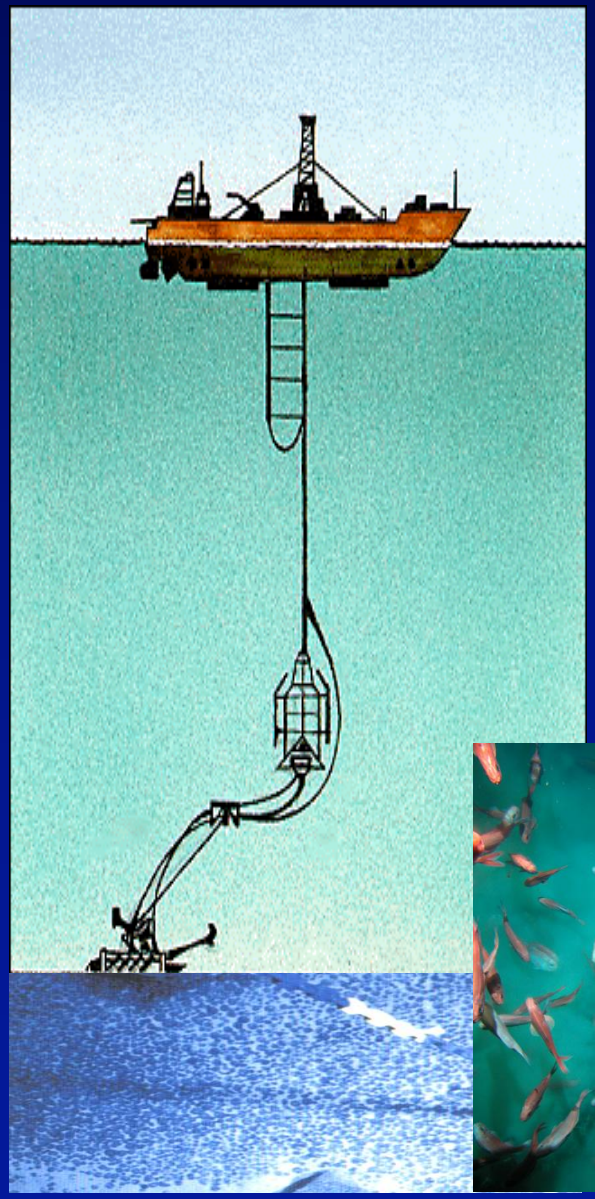
Deep seabed mining in the Area:



Protection and preservation of marine environment

Rahul Sharma
(Retd. Chief Scientist)
CSIR-National Institute of Oceanography
Dona Paula, Goa 403004, India
Email: rsharmagoa @ gmail.com

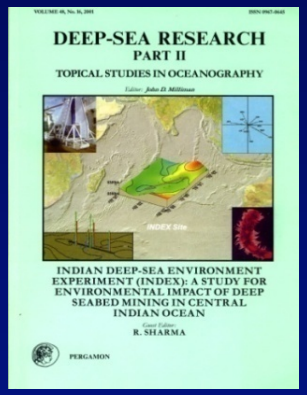
Rahul Sharma, M.Sc., Ph.D.

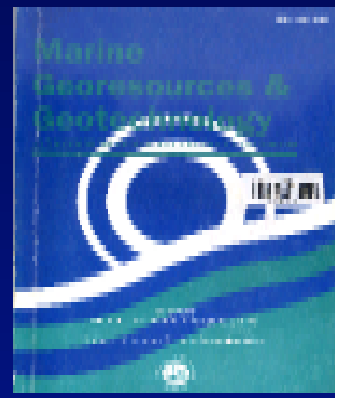
Affiliation: Chief Scientist and Project Leader (Retd)
EIA studies for deep-sea mining
National Institute of Oceanography
Goa, India

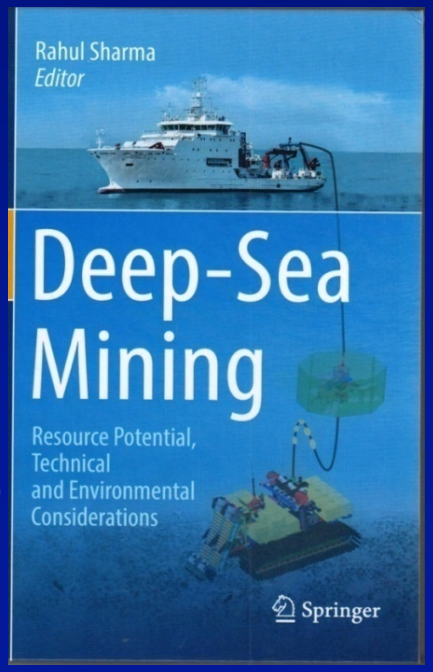
Research area: Application of oceanographic data for exploitation of marine minerals and conservation of marine environment.

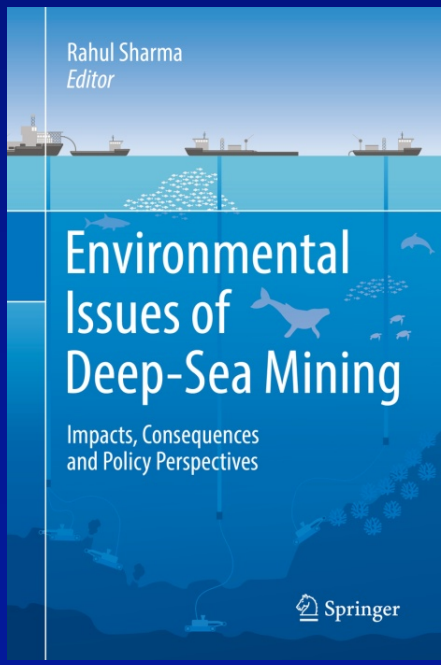
Assignments: Member, UNIDO Mission on DSM (1991)
Visiting Fellow to Japan (1993, 2000)
Resource person for ISA (1998-2015)
Visiting Professor to Jeddah (2011-12)
Member, Ocean Mining Working Group

Publications: Edited 3 special issues (2000,2001, 2005)
Edited books 'Deep-sea Mining' (2017) and 'Environmental issues of deep-sea mining (2019)
Published 37 papers in technical journals
Contributed 22 chapters to books
Presented > 60 papers at various symposia



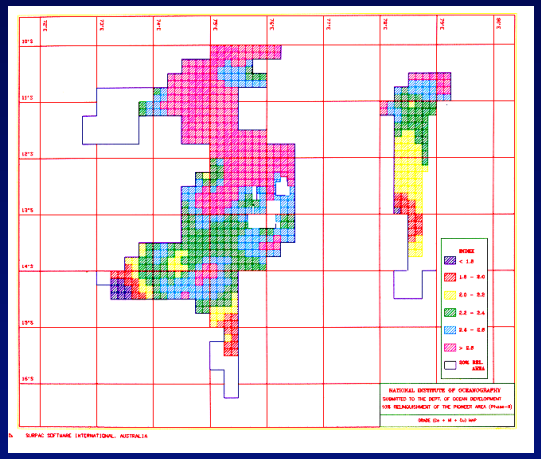






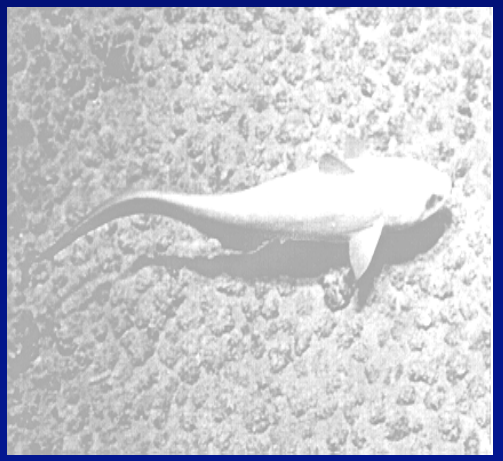
Components of deep-sea mining

Exploration
(Mine-site)



EIA
(Environmental data)

Deep-sea mining



Mining
(Mining technology)

Metallurgy
(Extraction process)

