US-SODA
https://us-soda.org
United States – Scientific Ocean Drilling Alliance

Representing U.S. Research Institutions and Universities in Support of Future Scientific Ocean Drilling

Our Vision: Long-term investment and maintaining leadership in the *ocean sciences* and *scientific ocean drilling* will be vital to enhancing our understanding of planetary health and sustainability while strengthening STEM research and inclusive workforce development in the United States of America

Re: On the Critical Importance of Continued, Future Scientific Ocean Drilling in the U.S.

May 16, 2022

Director, Dr. Sethuraman Panchanathan
National Science Foundation

CC: Assistant Director, Geosciences Directorate, Dr. Alexandra R. Isern
Division Director, Ocean Sciences, Dr. Terrence M. Quinn
Section Head, Ocean Sciences, Integrative Programs, Mr. Bauke H. Houtman

Dear Dr. Panchanathan,

Scientific ocean drilling is a foundational research capability to the nation and society and has been so for five decades (see January 2022 EOS article: https://eos.org/opinions/an-ambitious-vision-for-the-future-of-scientific-ocean-drilling). Exploring new frontiers in scientific ocean drilling will strengthen U.S. leadership within the international sphere, as China brings new drilling vessels online that eclipse the U.S. *JOIDES Resolution* in capabilities. Continued investment in future scientific ocean drilling supports the *NSB 2030 Vision* by addressing challenges facing the U.S. science and engineering enterprise, creating economic and employment opportunities for Americans, and leading the evolution of the global practice of science. Terminating this essential NSF-sponsored U.S. research capability will significantly harm future opportunities in the Earth, ocean, life, and planetary sciences. Conversely, realizing the community-developed *2050 Science Framework* and the lease or acquisition of a well-designed modern drilling vessel in the U.S. will yield tremendous new research opportunities across numerous disciplines, enhance workforce development in STEM, attract a diverse student population from numerous fields including the data sciences and machine learning, and inform U.S. scientists, managers, and policymakers on key topics such as climate change, sea-level rise, geohazard assessments, carbon sequestration, ocean health, coastal resilience, and much more.

This letter is written by the *United States—Scientific Ocean Drilling Alliance* (US-SODA; https://us-soda.org) founded by thirteen U.S. research institutions (see pages 3-4) with the following goals: **(1)** to promote scientific ocean drilling as a critical foundation to advance climate science, hazard assessment, resilience, and sustainability planning; **(2)** to advocate for innovative new scientific ocean drilling strategies, facilities, and technologies that lead to major progress in our understanding of the complex Earth system that shape our planet's future; **(3)** to support trustworthy societally relevant scientific ocean drilling research that attracts a diverse student population to STEM careers, provides effective STEM training, and transfers key knowledge about our planet to the public and decision makers; and **(4)** to assist and provide advice to NSF in the process leading to a new U.S. drilling vessel and future accompanying drilling program(s).

Scientific ocean drilling is a signature research capability that has continuously revolutionized science with great impact to the U.S. and society. This is underscored by the effort of more than 650 scientists who came together and produced the visionary *2050 Science Framework* (https://iodp.org/2050-science-framework). To achieve the framework's *Strategic Objectives* and *Flagship Initiatives*, it is imperative in our opinion that NSF **(1)** establishes a bridging program to allow the *JOIDES Resolution* to continue to operate from October 2024 through 2028, and **(2)** leases or acquires a new U.S. operated global-ranging riserless drilling vessel.

