AC GEO Subcommittee Report on Ocean Drilling
January 31, 2012

I. Introduction

In April of 2011, the Advisory Committee for the National Science Foundation Geosciences Directorate (AC GEO) created an ad hoc subcommittee with the following charge:

Using the NRC report on scientific ocean drilling[1], the recently completed NRC report on future needs for ocean infrastructure[2], the updated version of the Ocean Research Priorities Plan[3], and the new science plan developed by the Integrated Ocean Drilling Program[4], and other reports and reviews as may be relevant, produce a synthesis that considers past advancements in knowledge acquired through scientific ocean drilling programs, assesses importance of future advancements in knowledge likely to result from a continuation of scientific ocean drilling, and scales these in the context of resource requirements and the broader need for improved understanding of ocean sciences, geosciences, and climate sciences in general. Assess alignment of program goals with the new strategic plan and overall mission of NSF. Evaluate alternative means of achieving program goals, noting possible synergies with other drilling programs, and including an assessment of the value and nature of international or industry partnerships. Identify and prioritize societal benefits to the Nation and the global community of maintaining the platforms and infrastructure necessary for, and the knowledge acquired through, scientific ocean drilling including impacts of increased or decreased future funding levels.

[1]National Research Council, 2011. Review of the Scientific Accomplishments and Assessment of the Potential for Future Transformative Discoveries with U.S.-Supported Scientific Ocean Drilling. National Academies Press. 158 pp.

[2]National Research Council. 2011. Critical Infrastructure for Ocean Research and Societal Needs in 2030. National Academies Press. 128 pp.

[3]NSTC Subcommittee on Ocean Science and Technology (in press). Science for an Ocean Nation: An Update of the Ocean Research Priorities Plan.

[4]Illuminating Earth's Past, Present, and Future: Exploring the Earth Under the Sea. The International Ocean Discovery Program, 2011 Science Plan for 2013–2023. 84 pp.

AC GEO member, Susan Lozier (Duke University), was asked to serve as chair of this committee. Other committee members were selected from the broader oceanographic community. These members were nominated by Dr. David Conover, Director of Ocean Sciences, and approved by AC GEO. The full committee membership is:

Robert Aller, Stony Brook University
Catherine Constable, Scripps Institution of Oceanography
David Karl, University of Hawaii
Charles Langmuir, Harvard University
Susan Lozier, Duke University (Chair)
James McCarthy, Harvard University
George Philander, Princeton University
Lori Summa, ExxonMobil

The committee met twice: first, via a teleconference on October 24, 2011 and second at a two-day meeting in Arlington, Virginia on November 14-15, 2011. During the teleconference, the committee reviewed the charge and discussed agenda items and background material needed for the planned November meeting. Full committee deliberations occurred at the November meeting.

II. Background

In addition to the documents referred to in the charge, all committee members were provided with NSF's strategic plan, *Empowering the Nation Through Discovery and Innovation 2011-2016*, and AC GEO's 2009 strategic planning document, *GEO Vision*, prior to the November meeting.

At the November meeting, the following presentations were made to the committee:

1. Overview of Committee Charge: Tim Killeen (NSF)
2. Overview of Ocean Sciences Division: David Conover (NSF)
3. Overview of NSF's Investment in IODP: Past, Present and Future: Tom Janecek (NSF)
4. IODP Science Plan: Susan Humphris (WHOI)
5. NRC Review of IODP: Bob Duce (Texas A&M) and Art Goldstein (Bridgewater State University)
6. Ocean Research Priorities Plan: Jerry Miller (OSTP)

A brief summary of the committee's reactions to the information presented is given below.

A. IODP Science Plan and NRC review

The NRC evaluation of the IODP Science Plan (cited above) provides an excellent review of the past accomplishments of the drilling program and a thorough evaluation of its science plan. The committee relied heavily on this evaluation and is pleased to note our appreciation for and endorsement of the NRC report. In addition to this overall endorsement, the committee would like to make two main points regarding the science plan and its review:

1. The IODP science plan assumes increased funding and full access to all three drilling platforms. In light of the new IODP organization and projected funding limits, it is highly likely that the science goals need to be reconsidered. Such reconsideration should include a prioritization of program goals.

2. There is no question that ocean drilling has had a large positive impact on the advancement of earth system science over the past several decades. These impacts are listed in detail in the NRC review cited above. Likewise, there is little question of the potential for excellent science in the future. However, it is also inescapable that plans for such science must be evaluated in the context of harsh budgetary realities and with full recognition and appreciation of other potentially excellent science priorities in the ocean sciences, geosciences, and broader scientific community.

