# Deep water non-living marine resources

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# Scope of the work

- Definition of the area
- Description of potential resources
- Technical feasibility of recovery
- Evaluation of economical aspects

# EEZ / CS / The Area

- UNCLOS Articles
- Generic resource exploitation
- Significance for coastal state
- ISBA

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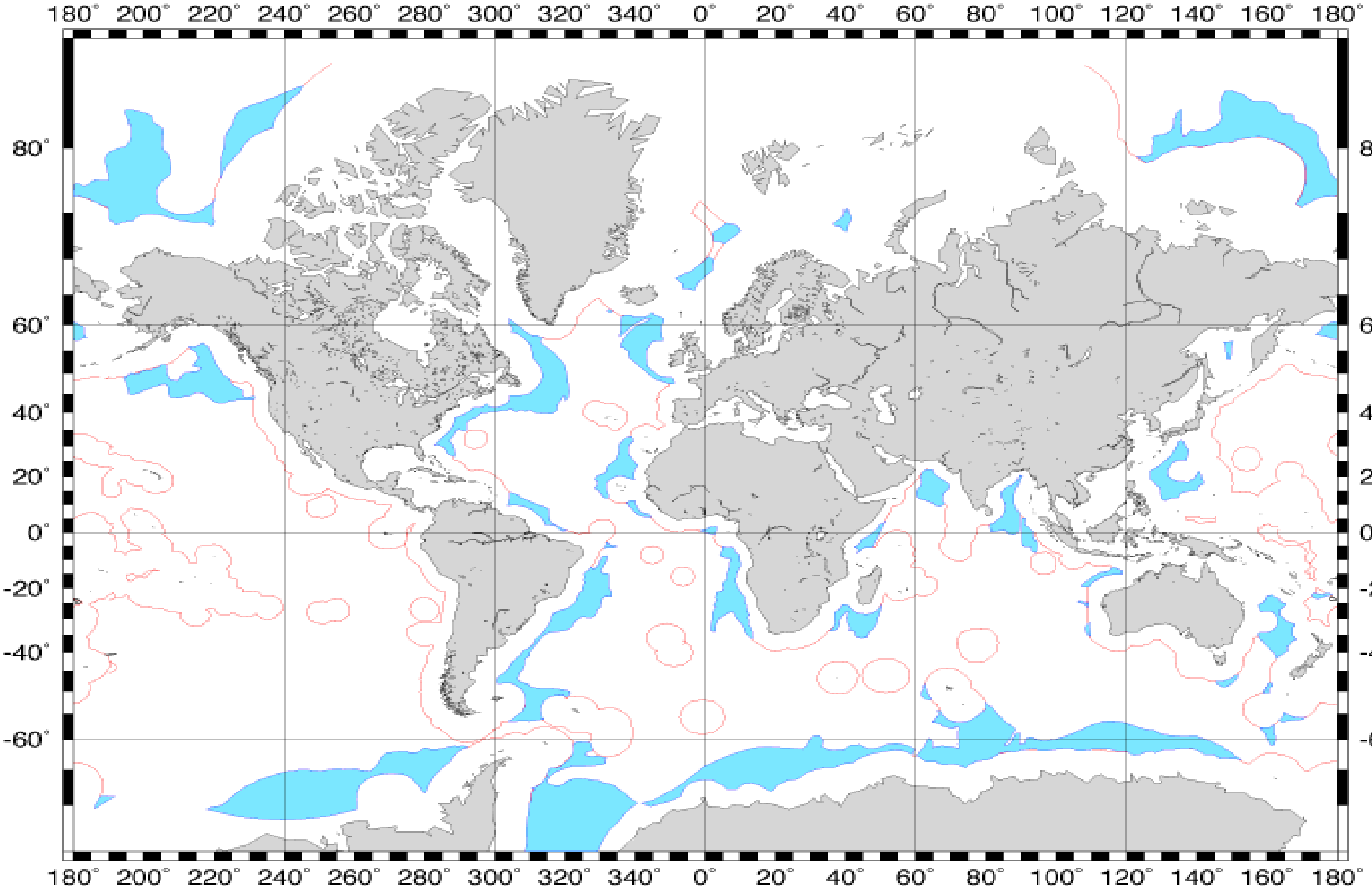


Map showing 200 nautical mile limit boundaries (in red) from coastal base-lines and potential areas of extended continental shelf (in blue) based on paramaters set by the United Nations Convention on the Law of the Sea, Article 76. These are potential boundaries, used here as a giude, and are in no way meant to be difinitive or final.

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# The nature of the ocean floor

- Between 100s and 1000s m water depth
- Shelf, slope and rise
- Several 100s km from land

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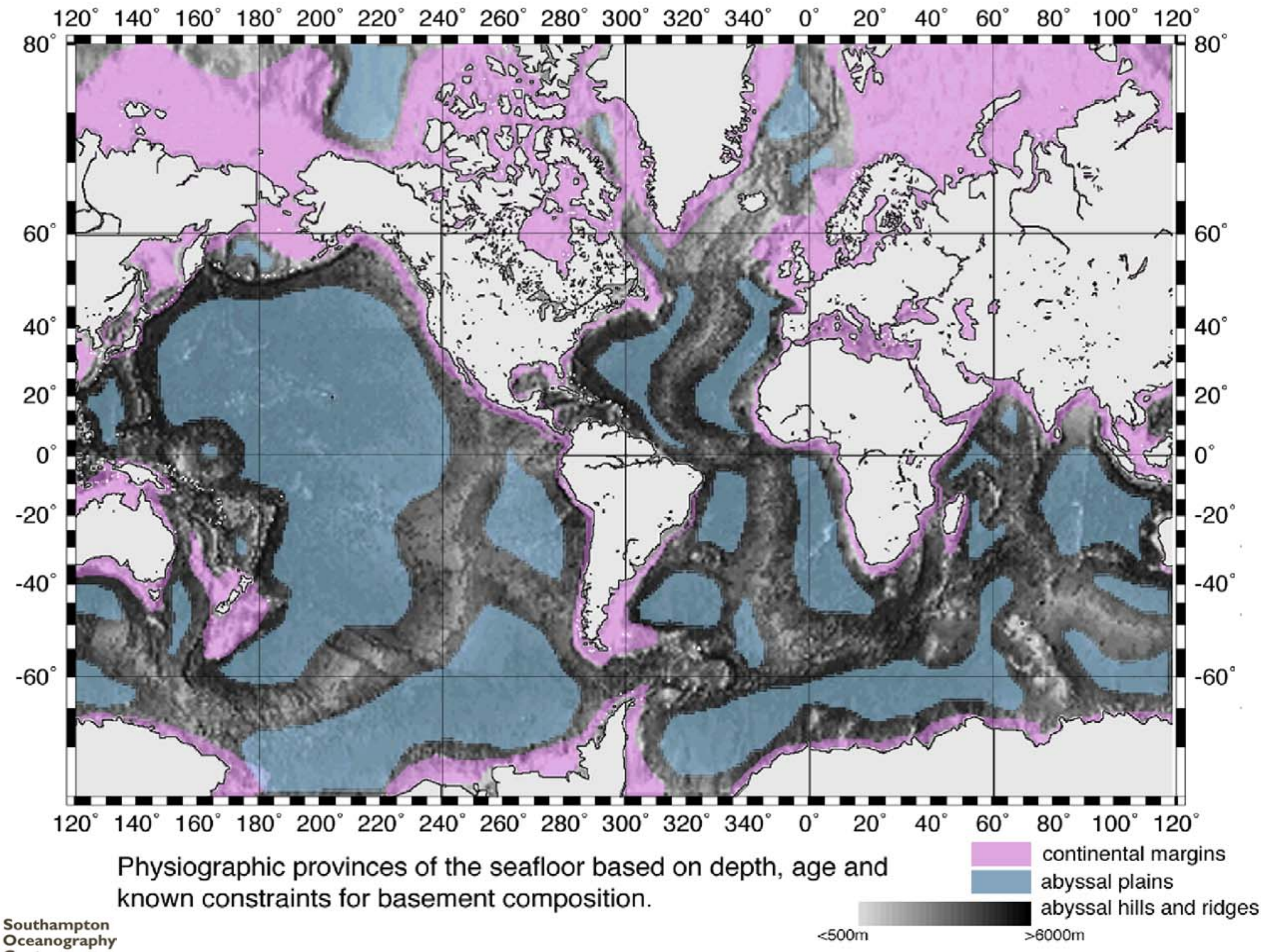


Physiographic provinces of the seafloor based on depth, age and known constraints for basement composition.

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# Description of potential resource

- Definitions
- Individual deposits

# Resource/Reserve

- Progress in exploration, technology and economic conditions
- Reserves = abundance
- Resources = potential
- Para-marginal and Sub-marginal

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# Description of potential resources

- Placer deposits
- Phosphorite deposits
- Evaporite deposits
- Polymetalic sulphides
- Manganese nodules and crusts
- Hydrocarbons
- Gas hydrate
- Aggregate, Coral
- Living resources

