INTERNATIONAL SEABED AUTHORITY, OFFICE OF RESOURCES AND ENVIRONMENTAL MONITORING (OREM):

EXPLORATION ACTIVITIES FOR POLYMETALLIC NODULES IN THE CLARION-CLIPPERTON ZONE OF THE NORTH PACIFIC OCEAN.

Sandor Mulsow
Head - OREM
ISA

Outline

- Introduction
  - The “Area”
  - Mining Resources
    - Nodules, massive sulphides and cobalt crust
- Exploration-Exploitation Framework of CCFZ
  - The Contractors and Exploration Licenses
  - Current Status of Exploration Licenses
- Environmental Management Plan: baseline data and database
- Technologies used in Exploration/Exploitation

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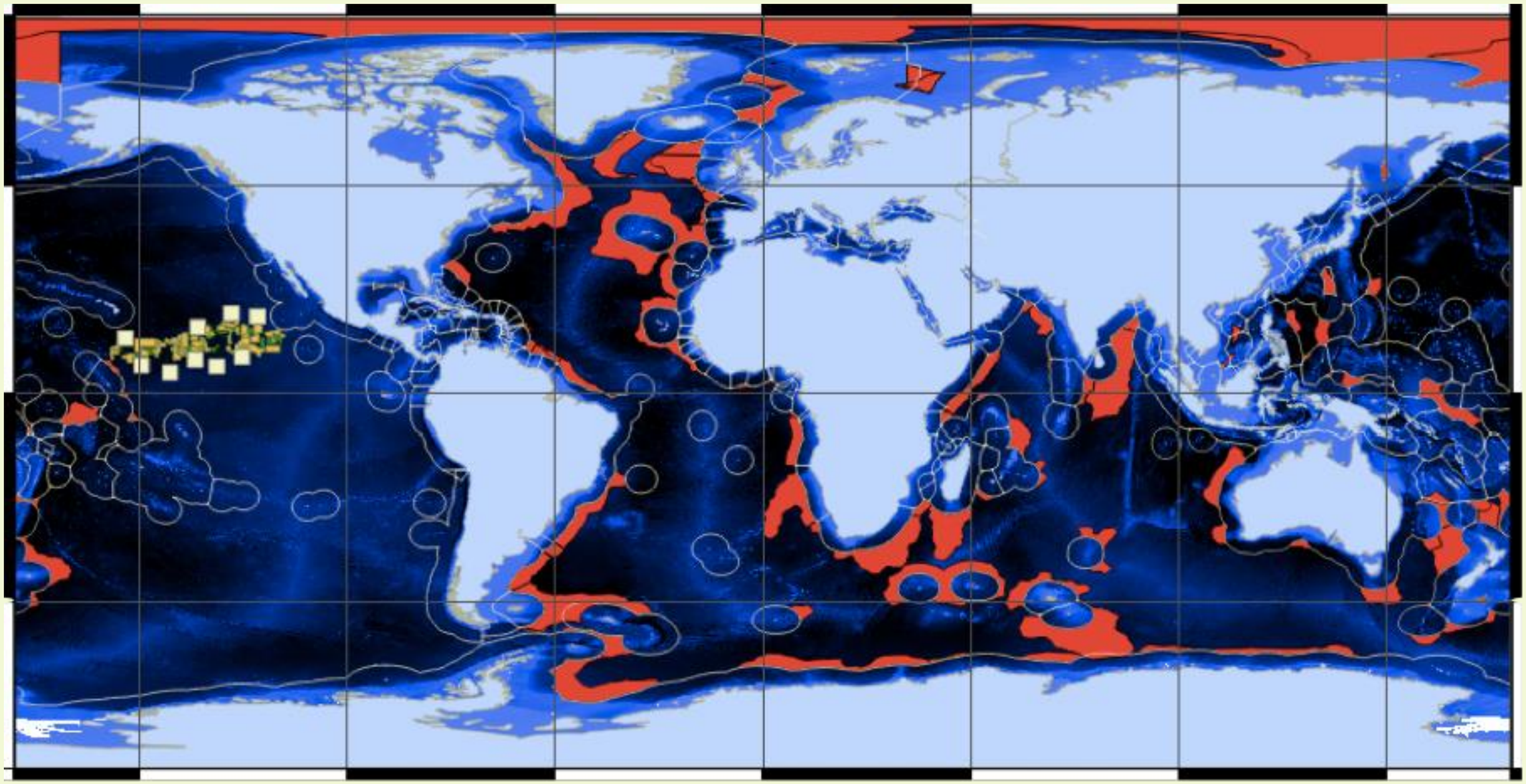
The “Area”



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Mining Resources

Polymetallic Manganese Nodules

Orogeny

Slow precipitation of Mn and Fe oxyhydroxides
Size range from few mm to 10's of centimetre
Abundance from few kg to >20 kg m^{-2}.

Mineral Ores

Mn, Fe, Cu, Ni and Co among many other minerals including REE.

Distribution

Found everywhere in the open an enclosed oceans

Depth range from 800 m to 6000 m water depth

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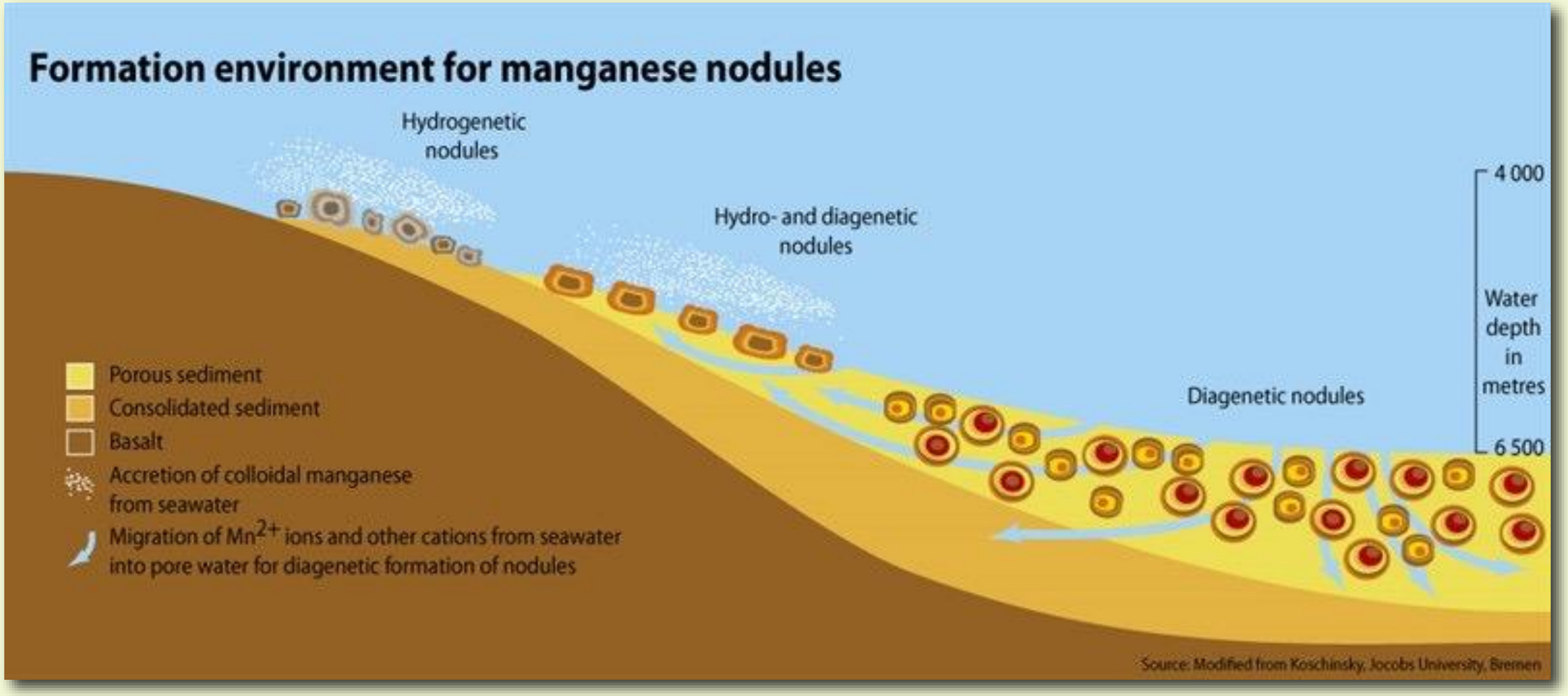
Mining Resources: Polymetallic Manganese Nodules

Orogeny



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Collected by S. Mulsow, South Pacific Ocean. 5600 m (AEA-1998)

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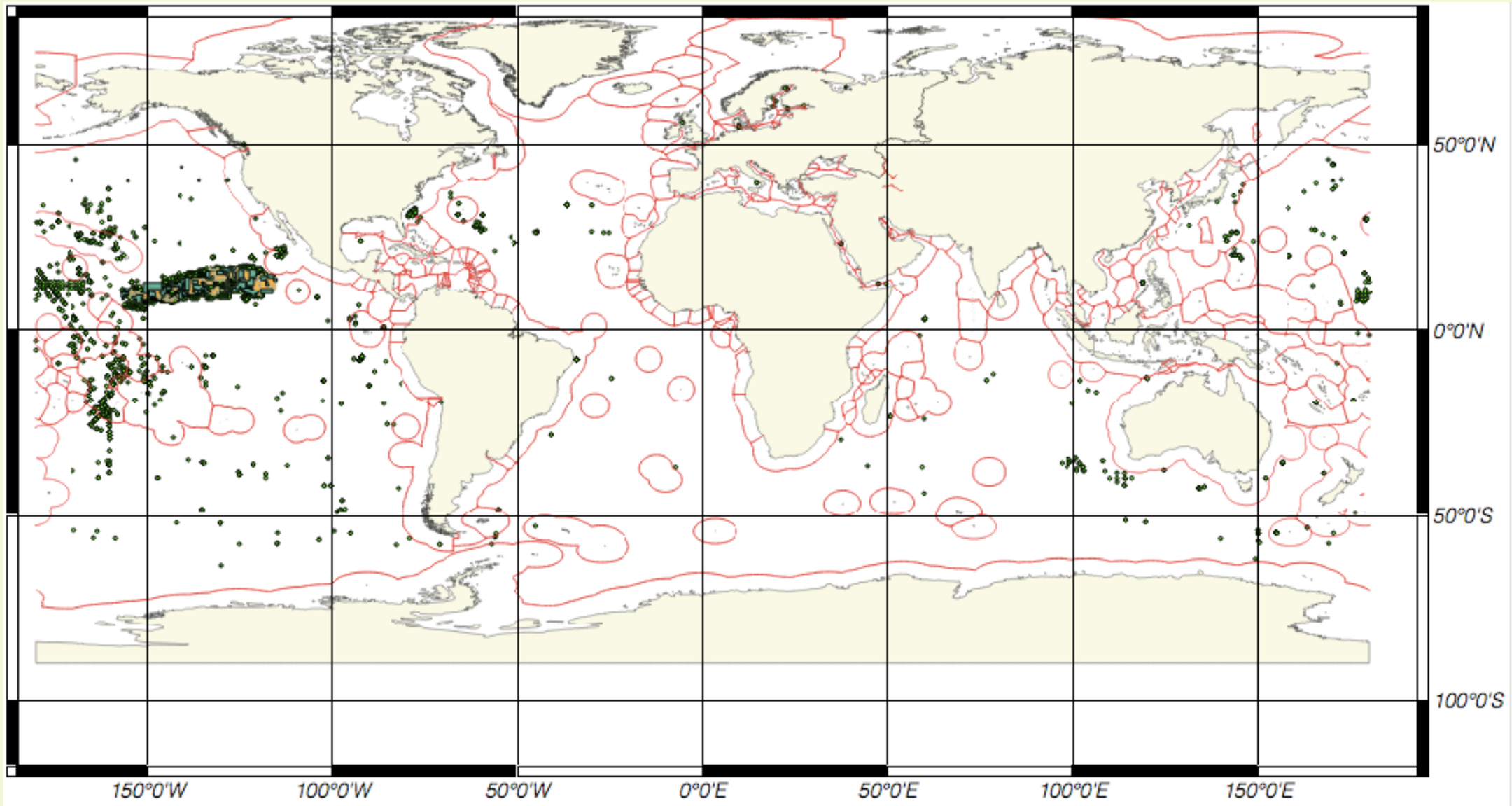
Mining Resources: Polymetallic Manganese Nodules

Distribution



Prepared for Joint Meeting ICPC-ISA,
New York, March 10 -11, 2015

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Sampled Location

Polymetallic Mangenese Nodules

Exclusive Economic Zone (EEZ)

Contractor's Area

Reserved Area

Worldwide Marine Mineral Deposits

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The “Area”

Table 1. Licenses Applied to/Granted to for PMN by the International Seabed Authority in the “AREA”

	Contractor	Contract signed	Expiration of Contract	Sponsoring State	General geographical location	Resource	Area (km²)
1	Interoceanmetal Joint Organization	29 March 2001		Bulgaria, Cuba, Czech Republic, Poland, Russian Federation and Slovakia	CCFZ (North) Pacific Ocean	polymetallic nodules	75000
2	Yuzhmorgeologiya	29 March 2001	28 March 2016	Russian Federation	CCFZ (North) Pacific Ocean	polymetallic nodules	75000
3	Government of the Republic of Korea	27 April 2001	26 April 2016	Korea	CCFZ (North) Pacific Ocean	polymetallic nodules	75000
4	China Ocean Mineral Resources Research and Development Association (COMRA)	22 May 2001	21 May 2016	China	CCFZ (North) Pacific Ocean	polymetallic nodules	75000
5	Deep Ocean Resources Development Co. Ltd. (DORD)	20 June 2001	19 June 2016	Japan	CCFZ (North) Pacific Ocean	polymetallic nodules	75000
6	Institut français de recherche pour l'exploitation de la mer (INFRAMER)	20 June 2001	19 June 2016	France	CCFZ (North) Pacific Ocean	polymetallic nodules	75000
7	Government of India	25 March 2002	24 March 2017	India	Indian Ocean	polymetallic nodules	75000
8	Federal Institute for Geosciences and Natural Resources of Germany	19 July 2006	18 July 2021	Germany	CCFZ (North) Pacific Ocean	polymetallic nodules	75000
9	Nauru Ocean Resources Inc. (NORI)	22 July 2011	21 July 2026	Nauru	CCFZ (North) Pacific Ocean - Reserved Area	polymetallic nodules	75000
10	Tonga Offshore Mining Limited	11 January 2012	10 January 2027	Tonga	CCFZ (North) Pacific Ocean - Reserved Area	polymetallic nodules	75000
11	UK Seabed Resources Ltd.	8 February 2015	7 February 2028	United Kingdom of Great Britain and Northern Ireland	CCFZ (North) Pacific Ocean	polymetallic nodules	58000
12	Marawa Research and Exploration Ltd.	19 Janaury 2015	18 January 2030	Kiribati	CCFZ (North) Pacific Ocean - Reserved Area	polymetallic nodules	75000
13	Global Sea Mineral Resources NV	14 January 2015	13 Janaury 2028	Belgium	CCFZ (North) Pacific Ocean	polymetallic nodules	75000
14	Ocean Mineral Singapore Pte Ltd (OMS)	21 January 2015	21 January 2030	Singapore	CCFZ (North) Pacific Ocean - Reserved Area	polymetallic nodules	58200
15	UK Seabed Resources Ltd.	approved, to be signed		United Kingdom of Great Britain and Northern Ireland	CCFZ (North) Pacific Ocean	polymetallic nodules	
16	Cook Islands Investment Corporation	approved, to be signed		Cook Islands	CCFZ (North) Pacific Ocean - Reserved Area	polymetallic nodules	

