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Mining development in frontier areas

Subsea

High North/Arctic

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The Norwegian basis

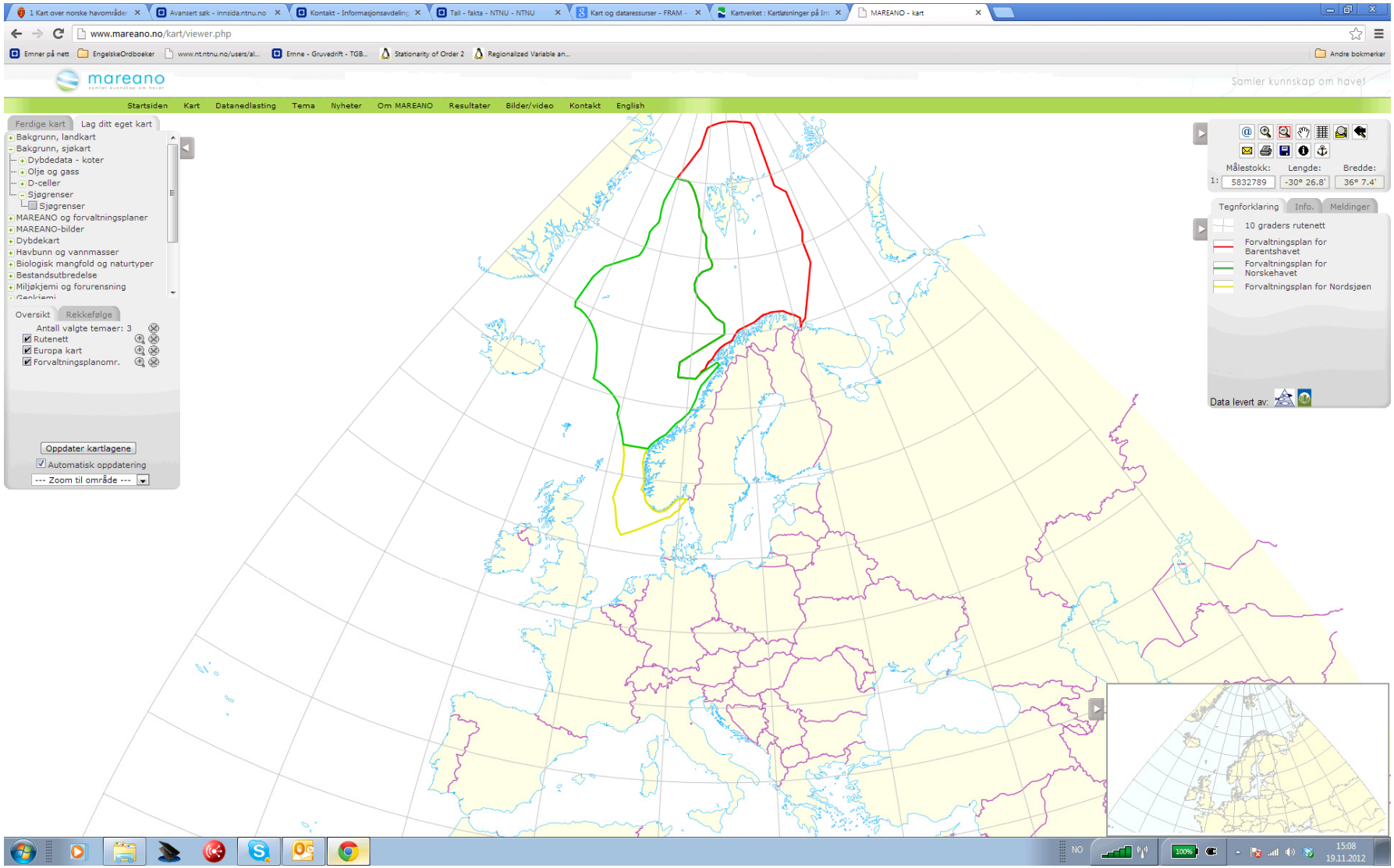
- Development of the country has been based on our natural resources
  - Fish
  - Energy (hydro power)
  - Minerals
  - Oil & Gas
- Industry/business development
  - Aquaculture
  - Shipping
  - Metallurgy (Aluminium, Steel, Nickel, Ferro Alloys)
  - Petroleum (operating companies, service/technology companies, …)
  - ++

