Deep Sea Minerals: A New Development Opportunity for the Pacific?

4th DSM Regional Training Workshop
Nadi Fiji
9th – 13th December 2013

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Objectives of the Training Workshop

- To build on the outcomes of the last two Deep Sea Minerals environment workshops.
- To assess site and national perspectives, particularly related to national responsibilities within the EIA process, such as evaluating the EIA, establishing the Environmental Management Plan (EMP), monitoring and enforcement of the EMP.
- To assess regional issues, particularly any policy needs.
- To raise awareness and provide a forum for discussion amongst environment professionals of the emerging Deep Sea Mineral industry, potential issues from an environment sector perspective.
- To assist countries to identify capacity gaps for implementing all steps of the EIA process at national and regional scales and proposing measures to fill these gaps.

Expected Workshop Outcomes

- **Agree on a number of broad outcomes as the way forward for environment management and conservation:**

  - Prepare Guidelines for a Regional Strategic Environmental Assessment (SEA);

  - Draft national EIA template that can be applied to the three different deep sea mineral types;

  - Establish how environmental baseline data are collected;

  - Strengthen capacity to implement the EIA process;

  - Develop a draft regional Environment Management Plan (EMP) template for DSM Activities;

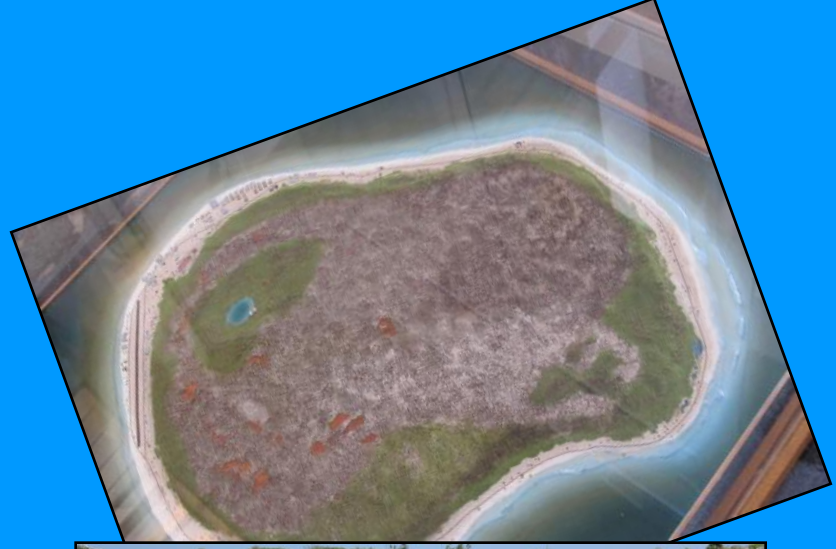
  - Encourage Marine Spatial Planning;

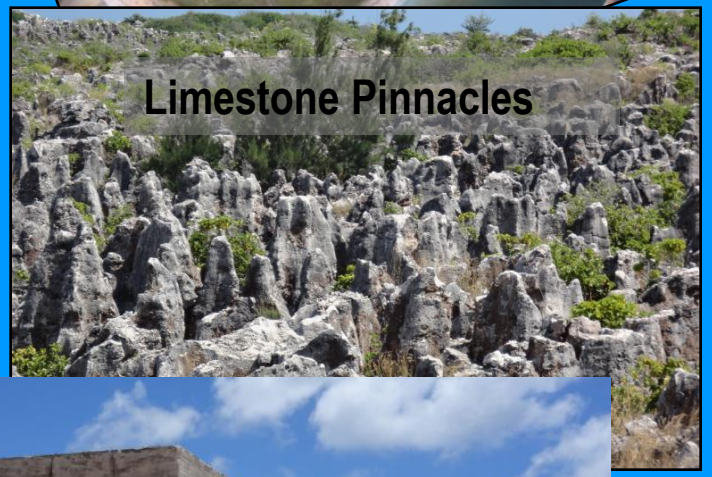
  - Recognise the importance of Marine Scientific Research (MSR).

Known Mineral Resources of PNG

Phosphate Mining in Nauru

- Mining in Nauru started in 1908 and ceased in 2000;
- 80% of the island's surface have been strip-mined;
- Mining re-commenced on a smaller scale in 2006;
- Mining of secondary phosphate will take 20-30 years;
- Phosphate was/is Nauru's main export revenue earner.




Limestone Pinnacles


Recent Mining of Phosphate

GDP and Export Earning of Mining

	PNG (2008) *	New Caledonia (2009) *	Fiji (2006) ^	Solomon Islands (2011) ^^
GDP (%)	64	10	1.5	2.5
Export Earning (%)	72	80	7.7	16

* (SMI, 2011)

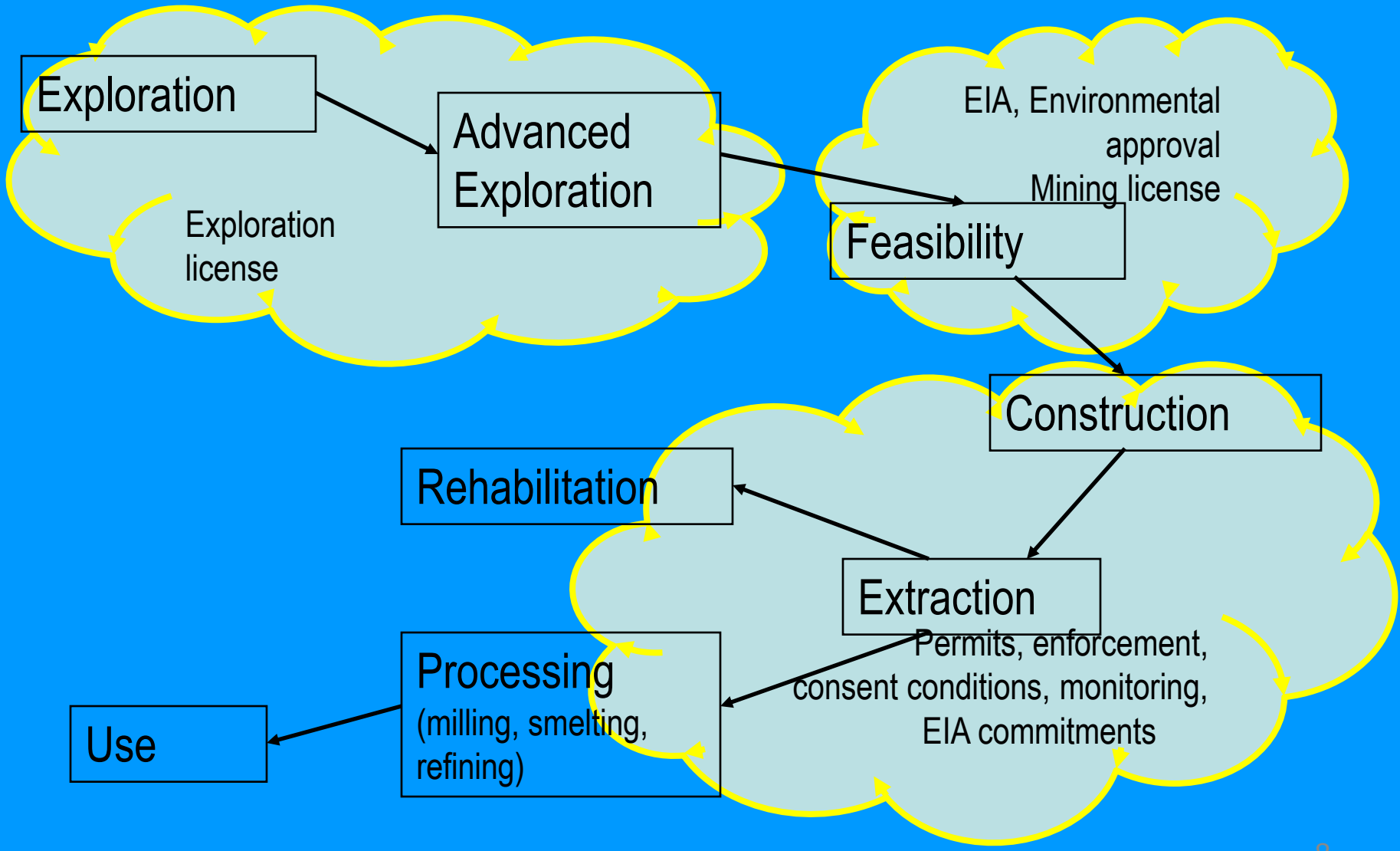
^ (Ackley, 2008) – these are pre-mine closure figures. Mining was suspended at Vatukoula between December 2006 - April 2008.

