BOEM Bureau of Ocean Energy Management

Not Just Nodules - Critical Minerals on the Federal Seabed

COSA-BOEM Marine Minerals Meeting

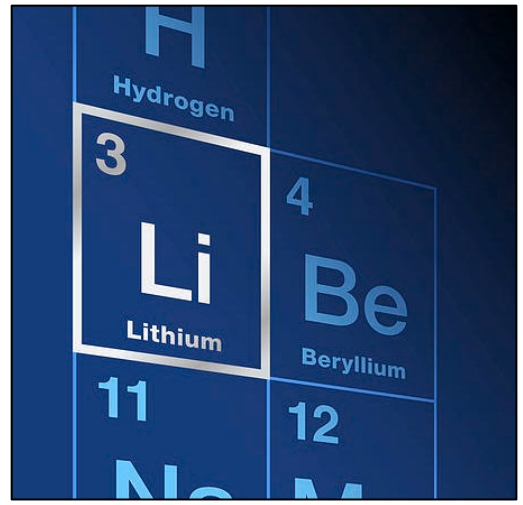
April 3, 2024

Paul Knorr, Ph.D. – Critical Minerals Specialist

Shannon Cofield, Ph.D. – Geological Oceanographer

Not Just Nodules - Critical Minerals on the Federal Seabed

- **Overview of Critical Minerals (CMs)**
  - What are CMs?
  - Where are CMs located in the marine environment?
- **BOEM's Role: Management and Facilitation**
  - Regulatory path and projected timelines
  - Current research efforts (resource and environmental)
- **Data Gaps and Exploration Needs**

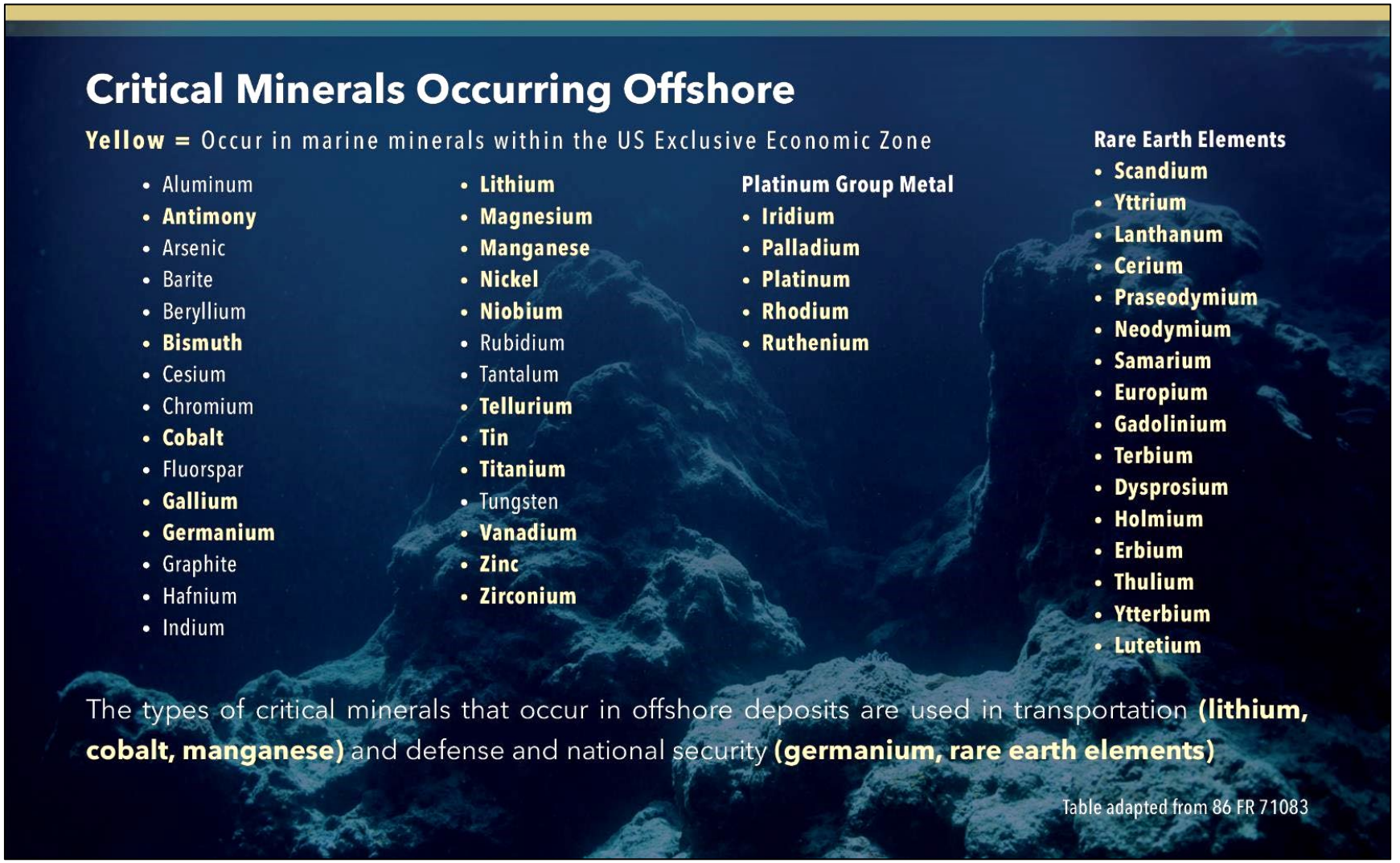


Offshore Critical Minerals: Elements of Interest

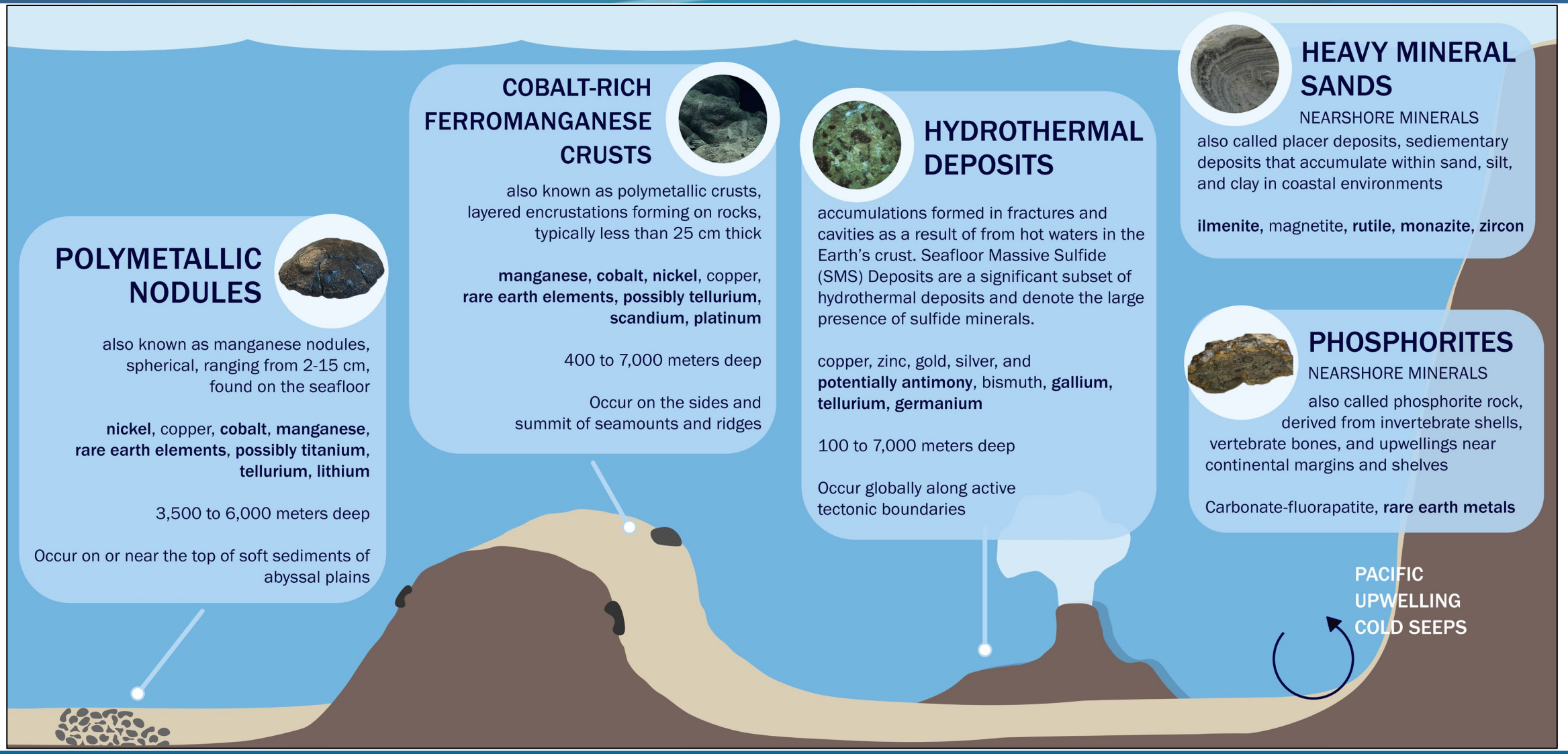
Hard Minerals

- Non-energy [marine] minerals
- Minerals other than Oil, Gas, and Sulphur on the Outer Continental Shelf (OCS)
- **Critical Minerals** are a type of Hard Mineral

- U.S. Geological Survey (USGS) developed list of Critical Minerals (Elements)
  - Essential to U.S. economic and national security
  - Green energy metals
  - Revised 2022 list adds Ni / Zn, total of 50 minerals