Frontier developments

•The Petroleum activity moves into deeper waters, long distance from shore, into cold climate (Arctic), and should be 'invisible' with minimum area- and environmental footprint -> subsea solutions

•The mining industry moves into the 'ocean space', into cold climate (Arctic), and should be 'invisible' with minimum area- and environmental footprint

•The experience gained and the knowledge base from the one of the most innovative petroleum regions in the world, should be well suited for developing a sound technological framework for subsea mining (or even sub seabed mining)



- Norway manages one of the largest maritime zones in the world
  - 2 140 000 km²

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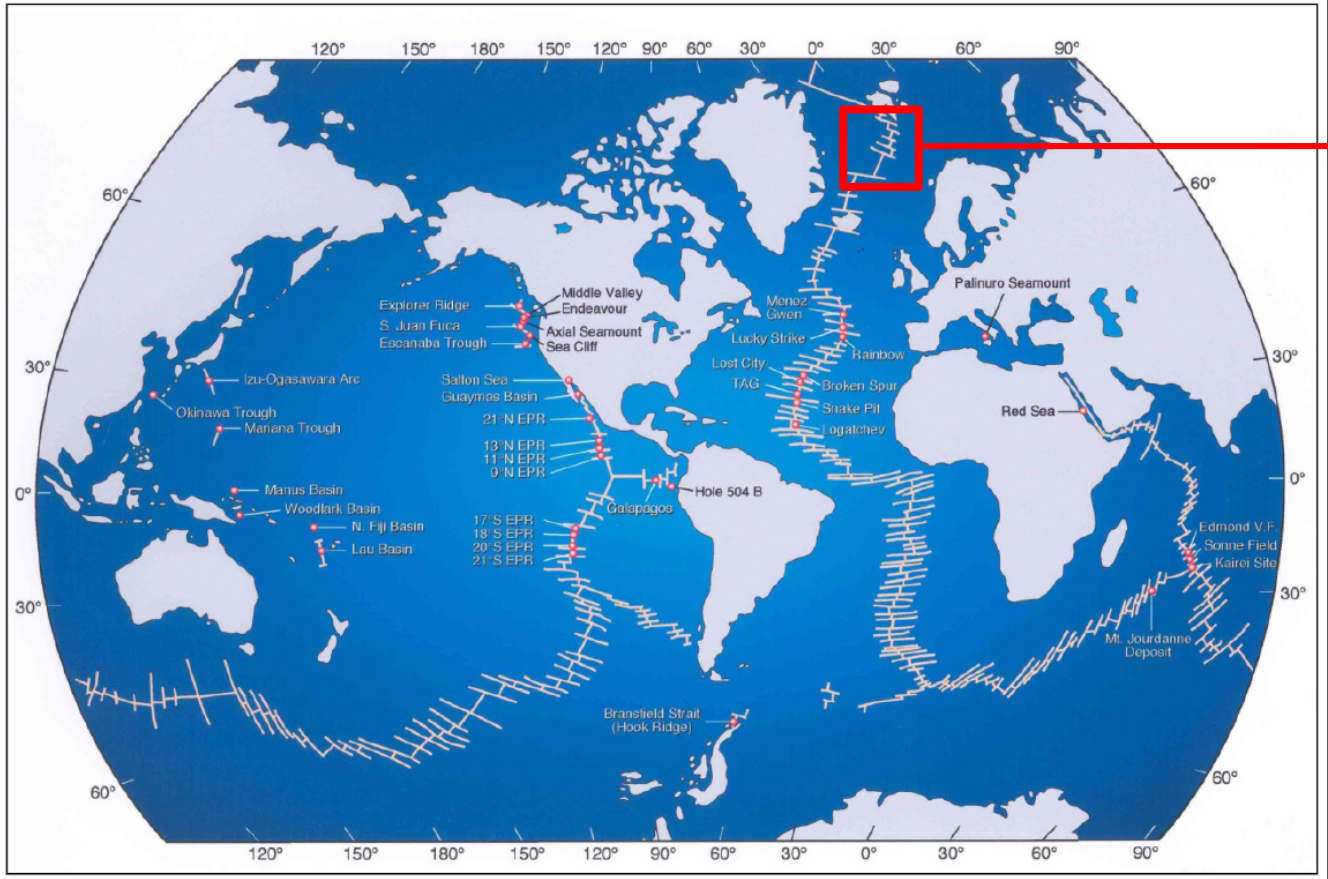
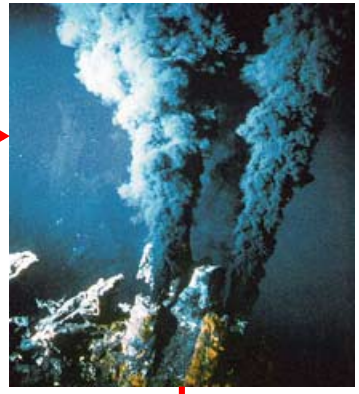
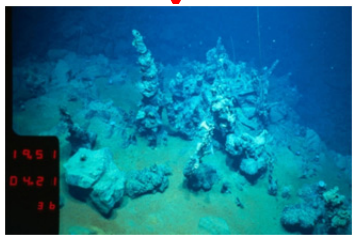
Strategic areas: – Deposits on the Mid Atlantic Ridge (MAR)