^^ (EITI, 2012) – mining at Gold Ridge was suspended between June 2000 – March 2011.

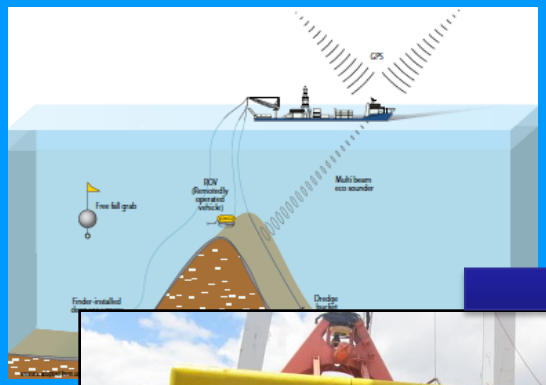
Nature of Mining Projects…

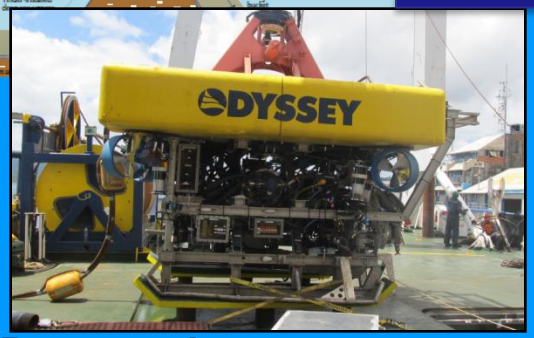
- Long exploration history;
- Huge investment – multi-million/billion dollar mining projects;
- Huge infrastructure development;
- Significant physical footprint;
- Generate huge amount of waste materials (waste rocks, tailings, leachates);
- Environmental impacts can be significant;
- Non-renewable resource;
- Use significant amount of power (E.g. Lihir power requirement: 75 MW);
- Can be marginal, profitable or very profitable;
- Support economic and social development of any country.