Offshore Critical Minerals: Deposit Types

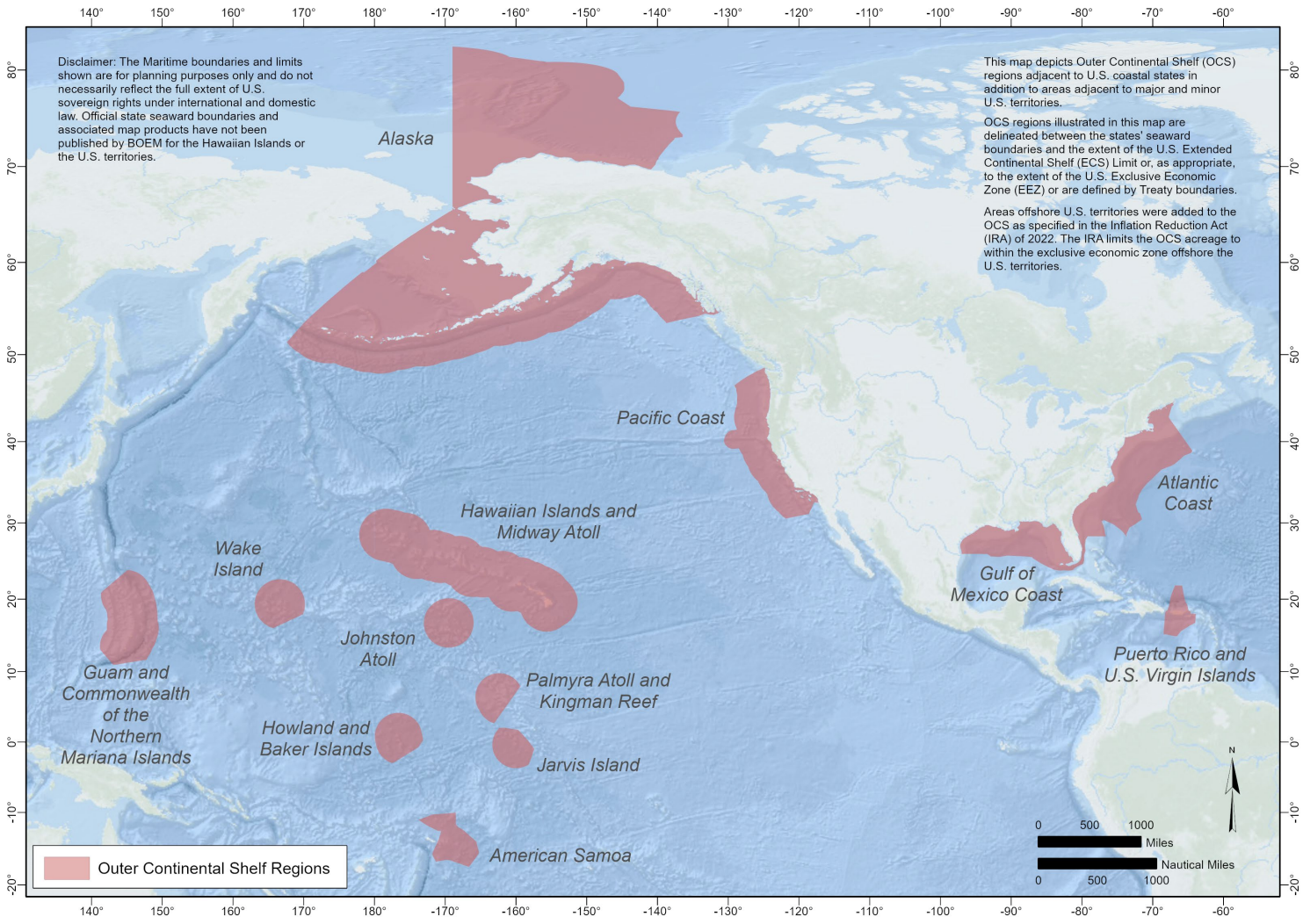


Offshore Critical Minerals: BOEM Jurisdiction

OCS Region Size (acres)

- Alaska- 1,047,170,000
- Pacific Territories- 825,830,000
- Hawaiian Islands & Midway Atoll- 609,120,000
- Atlantic- 273,630,000
- Pacific- 204,470,000
- Gulf of Mexico- 159,360,000
- Puerto Rico, U.S. Virgin Islands- 49,630,000

Total - 3,169,210,000 acres



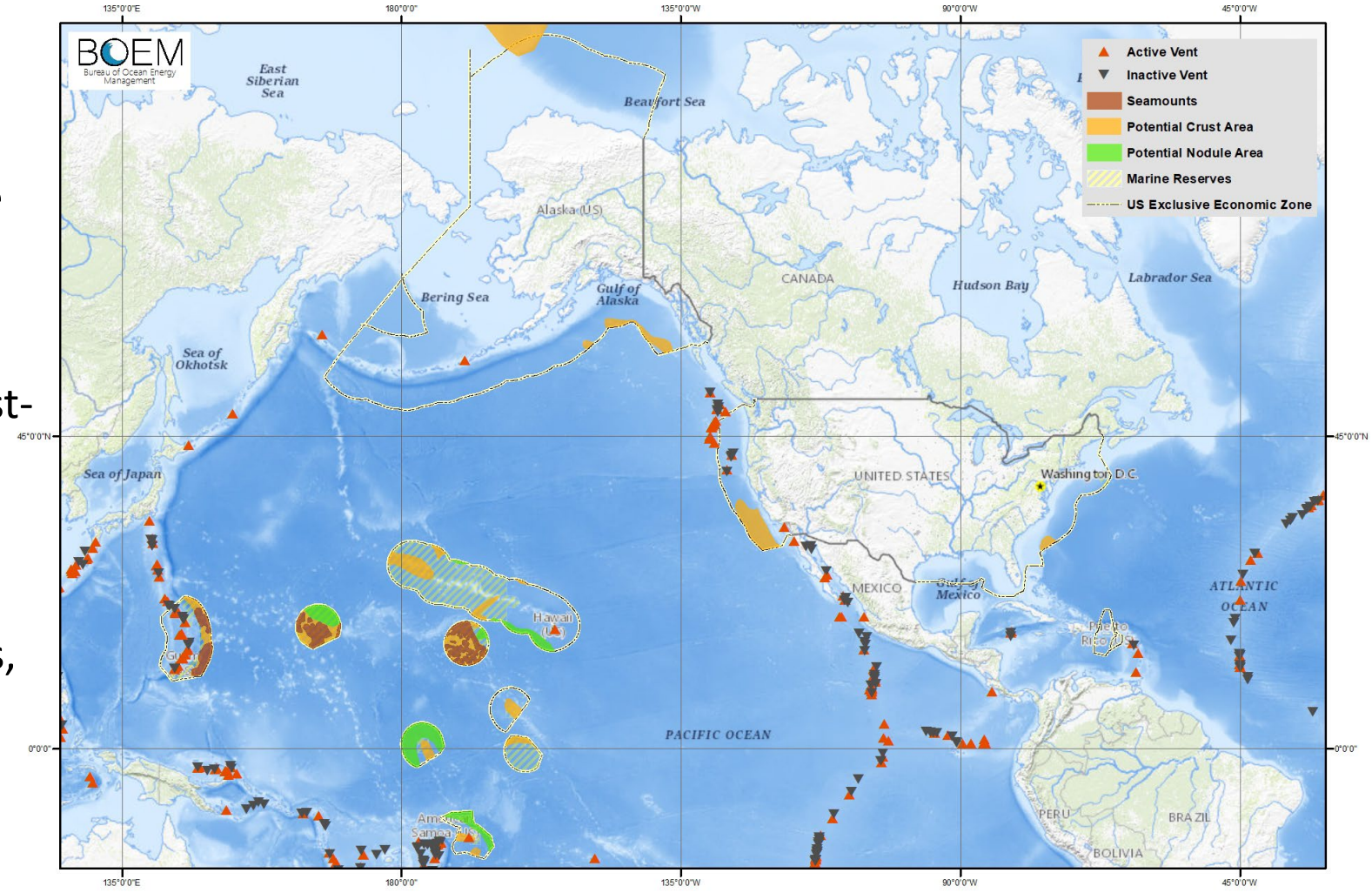
Offshore Critical Minerals: OCS Locations

Prospective Maps

- Developed from models and expert knowledge
- Indicates areas where minerals could be present, based on current knowledge

General Trends

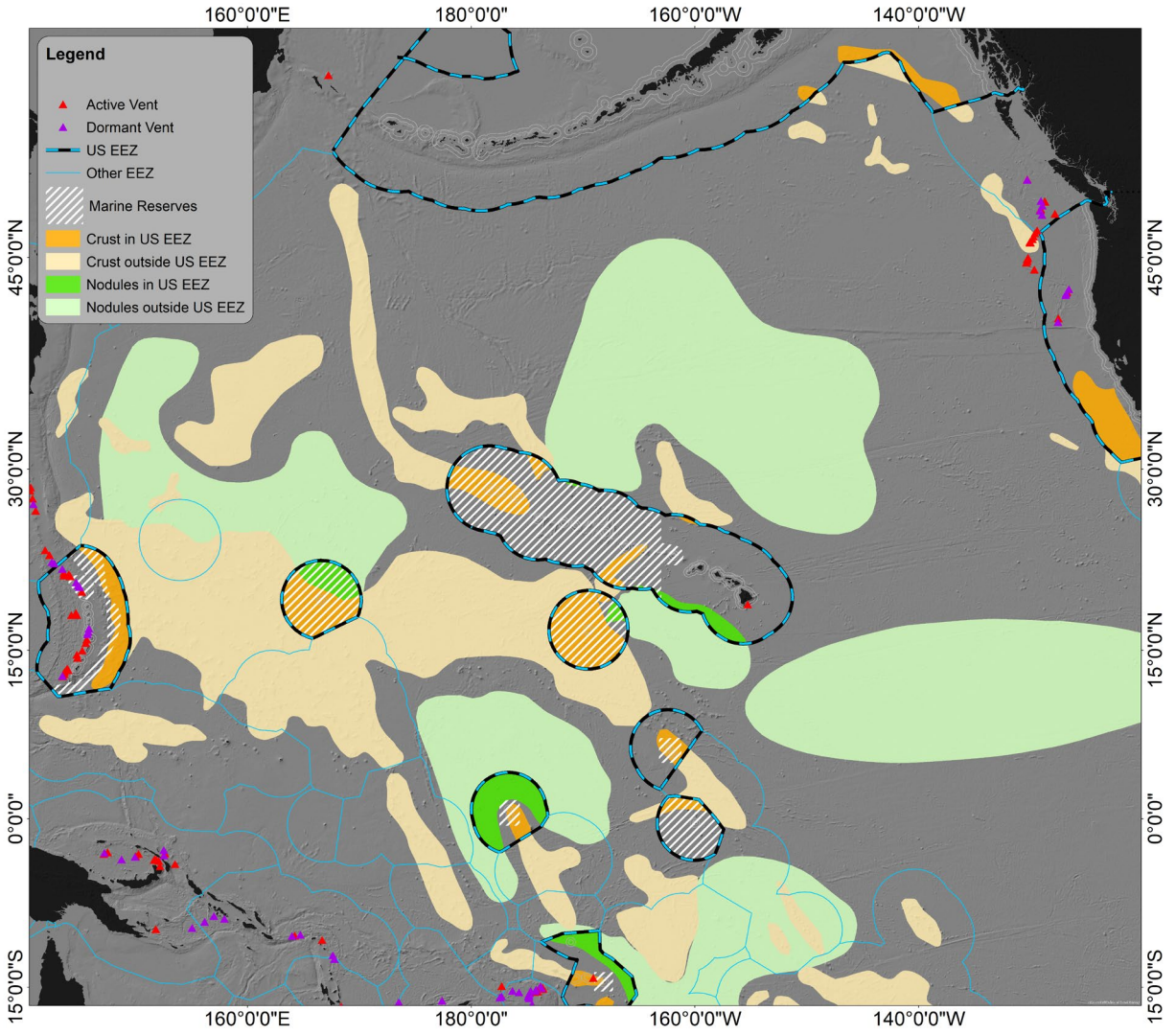
- **Remote Pacific** is likely nodule- and crust-rich
- **Atlantic** likely has heavy minerals, nodules, and crust
- **Gulf of Mexico** likely has heavy minerals, possible brine minerals
- **Pacific Coast** likely has phosphates, hydrothermal deposits
- **Alaska** likely has heavy minerals, crust



