2022

# An Ambitious Vision for the Future of Scientific Ocean Drilling

Paula Bontempi
*University of Rhode Island*, paulabontempi@uri.edu



## Citation/Publisher Attribution

Bontempi, P. (2022). An Ambitious Vision for the Future of Scientific Ocean Drilling. *Eos, 103*. https://doi.org/10.1029/2022EO220019
Available at: https://doi.org/10.1029/2022EO220019

# An Ambitious Vision for the Future of Scientific Ocean Drilling




## Creative Commons License

This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 4.0 License.

Eos

# An Ambitious Vision for the Future of Scientific Ocean Drilling

*Scientific ocean drilling is an enduring paragon of global research, advancing knowledge of Earth and informing scientists and educators for 55 years. A new road map plots the way to further discovery.*

By **Paula Bontempi**
7 January 2022

R/V *JOIDES Resolution* departs from port at Lautoka, Fiji, in January 2020 at the start of International Ocean Discovery Program Expedition 378. Credit: Phil Christie and IODP

The summer of 1966 was a watershed time in the geosciences. On 24 June that year, as the formative ideas and observations of plate tectonic theory were **continuing to gel** in so many discussions and publications, the National Science Foundation (NSF) and the regents of the University of California signed the momentous contract **establishing the first phase** of the Deep Sea Drilling Project (DSDP).

The purpose of DSDP was scientific exploration through the collection of seafloor core samples from around the world. These cores would help researchers study seafloor compositions and ages, explore for natural resources, and otherwise inform a variety of questions about Earth's deep-ocean environs. Just over 2 years later, in July 1968, a team of distinguished scientists **sailed from Orange, Texas**, aboard D/V *Glomar Challenger*, bound for sample sites in the Gulf of Mexico and the western Atlantic Ocean. This was DSDP Leg 1. Soon after, DSDP Leg 3 retrieved samples that provided definitive proof that new seafloor is created at rift zones, further supporting the theory of plate tectonics.

Over 55 years later, **more than 275 expeditions** have been completed through DSDP and its successors—the Ocean Drilling Program, the Integrated Ocean Drilling Program, and the **International Ocean Discovery Program** (IODP). These explorations have yielded staggering returns, enabling pure discovery and revealing foundational knowledge about the geosphere, the biosphere, and the entire Earth system. The ocean drilling programs have also yielded economic returns—for example, through the discovery of salt domes linked to oil and gas resources—as well as expanded knowledge of the deep biosphere, led to technological advances in piston coring, and provided countless opportunities for training and education in science and engineering for the next generation of explorers.

> *More than 275 expeditions have been completed through the Deep Sea Drilling Project and its successors, yielding staggering returns that have enabled pure discovery and revealed foundational knowledge about the entire Earth system.*

These gains not only have validated the visionary and long-term investments in the programs but also have been vital to our understanding of planetary health and sustainability. For example, continued advances in drilling, analysis, and recovery of cores have increased the temporal and spatial resolution of paleoclimate and paleoceanographic records needed to improve global climate forecasts.

Expanding support for scientific ocean drilling is integral to ensuring the long-term health of science, technology, engineering, and mathematics (STEM) research in our country. It is also integral to strengthening the role of STEM in building a more sustainable and inclusive future on Earth and perhaps even in gaining insights into the geology, form, and function of other worlds.

## A Framework for the Future

In 2018 and 2019, an international community of Earth scientists came together to produce a visionary planning effort for scientific ocean drilling. This effort underscored the vast potential for scientific and societal return on investment of expanded support for such drilling and resulted in IODP's 2050 Science Framework, titled "**Exploring Earth by Scientific Ocean Drilling**." This consensus framework was crafted with the grassroots input of scientists from 23 nations and was initiated through six major international workshops conducted by the scientific ocean drilling communities in **Australia and New Zealand**, China, **Europe**, India, Japan, and the United States. The workshops

engaged more than 650 scientists, with substantial representation by women (30%) and early-career scholars (40%).

> *"Exploring Earth" charts an ambitious path forward, laying out strategic objectives that focus on major challenges within the Earth sciences.*

"Exploring Earth" charts an ambitious path forward, laying out strategic objectives that focus on major challenges within the Earth sciences. These challenges include improving our understanding of the limits of habitability for life on Earth, many aspects of Earth's climate system (including feedbacks and tipping points related to **sea level rise and ice sheet stability** during times when atmospheric carbon dioxide concentrations were higher), the life cycle of tectonic plates, global cycles in energy and matter during seafloor spreading, and geophysical hazards like **earthquakes and tsunamis** that affect society.

Five flagship initiatives detailed in the framework provide an integrated road map to address the strategic objectives and societally critical issues by obtaining the necessary core samples and crustal records. For example, the "Probing the Deep Earth" initiative will improve our understanding of Earth's formation and the inextricable connections among tectonics, climate, and planetary habitability. And the "Diagnosing Ocean Health" initiative will build on our understanding of how past catastrophic events have affected biology to refine assessments of how rapidly ocean health may deteriorate in response to climate change. Drilling into Earth's crust, recovering cores, and installing seafloor observatories are the only ways to accomplish these ambitious initiatives.