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# Placer deposits

- Detrital metallic or gem minerals
- Predominantly near-coast
- High value

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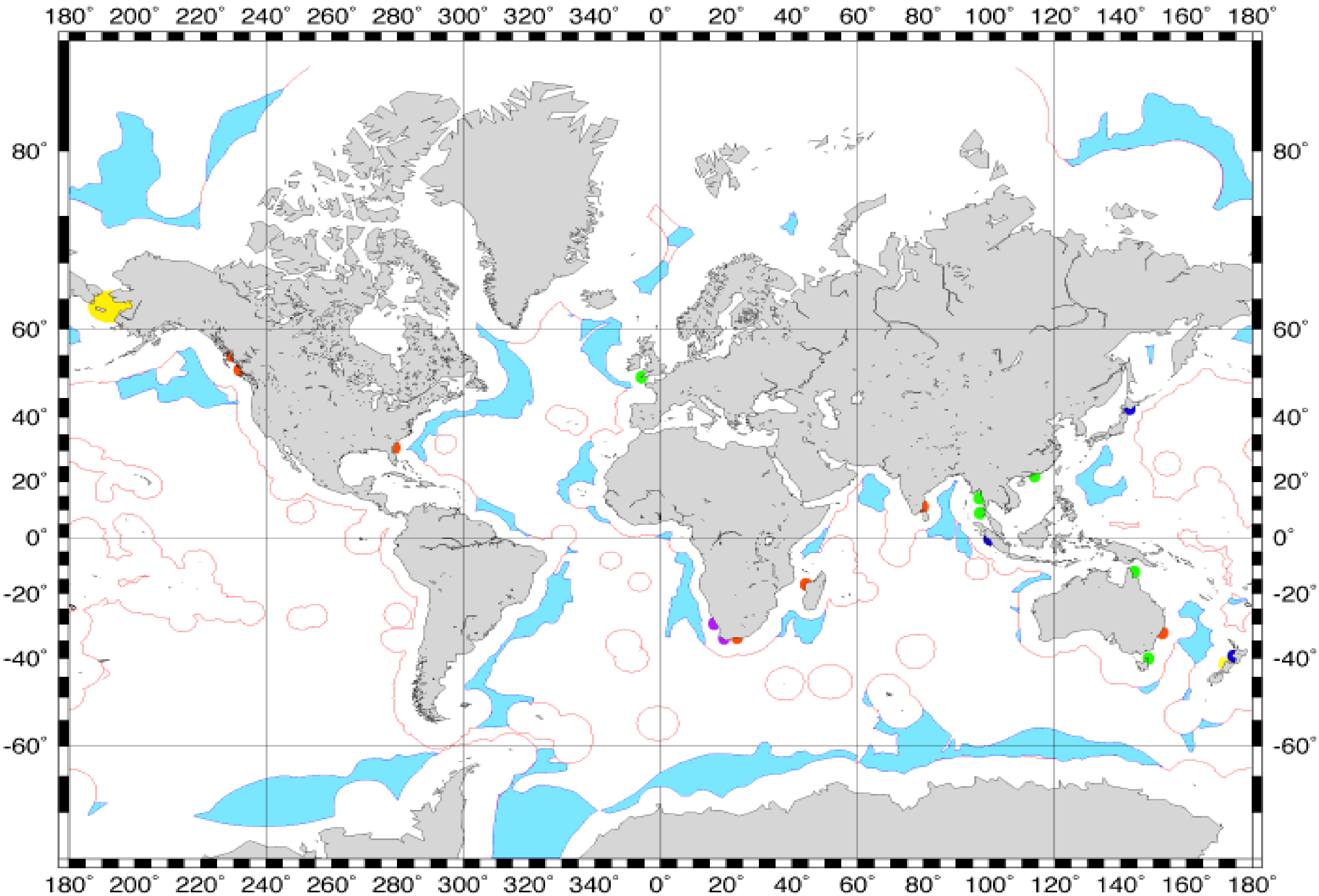


Map showing known localities of marine placer deposits.

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gold

diamonds

tin

titanium

iron (magnetitte)

# Phosphorite deposits

- Upwelling areas
- Medium water depths
- Large reserves
- Low value

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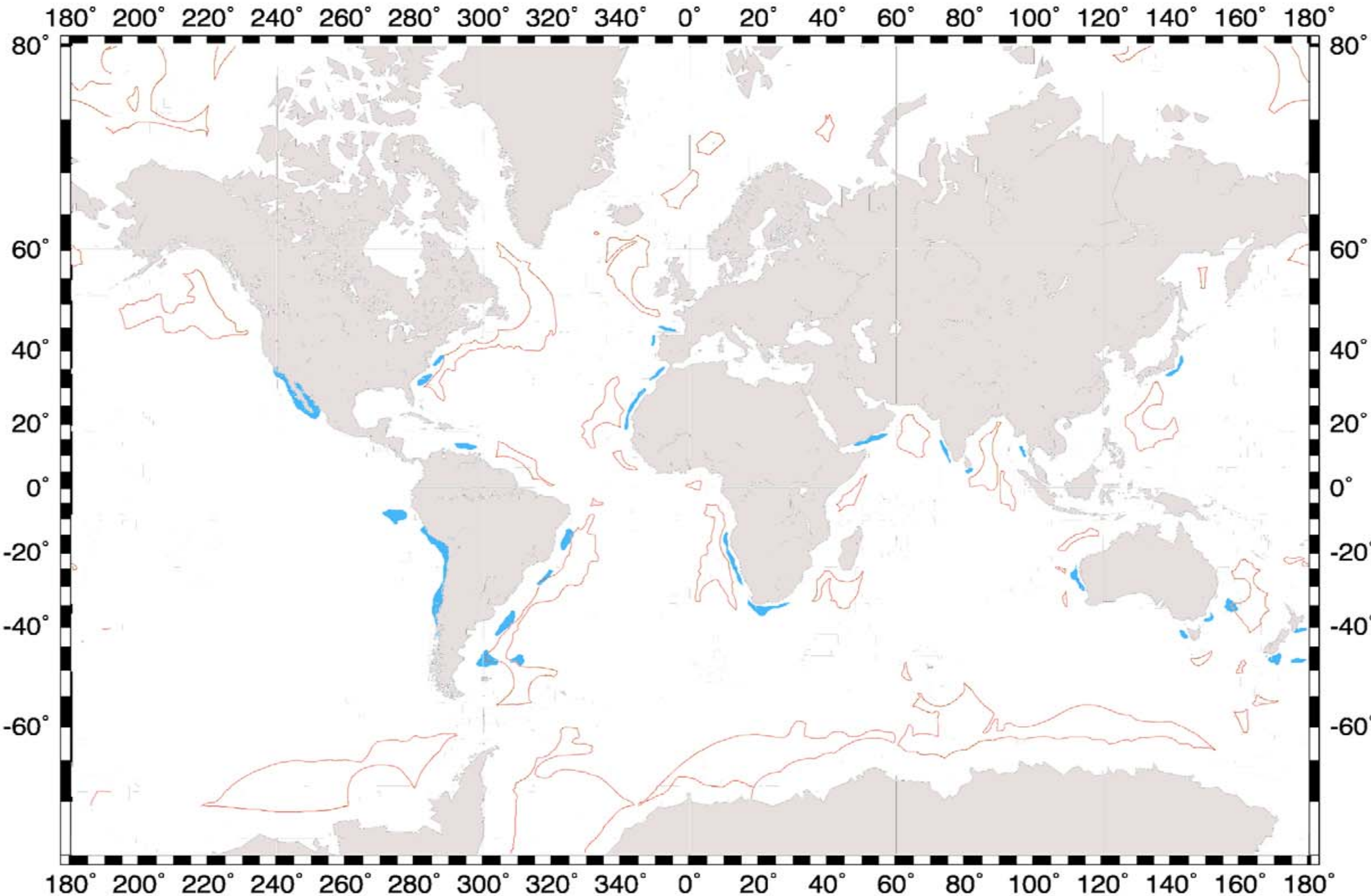


Known areas of offshore phosphorite occurences

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# Evaporites

- Anhydrite, gypsum, salt and potash
- Mg and S
- Local association with hydrocarbons
- Abundant, but sub-marginal

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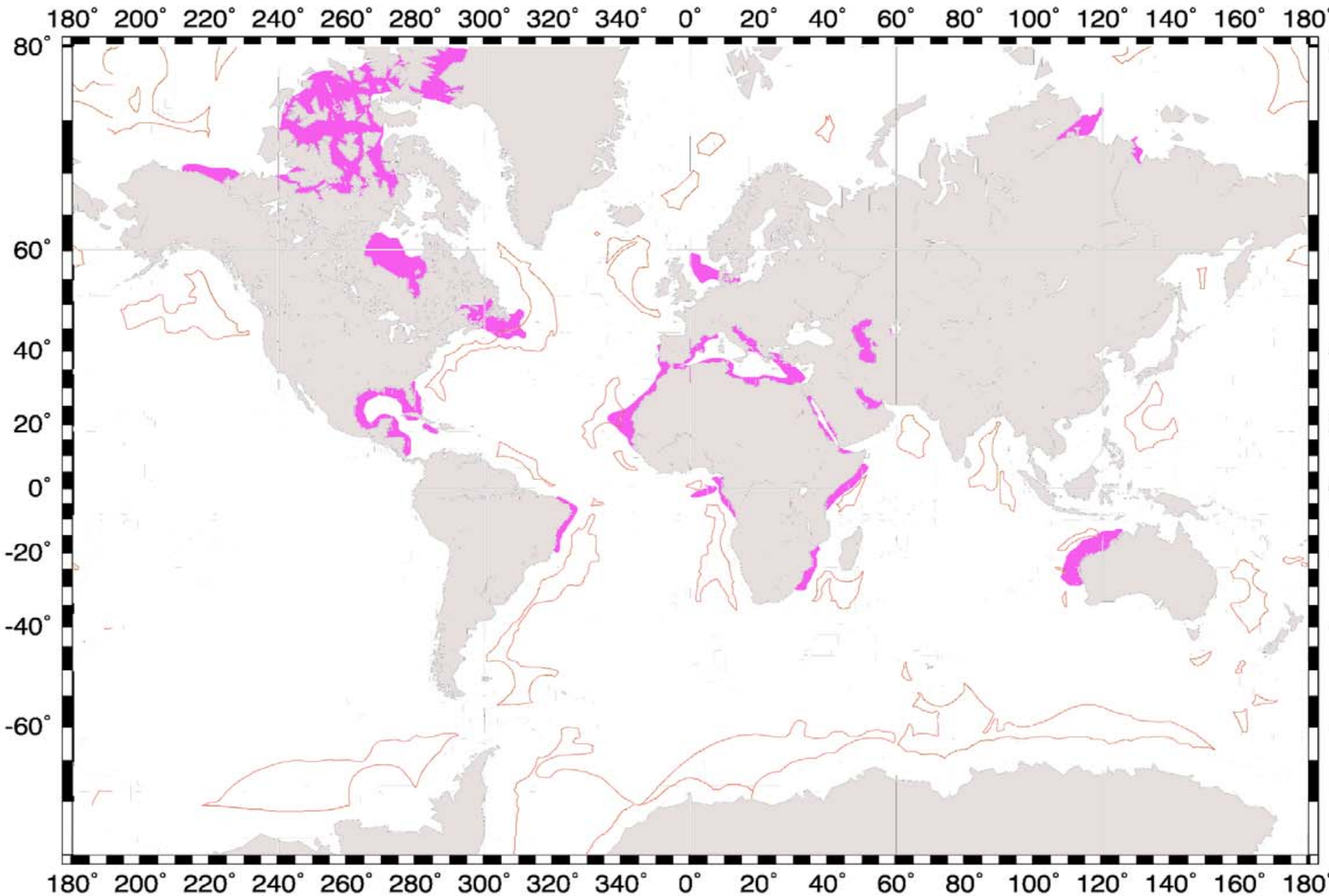


Known areas of anhydrite, potash and magnesium evaporite deposit occurences

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# Polymetallic sulphides

- Mid-ocean ridge hydrothermalism
- Up to 400°C vents
- High grade ores of Pb, Cu, Zn, Au
- Mostly deep water
- Very localised

QuickTime™ and a
decompressor
are needed to see this picture.

