

On the Verge

Deep Seabed Mining: Opportunities and Hurdles

Caitlyn Antrim

Rule of Law Committee for the oceans



Focus: Outlook for Nodule Development

- Ocean- Based Resource
- Minerals of Interest
 - Nickel
 - Copper
 - Cobalt
 - Manganese
 - Rare Earth Elements
- Beyond National Jurisdiction



Why is the CCZ Special?

Inferred Resources (Estimated Tons: metric tons X 10 ⁶)						
	Area (km ² x 10 ⁶)	Nodules	Mn	Co	Ni	Cu
Total study area	4.19	30,700	8,657	67.5	393	341
Reduced area	3.83	21,100	5,950	46.4	270	234
Biogeochemical model	4.85	27,100	7,300	58.0	340	290
Potential resources of nodules	12.57	62,000	17,500	134.0	761	669

- Depth: 4500-5500 meters
- Soil Type: Siliceous Ooze/Clay
- High Critical Mineral Content
- International Legal Regime in Place



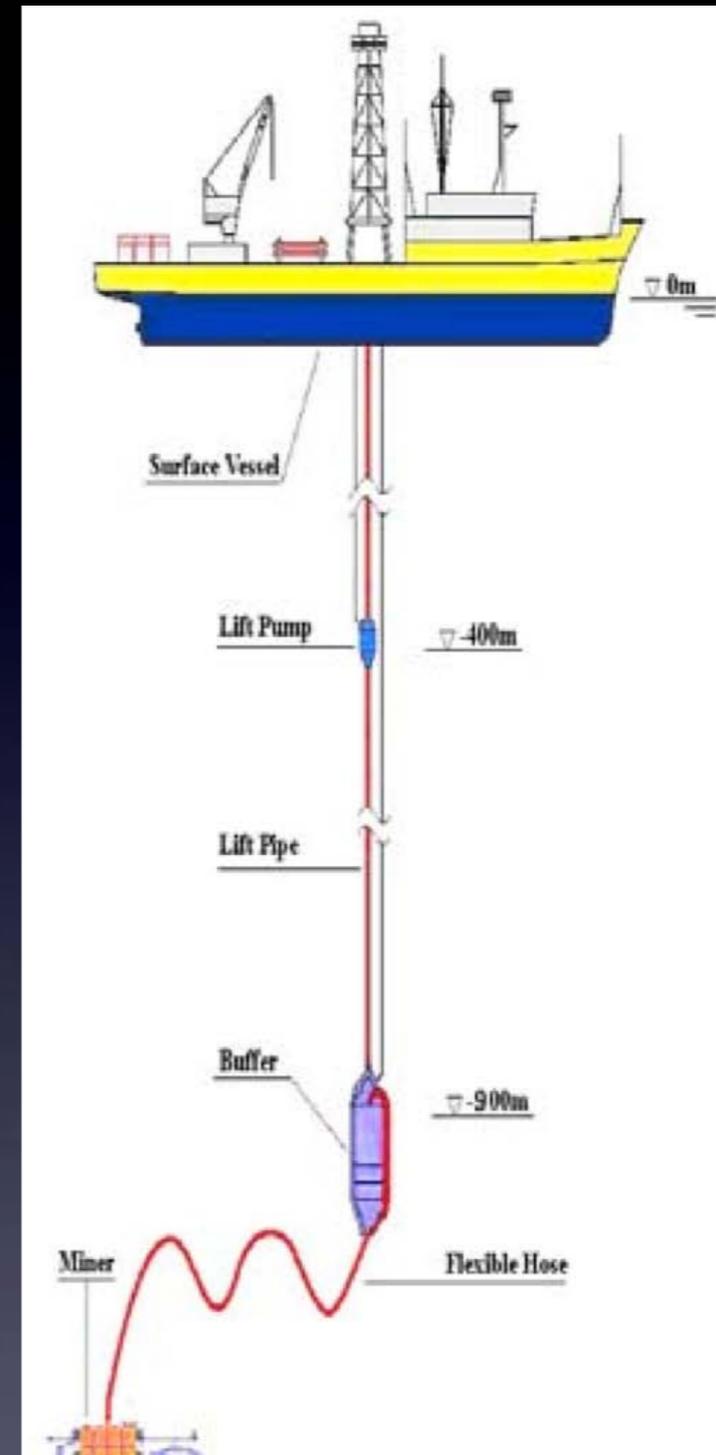
Economics of Deep Sea Nodule Development