Offshore Critical Minerals: Deposit Locations

Prospective Maps

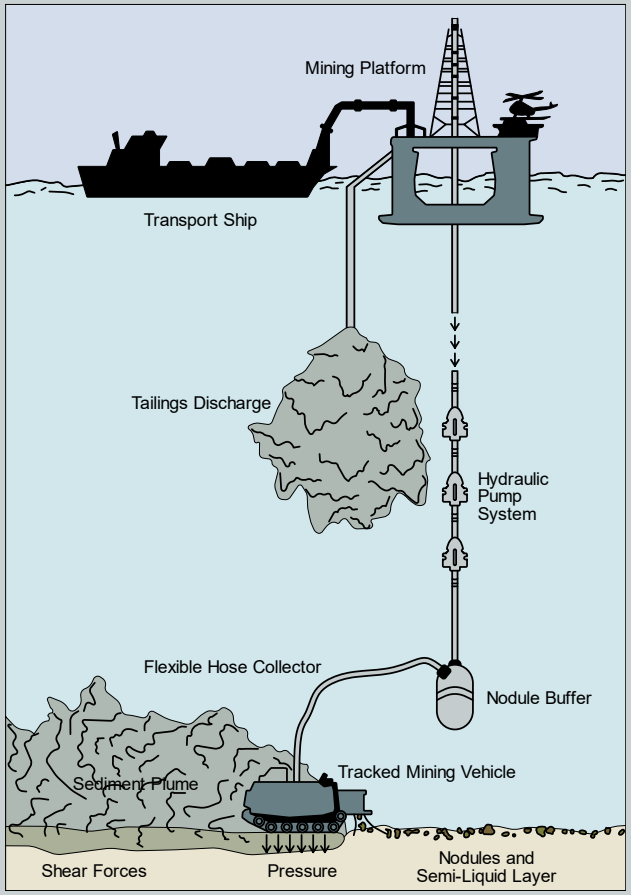
- Developed from models and expert knowledge
- Indicates areas where minerals could be present, based on current knowledge
- Example for the Pacific and Alaska Regions
- Mineral locations on the OCS are also focus of environmental baseline work



Offshore Critical Minerals: Recovery Methods

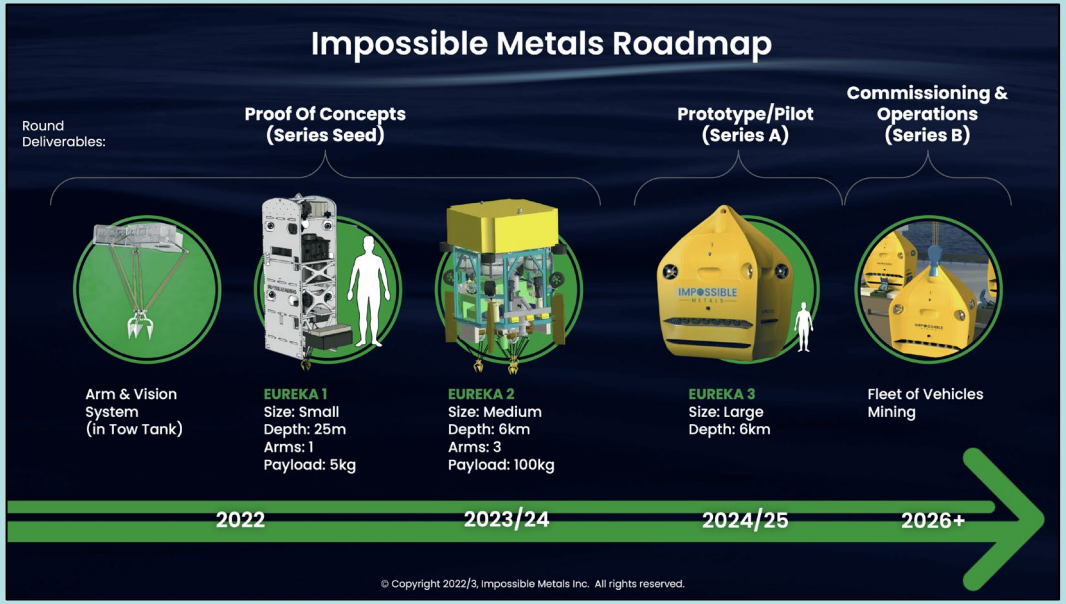
Traditional Approach

- Tracked harvester raking or scooping minerals from seabed
- Minerals transported to surface in a slurry pipe
- Sediment plumes are the primary environmental concern



Newer Approaches

- Postulate floating A.I.-enabled harvesters
- Use of claws or water jets to recover nodules
- Lower-impact methods of surfacing nodules



Sources: Mimideepsea (public domain), Impossible Metals

BOEM's Role:
Management and Facilitation
Regulatory path and projected timelines

BOEM's Executive Order(s) Guidance

Outer Continental Shelf Lands Act (OCSLA)

- 43 U.S. Code § 1340(a)(1) (Geological and geophysical exploration)
- 43 U.S. Code § 1337(k)(1) (Mineral leasing)

Executive Orders

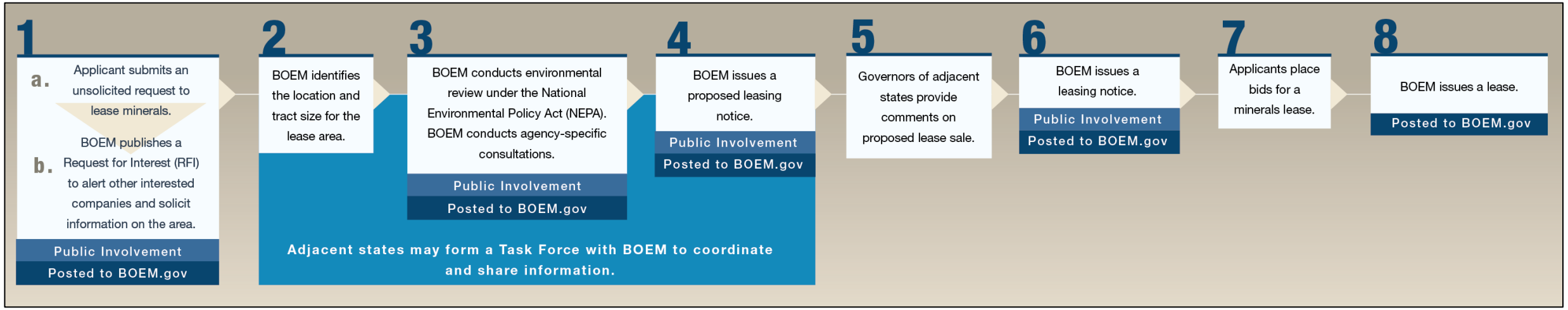
- **EO 14017 (2021)** states "it is the policy of [the Biden] Administration to strengthen the resilience of America's supply chains."
- **EO 13953 (2020)** recognizes the importance of building up the domestic supply chain for critical minerals and further emphasizes the importance of reducing the vulnerability of the U.S. to the disruption of critical mineral supply chains through cooperation and coordination with partners and allies.
- **EO 13817 (2017)** "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals"- those minerals considered critical to the economic and national security of the United States.

BOEM's role: management and facilitation

BOEM's Regulations:	30 CFR 580 Prospecting for Minerals	30 CFR 581 Leasing of Minerals	30 CFR 582 Operations

Action:	**Prospecting**
	• Commercial prospecting requires a Geophysical and/or Geological Permit; prospecting does not convey mineral rights
	• Non-commercial exploration requires an Authorization (or Notice for Scientific Research)
	Total = ~2-3 months for Permit; ~ 1 month for Authorization
		Leasing
		• Competitive process separate from prospecting
		• Two components:
		  • Sale
		  • Lease administration (e.g., required payments, bonding)
		Process likely to take years
			Activities under a Lease
			• Operations are to be conducted in manner that protects environment and promotes orderly development
			  • Delineation
			  • Testing
			  • Mining
			• Lessees must also comply with applicable BSEE regulations

Leasing: Regulatory Pathway and Projected Timeline Estimates



3 - 12 months	1 - 3 (or more) years	6 - 12 months

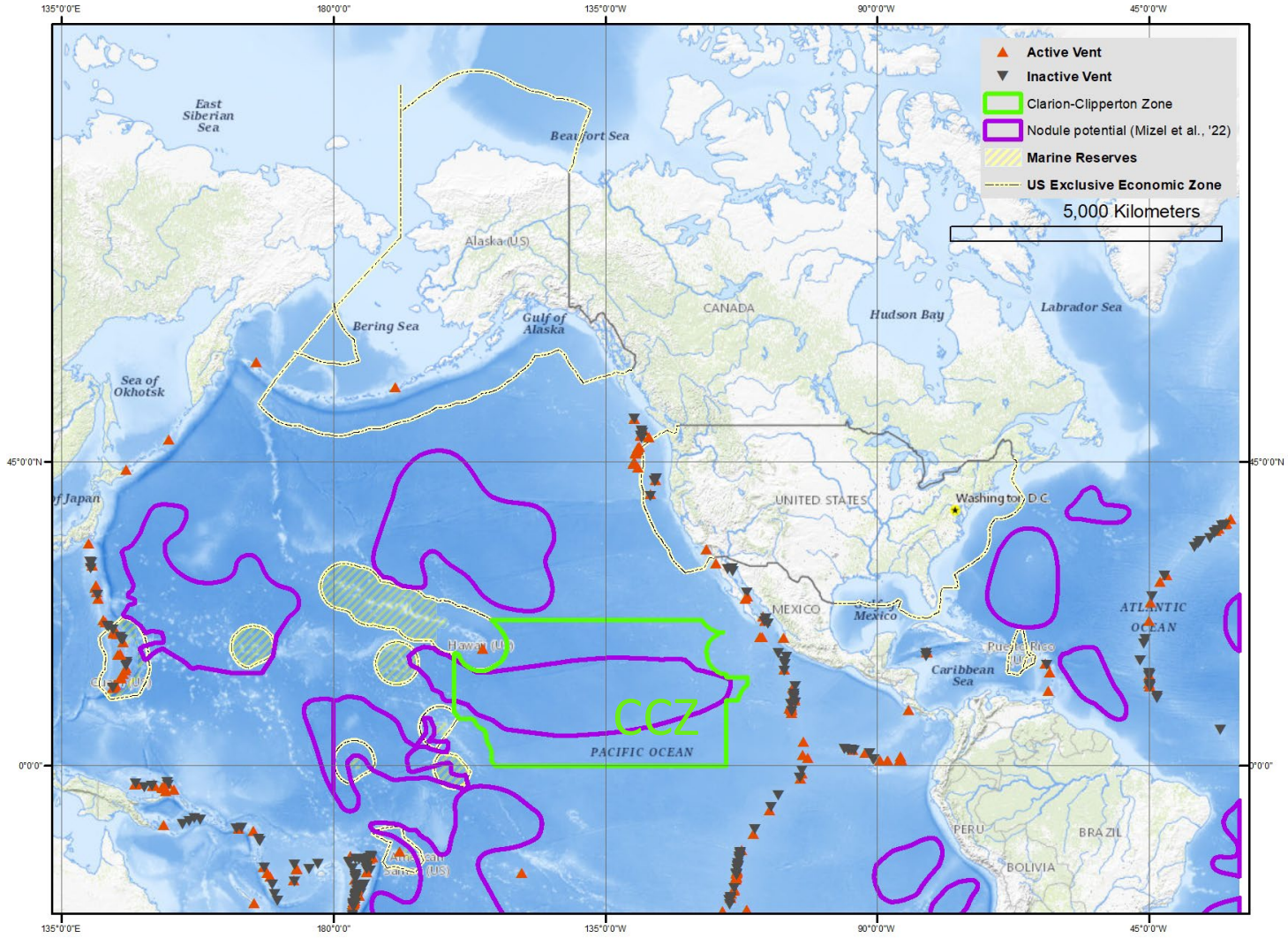
Total = 4 - 5 (or more) years

- **45 days to respond** to an unsolicited request to lease minerals (e.g., decision to publish Request for Information)
- Environmental assessment occurs at almost every step
- **Secretary can stop work at any stage**
- Minimum lease period currently 20 years, with prescribed terms and conditions
- Leasing process similar to BOEM's oil and gas leasing process with sealed bid, cash bonus bid, and royalties