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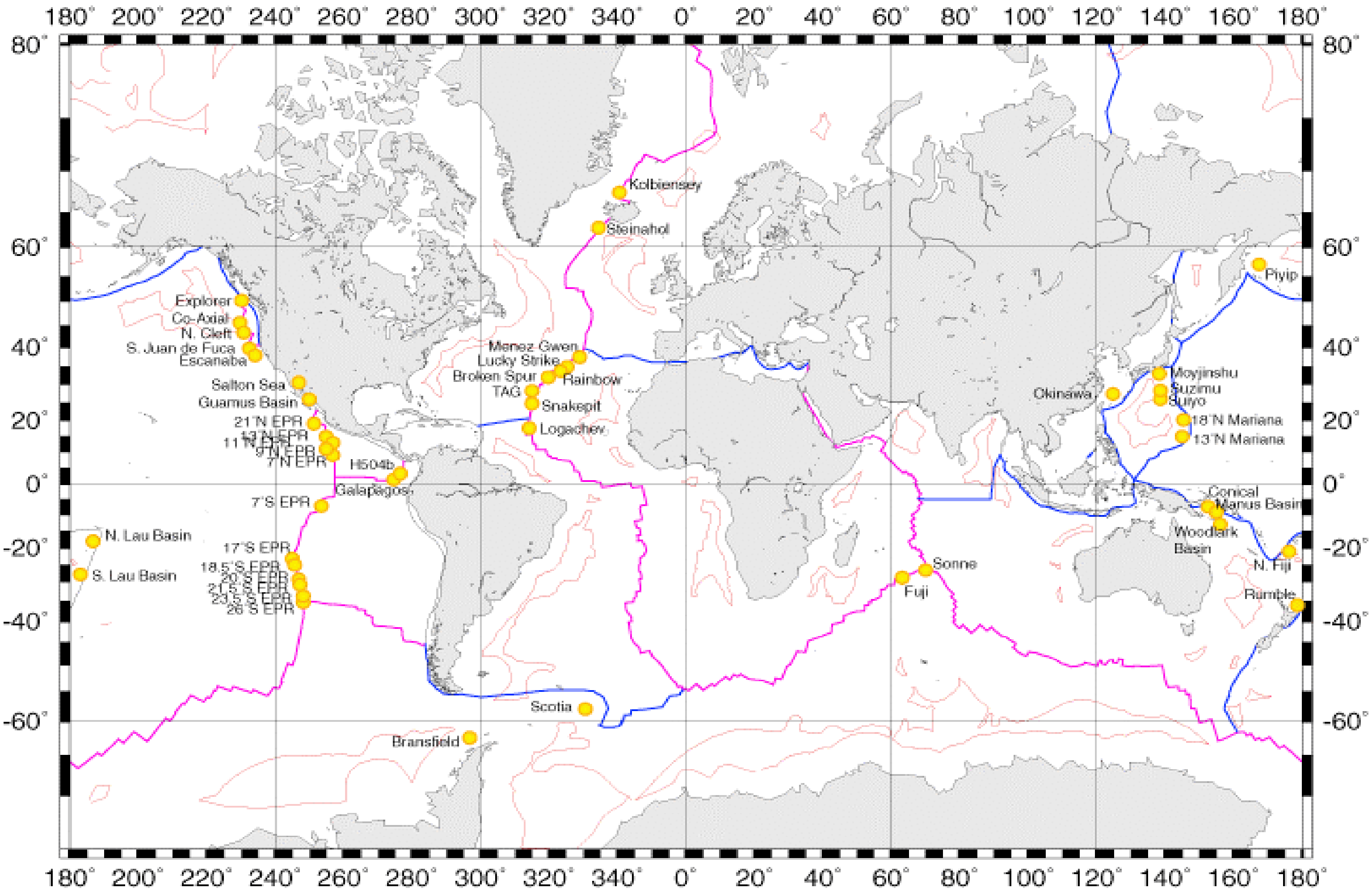


Figure 10. Location of known marine polymetallic sulphide (PMS) deposits (orange-filled circles) with reference to the ECLS regions outlined in red (after: Rona, 1988; Rona and Koski, 1985; Herzig, 1999; Herzig and Hannington, 2000 and others cited in the text).

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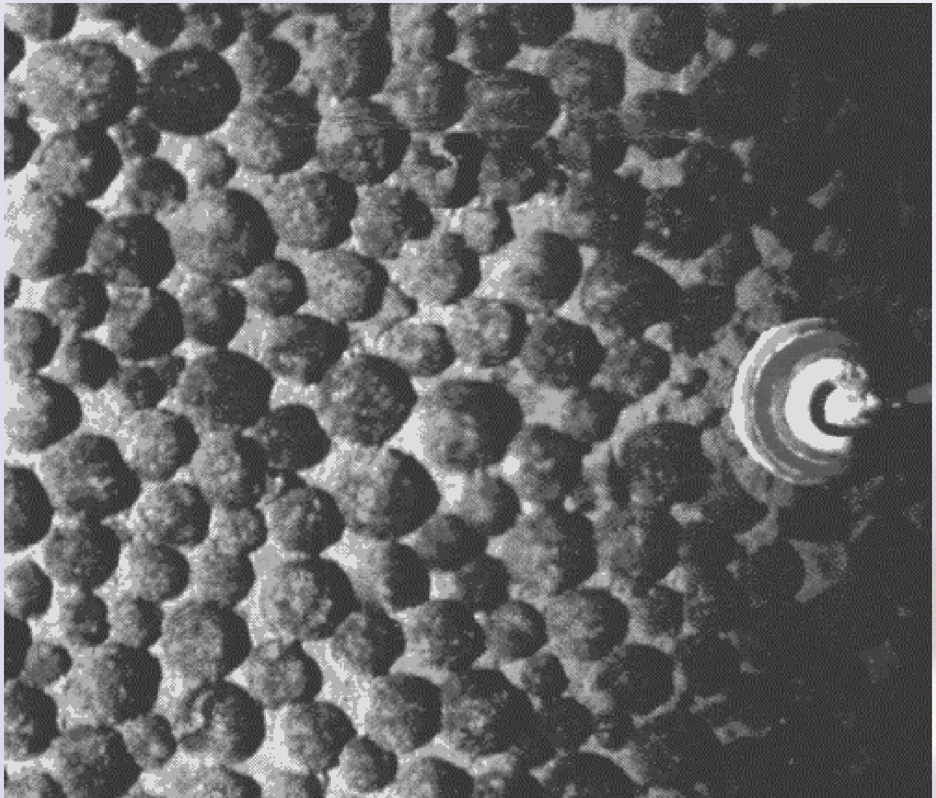
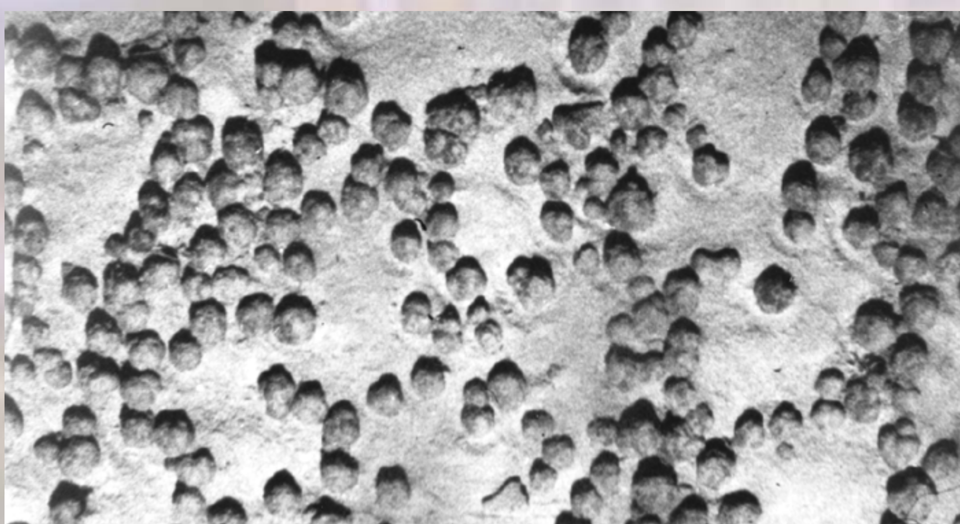
# Manganese nodules

- Complex intergrowth of mineral phases
- Significant Ni, Cu, Co, Mo





# Principal components

| Average content | | Atlantic | | Pacific | | | Indian |
|---|---|---|---|---|---|---|---|
| (in dry wt. %) | | | | | | | |
| | | | | | | | |
| Manganese | | 15.46 | | 19.27 | | | 15.25 |
| Iron | | 23.01 | | 11 79 | | | 13.35 |
| Nickel | | 0.308 | | 0.846 | | | 0.534 |
| Copper | | 0.141 | | 0.706 | | | 0.295 |
| Cobalt | | 0.2341 | | 0 290 | | | 0.247 |
| Manganese/Iron | | 0.67 | | 1.6 | | | 1.14 |

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# Manganese crusts

- Up to 2% Cobalt
- Layered up to several cm thick
- Low sedimentation rate
- Enhanced biological activity
- Less than 2000 m water depth
- Relatively easy to mine

