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Introductions

Who are we?
Dredging, Environmental and Marine Engineering [DEME]

• 5,200 colleagues worldwide
• 100+ main vessels

• 77+ nationalities
• 140+ years of experience

Turning challenges into opportunities
2 Why are we here?
Clean energy technologies are metal intensive
  › Demand for cobalt four times greater than reserves by 2050, and will also exceed nickel reserves
    Institute for Sustainable Futures, 2019 (1.5-degree scenario)

Urban infrastructure is metal intensive

Recycling unable to bridge supply gap for many decades

Sufficient terrestrial resources but seafloor may be a better option

New urban infrastructure to house a population of the size of New York required every eleven weeks between now and the end of the century
- Rich in manganese, nickel, copper and cobalt
- Rare earths also present
- Potato-sized, hard
- Exist on the surface – not attached
- They cover extensive areas of the ocean’s abyssal plains
“Nodules in the Pacific Ocean contain more Mn, Ni and Co than the entire global terrestrial reserve base for those metals.”
[Hein et al., 2012]
3

Project
Development
**GSR MINING SYSTEM OVERVIEW**

1. **HARVESTING UNITS**
   - Hydraulic nodule collector, mounted on a tracked undercarriage

2. **VERTICAL TRANSPORT VIA RISER**
   - Collected nodules transported to the surface using a flexible riser, fitted with a series of single stage centrifugal pumps

3. **SURFACE VESSEL**
   - Surface vessels with the capability of handling nodules to be purpose built based upon current designs

4. **BULK TRANSPORT**
   - Transported on standard cargo vessels for shipment to land-based processing plant
GSR model for collecting and processing nodules

Concept of Operations
**STEP-BY-STEP APPROACH**

**HARVESTING UNITS**

<table>
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<tr>
<th>2017</th>
<th>2020 - 2021</th>
<th>2023-2024</th>
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<tbody>
<tr>
<td>Patania I</td>
<td>Patania II</td>
<td>Patania III</td>
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<tr>
<td>Tracked Soil</td>
<td>Pre - Prototype</td>
<td>Prototype</td>
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<td>Testing Device</td>
<td>Nodule Collector</td>
<td>Commercial Nodule</td>
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GSR Proprietary Information – Commercial in Confidence Treatment Requested
Patania II

FROM DRAWING BOARD TO REALITY

Patania II - named after the fastest moving caterpillar on earth.

12m-long
4m-wide
4.5m-high
25-ton
nodule-collecting robot on caterpillar tracks
**STEP-BY-STEP APPROACH**

**COLLECTOR ASSESSMENT ATLANTIC**

- **Atlantic Expedition**
  - 22 June – 19 July 2020
  - Validation of launch & recovery system and hyperbaric test of Patania II
  - Depth: 4500 m
  - No touch-down on seabed

- **Trafficability assessment in Belgian EEZ**
  - Depth: 28m
NEXT STEPS

STEP-BY-STEP APPROACH

- Prepare for Patania II trial in CCZ
- Period: February – May 2021
- Goal: In-situ validation of PII as per original EIS
- GSR Environmental Program complemented by independent vessel [GEOMAR – BGR]
- Early, inclusive, transparent and ongoing engagement of key stakeholders
- Environmental Risk Assessment approach
- Step-by-step, precautionary
- Partnering with the scientific community
- **Demonstration that environmental effects can be adequately predicted and monitored**
- Demonstration that impacts and effects are acceptable
OBJECTIVES

ProCat Project | Patania II Phase

In situ trials, in the operational environment of the CCZ, in order to:

- Confirm trafficability and maneuverability of soil specific- and purpose-built caterpillar tracks, decreasing energy consumption and direct seabed disturbance
- Optimize the in-situ operations of a hydraulic collector head to increasing pick-up efficiency and decrease energy consumption
- Validate nodule-sediment separation process of primary flow and subsequent nodule transport by secondary flow
- Verify reliability and the robustness of the technology to increase the state-of-the-art

JPI-O MiningImpact 2 project – Assessing environmental effects

Independent scientific evaluation of the environmental impacts of the ProCat trials, in order to:

- Reduce existing knowledge gaps and uncertainties about environmental impacts
- Gather data about operational impacts
- Design of fit-for-purpose environmental monitoring programs
- Make recommendations of a precautionary approach for ISA’s exploitation mining code
ENvironmentsal Impact Assessment for a Scientific Test [PRIOR-EIS]

- Environmental Impact Statement
  - Introduction
  - Policy, legal and administrative context
  - Project description
  - Description of the existing environment
  - Assessment of impacts and proposed mitigation
  - Accidental events and natural hazards
  - Environmental management, monitoring and reporting
  - Abbreviations
  - Study team
  - Expert review
  - References

Ref: Following ISBA/23/LTC/CRP.3* Download:
► **MiningImpact2** | Before, After, Control, Impact (BACI)

► **Environmental Monitoring** | Same conditions as presented in the prior-EIS

► **B4S03A** : Area for the JPI-O MiningImpact 2 sites
  › 'Mined' Area → Known
  › Sediment plume → To be confirmed/determined
  › During 2019: Before sampling, in-survey
  › Long mooring since 2017 for background current, background turbidity levels & background Vertical fluxes, sedimentation

► **B4S03B** : Reference Site
PATANIA II MONITORING
SENSORS AND EQUIPMENT

► Sediment cloud behavior & design optimization – Near Field

- Densitometer / Flowmeter: sediment load and flow
- Multibeam / Altimeter: Depth of removal of sediment
- ADCP: 3D sediment plume dispersion & current
- Turbidity sensors: concentration in the plume
- HD camera (visual observations)
- Niskin bottles (water samplers)
Plankton Pump

Remote-sampling Niskin bottle array for water sampling
Mooring Placement
- Turbidity data
- ADCP data
- Hydrophone
- Turbulence data
- Transponder (positioning)
► Sediment cloud behavior & design optimization – Near Field

► Operations: Use Patania II as a monitoring tool to test multiple scenarios
  › number of suction heads,
  › flow rate,
  › speed of collection,
  › height of collection above seabed

► Objective:
  › Validate sediment plume model
  › Sediment remaining in suspension
  › Sediment characterization
  › Sediment layer removed
Environmental Monitoring | Independent third-party:

- In line with its commitment to an open, transparent, and scientifically rigorous testing program, the Patania II trial will be independently monitored by the MiningImpact 2 consortium.
- Another contractor, the Federal Institute for Geosciences and Natural Resources (BGR) has offered the use of its regular baseline charter for a monitoring campaign dedicated to achieving the objectives of the MiningImpact 2 project.
- Impact of the Patania II trial has not changed.
- MiningImpact 2 researchers remain involved.
- Monitoring objectives will be met.
- Study represents an important collaboration.

Aim: remove nodules from part of the seafloor to mimic conditions of an actual mining operation and monitor impacts.