Offshore Critical Minerals: International Framework

International Seabed Authority (ISA)

- Established in 1994 under the United Nations Convention on the Law of the Sea (UNCLOS)
- ISA regulates mineral-related activities in areas beyond national jurisdiction
- As the U.S. has not ratified UNCLOS, it participates in ISA proceedings as an "observer" nation
- Exploration Regulations: In place
- Exploitation Regulations: In advanced development



BOEM's Role:
Management and Facilitation
Current Research Efforts
(Resource and Environmental)

BOEM Strategic Priorities:

National Offshore Critical Minerals Inventory and Related Investments

1. Advance resource evaluation and environmental assessment standards and information assets.

2. Advance assessment of offshore critical minerals.

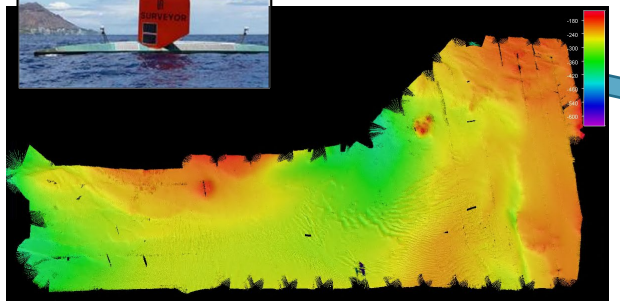
3. Advance understanding of baseline environmental conditions.

4. Advance technologies that efficiently and cost-effectively assess offshore critical minerals.

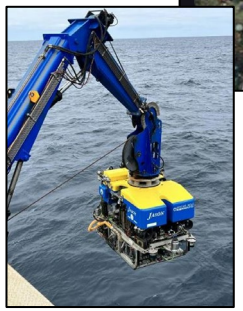
5. Provide accessible information on OCS critical minerals.

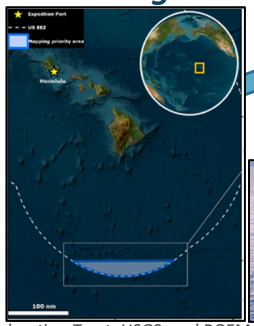
BOEM-Funded Offshore Critical Mineral Exploration Projects

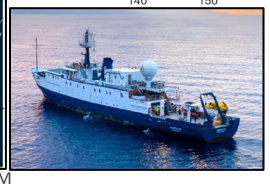
Western Aleutian Seamounts



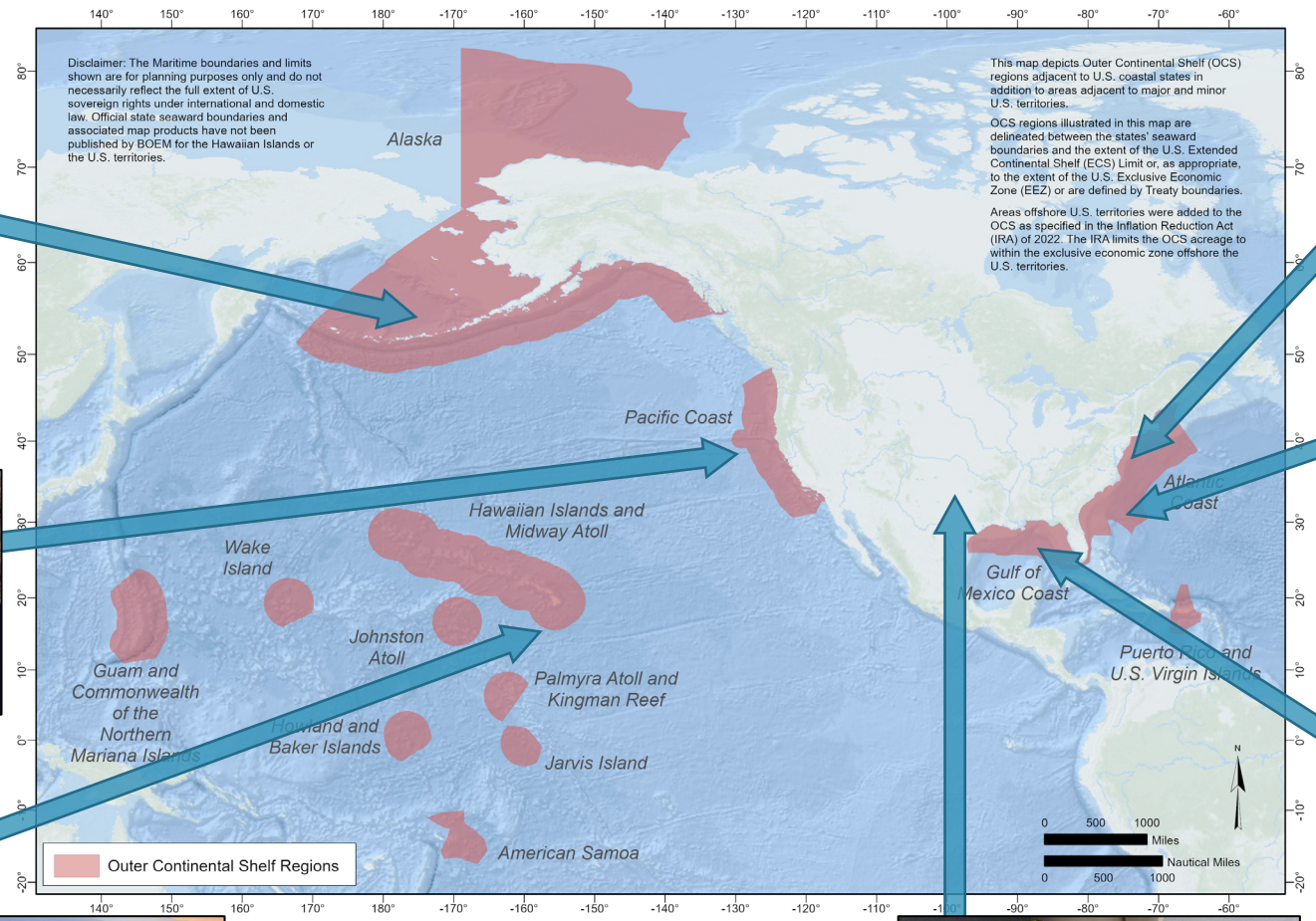
Escanaba Trough

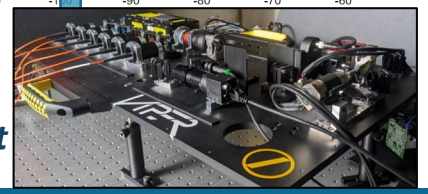






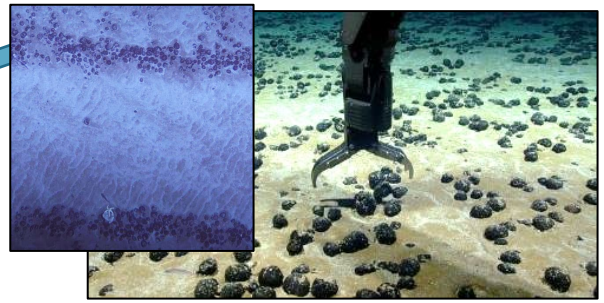
Hawaii abyssal plain





Tech development

Wallops Island (Virginia) Heavy Mineral Sands

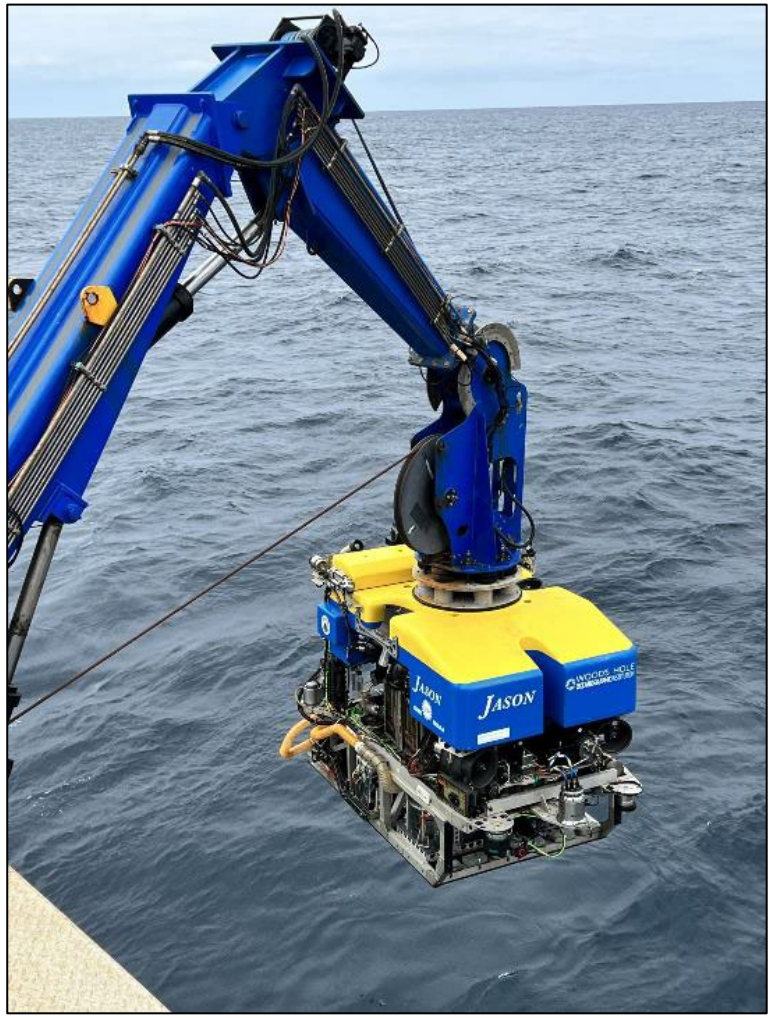


Blake Plateau historic test site

Gulf of Mexico salt brines

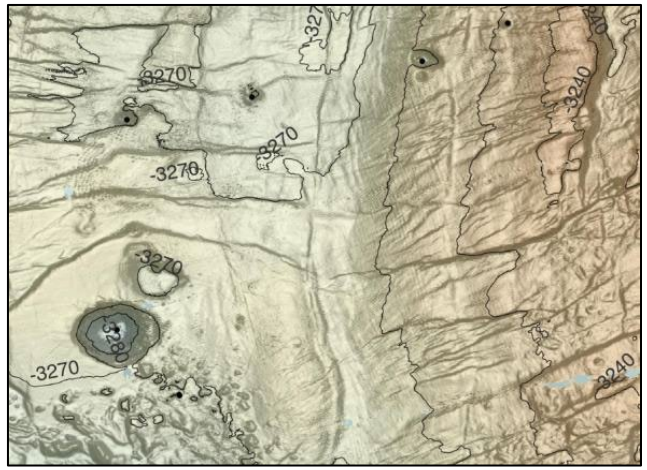
Photos courtesy of: Saildrone, inc., Ocean Exploration Trust, USGS, and BOEM