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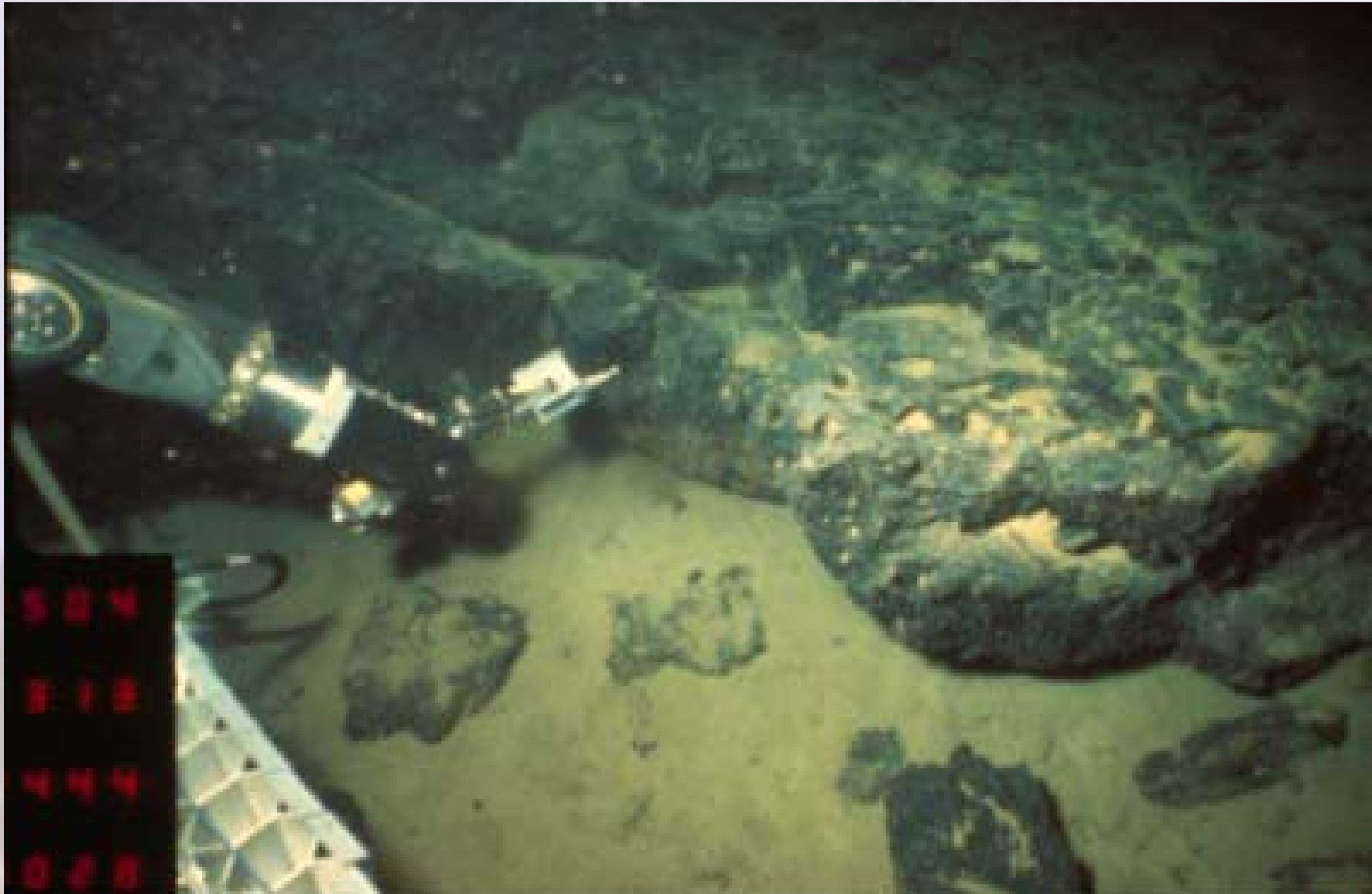

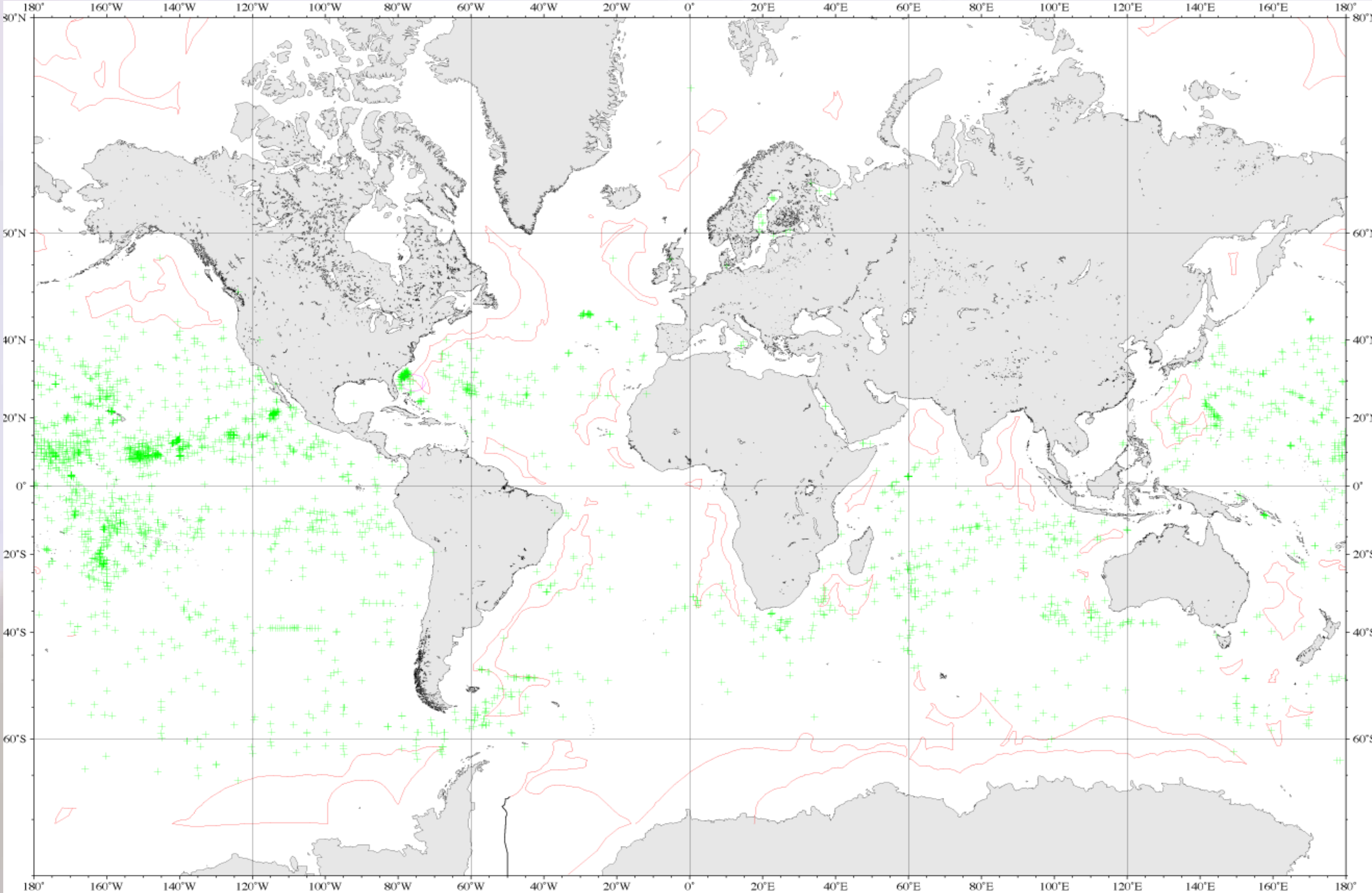


All published locations of manganese nodules and crusts for which there are chemical analyses

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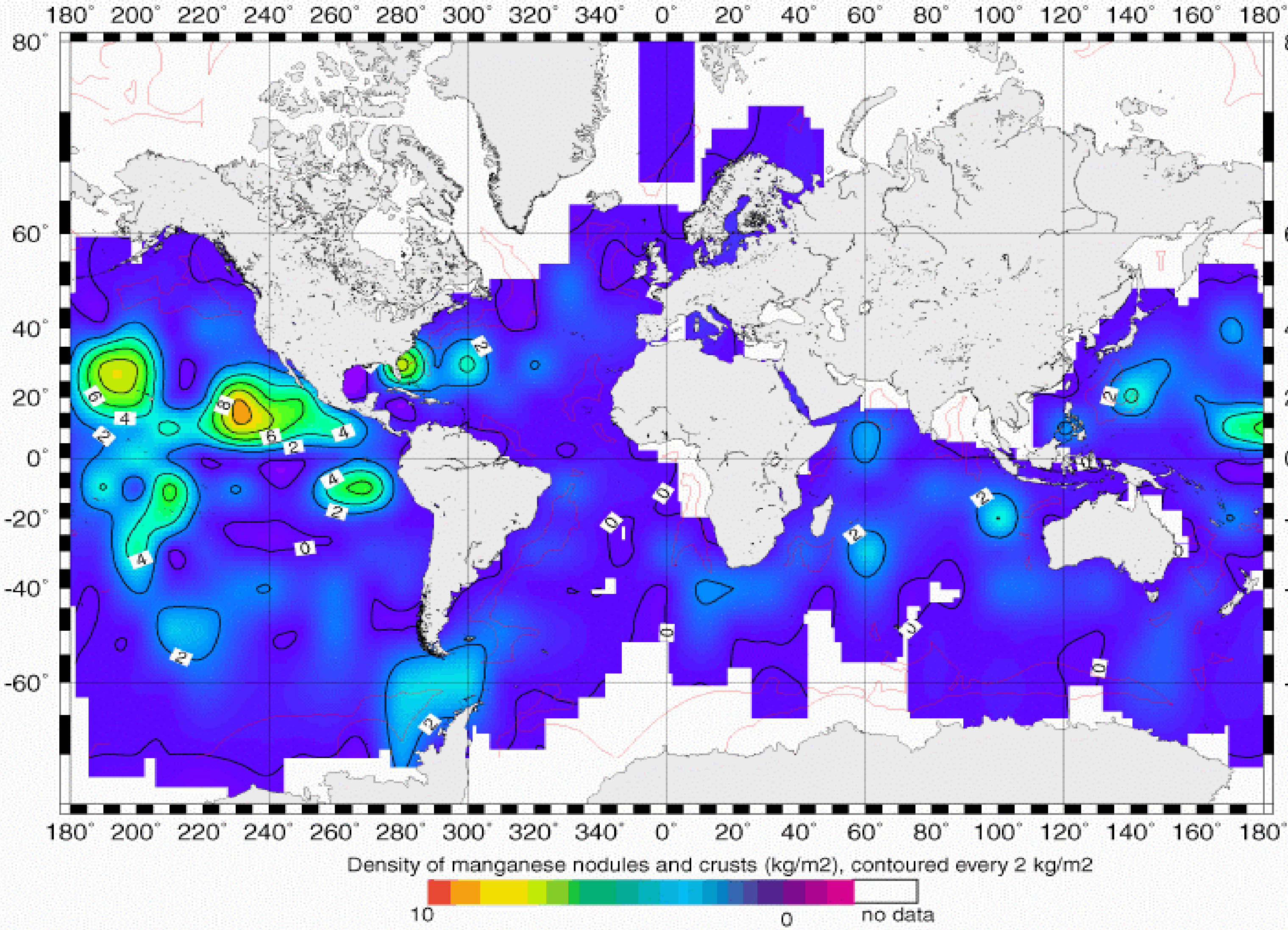


