Design and Implementation of Cold-Hardened Seismic Stations

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PASSCAL currently supports roughly 60 experiments per year worldwide, with 5-10% funded by the National Science Foundation (NSF) Office of Polar Programs (OPP). Polar projects commonly require a level of support that is several times that of seismic experiments in less demanding environments inclusive of very remote deployments (e.g. Tibet). In order to ensure OPP funded Antarctic projects the highest level of success, we have established a PASSCAL Polar Program and have secured funds from OPP to better support new and ongoing experiments in the extremely cold Polar Regions.

In 2006, the National Science Foundation (NSF) awarded a Major Research Initiative (MRI) grant to UNAVCO and the Incorporated Research Institutions for Seismology (IRIS) to develop a power and communications system that will improve remote autonomous geophysical observations in the polar environments. Currently in the second year of a three year program, field developments and designs have proven that a high-quality seismic station can be operated and maintained in an extremely cold environment utilizing recent manufacturing breakthroughs in light weight battery designs and insulating materials. Our strategy for designing cold-hardened seismic systems is driven by the need to maximize heat efficiency and minimize payload while maintaining continuous recording throughout the Polar winter. Our design is for a basic 2W autonomous system. Power is provided by a primary Lithium Thionyl Chloride battery pack and is backed by a secondary, solar charged AGM battery pack. Station enclosures are heavily insulated utilizing vacuum-sealed R-50 component panels and rely on instrument-generated heat to keep the dataloggers within operating specification. Although insulated, broadband sensors are operated close to ambient temperature.

In 2007, the NSF awarded a second MRI to IRIS as a result of intermediate results and successes with the autonomous station design MRI 2006. The purpose of this grant to IRIS is to begin establishing a pool of seismic instrumentation and station infrastructure packages designed to operate PASSCAL experiments in Polar Regions. Procurement has begun on this new pool and support of field operations have already begun on projects in Greenland and Antarctica. Along with the equipment, PASSCAL has now established a dedicated staff to polar projects to further enhance the support and quality of the data return from these challenging projects.

In conjunction with the MRI efforts, PASSCAL (in collaboration with the IRIS GSN and Quantarra) is developing an Iridium modem capability for the Quanterra Q330 datalogger. The system will be used for transmitting both state-of-health and daily file transfers and is being tested for integration into a standard full time telemetry link. The Iridium system is scheduled to deploy in Antarctica this austral summer (2007-2008) at several remote seismic sites.

With modern, state-of-the-art seismic equipment now being designed to operate at very low power in more extreme temperature ranges, we have the opportunity to exploit new opportunities in polar environments with increased reliability and reduced logistics requirements on the polar field support agencies (primarily, the NSF's Office of Polar Programs).