Pacific Region: Escanaba Trough (2022)

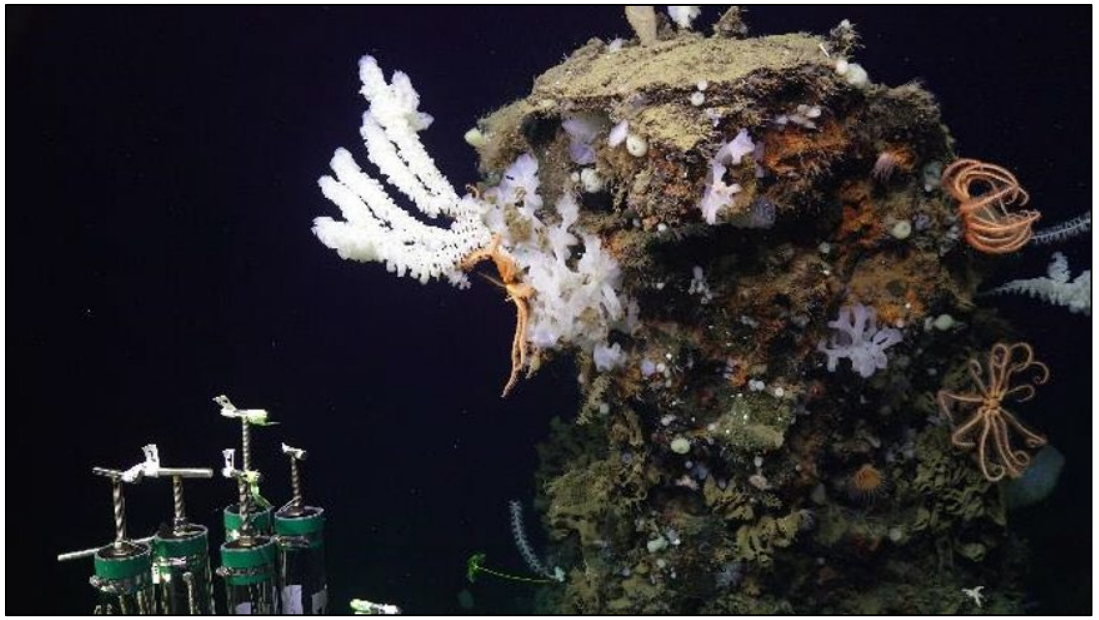


***Jason* ROV**

***Sentry* AUV**

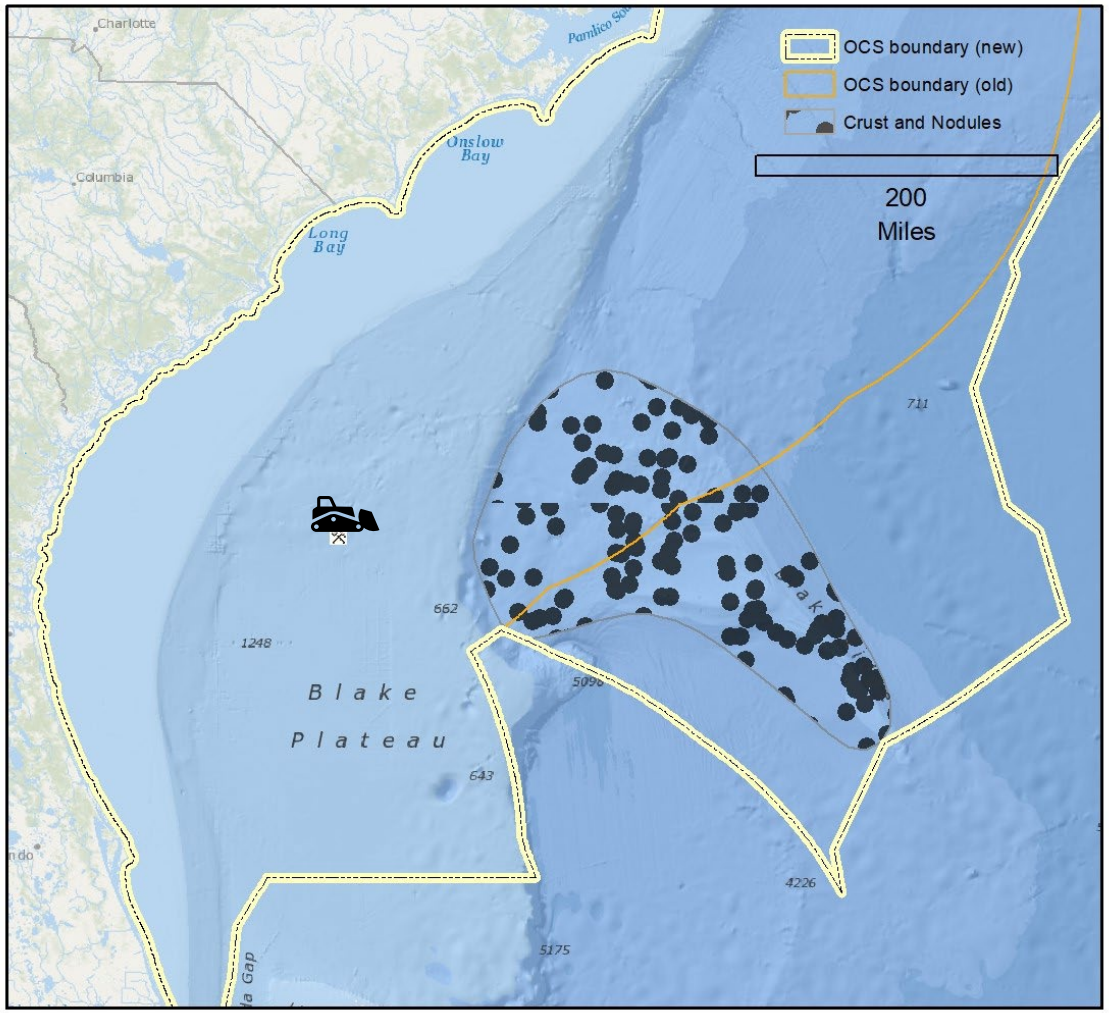


Multibeam sonar



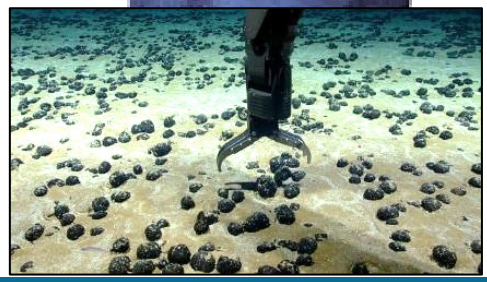
Hydrothermal vents and sediment beds

Atlantic Region: Blake Plateau Ecological Recovery Study



Blake Plateau

- Nodule and crust-rich
- About 300 km offshore, 800 m depth
- Used to test equipment in the 1970s
- 2022 documented 50 km2 study area:
  - ~ 550,000 high resolution photos
  - 12 megapixels at 5 m flight height
  - Fine scale bathymetry data
  - 1 m or better, most at 0.5 m
  - Side-scan sonar
  - Sub-bottom profile and magnetometry
- 2025 or 2026 planned science cruise
  - Document ecological recovery
  - Establish recovery experiments
  - Continue delineating resources



Upcoming Study: Phase 1 – Identify Env. Data / Info Gaps & Needs

Critical Minerals Environmental Assessment Framework (CMEAF)

The National Academies of SCIENCES ENGINEERING MEDICINE

Engage NASEM to:

- Identify **information needs** peculiar to deep sea mineral actions
- Identify which **baseline environmental parameters** should be gathered
- Review existing information to **identify, describe, and prioritize information gaps** that can be addressed by future CM environmental studies:
  - Identify information needs and data gaps, primarily associated with nodules and heavy mineral sands
  - Identify assessment needs specific to critical mineral prospecting, leasing, and operations
  - What is needed to document the environmental baseline?

Upcoming Study: Phase 2 – Develop Env. Assessment Methods

Environmental evaluation of the critical and hard offshore mineral programmatic reference (EE-CHOMPR)

** Phase 2- Desktop study (Phase 1 was a resource evaluation study of known critical minerals)*

Objectives

- Compile, assess, and summarize **best practices and standards for deep-sea data and sample collection**.
- Identify, compile, consolidate, and summarize existing governmental, industry, academic, and non-governmental data and information needed to assess and monitor impacts associated with:
  - Each lifecycle phase of a CM project (**prospecting; exploration/ site characterization; construction/ operations; and decommissioning**); and,
  - The associated habitats, ecological patterns, and environmental baselines against which impacts can be analyzed.
- Based on this study's findings, **develop suggested environmental guidelines** for exploration and development for critical minerals.

Additional Research Possibilities

Marine Minerals Resources Research Act (1996)- 30 U.S.C. Chapter 30

- Congressionally-mandated, but not fully funded
- **Goal**: promote research, identification, assessment, and exploration of marine mineral resources in an environmentally responsible manner
  - Technology (assist, development, and coordinate)
  - Encourage federal partnerships, and academic and industry participation for exploration, mapping, etc.
  - Ensure data are accessible and widely-available
- **Grant** authority for research and development not exercised.
- Three previous Marine Mineral Technology Centers now closed:
  - University of Mississippi focusing on the continental shelf regions of the United States
  - University of Hawaii at Manoa focused on deep seabeds and nearshore island environs
  - University of Alaska, Fairbanks focused on Arctic and cold water regions.

COSA Feedback

- What is the most important information that will inform critical mineral regulatory decisions (e.g., environmental, socio-economic, cultural, environmental justice, climate)?
- Which resources and locations have the highest research priority?
- Which topical areas have the highest priority (e.g., benthic sessile organisms, deep diving whales)?
- Do you have recommendations for specific types of environmental studies (e.g., biological, physical, chemical, cultural)?
- Any technology-related suggestions (e.g., eDNA, sensor technology, machine learning)?
- What approach toward research collaborations (e.g., academia, phased studies) would be the most productive?
- What data (e.g., bathymetry, ecological) are needed?
- What areas would benefit most and least from federal attention?