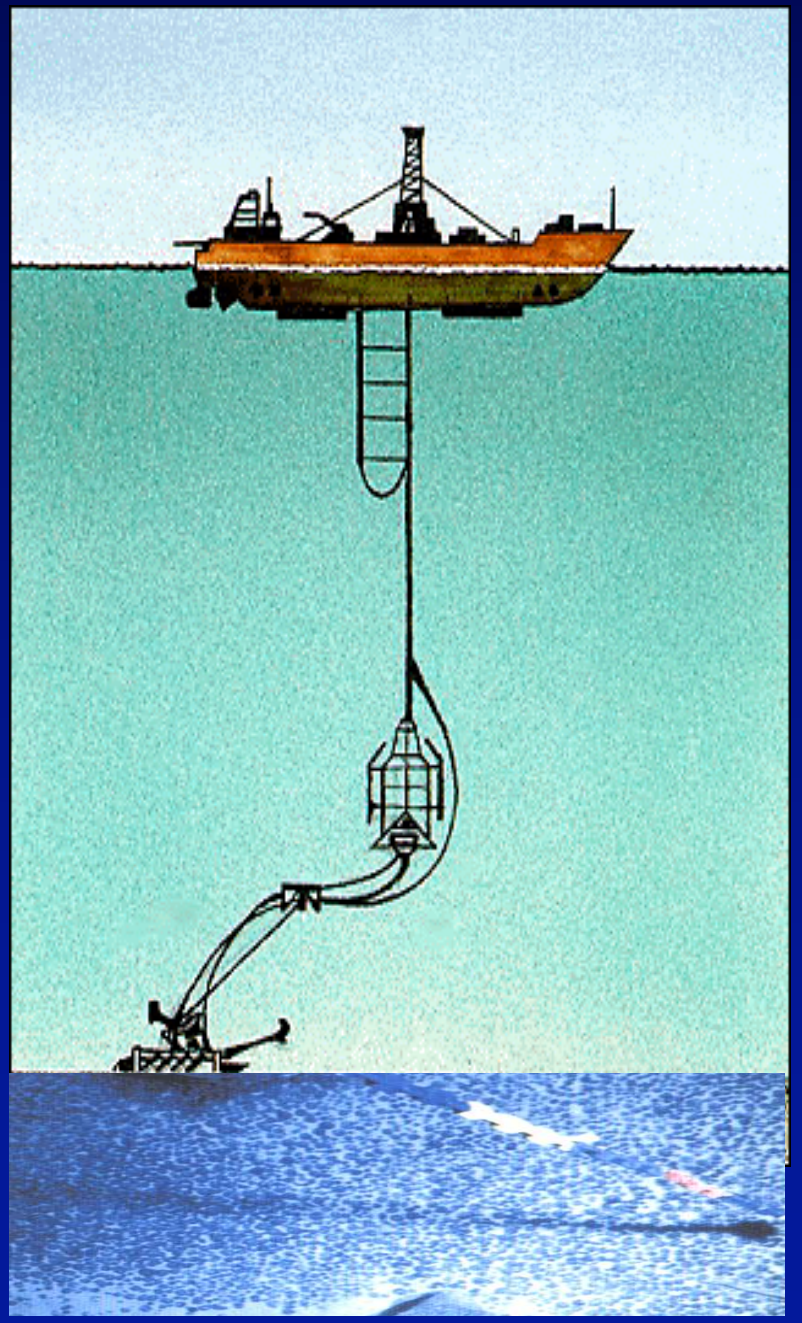
Deep-sea Mining System – schematic

Surface components

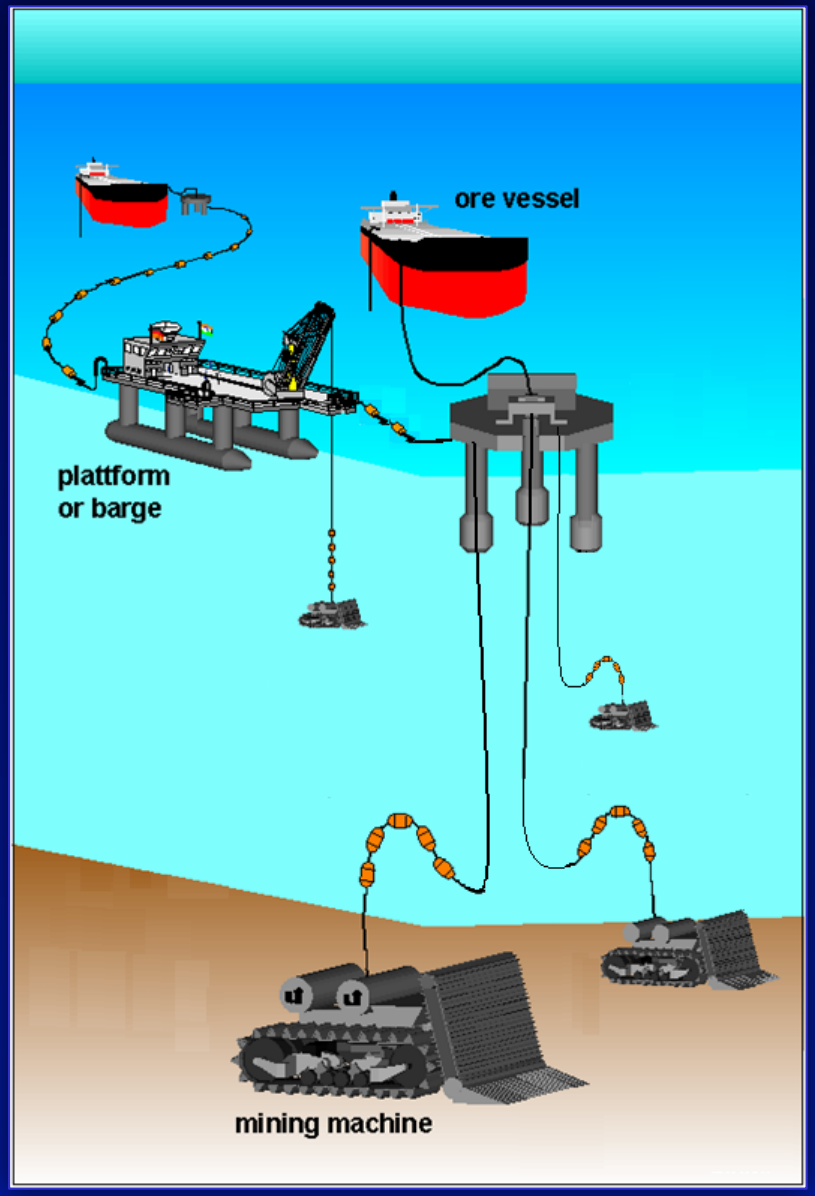
1. Surface platform
2. Storage and handling
3. Power generation
4. Processing plant
5. Transport vessels

Sub-surface components

1. Collector mechanism
2. Ore lifting mechanism
3. Navigation device
4. Propulsion devices
5. Obstacle avoidance mechanism
6. Rescue/recovery devices



