Accelerating Ocean Exploration

LAST MONTH, A DISTINGUISHED GROUP OF OCEAN RESEARCHERS AND EXPLORERS CONVENED IN Long Beach, California, at the Aquarium of the Pacific to assess progress and future prospects in ocean exploration. Thirteen years ago, U.S. President Clinton challenged a similar group to provide a blueprint for ocean exploration and discovery. Since then, the fundamental rationale has not changed: to collect high-quality data on the physics, chemistry, biology, and geology of the oceans that can be used to answer known questions as well as those we do not yet know enough to pose, to develop new instruments and systems to explore the ocean in new dimensions, and to engage a new generation of youth in science and technology. Recently, however, exploration has taken on a more urgent imperative: to record the substantial changes occurring in largely undocumented regions of the ocean. With half of the ocean more than 10 kilometers from the nearest depth sounding, ecosystem function in the deep sea still a mystery, and no first-order baseline for many globally important ocean processes, the current pace of exploration is woefully inadequate to address this daunting task, especially as the planet responds to changes in climate. To meet this challenge, future ocean exploration must depart dramatically from the classical ship-based expeditions of the past devoted to mapping and sampling.

As a first step, future exploration should make better use of autonomous platforms that are equipped with a broader array of in situ sensors, for lower-cost data gathering. Fortunately, new, more nimble, and easily deployed platforms are available, ranging from $200 kits for build-your-own remotely operated vehicles to long-range autonomous underwater vehicles (AUVs), solar-powered autonomous platforms, autonomous boats, AUVs that operate cooperatively in swarming behavior through the use of artificial intelligence, and gliders that can cross entire oceans. New in situ chemical and biological sensors allow the probing of ocean processes in real time in ways not possible if samples are processed later in laboratories.

Exploration also would greatly benefit from improvements in telepresence. For expeditions that require ships (very distant from shore and requiring the return of complex samples), experts on shore can now "join" through satellite links, enlarging the pool of talent available to comment on the importance of discoveries as they happen and to participate in real-time decisions that affect expedition planning. This type of communication can enrich the critical human interactions that guide the discovery process on such expeditions.

Words such as "crowd sourcing," "crowd funded," and "citizen scientist" are nowhere to be found in the President’s Ocean Exploration Panel report of 2000, but at the Long Beach meeting, intense excitement revolved around growing public engagement in many aspects of ocean exploration through mechanisms that did not exist 13 years ago. However, there is not yet a body of experience on how to take advantage of this new paradigm on the scale of a problem as large as ocean exploration. For example, what tasks are most suitable for citizen scientists, and how can they be trained efficiently? Can the quality control of their work be automated? Can crowd-sourced tasks be scheduled to avoid duplication and gaps?

Should any region of the ocean receive priority? Although the southern oceans are still largely unexplored, and coral reef hot spots for biodiversity are gravely imperiled by ocean warming and acidification, there was much support by Long Beach participants for prioritizing the Arctic, a region likely to experience some of the most extreme climate change impacts. An ice-free ocean could affect weather patterns, sea conditions, and ecosystem dynamics and invite increases in shipping, tourism, energy extraction, and mining. Good decisions by Arctic nations on Arctic stewardship, emergency preparedness, economic development, and climate change adaptation will need to be informed by good science. Exploration of this frontier needs to happen now to provide a useful informational baseline for future decisions.

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