

# COBRA: A Research Accelerator for the Crustal Ocean Biosphere

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## ABSTRACT

The deep seafloor covers two-thirds of Earth's surface area, but our understanding of the ecosystems and resources found in the deep ocean, as well as the ability of deep-sea ecosystems to withstand human perturbation, is limited. These deep-sea habitats demand urgent study as there are emergent human uses in the form of deep-sea mining and carbon sequestration that will fundamentally alter physical, chemical, and biological conditions that took millions of years to establish. We propose the international network COBRA, a research accelerator for the crustal ocean biosphere. COBRA will bring together diverse stakeholders and experts, including interdisciplinary academic and government scientists, private institutions, policy makers, data systems engineers, industry experts, and others to coordinate efforts that generate new knowledge and inform decision making about activities that could affect the deep ocean and, by extension, all of society. We will also train the next generation of leaders in ocean exploration, science, and policy through an innovative virtual program to carry this effort into future generations of ocean and earth science research. COBRA will inform policies relating to emergent industrial uses of the deep ocean, decrease the likelihood of serious harm to the environment, and maintain ecosystem services for the benefit of society.

## Vision and Potential Transformative Impact

The potential far-reaching impacts of mining and carbon sequestration on deep-ocean ecosystems underscores the urgent need to understand the crustal ocean biosphere in ways that will immediately enable smart resource management. Deep-sea mining trials are already underway, and draft regulations for seabed mining code are taking shape. Likewise, trials of subseafloor carbon sequestration have begun. Both activities have the potential to dwarf other human impacts in the deep sea, yet the science to inform and evaluate the impacts of these new industries is lacking. A grand challenge for the international scientific community is to determine the ecosystem structure and function of the crustal ocean biosphere and its resilience or vulnerability to human disruption. Our vision is to accelerate this effort in order to inform sustainable management of the deep ocean and subseafloor, especially related to the emergent human activities of deep-sea mining and carbon sequestration. We will achieve this through a "network-of-networks" approach that facilitates collaborative ocean exploration expeditions and observations in ways that identify mutual benefits to multiple stakeholders. In addition to the challenges of the Ocean Decade, outcomes will also be relevant to achieving objectives of the US National Strategy for Mapping, Exploring and Characterizing the U.S. EEZ.

## Scientific/Technological Sectors Engaged Outside of Traditional Ocean Sciences


We will bring together an international mix of interdisciplinary academic and government scientists, private institutions, policy makers, engineers, and other stakeholders to coordinate efforts and to achieve objectives of mutual benefit that catalyze new knowledge and inform decision making. Given the focus well beyond science, including ocean legal and societal issues, this effort will include

engagement with and entrainment of experts in a variety of sectors outside of traditional ocean sciences, including resource and environmental economists, industrial mining and carbon sequestration specialists, manufacturers, political and social scientists, lawyers, historians, and data systems engineers.

## Opportunities for International Participation and Collaboration

This program will enable international partner networks and organizations to forge new linkages, strengthened by a student and young investigator exchange program and expedition leadership training program. Potential partnerships will include InterRidge (global, focus on mid-ocean ridge environments), the Excellence Cluster Ocean Floor at MARUM (Germany, focus on seafloor processes), the K.G. Jebsen Centre for Deep Sea Research (Norway, focus on the deep sea and its potential resources), the Science for Clean Energy consortium (EU, focus on subsurface energy industry), Ocean Networks Canada (ocean observation), and the Deep-Ocean Stewardship Initiative (global, ecosystem-based management of resource use in the deep sea).

## Develops Global Capacity and Encourages the Development of the Next Generation of Ocean Scientists, Engineers, and Technologists

We will combat the continued inequity faced by historically excluded groups in oceanographic research and the persistence of colonialist mindsets that do not meaningfully engage local communities and stakeholders. We will train a new generation of diverse and globally distributed leaders in ocean exploration and characterization through an innovative virtual training program that leverages public-private telepresence assets and that establishes and elevates best practices for promoting diverse, equitable, and inclusive collaboration. Such connections will enable capacity-building and skills training to expand the workforce in ocean research for sustainable development. 