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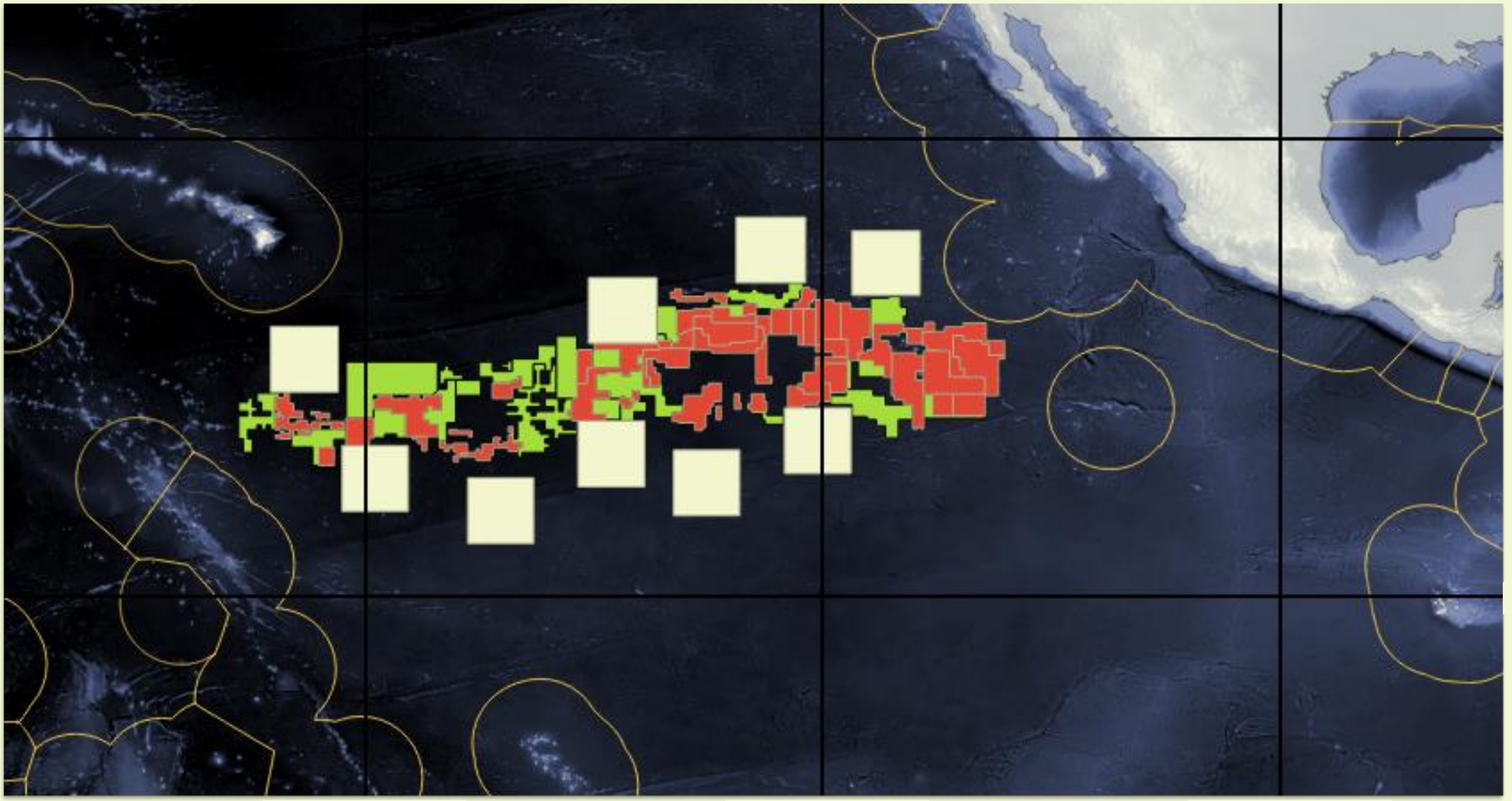
The “Area”



Prepared for Pretoria Meeting Pretoria March 17 -19, 2015	Contractor’s sites	Exclusive Economic Zone (EEZ)	Worldwide Marine Mineral Deposits
Prepared by S. Mulsow (2015)	Reserved sites	Areas of Particular Interest	

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Mining Resources

Polymetallic Massive Sulphides

Orogeny

convective systems that mixed fluids (seawater) and heat (volcanic activity) to bring up sulphides brine rich of metals to form black smokers (chimneys)

Mineral Ores

Size are difficult to set. Chimneys may reach 10’s of meters high
PMS are mostly found at 1000 to 4000 meters water depth.
Mn, Fe, Cu, Zn, Ag and Au and REE.

Distribution

Located at back island-arcs, mid ocean ridges and volcanic arc.

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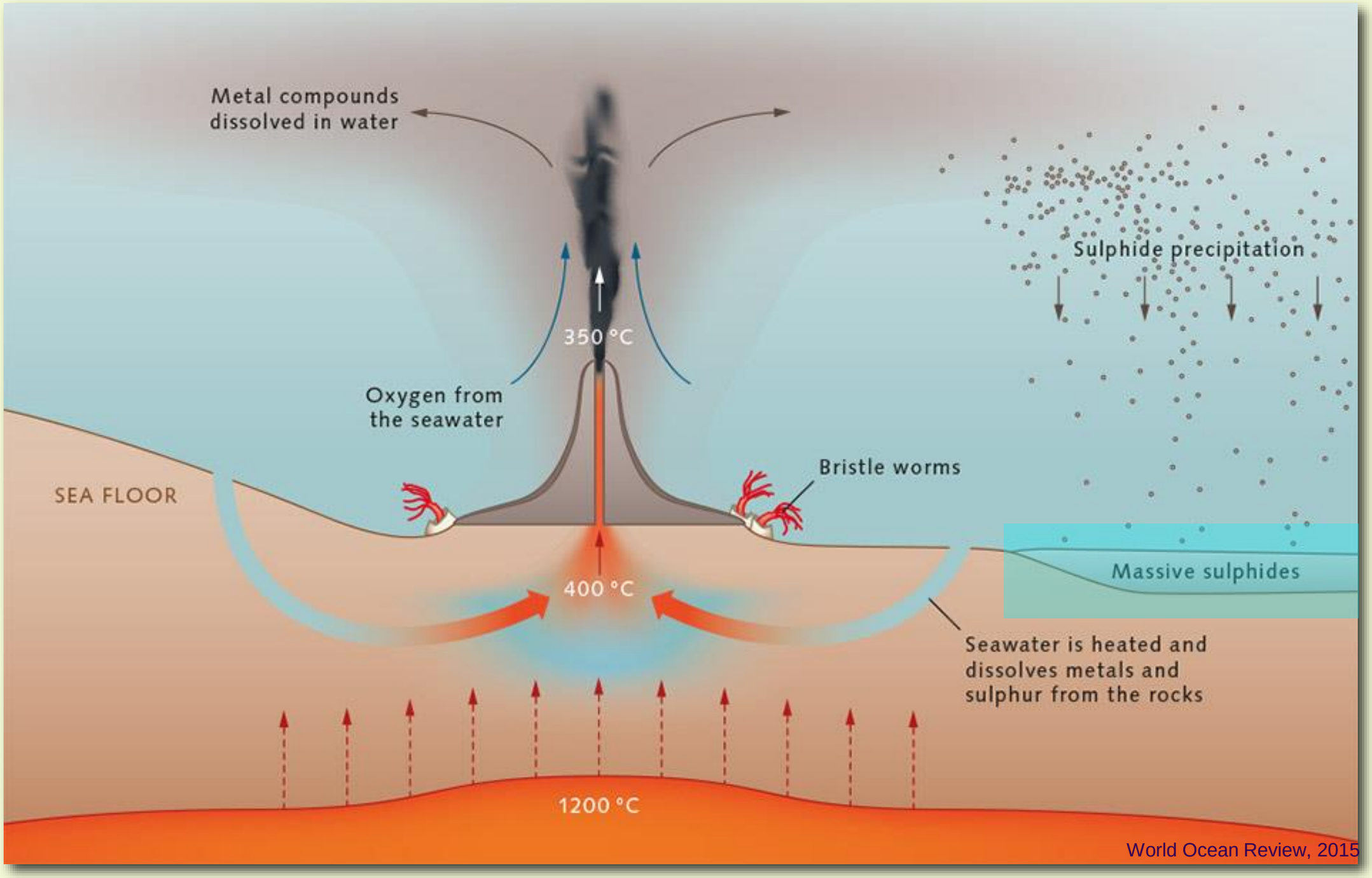
Mining Resources: Polymetallic Massive Sulphides

Orogeny



World Ocean Review, 2015

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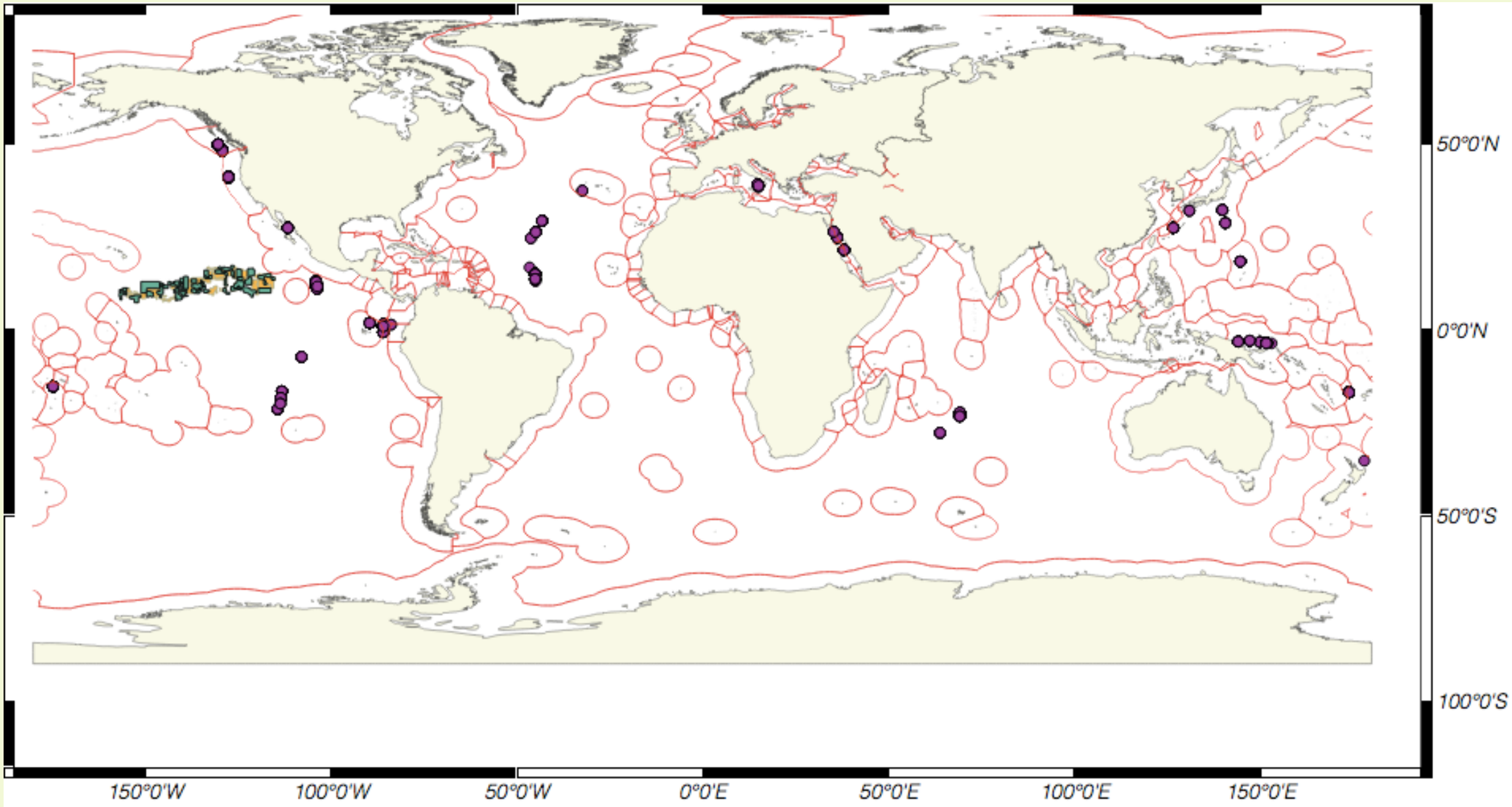
Mining Resources: Polymetallic Massive Sulphides

Distribution



Prepared for Joint Meeting ICPC-ISA,
New York, March 10 -11, 2015

Prepared by S. Mulsow (2015)

Polymetallic Massive Sulphides

Contractor's Area

Exclusive Economic Zone (EEZ)

Reserved Area

Worldwide Marine Mineral Deposits

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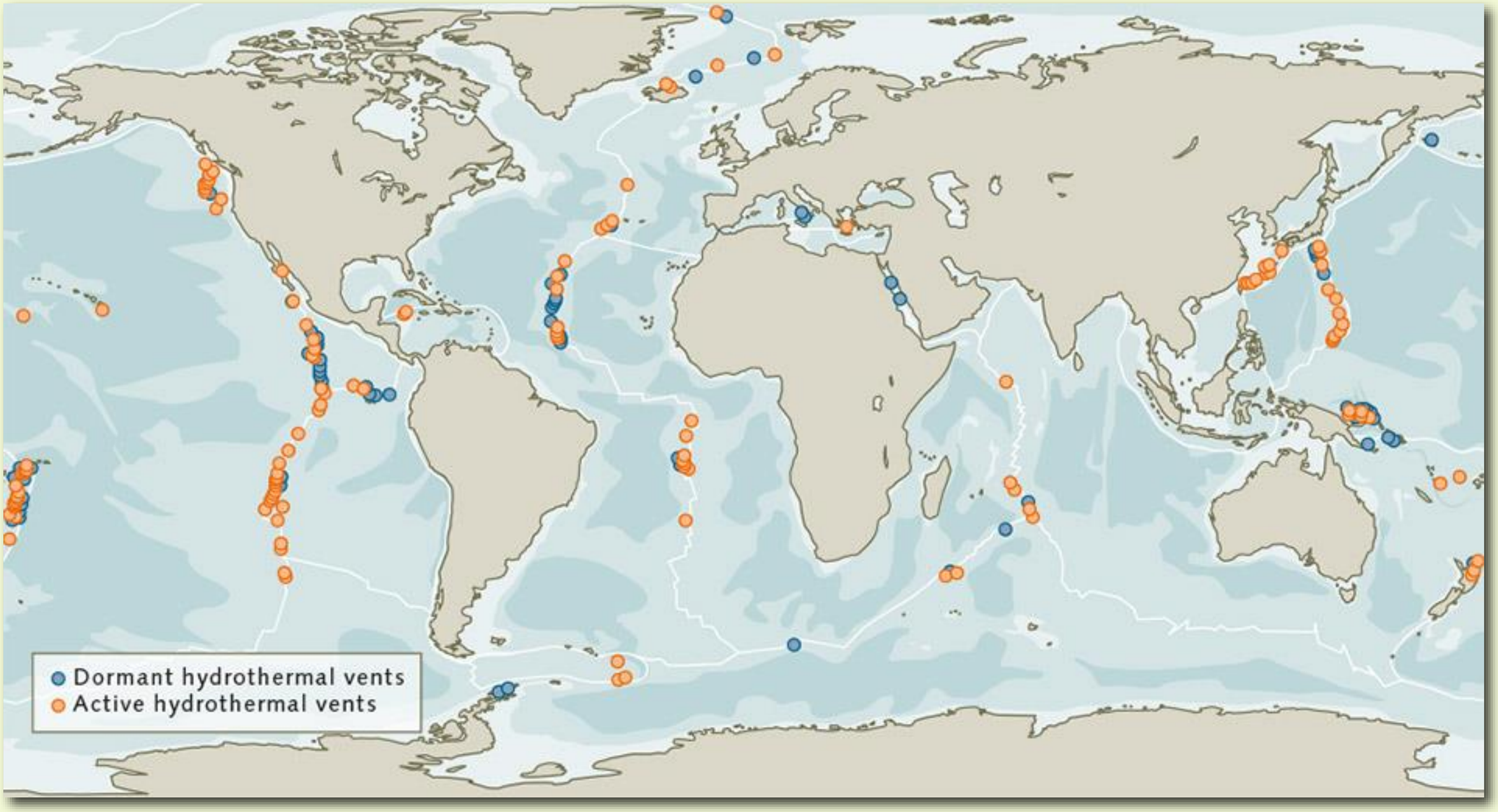
Mining Resources: Polymetallic Massive Sulphides