Conceptual design for deep-sea mining



Salient features

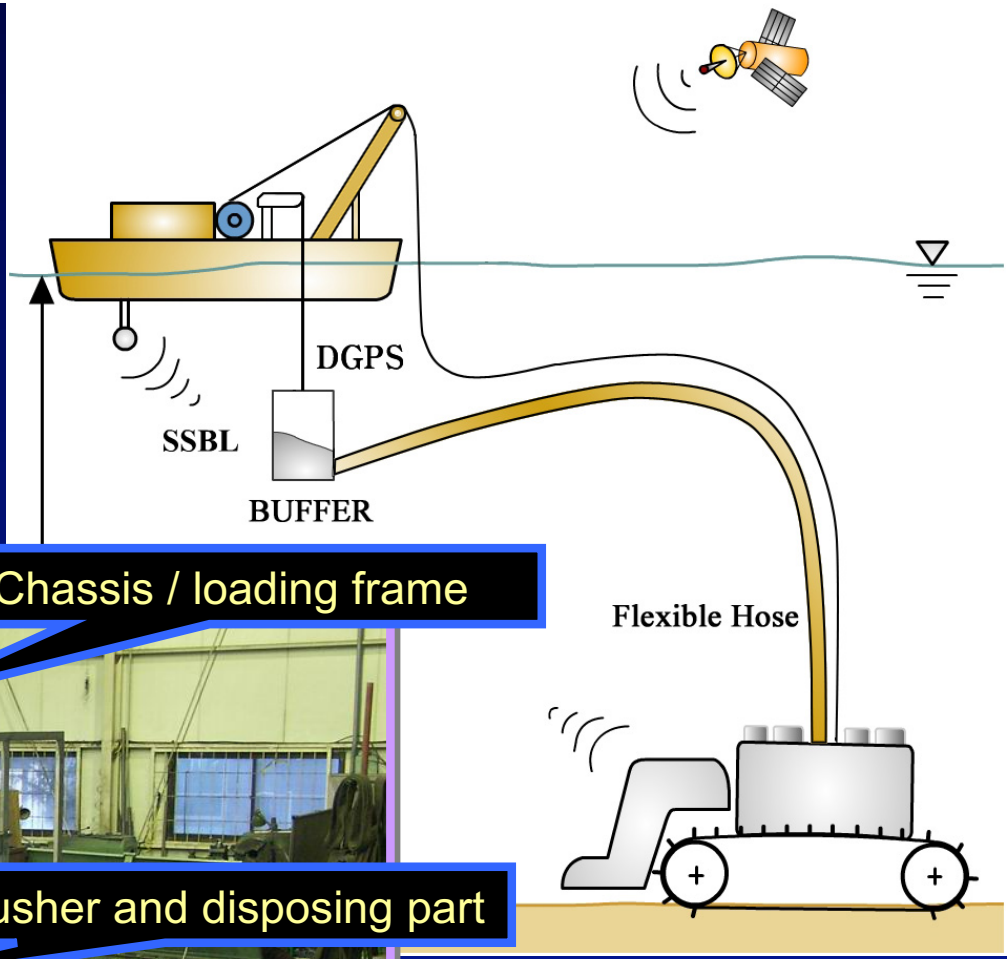
- Multiple Self propelled mining vehicles collect, crush and pump polymetallic nodules
- Flexible riser is mounted on the vehicle to pump nodules to platform
- A small semi-submersible platform pumps the mined nodules to ore-ship or storage mother station

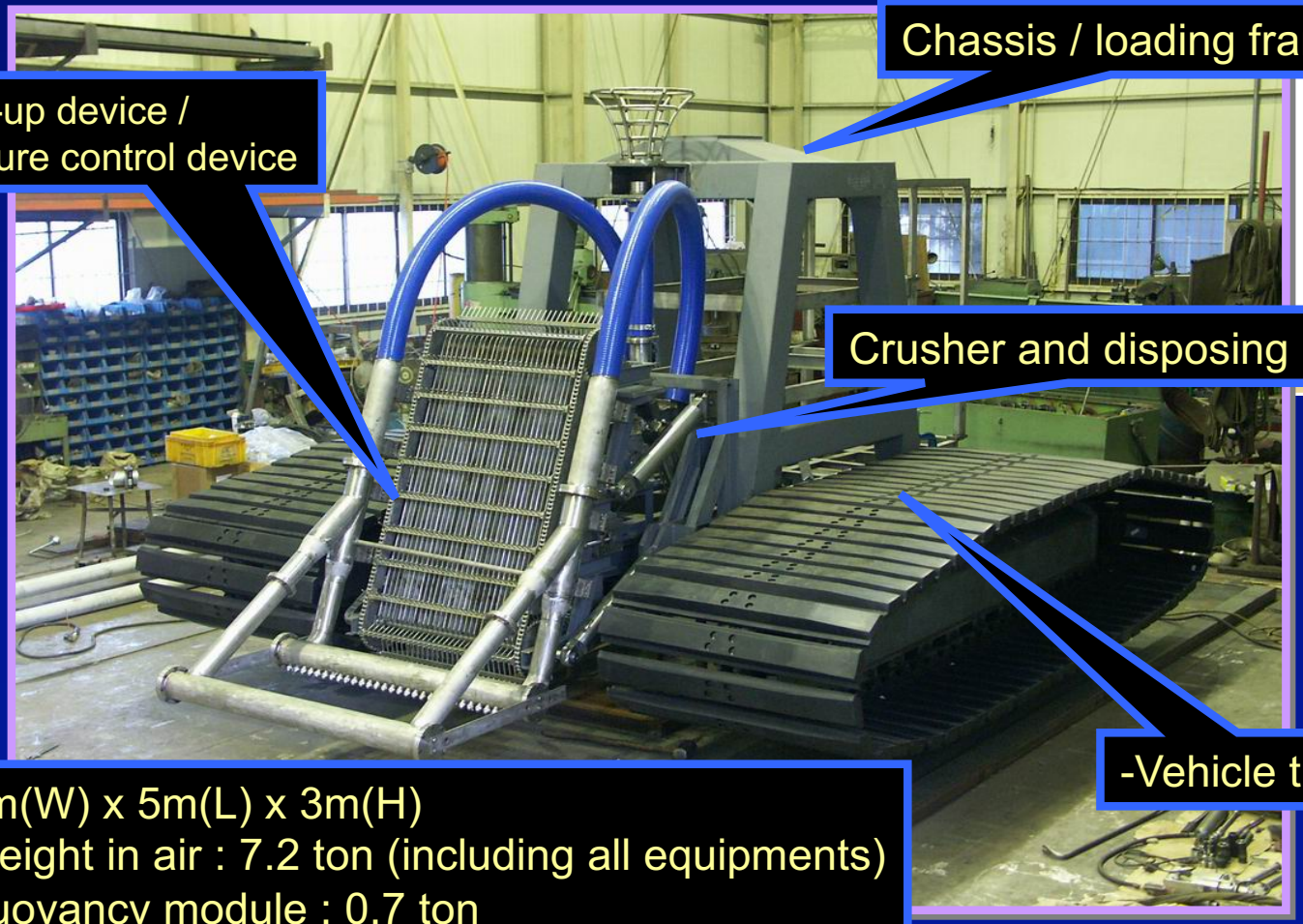
Advantages

- Failure in one system will not affect total operations
- Less cost intensive
- Ease in deployment, retrieval

