
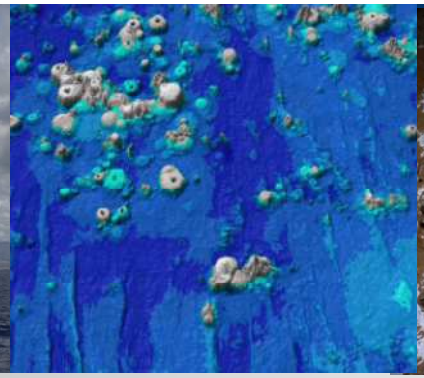


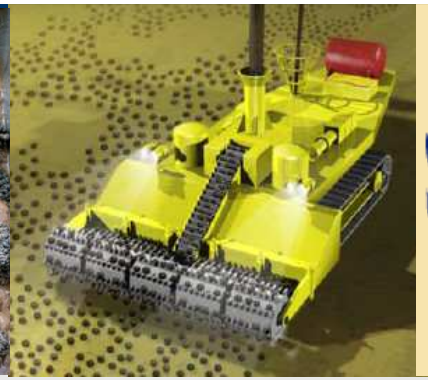

Deep-sea mining of mineral resources – chances and challenges of a new field with economic potential

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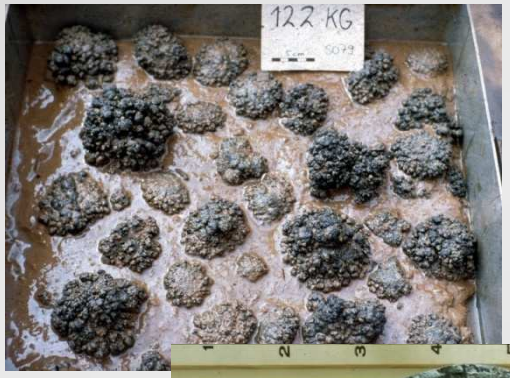
Hannover, Germany

Deep sea mineral resources

- **Mn nodules**
  (Ni, Cu, Co)



4000 - 6000 m

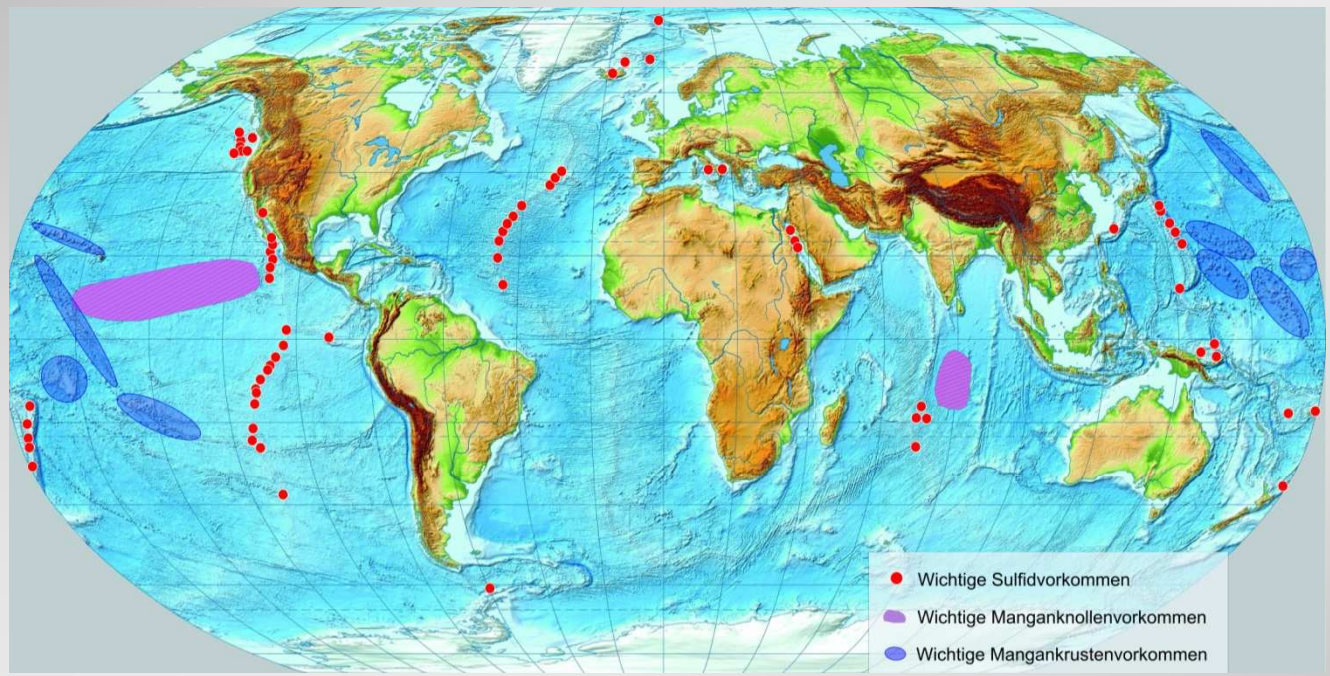
- **Co-rich crusts**
  (Co, Ni, Pt..)