Figure 12a. Density of manganese nodules and crusts (kg/m2) gridded on a 1° latitude and longitude basis from data compiled from the same sources cited on figure 11.

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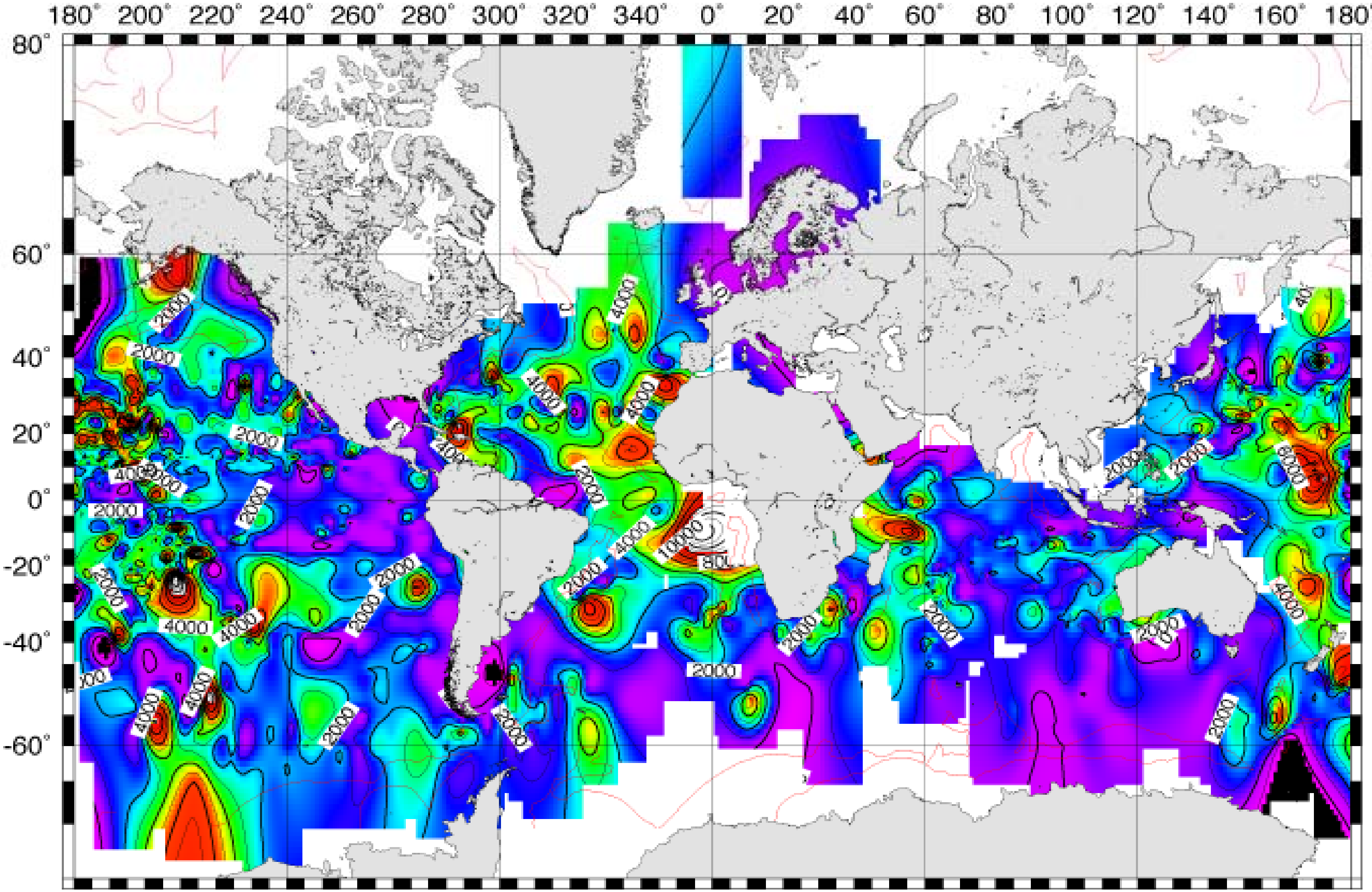


Cobalt (ppm) in nodules and crusts, contoured every 2000 ppm.

>10,000 0 no data

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# Gas hydrate

- Methane/Ice solid in sediments
- BSRs
- Gas traps
- Billions/trillions cu. m of potential resource
- No current offshore extraction technology
- Geohazard

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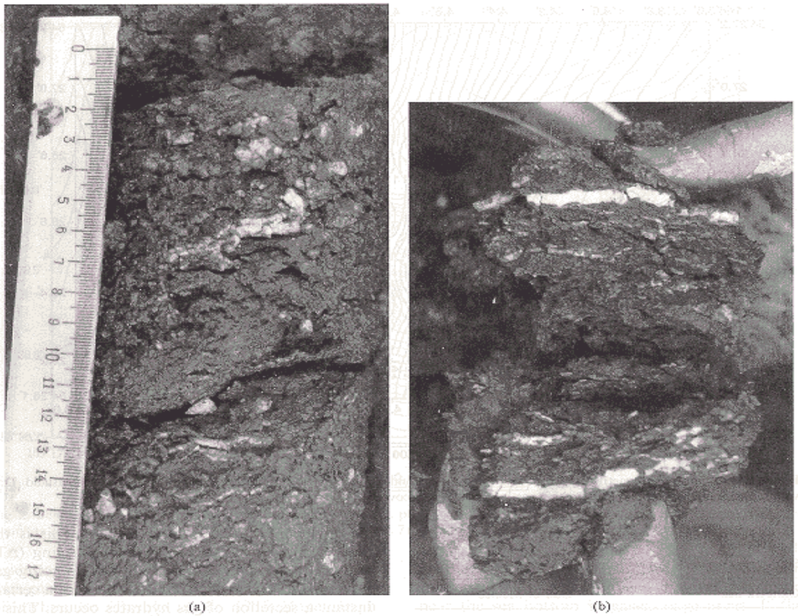
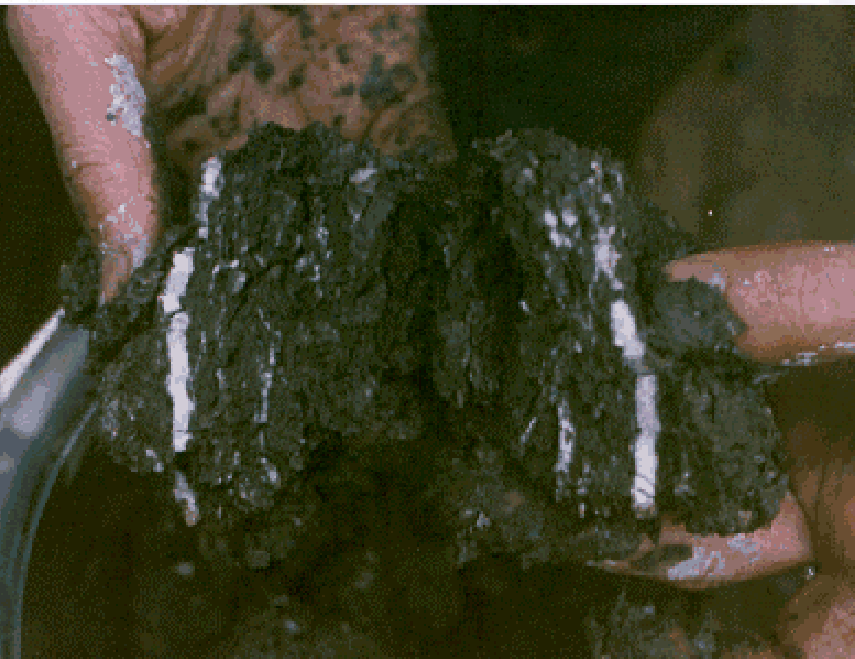



Fig. 4. The lenticular-bedded structure caused by gas hydrates, site 91-02-44, Okhotsk Sea, offshore Sakhalin Island: (a) general view of gas-hydrated sediments; (b) part of the core broken along vertical axis—subhorizontal layers and lenticules of gas hydrates are seen.