Distribution



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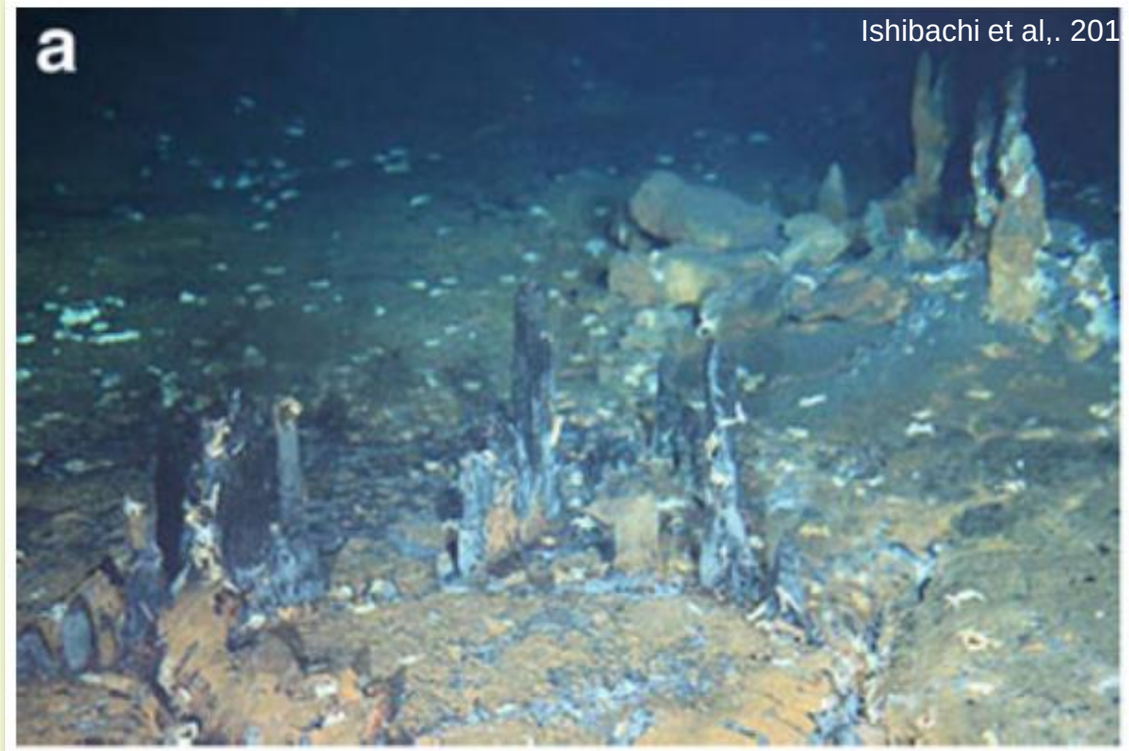

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The “Area”

Table 2. Licenses Applied to/Granted for PMS to by the International Seabed Authority in the “AREA”

	Contractor	Contract signed	Expiration of Contract	Sponsoring State	General geographical location	Resource	Area (km²)
1	China Ocean Mineral Resources Research and Development Association (COMRA)	18 November 2011	17 November 2026	China	Southwest Indian Ridge, Indian Ocean	polymetallic sulphides	10000
2	Government of the Russian Federation	29 October 2012	28 October 2027	Russian Federation	Mid-Atlantic Ridge, Atlantic Ocean	polymetallic sulphides	10000
3	Government of the Republic of Korea	24 June 2014	23 June 2029	Korea	Central Indian Ridge, Indian Ocean	polymetallic sulphides	10000
4	Institut français de recherche pour l'exploitation de la mer (INFREMER)	18 November 2014	17 November 2029	France	Mid-Atlantic Ridge, Atlantic Ocean	polymetallic sulphides	10000
5	Government of India	approved, to be signed		India	Central Indian Ocean	polymetallic sulphides	
6	Federal Institute for Geosciences and Natural Resources of Germany	approved, to be signed		Germany	Central Indian Ocean	polymetallic sulphides	

Mining Resources: Cobalt Crust

Orogeny

Precipitates of manganese oxide and iron hydroxides associated with the oxygen minimum zone of the water column

Mineral Ores

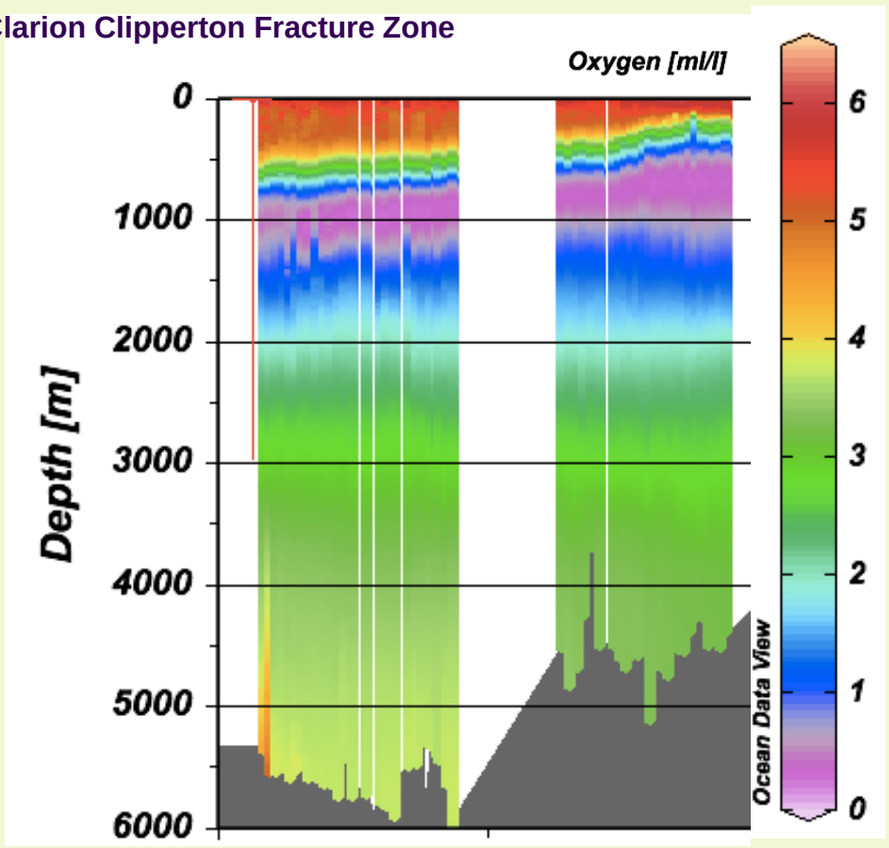
Co, Zn, Ni, Cu and REE, if Mn is the dominant precipitate. Pb, Mo if the precipitate is iron oxihydroxides

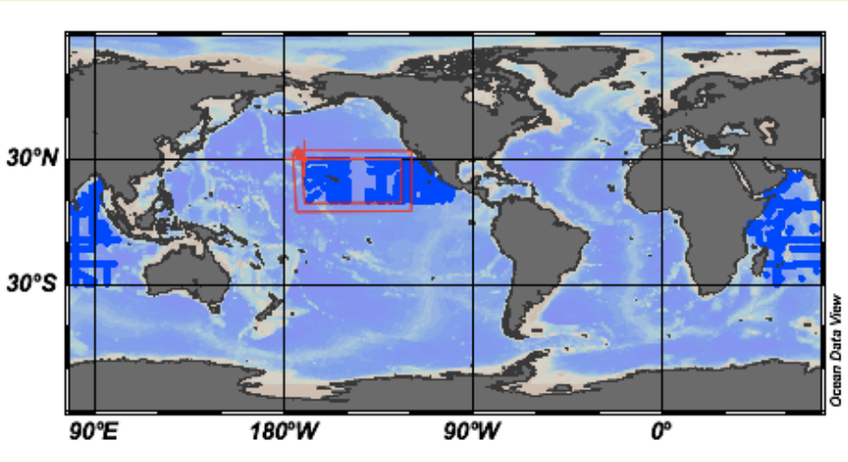
Distribution

This process occurs between 500 to 2000 meters water depth.

Mining Resources: Cobalt Crust

Clarion Clipperton Fracture Zone





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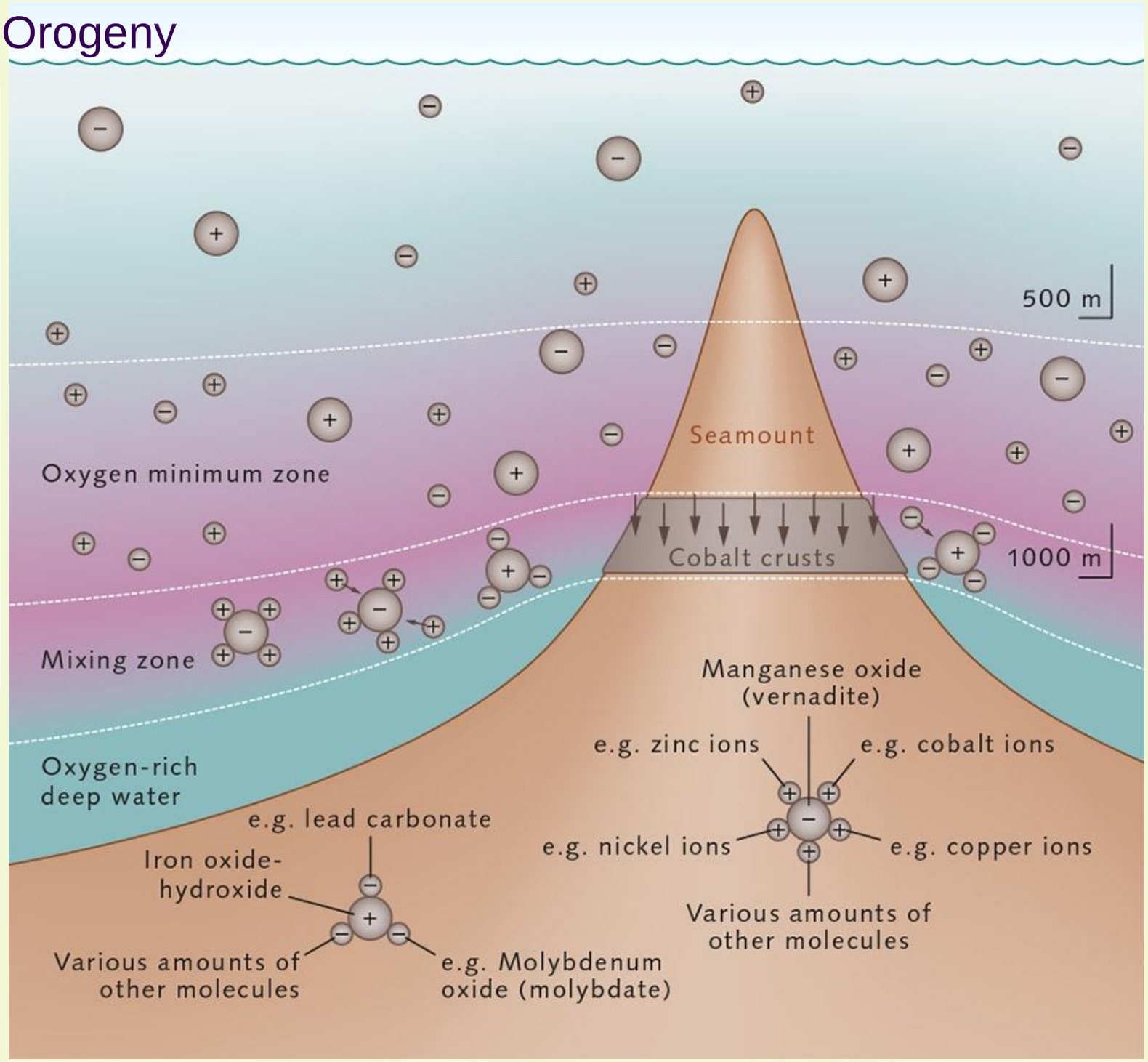
Orogeny