From Exploration to Ore Processing…

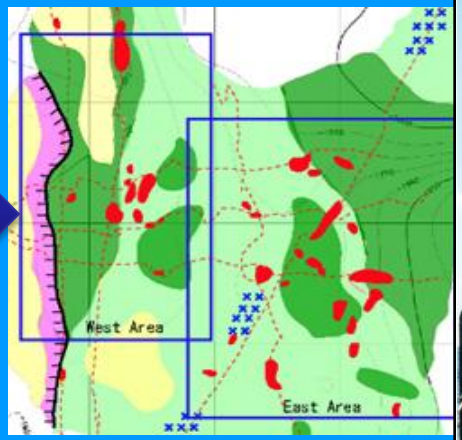


Deep Sea Exploration Procedures…

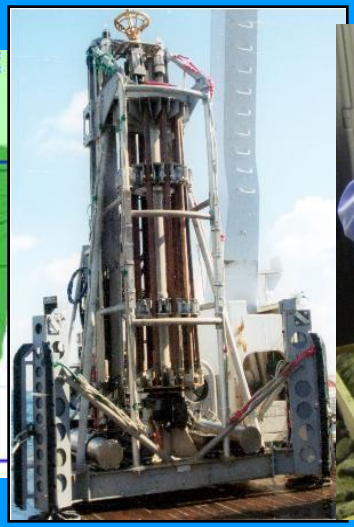




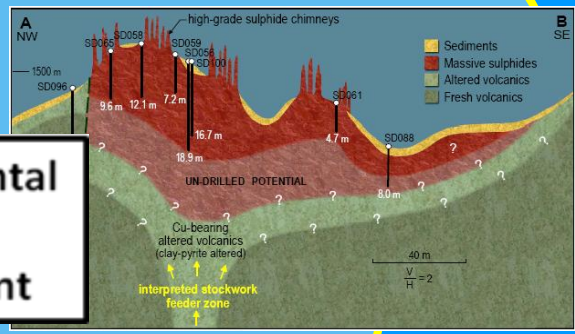
Prospecting and Discovery



Exploration



Feasibility Study



Resource Definition

Environmental Impact Assessment

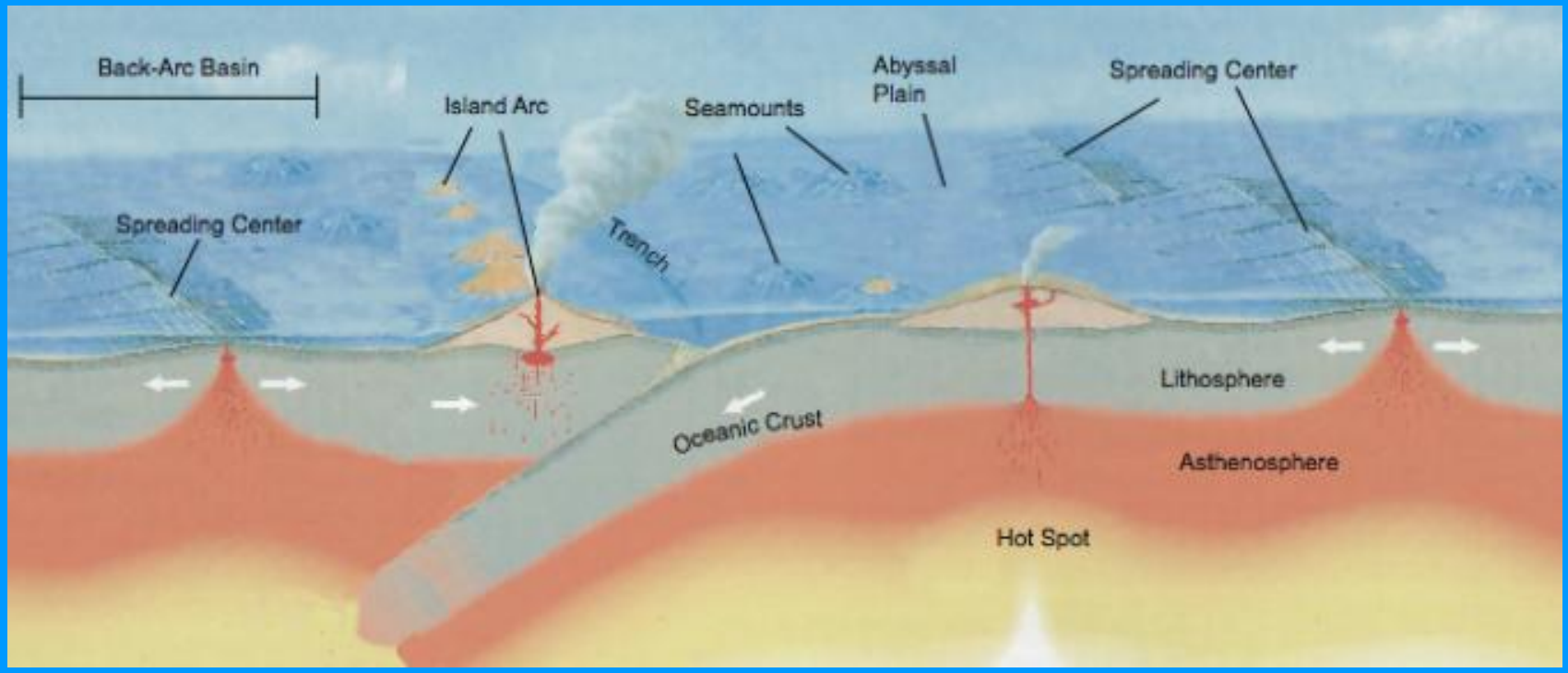
Mine Design

Mining

Ocean dependent Pacific Islands region

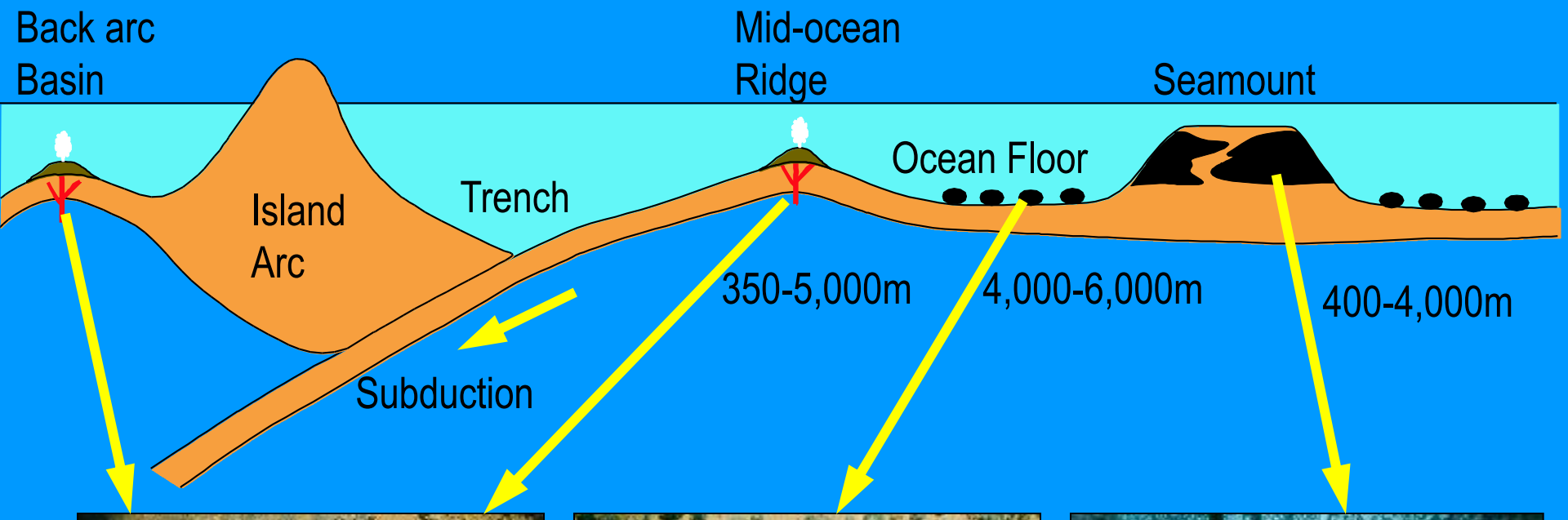
- Pacific Island Countries (PICs) have a total area of 38.5 million km^2 of EEZ in comparison to a land area of around 550,000 km^2 (a ratio of 70:1).
- For some PICTs, deep sea minerals may represent the only exploitable natural resource sector apart from fish.
- DSM may bring much needed economic development opportunity.

Plate Tectonics and Marine Mineral Deposits



- Hydrothermal vents / Seafloor Massive Sulphide) are found in tectonically active areas in all the worlds oceans.
- Manganese nodules occur mainly in the Abyssal Plains.
- Cobalt-rich Crusts are found on the side of seamounts and volcanic islands.

Deep Sea Minerals Occurrence

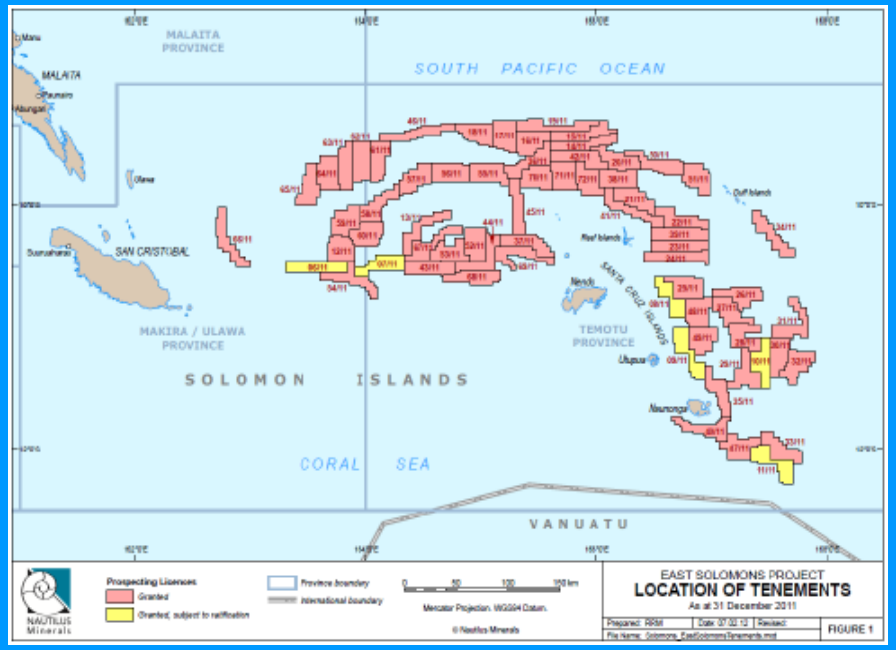


SMS Deposit

Manganese Nodules

Cobalt-rich Crust

Country	MN	CRC	SMS
Kiribati	√	√	
Cook Islands	√		
Tuvalu	√	√	
Samoa		√	
Tonga			√
PNG			√
Solomon Islands			√
Vanuatu			√
Fiji			√
Marshall Islands		√	
Federated States of Micronesia		√	
Palau		√	
Niue	√	√	