The U.S. scientific ocean drilling community is a vibrant and highly diverse scientific community representing more than 600 U.S. research institutions across all 50 states and multiple U.S. territories. Early to mid-career scientists and students make up 60% of the U.S. community, which is one of the only Earth Science communities to reach gender parity (see page 5 for statistics). Since 2014, more than 2,000 U.S. scientists, students and post-docs have been involved in the *International Ocean Discovery Program* (IODP), including **(1)** seagoing science party members, **(2)** shore-based participants who depend on curated samples and data collected by IODP, **(3)** scientists and students carrying out NSF-funded site surveys to prepare for and ensure innovative, safe, and successful IODP expeditions, **(4)** scientists and students involved in post-expedition experiments to collect data and service instrumentation at IODP-installed subseafloor observatories, and **(5)** all those involved in IODP meetings, workshops, panels, and conferences. Importantly, in IODP—as with other NSF Large Facilities such as telescopes and colliders—there are a relatively small numbers of *direct seagoing* participants relative to the many *end users* who receive the benefits of IODP shipboard operations for decades afterwards and novel scientific purposes.

The science accomplished through IODP and the future research goals set out in the *2050 Science Framework* embody a truly transdisciplinary framework touching on many disciplines. In other words, scientific ocean drilling both reaches and requires many other disciplines, including physics, chemistry, biology and microbiology, planetary sciences, and engineering. Since 2003, more than 4,000 peer-reviewed papers using IODP-associated samples and data have been published in 30 journals with a >3.2 impact factor (see pages 5-6 for details) and those include 383 papers in high-impact journals such as *Nature* and *Science*. These papers have been cited more than 67,000 times. These high-impact publications are made possible because of *continuous* NSF-funded scientific ocean drilling and the professional management of the NSF Large Facility operating the *JOIDES Resolution*.

Between 2013 and 2024, the *JOIDES Resolution* has supported an average of five expeditions/year (when correcting for COVID-related expedition cancelations), occupied 163 globally-distributed sites, and recovered >65 km of sediment and rock core (see page 6 for details). Consequently, the *JOIDES Resolution* achieved the operational goals laid out in the *2013 IODP Science Plan* and implemented more than 82% of all IODP expeditions and collected 93% of all IODP sediment and rock cores. Finally, more than 53,000 database downloads and more than 1,400 sample requests from IODP repositories indicate a robust post-expedition research enterprise, fueled by scientists and students from the United States.

In conclusion, what would we know about Earth's systems without 50+ years of scientific ocean drilling? It is impossible to open an Earth or Ocean Sciences textbook or an IPCC report and not find references to IODP-derived discoveries, from the discovery of plate tectonics to climate change. The sub-discipline of *paleoceanography* would not exist without the sedimentary archives of climate and ocean change collected by the *JOIDES Resolution*. Paleoceanographic and paleoclimate data is so fundamental to our understanding of sea-level rise, oceanic and atmospheric circulation, and climate change that scientists writing the 2021 IPCC report decided to included insights from these records throughout the report, rather than restricting paleoclimate data to just one chapter. IODP data has also enriched the fields of marine geology and geophysics by providing ground truthing and age constraints on multi-channel seismic profiles and improving understanding of earthquake and tsunami processes and their associated societal risks. Most recently, IODP-facilitated microbiological research has provided new insights into the origin of life on Earth and elsewhere in our solar system and the universe.

Without question, scientific ocean drilling permeates the natural sciences. Without drilling there is so much we would *not know* and so many questions we would *not even know* to ask. These fundamental scientific discoveries have been facilitated by NSF's continuous support for scientific ocean drilling,

including engineering and analytical upgrades, over the last five decades. A 2024 to 2028 bridging program using the *JOIDES Resolution* and the lease or acquisition of a new U.S. operated global-ranging riserless drilling vessel are essential for continuing scientific progress. It will strengthen U.S. leadership in science and technology to drive improvements in our domestic economy and national security within the context of internationalization.

Finally, we refer you to the statistics compiled at the bottom of this letter, which provide insights into the makeup of the nationwide IODP community, the strong IODP contribution to the STEM workforce, the inter- and cross-disciplinary nature of IODP, past scientific ocean drilling success metrics, and the productivity of the NSF-funded *JOIDES Resolution* relative to the *2013 IODP Science Plan*.

If you have any questions, we would be pleased to set up a meeting to further discuss the continuation of scientific ocean drilling and the acquisition of a new U.S. drilling vessel.