# The Crustal Ocean Biosphere and Emerging Human Activities in the Deep Sea

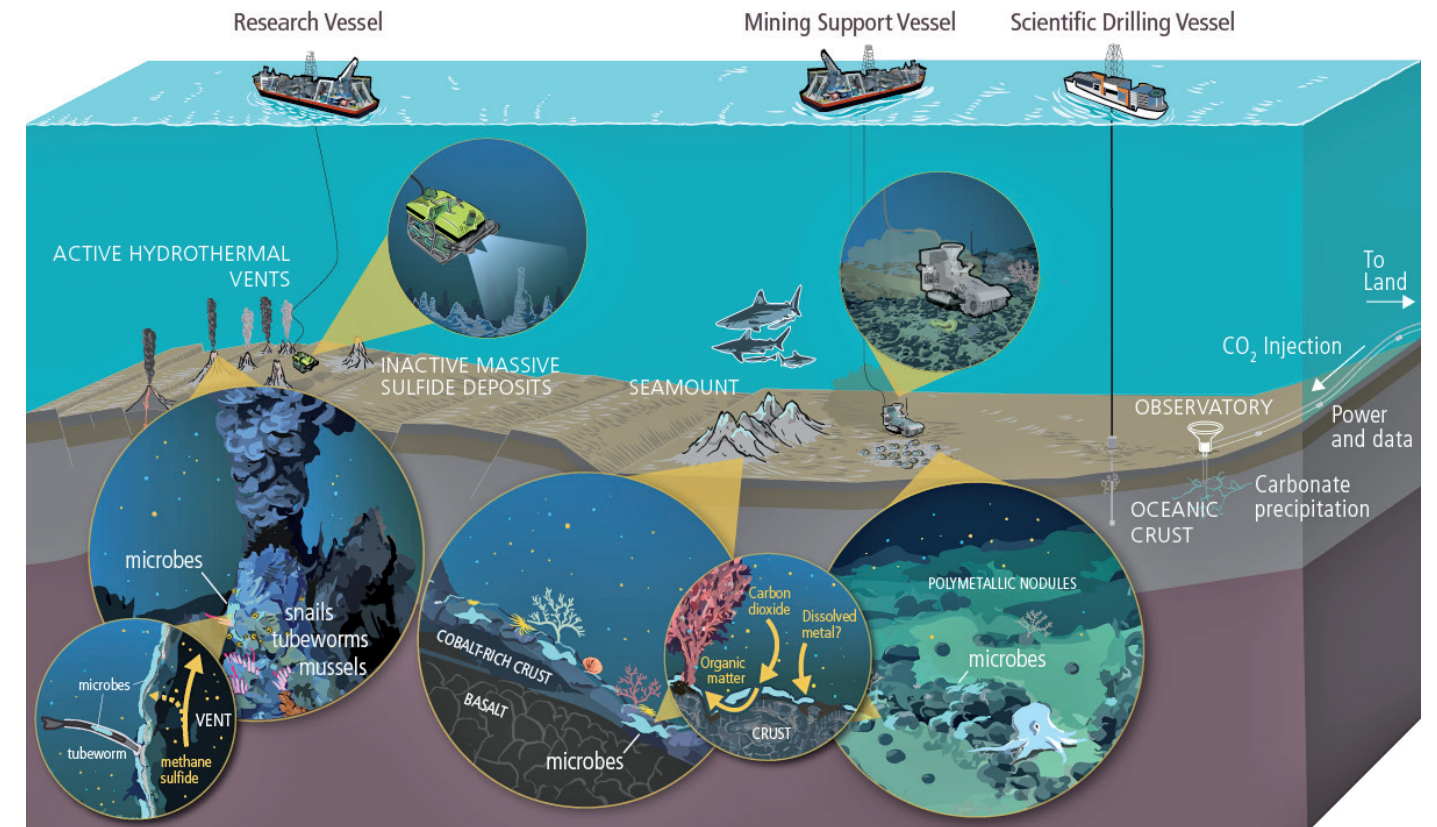


FIGURE 1. Schematic of the crustal ocean biosphere, emphasizing emergent human activities in these habitats, such as 2 deep-sea mining and carbon capture and sequestration. From Orcutt, B.N., D'Angelo, T., Jungbluth, S.P., Huber, J.A., & Sylvan, J.B. 2020. Microbial life in oceanic crust. OSF Preprints. <https://osf.io/2wxe6/>.

## Grand challenges for deep-sea mining and carbon sequestration industries:

- What are the ecosystem services of the crustal ocean biosphere that could be impacted?
- How resilient is the crustal ocean biosphere to perturbation?
- What are cost-effective strategies that can provide early warning to prevent serious harm?
- How can we accelerate the characterization and monitoring of the crustal ocean biosphere?

## Key gaps preventing addressing these challenges

Few crustal ocean biosphere sites are characterized, resulting in limited information on ecosystem structure, function, and resilience to perturbation

Deep-sea exploration, characterization, and monitoring is limited by technology, access, and a relatively small and homogenous science community

## Mission of the Crustal Ocean Biosphere Research Accelerator (COBRA):

To accelerate research on the structure, function, resilience and ecosystem services of the crustal ocean biosphere to inform decision making

Coordinate research of the crustal ocean biosphere

Accelerate characterization with data discovery approaches

Translate scientific findings for policy-makers and industry

Train the next generation of diverse ocean leaders to expand the workforce in ocean research for sustainable development

FIGURE 2. Challenges and mission of COBRA.