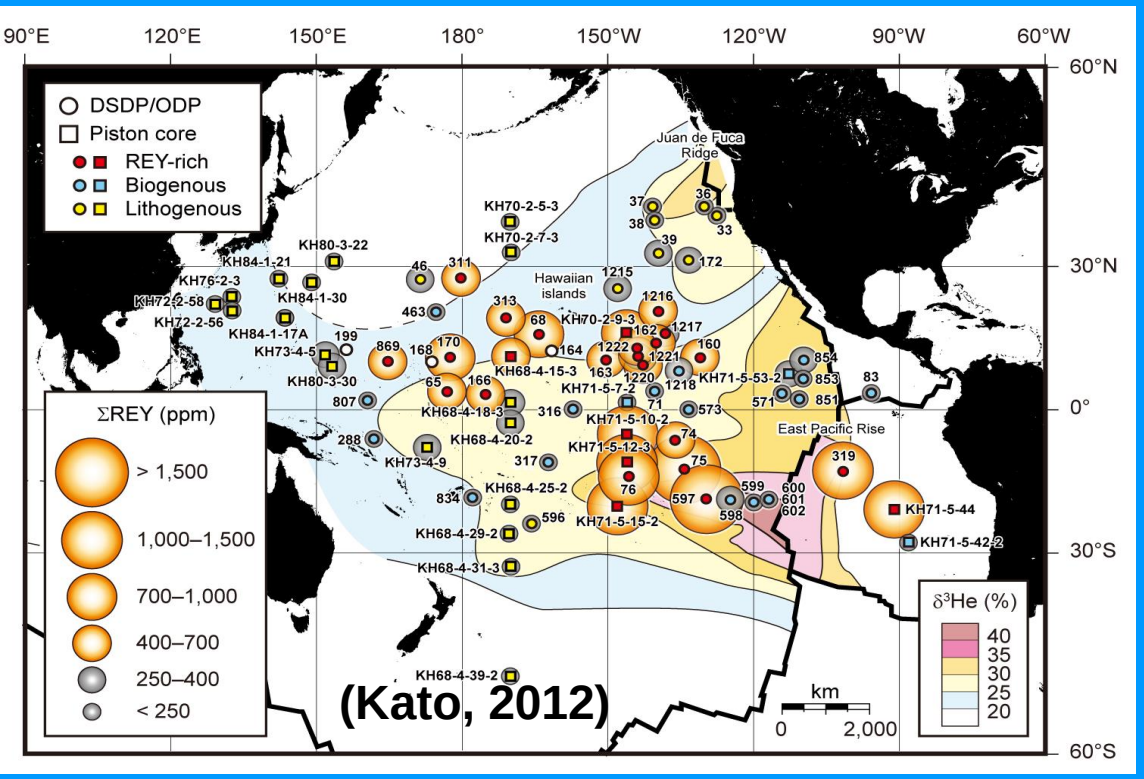


DSM Potential and Recent Exploration

- **Nautilus Minerals: Mining license** in PNG; Exploration license in PNG, Solomon Islands, and Tonga, Vanuatu and Fiji
- **Bluewater Metals:**

  - Exploration licenses in PNG, Solomon Islands, Vanuatu, and Tonga, Fiji.
- **Korea Institute of Ocean Science and Technology (KIOST):** Exploration licenses in Tonga and Fiji.
- Other exploration / mining companies may be interested in the mineral resources of PICTs.

Rare Earth Elements in Marine Minerals



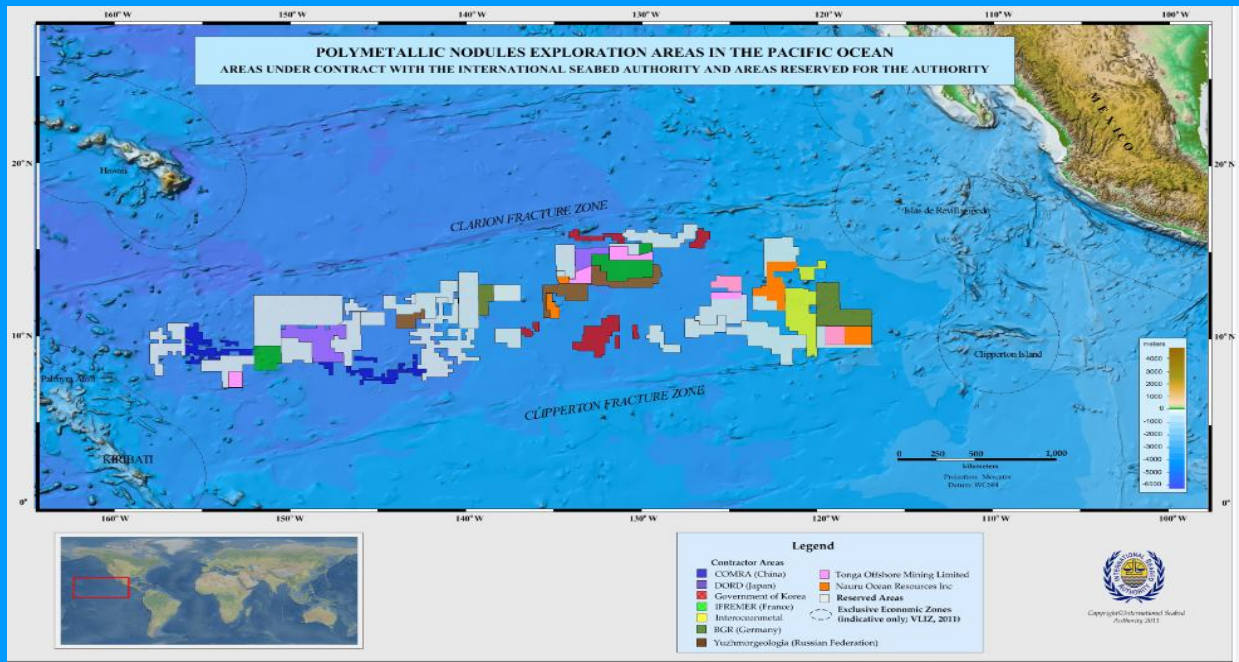
- 95% of REE are mined and produced by China.
- Increasing demand for REY in green, communication and military technologies.
- The Co-rich ferromanganese crusts of the Pacific Ocean have **2 to 3 times** the REE concentration of the CCZ nodules (Halbach, 2012).

- Nodules of the Cook Islands have higher REY concentrations then CCZ (Hein, 2013)

- Discovery of mud containing high concentration of REE in the south-eastern (within and outside the EEZ of Tahiti) and central Pacific.
- South-eastern Pacific mud has an average thickness of 8m at an average REY concentration of 1,054ppm (Kato, 2012).