- Market Prices Determined by Land-Based Mineral Sources
- At-Sea Capital and Operating Technology Based on Off-Shore Development and Maritime Shipping Industry
- On-Land technology based on Nickel Laterite Processing Systems and Ferroalloy Production

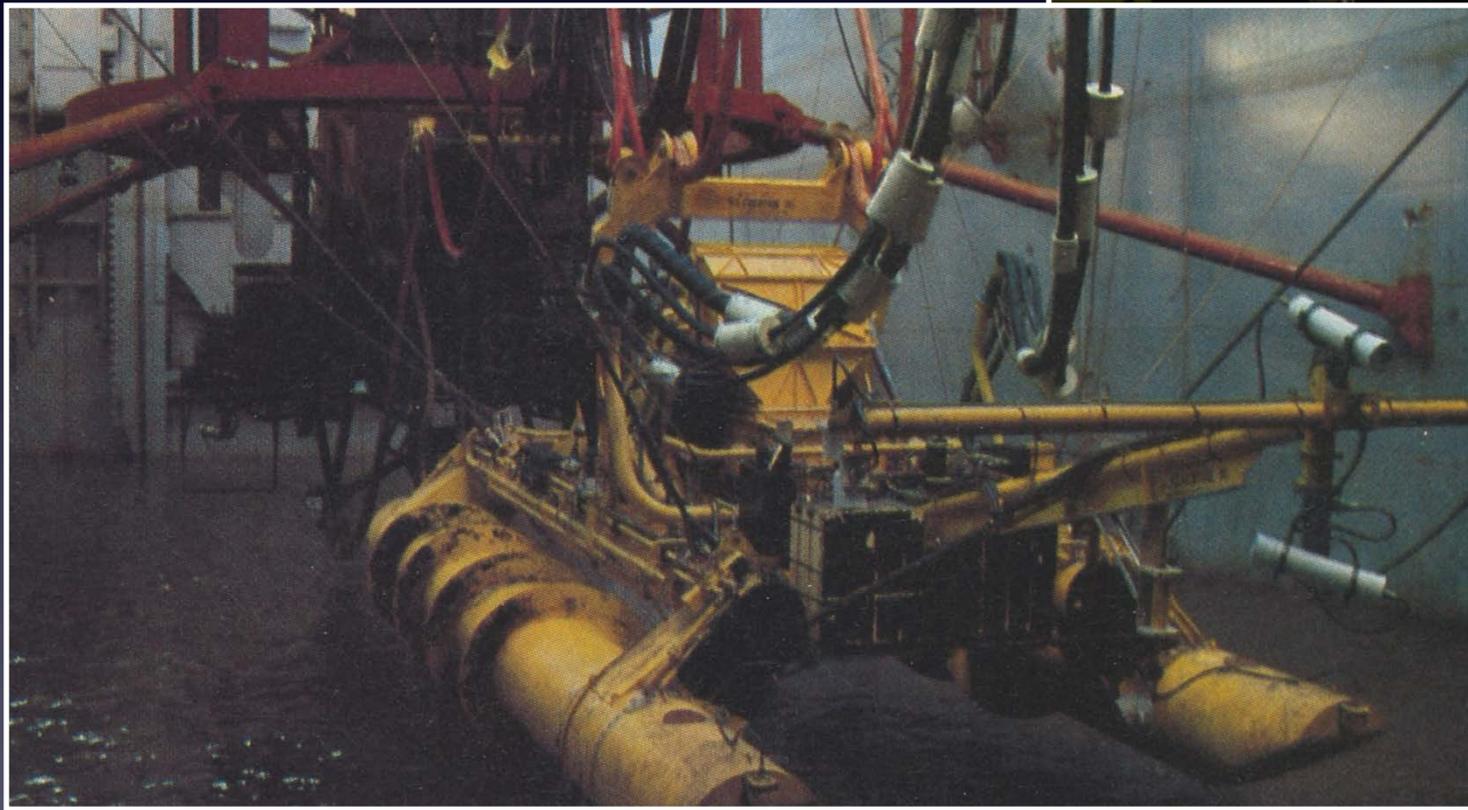
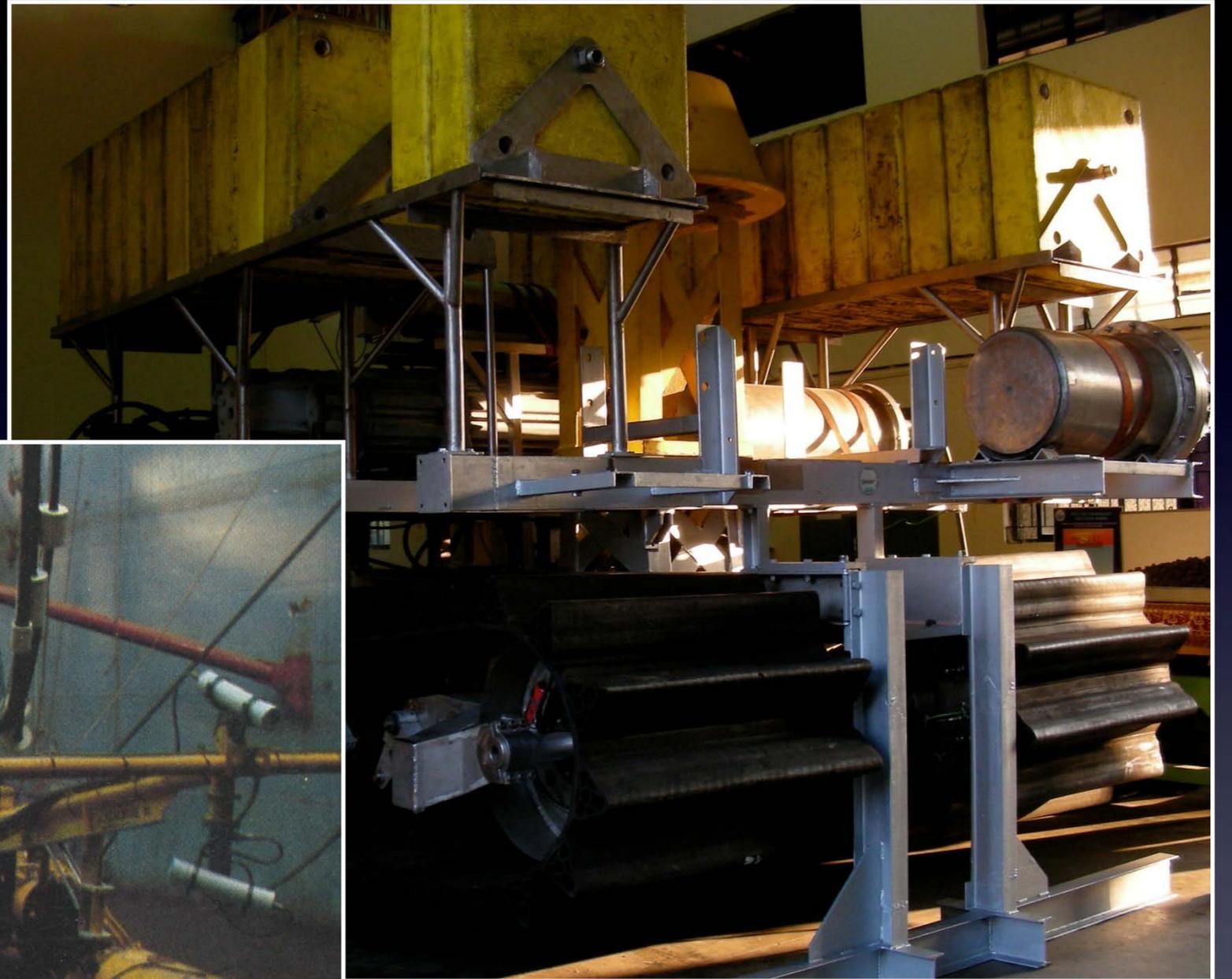