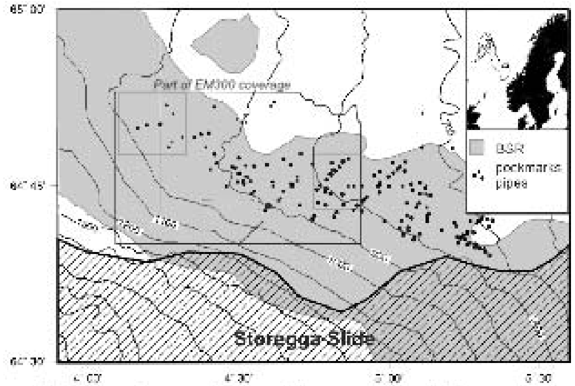
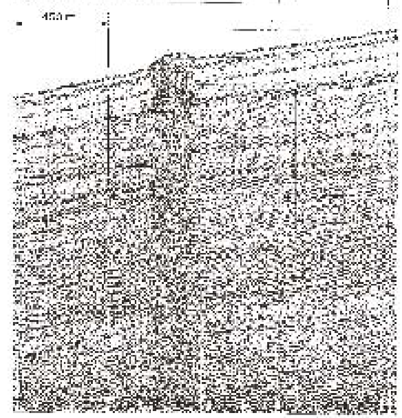



Fig. 1 Area of proposed work on chimneys and associated seeps/vents, of which those identified to date are shown by black dots.
Region underlain by the BSR is shown in grey, and the Storegga slide is shown in cross hatch.Bathymetric contours are at 100-m intervals.
Entire area shown has been surveyed with TOBI 30kHz sidescan sonar.
Thin lines enclose parts of the EM300 multibeam coverage shown in Fig. 2.

Fig. 3a Chimney 1



Chirp profile showing chimney beneath large mound at the seabed in water depth of 1020 m.
Separation of horizontal lines 20 ms (15 m)

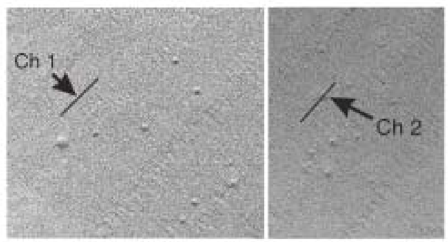
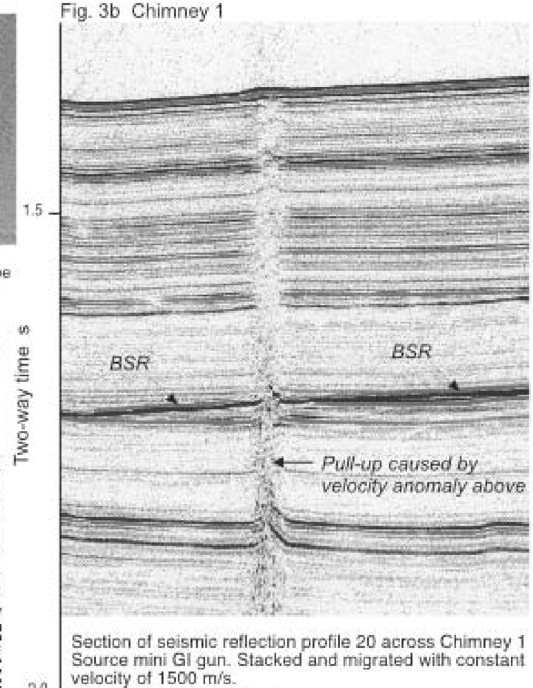


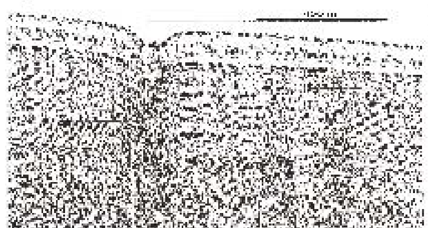

Fig. 2 Grey-scale images of bathymetry of continental slope north of the Storegga slide showing pockmarks and mounds associated with gas/fluid escape chimneys.
From EM300 survey by IFREMER June-July 2002.
[Illumination of images is from the south, bottom of image.]

Fig. 3b Chimney 1

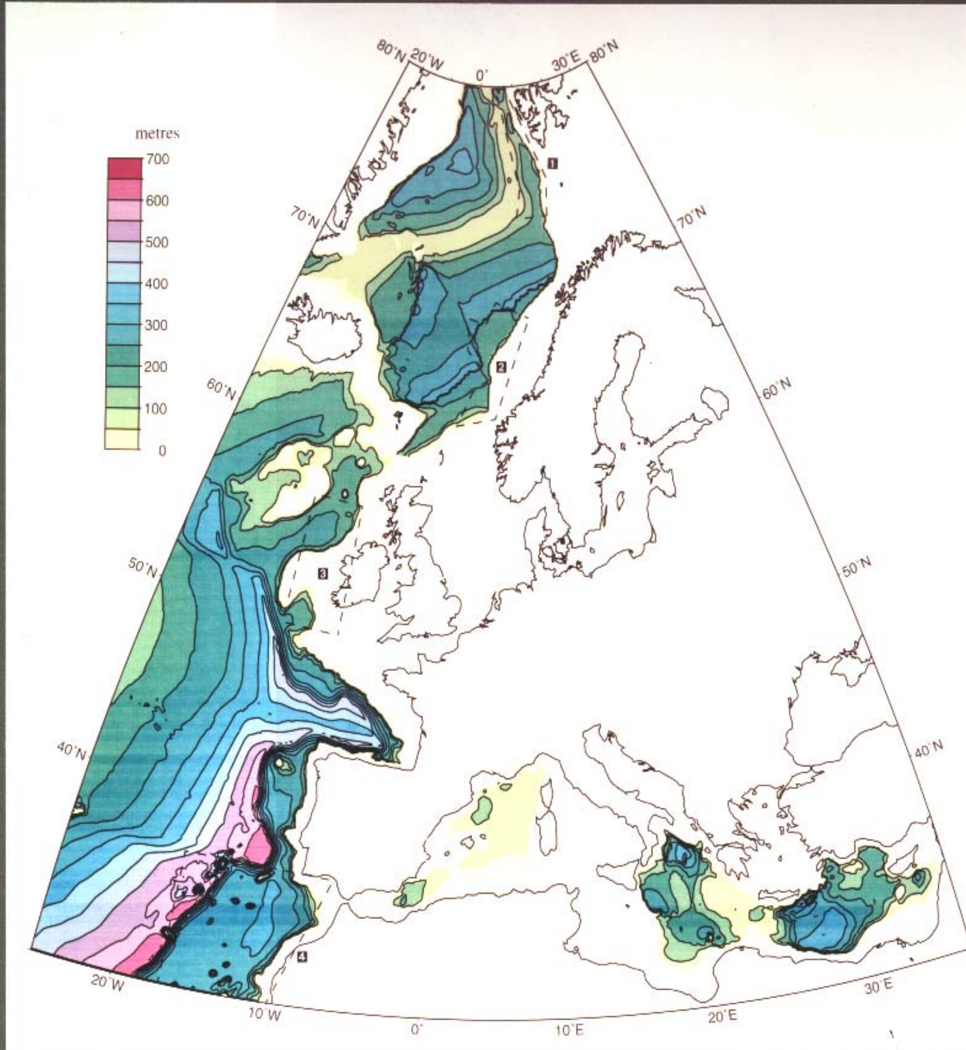



Section of seismic reflection profile 20 across Chimney 1
Source mini GI gun. Stacked and migrated with constant velocity of 1500 m/s.
IFREMER June-July 2002

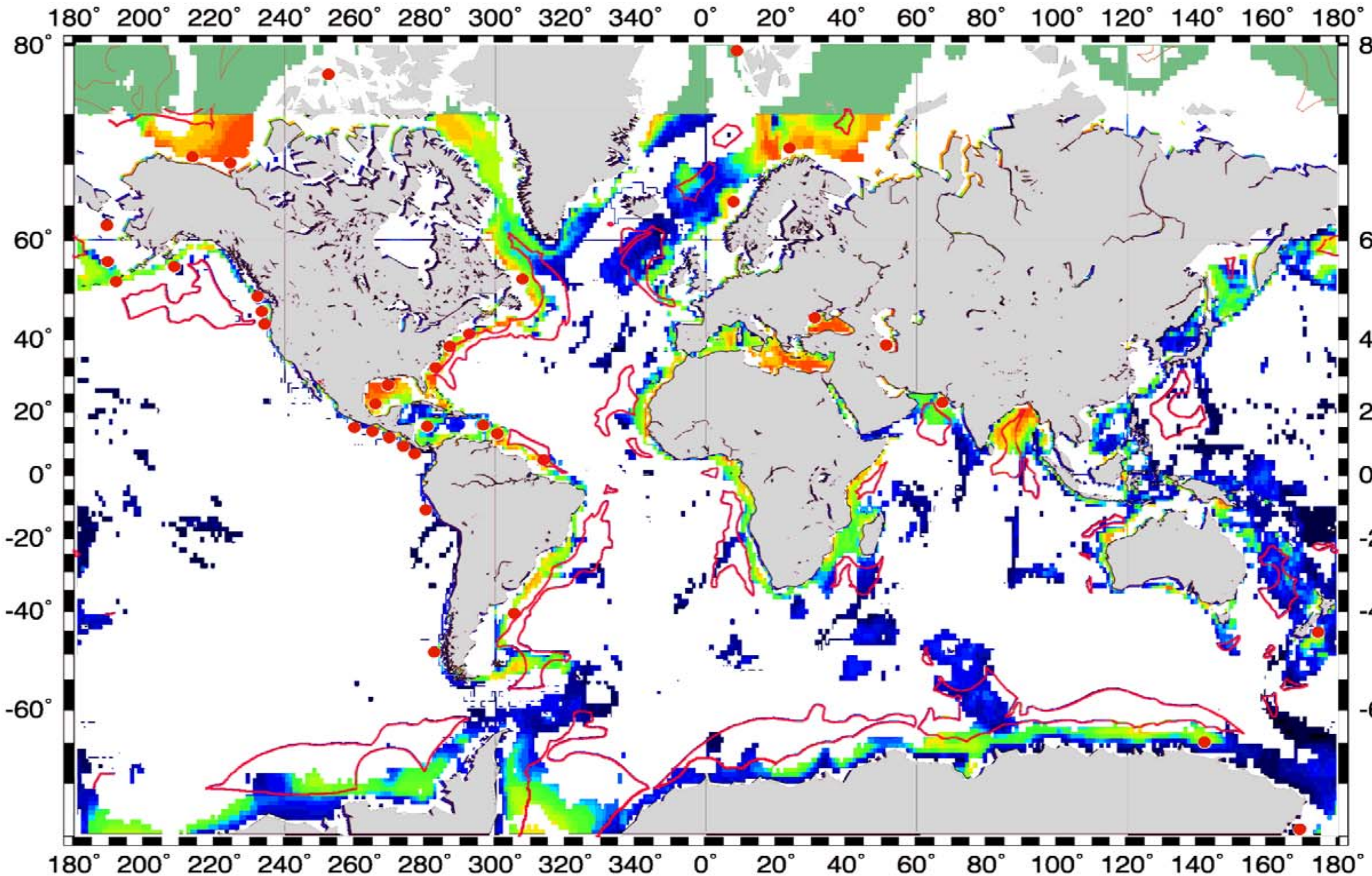
Fig. 3c



Chimney 2
Chirp profile showing pockmark at top of chimney in water depth of 803 m.
Separation of horizontal lines 20 ms (15 m)




Potential thickness of the gas hydrate layer. This does not propose that gas hydrates actually exist over all these areas, only that if they do then these are the depths to the bottom simulating reflector (BSR) - should one exist! Areas marked 1-4 are those of sufficient sedimentation, organic carbon and other geochemical characteristics to be most likely to form gas hydrate.




