Antarctic Ice Shelf Environmental Survey and Oceanographic Capability: Interdisciplinary Science Plans and Prospects.

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We have proposed the development of an Antarctic Ice Shelf Environmental Survey and Oceanographic Capability (AISESOC, pronounced "icey sock"), which would provide access through the ice shelf to environments in the Ross Sea, and potentially other ice shelf regions around Antarctica. If funded, the AISESOC will support current and future ANDRILL (ANtarctic geological DRILLing) survey and drilling projects as well as providing a community-based, multidisciplinary environmental survey capability.

Ice shelves isolate the seafloor beneath them from sunlight and primary productivity, alter water motion from waves and currents, and prevent gas exchange between surface ocean waters and the atmosphere. Ice shelves also play a role in regulating global sea level by buttressing the ice sheets that feed into them. Understanding the role of heat transport to the base of the ice shelf by currents and determining the rate of change in ice shelf thickness are two critical parameters for understanding past and future ice shelf/ice sheet dynamics. Understanding the transport of nutrients under the ice shelf and their influence on benthic ecology and diversity is another important question that should be addressed to quantify change in these remote ecosystems. Linking the known Ross Sea oceanographic system to the unknowns under the Ross Ice Shelf is a highly significant and desirable goal that will be advanced through the deployment of AISESOC.

AISESOC is conceived as an integrated "instrument package" (comprising six modules), including: (1) the development of a deep-water, modular, small-diameter, Remotely Operated Vehicle (ROV), topside winch system and maintenance van (i.e., a deep-water enhancement of the existing SCINI ROV (300 m water depth limit) to enable operations in combined ice shelf and water depth thicknesses of up to 1200 m); (2) a mobile hot water ice drilling system (designed to make 30 cm in diameter access holes through the 300 to 500 m-thick regions of the ice shelf) that can also be used in a stand-alone mode for specific projects; (3) mobile environmental laboratories (with power, plumbing, environmental systems, and instrumentation appropriate to their functions); (4) an oceanographic instrument pool (i.e., current meters, thermistors, CTDs, water samplers, profilers, etc.) and supporting deployment equipment (A-frame and winches); (5) two tractors (traverse heavy equipment, e.g., Caterpillar Challengers or Case IH articulated quad trac tractors) that will tow the modules across the ice shelf to specific site locations; and (6) mobile camp facilities to support 10-16 people.

The drilling strategies being explored for the ANDRILL Coulman High (CH) Project, either POGO-style (offset) drilling or borehole re-entry, each require the use of a deep-water ROV to provide observations, mapping, and/or advanced capabilities requiring a gripper, such as attaching lines or guiding tools, or

sampling the benthic biology, water and sediments. The mechanics of re-entry operations are complex and will require the ability to access the sea riser and the re-entry cone during re-connection operations. The Deep-SCINI ROV will be designed to carry out "lightweight" tasks, such as triggering equipment on the seafloor, aligning logging tools for bore hole re-entry, and transferring light guide lines. Preliminary field site surveys at the CH sites are scheduled in 2010 to investigate the sub-ice cavity with the existing SCINI ROV, to deploy current moorings, and begin to develop and test procedures for sub-ice shelf deployments of longer-duration and deeper depths during ANDRILL Coulman High sediment drilling.

The Deep-SCINI ROV system will be supported by a hot water drill (HWD) system that melts (~30 cm in diameter) access holes through an ice shelf up to 500 m thick. The proposed HWD will be used to augment the existing ANDRILL HWD system during drilling operations requiring ROV support, as well as providing a mobile, independent capability for interdisciplinary surveys across the Ross Sea that require integrated hot water drilling, ROV operations, and deployment of oceanographic sensors. Mobile laboratories that can be reconfigured to support science requirements will be combined with mobile logistics infrastructure (camp/kitchen/sleeping quarters) and heavy equipment to tow these modules. This integrated environmental survey capability is intended to be capable of conducting benthic (photographic and multi-beam sonar imaging/mapping) surveys of the seafloor beneath the ice shelf, make water column measurements, and perform discrete sampling at the seafloor, augmented by the deployment of oceanographic instrument arrays (oceanographic moorings and ice-tethered profilers) to conduct both short- and long-term time series observations.