Exploration Interest in 'the Area'

- Area of interest: "Clarion-Cipperton Fracture Zone".
- Nauru (NORI), and Tonga (TOML) registered companies have been granted exploration licenses in the "Clarion-Clipperton Fracture Zone (CCFZ) in 2011 by the ISA.
- Marawa Research and Exploration Limited (MREL) of Kiribati has been granted exploration licenses in the CCFZ in 2012.
- PICs such as Fiji, Tuvalu and Cook Islands have shown interest to participate in exploring "the Area".



Economic Issues

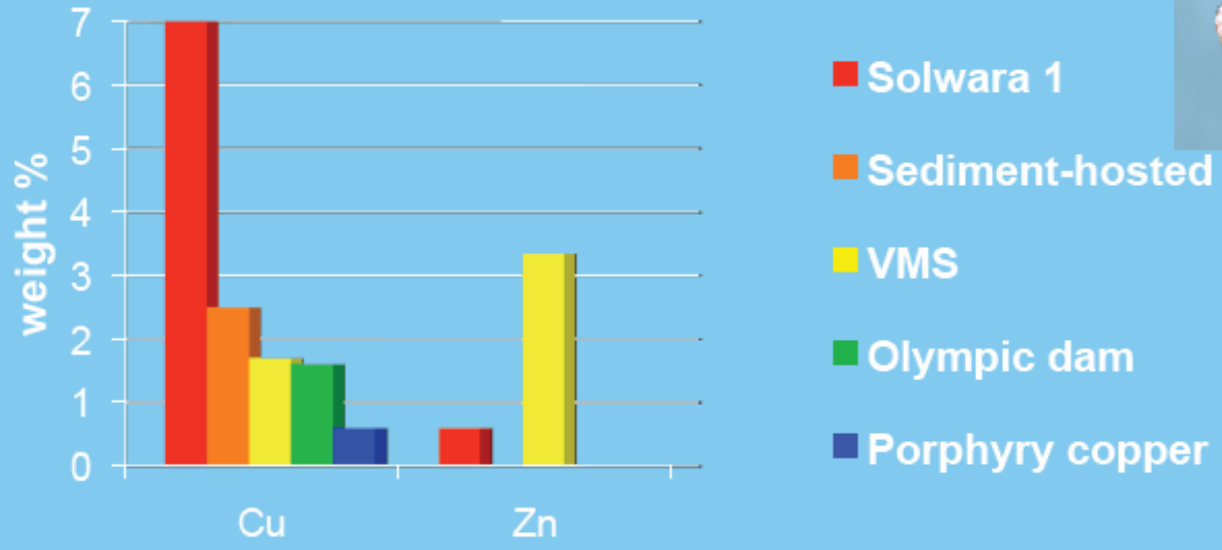
- SMS deposits are higher in mineral content than on-land deposits:

Metal	On-land	SMS
Copper	0.5-2%	5-15%
Gold	0.5-8g/t	2-20g/t
Zinc	5-20%	5-50%
Lead	5-20%	3-23%

- Typical value of a tonne of land based ore: US$50-180.
- Typical value of a tonne of SMS ore: US$500-1500.
- One full mining operation could produce export revenues of up to US$500m pa and taxes/royalties of up to US$50m pa.

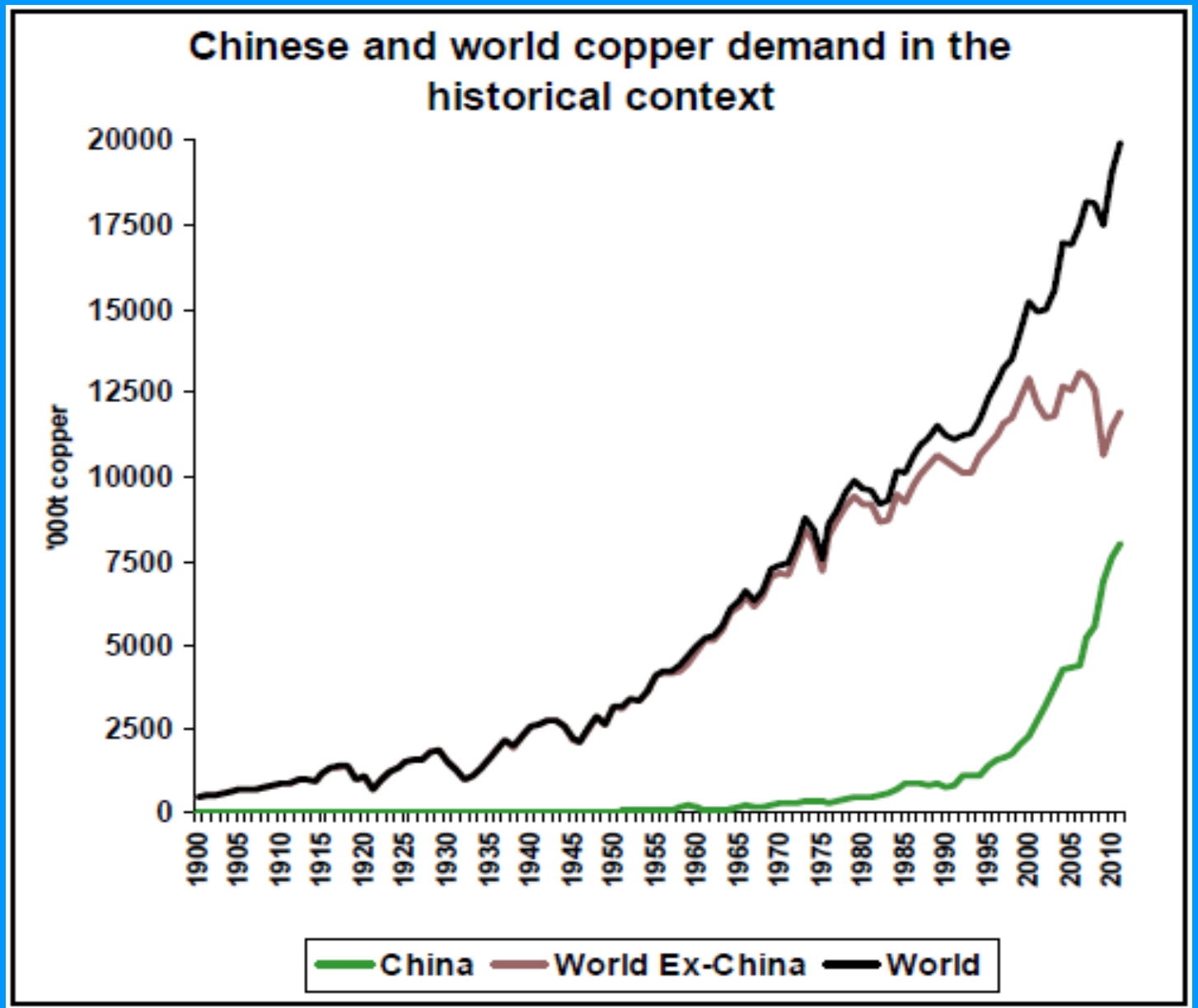
High Grade Copper SMS Deposits

Attractive High Grades for Deep-Ocean Deposits, e.g. Copper:



Mean composition of Nautilus Solwara 1 marine mine compared to all major types of land-based copper deposits