Areas of potential gas hydrate formation in water depths between 500 and 4000 m and and on seafloor more than 30My old.

● Areas where gas hydrates have been found or inferred. Other areas with potential for gas hydrate formation.

Gas hydrate potential from high (red) to low (blue).

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# Hydrocarbons

- Oil and Gas

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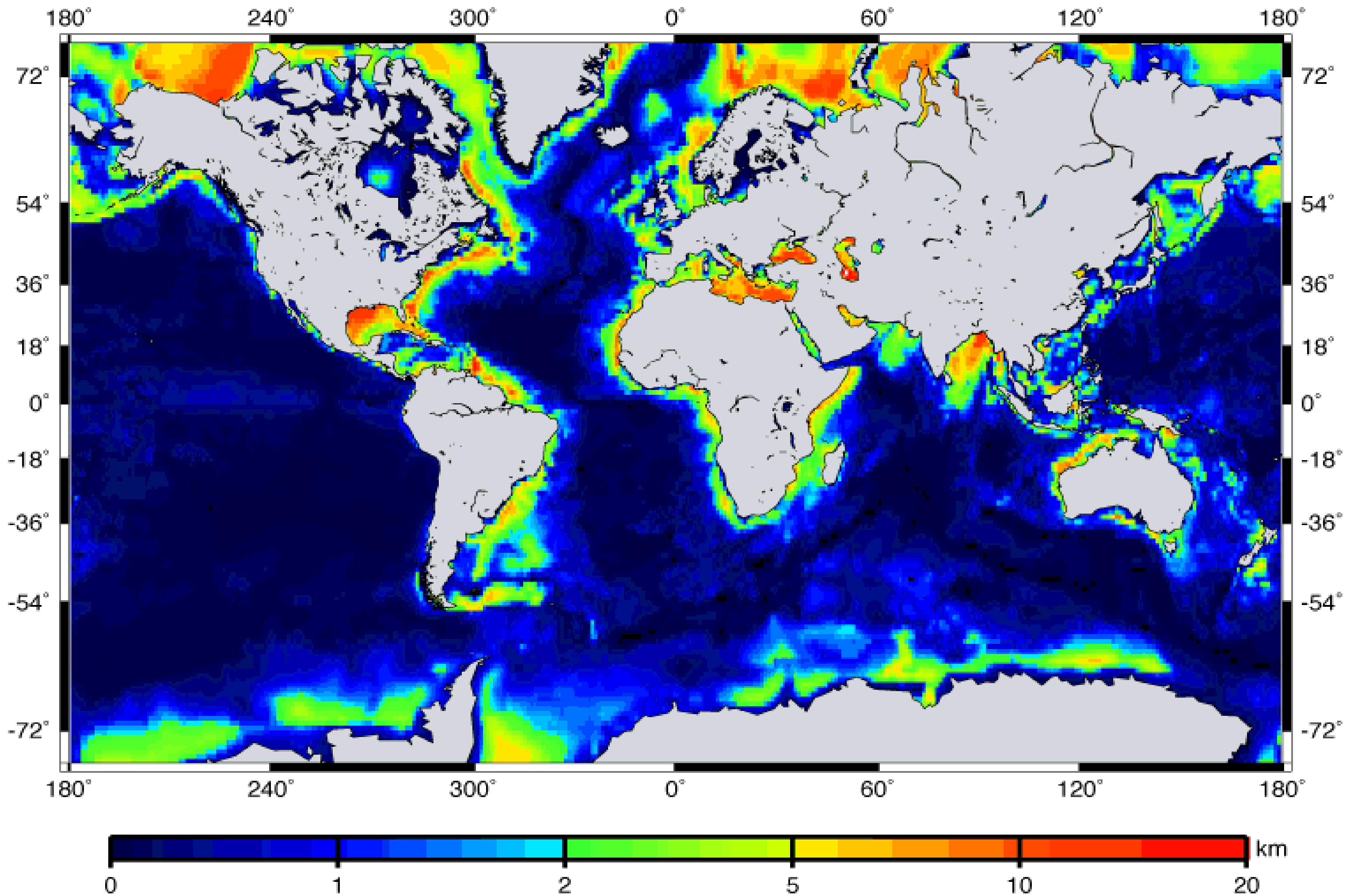


Sediment thickness model gridded in 1° intervals

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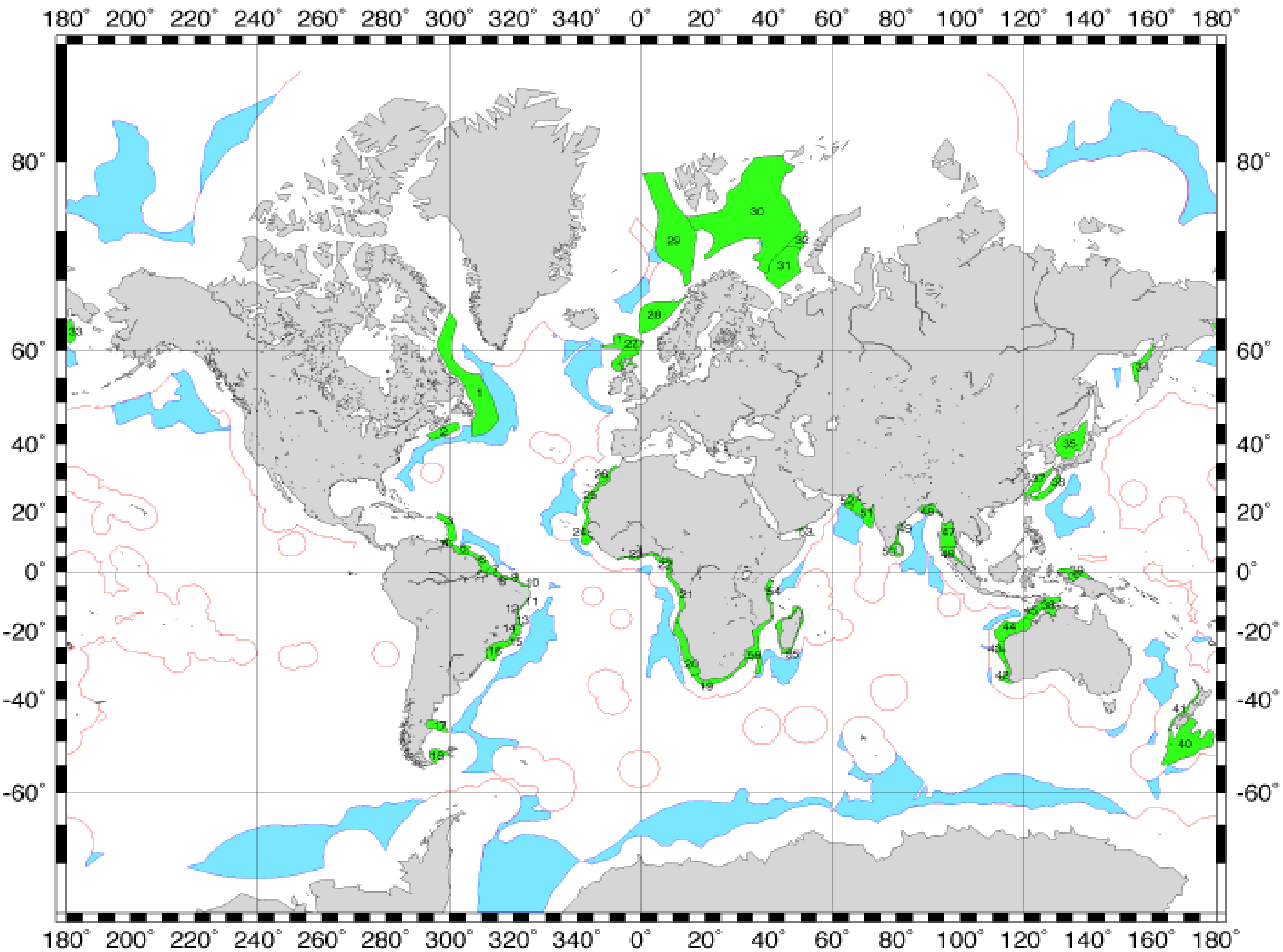


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# Technical feasibility of recovery

- Technical challenges
- Speed of progress
- Funding for research

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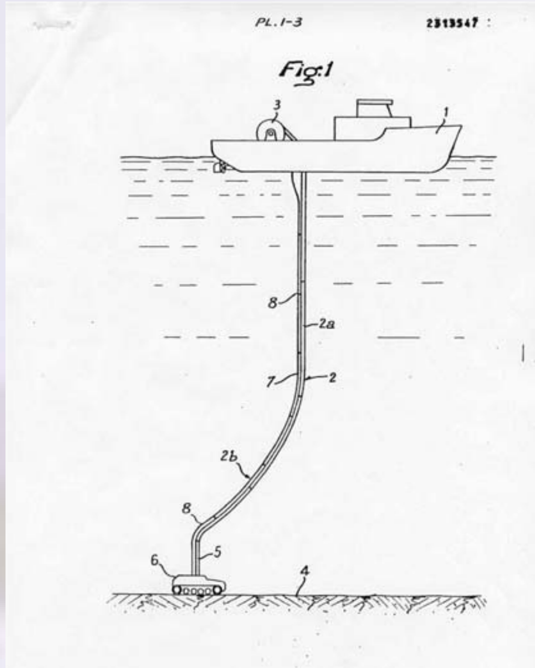