Sea System Design

- Nodule Harvester
- Lift System
- Base Vessel
- Tailings Return
- Sea Transport
- Alternative Designs



Unique Marine Systems



Costs and Revenues

- Capital Costs: \$2.1 to \$3.5 Billion
- Operating Costs: \$470 million to \$600 million
- Contained Metal Value, not including REE values (normalized to millions of 2012 US \$)

Annual Recovery Rate (Dry Metric Tons)	2007	2011
3 Metal System: 3 million	\$2,295	\$1,491
4 Metal System: 1.5 million	\$1,718	\$1,415

Public Benefits of Seabed Mineral Development

- Employment and Domestic Capital Investment
- International Trade
- Secure Supplies of Critical Minerals



Employment

At-Sea Mining Systems:	Two alternate 40 person teams of ship crew and mine system operators for each of two mine ships	160
Ore Transport Ships:	28 to 32 crew members for each of four ore vessels	112-128
Ore Processing Plant:	24/7 operations with 300 operators, 50 each of supervisors, managers, administrative staff, and support	500
Net Jobs	Per Operation, not including construction	780
Labor costs in ship construction	Labor costs in construction of mine and transport ships. \$2012	\$324 million



Capital Investment

- Offshore Industry
- Shipping
- On-Shore Processing



Critical Mineral Security

	Net Import Reliance*	Major World Ore Producers	US Import Sources	Fraction of US Consumption in 1 million tons of nodules
Nickel	47%	Russia, Canada	Russia, Canada, Australia, Norway	10.1%
Copper	35%	Chile, United States	Chile, Canada, Peru	0.6%
Cobalt	75%	D.R. Congo, Zambia	China, Norway, Russia, Canada	36.9%
Manganese	100%	Gabon, Australia	Gabon, South Africa, Australia, China	35.8%
Rare Earths	100%	China	China	10.0%