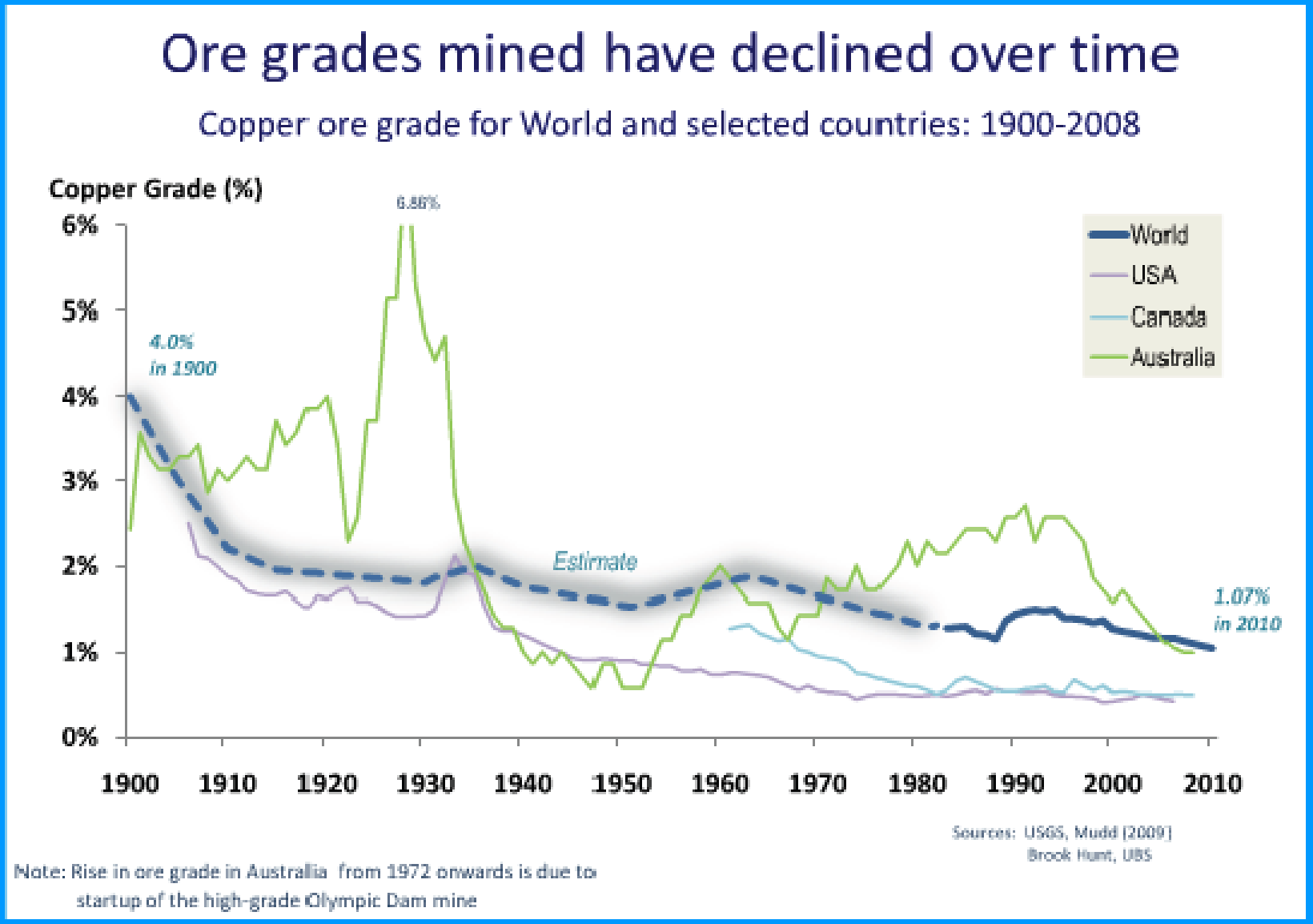
1900 – 2010 World Copper Demand



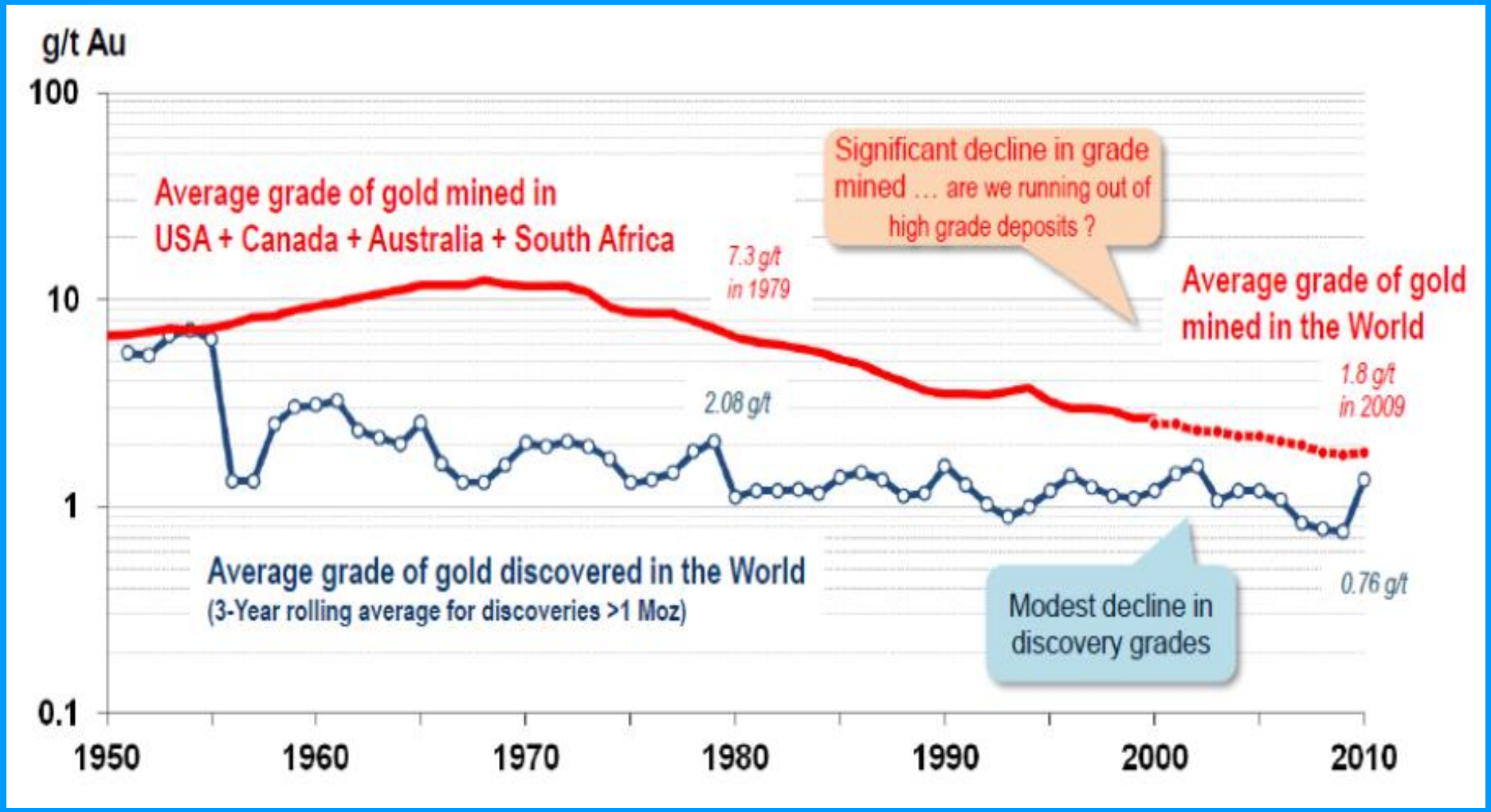
(Macquarie Research, 2012)