Known hydrothermal systems and polymetallic massive sulphides deposits





- Mid Atlantic Ridge (MAR) extends through the Northwestern part of the Norwegian maritime zone
- Previous research programs and mappings in the area have documented the existence of mineral deposits
- Marine minerals in the Norwegian zones have been mapped to a very limited extent and not for resource potential

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Activities and potential

- Research project established at NTNU in 2012 to evaluate the resource potential in cooperation with Statoil and Nordic Ocean Resources AS.

- Carried out in cooperation with VNIIO (Institute for Geology and Mineral Resources of the Oceans, Ministry of Natural Resources of the Russian Federation), and the Norwegian Petroleum Directorate (NPD)

The project goals

- Interpretation of existing multibeam data
  - Data from the Norwegian zones
  - Various interpretation techniques
- Evaluation of known deposits
  - Literature study
  - Beneficiation studies
- Resource evaluation

Preliminary results

- Based on morphostructural and geodynamical analysis:
  - Knipovich ridge
    - 4 identified favorable areas
  - Mohns ridge
    - 12 identified favorable areas

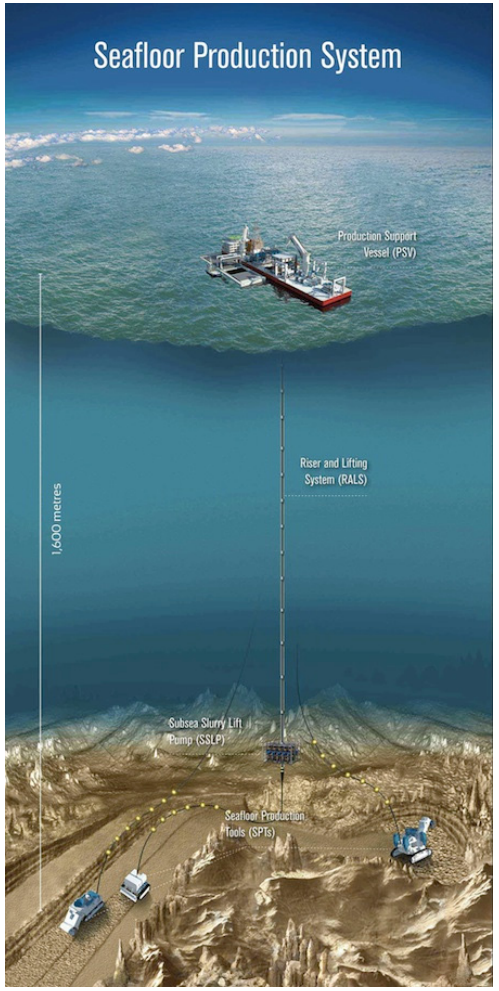
Types of conclusions that will be developed

- The resource potential of the North Atlantic ridge will be evaluated:
  - Number of accumulations
  - Accumulation sizes
  - In-place seafloor massive sulphide resources

- Different scenarios will be used to arrive at a resource estimate:
  - Different field size distributions
  - Uncertainties

- Resource potential estimate expected in the Autumn of 2013

Future ocean mining activities in Norway?