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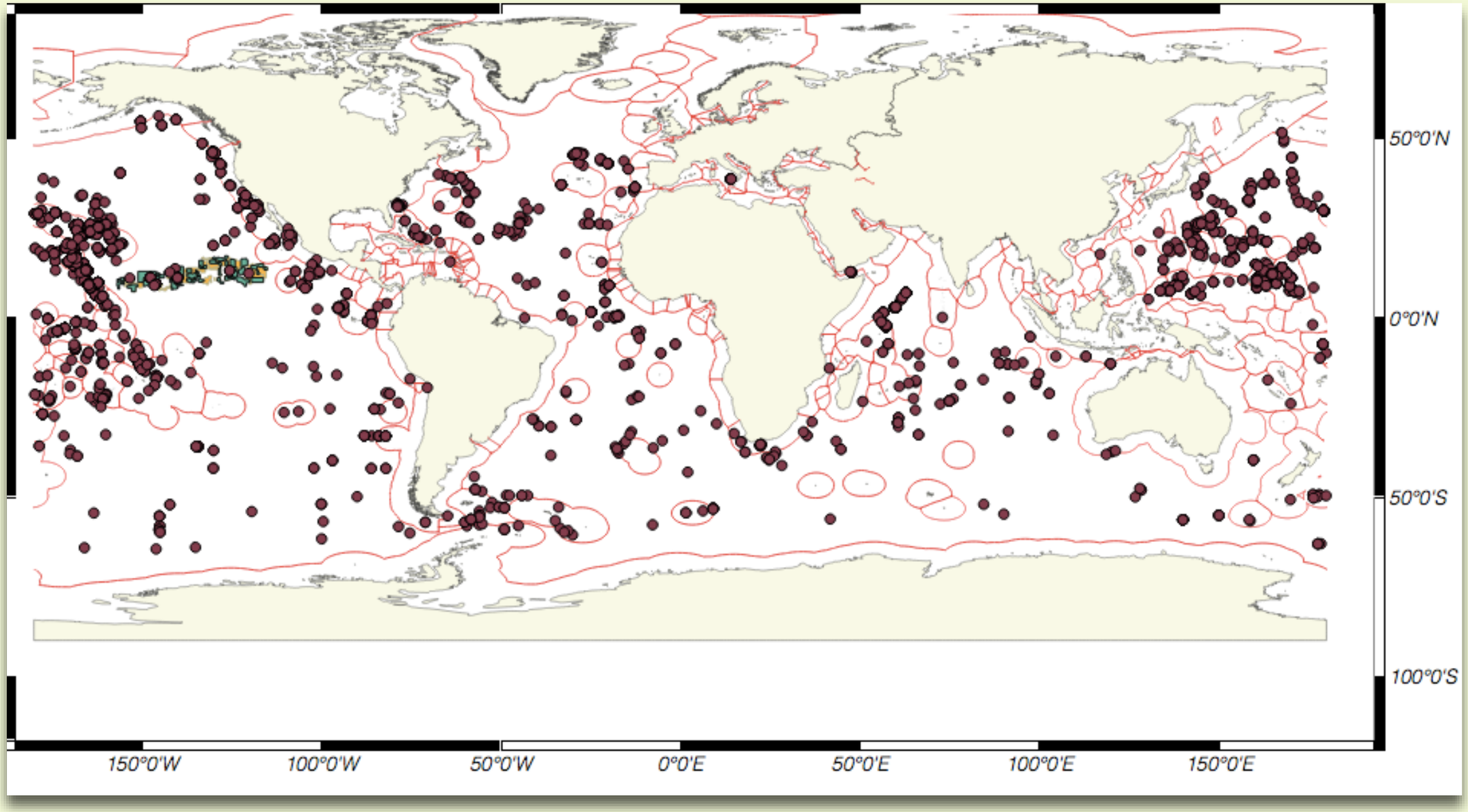
Mining Resources: Cobalt Crust

Distribution



Prepared for Joint Meeting ICPC-ISA,
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Cobalt Crust

Contractor's Area

Exclusive Economic Zone (EEZ)

Reserved Area

Worldwide Marine Mineral Deposits

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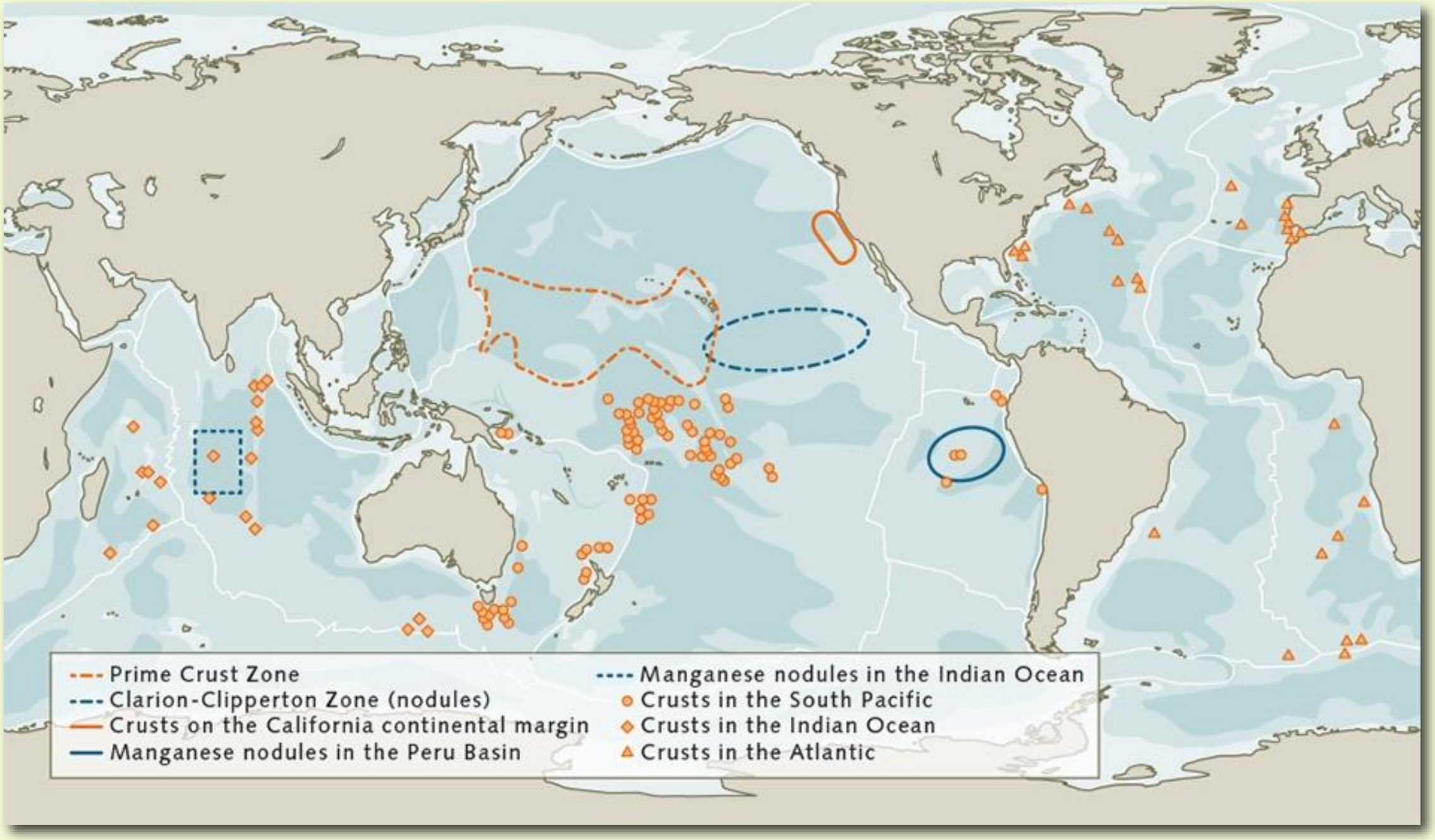
Mining Resources: Cobalt Crust

Distribution



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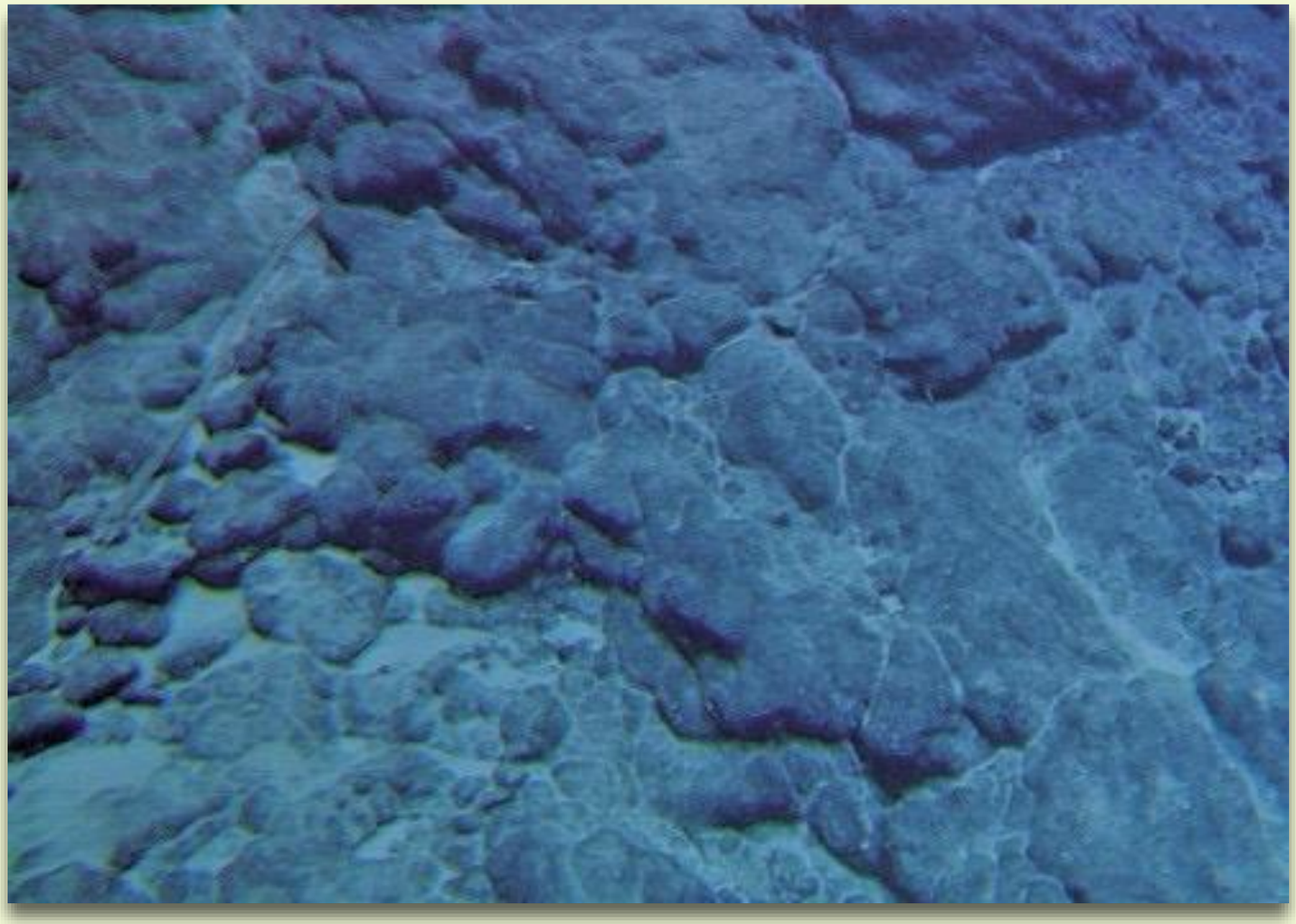
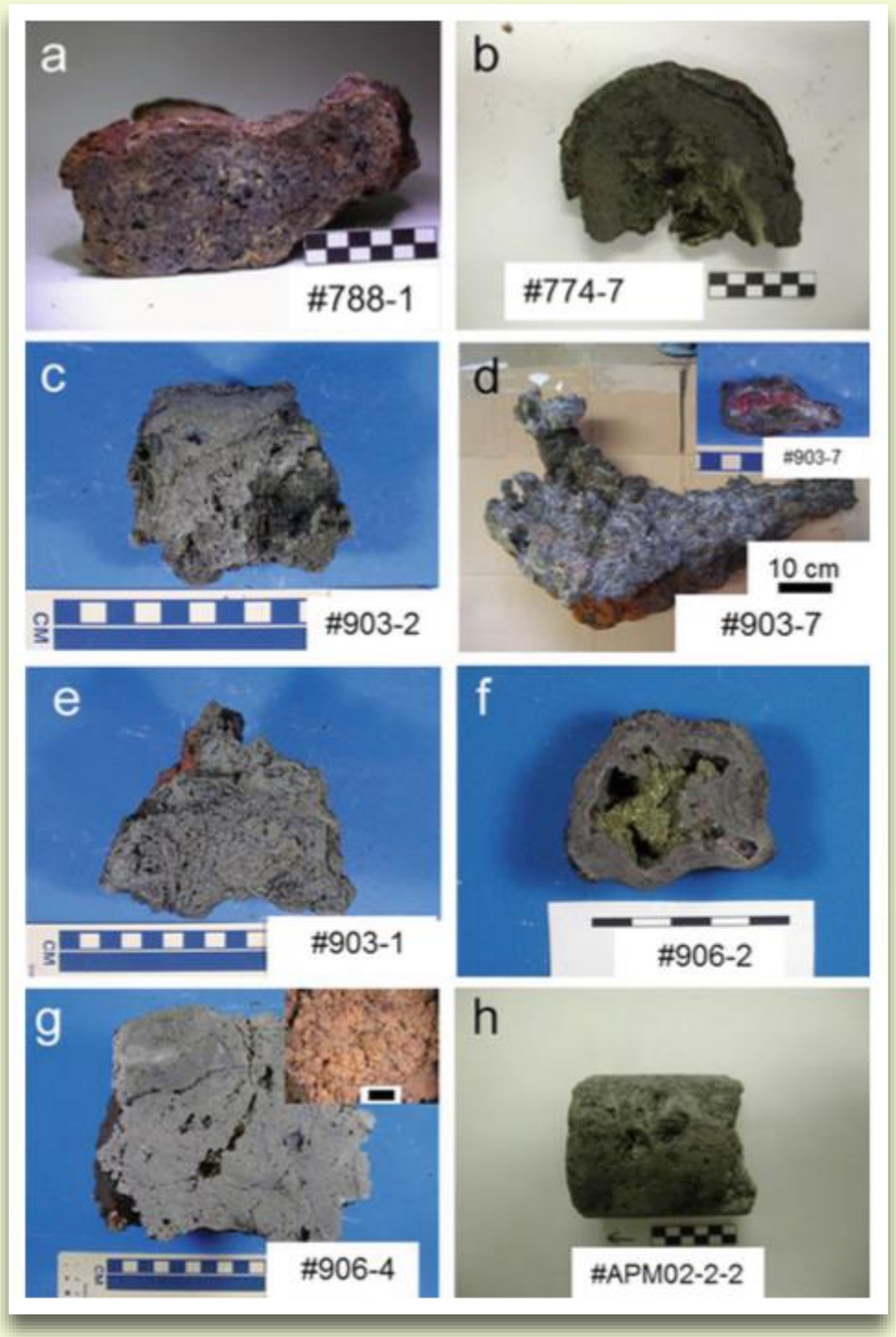
Mining Resources: Cobalt Crust





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The “Area”

Table 3. Licenses Applied to/Granted for CC to by the International Seabed Authority in the “AREA”

	Contractor	Contract signed	Expiration of Contract	Sponsoring State	General geographical location	Resource	Area (km²)
1	Japan Oil, Gas and Metals National Corporation (JOGMEC)	27 January 2014	26 January 2029	Japan	Western Pacific Ocean	cobalt-rich ferromanganese crusts	3000
2	China Ocean Mineral Resources Research and Development Association (COMRA)	29 April 2014	28 April 2029	China	Western Pacific Ocean	cobalt-rich ferromanganese crusts	3000
3	Ministry of Natural Resources and Environment of the Russian Federation	approved, to be signed		Russian Federation	Western Pacific Ocean	cobalt-rich ferromanganese crusts	
4	Companhia de Pesquisa de Recursos Minerais S.A.	approved, to be signed		Brazil	Rio Grande Rise (about 1,100 km from the coast of the Rio Grande do Sul State (Brazil)	cobalt-rich ferromanganese crusts	

Deep Sea Mining Framework

time (y)

15

Prospection

Defining Exploration Area vs Reserved Area

Exploration*

Geology
Environmental
Feasibility Study - Mining Test
Resource Classification

20 to 30

Exploitation

Defining Mineable Area
Plan of work and mining schedule
Environmental Impact Assessment/Statement
Remediation/Mitigation Plan of work

External Factors

Rules and Regulations for Prospection and Exploration

Economical Constrain
Socialisation
Royalty Regime

Deep Sea Mining Code

**Exploration period could be extended up to 3 times, 5 year extension periods*

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Table 1. Status of Exploration/exploitation Plan of Work of contractors for PMN [March 2015]

		Exploration period of 15 years				explotation		
	contractor	geology	environment	Mining Test	Res. Classification	grading	Area	EIS
1	Interoceanmetal Joint Organization	yes	not yet	not yet	?			
2	Yuzhmorgeologiya	yes	not yet	not yet	indicated (NAEN)			
3	Government of the Republic of Korea	yes	yes	not yet	measured/estimated (?)			
4	China Ocean Mineral Resources Research and Development Association (COMRA)	yes	yes	not yet	indicated (?)			
5	Deep Ocean Resources Development Co. Ltd. (DORD)	yes	yes	not yet	inferred (JORC)			
6	Institut français de recherche pour l'exploitation de la mer (INFRAMER)	yes	not yet	not yet	estimated (?)			
7	Government of India	yes	yes	not yet	?			
8	Federal Institute for Geosciences and Natural Resources of Germany	yes	yes	not yet	indicated (NI 43-101)			
9	Nauru Ocean Resources Inc. (NORI)	not yet	not yet	not yet	inferred (JORC & NI 43-101)			
10	Tonga Offshore Mining Limited	not yet	not yet	not yet	inferred (NI 43-101)			
11	UK Seabed Resources Ltd.	not yet	not yet	not yet	na			
12	Marawa Research and Exploration Ltd.	not yet	not yet	not yet	na			
13	Global Sea Mineral Resources NV	not yet	not yet	not yet	na			
14	Ocean Mineral Singapore Pte Ltd (OMS)	not yet	not yet	not yet	na			
15	UK Seabed Resources Ltd.	not yet	not yet	not yet	na			
16	Cook Islands Investment Corporation	not yet	not yet	not yet	na			

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Environmental Management Plan (EMP): Clarion Cliperton Z

Workshop held in 2010 – International Workshop for the Establishment of a Regional Environmental Management Plan for the Clarion-Clipperton Zone in the Central Pacific

Results issued by LTC as ISBA/17/LTC/7

Decision of the Council contained in ISBA/17/C/19

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The EMP: Entire CCZ

Establish a periodically updated environmental baseline data for the region

Consider the environmental risks to the Clarion-Clipperton Zone posed by technological developments in mining technologies.