This increasing trend in global demand / consumption of copper is applicable to any commodity

Decrease in Land Based Ore Grades



Global Gold Grade and Discovery



(HD Capital, 2012)

Value of Selected Metals in 1 tonne of Cobalt-rich Crusts from the Central Pacific

	Mean Price of Metal (2011 $/kg)	Mean Content in Crusts (g/tonne)	Value in Tonne of Ore ($)
Cobalt		6899	$272.20
Dysprosium	$2,760.00	60	$165.60
Cerium	$81.00	1605	$130.01
Titanium	$10.30	12035	$123.96
Europium	$5,210.00	13	$65.13
Nickel	$20.74	4125	$42.49
Zirconium	$64.00	618	$39.55
Platinum	$55,299.20	0.5	$27.65
Tellurium	$360.00	60	$21.60
Molybdenum	$34.90	445	$15.53
Copper	$8.91	896	$7.98
Total	--	--	$911.70

(USGS, 2011)

Uses of Metals in Marine Minerals

Metal	Uses
Copper	Generators, fuels cells, electrical appliances, transformers for renewable energy technologies, mobile phones, computers, transportation, etc
Cobalt	Mobile phones, laptops, super alloys, hybrid car batteries, artificial joints, etc
Nickel	Stainless steel, high nickel alloy, Chemicals and Batteries, Catalysts, etc
Manganese	Steel production, rechargeable batteries, animal feed, plant fertilizer, bactericide in waste water treatment, etc
REEs	Smart phones, flat TV screens, advanced military technology, permanent magnets for wind power generation, hybrid vehicles, fuels cells, etc

E.g. of REEs: Cerium, Neodymium, Samarium, Europium, Terbium

Deep Sea Mining Process…

If the SPS is efficient and robust, there is less likely to be any significant impacts of SMS mining.

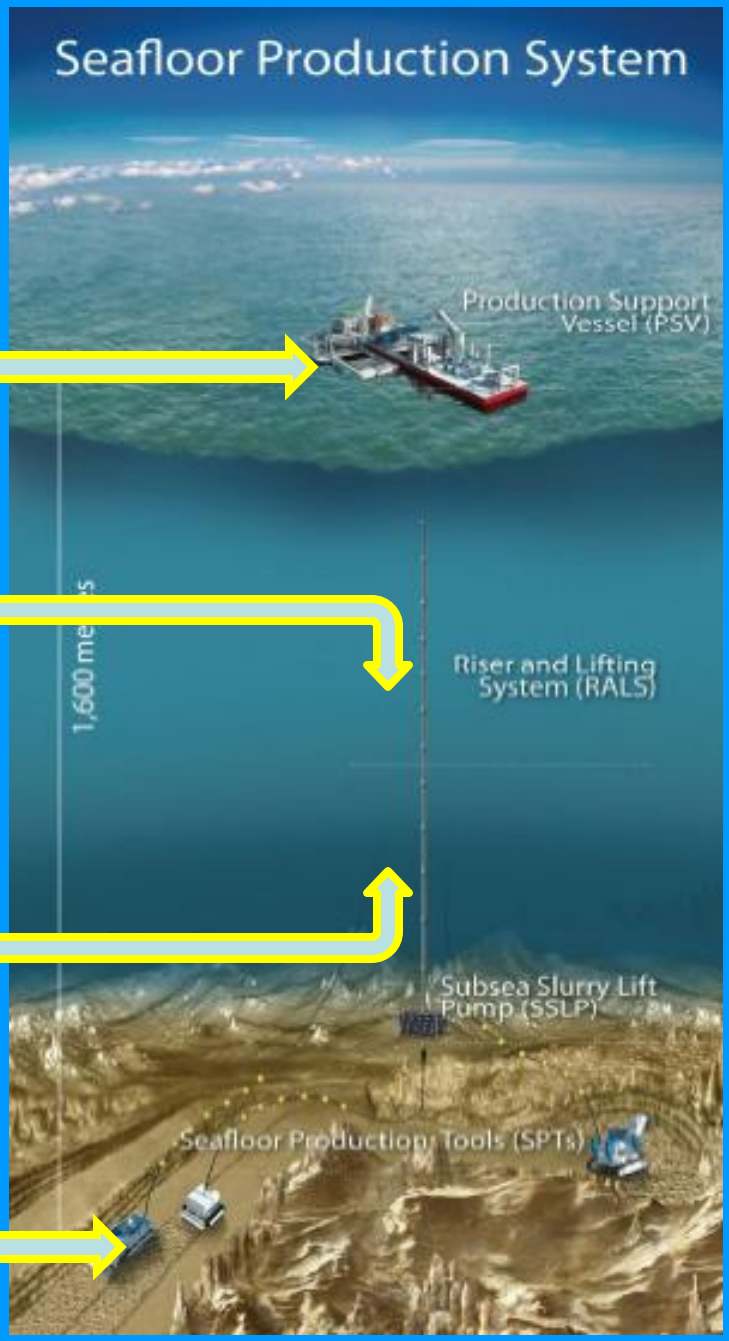
The performance of the SPS will only be known during actual mining

Slurry discharge, transfer of ore, and treatment of effluent

Return of treated effluent to the ocean floor

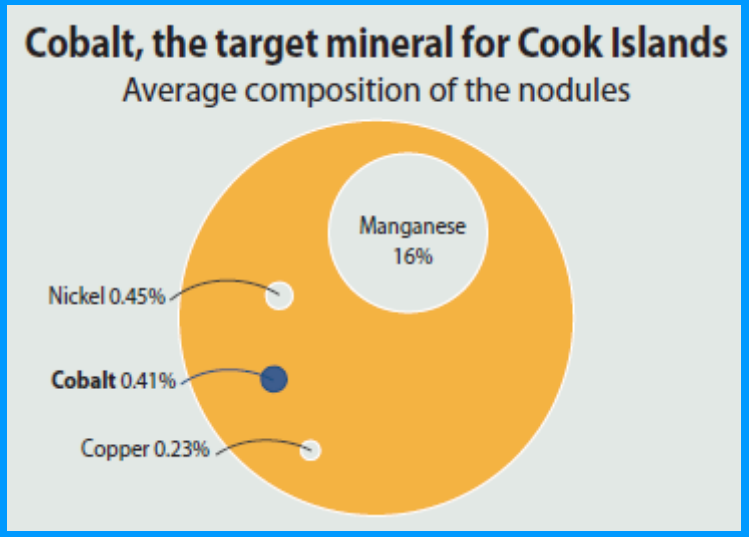
(Pumping of ore slurry (crushed ore materials + seawater)