Yours sincerely and representing the 13 founding members of US-SODA.

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US-SODA Founding Members (20 members from 13 institutions)

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US Scientific Ocean Drilling Community

Besides the more than 650 researchers who collaborated on the *2050 Science Framework*, more than 270 researchers are directly involved in the establishment of *Science Mission Requirements* (SMRs) to establish the design basis for a new drilling vessel in support of the framework. Below we list other community statistics: **(1)** During IODP from 2013-2021 we sailed 286 unique U.S. scientists on IODP expeditions (some more than one time) representing 115 U.S. research institutions from 43 U.S. states. Amongst those, 99 (56% female) were graduate students and 31 (39% female) were selected as co-chief scientists; **(2)** These scientists also received support through the *US Science Support Program* for sailing and post-expedition initial sample and/or data analyses. Overall, the 2003-2024 IODP program has provided support to scientists from more than 600 U.S. institutions, community colleges, industry partners, government labs, musea, and more, representing 50 states.

IODP EXPEDITION SCIENCE PARTIES (2014-2021)

	TOTALS	
Total U.S. Scientists Sailed	340	
Unique U.S. Scientists	286	
Total Students	99	
Female Students	55	56%
Male Students	44	44%
Total Co-Chief Scientists	31	
Female Co-Chief Scientists	12	39%
Male Co-Chiefs Scientists	19	61%
Institutions Producing Co-Chiefs	21	
Total Number of U.S. Institutions	115	
Total Number of U.S. States	43	

IODP US SCIENCE SUPPORT (2015-2021)

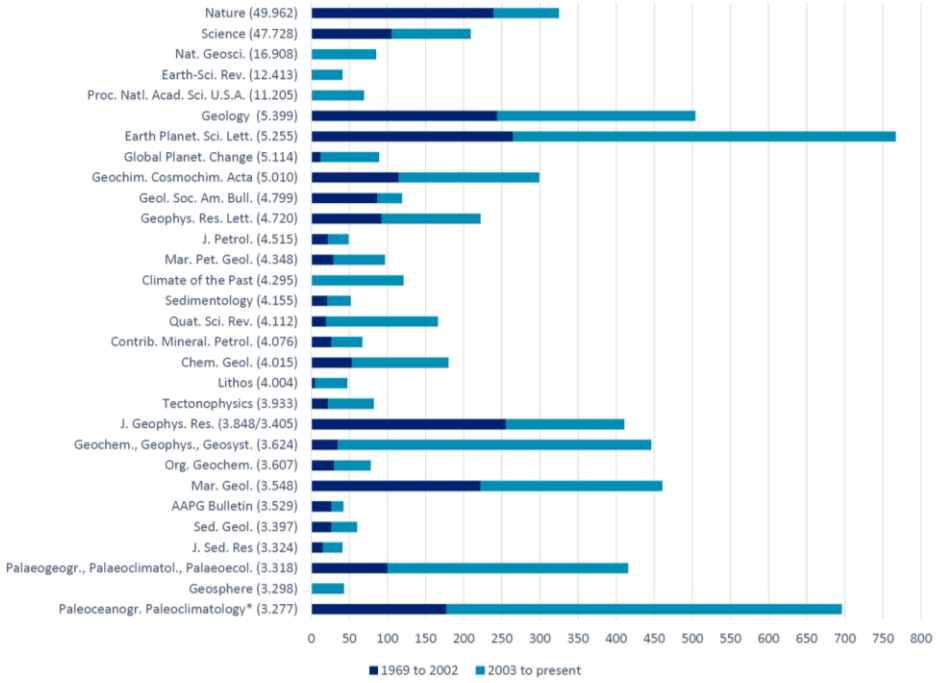
	TOTALS
Subawards IODP 2015-2021 for Sailing and other Involvement	
U.S. Institutions	118
U.S. States	44
All Involvement in ODP-IODP from 1985-2021 (sailing, sponsored, workshop attendance, etc.)	
U.S. Institutions, Industry Partners, Gov Labs, Musea	606
U.S. States	50

US Scientific Ocean Drilling Success Metrics

In total 12,262 scientific ocean drilling program-related publications appeared in the peer-reviewed science literature between 1969-2021. Of these 6,284 were published in the 30 top-ranking journals with >3.2 impact factors.