Undertake cumulative environmental impact assessments as necessary based on exploitation proposals;

Establish guidelines for impact and preservation reference areas: Licensed Areas and areas of Particular Environmental Interest (PEI)

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Taxonomic standardisation: guideline generation

Megafauna Taxonomic Standardisation Workshop

A Standardised Megafaunal Taxonomy for Exploration Contract Areas in the Clarion-Clipperton Fracture Zone. Marine Research Department of Senckenberg am Meer in Wilhelmshaven, Germany from 10th to 15th June 2013

Macrofauna Taxonomic Standardisation Workshop

A Standardised Macrofauna Taxonomy for Exploration Contract Areas in the Clarion-Clipperton Fracture Zone. Korea Institute of Oceanography Science and Technology -KIOST- 23-30 November, 2014

Meiofauna Taxonomic Standardisation Workshop

A Standardised Meiofauna Taxonomy for Exploration Contract Areas in the Area. University of Ghent, Belgium December 14 - 18, 2015

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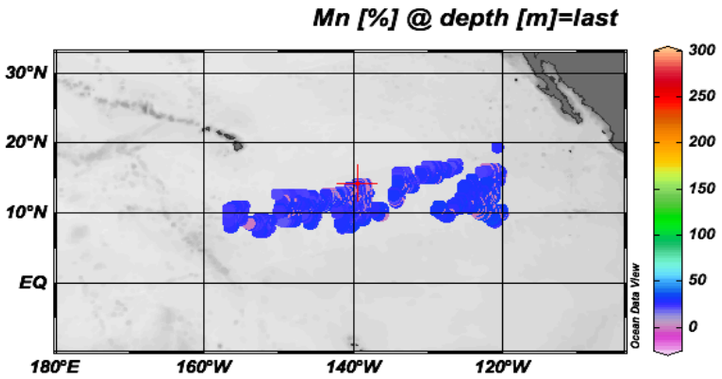
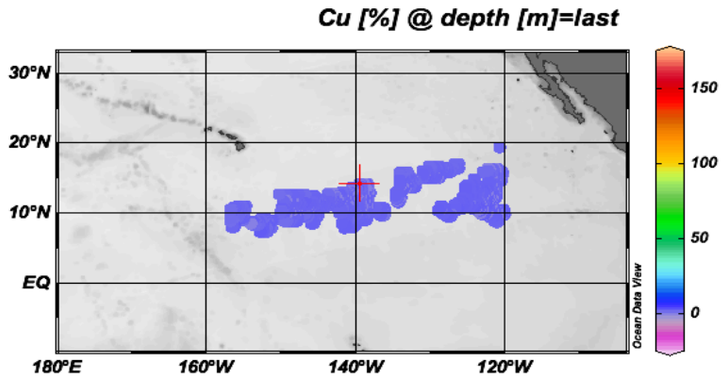
Methodologies standardization: guideline generati

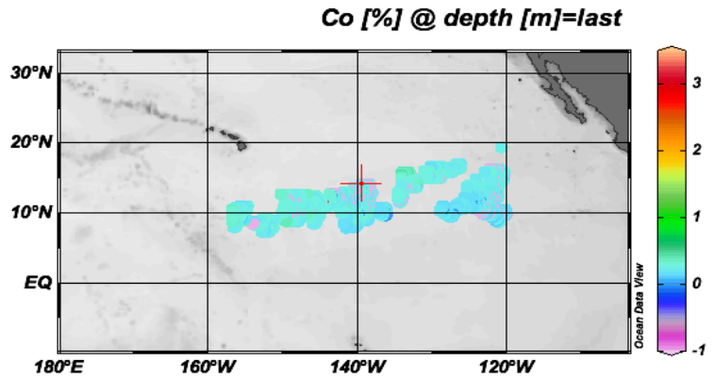
Mineral Resource Classification Workshop

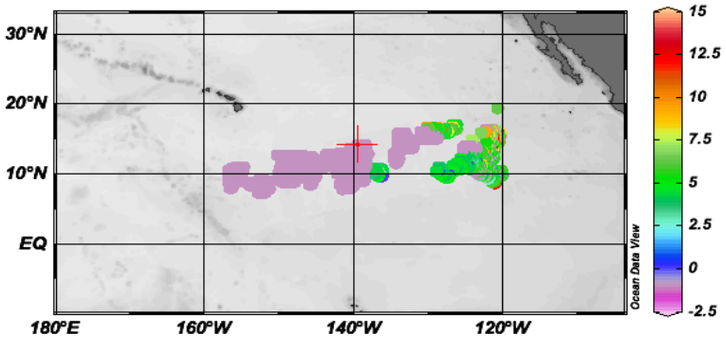
Contractors and experts in Mineral Resource Classification, Goa-India, October 14-17, 2014

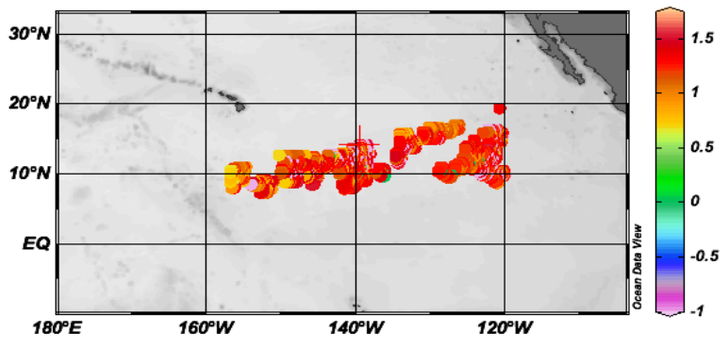
THE CLARION-CLIPPERTON ZONE DATABASE: PMN

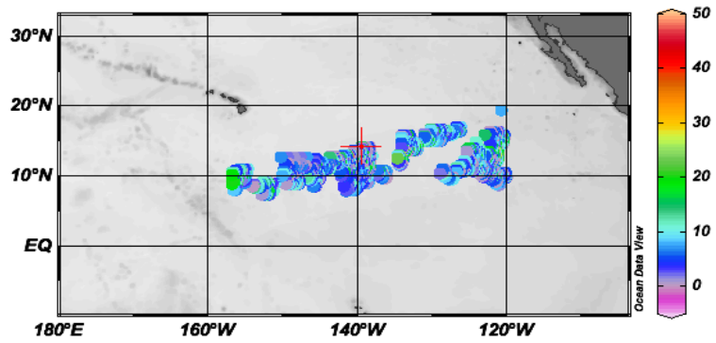


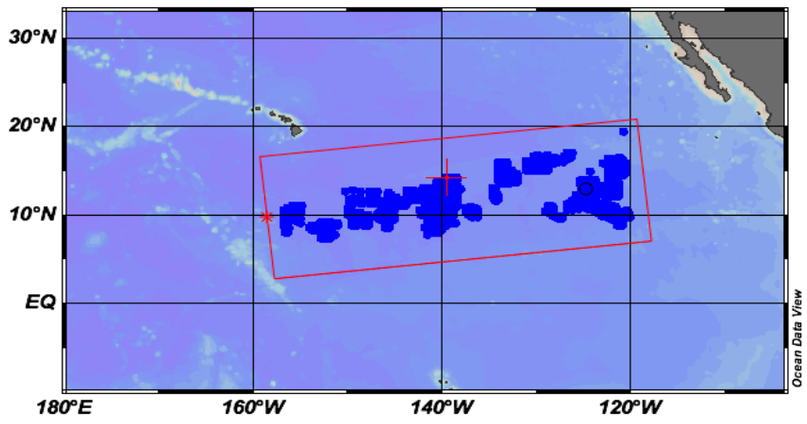












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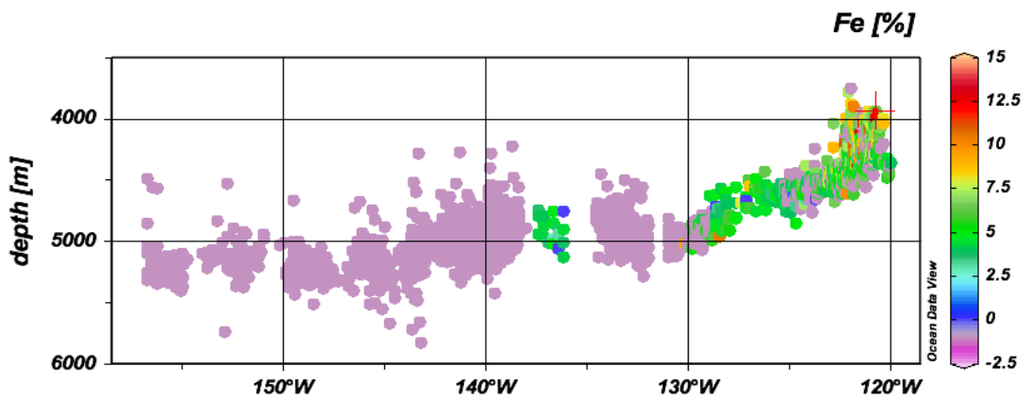