- NTNU is partner in a new EU initiative to develop the ocean mining methods of the future along the mining value chain (the "Blue Mining" project)
- NTNU and SINTEF possible partners in a EU project focusing on sub-seafloor resources…
- SINTEF and NTNU is working on establishing a new national research center on marine mineral resources

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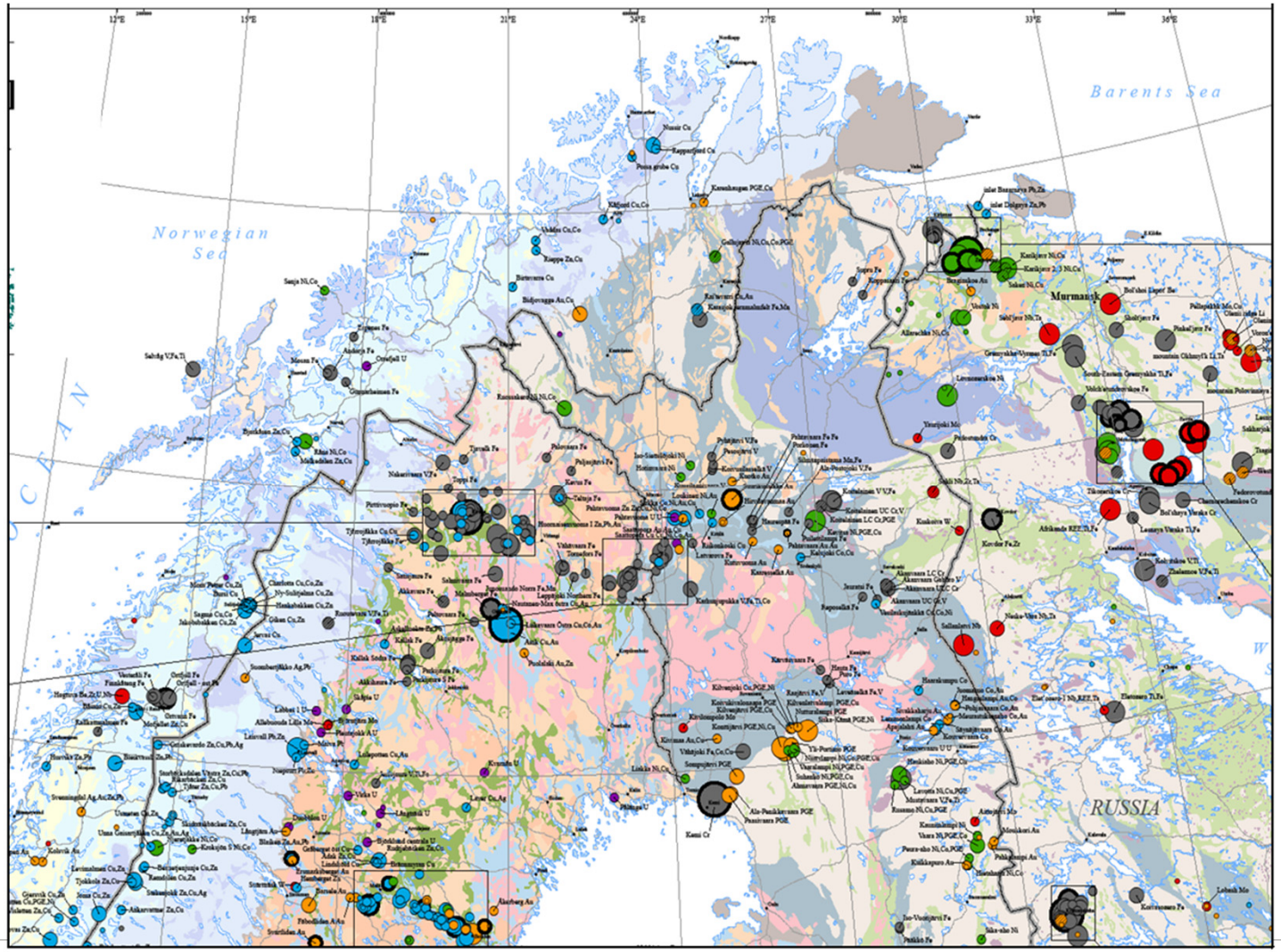
On land…..