1000 - 2500 m

- **polymetal. sulfides**
  (Cu, Zn, Pb, Au)

1000 - 3000 m

Distribution of deposits



- **Mn nodules: deep ocean basins**
- **Crusts: seamounts (W-Pazifik)**
- **Sulfides: mid-ocean ridges**

Arguments for deep sea exploration

- **New additional deposits**

  enlargement of resources

- **„High Sea“ (long-term contracts with ISA)**

  contribution to stability of supplies

- **Technology**

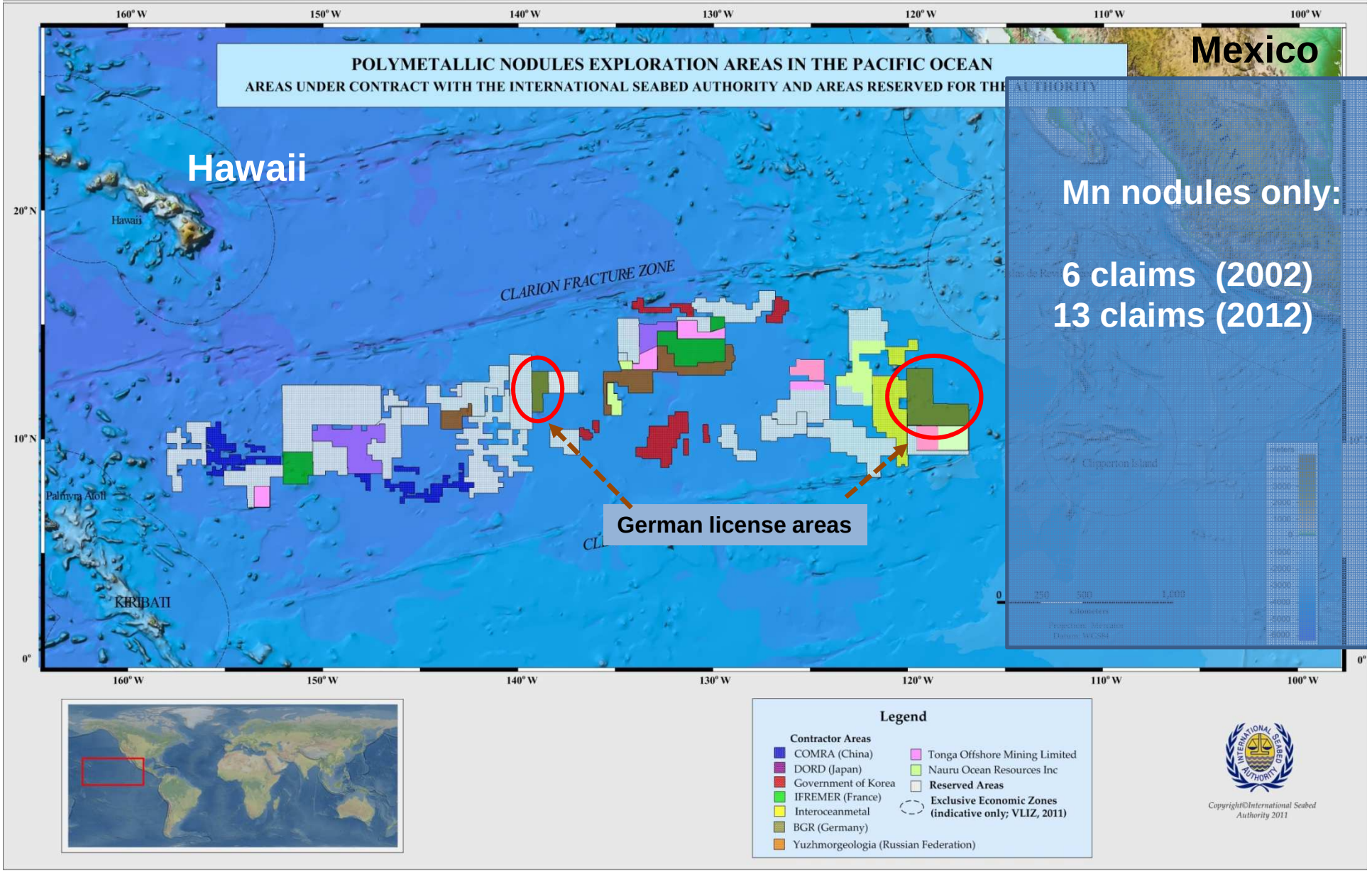
  prospects for high-tech economies

1994: UNCLOS in effect

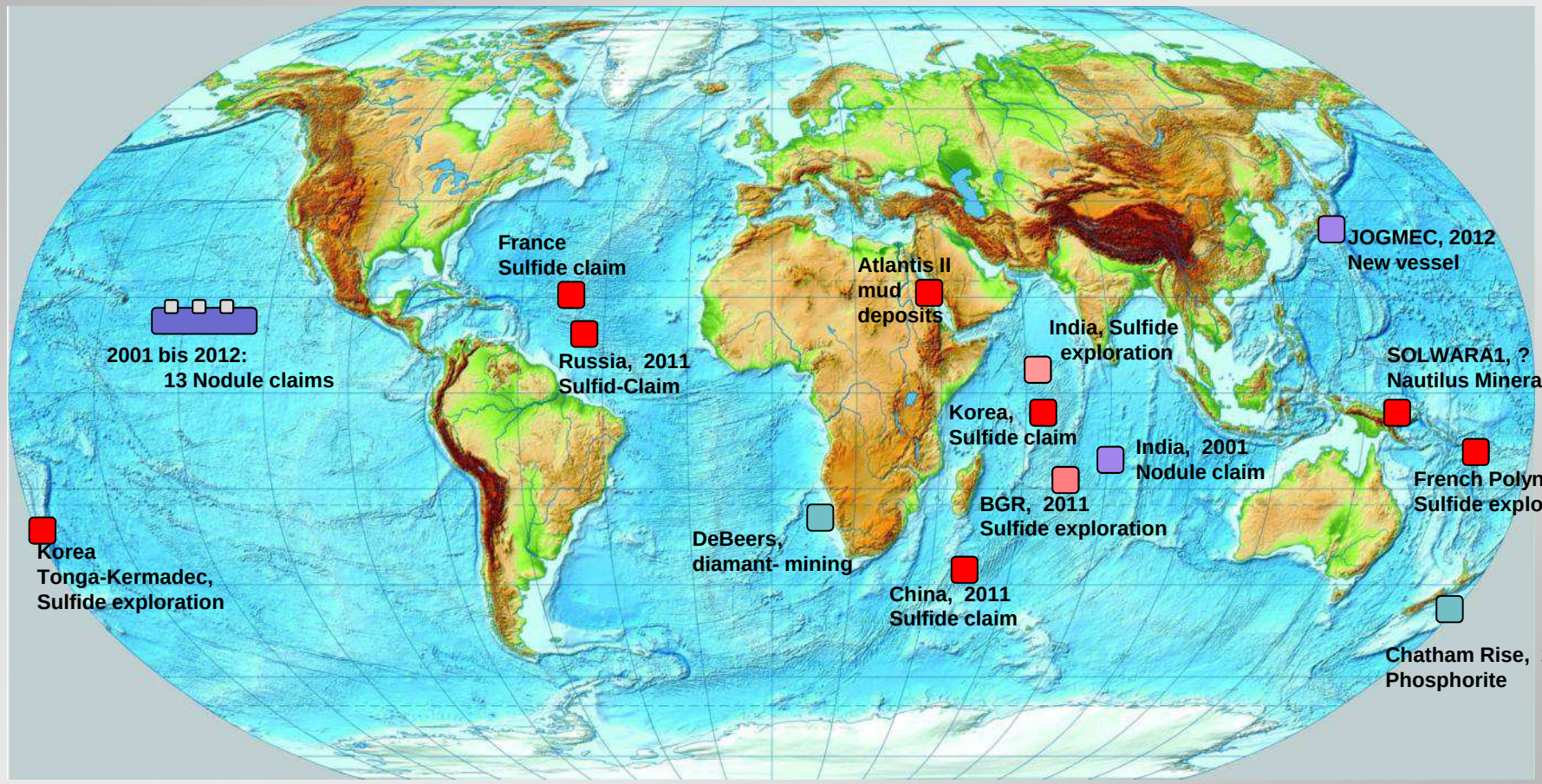
- Foundaton of ISA

- ISA managing seabed resources
- Regulations for prospecting and for mining

Mn nodules license areas



International trends



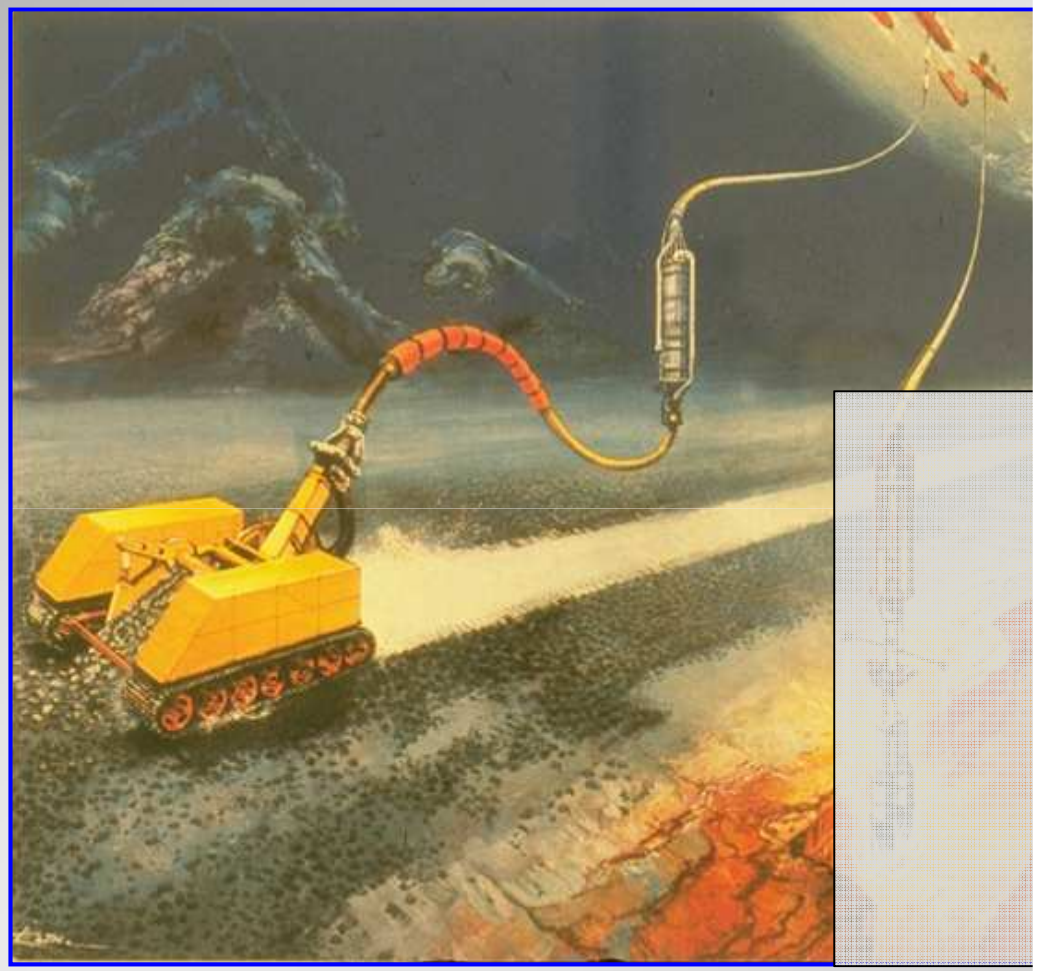
Trends in marine mineral exploration: Claims, explorations, etc.

