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America's Offshore **Critical Mineral Resources**

The U.S. has potential offshore critical minerals to supply our strategic need, but they are currently an underexplored and untapped resource.

Why do we care?

The United States is wholly import dependent for 17* of the 35 minerals defined as critical by the U.S. Geological Survey (USGS). To address this shortfall, the U.S. is pursuing A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals published in response to Executive Order 13817. For its part the Bureau of Ocean Energy Management (BOEM) is leading the development of a National Offshore Critical Mineral Inventory to address the potential for offshore critical minerals.

*from USGS Mineral Commodity Summaries 2019

Critical Minerals Occurring Offshore

Yellow = Occur in marine minerals within the US Exclusive Economic Zone

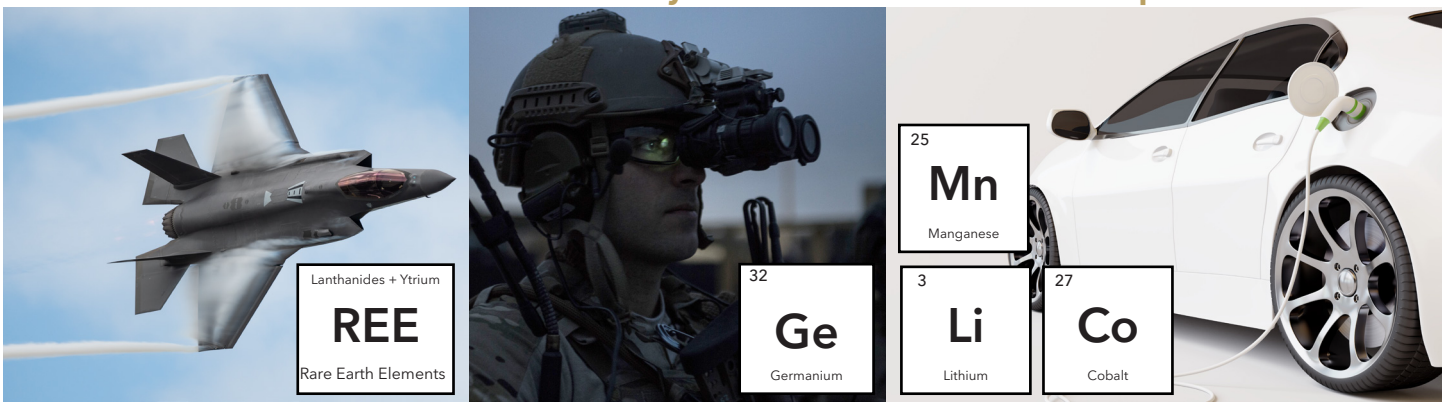
- Aluminum (bauxite)
- **Antimony**
- Arsenic
- Barite
- Beryllium
- **Bismuth**
- Cesium
- Chromium
- **Cobalt**
- Fluorspar
- **Gallium**
- **Germanium**
- Graphite (natural)
- Halfnium
- Helium
- Indium
- **Lithium**
- **Magnesium**
- **Manganese**
- **Niobium**
- **Platinum group metals**
- Potash
- **Rare earth elements**
- Rhenium
- Rubidium
- **Scandium**
- Strontium
- Tantalum
- **Tellurium**
- **Tin**
- **Titanium**
- Tungsten
- **Uranium**
- **Vanadium**
- **Zirconium**

The types of critical minerals that occur in offshore deposits are used in transportation **(lithium, cobalt, manganese)** and defense and national security **(germanium, rare earth elements)**

Table adapted from 83 FR 23295

It is not just about consumer electronics...