B. Larger scientific context for the IODP Science Plan

GEO Vision and the 2007 Ocean Research Priorities Plan outline the path forward for OCE. The Ocean Research Priorities Plan places a strong emphasis on observing the current and evolving state of the ocean and associated issues of sustainability. The IODP science plan can be linked to these priorities through the study of geohazards and the biosphere. The *GEO Vision* document focuses on the need for transformational research, preparing a diverse STEM workforce,

increasing international partnerships and enhancing research infrastructure. The committee's evaluation of the drilling program acknowledges these important priorities and recognizes the capabilities of the ocean drilling program to contribute to these enunciated goals.

C. Financial context for the IODP Science Plan

There are enormous challenges for the OCE budget in the foreseeable future. Costs associated with IODP and OOI over the next five years are projected to increase the portion of OCE's total expenditures on infrastructure from approximately 40% to 60% of its entire budget. Without significant associated increments in OCE funds or reconsideration of spending on infrastructure, such an increase would have a detrimental impact on the allocation of funding for core ocean science. NSF is to be congratulated on one such reconsideration: the rearrangement of the IODP funding structure that places the JOIDES Resolution (JR) on an independent footing is an encouraging sign that rising infrastructure costs can be curtailed.

D. Summary

From background information accessible to and presented to the committee, a clear need emerged to more closely align IODP goals with the new White House guidelines for ocean science, NSF's strategic plan and *GEO Vision*. In an acknowledgement that this science program is not isolated from the OCE, GEO and NSF budget realities, such alignment should be accompanied by a clear prioritization of program goals. In short, the ocean drilling community should be asked to formulate its most exciting and important scientific questions within the context of their potential societal relevance and pressing fiscal bounds.

III. Committee philosophy and assumptions

The committee's deliberations and recommendations are based on two assumptions: 1) The NSF budget will be flat into the foreseeable future and 2) the JOIDES Resolution contract will be re-competed and presented to the National Science Board in three years. In addition to these assumptions, the committee adopted two guiding principles that shaped our discussion and recommendations:

• Investment in core science should not be sacrificed to meet rising OCE infrastructure costs. The committee believes that the total infrastructure costs should constitute no more than ~40% of total OCE budget, which is the current level. We urge NSF OCE to at least preserve its current investment in core programs and, preferably, aggressively explore opportunities to grow that investment.

• Legacy programs, with the benefit of years or even decades of NSF funding, should largely bear the responsibility for broadening their base of support as they mature so that NSF has funds available to seed new programs. Such investment in new programs is vital to the health of ocean sciences. Broadening the base of support for legacy programs provides additional benefits from the infusion of new ideas, goals, and partners. Thus, although the obvious advantage of spending less of NSF funding on legacy programs as they mature is that funding opens up for new, innovative, and promising programs, another real advantage is that legacy programs are given the opportunity, and the challenge, of looking for efficiencies, seeking partnerships and refreshing their scientific goals and objectives.

IV. Options considered

Within the context of the above guiding principles and assumptions, the committee considered the following four options for achieving program goals in light of budgetary realities:

1. Abandon an active IODP drilling program, yet maintain legacy repositories

Advantages: An impressive number of geoscience problems could still be addressed with legacy cores, while freeing up substantial funds for other high priority programs in ocean sciences, including core science funding.

Disadvantages: The primary disadvantage of this option is that the U.S. would lose leadership of a major source of international research, innovation and discovery in the Earth sciences. This loss would conflict directly with the NSF strategic plan calling for increased international partnerships. Furthermore, the high visibility and large accomplishment potential of the drilling program would be lost. Additionally, some ocean drilling research goals broadly important in Earth sciences, e.g. deep biosphere, would be completely sacrificed.

Because of the current contractual relationships with the JOIDES Resolution, a substantial opportunity cost would accompany cancellation of the drilling program. Reinstating the drilling program at a later time would be far more expensive. Also the opportunity to capitalize on the recent $115M investment for ship refurbishments would be diminished: completed in 2008, the refit gave the JR ~20 more years of service.

2. Abandon the JOIDES Resolution, yet maintain a modest drilling budget to support ECORD, MSPs and the participation of U.S. scientists in those programs. Encourage the pursuit of ocean drilling science from legacy cores and international partner drilling. Call for a new science plan constructed on this basis.

Advantages: As above, an impressive number of geoscience problems could still be addressed, while freeing up substantial funds for other high priority programs in ocean sciences, including core science funding. In this case, however, funds would still be available to provide U.S. scientists access to drilling-based research. This approach might spur more productive and broader use of alternative platforms, which could expand the research potential of our international partners.

