic tools
Energy; Submarine cabling, wind farming, wave energy, etc.
Shipping Cia; Shipyards, ship design, green ships
Management; Services, HSE Control, Training, etc.
Partnership Agreement with RI SIOS - Svalbard Integrated Arctic Earth Observing System (www.sios-svalbard.org)

Cross collaborations with other RIs, such as: EURO-ARGO, EPOS, ICOS, EMBRC, LIFEWATCH and KM3NeT

Participation in many EU projects (e.g., FixO3, ENVRI, MARsite, SCIDIP-ES)

Links with other EU initiatives (e.g., EUROFLEETS-2, SeaDataNet, EMODnet)

Future cooperation with European Centres of Excellence (e.g., CAGE-Centre for Arctic Gas Hydrate, Environment and Climate in Norway)

Cooperation and co-investment with industry (e.g., oil and gas, renewable energy, deep-sea mining, fisheries)
Contacts and exchanges with sister research infrastructure initiatives:
- ONC - Ocean Networks Canada
- OOI - Ocean Observatories Initiative (USA)
- DONET - Dense Oceanfloor Network for Earthquakes & Tsunamis (Japan)
- IMOS - Integrated Marine Observing System (Australia)

Partnership Agreement with DONET

Collaboration with OOI is on-going within the EU-US research cooperation project, CoopEUS

Also, have teamed up with ONC, OOI, IMOS to propose an extended continuation of CoopEUS under Horizon 2020

ONC is joining EMSO as an Observer

The EMSO Coordinator nominated to the ONC International Science Advisory Board
Three humans have managed to reach deepest point of the world’s oceans—the Marianas Trench.

By contrast, more than 500 people have journeyed into space and 12 people have actually set foot on the surface of the moon.

Fiscal year 2013 NASA’s annual exploration budget was roughly $3.8 billion. That same year, to NOAA’s Office of Exploration and Research received just $23.7 million.

There are some similarities between space and ocean travel: Both are dark, cold, and completely inhospitable to human life.

Scientists estimate that we still have not discovered 91 percent of the species that live in our oceans.

The deep seabed is a much more likely source of so-called rare-earth metals than distant asteroids. Recently the United Nations published its first plan for management of mineral resources beneath the high seas that are outside the jurisdiction of any individual country.
SIGNIFICANT VESSELS – Specialized Vessels

ROV/CONSTRUCTION VESSEL. POLAR KING AND POLAR QUEEN
Why Seafloor Observatories are a challenge opportunity for RV’s?

The **deep sea is the engine** that controls the overall climate—but we don’t yet understand enough about how this engine works. Monitoring deep-sea changes could better predict future crises, such as rising sea-level, for heavily populated coastal areas.

Species that live closer to the surface are depleted, commercial fisheries are seeking other species at even greater depths. But we know little about the biology of these delicious deep-sea habitants.

Around the hydrothermal vents, there are very valuable mineral deposits, covering thousands of square km of the deep-sea floor are billions of tons of so-called “manganese nodules” that are rich in cobalt, nickel, and manganese. International consortia are pressing to get started! What effects will mining have on fragile deep-sea habitats?

There are almost four thousand offshore oil wells in the Gulf of Mexico. When will we have another gigantic oil spill like the Deepwater Horizon accident of 2010, and how much short-term and long-term damage will it do? Do we have enough information now, so we can accurately judge the extent of possible future damage and recovery times?

Credits: Charles Fisher
The deep sea—that part of the ocean that is perpetually dark—is 280 million of km\(^2\) in area. Canada extends for 9.9 million km\(^2\). However, despite a significant increase in exploration in recent decades, we still know very little about this “inner space.” We urgently need to know a lot more.

**RECENT HISTORY**

**HERMIONE** (Hotspot Ecosystem Research and Man's Impact On European Seas (2009-2012) EU funded project) mobilized hundreds of scientist and marine technicians across Europe, more than 1000 days at sea, 50 RV’s, ROV’s, AUVs, etc.

**HERMES AND HERMIONE** mobilized a substantial amount a marine research infrastructures between 2006-2012 without any thoughtful preparation on the side of ship operators. Lesson learned

Currently there are few Submarine Labs operative (Canada Neptune, OOI-USA, etc.) RVs are part of the program by installing sensors, reparations, and some maintenance, etc.

**ERVO** has a unique opportunity to anticipate events and prepare our RV’s in an efficient and collaborative way to address the challenge of early implementation of undersea laboratories.
CONCLUDING REMARKS
Scientific & Societal demand for Deep Sea and Water Column

- Oceans are essential to quality of life on Earth. Largest most complex Biome on Earth
- ORIGIN OF LIFE
- Oceans dynamics drive most of the ecosystems on Earth, and control on the Planetary Climate
- 70% of Volcanism on Earth Occurs Underwater. Source of Hazards- Often Unpredictable
- Oceans are the last unexplored frontier on Earth
- There is a increasing exigency to understand de oceans

EMSO AIMS: For long-term monitoring series of sub-seafloor, seafloor and water column
To study Ecosystems, Global changes, Earth Sciences and Geo-hazards and for Environment protection

Marine component of GMES and GEOSS Platform for Data Access and management

Earth's interactions hydrosphere, biosphere, lithosphere, atmosphere

Geohazard and early warning capacity for earthquakes, tsunamis, gas-hydrates release and submarine slope failure and sediments instability
Research and long term and continuous monitoring has the highest priorities?

Interactions between ecosystems, biodiversity, biogeochemistry physic and climate for e.g. understanding present and past climate changes in the poles?
Regular operations are needed and prioritized for research, monitoring purposes, and maintenance of permanently installed observatories, based on the previous items?

Impact of exploration and extraction of natural resources and living resources

Observation on how Natural and Anthropogenic changes Connecting scientific outcomes to stake holders and policy makers

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Thanks for your attention