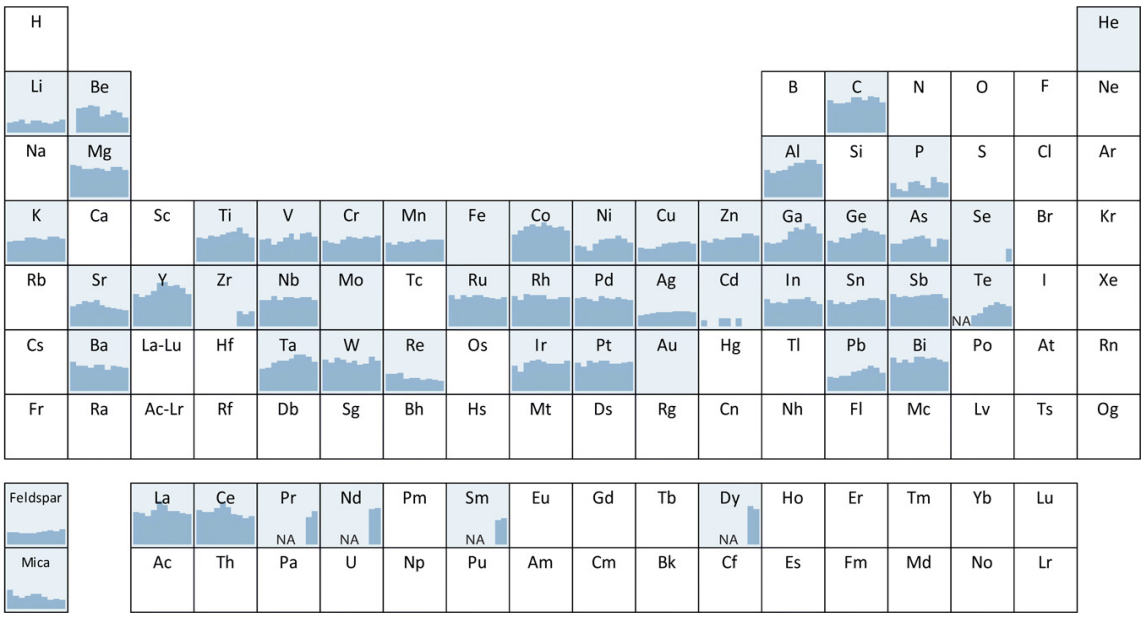
Defense and National Security **Transportation**



While the need for critical minerals in the manufacturing of cell phones and other consumer products is well known, there is growing domestic demand for critical minerals in high-tech industry, transportation, and defense applications.

Domestic production of critical minerals will assure a resilient supply chain (see below for graphical depiction of supply risk) and represents a potential revenue source for the U.S. Government. Critical minerals are essential to the production of high-tech equipment in a wide variety of sectors including energy production, national defense, battery technology, information technology, and health care.

BOEM is developing an evaluation of hard mineral resources on the Outer Continental Shelf, in conjunction with the USGS. The inventory of hard mineral resources will include identification of offshore areas with high economic potential. These areas can be evaluated further for potential exploration and leasing, including consideration of environmental risk.



Supply Risk scores for all commodities examined for the years 2007–2016, each bar represents one year with the height of the bar ranging from 0 (no supply risk) to 1 (high supply risk). Adapted from Nassar et al., Sci. Adv. 2020; 6: eaay8647

What Marine Deposits Contain Critical Minerals?

Five main categories:

nearshore minerals, phosphorites, manganese nodules, ferromanganese crusts, and hydrothermal deposits

NEARSHORE MINERALS

include placers, which are heavy minerals concentrated by moving water, and offshore extensions of continental deposits

- Water Depth: Typically, < 500 ft
- Occurrence: Continental margins
- Habitat: Soft sediment (e.g., sand, mud) with burrowing invertebrates and bottom-dwelling fish
- Location: Close to terrestrial mineral deposits
- Minerals **(Critical Minerals in Bold):** **Titanium**, tin, **platinum**, gold, silver, and **rare earth elements**


Photo: Carleton Bern, USGS

PHOSPHORITES

- Water Depth: 0.5 to 2 miles
- Occurrence: Along continental shelves and slopes, also comingled with crusts on seamounts
- Habitat: Hard surface possibly populated by sponges and corals
- Location: Atlantic and Pacific continental margins and seamounts
- Minerals: Phosphorous, **rare earth elements, possibly uranium**


Photo: Amy West, USGS

MANGANESE NODULES

- Water Depth: 2 to 4 miles
- Occurrence: Nodules occur in soft sediments of abyssal plains and provide hard substrate
- Habitat: Deep sea corals, worms, and crustaceans
- Location: All ocean basins, most abundant in central Pacific
- Growth Rate: 2-10 mm / million years
- Minerals: Nickel, copper, **cobalt, manganese, rare earth elements**, possibly **titanium, tellurium, lithium**

Photo: Jim Hein, USGS

FERROMANGANESE CRUSTS

- Water Depth: 0.5 to 4 miles
- Occurrence: Sides and summit of seamounts
- Habitat: Crusts are potential hard substrate for deep water corals and other sessile organisms; seamount ecosystems host fish, crustacean, and other fauna
- Location: Most extensive in central and western Pacific
- Growth Rate: 1-4 mm / million years
- Minerals: **Manganese, cobalt,** nickel, copper, **rare earth elements , possibly tellurium, scandium, platinum**

Photo: Jim Hein, USGS

HYDROTHERMAL DEPOSITS

- Water Depth: 0.5 to 4 miles
- Occurrence: Undersea volcanoes and mid-ocean spreading centers
- Habitat: Active hydrothermal vents host vent-fluid dependent animals including snails, crustaceans, and worms
- Location: Globally along active tectonic boundaries
- Growth Rate: Variable up to approximately 2 cm / day
- Minerals: Copper, zinc, gold, silver, and potentially **antimony,** bismuth, **gallium, tellurium, germanium**

