WRITTEN TESTIMONY OF
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HEARING ON "DEEPSEA CHALLENGE:
INNOVATIVE PARTNERSHIPS IN OCEAN OBSERVING"
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Good afternoon Chairman Begich and Members of the Committee. My name is James Cameron, and I am a explorer and director. Thank you for the opportunity to testify today about innovative partnerships in ocean observing and exploration.

This week we brought to the nation's Capitol a unique symbol—one that demonstrates the power of curiosity and imagination to surmount fantastic technological hurdles and explore the unknown. The *DEEPSEA CHALLENGER* is the only human-occupied vehicle currently able to access the deepest parts of the ocean. In 2012, I used it to explore the famed Challenger Deep, in the Mariana Trench, as well as exploring the previously unseen New Britain Trench. Far from being out of its element on Capitol Hill, it serves as a stark reminder of a task that has barely begun: the exploration of the deep ocean.

A dozen people have stood on the moon. Only three have made the seven-mile descent to Challenger Deep. In fact, the vast majority of the world's ocean trenches, comprising an area larger than North America, remains virtually unknown to us.
Why? Because they lie beneath five to seven miles of water. The deep ocean is a lightless, high-pressure region that, from a technological standpoint, is exceedingly challenging to see through, to get to, and to operate in.

Because we routinely travel four miles beneath the surface, the depth other exploration vehicles are capable of reaching, people think the extra three miles is not a significant challenge be a big problem. But everything changes in attempting to reach hadal depths below 6,000 meters (20,000 feet), the deepest places in the ocean. At those depths, from an engineering perspective, the performance–benefit ratio changes in terms of flotation, pressure vessels, wall thickness, and other components. Vehicles become very heavy and unmanageable. That not only drives up the cost of hadal-depth vehicles themselves, it drives up the cost of the ships used to launch and recover them, multiplying the at-sea operational costs that have historically been prohibitive factors to exploration. There are also limits in materials science that require the creation of entirely new materials in order to build vehicles that have the same agility and cost factors as those operating higher in the water column. One goal of the *DEEPSEA CHALLENGE* Project was to demonstrate a spectrum of new technologies in a relatively small manned vehicle for full-ocean-depth science diving and at reasonable cost.

These challenges are largely responsible for the fact that hadal depths are still relatively unexplored and why so little is known about the biology and geology in hadal depths. Yet it is known that these regions are geologically dynamic. In ocean trenches, where one tectonic plate is subducting beneath another, causing a great deal of stress, friction, and fracturing that result in earthquakes and submarine landslides, which, in turn, are sources of the kinds of tsunamis that devastated Indonesia just a few years ago, and recently dealt such a horrific blow to the people and economy of Japan.

There is also intriguing evidence of a diversity of unusual and unknown life forms. These life forms have unusual biochemical and physiological adaptations to the exotic chemistry and extreme pressure in hadal regions.

I was born in 1954 and grew up during an era of exploration. In the 1960s, the Apollo program was sending men to the moon. In 1964, the deep-sea sub *Alvin*, operated by Woods Hole Oceanographic Institution, began bringing humans to the deep sea. These exploratory pursuits inspired me at an impressionable age resulting in my later pursuit of deep ocean exploration in parallel to my filmmaking work.

I assembled a team of engineers to build *DEEPSEA CHALLENGER*—to push exploration into the deep sea, further and faster. A small, private, international team of young engineers developed a vehicle that was pioneering in several ways. It was able to dive to the deepest place in the world's oceans, a feat that had only been accomplished once before, by the historic dive of the *Trieste* bathyscaphe under U.S. Navy authority in 1960. However the *DEEPSEA CHALLENGER* weighs less than one-tenth of *Trieste*, and can be deployed like a contemporary science submersible from the deck of a mid-sized research vessel, as opposed to being towed to the site. In addition, the new sub is able to explore horizontally for miles over the seafloor, collecting samples with a robotic manipulator arm, recording data with a number of instruments, and gathering high definition stereoscopic video with multiple cameras. Preliminary science results of our 2012 expedition were presented by a joint team of researchers at the December gathering of the American Geophysical Union. These results included the discovery of at least 68 new species such as the deepest examples of gigantism in amphipods, as well as images of the deepest bacterial mats ever discovered, which may lead to an understanding of the origin of life on Earth.