Exploration contract

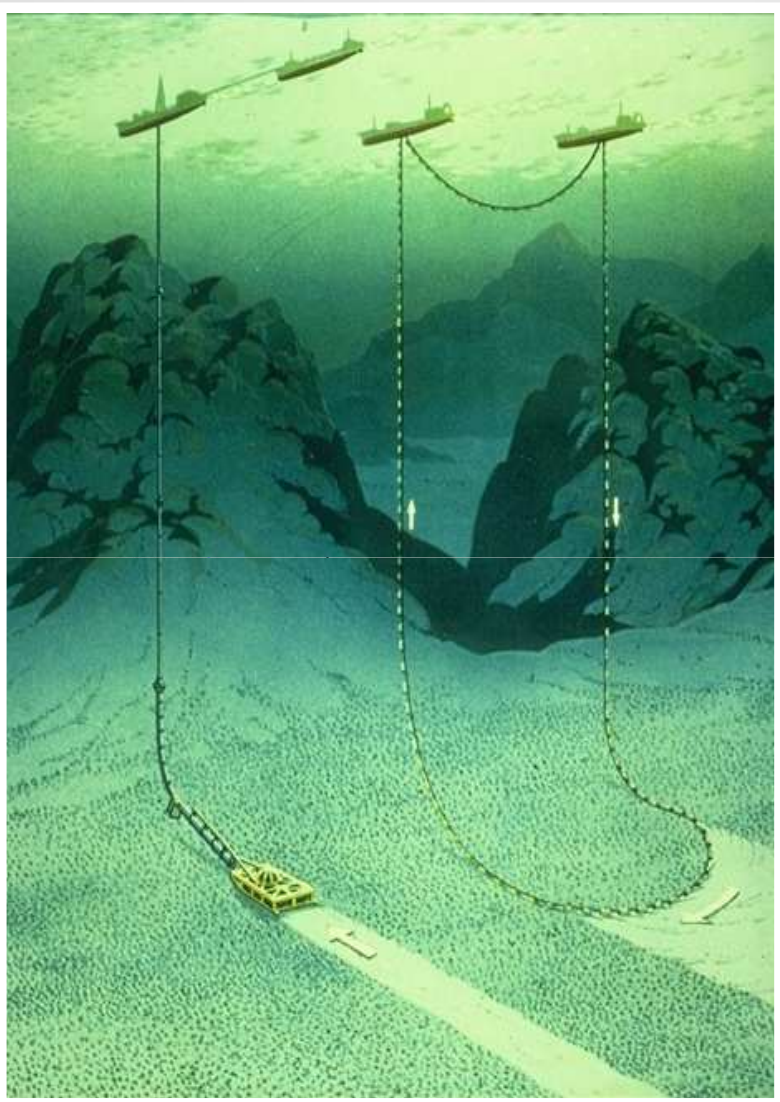
!presently exploration – no mining!