Source: NIOT, Chennai

Deep-sea mining technology development in Korea

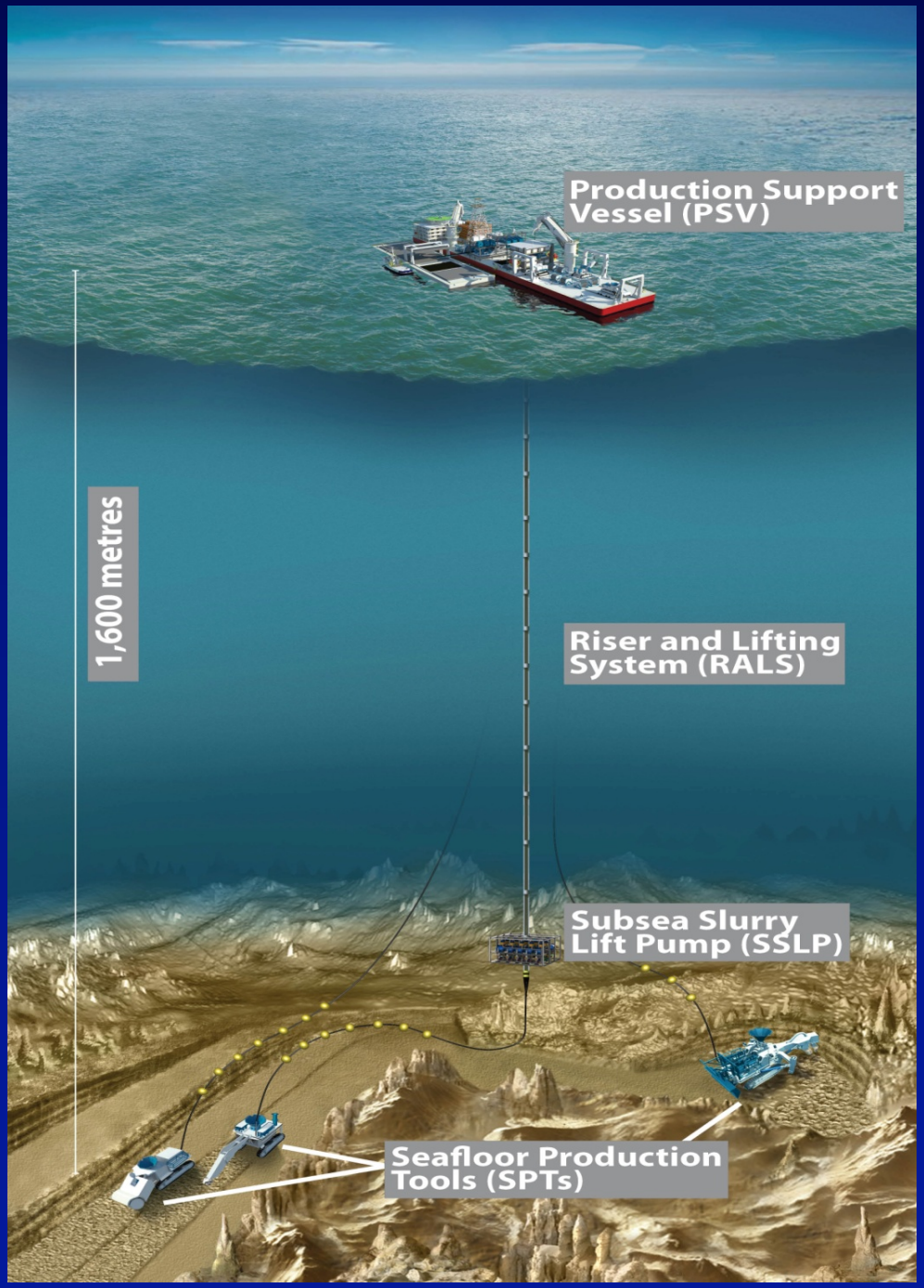




- 4m(W) x 5m(L) x 3m(H)
- Weight in air : 7.2 ton (including all equipments)
- Buoyancy module : 0.7 ton
- Weight in water : 4.4 ton ≈ 5.9 kPa < 6kPa

Courtesy: Sup Hong, KORDI

Nautilus Minerals seafloor production system for sulfides



To produce commercial quantities of copper, gold and other metals from the deep ocean.

At proposed Solwara 1 project in the Bismarck Sea of Papua New Guinea (PNG)

The components will include:

- Production Support Vessel (PSV) floating 1600 m above
- Riser and lifting system (RALS) to carry the ore to the vessel
- Subsea Slurry Lift Pump (SSLP) to pump high grade slurry from the bottom
- Seafloor production tools (SPTs) to cut and gather the ore from the seafloor

(Source: Nautilusminerals.com)

Nautilus Minerals seafloor production system for sulfides

Nautilus Production Support Vessel (PSV), under construction at the Mawei shipyard in China. © Nautilus Minerals.

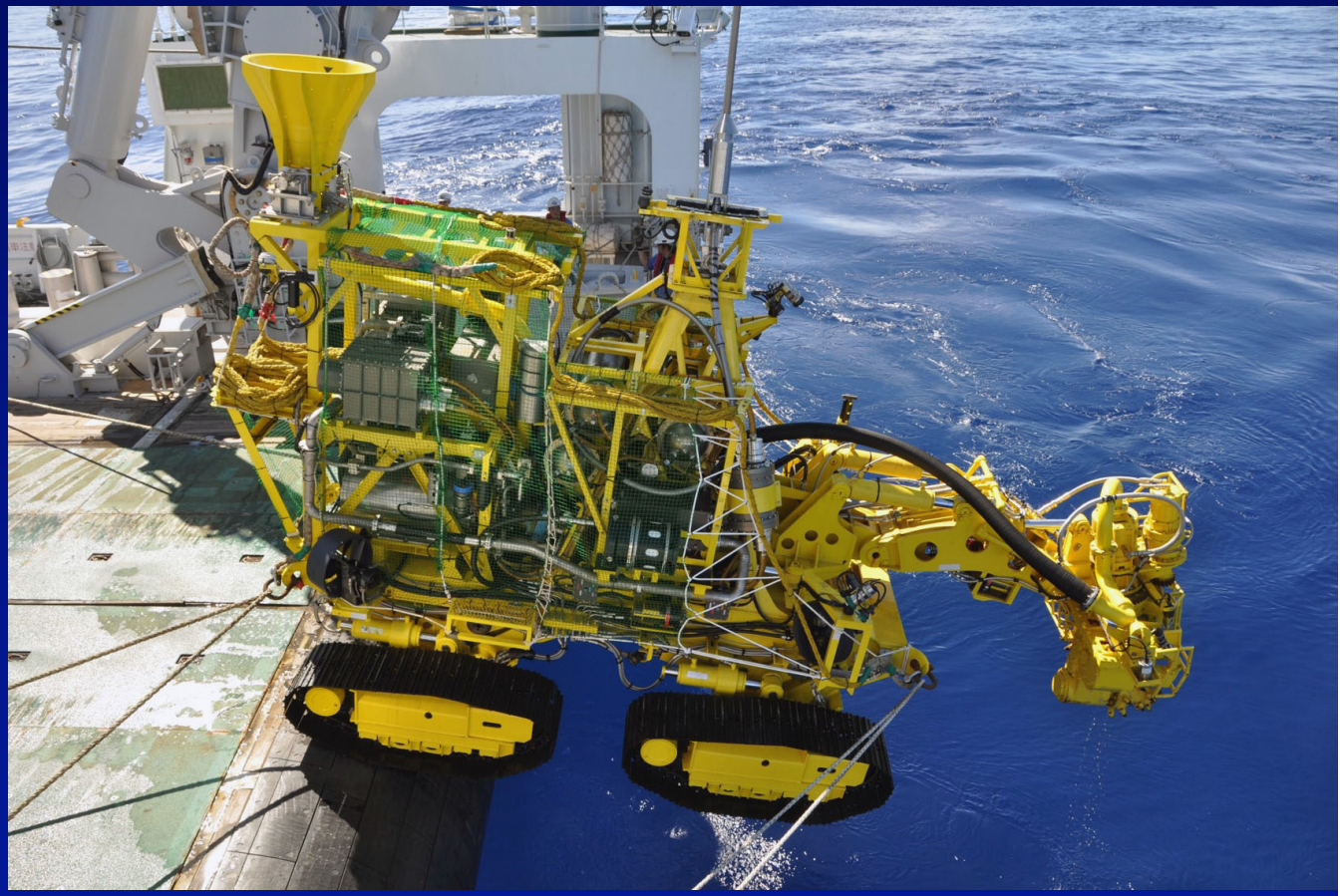
The Bulk Cutter on site in Papua New Guinea. © Nautilus Minerals.

(Source: www.DSMobserver.org)

Japan successfully undertakes large-scale deep-sea mineral extraction

Kyodo Sep 26, 2017

- Japan has successfully tapped into a deposit of mineral resources from a deep-water seabed off the coast of Okinawa, the economy ministry said, the largest such extraction
- It is the first time metals have been mined from the seabed in such quantities using ship-based extraction technology, according to the Economy, Trade and Industry Ministry and Japan Oil, Gas and Metals National Corp.