Disadvantages: As above, the U.S. would lose leadership of a major source of research, innovation and discovery in the Earth sciences and some science goals would not be achievable. This loss of goals would likely occur for several reasons: 1) there would be much less drilling ship time available without the JR on-line (post-refit, the JR has provided 8.5 months per year of drilling time, compared to 3.5 months for the Chikyu and ~50 days for MSP); 2) no other platform obtains cores as complete as JR cores, an accomplishment attributable to JR crew expertise; 3) a range of water depths for ocean drilling would not be accessible (while the JR has proven operations in depths of 75 m – 6000+ m, the Chikyu has operation limits in waters shallower than ~500m); and 4) the costs for ocean drilling would be greater since charter vessels similar to the JR could have a substantially higher day rate.

As above, because of the current contractual relationships with the JOIDES Resolution, a substantial opportunity cost would accompany the cancellation of the program.

3. Continue with IODP, but recommend that IODP costs consume no greater, and preferably a smaller, portion of the total OCE budget than they currently do. Encourage a vigorous search for costs savings and other funding sources.

Advantages: This approach takes advantage of the substantial financial investment and multi-decadal expertise that resides in the JR, retains U.S. leadership of the international drilling community, allows for the continuation of the new IODP funding structure and permits effective international collaboration. Importantly, this approach permits the highest priority scientific objectives to be accomplished, perhaps at a slower pace, while allowing for the expansion of the IODP science program as non-NSF funding opportunities arise.

Capping or reducing the growth of IODP as a percentage of the total OCE budget helps to preserve the current allocation of OCE core science funding and allows for the initiation and evolution of new OCE programs that carry with them the potential for significant scientific discovery.

Disadvantages: This approach requires increased effort to secure non-NSF funding for ship operations. It also carries some risk in that the program would be in jeopardy if OCE budgets decline, international partners drop out, or ship costs rise substantially. Furthermore, the budgetary restrictions on the program will likely not permit the full expression of the current science plan.

Compared to abandonment of the program, this approach limits the extent to which resources are liberated for new programs and/or the enrichment of core funding. Moreover, continued allocation of a significant fraction of OCE funding to IODP will remain a challenge to OCE over the next five years as major investments are also made to OOI.

4. Continue with IODP as envisaged in the science plan

Advantages: As above, this approach takes advantage of the substantial financial investment and multi-decadal expertise that resides in the JR, retains U.S. leadership of the international drilling community, allows for the continuation of the new IODP funding structure and permits effective international collaboration. Only this approach assures the full expression of the planned science program.

Disadvantages: Such an approach would significantly hamper investment in new programs and negatively impact core funding. Furthermore, this approach would decrease the incentives to explore beneficial cost efficiencies, seek new resources and expand the base of international partners.

V. Recommendation

After a thorough discussion of the options detailed above, the committee unanimously endorsed option (3), recognizing that in three years the ship contract will be recompeted and presented to the National Science Board. This option provides a three-year window of opportunity for the community and NSF to broaden the base of IODP as a means of sustaining a successful program within budget realities. In essence, the community, ocean leadership and NSF have the opportunity in these next three years to become more entrepreneurial and to continue making IODP more cost-effective, thereby relieving the burdened OCE budget of some of the projected

IODP funding. In three years, prior to a decision about re-competing the JR, it should be clear whether the IODP goals and pathway we have enunciated for a successful program have been accomplished. If so, continuation of IODP should be encouraged. If not, the termination of the program should be considered at that time.

Specific recommendations:

1. We recommend that IODP be funded at no higher fraction of the OCE budget than its current level, with that fraction on a declining trajectory in the years ahead. We recommend that such reduction be accomplished via the broadening of funding sources and through increased efficiencies, examples of which are mentioned below.

2. We recommend a vigorous investigation of new and expanded funding sources for IODP. Examples of additional sources of funding include: acquisition of larger contributions from international partners; allotment of ~two months of ship time per year for industrial use; private foundation support; and other sources within NSF.

3. We recommend further investigations of cost savings and encourage NSF to continue to look for efficiencies in the program.

4. We recommend that, to the extent possible, IODP be configured more as an infrastructure program than as a science program. To that end, the inclusion of costs in the IODP budget that are not strictly infrastructure should be thoroughly examined and justified. In particular, we recommend better integration of IODP Education and Outreach funds with general ocean sciences education and outreach funds. Such a change could have two advantages: one, IODP costs as a percentage of the OCE budget would decline, and two, IODP education and outreach could more effectively leverage the EO budget for all of ocean sciences. Additionally, it may be worthwhile to examine the question of integrating IODP science funding into the core OCE science programs as this would parallel funding models for other large infrastructure programs such as OOI.

5. Considering the surprisingly small costs savings that result from operating the ship on a reduced schedule (~8 months), we recommend that the ship be operated for 12 months.

6. Finally, we recommend that the IODP planning groups reconvene to reconsider their science goals given the realities of a more limited program with a broader base. As we mentioned earlier in this document, such reconsideration should include a prioritization of the ambitious science goals in the context of financial constraints and the priorities of the larger ocean science and geoscience communities.