- **Duration: 15 years** (exploration)
  work program including test of equipment/ mining
- **Sustainable**
  limit impact on environment
- **Area: 75,000 km²** (Mn nodules)
  10,000 km² (sulfides)

Concept of 1984



self propelled nodule collector

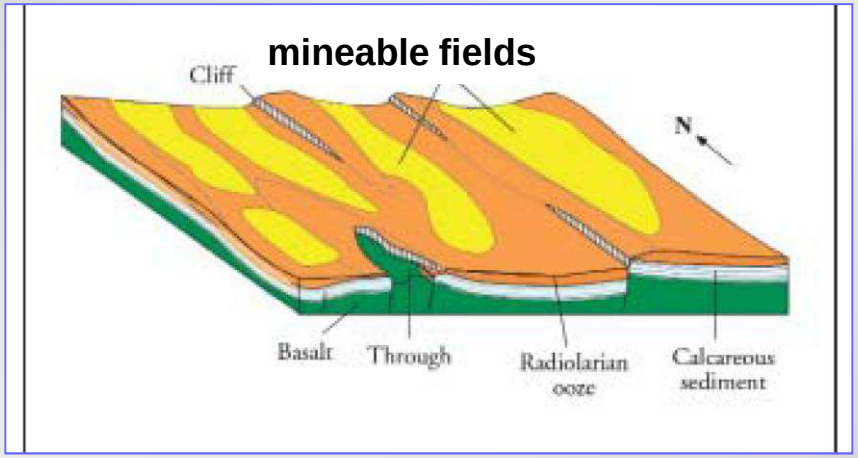


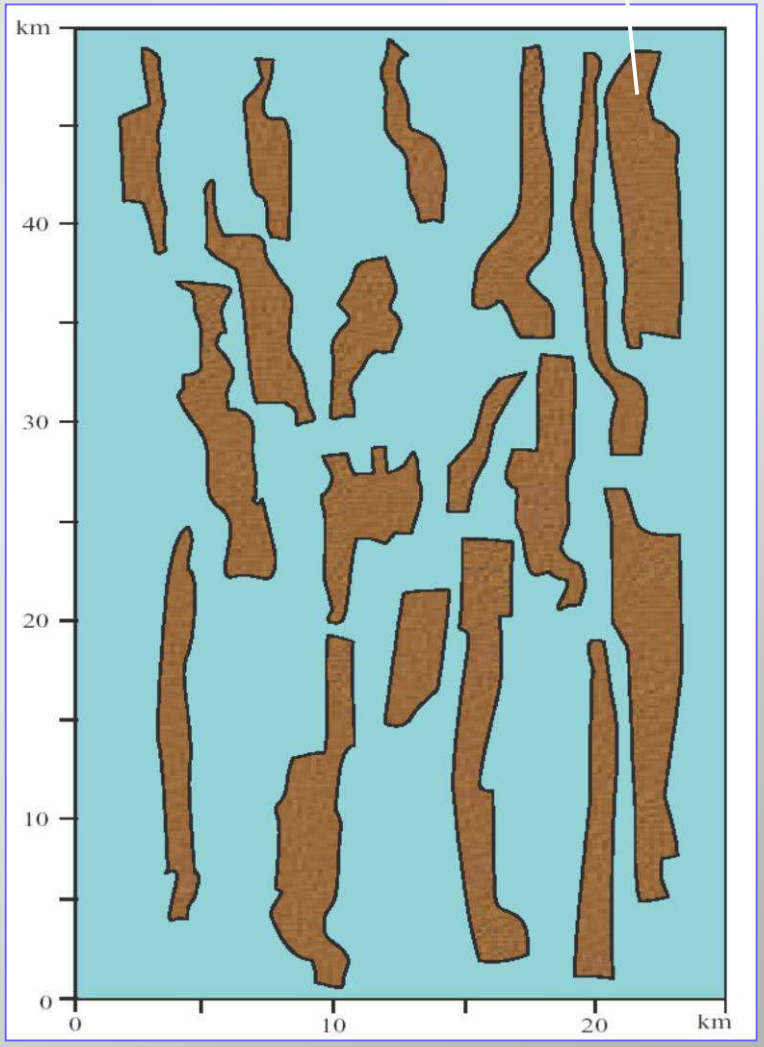
Mn nodules: prospective areas

Sea floor topography of mining areas:

Slope inclination and escarpments greatly reduce area suitable for mining

an estimated 30% remain



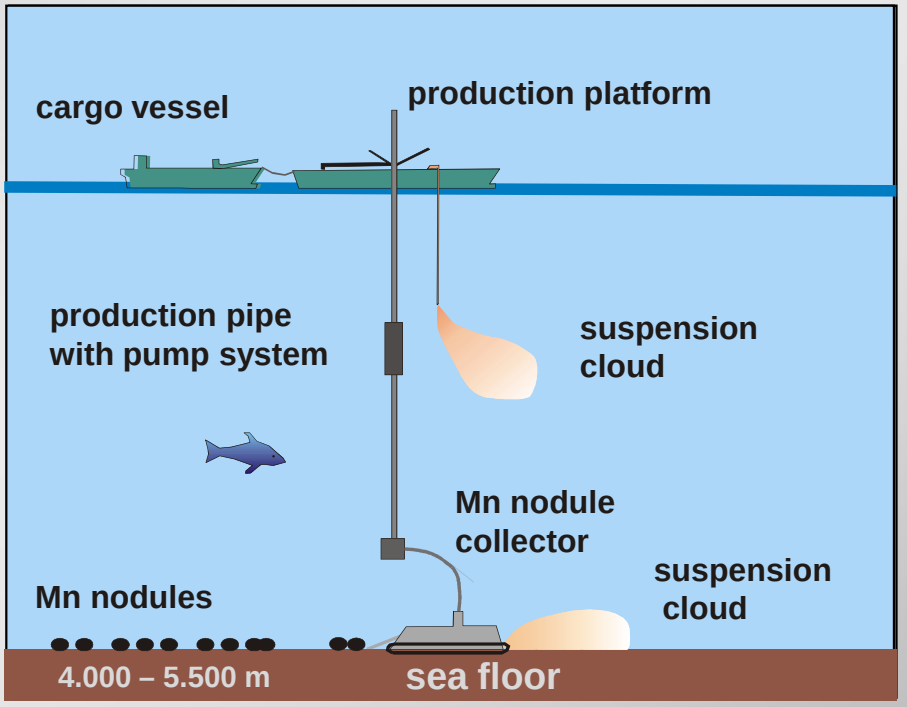


Environmental questions

Important aspects:

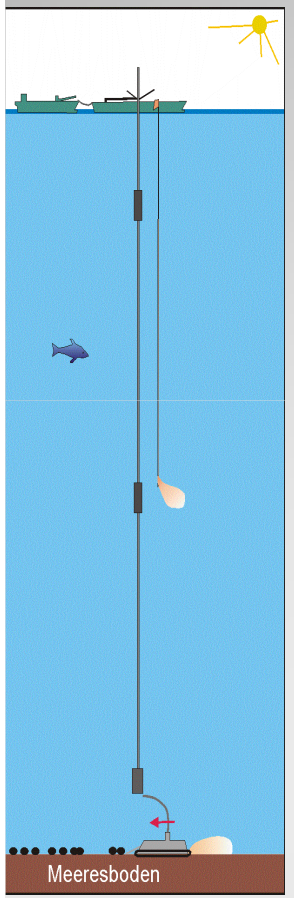
- Suspension cloud
- Huge size of affected area
- Extraction of hard substrate

effect on biodiversity



Based on the UNCLOS, any decision on mining requires a sustainable approach.

Concept for mining technology



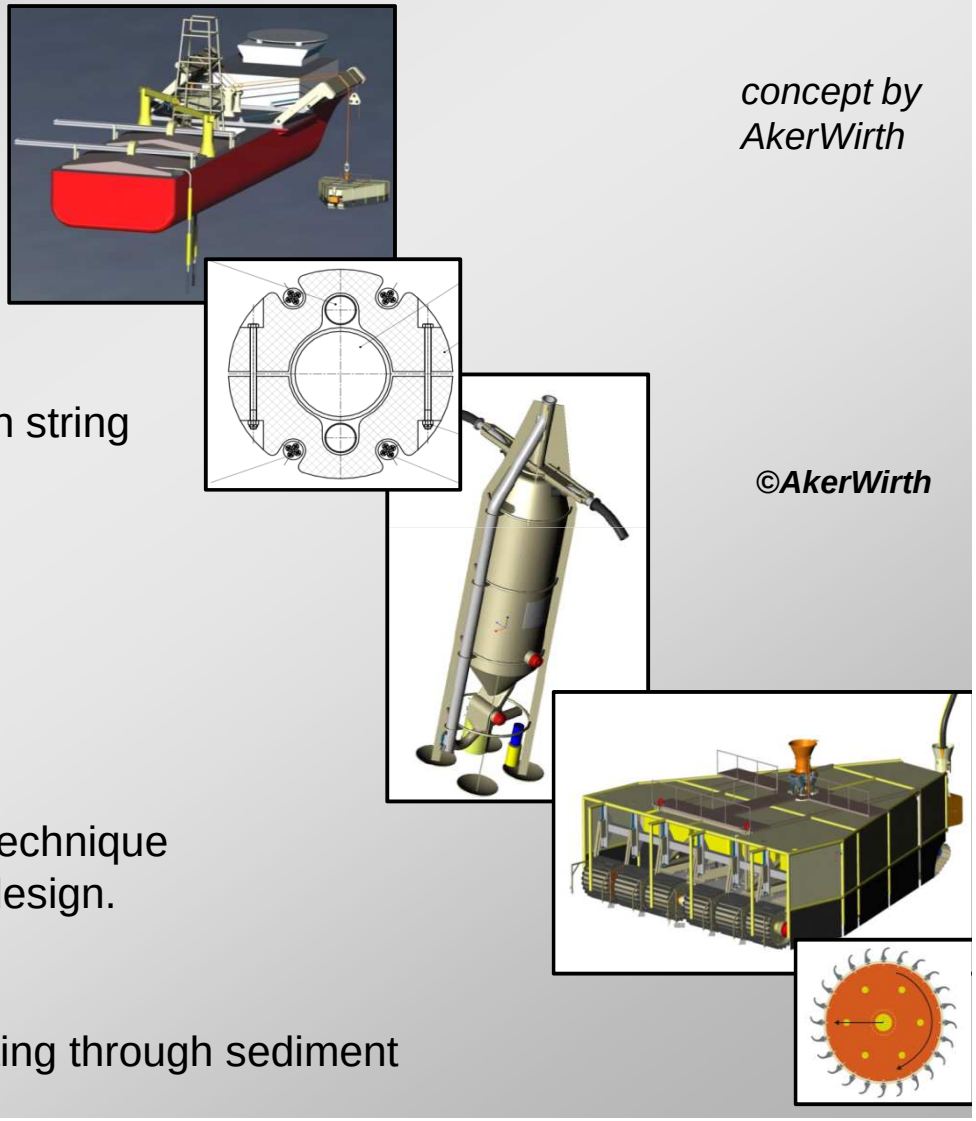
mining platform
lifting gear, buffer, …

riser pipe
suspension design, air lift, incl.
energy supply and communication string

buffer
for continuous lifting process,
clogging prevention

collector
self propelled, extensive sensor technique
at collector drum, encapsulated design.

