Scientists unveil robotic submarine to explore beneath Antarctic ice shelf

January 7 2011

Reed Scherer and Ross Powell

(PhysOrg.com) -- Northern Illinois University and DOER Marine today unveiled a new 28-foot long, cigar-shaped robotic submarine to be used in exploration beneath the Ross Ice Shelf in Antarctica.

Bristling with high-tech instrumentation, the submarine is among the exhibits at the Moscone Convention Center in San Francisco this week during the American Geophysical Union's Fall Meeting. The exhibition continues through Friday, Dec. 17.

“This one-of-a kind ROV (remotely operated vehicle), built by DOER Marine especially for NIU, is truly a feat of ingenuity, engineering and

technology," said Ross Powell, an NIU Board of Trustees Professor of geology.

"The entire project will be groundbreaking in several ways," Powell said. "We have developed new technology and new instrumentation to explore parts of our planet that have never been seen before and to collect unique scientific data that are aimed at helping plan for humanity's future as the earth's climate changes."

Powell and NIU Presidential Research Professor of Geology Reed Scherer will discuss the submarine project during a workshop for the media at 10 a.m. Wednesday, Dec. 15, in Room 3000, Level 3, of the Moscone Convention Center West.

The 2,200-pound submarine is equipped with five cameras, a water sampler, a sediment corer, a Doppler current meter, more than two dozen sensors, a laser-beam for measuring objects, a robotic arm with "fingers" for gathering samples, a device for imaging and mapping the seafloor surface, an acoustic sounder for profiling sub-seafloor sediment and numerous other instruments.

Powell, Scherer and scientists from other institutions will use the remotely operated submarine to investigate melting near the base of the West Antarctic Ice Sheet (WAIS).

The researchers intend to drill through more than a half mile of ice and lower the submarine—which can collapse to a width of just 22 inches in diameter—through a 30-inch-wide ice borehole into the ocean water beneath the Ross Ice Shelf adjacent to the WAIS. About two miles of cable will tether the submarine to a control center on the ice, where images and data will be collected.

The robotic submarine will allow scientists for the first time ever to

observe melting and other conditions at the interface between seawater and the base of the glacial ice. Scientists also will use the submarine to investigate the sea floor and layers of sediment beneath. The project is scheduled for late 2013, but the submarine will be tested this coming March at Lake Tahoe and at the end of 2011 near McMurdo Station, the United States' main base in Antarctica.

"The submarine has an array of high-definition and still cameras, and has the ability to retrieve geologic cores," Scherer said. "But what makes the submarine really special—and the reason it's so large—is the incorporation of equipment that will provide geophysical images of the structure of sediments beneath the seabed. It's analogous to taking an X-ray to find out what's beneath the sediment surface.

"This is absolutely the first project of its kind," Scherer added. "Ross Powell came up with the idea of using a robotic submarine, and we first proposed a project like this 10 years ago. It has tremendous potential. Up to now, all we know about conditions at the base of the ice shelf is from theory and remote data from surface instruments. The submarine will provide scientists with images of the environment and physical, chemical and biological measurements of the ice, water and sediment conditions."

DOER Marine, a robotics engineering firm located in the San Francisco Bay area, spent nearly three years building the submarine.

"We've built some wild things before, but to pull all these things together into this one big vehicle is pretty fantastic," DOER President Liz Taylor said. "The vehicle must fold up compactly to get down through the borehole, yet when it is released into open water the submarine goes through an elegant exercise to transform itself into 'flight mode.' This is really a unique feature.

"We wanted to pack as much into the submarine as we could, so we can

retrieve as much data per hour of operational time as possible," she added. "If you're going through all that time and trouble, you want to make sure whatever you're putting down there is a data pig."

The information that will be gathered is critical to glacial and climate modelers trying to project potential future rises in global sea levels due to global warming. Substantial melting at the base of the ice shelf, which floats atop seawater, and the ice sheet, which is grounded on land, would lead to a more rapid sea-level rise.

The National Science Foundation has already awarded $10 million in support of scientists at nine U.S. institutions involved in the Antarctic project. That figure includes $2.5 million awarded to Powell for his lead role in the project. The funds were generated through the American Recovery and Reinvestment Act, or federal economic stimulus.

The University of California at Santa Cruz and Montana State University are also lead institutions in the 5-year Antarctic program, known as WISSARD, for Whillans Ice Stream Subglacial Access Research Drilling. The project will include a drilling investigation of Subglacial Lake Whillans—although the submarine is not involved in that aspect of the research. The interior

lake is hidden beneath a thick layer of relatively fast-moving, grounded WAIS ice and might host a complex community of microbial life.

In addition to NSF, Powell and NIU colleagues previously received funding from the National Oceanic and Atmospheric Administration for design and construction of the robotic submarine. Gordon and Betty Moore Foundation, based in San Francisco, contributed $1.3 million in funding for the robotic submarine's instrumentation and testing.

Stefan Vogel, a former researcher at NIU, significantly contributed to

technical development of instrumentation for sub-ice exploration. NIU undergraduates and graduate students are expected to participate in the Lake Tahoe test dives, as well as in each of three research field seasons in the Antarctic.

The dive at Lake Tahoe, one of the world's deepest freshwater lakes, is designed to test the extensive instrumentation on the submarine and gather information on fault lines beneath the lake.

More information: For more information on the robotic submarine, see wissard.org/science/science_instrumentation/SIR

Provided by Northern Illinois University