Outreach and Exploration Needs

- The newly-added OCS areas expanded the scope of the Marine Minerals Program
- Need to engage local governments, indigenous peoples, and local stakeholders to assess level of interest in and concerns regarding eventual BOEM activities
- Data and information gaps exist for most OCS areas, including baseline information
- Encourage development of lower-impact recovery technologies, mitigations, and practices
- **Coordinate** efforts with federal agencies (e.g., NOAA, USGS, State, USGC, FWS, DOD)

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Paul Knorr, Ph.D., Critical Minerals Geologist | paul.knorr@boem.gov

Shannon Cofield, Ph.D. – Geological Oceanographer | shannon.cofield@boem.gov

Outreach and Exploration Needs - OLD

- The newly-added OCS areas expanded the scope of the Marine Minerals Program
  - Which resources and areas have the highest research priority?
- Need to engage local governments, indigenous peoples, and local stakeholders to assess level of interest in and concerns regarding eventual BOEM activities
  - Work with federal partners to engage stakeholders. What are preferred engagement methods?
- Data gaps exist for most information areas, including OCS baseline information concerning
  - What data are needed? (e.g., bathymetry, water column, resources, ecology, cultural)
- Encourage development of lower-impact recovery technologies, mitigations, and practices
  - What areas would benefit most from federal attention?
- **Coordinate** efforts with federal agencies (e.g., NOAA, USGS, State, USGC, FWS, DOD)
  - What is the best method of ensuring participation and collaboration?

Reference Slides

U.S. CRITICAL MINERALS

FROM DEEP SEA MARINE SOURCES

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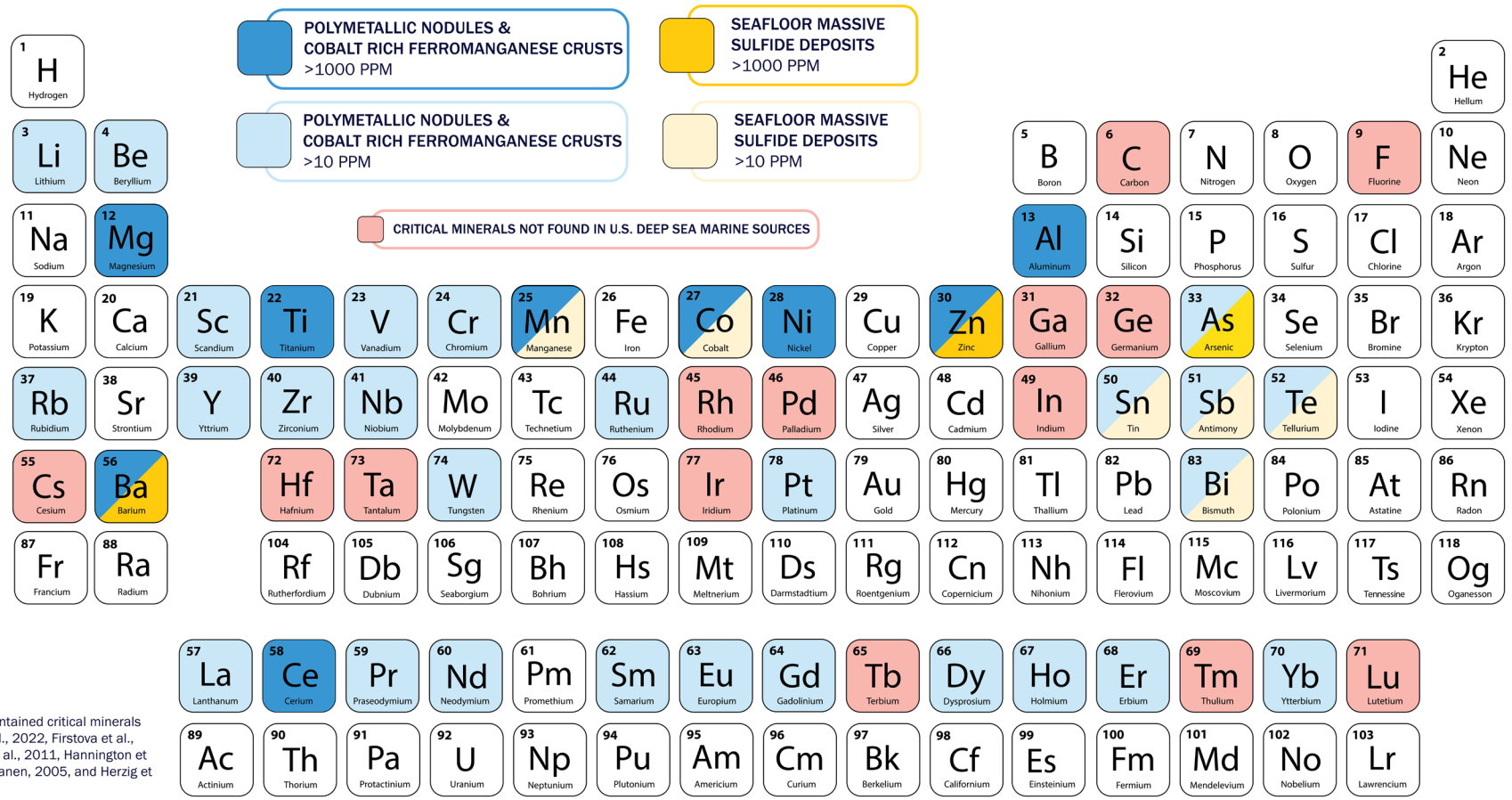


Estimates of contained critical minerals from Mizell et al., 2022, Firstova et al., 2019, Herzig et al., 2011, Hannington et al., 2010, Tormanen, 2005, and Herzig et al., 2022

Reference Slides

U.S. CRITICAL MINERALS

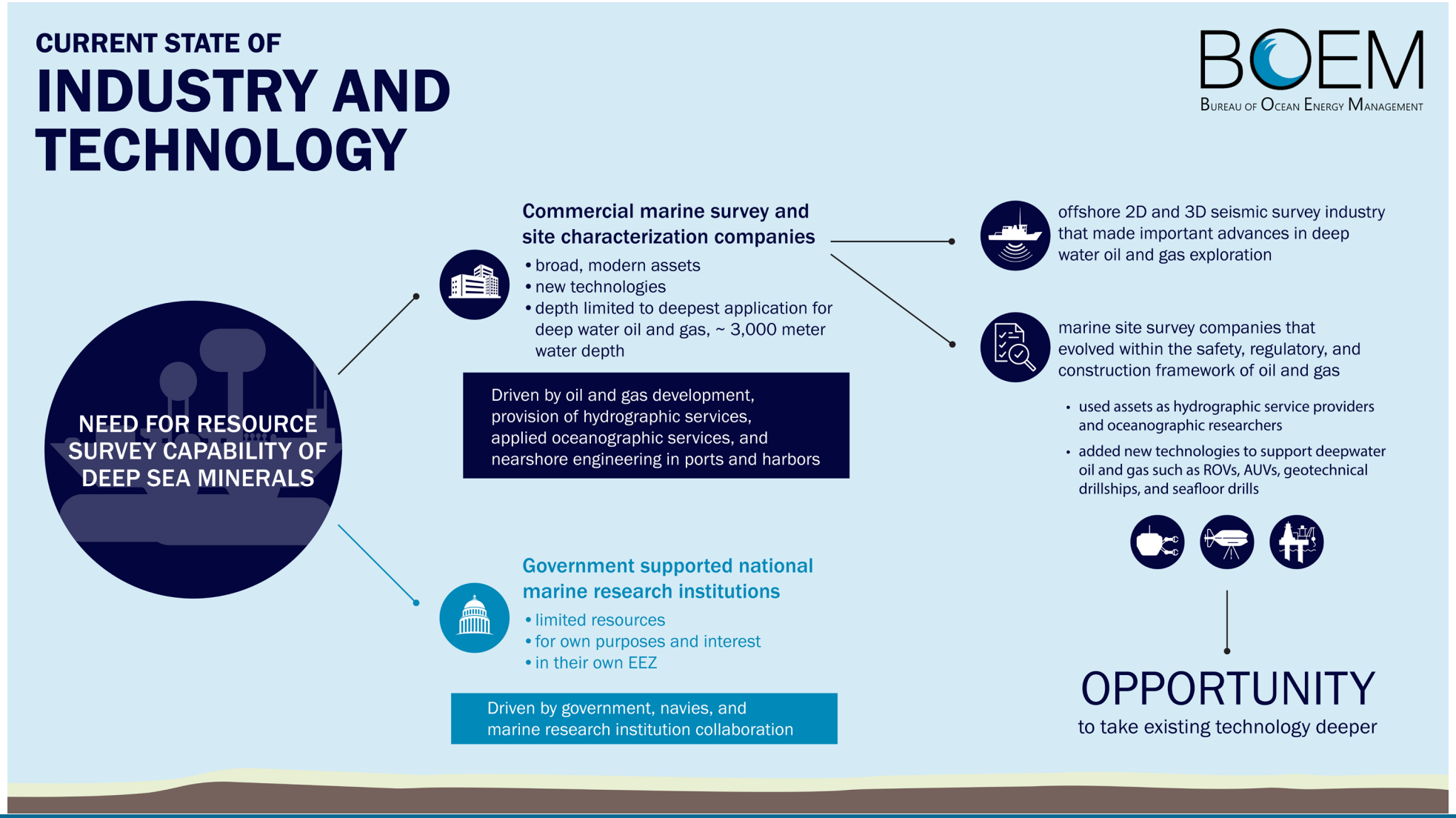
Identified by the Secretary of the Interior as essential to the economic and national security of the United States

BOEM
Bureau of Ocean Energy Management

present in the outer continential shelf (OCS) or exclusive economic zone (EEZ)