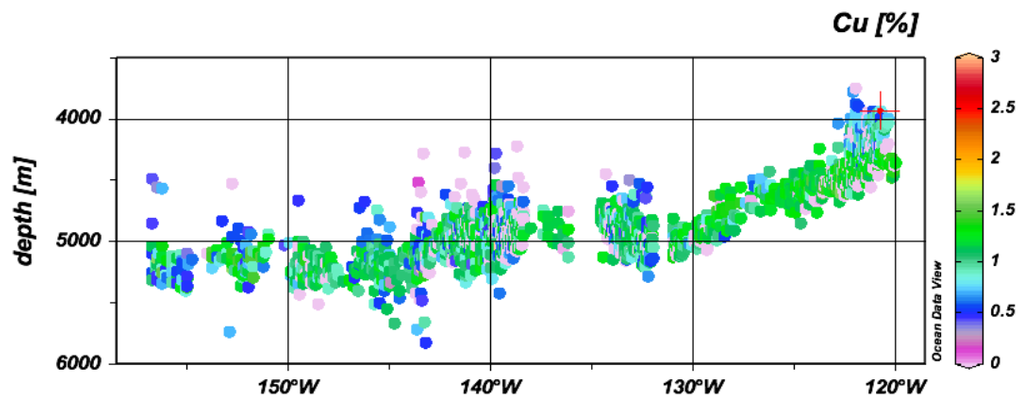

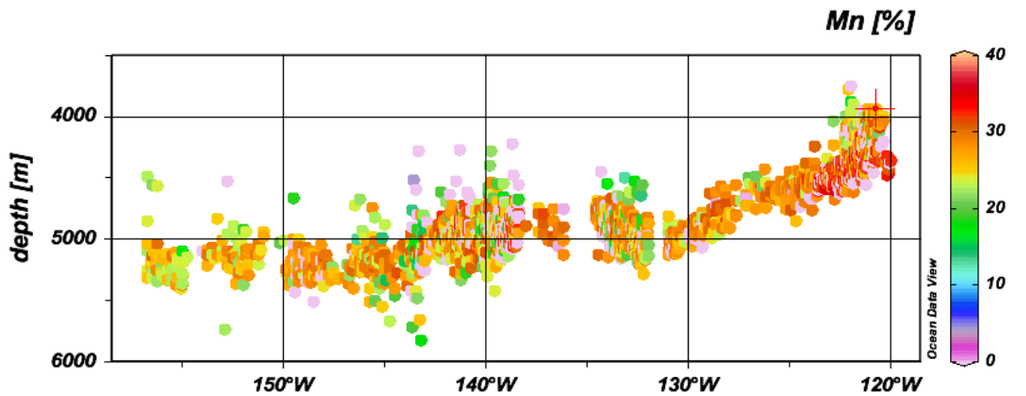

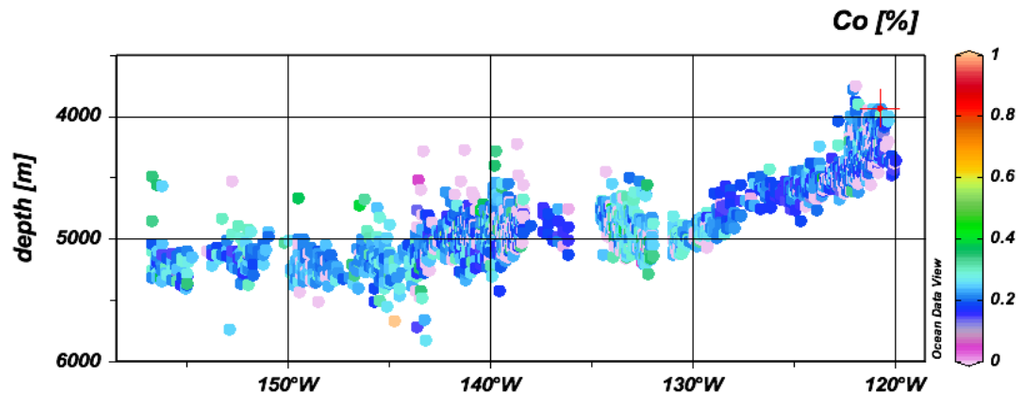

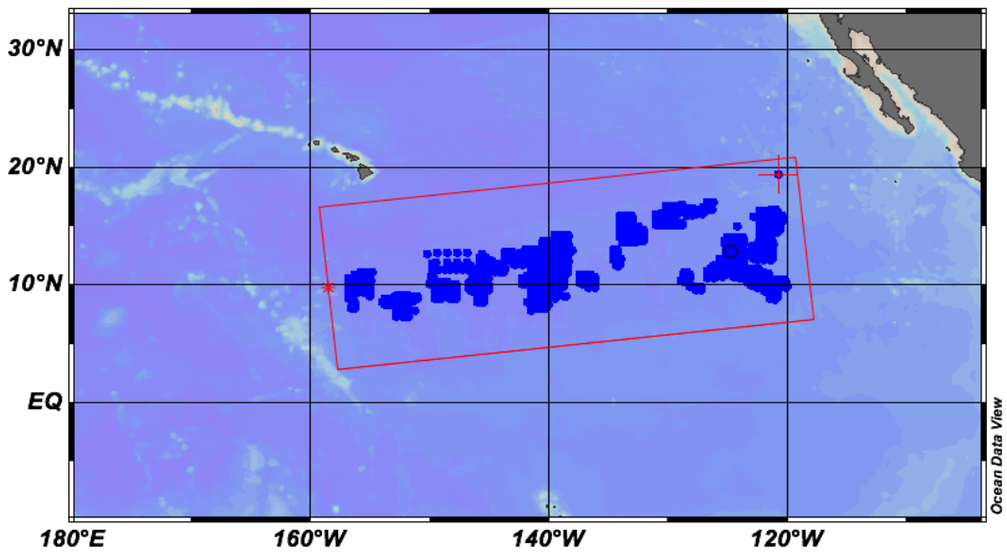

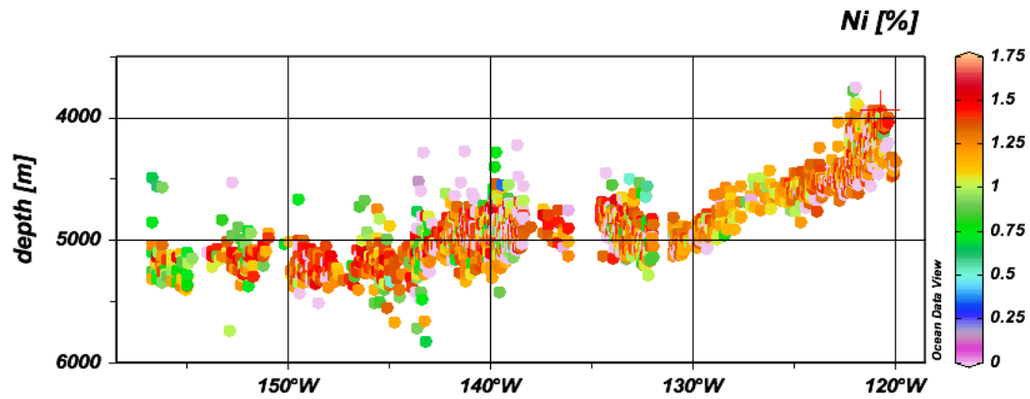

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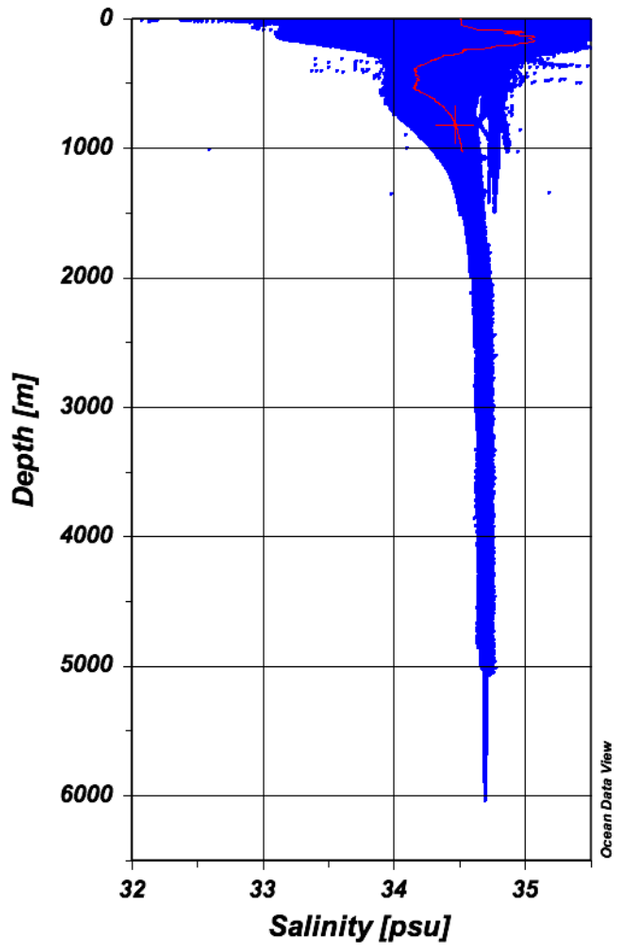
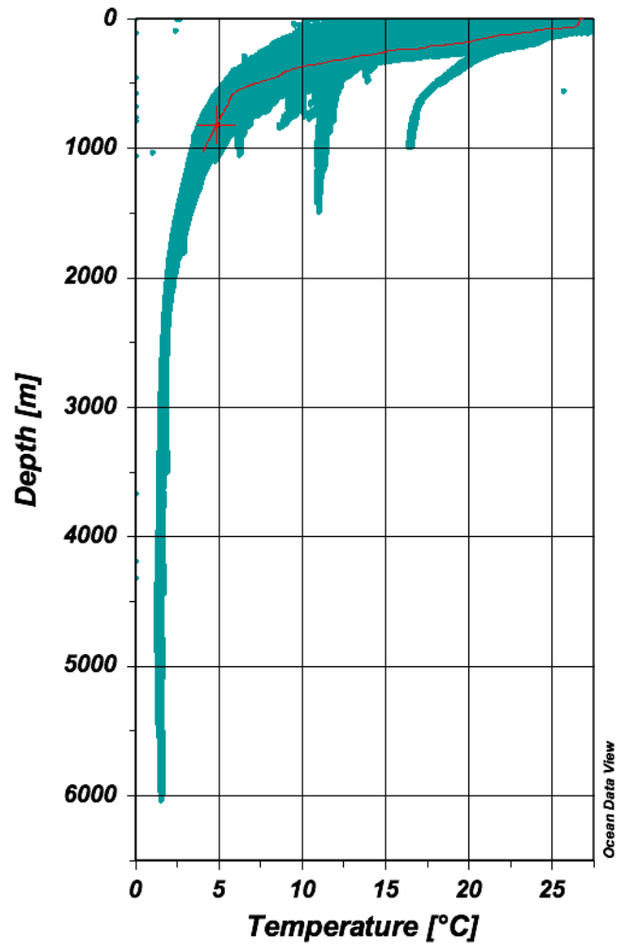
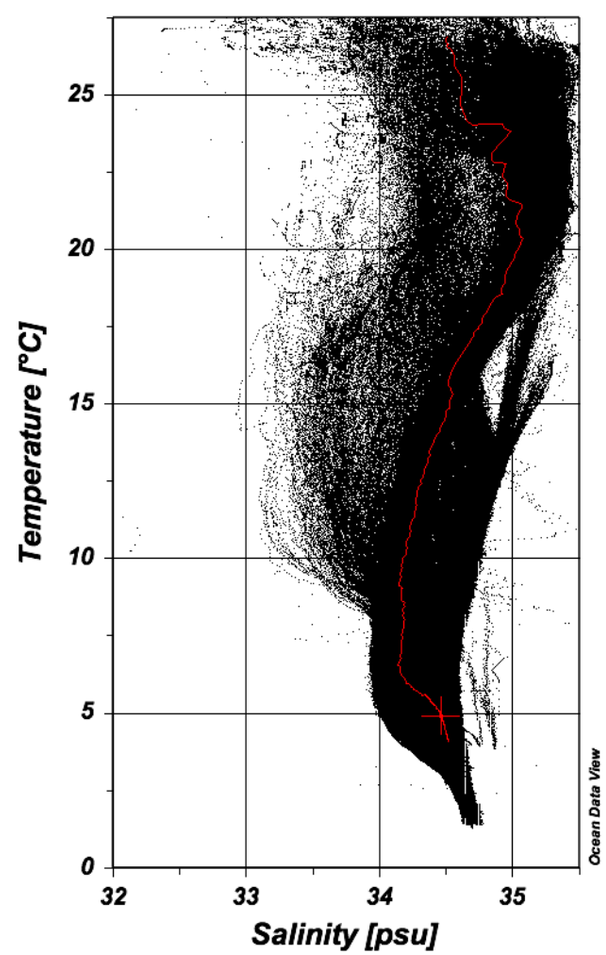
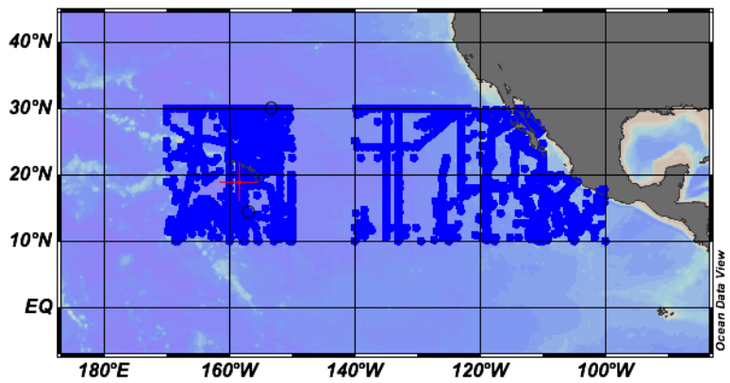
THE CLARION-CLIPPERTON ZONE DATABASE WATER COLUMN









Prepared by S. Mulsow

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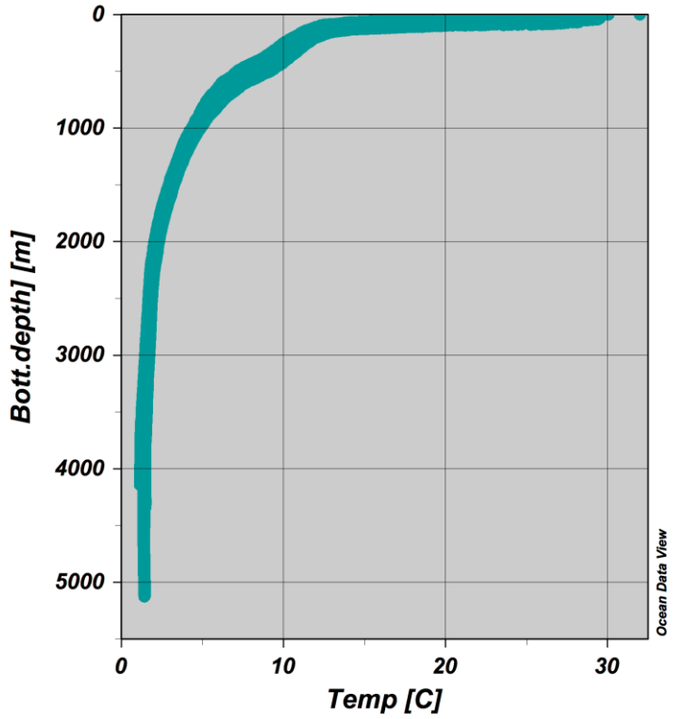
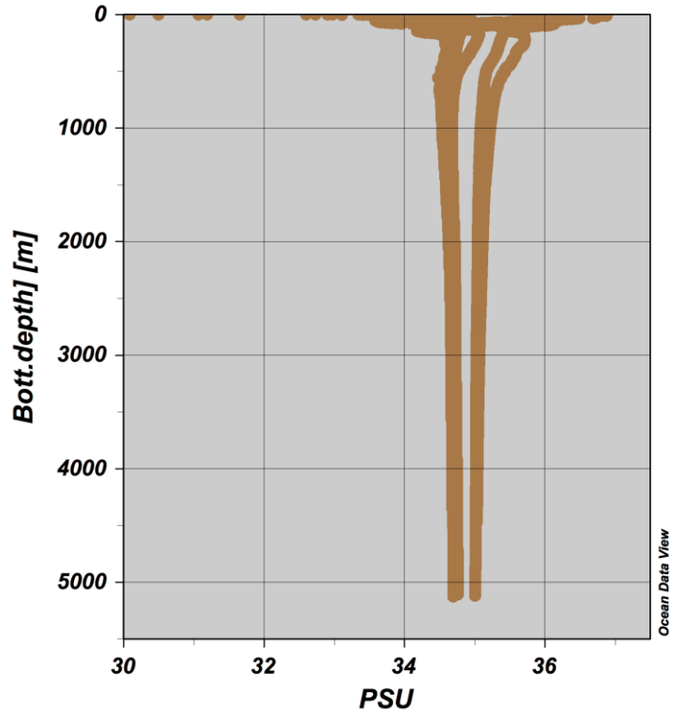
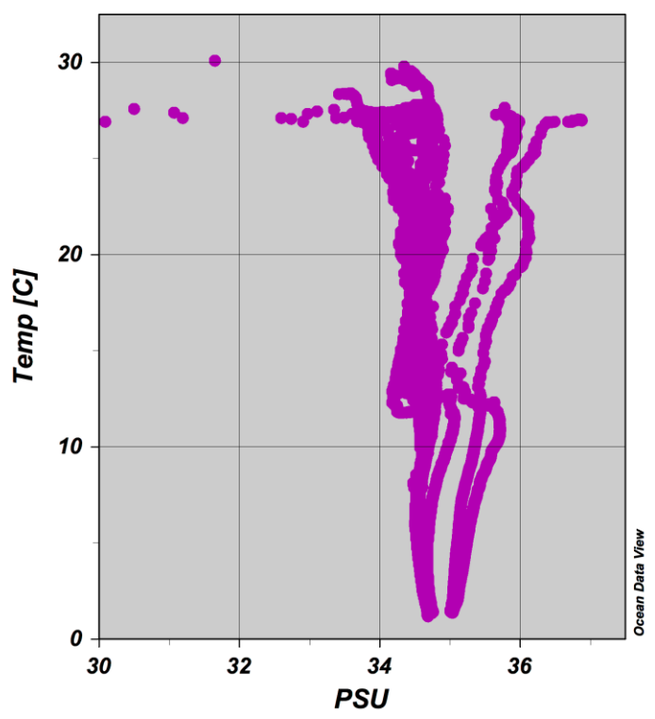
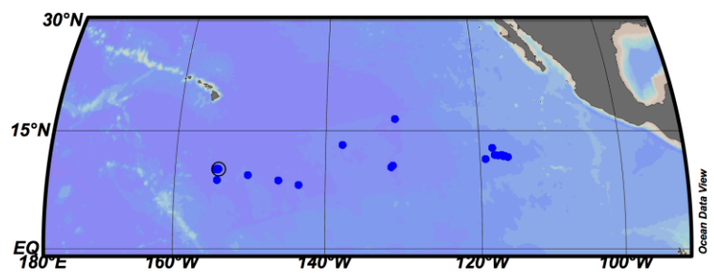
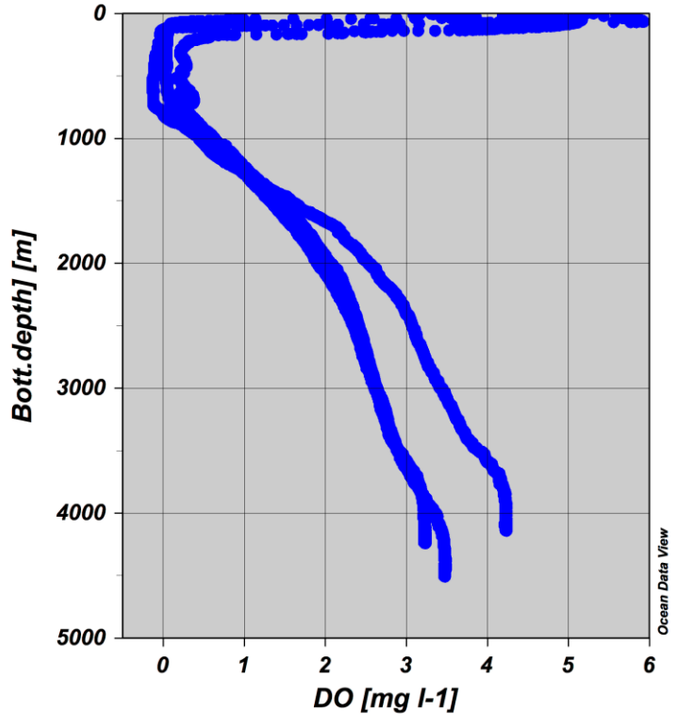
THE CLARION-CLIPPERTON ZONE DATABASE WATER COLUMN