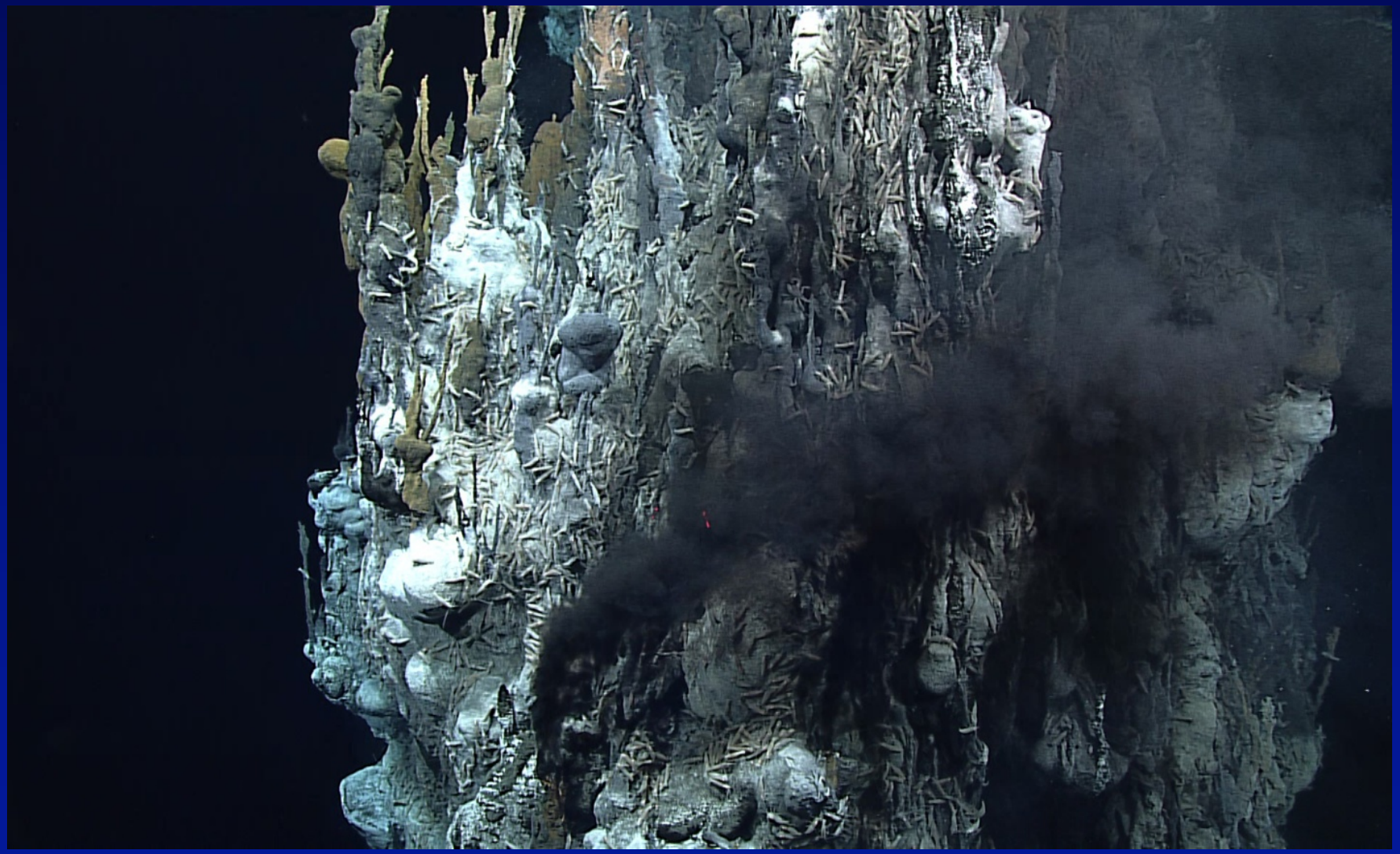


https://www.japantimes.co.jp/news/2017/09/26

Megafauna associated with polymetallic nodules

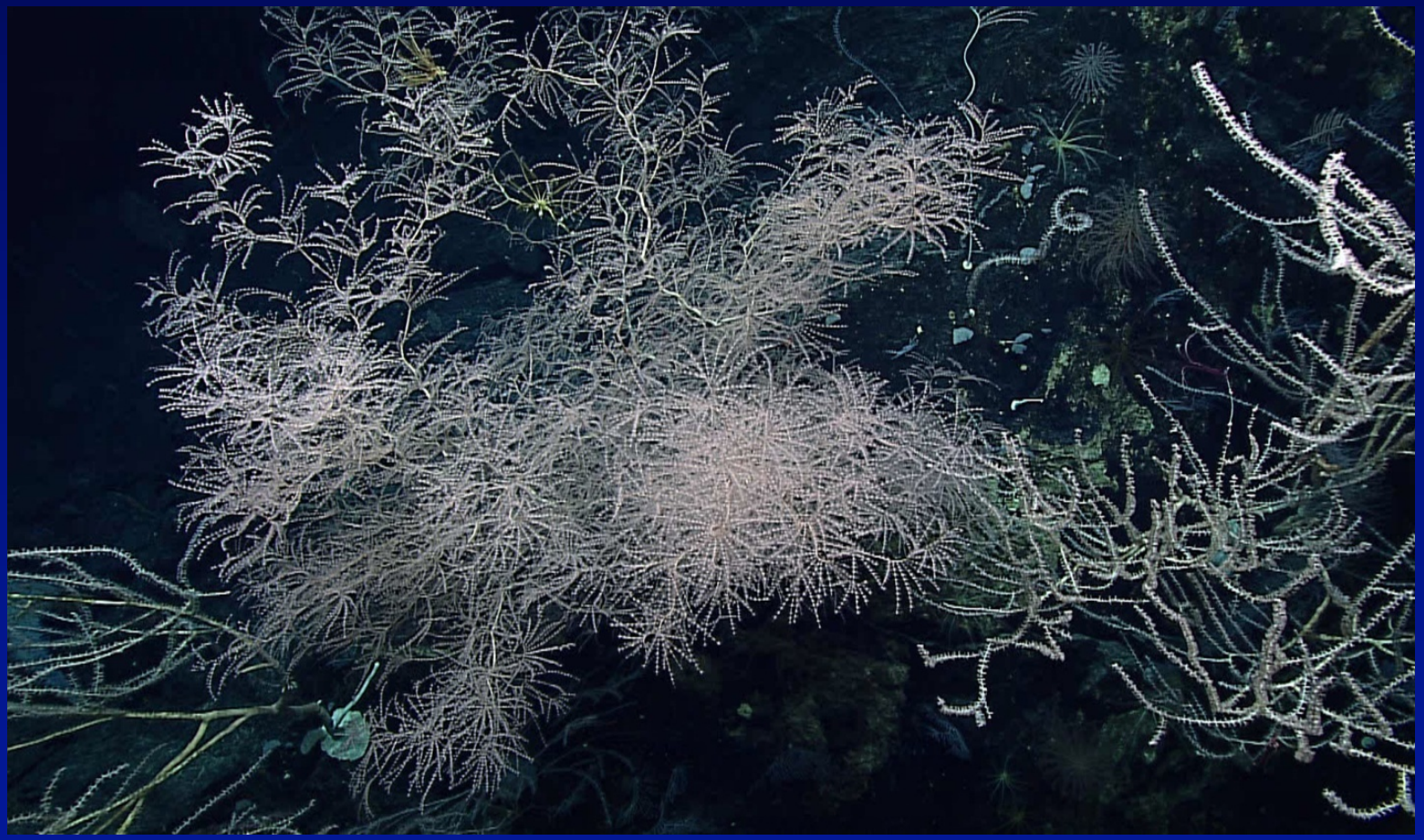
(a–c) actiniarians; (d–f) alcyonacean corals; (g) antipatharian coral; (h–l) hexactinellid sponges. Copyright: ROV Kiel 6000 Team/ GEOMAR Kiel. (From Vanreusel et al, 2016)