However, despite being a small, international, privately funded group, I want to emphasize that our team built on a monumental foundation of prior ocean research and exploration funded by Congress and a range of government agencies.

It should also be noted that *DEEPSEA CHALLENGER* was built by a joint American/Australian team, with approximately one-third of the work done in the U.S., by engineering companies in the Bay Area, and two-thirds of the work done by a start-up company in Sydney. The Australian government provides generous rebates to encourage research and development, and this was a strong driver in my choice to site the project primarily in Australia. I would strongly urge Congress to establish new incentives, as

well as enhancing existing ones, to encourage R&D among small companies in the U.S., thus maintaining this nation's critical lead in engineering and science.

Now, the scientists and engineers at Woods Hole Oceanographic Institution and ocean research centers across the nation are poised to take the technologies developed for *DEEPSEA CHALLENGER* submersible and science platform to the next level, so that the knowledge gained in this project can help advance ocean science.

This public/private collaboration is one of many that signal a new path to supporting the R&D and education initiatives that are critical to the future of the U.S. and global economies. I believe that advances in ocean science and technology must be at the forefront of this effort, given the growing recognition of the importance of ocean processes and their influence on weather and climate and economic and national security. Woods Hole's expertise in this area is part of the reason I have agreed to join one of its new initiatives, the Center for Marine Robotics, which aims to spur collaborations across government, industry, and academia to advance ocean science and exploration through the development and integration of new marine robotic vehicles and technologies. Despite our best efforts, the ocean remains *aqua incognita* to us—much the way the ground we're sitting on now was once considered *terra incognita* by early explorers. There's much more we need to know about how the ocean operates. We haven't invested nearly enough in ocean research. And I think it's gong to come back to bite us at this moment in history when we know that the ocean is rapidly changing.

The only way we can learn about this vast and crucial part of our planet is to submerge ourselves in it, using both human and remote automated technology, which requires adequate funding, given the difficulties of operating in the ocean, from the surface to the trenches.

During the past 10 days, *DEEPSEA CHALLENGER* made a cross-country trek from Los Angeles to Washington on its way to its eventual home at Woods Hole Oceanographic Institution on Cape Cod. Along the way, the sub stopped to give young people a chance to see and touch the sub and, more importantly, to imagine themselves exploring the unknown—inspiring them, as I was inspired.

We need exemplars like this for young people to see that not only is there much we haven't explored right here on our home planet, but also that there is much we need to know about how our natural world functions. Our planet is a big, complex, intricate system, and the ocean is the most poorly understood part of it. That system is under stress, and we need to improve our understanding of how it works so that we can help preserve our home.

As the next generation of scientists, engineers, teachers, business owners, and political leaders, their enthusiasm for exploration, for taking risks, for solving problems, and pursuing knowledge is vital to our continued international leadership, national security and economic growth. To that end, the STEM programs are essential to give students at

impressionable ages the inspiration and skills to learn how nature and technology works. Continued federal investment in education at all levels must remain a high priority.

So many people think we live in a post-exploration age—that it's all been seen, and all been mapped. We brought the sub to the nation's Capitol to help dispel this myth, to communicate the need for greater investment in ocean science and the technologies that make it possible. *DEEPSEA CHALLENGER* proves that remote parts of the ocean are within our reach. We live in a new Age of Exploration. We also live in an age in which the impacts of human industrial civilization on the natural world are becoming more dire. All future policy regarding the prevention of dangerous changes to our climate and its impacts to human life and biodiversity must be informed by scientific fact. That science must include an understanding of the oceans and their role in the transfer of heat, in the hydrological cycle, the carbon cycle, and in extreme weather events.

I will continue to support ocean R&D and build on the growing number of public, private and philanthropic partnerships, and I encourage Congress to capitalize on this opportunity by expanding its investment in ocean science, technology and education. I believe the return on this investment will provide benefits far beyond anyone's expectations.

Thank you again for this opportunity to address the Committee.

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