The proposed AISESOC modules are aligned with the scoping requirements of the ANDRILL CH Project and those of the WISSARD project, both of which are being planned for presumed field operations between 2012-2016 based on proposed schedules. The development of the AISESOC would provide significant risk mitigation for these large, complex projects that require traverse and other capabilities. Oceanographic instrument deployments using the AISESOC, combined with modeling efforts using the data generated by these installations, would contribute to an improved understanding of the sub-ice shelf environment and support long-term observatory science as part of a Southern Ocean Observatory System (SOOS). The availability of year-around data from the sub-ice cavity, from time series measurements and discrete observations of critical parameters, will lead to improvements in our understanding of Ross Sea oceanographic, biological and ecological processes, which in turn will improve our understanding of these environments and allow data to be incorporated into a wide variety of models.

Figure 1. Ross Ice Shelf thickness in meters overlain on LIMA imagery.

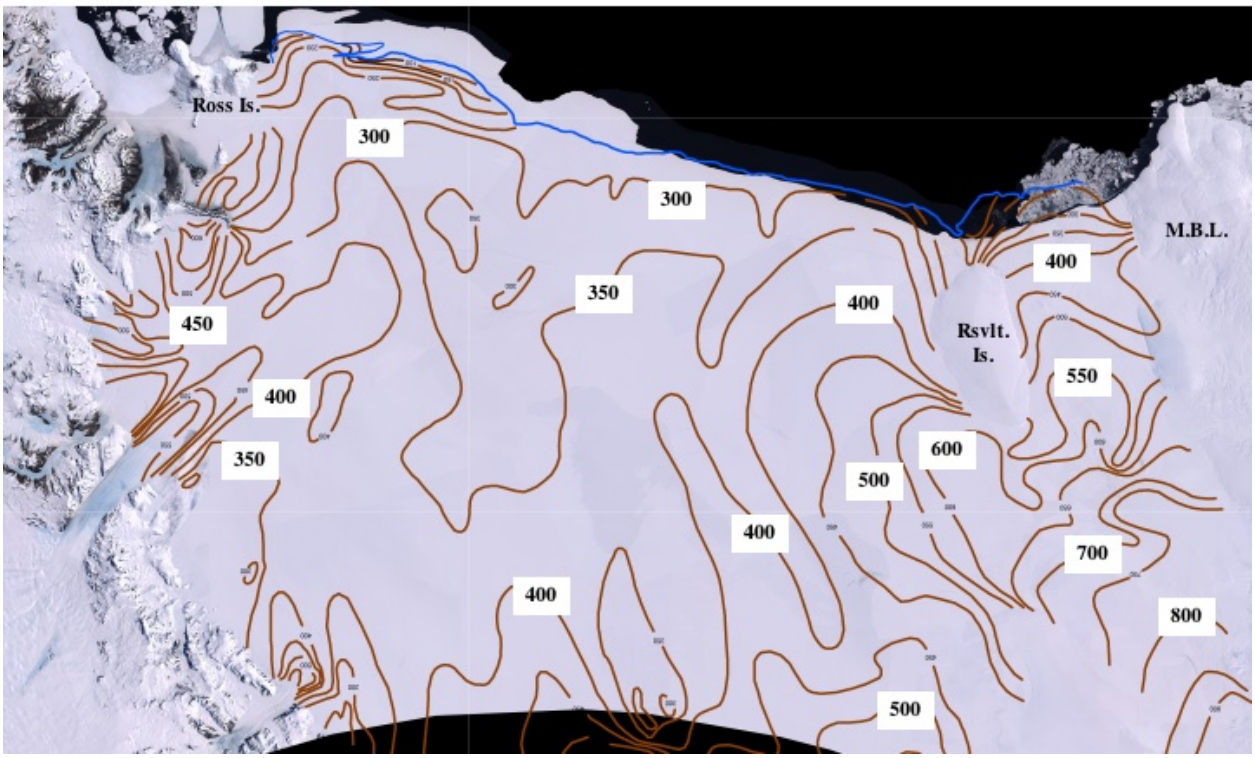

Figure 2. SCINI-2009 and Deep-SCINI remotely operated vehicle schematics.