Hydrothermal sulfide vent with fauna



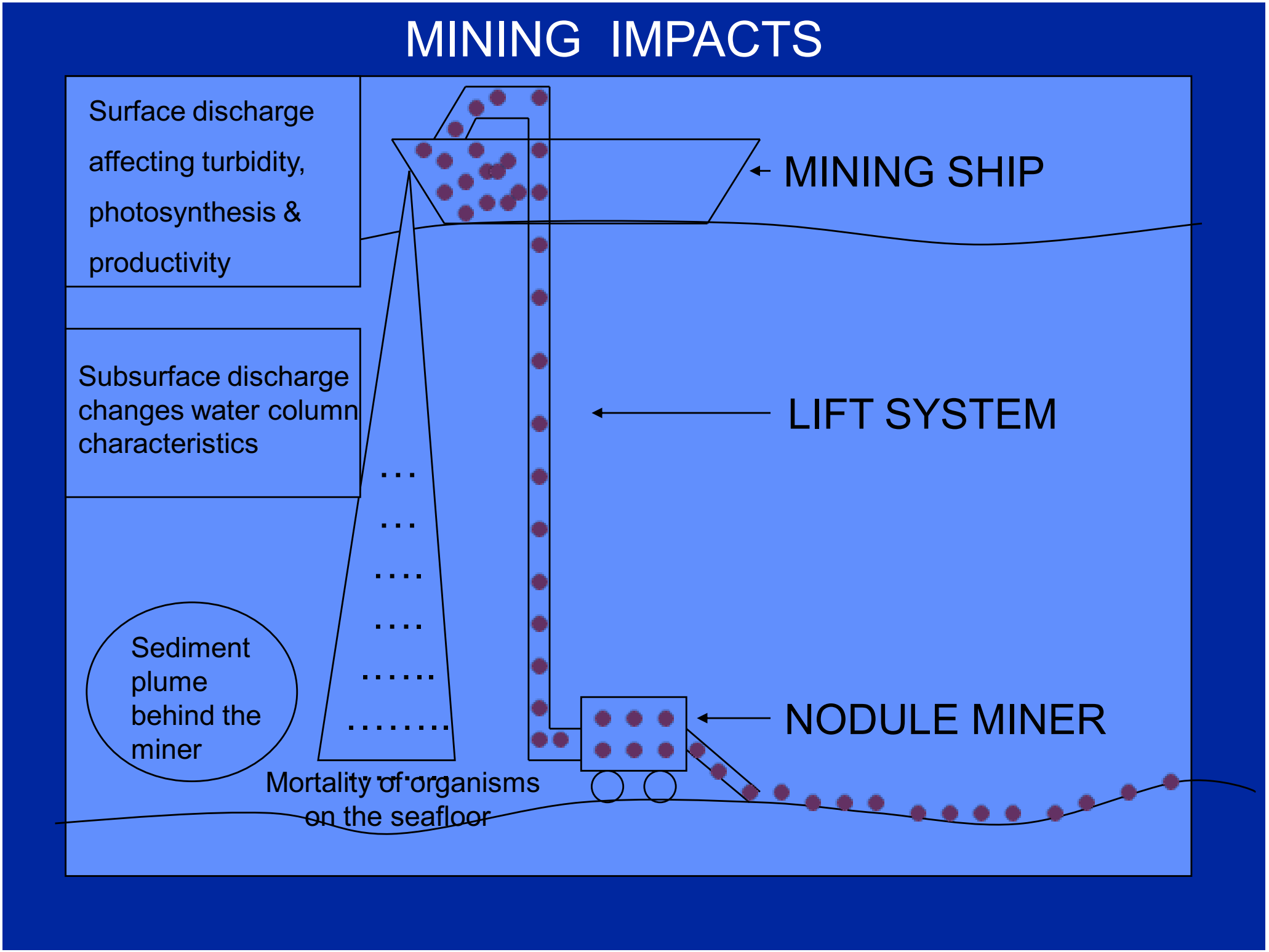
(Credit: NOAA/OAR/OER.
https://oceanexplorer.noaa.gov/okeanos/explorations/ex1605/logs/photolog/welcome.html#cbpi=/okeanos/explorations/ex1605/logs/may2/media/1605activevent.html)

Fauna including deep-sea corals attached to ferro-manganese crust



Credit: NOAA/OAR/OER: https://oceanexplorer.noaa.gov/okeanos/explorations/ex1605/logs/photolog/welcome.html#cbpi=/okeanos/explorations/ex1605/logs/jul12/media/corals.html)

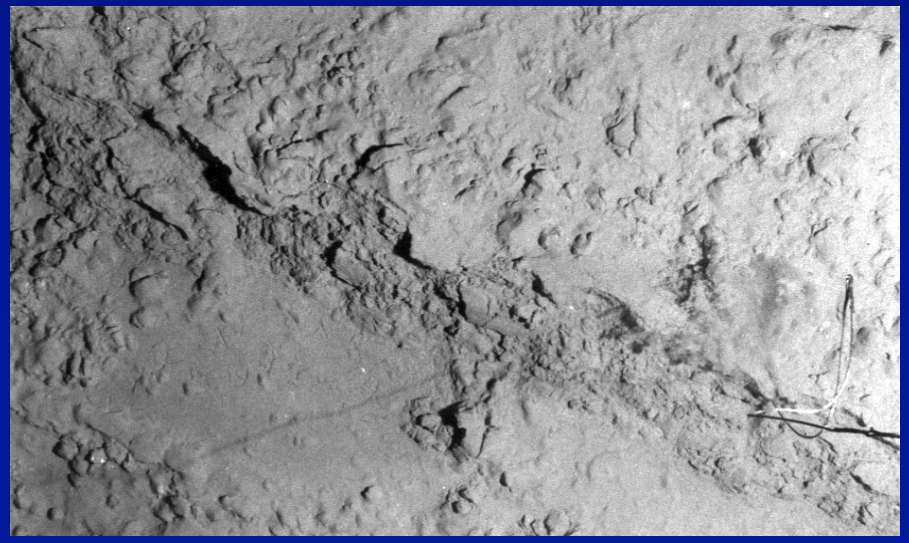
MINING IMPACTS



Potential seafloor impacts

•direct impacts along the track of the nodule collector, where the sediments and associated fauna will be crushed or dispersed in a plume when the nodules are removed

•smothering or entombment of the benthic fauna away from the site of nodule removal, where the sediment plume settles; and clogging of suspension feeders and dilution of deposit-feeders food resources.



Potential water-column impacts

Discharge of tailings and effluent may cause environmental harm to the pelagic fauna:

•mortality of zooplankton species

•impacts on deep-diving marine mammals

•depletion of oxygen by suspended particles

•effects on fish behaviour and mortality caused by the sediments or trace metals

•release of heavy metals (e.g. copper and lead)

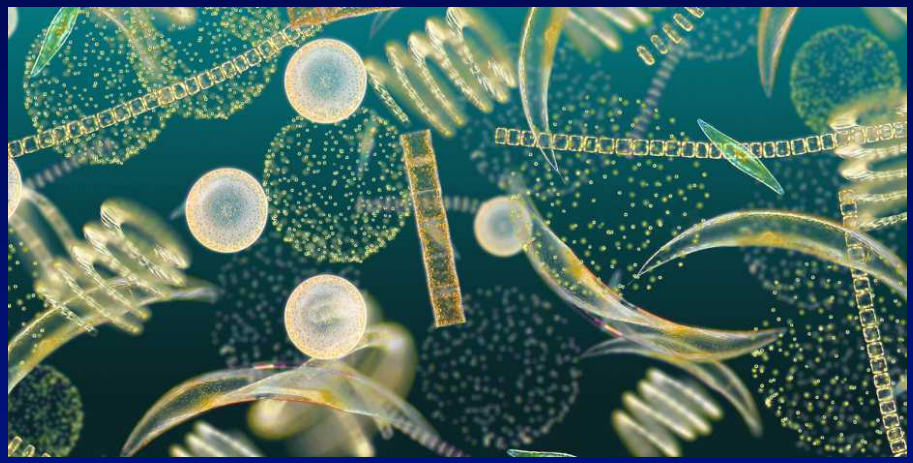
•the possible clogging of zooplankton by particles