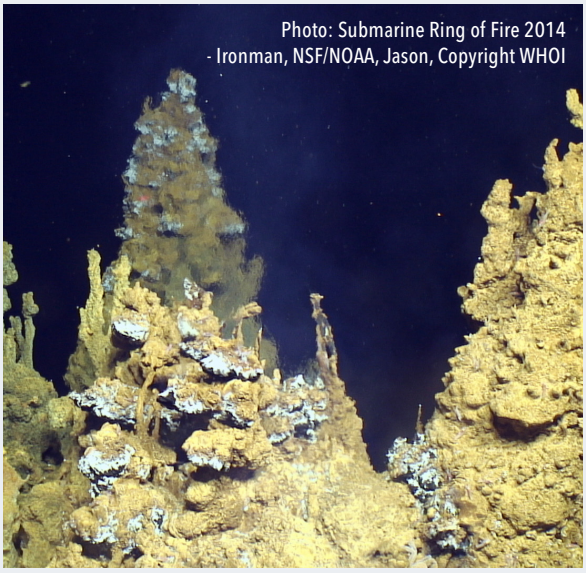
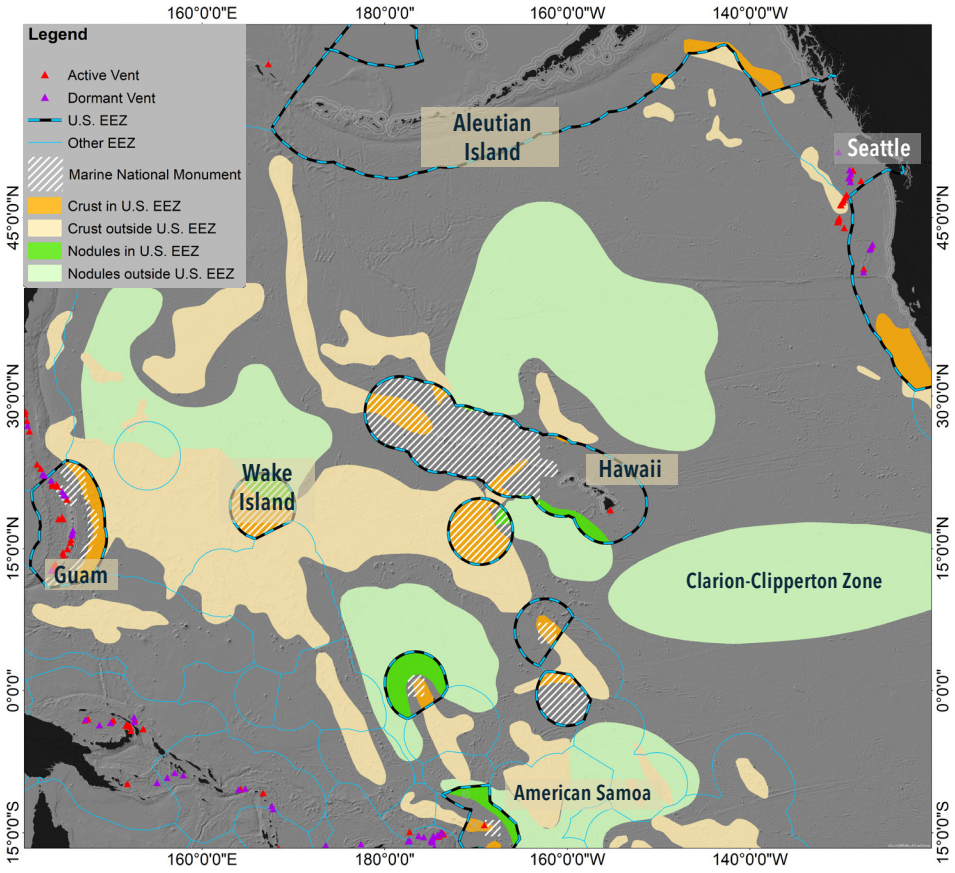


Photo: Submarine Ring of Fire 2014 - Ironman, NSF/NOAA, Jason, Copyright WHOI

Where are they found in the U.S.?



Resources areas colored by type and highlighted with darker colors within the U.S. Exclusive Economic Zone (EEZ) from Hein et al., 2013 doi: 10.1016/j.oregeorev.2012.12.001

- Throughout the U.S. exclusive economic zone but mostly in the Pacific (off California, Alaska, U.S. territories).
- Nearshore minerals are currently leased in U.S. state waters, including active gold leases in Alaska.
- Of the deep ocean minerals, manganese nodules are the most likely to be exploited first (based on interest in international waters). Nodules are likely present off U.S. territories. Hydrothermal deposits occur offshore California and possibly Alaska, but are of unknown size and location.

