Scarcity of Resources

Harvesting minerals at great depth
Creating land for the future by providing sustainable solutions for the global threats and challenges.

Kris Van Nijen
General Manager
Global Sea Mineral Resources
van.nijen.kris@deme-group.com

nm = nautical mile
m = meters
• The **Clipperton Fracture Zone** ("CCZ") is a geological submarine fracture zone of the Pacific Ocean, with a length of some 4,500 miles (7,240 km)

• Manganese nodules that are also known as polymetallic nodules ("PN") are found in the abyssal areas of the CCZ

• PN resources contain nickel, cobalt, manganese and copper and generally grow very slowly, at rates of 1-10 mm per $10^6$ year

• The highest percentages of seafloor covered by PN are found in water depths between 4,100 - 4,200 m

• The **International Seabed Authority** ("ISA") is the organization through which States Parties to the Convention organize and control activities in the area

• Presently, fifteen of twenty-four exploration contractors with the International Seabed Authority have exploration contracts in this area
• Global Sea Mineral Resources ("GSR") is a privately owned concessionaire with **exclusive control** over 75,000 km² of seabed located in the Pacific Ocean.

• GSR has **100% control** over GSR-1B for a period of 15 years; during that period GSR has the exclusive right for exploration and a Right of First Refusal for exploitation.

• GSR has obtained approval of a plan of work including environmental baseline monitoring.
World population (1)

Urbanization (commodity intensity indexed at 100 for max) (2)

Clean energy technology (1)

• Rising demand for clean energy infrastructure needed to replace fossil fuels and reduce carbon emissions will place further demand pressure on selected metals – in particular Rare Earth Elements (REE)
• Copper, nickel, rare earth minerals and other metals are crucial to cell phones, computers and other modern technology that the world depends upon
• Meanwhile such elements are also central to the production and further development of clean energy technology including batteries, electric vehicle motors, transmission lines, wind turbines and solar panels – requiring far greater quantities of metal to produce an equivalent unit of energy output

Steel intensity (tonnes of steel/MW) (2)

Project development
Exploration for polymetallic nodules | “Resource Definition”

Increasing Environmental, Technical, Economic, Legal & Social considerations

**RESOURCE**
- Measured Resource: Based on exploration cruises to the CCZ
- Indicated Resource: Based on exploration cruises to the CCZ
- Inferred Resource: Based on historical, public, private data

**RESERVE**
- Proven Reserve: Based on feasibility studies, ISA regulation [Incl. EIA]
- Probable Reserve: Based on desktop studies, ISA regulation [Incl. EIA]
Exploration for polymetallic nodules
Deposit Mapping [Increasing geological considerations]
- Collect HR geophysical data (AUV) within three selected locations
- Collect enough boxcore samples to determine nodule abundance and,
- Calibrate the geophysical data
- Correlate and extrapolate HR study to lower resolution

Engineering [Increasing technical considerations]
- Collect the first in-situ geotechnical data of the soil’s strenght, up to 4m below seabed
- Process to additional geotechnical tests on soil recovered with boxcore
- Process to point load tests on nodules to determine their strenght (crushing test)
- Help to improve the design of the deep-sea vehicle

Biology & Environment [Increasing environmental considerations]
- Collect baseline data for deep-sea micro to macrofauna
- Visual mapping and quantification of the deep-sea megafauna
- Biochemical analysis of water samples
Exploitation of polymetallic nodules
Exploitation of polymetallic nodules | Technology advances

- **2000** NamSSol
- **2007** I-Trencher
- **2007** Pia
- **2011** Flintstone
- **2012** Innovation
Step by step approach to reduce risk

- Environmental impact
- Resource assessment
- Economic evaluation
- Harvesting vehicle
- Vertical transport systems
- Ship to ship transfer
- Processing technologies
Environmental Impact
Environmental Impact | Four impacts

**Carbon Footprint**
Following industrial activity, there will be GHG emissions. The global warming potential of the entire cradle-to-gate life cycle of polymetallic nodules harvesting activity needs to be minimal.

**Removal of hard substrate**
The abyssal fauna with a high biodiversity but low biomass – of which the majority is present on the nodules – will be reduced after harvesting operations.
Spatial variability & connectivity remains to be proven.

**Noise & Light**
Following industrial activity, there will be additional acoustic, light and electromagnetic emissions that needs to be monitored & controlled.

**Turbidity**
(1) Resulting from the harvesting operation
(2) Resulting from the vertical transport
(3) Resulting from the [filtered] tailings return water

**Engineering**

**Resource Definition**

**Adaptive Management**
Conclusion
Enhance Deep Sea Mining Industry (DSMI) on research design and output analysis by enabling an operational environmental impact assessment & facilitating environmental responsible mining.

- **Sedimentation**
  - How much is too much on the seabed?

- **Turbidity**
  - How much is too much in the water column, at what height, for how long?

- **Removal of hard substrate**
  - How much of the nodule coverage needs to remain in place?

- **Duration baseline research**
  - What is the minimum necessary duration of initial baseline research?

- **Tailing water**
  - What is the maximum allowable concentration of metal released in the water column?
Questions?

Thank you