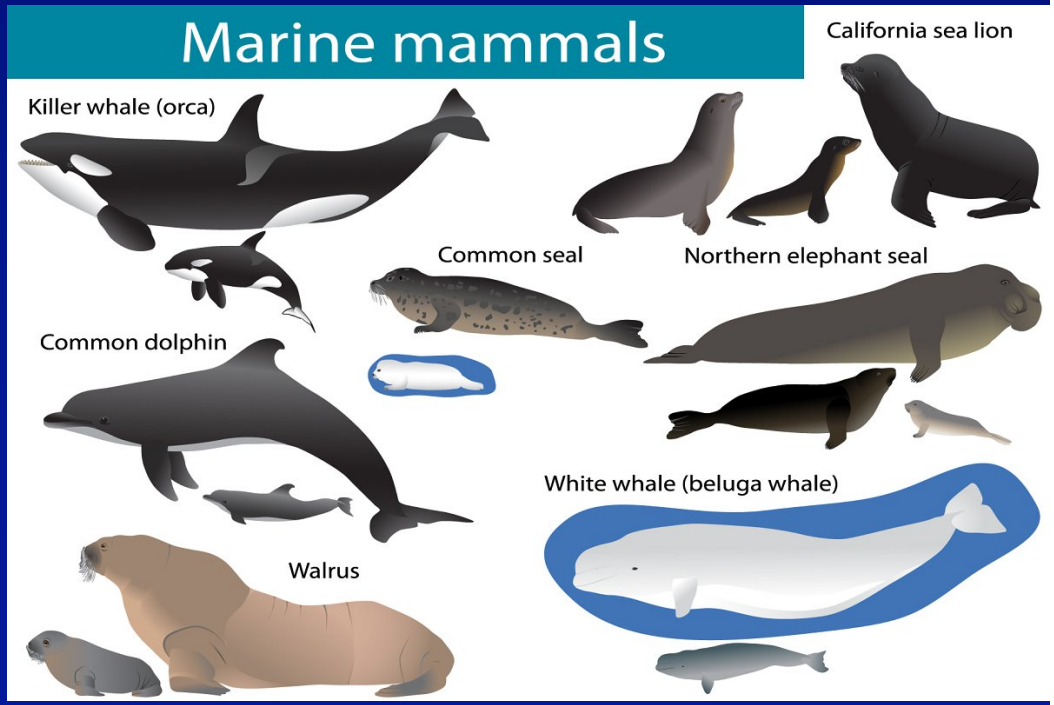
https://www.google.com/search?q=deep-sea+fishes+pictures

Potential upper-water column impacts

If tailings consisting of sediments and other effluent are discharged in near-surface waters

- the potential for trace-metal bioaccumulation
- reduction in primary productivity due to shading of phytoplankton
- effects on phytoplankton from trace metals
- behaviour of marine mammals caused by mining operation





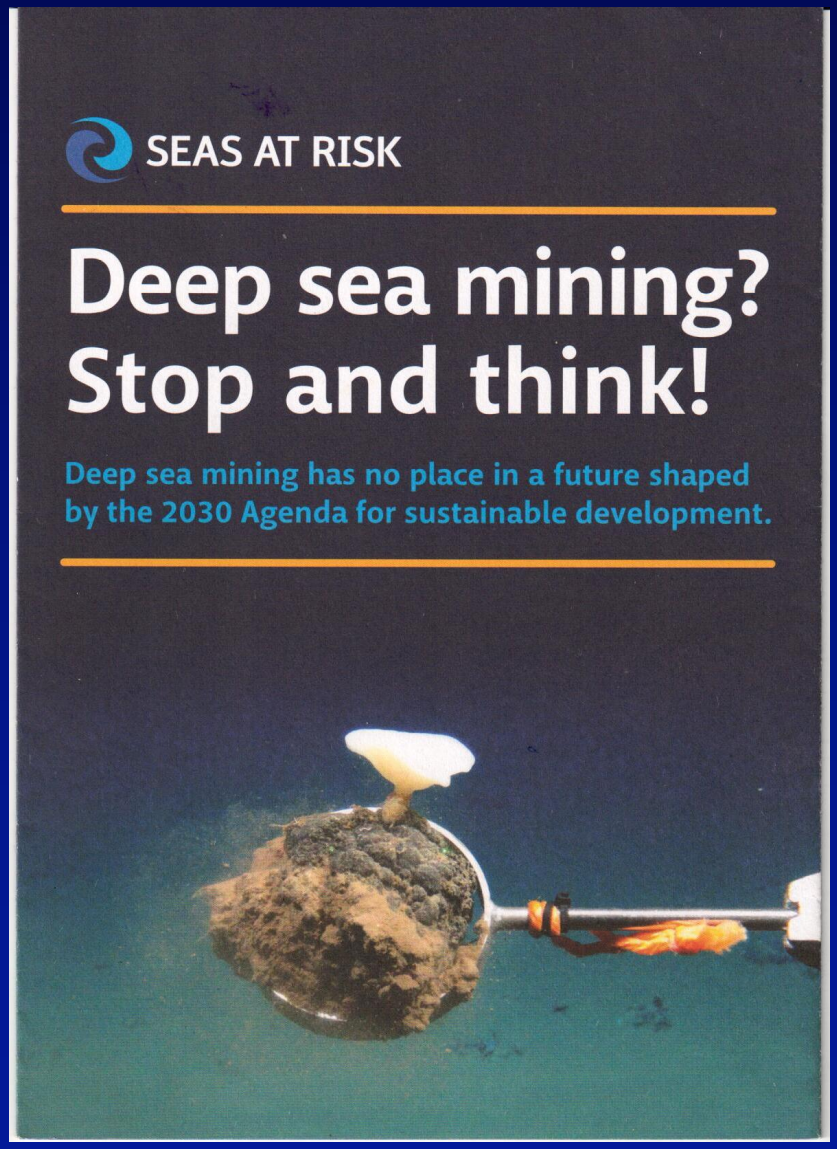
Environmental impacts of different activities

Activity	Seafloor	Water Column	Surface	Land
Collection				
Separation				
Lifting				
Washing				
At-sea processing				
Transport				
Extraction				
Tailing discharge				

Indicates likely impact
Indicates impact not known

(Sharma, 2017)

Anti-mining campaigns



Environmental guidelines for exploration

International Seabed Authority

International Seabed Authority
14-20 Port Royal Street
Kingston
Jamaica

Recommendations for guidance of the contractors for assessment of possible environmental impacts arising from exploration for marine minerals in the Area

ISBA/19/LTC/8 (July 2013)*

- Environmental baseline studies in the proposed mining area
- Environmental impact assessment
- Delineation of impact and reference zones
- Expected environmental impact due to mining
- Critical parameters for monitoring impacts
- Proposed measures to minimize the effects

* Under revision since 2017

Environmental management strategy

- Potential impacts on marine environment
- Which levels of 'harm' are acceptable
- Content of draft regulations
- Legal threshold criteria
- Risk management
- EIA/EIA templates
- EIA roles and responsibilities
- Environmental governance
- EIA for testing of mining equipment
- Monitoring of pilot mining tests
- Regional environmental assessment
- Environmental management plans
- Selection of PRZ and IRZ

International Seabed Authority
14-20 Port Royal Street
Kingston
Jamaica

Draft regulations on exploitation of mineral resources in the Area (ISBA/25/C/WP.1, 22 March 2019)

Part IV : Protection and preservation of the Marine Environment

Section 1 : Obligations relating to the Marine Environment
Development of environmental Standards
Environmental management system

Section 2 : Preparation of the Environmental Impact Statement and Environmental Management and Monitoring Plan

Section 3 : Pollution control and management of waste

Section 4 : Compliance with Environmental Management and Monitoring Plans
Performance assessments of Environmental Management and Monitoring Plan
Emergency Response and Contingency Plan

International Seabed Authority
14-20 Port Royal Street
Kingston
Jamaica

Draft regulations on exploitation of mineral resources in the Area (ISBA/25/C/WP.1, 22 March 2019)

Annexes

I. Application to obtain an exploitation contract
II. Mining Workplan
III. Financing Plan
IV. Environmental Impact Statement
V. Emergency Response and Contingency Plan
VI. Health and Safety Plan and Maritime Security Plan
VII. Environmental Management and Monitoring Plan
VIII. Closure Plan
IX. Exploitation contract and schedules
X. Standard clauses for exploitation contract

International Seabed Authority
14-20 Port Royal Street
Kingston
Jamaica

Draft regulations on exploitation of mineral resources in the Area (ISBA/25/C/WP.1, 22 March 2019)

Annex IV : Environmental Impact Statement - Template

1. Introduction
2. Policy, legal and administrative context
3. Description of the proposed development
4. Description of the existing physicochemical environment
5. Description of the existing biological environment
6. Description of the existing socioeconomic environment
7. Assessment of impacts on the physicochemical environment and proposed mitigation
8. Assessment of impacts on the biological environment and proposed Mitigation
9. Assessment of impacts on the socioeconomic environment and proposed mitigation
10. Accidental events and natural hazards
11. Environmental management, monitoring and reporting

.....