PL. I-3
2313547
Fig.1

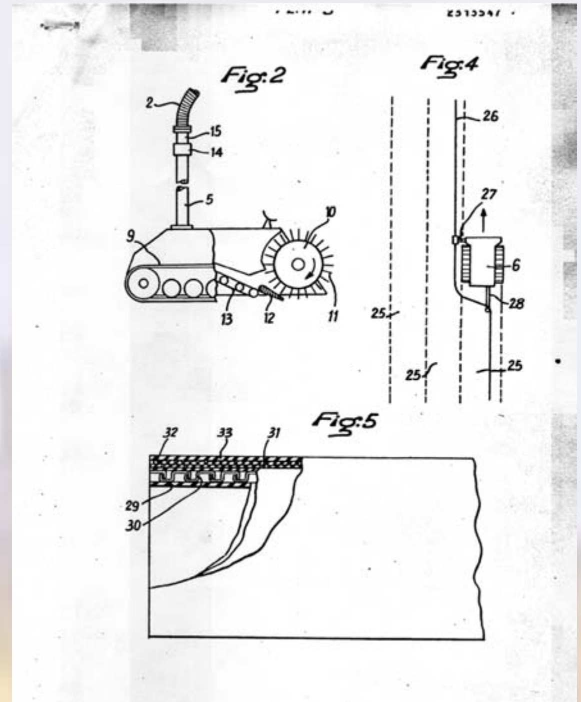
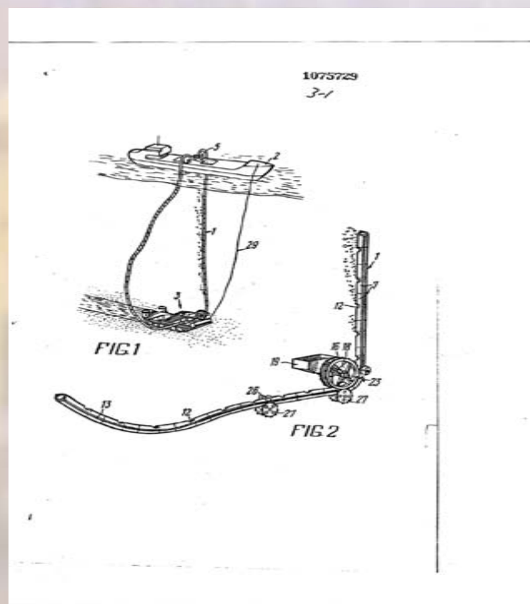


Fig.2
Fig.4
Fig.5


1075729
3-1
FIG 1
FIG 2

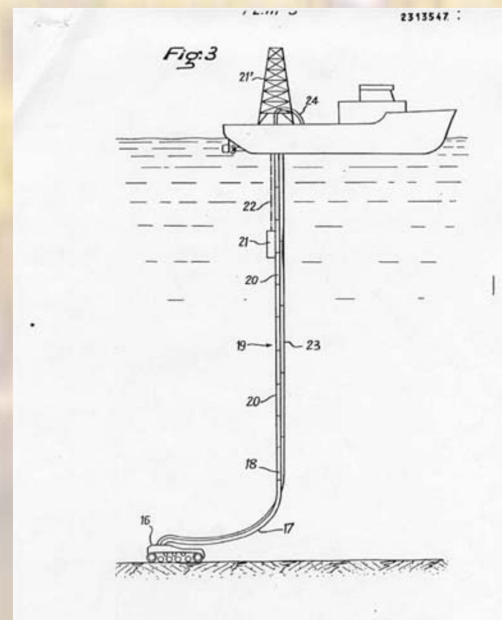

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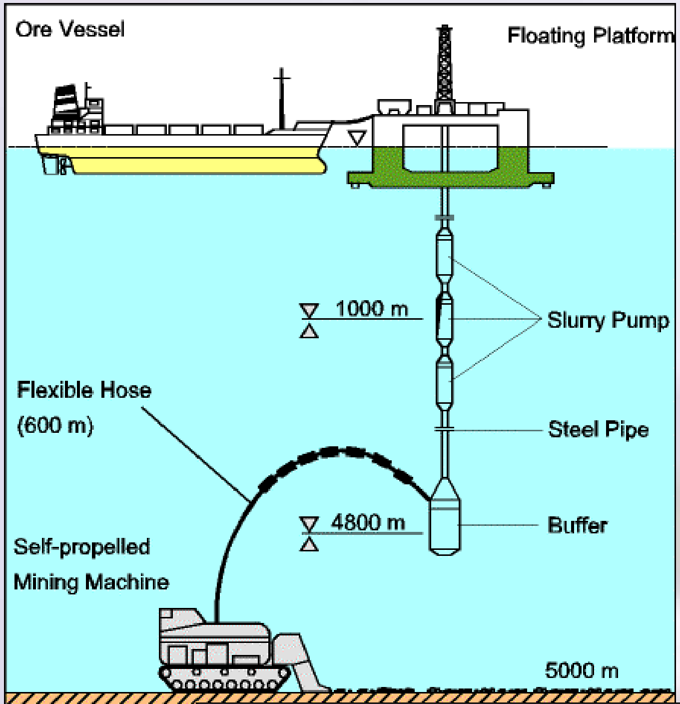
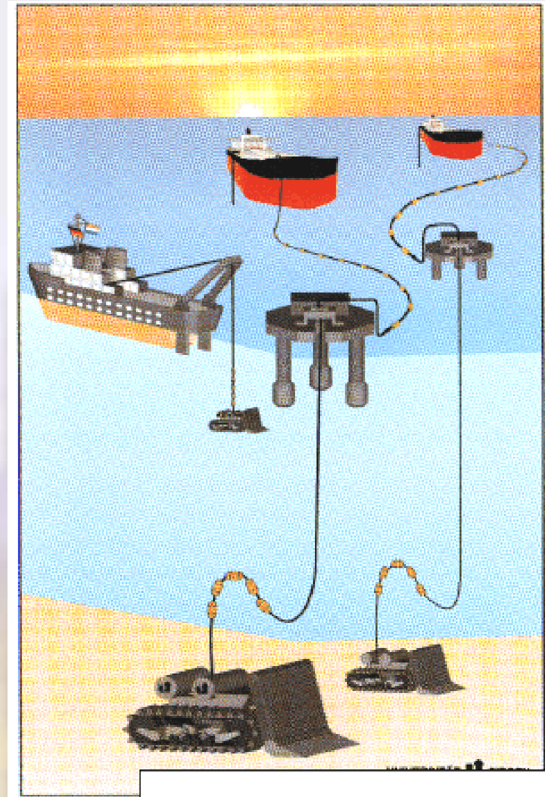
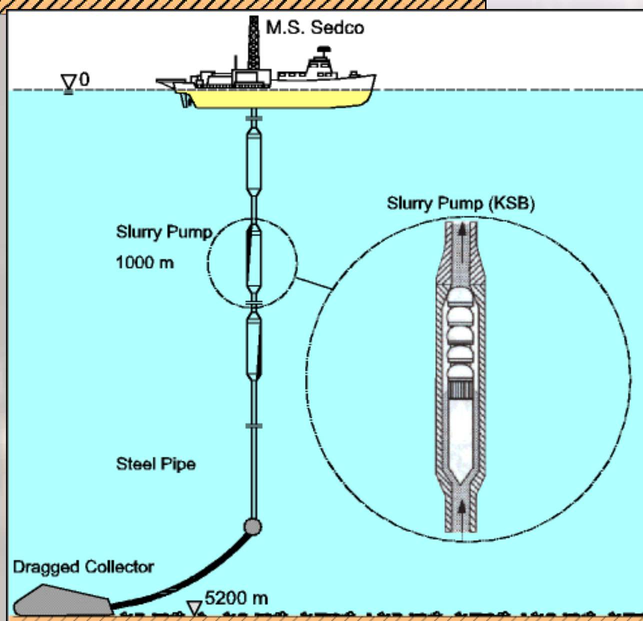
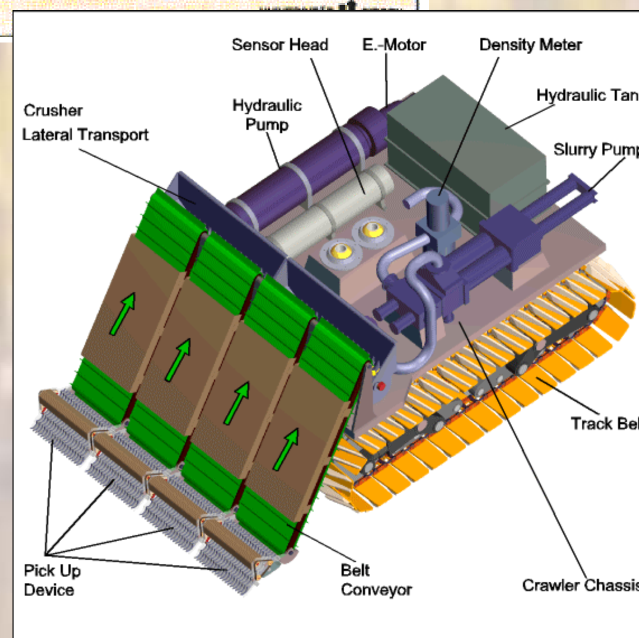
Fig.3


Ore Vessel
Floating Platform
1000 m
Slurry Pump
Flexible Hose
(600 m)
Steel Pipe
4800 m
Buffer
Self-propelled
Mining Machine
5000 m




M.S. Sedco
0
Slurry Pump (KSB)
Slurry Pump
1000 m
Steel Pipe
Dragged Collector
5200 m


Sensor Head
E.-Motor
Density Meter
Hydraulic Tank
Crusher
Lateral Transport
Hydraulic
Pump
Slurry Pump
Track Belt
Pick Up
Device
Belt
Conveyor
Crawler Chassis

# Evaluation of Economic Aspects

- EEZs
- Present day CS
- Present day Area

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# Summary

- The extent of the study
- The resource/reserve of the area
- The future

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