ALUMINUM	transportation, construction, packaging, machinery, energy
ANTIMONY	batteries, flame retardants
ARSENIC	semi-conductors
BARITE	cement, petroleum
BERYLLIUM	aerospace, defense
BISMUTH	medicine
CERIUM	metallurgy, glass, ceramics, transportation
CESIUM	research and development
CHROMIUM	stainless steel
COBALT	batteries, superalloys
DYSPROSIUM	magnets, lasers, data storage devices
ERBIUM	lasers, fiber optics, optical amplifiers
EUROPIUM	nuclear energy
FLUOROSPAR	transportation, cement, steel, gasoline
GADOLINIUM	magnets, electronics, medical technology
GALLIUM	electronics, LEDs
GERMANIUM	fiber optics, night vision applications
GRAPHITE	batteries, fuel cells, lubricants
HAFNIUM	nuclear energy, alloys, ceramics
HOLMIUM	lasers, medical technology, nuclear energy
INDIUM	LCD screens
IRIDIUM	fertilizer, crude oil refining
LANTHANUM	ceramics, glass, batteries
LITHIUM	rechargeable batteries
LUTETIUM	medical technology
MAGNESIUM	manufacturing steel
MANGANESE	manufacturing steel, batteries
NEODYNIUM	magnets, medical lasers, industrial lasers
NICKEL	stainless steel, batteries
NIOBIUM	steel, superalloys
PALLADIUM	catalytic convertors, transportation
PLATINUM	catalytic convertors, transportation
PRASEODYMIUM	magnets, batteries, aerospace alloys
RHODIUM	catalytic converters, transportation, electronics
RUBIDIUM	electronics
RUTHENIUM	electrical contacts, chip resistors
SAMARIUM	magnets, nuclear energy, medical technology
SCANDIUM	fuel cells, alloys
TANTALUM	electronics, capacitors
TELLURIUM	solar cells, steel making
TERBIUM	magnets, fiber optics, lasers, electronics
THULIUM	alloys, lasers
TIN	protective coatings, steel alloys
TITANIUM	white pigment, alloys for steel
TUNGSTEN	metal making
VANADIUM	alloying agent for iron and steel
YTTERBIUM	catalysts, scintillometers, lasers, metallurgy
YTTRIUM	ceramic, catalysts, lasers, metallurgy, phosphors
ZINC	production of galvanized steel
ZIRCONIUM	ceramics, corrosion resistant salloys

Reference Slides



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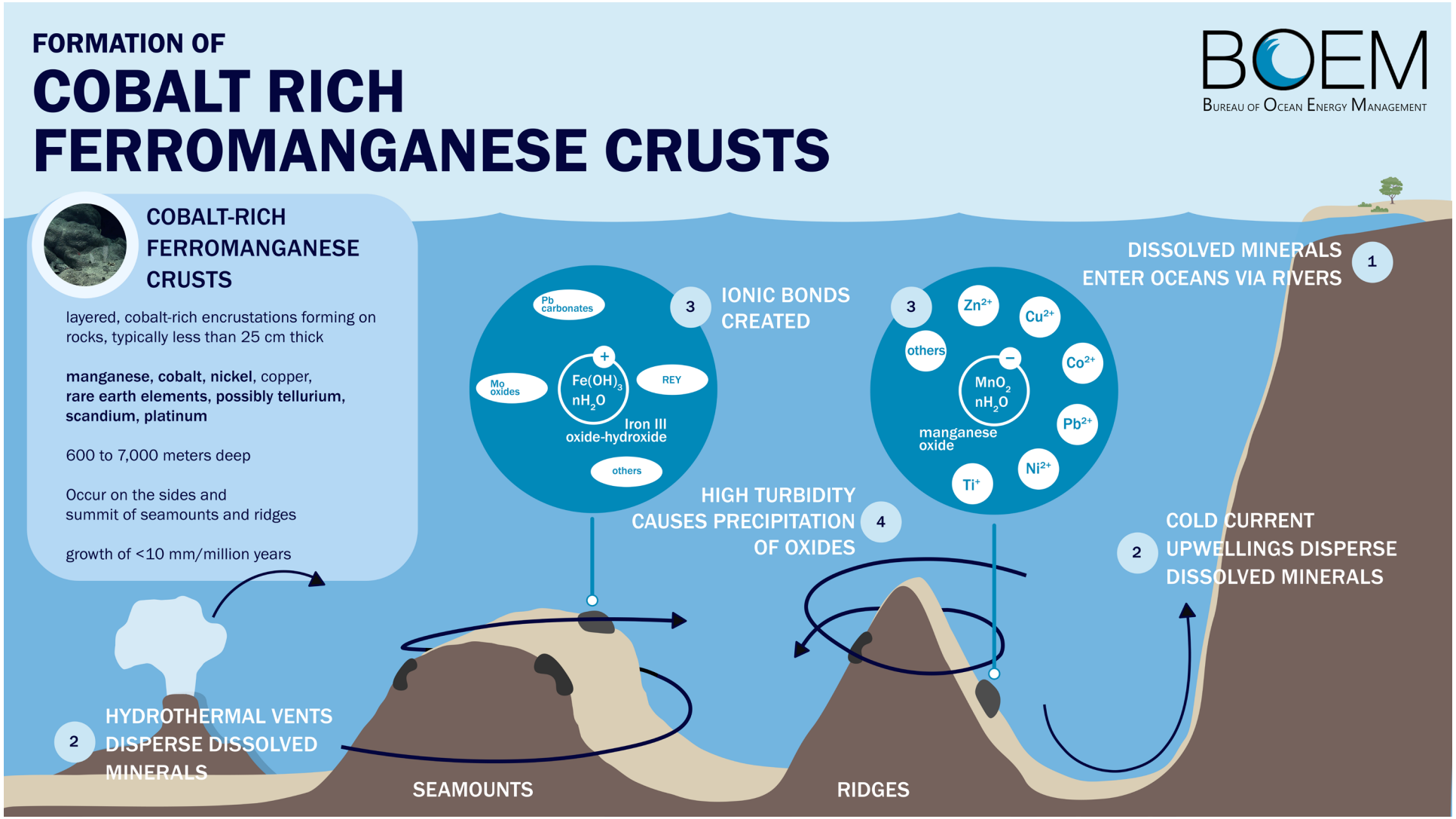

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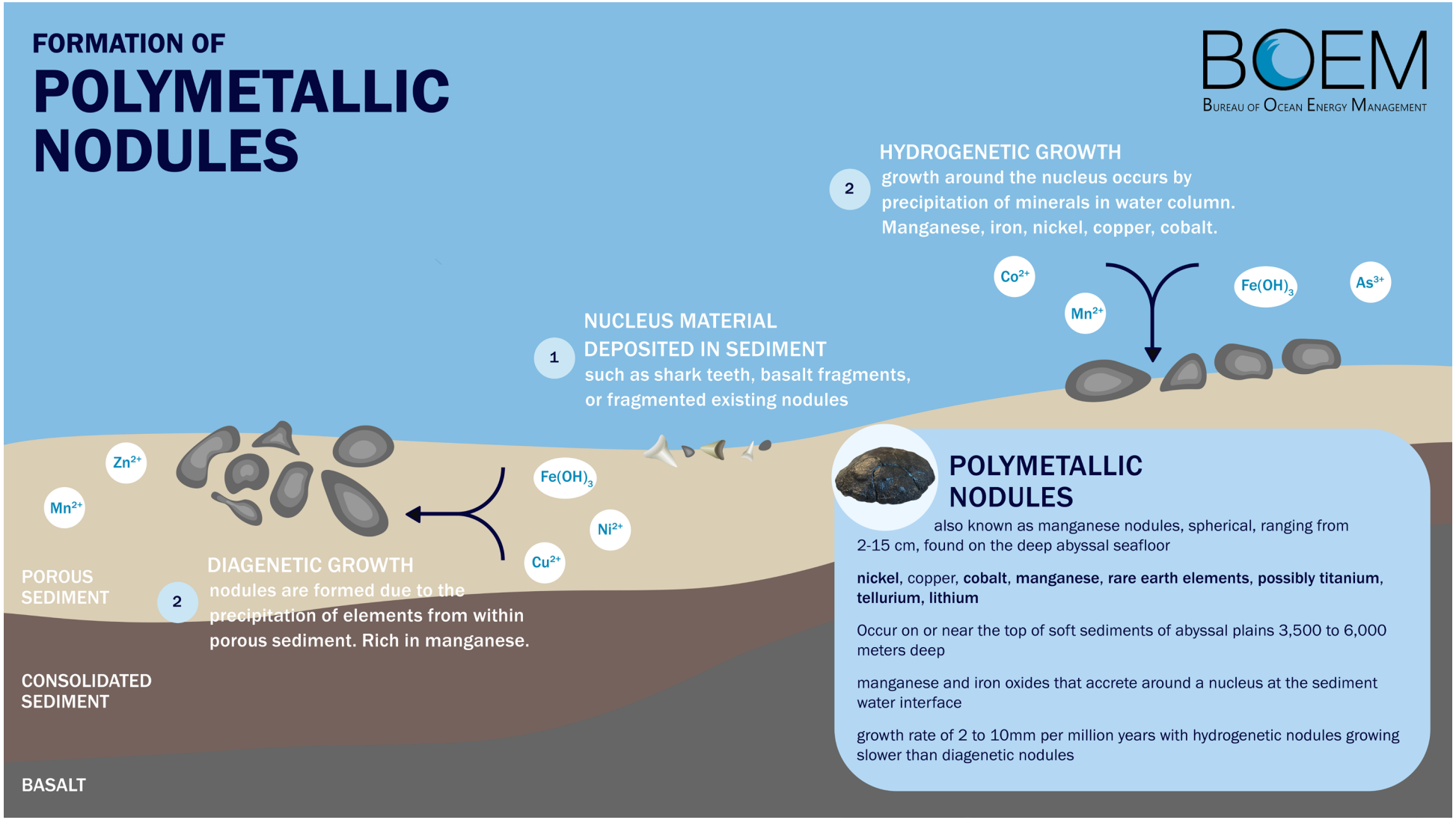

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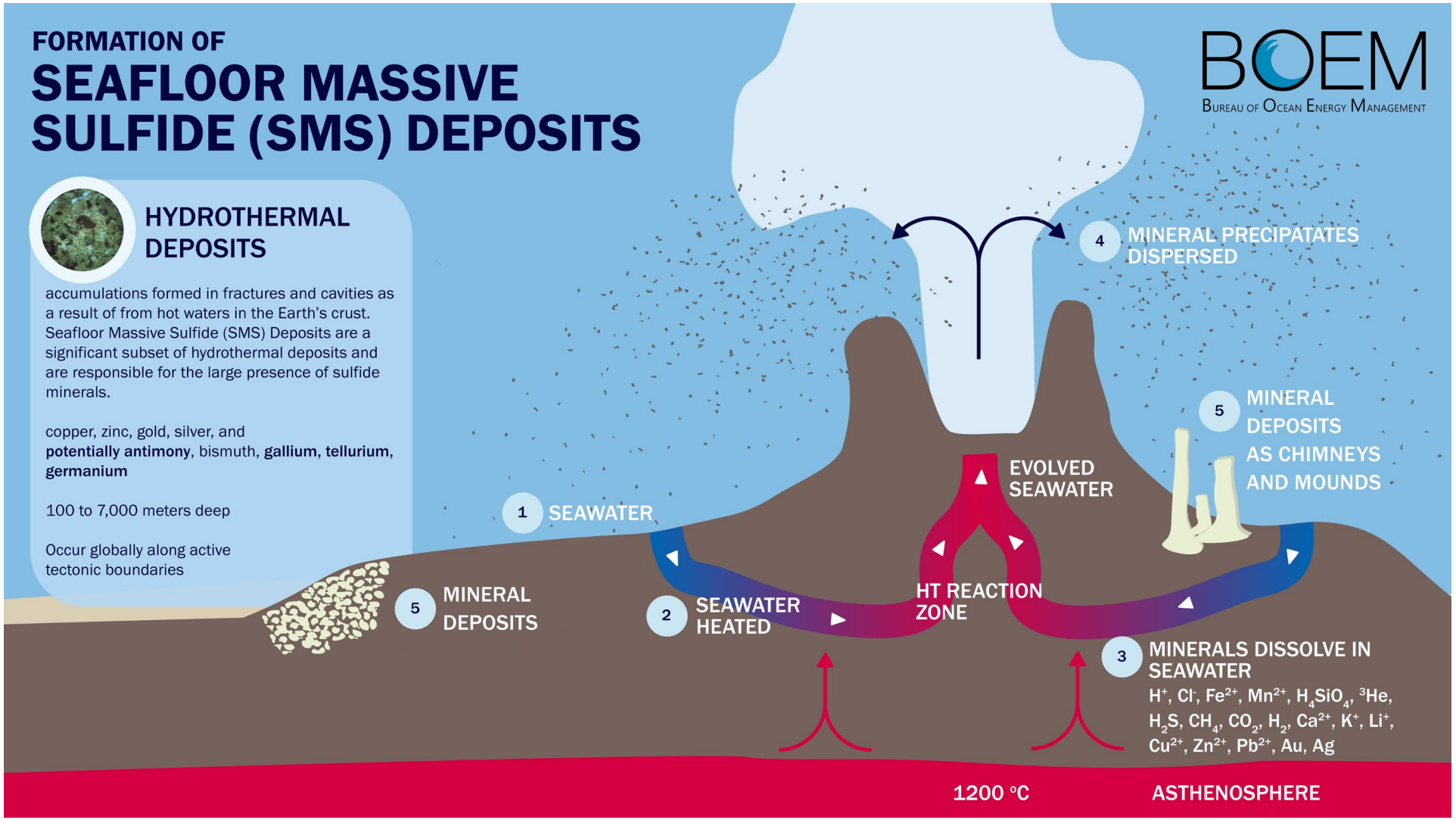