The Fennoscandian shield is considered as one of the most prospective/promising regions in EU to be developed (+Greenland…)



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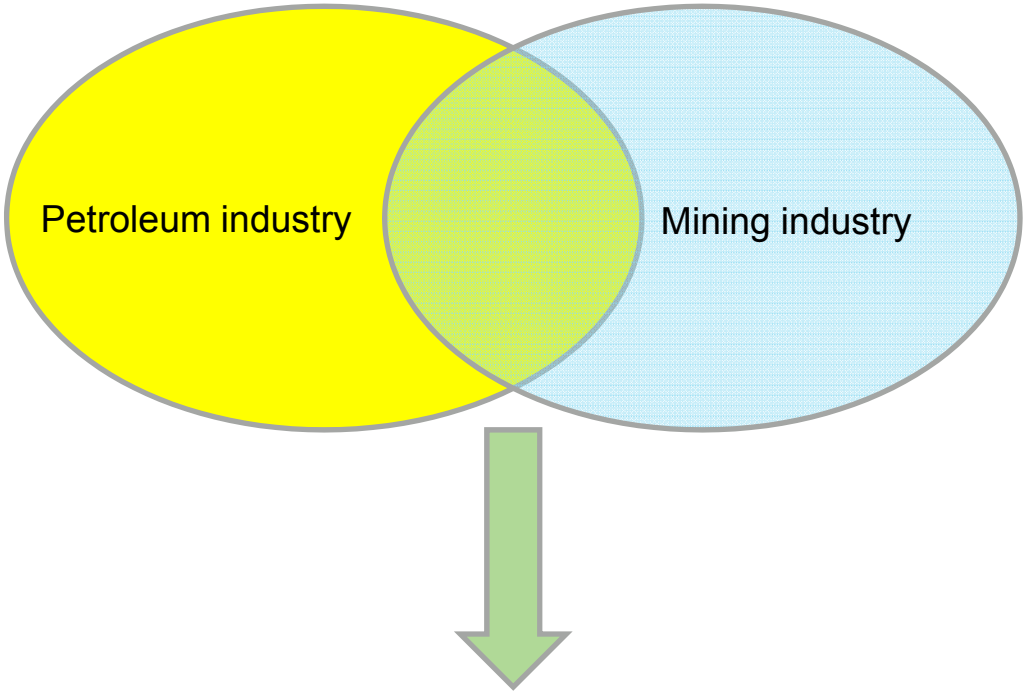
Cold climate/Arctic challenges

- Temperature/winter conditions
  - Excavation, processing and handling equipment
  - Refining processes
  - Water handling/management
  - Transportation/logistics
- Indigenous people
- Environmental sensitivity

(some) SINTEF /NTNU strength areas

- Marine Environmental Technology
  - Submarine disposals; effect of (flotation-)chemicals and fine-particles, distribution/dispersion in water column and on the seabed, …
- Petroleum & Maritime Technology
  - (sub-sea)equipment
  - marine operations
  - ++
- Minerals exploration & exploitation in frontier areas
  - High North regions (Fenno Scandian Shield ++)
  - Sub-sea (mid-Atlantic ridge ++)
- Resource estimation and characterization
- Advanced minerals processing, refining and agglomeration
- Use of natural gas in down-stream minerals/ore processing
- Metallurgical (down-stream) processing (ferro-alloys, silicon, iron/steel, aluminum)
- Tunneling technology (rock mechanics/geo-technique)
- Water management
- Energy efficiency and low-carbon footprint

Frontier developments



Framework conditions
Resource estimation
Exploration
Technology
-
-
-

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The position of SINTEF and NTNU

- Is active on the national and Nordic R&D agenda on minerals
- Will be active in H2020 (as been in previous FWP's)

- Is working with a larger national initiative on marine mining
  - Weighted in H2020
  - Explicitly mentioned in the Norwegian minerals strategy
  - Explicitly mentioned in the high-north/arctic strategy from the research council of Norway

- The national subsea mining initiative will have four pillars
  - Technology (Exploration, extraction, processing, marine operations/logistics, surveillance & control, ++)
  - Resource geology (resource estimation, mapping, characterization, ore knowledge, ++)
  - Environment (effects on ecosystem, bio-prospecting, energy-efficiency, ++)
  - Legal/juridical aspects

  - Ambition:

  (1) To become a valuable and wanted 'asset' for future mining consortia in Europe

  (2) To become an industrial innovation engine for the best subsea mining solutions