collector drum
floating, variable steel fingers cutting through sediment

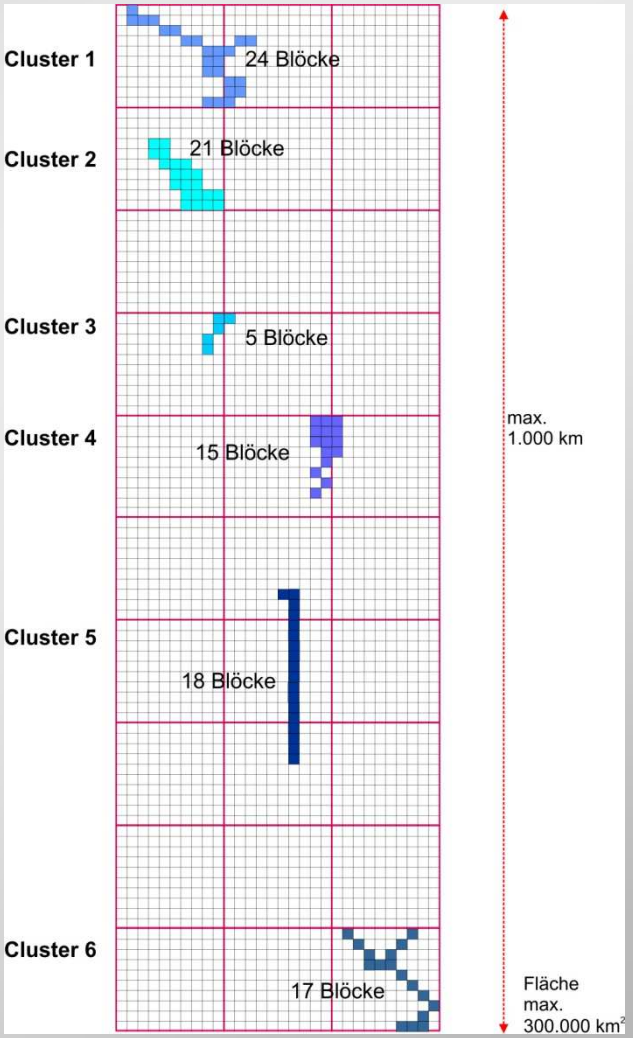


concept by AkerWirth

Example: sulfide claim

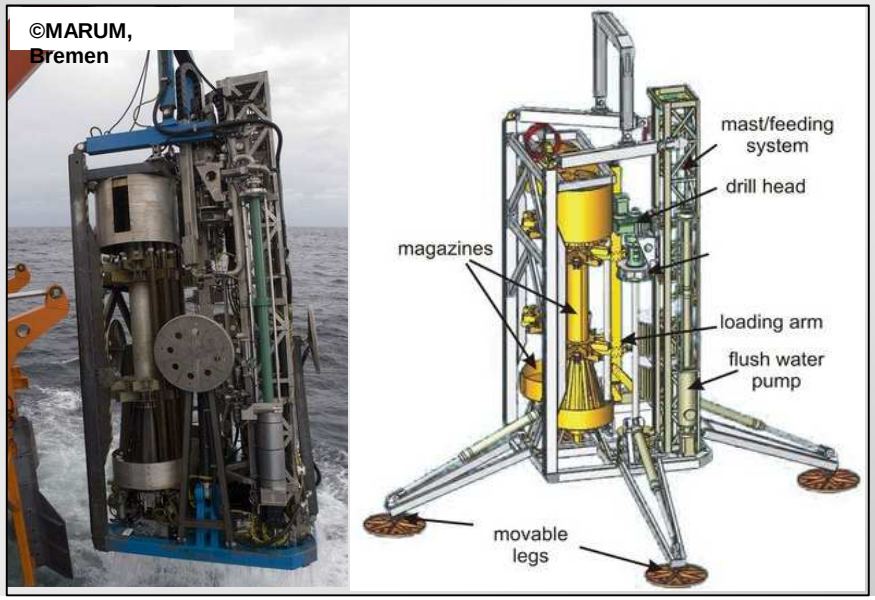
Important aspects:

- Explore > 100 blocks
- Deposits are small and in part subbottom
- Rough terrain in rocky surrounding



Sulfide exploration needs drilling

- **Challenge**:
  deposits can only be evaluated, if drilling indicates presence of subbottom resources.
- **Problem**:
  too deep to use existing devices



Drilling device From ROVDRILL (see SEAFLOOR Geoservices)

Mining Technology Massive Sulfides

Seafloor production system for marine polymetallic sulfides

see
Nautilus Minerals

©Nautilus Minerals Inc.