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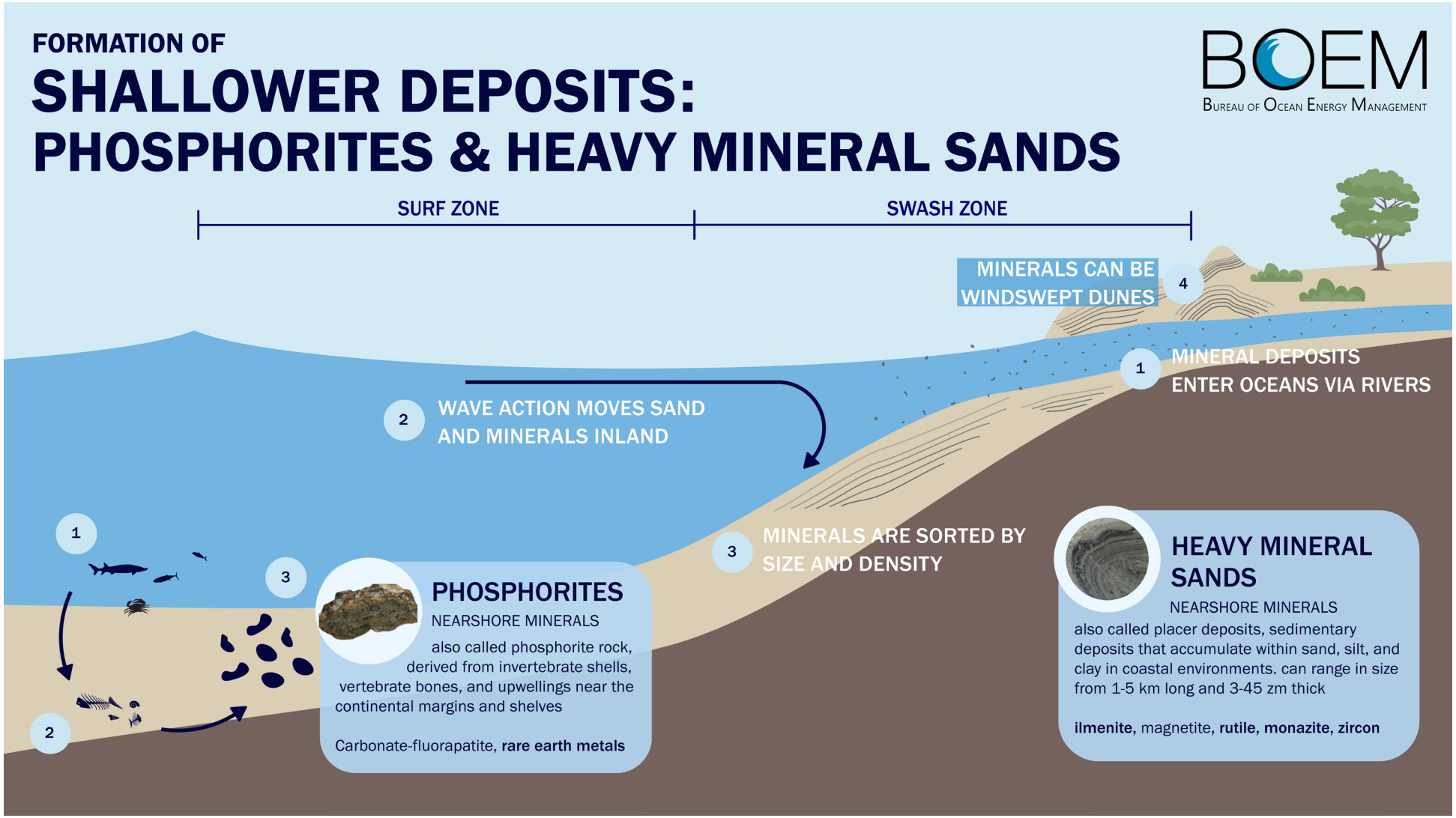
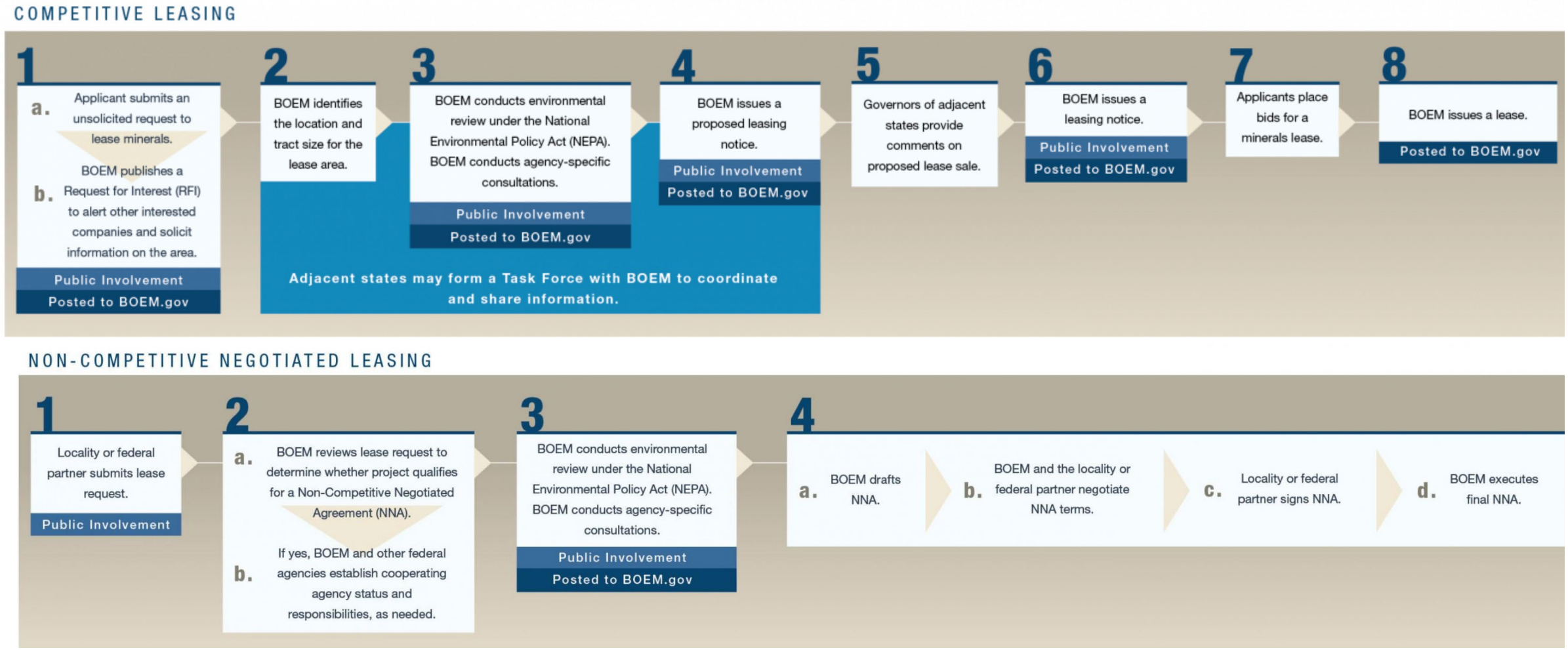


Leasing: Regulatory Pathway for Competitive and Non-Competitive



Reference Material- Additional Research Possibilities

Marine Minerals Resources Research Act (1996)- 30 U.S.C. Chapter 30)

§1902. Research program

(a) In general

The Secretary shall establish and carry out a program of research on marine mineral resources.

(b) Program goal

The goal of the program shall be to—

(1) promote research, identification, assessment, and exploration of marine mineral resources in an environmentally responsible manner;

(2) assist in developing domestic technologies required for efficient and environmentally sound development of marine mineral resources;

(3) coordinate and promote the use of technologies developed with Federal assistance, and the use of available Federal assets, for research, identification, assessment, exploration, and development of marine mineral resources; and

(4) encourage academia and industry to conduct basic and applied research, on a joint basis, through grants, cooperative agreements, or contracts with the Federal Government.

(c) Responsibilities of Secretary

In carrying out the program, the Secretary shall—

(1) promote and coordinate partnerships between industry, government, and academia to research, identify, assess, and explore marine mineral resources in an environmentally sound manner;

(2) undertake programs to develop the basic information necessary to the long-term national interest in marine mineral resources (including seabed mapping) and to ensure that data and information are accessible and widely disseminated as needed and appropriate;

(3) identify, and promote cooperation among agency programs that are developing, technologies developed by other Federal programs that may hold promise for facilitating undersea applications related to marine mineral resources, including technologies related to vessels and other platforms, underwater vehicles, survey and mapping systems, remote power sources, data collection and transmission systems, and various seabed research systems; and

(4) foster communication and coordination between Federal and State agencies, universities, and private entities concerning marine mineral research on seabeds of the continental shelf, ocean basins, and arctic and cold water areas.

In carrying out these responsibilities, the Secretary shall ensure the participation of non-Federal users of technologies and data related to marine mineral resources in planning and priority setting.

(Pub. L. 91–631, title II, §202, as added Pub. L. 104–325, §2(3), Oct. 19, 1996, 110 Stat. 3995.)