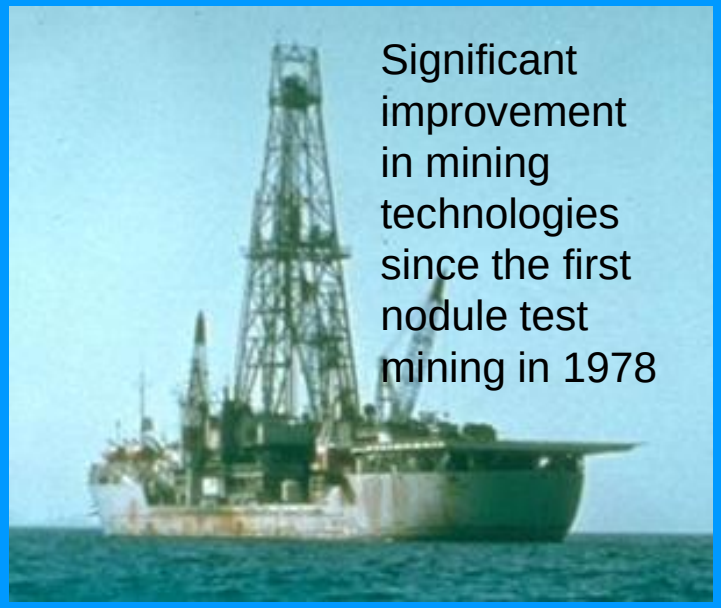
Disaggregation, crushing and collection of ore



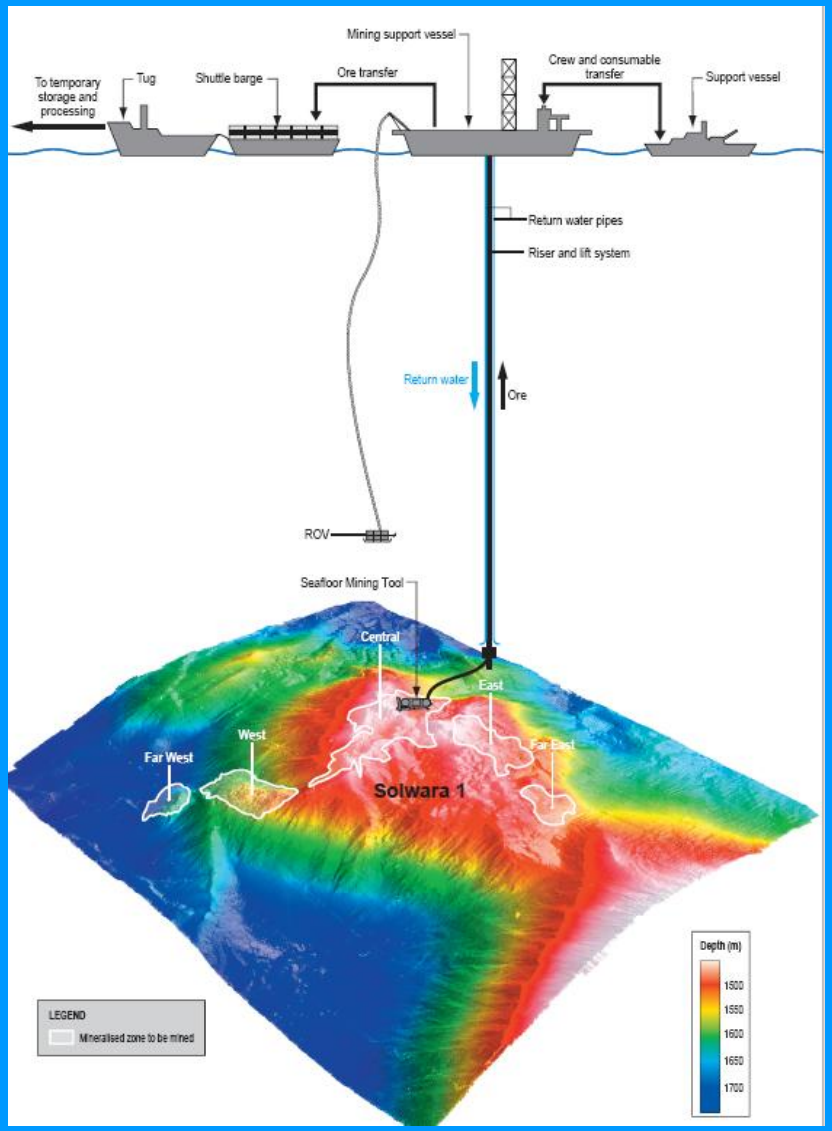
Drivers of Marine Minerals Development

- High demand for metals globally;
- Increasing metal prices;
- Decreasing metal concentration in terrestrial mineral deposits;
- High concentration of certain metals in offshore mineral deposits;
- Significant improvement in marine mining technologies;
- Increasing demand for non-traditional metal sources such as REE.





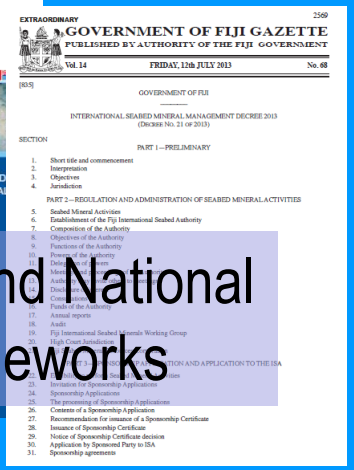
How PICTs will Benefit from Offshore Mining?



- **Host country will benefit through:**
- Revenue generation;
- Opportunity to participate in a new economic sector;
- Economic development;
- Employment;
- Mining revenue saving scheme (sustainability opportunity);
- Stimulation of other economic sectors;
- Contribute to poverty alleviation.

SPC-EU DSM Project Initiatives

Capacity Building



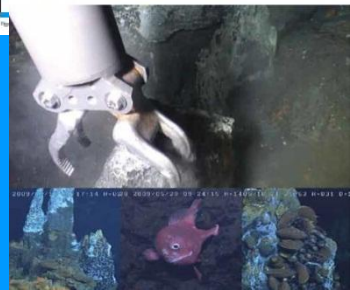
Regional and National Legal Frameworks

Stakeholder Consultations

Technical Reports

www.sopac.org/dsm

Information Sharing



DSM Regional Training Workshops

- ***August 2012 – "1st Regional Training Workshop on Geological, Technological, Biological and Environmental Aspects of Deep Sea Minerals"*** , Nadi Fiji;
- ***March 2013 – "2nd Regional Training Workshop on Deep Sea Minerals Law and Contract Negotiations"*** , Nukua'lofa Tonga;
- **June 2013 –** "3rd Regional Training Workshop on Stakeholder Participation and Social Impacts of DSM Activities", Port Vila Vanuatu.
- **December 2013 – "4th** Regional Training Workshop on Environmental Perspectives of Deep Sea Mineral Activities", Nadi, Fiji
- **May 2014** – "5th Regional Training Workshop on Fiscal Regime and Revenue Management of Deep Sea Mining", Rarotonga, Cook Islands.

Key Points to be Considered….

- Geological potential should be recognized as the driver of any DSM development.
- EIA has to be conducted as part of a feasibility study where a decision to mine or not is made.
- Proper environmental management planning and a commitment to best environmental practice are necessary for any DSM development.