What Can Be Done to Facilitate Development of Offshore Critical Minerals?

Consider statutory and regulatory changes to simplify commercial mineral leasing.

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- Current U.S. law limits scope of mineral leasing to the Outer Continental Shelf, which includes areas offshore U.S. states but not offshore U.S. territories.
- BOEM's current regulations require that a developer obtain an initial exploration permit, but this permit does not convey the exclusive right to lease the prospecting area.
- Assess and recommend statutory as well as regulatory changes to give prospecting companies exclusive, or preferential, rights to lease the prospecting area, taking into consideration international regulatory approaches.

Increase scientific information in areas with the highest potential for resources:

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- Characterize U.S. exclusive economic zone with modern remote sensing systems to find areas favorable for critical minerals.
- Characterize priority areas to determine mineral resource extent and composition through systematic sampling; collect data regarding the potential impact on other natural resources from extractive activities.

Which Federal Agencies are Working on Offshore Critical Minerals?

- BOEM, USGS, and NOAA are working closely together to leverage available funds and coordinate Federal offshore critical mineral activities.

- The National Ocean Mapping, Exploration, and Characterization Council, formed as a result of the November 2019 Presidential Memorandum on Ocean Mapping, will coordinate interagency activities and working groups and support collaboration with non-government partners and stakeholders.

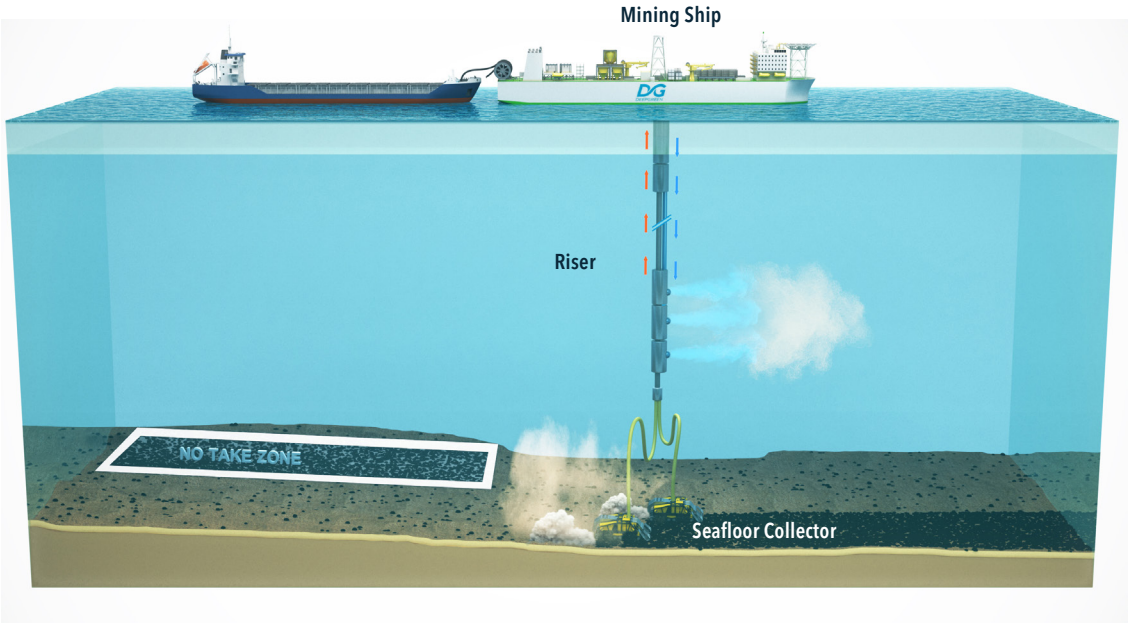

Image depicts a proposed deep sea nodule mining operation with mining ship, seafloor collector, and riser system photo credit: DeepGreen

What Critical Mineral Activities are Planned for International Waters?

- In areas beyond national jurisdiction, companies sponsored by other countries are working to begin mining nodules in the central Pacific Ocean in the next 5 to 7 years under the governance of the International Seabed Authority. The Unites States legislation on seabed mining, the Deep Seabed Hard Mineral Resources Act (under NOAA jurisdiction), establishes an interim domestic licensing and permitting regime for deep seabed hard mineral exploration and mining in international waters pending adoption of an acceptable international regime. The U.S. has two active exploration licenses, USA-1 and USA-4, both held by Lockheed Martin for five-year terms that were last reissued for 2017-2022.

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