Cutting device
see
Nautilus Minerals

Problem:

- **Concept only - no existing devices**
- **Begin of mining at SOLWARA postponed**
- **Not designed to be used for deposits at high seas (=> 3-4 km water depth)**

Existing demand

Exploration:

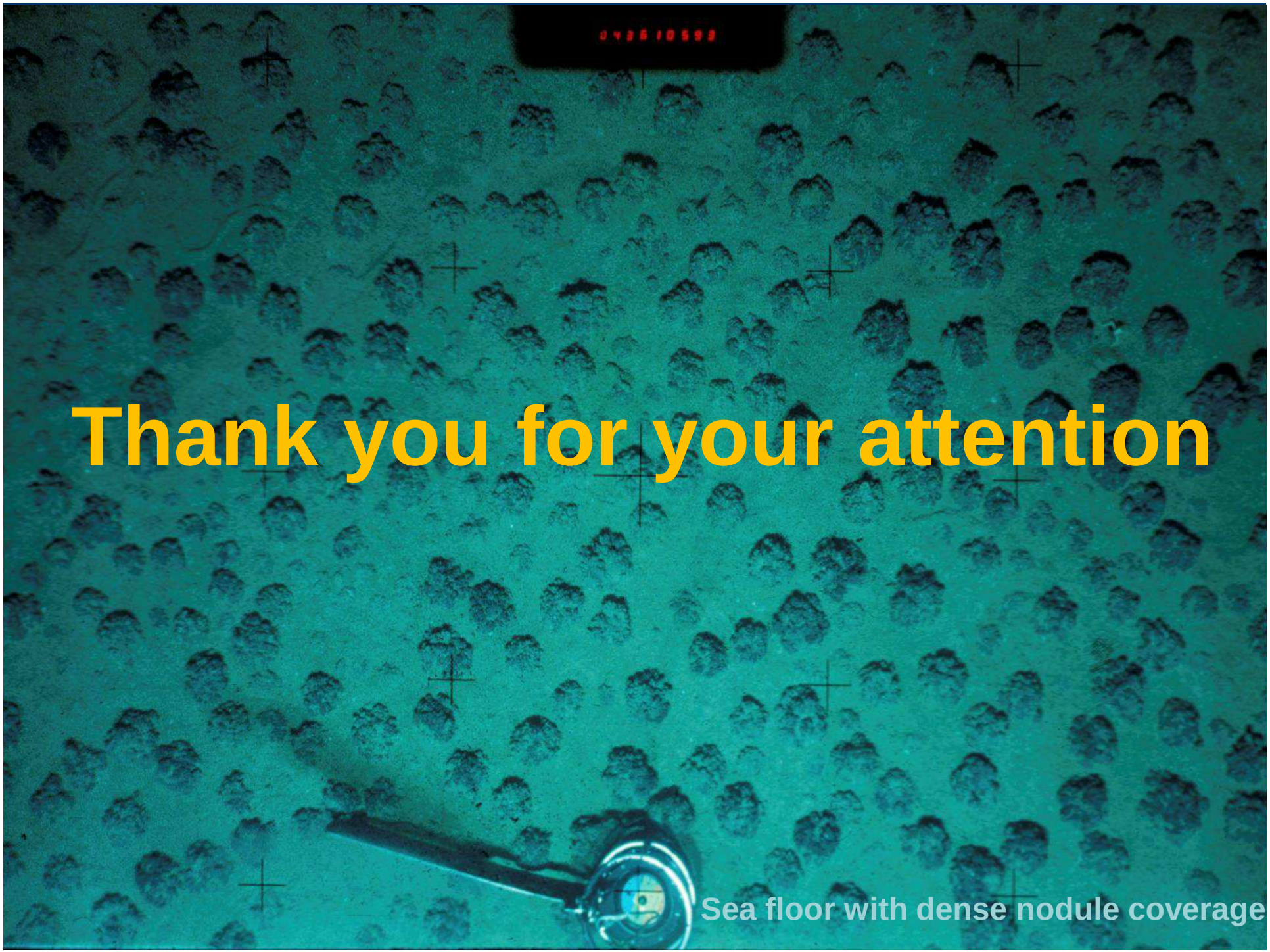
- high-resolution mapping, hard-rock drilling (deep tow, AUV,ROV)
- long lasting deep-sea energy supply, communications
- monitoring, long-term stations

Mining:

- construction of (proven) mining technology;
- mining vessel, transport barges;
- Metallurgical processing to be designed;

Summary

- **Mineral deposits are present**
- **Global trend towards marine claims**
- **Challenges:** proven technology for mining, sustainability (limiting impact), (metallurgical process)
- **Chances (technology):**
  Exploration: enduring exploration tools, sensor techniques, AUVs for large depth, deep marine energy supply…
  Mining: enduring and sustainable mining equipment (collector, riser, mining vessel; environmental monitoring equipment,)
- **Future market is quickly evolving, recognize options**


Thank you for your attention
Sea floor with dense nodule coverage