* Import reliance counts secondary recovery (recycling) as domestic production



Benefits to US of Seabed Nodule Development

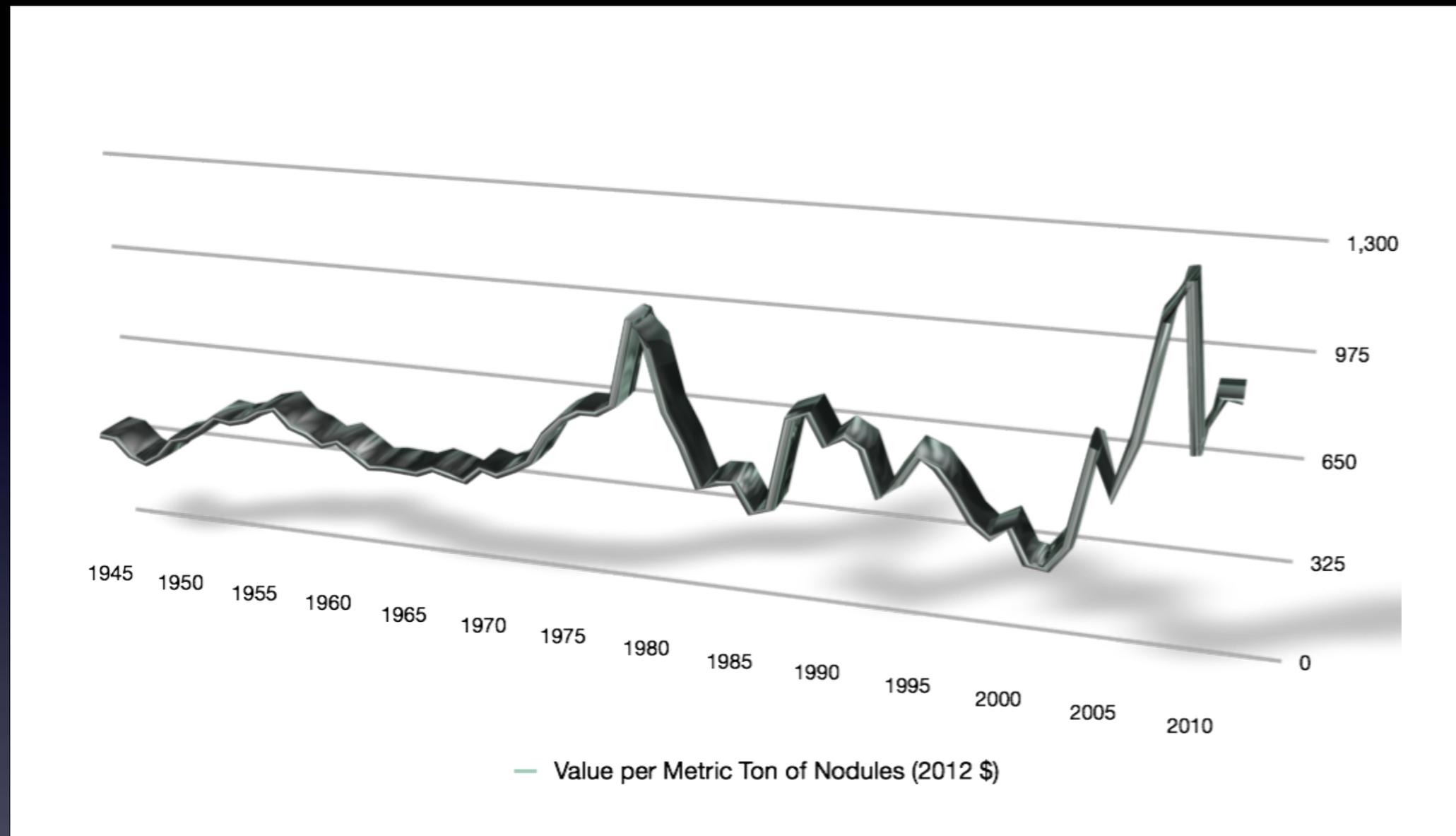
- Technology leadership in first of three new high seas sources of critical metals
- Capital Investment of about \$3 billion
- Annual Sales about \$2 billion
- 780 direct jobs; 2727 or more total per operation
- Significant contribution to critical materials security
- Significant improvement in import-export balance
- Downstream employment and business benefits will be felt in the Gulf Coast and Ohio River Valley



Investment Climate for Deep Seabed Minerals

- Economics
- International Legal Regime
- Operation outside the LOS Regime





Value of Nodules



Reduced International Risk

- 1982-1994 - Era of Dueling Seabed Regimes
- 1991-2001 - Resolution of Overlaps; International Recognition of Pioneer Investors
- 1994-1997 - Withdrawal of 3 of 4 US Consortia
- 2005 - ISA Recognition of German Claim
- 2011-2012 - Recognition of UK, Belgian and Three Developing State Claims: 13 Nodule Sites, 4 Sulfide Sites, 2 Applications for Cobalt Crust Sites



International Partners

- US Companies Can't "Go It Alone"; Private US Consortia with International Partners in 1989:
 - Ocean Mining Associates (50% by Belgium and Italy)
 - Ocean Management Inc. (50.22% by Canada and Japan; Germany takes share in 1990s)
 - Kennecott Consortium (48% by Canada Japan, UK; Kennecott itself was owned by Rio Tinto Zinc and later by British Petroleum)
 - Lockheed/Ocean Minerals Co. (Dutch partners in early 1980s)