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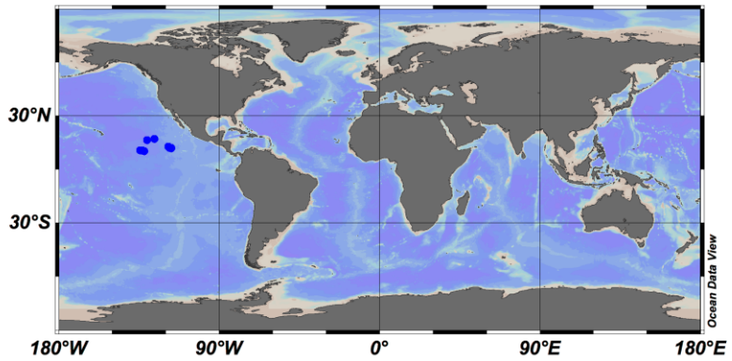
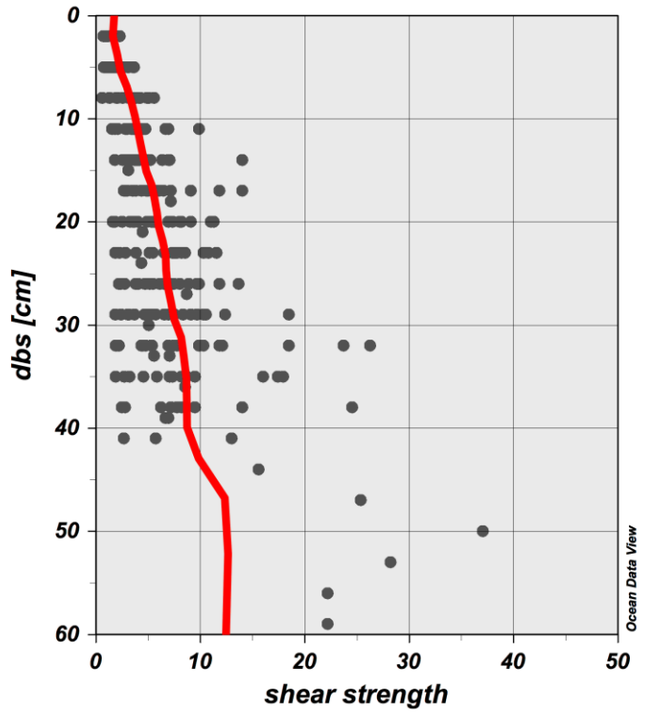
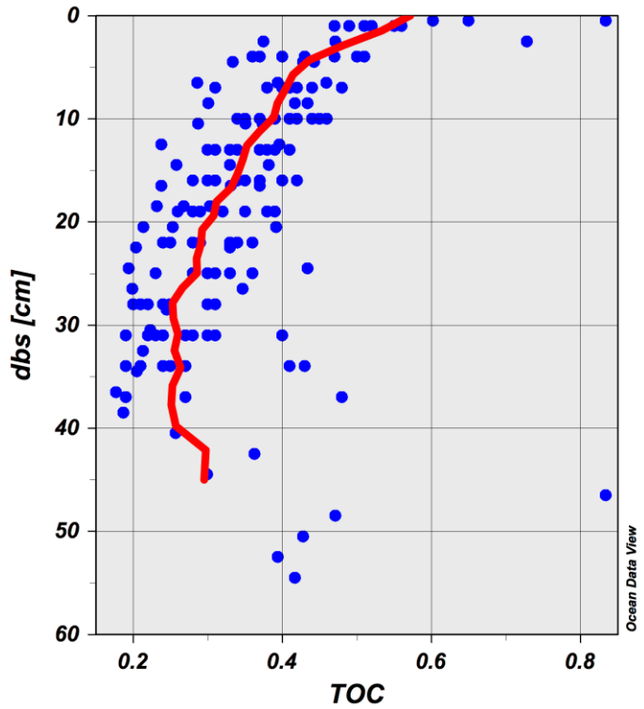
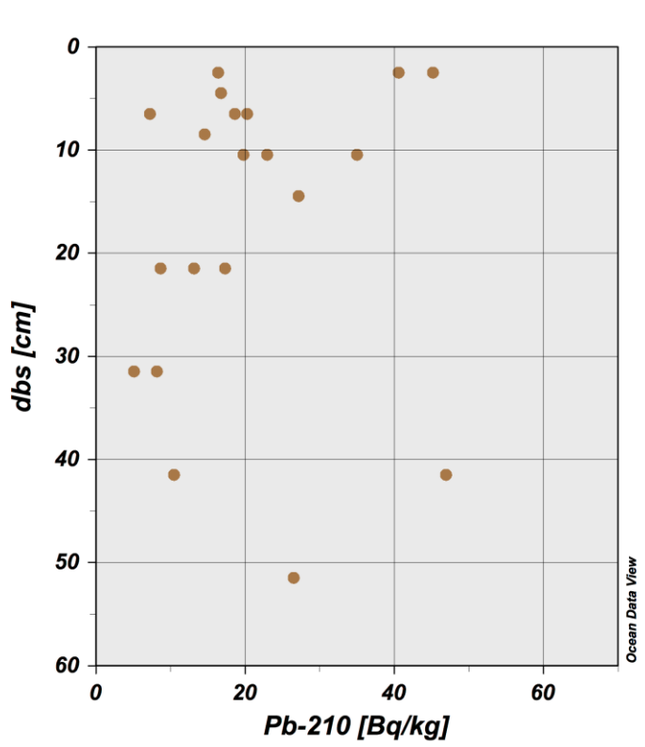
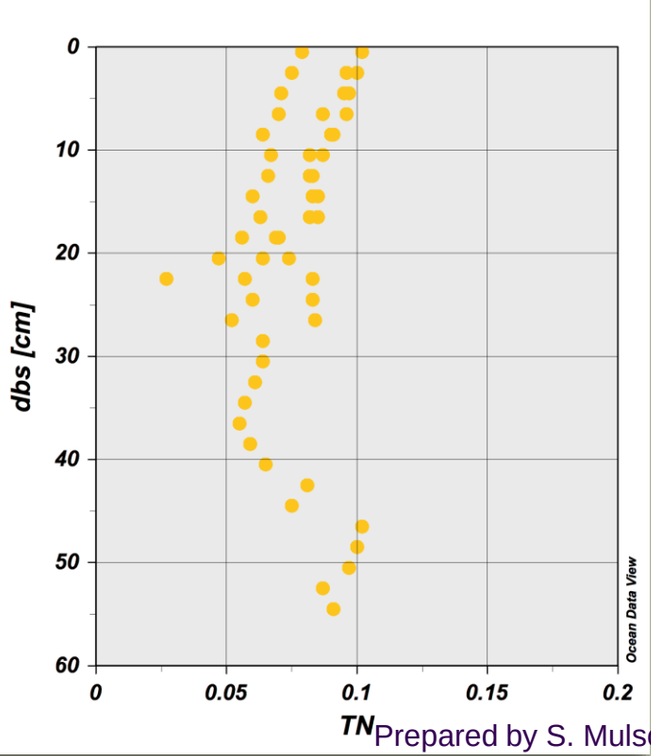
THE CLARION-CLIPPERTON ZONE DATABASE SEDIMENT COLUMN











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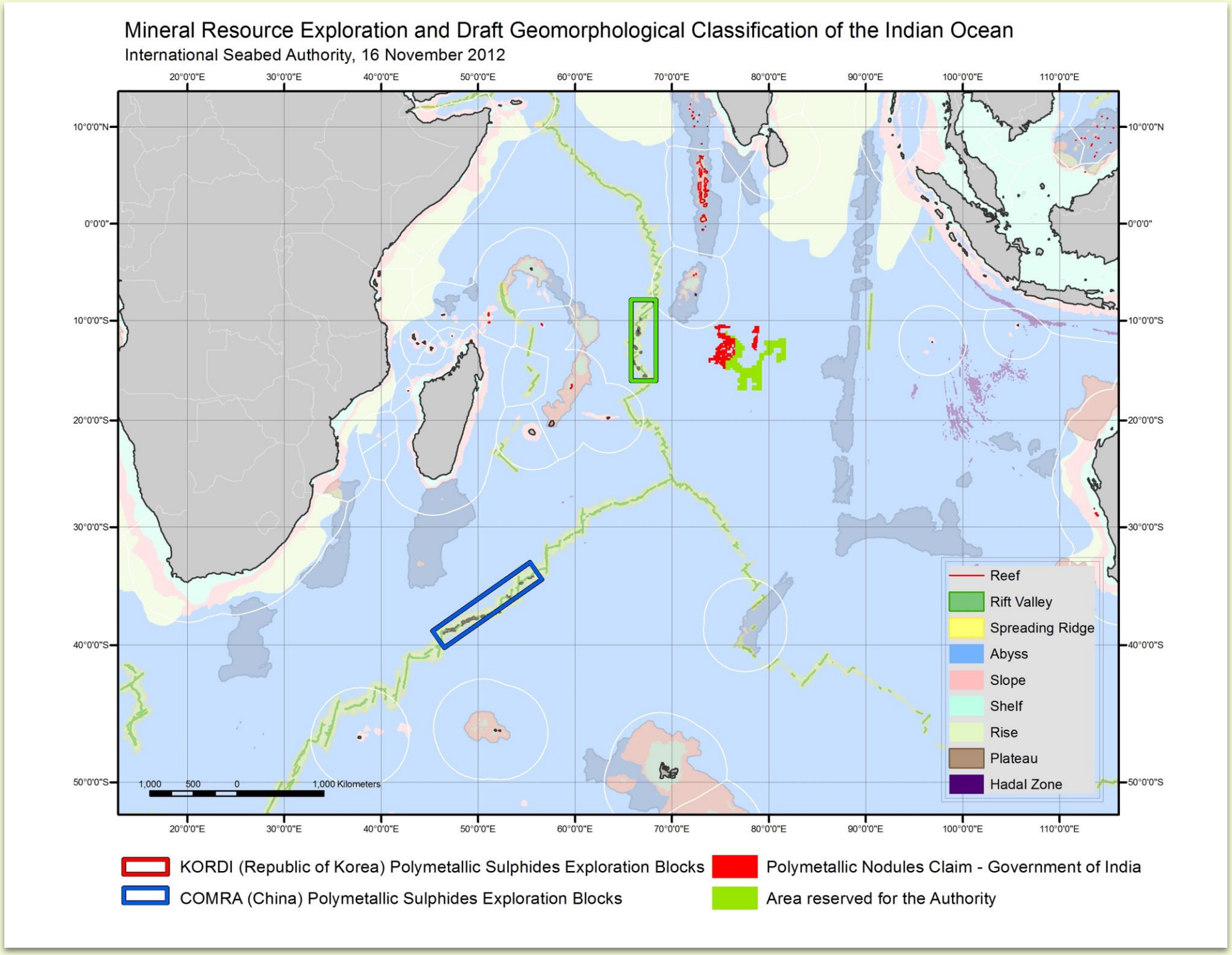
Towards an Environmental Impact Assessment II



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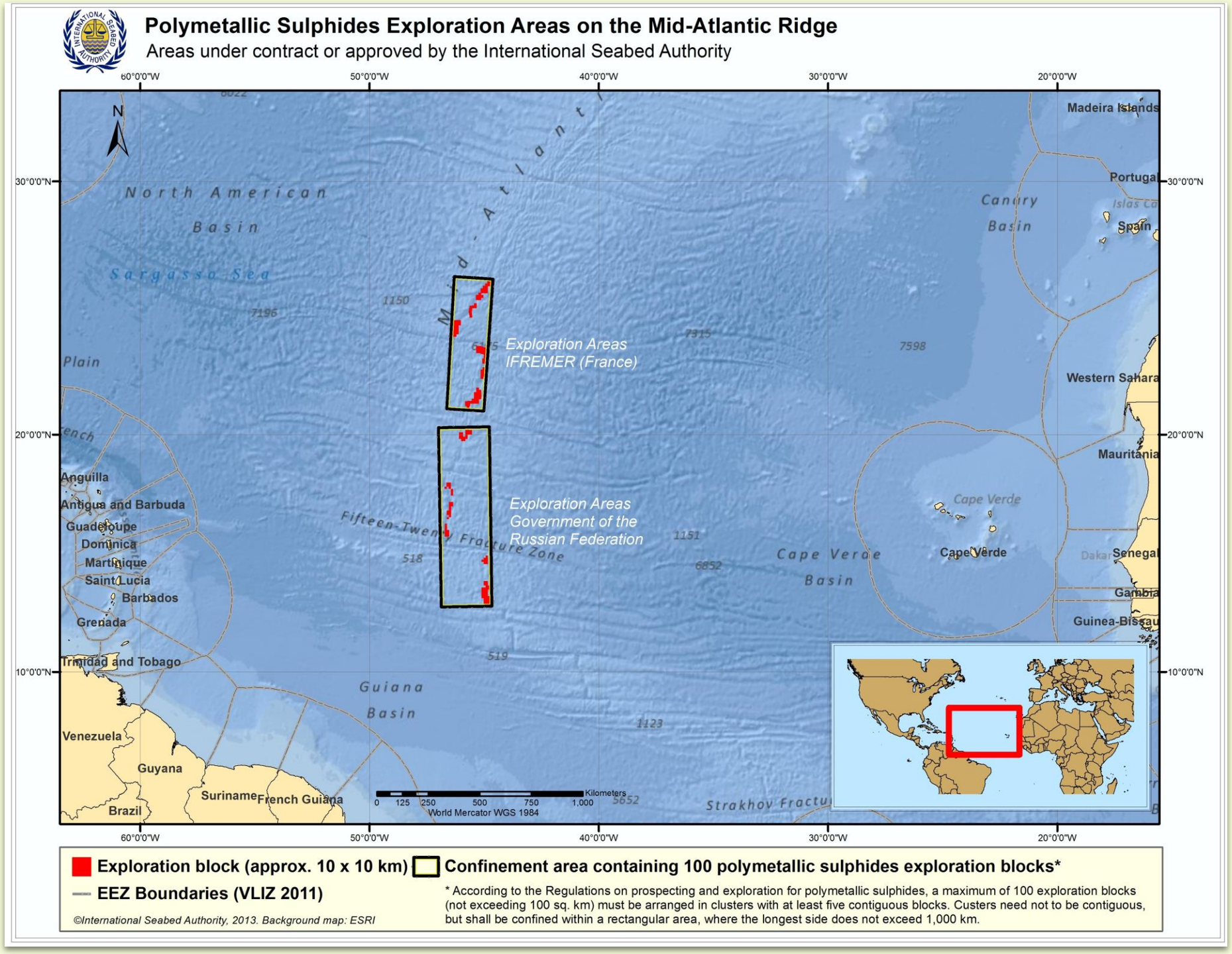
Towards an Environmental Impact Assessment III