At the heart of "Exploring Earth" is a set of "enabling elements" that center enhancements in diversity and research community–led planning. These efforts focus on addressing the well-known challenges regarding **equity and diversity in the geosciences** by promoting recruitment of diverse science parties, codifying enhancement of diversity and inclusion **in expedition objectives** and as enduring principles in future scientific ocean drilling programs, and **using telepresence** technology to conduct ship-to-shore video conferences with minority-serving institutions. This collaborative and active engagement is intended to foster mentorship and a sense of belonging for current and future explorers in ocean drilling and exploration environments.

Inspired by the vast, international effort to create "Exploring Earth," leaders from many U.S. oceanographic research and education institutions (represented by the contributing authors acknowledged below) have come together to express their strongest support for continuing to fund scientific ocean drilling. This impressive framework should serve as a valuable model for similar community-led planning efforts, and implementing the vision laid out in "Exploring Earth" will affect the entire Earth science community. Below I highlight some of the wide-ranging strategic considerations and science drivers that provide a compelling rationale for continuing this support as part of the nation's commitment to renewed and enhanced investment in infrastructure and communities.

## Maintaining Our Leadership

The decision by the United States to **rejoin the Paris Agreement** is an opportunity to highlight the country's leadership in ocean and climate science. Much of our knowledge of past climate and sea level change has derived from studies of ocean sediments collected via ocean drilling. Observations from these studies have, for decades, provided ground truthing of climate models, including those considered by the Intergovernmental Panel on Climate Change in its reports, and have been key to our understanding of future climate risks and assessment of possible adaptation and remediation options. Scientific ocean drilling will continue to be the foundation upon which advances in climate science, risk assessment, and resilience planning are built, as interdisciplinary research expeditions and analyses address key questions about Earth's past, present, and future.

> *Scientific ocean drilling will continue to be the foundational platform upon which advances in climate science, risk assessment, and resilience planning are built.*

Another example of the acute societal relevance of drilling efforts relates to studying the tectonic processes that result in megaearthquakes and tsunamis, which cause some of our planet's deadliest and costliest natural disasters, especially among highly vulnerable communities. Scientific ocean drilling has provided, and will continue to provide, crucial insights and state-of-the-art monitoring data to enable increasingly reliable forecasts and assessments of risks to vulnerable populations and infrastructure. These data may, for example, further inform our knowledge of fault locations and conditions that lead to destructive events along highly populated coastal areas surrounding the Pacific Ocean.

Continued leadership in ocean and climate science requires enhanced investment in the scientific drilling community and its associated infrastructure, which is an essential complement to other ocean-observing and satellite platforms. In particular, investment is needed for a new global-class drilling vessel. The strategic long-term value of such bold investments has multiple dimensions. Modern ocean and climate observations require the context of the geologic record to identify real signals and trends amid variability in background conditions and to discern natural versus anthropogenic change. Furthermore, vast areas of our oceans remain unexplored or underexplored—we have mapped more of the Moon's surface than of the seafloor, and we know little about the sizes of deep-ocean and lithospheric carbon reservoirs. These reservoirs, which could contribute considerably to climate change, require substantial additional exploration and sampling to assess climate mitigation strategies accurately.

> Research, education, and public engagement activities supported by scientific ocean drilling expeditions, currently through IODP, have created a legacy of effective STEM leadership and workforce development. IODP and predecessor programs have enabled numerous scientists not just to carry out cutting-edge research but also to serve as educators and mentors to thousands of students around the world, thus repeatedly fostering future generations of leaders and innovators. Building and maintaining a sustainable future requires a society in

*The International Ocean Discovery Program and predecessor programs have enabled numerous scientists not just to carry out cutting-edge research but also to serve as educators and mentors to thousands of students around the world.*

which people understand and trust science. Thus, we need programs that consistently produce trustworthy and societally relevant research and that provide STEM training to numerous scientists and science educators so they can seek out and convey knowledge about our planet to the public and to decisionmakers.

The past 55 years of international scientific ocean drilling collectively represent one of our nation's most successful and impactful investments in advancing basic research about Earth, as well as in advancing STEM education, the economy, and workforce development. It is no coincidence that so many leaders in the Earth and planetary sciences today, at home and abroad, cut their teeth in research by participating in the drilling programs. Simply put, these programs build talented scientists and educators. No doubt the next generation of leaders and innovators who will help the United States and the international community tackle challenges—from climate change to natural hazards—includes many who have already been involved in scientific ocean drilling.

## Acknowledgments

In addition to the author's perspectives, this article reflects the contributions and views of Peter de Menocal, Tom Frazer, Lisa Graumlich, Margaret Leinen, Roberta Marinelli, Claudia Mora, Bradley Moran, Christina Ravelo, Maureen Raymo, Demian Saffer, Brian Taylor, and Debbie Thomas. We express our deepest gratitude to NSF for its multidecadal commitment to scientific ocean drilling.

## Author Information

Paula Bontempi (**paulabontempi@uri.edu**), University of Rhode Island, Narragansett

**Citation: Bontempi, P. (2022), An ambitious vision for the future of scientific ocean drilling, *Eos, 103,* https://doi.org/10.1029/2022EO220019. Published on 7 January 2022.**