Safe Mining Methods

- Minimize sediment penetration of collector and mining vehicle
- Reduce mass of sediment swirled up into the bottom near-water layer
- Induce high rate of re-sedimentation from the plume behind the miner
- Minimise the transport of sediment and abraded nodule fines to the ocean surface
- Reduce the discharge of tailings into the bathyal or abyssal depth
- Reduce the drift of tailings by increasing their sedimentation

Mitigation of impacts - Exploration

Activity	Place of impact	Type of impact	Magnitude of impact	Mitigation guidelines
Cruising	Atmosphere, Sea surface, Water column, Seafloor	Emissions, noise, heated water, oil, garbage (plastics, metal, glass, chemicals), human waste	Minor	As per SOLAS and MARPOL guidelines
On-board data collection	Atmosphere, Sea surface	Impacts on humans and marine animals due to propagation of waves through air and water	Minor	As per SOLAS guidelines (chapter 4)
Sample collection	Water column, Seafloor	Physical disturbance, chemical reactions, changes in faunal abundance and diversity, alteration in seafloor micro topography	Minor	As per MARPOL and ISA guidelines

Mitigation - Mining

Activity	Place of impact	Type of impact	Magnitude of impact	Mitigation guidelines
Cruising	Atmosphere, Sea surface, Water column, Seafloor	Emissions, noise, heated water, oil, garbage (plastics, metal, glass, chemicals), human waste	Medium	As per SOLAS and MARPOL guidelines
Deployment & Operation of Equipment	Surface, Water column, Seafloor	Physical disturbance, chemical reactions, changes in faunal abundance and diversity, alteration in seafloor micro topography	Major	Minimum sediment penetration, avoid leakage / spillage, discharge below oxygen minimum zone, treat tailings before discharge
Ore transfer	Surface, Water column, Seafloor	Turbidity, mixing of sediments, alteration in faunal assemblage	Medium	As per SOLAS and MARPOL guidelines
Transport	Atmosphere, Sea surface, Water column, Seafloor	Emissions, noise, heated water, oil, garbage (plastics, metal, glass, chemicals), human waste	Medium	As per SOLAS and MARPOL guidelines
At-sea pre processing	Surface, Water column, Seafloor	Turbidity, mixing of sediments, alteration in faunal assemblage	Medium to Major	As per SOLAS and MARPOL guidelines
Power generation (nuclear, solar or ocean thermal)	Surface, Water column, Seafloor	Alteration in the physico-chemical conditions, waste disposal	Medium to Major	As per SOLAS and MARPOL guidelines

Mitigation - Processing

Activity	Place of impact	Type of impact	Magnitude of impact	Mitigation guidelines
Transportation	Land, Air	Emissions, noise, dust	Minor to Medium	As per National guidelines
Storage	Land, Air, Water	Growth of microbes and chemical alteration	Minor to Medium	As per National guidelines
Washing/pre-processing	Land, Air, Water	Leaching of clay particles, nodule fragments and massive microbes	Minor	As per National guidelines
Extraction	Land, Air, Water	Addition of chemicals and reagents to the environmental resources	Medium to Major	As per National guidelines
Waste Disposal	Land, Air, Water, Sea	Addition of slag to the environment	Major	As per National guidelines

Environmental Management Plan

For integrating and implementing the environmental management commitments, conditions, and statutory requirements that development proposals may or must observe

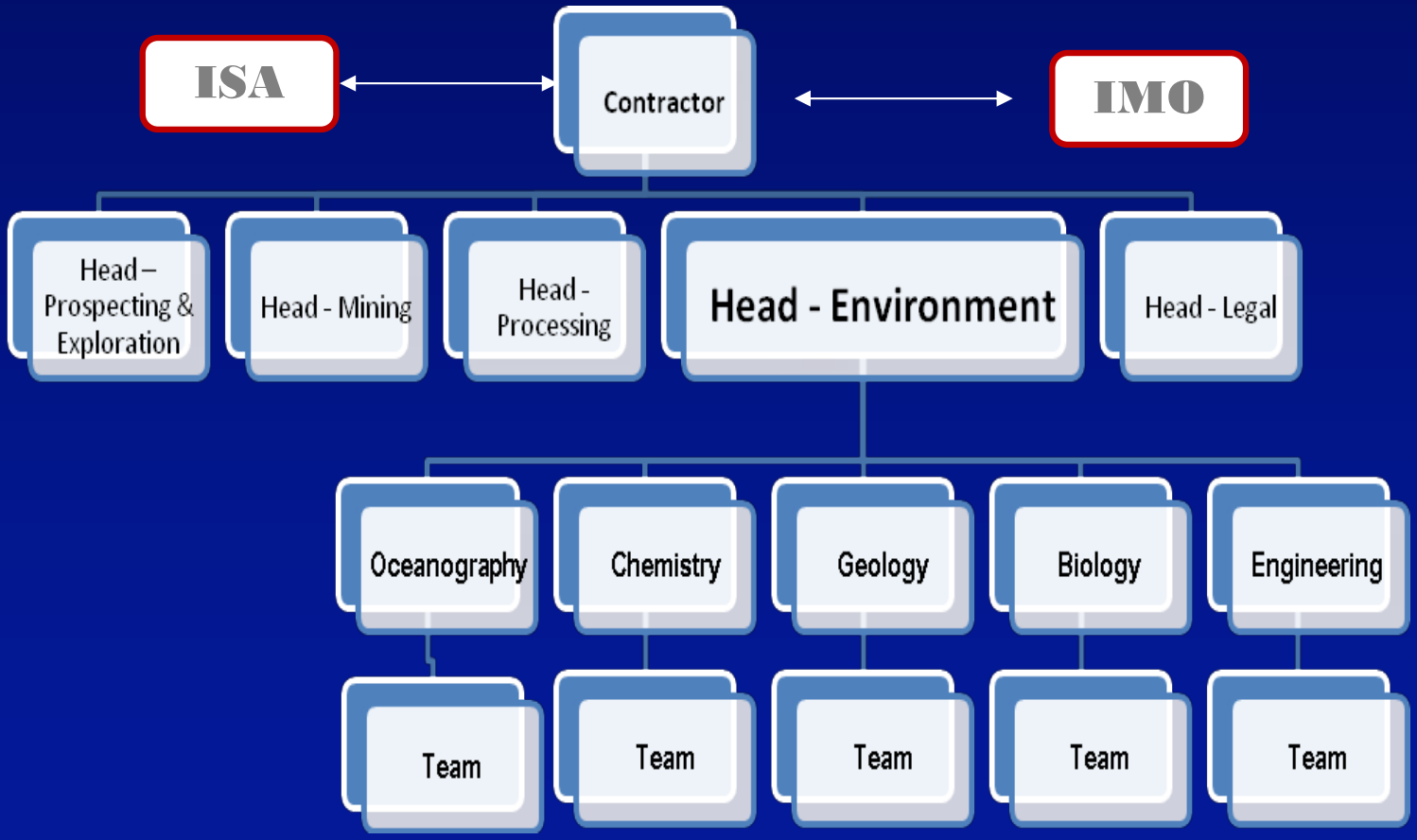
Components of an EMP

- ❖ Need for the proposed activity
- ❖ Mining design and potential impacts
- ❖ Detailed monitoring programme
- ❖Suggest mitigation measures
- ❖Apply relevant guidelines
- ❖Institutional arrangements
- ❖Implementation schedule and reporting procedures

Agencies	Role
International Seabed Authority	Regulatory agency; guidelines for environmental monitoring
International Maritime Organization	Shipping regulations , MARPOL regulations
Local Government	Environmental regulations for coastal and land based operations

Environment Management Office

To implement the EMP, monitor the environmental parameters and update the EMP by reviewing it periodically






Thank You

(rsharma@nio.org)