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Prospection/exploration Sampling Tools used by Contractors for P

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Epibenthic Sledge Sampler

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PMN collector systems designed

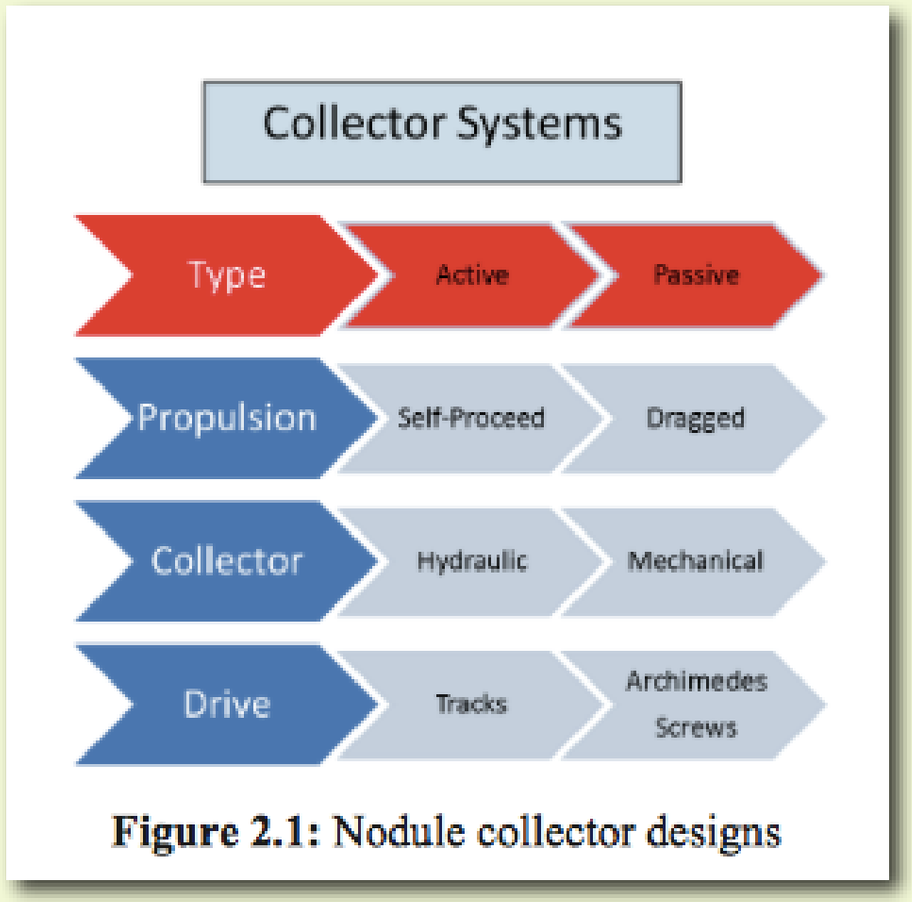

Figure 2.1: Nodule collector designs

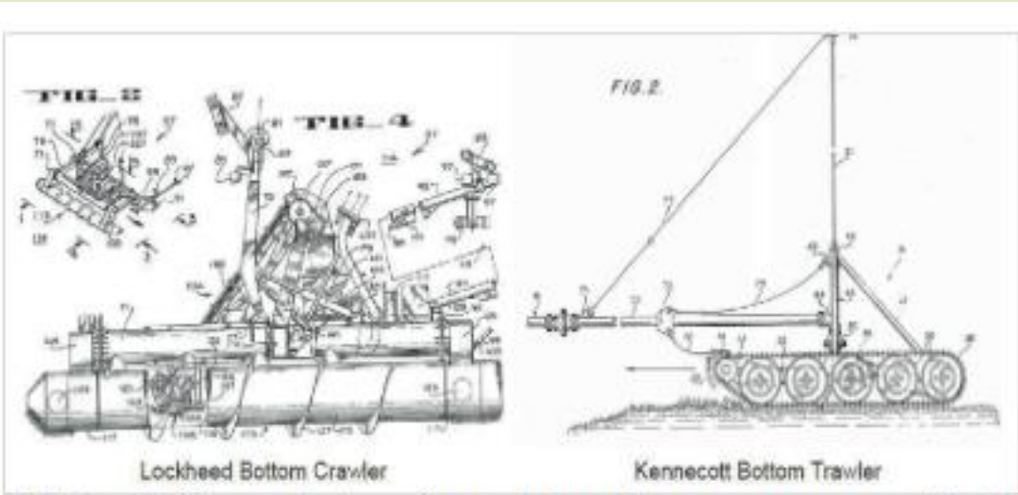

Figure 2.2 Two different designs for nodule collectors as presented by Morgan. The Lockheed bottom Crawler is a self-propelled screw-based design (patented in 2011) whereas the Kennecott Bottom Trawler is a dragged track-based design.

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KYOST (ex KORDI)

MineRO: tethered ROV, poly unit style

MineRO: 4 units system

MineRO: deployment/efficiency

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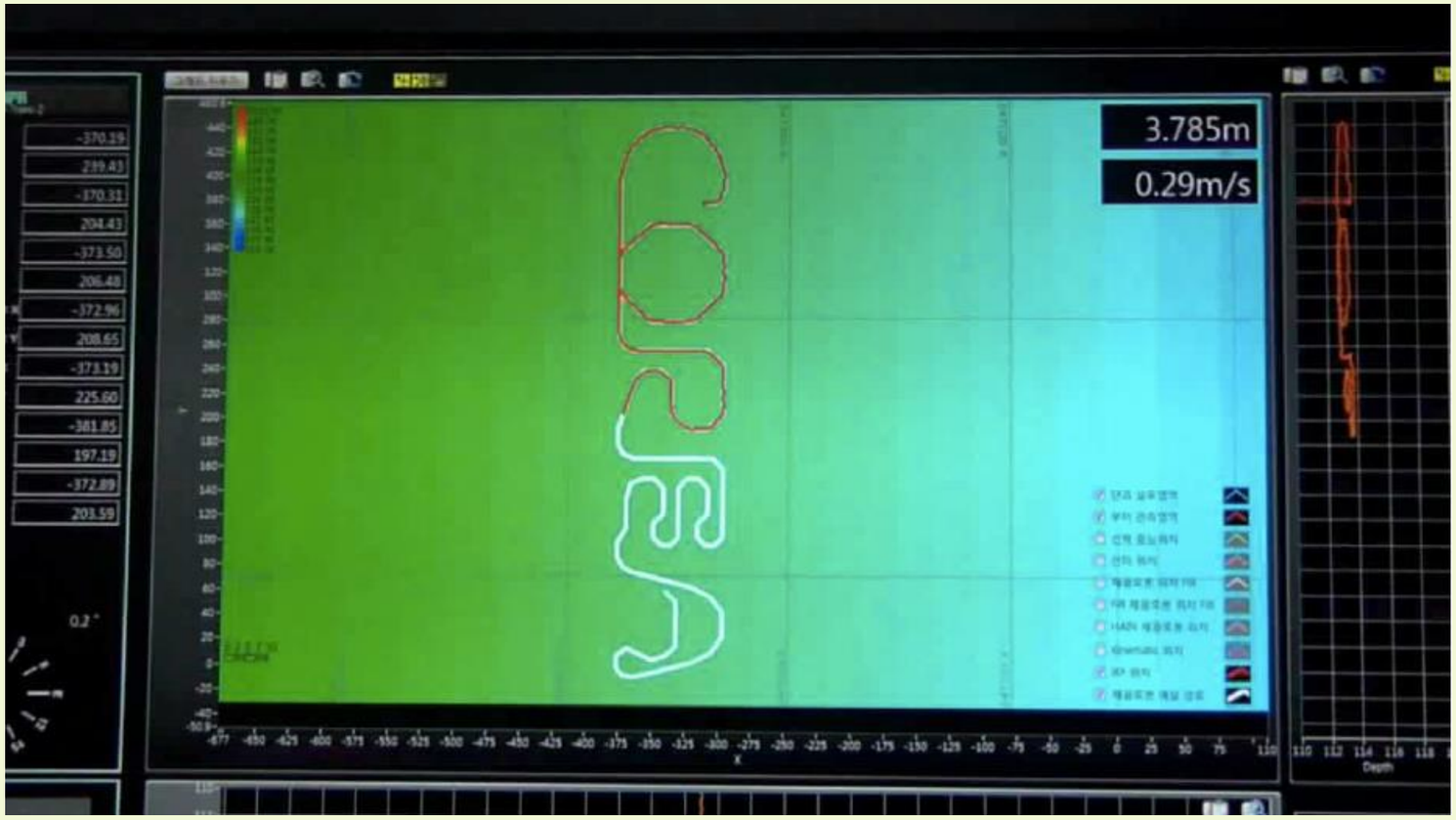
KYOST (ex KORDI)

MineRO: shallow water deployment visualisation,

MineRO: manoeuvrability/flexibility pre-programmed and follow up



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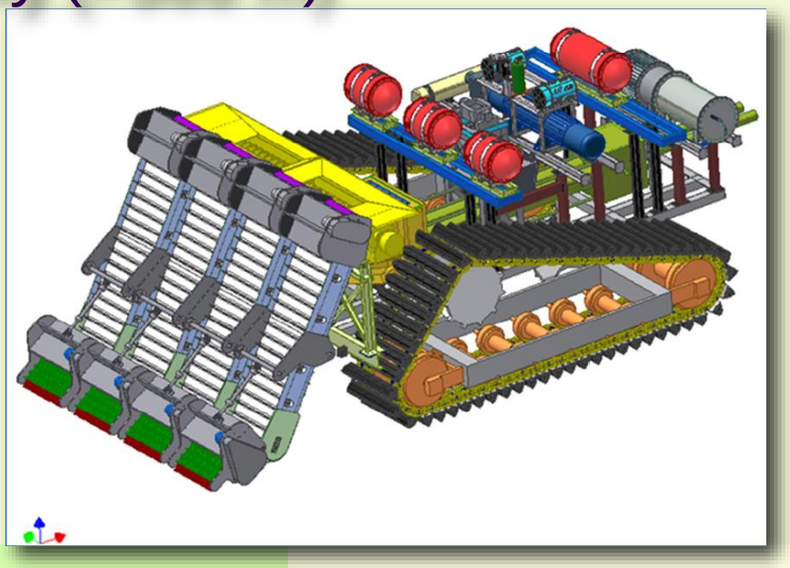
MOES-India

Shallow water pickup system (500 m)

Deep water pickup system design only (>500 m)



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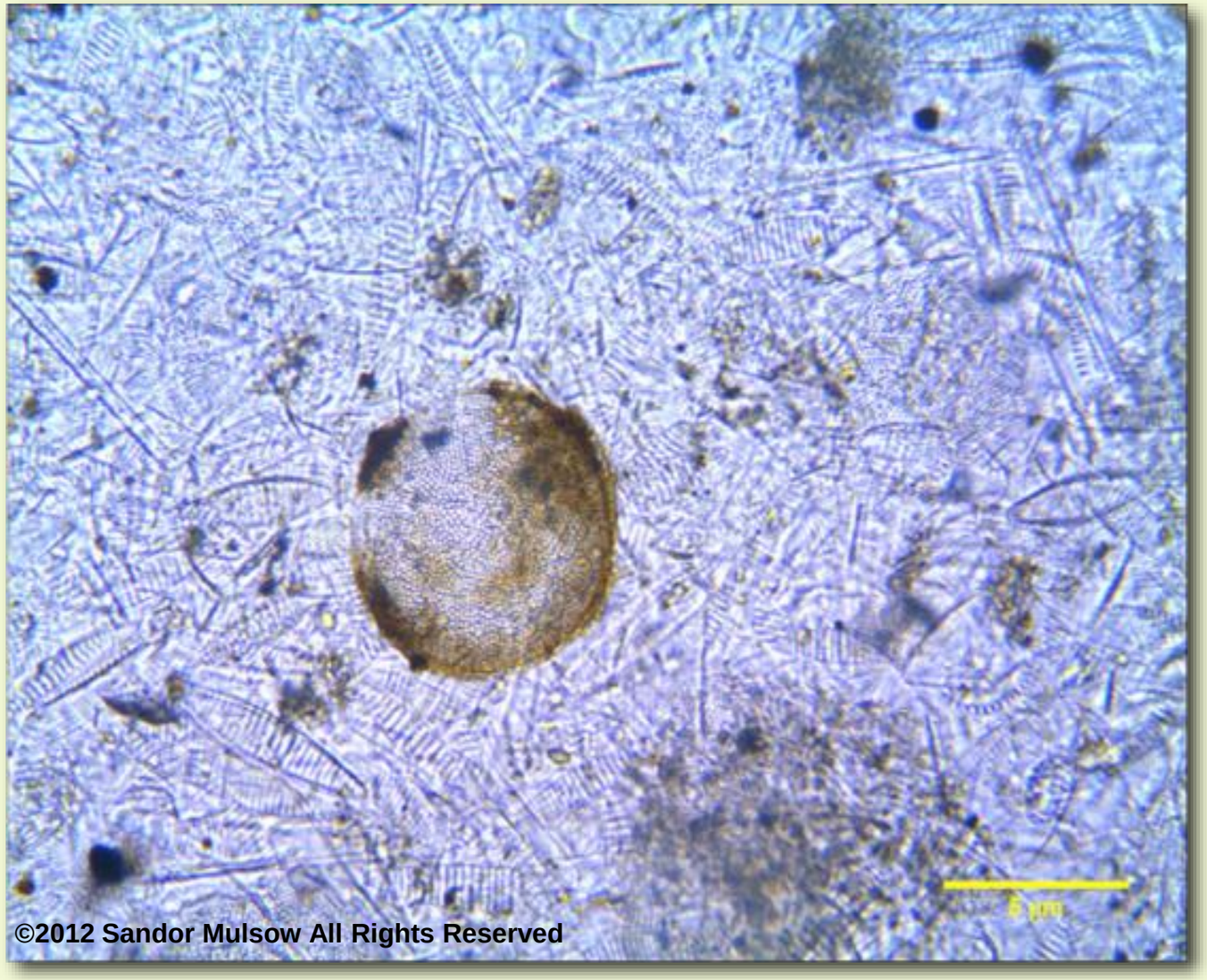
Deep Sea Sediment Constituents: mostly biogenic structures. 4500 m core, section 0-0.5 cm, Southern Ocean, 2012



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Concluding Remarks

Contractors are the main source of activity in Deep Sea Mining directly linked to the International Seabed Authority but we need to ensure that assimilable data is provided in standardized format.

Collaboration of all stakeholders is essential to advance in the understanding of deep sea resources before exploitation, to provide an environmentally sustainable management plan for the wellbeing of everyone.

Thank you

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