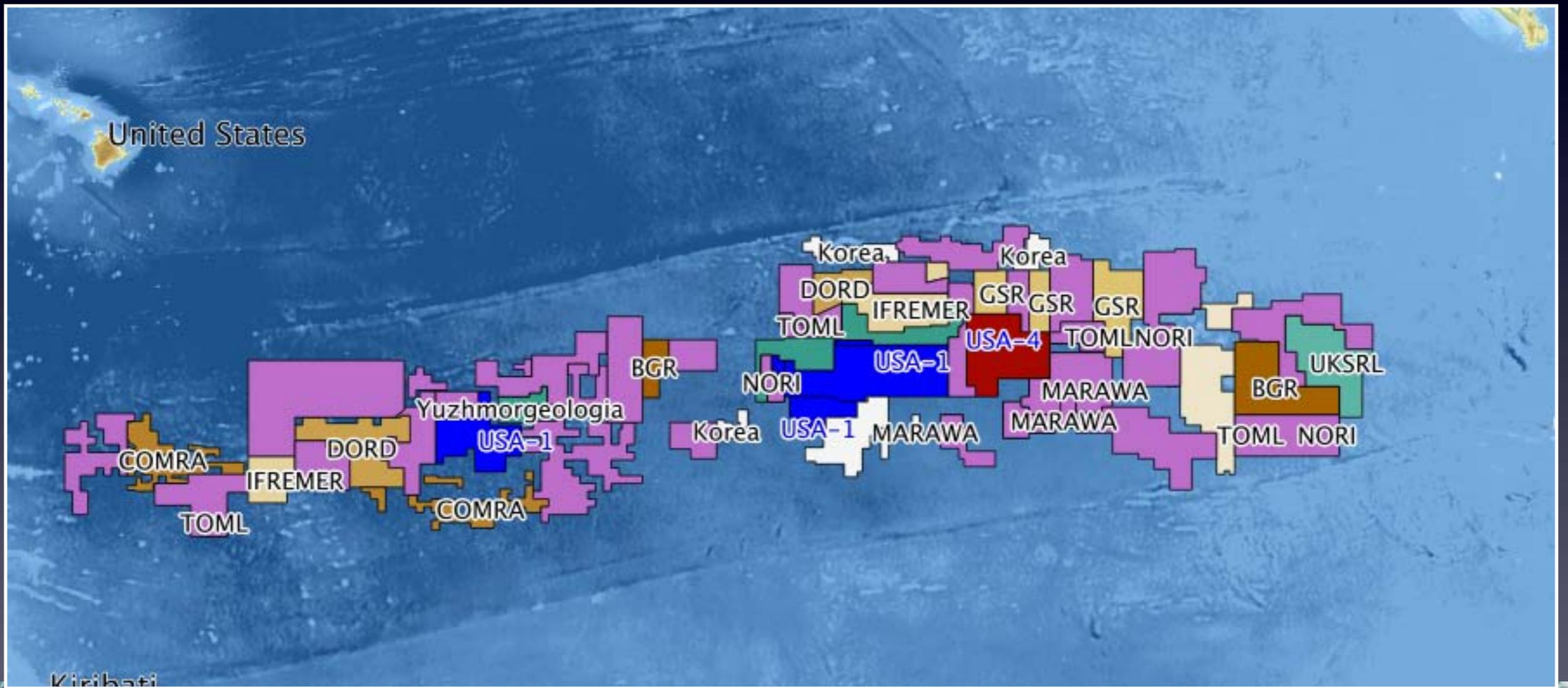


No US-Foreign Partnerships Outside UNCLOS

- The LOS Convention establishes that:
- Claimants must be sponsored by a State Party of their own nationality
- Parties to the Convention cannot recognize title to minerals recovered outside the Convention (precluding sale of minerals in international commodity markets)
- Exclusive access can only be recognized through the Convention's processes (no "Reciprocating States Agreement" or international legal protection of US claims)