During IODP from 2003-2021, in total 4,037 papers were published in those 30 journals (64.2% of the total since 1969), including 383 papers in journals such as *Nature* and *Science* with >10 impact factors and 1,406 in journals with >5 impact factors.

Review of Google Scholar data shows that program publications containing research results from IODP expeditions have been cited in other research articles more than 67,400 times between 2003 and 2021.



Data Usage and Sample Requests

Scientists, students, and post-docs are making strong use of the IODP repositories: **(1)** From 2015-2021 the IODP databases LIMS and JANUS have been accessed more than 150,000 times, of which 35% of the data requests came from the USA; **(2)** Sample requests from 2014-2021 totaled more than 4,500 with 1,477 requests (32%) coming from U.S. scientists, students, and post-docs who requested 124,015 (22%) samples from sediment and rock cores collected by IODP expeditions mainly using the JOIDES Resolution (see below).

IODP DATABASE SESSIONS (2015-2021)

COUNTRY	TOTALS	
Total Database Views	153,182	
USA	53,178	35%
China	26,515	17%
Other Countries (n=21)	29,826	19%
United Kingdom	15,572	10%
Germany	10,175	7%
Japan	6,760	4%
France	4,609	3%
Australia	3,419	2%
Canada	3,128	2%

IODP SAMPLE REQUESTS (2014-2021)

COUNTRY	REQUESTS		SAMPLES	
Total Sample Requests	4,582		555,706	
USA	1,477	32%	124,015	22%
UK	682	15%	81,997	15%
Germany	502	11%	62,301	11%
Japan	382	8%	52,093	9%
France	182	4%	19,033	3%
Australia	154	3%	19,018	3%
Chile	131	3%	31,826	6%
New Zealand	128	3%	22,781	4%
Colombia	120	3%	432	0%
China	93	2%	18,306	3%
Other Countries (n=32)	731	16%	123,904	22%

US JOIDES Resolution Drilling Vessel Productivity

In the Initial Science Plan for IODP 2013-2024, the following operational expectations were established: **(1)** full twelve months/year JOIDES Resolution operations equating to five expeditions/year assuming a nominal 2-month expedition length; **(2)** five months/year for Chikyu equating to two expeditions/year; and **(3)** one mission-specific platform (MSP) operation per year also of 2-month expedition length.

In the table below we list actual expedition statistics **(1)** completed from 2014 through May 2022; **(2)** planned until the end of the program in October 2024; and **(3)** those expeditions that were planned but canceled due to COVID. The JOIDES Resolution has been fulfilling expectations by sailing 5.0 expeditions/year when correcting for the COVID cancelations; if not correcting, then it has operated 4.3 expeditions/year. JOIDES Resolution has occupied 163 sites worldwide and recovered more than 65 km of sediment and rock core, which equates to 82% of the sites and 93% of all cores collected during IODP 2013-2024 thus far! The JOIDES Resolution therefore has cemented its reputation as the "workhorse" of IODP enabling most critical science achievements in scientific ocean drilling!

IODP EXPEDITION STATISTICS BY PLATFORM (2014-2024)

COUNTRY	JR		MSP		CH		OVERALL
Total Expeditions	47	82%	6	11%	4	7%	57
Completed by May 2022	36	4.3/year	4	0.5/year	4	0.5/year	44
Planned until October 2024	11	4.4/year	2	0.8/year	0	0.0/year	13
Canceled due to COVID *	6		1		0		7
Total Sites Occupied	163	82%	31	16%	5	3%	199
Total Recovery (in meters)	65,860	93%	3,418	5%	1,260	2%	70,538

* Expeditions per year increases to 5.0/year for JR and 0.6/year for MSP when including those canceled because of COVID