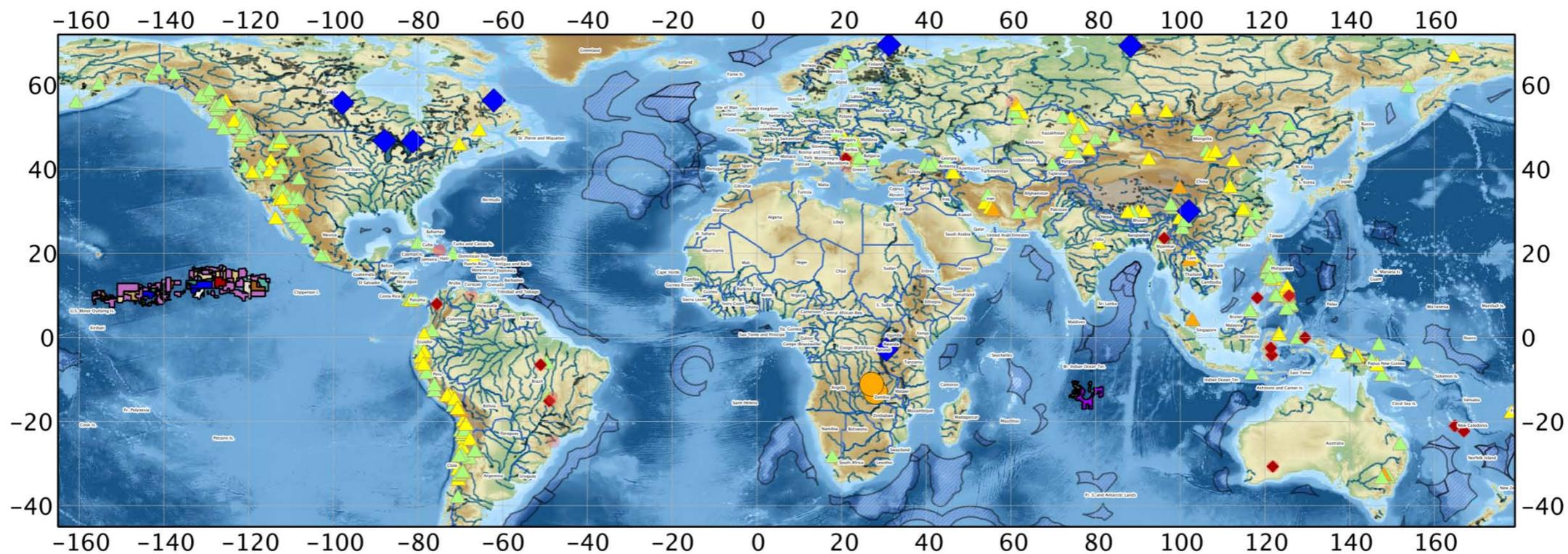


Current Nodule Claims in the Clarion Clipperton Zone



Land and Sea Hard Mineral Deposits

Nickel, Copper, Cobalt



Nickel Laterites

- Economic Interest
- ◆ Economic Deposit

Copper Porphyry Deposits

- ▲ 0.25% - 0.5%
- ▲ 0.5% - 1.0%
- ▲ 1.0% - 1.8%

ECS_Submissions



Nickel Sulfides



African Copperbelt

- Zaire and D.R. of Congo

ISA Contractors

- BGR
- COMRA
- DORD
- GSR
- IFREMÉR
- InterOceanMetal
- Korea
- MARAWA
- NORI
- TOML
- UKSRL
- Yuzhmorgeologia
- ISA Reserved

LMCO-USA-1



LMCO-USA-4



ECS Submissions

- National Claims



Conclusions

- Deep Seabed Nodules are a World-Class Resource of Critical Minerals
- Long Term Economics will be driven by industrial development in China, India, Brazil, South Africa and Russia
- Future seabed mining will compete against nickel laterite and porphyry copper deposits of declining grade
- Additional development of hundreds of millions of dollars are needed before full investment
- Investors will require international capital and access to commodity markets

