Cruise Report
LMG04-04
April 16 – May 11, 2004

Supported by U.S. National Science Foundation Office of Polar Programs

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LMG 04-04 Cruise Participants - GO-096

1) Eugene Domack, PhD
Chief Scientist
Department of Geology
Hamilton College
Clinton, New York 13323
edomack@hamilton.edu

2) Amy Leventer, PhD
Co-Principal Investigator
Department of Geology
Colgate University
Hamilton, New York 13346
aleventer@mail.colgate.edu

3) Robert Gilbert, PhD
Co-Principal Investigator
Department of Geography
Queen's University
Kingston Ontario ON K7L 3N6
gilbert@lake.geog.queensu.ca

4) Stefanie Brachfeld, PhD
Co-Principal Investigator
Department of Geology
Montclair State University
252 Mallory Hall,
Upper Montclair, NJ 07043
brachfelds@mail.montclair.edu

5) Scott Ishman, PhD
Co-Principal Investigator
Department of Geology
Southern Illinois University
1259 Lincoln Dr.
Carbondale, IL 62901
sishman@geo.siu.edu

6) Stephanie Higgins ('04)
Research Assistant
Department of Geology
Hamilton College
Clinton, NY 13323
shiggins@hamilton.edu

7) Joshua Kinsman ('06)
Research Assistant
U. Wisconsin Eau Claire
823 Towers South
642 University Dr.
Eau Claire, WI 54701
kinsmajw@uwec.edu

8) Gemma Kirkwood ('05)
Research Assistant
Dept. of Geology
Hamilton College
Clinton New York 13323
gkirkwoo@hamilton.edu

9) James A. Maritz ('05)
Research Assistant
Geology Department
Colgate University
Hamilton, NY 13346
jmaritz@mail.colgate.edu

10)Gina Quinones
Research Assistant
Earth and Environmental Studies
Montclair State University
Upper Montclair, NJ 07043
quinonesg1@mail.montclair.edu

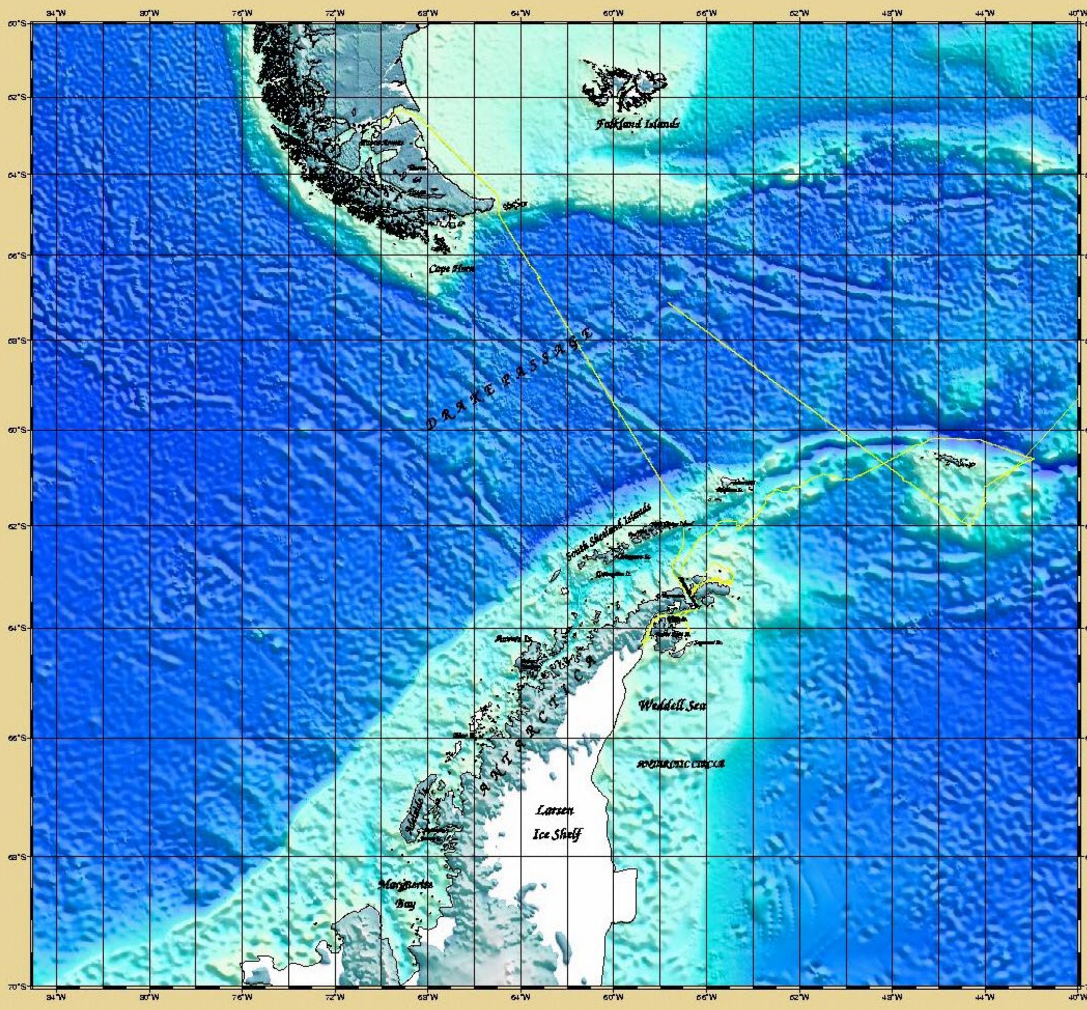
11)Heather Schrum ('05)
Research Assistant
Dept. of Geology
Hamilton College
Clinton New York 13323
hschrum@hamilton.edu

12)Phillip Szymcek ('04)
Research Assistant
Department of Geology
Southern Illinois University
1259 Lincoln Dr.
Carbondale, IL 62901
phillszymcek@hotmail.com

LMG0404

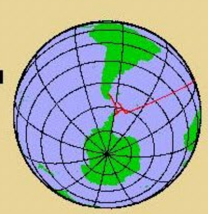
Apr 16 - May 11

ARSV Laurence M. Gould



ARSV Laurence M. Gould
LMG0404

Primary Scientific Objective:



Map created by the LMG ET's

02 March, 2004

PROJECT SUMMARY AS PROPOSED MAY 2003

The Larsen Ice Shelf is the third largest ice shelf in Antarctica and has continued a pattern of catastrophic decay since the mid 1990's. The proposed marine geologic work at the Larsen Ice Shelf built upon our previous NSF-OPP funding and intended to test the working hypothesis that the Larsen B Ice Shelf system has been a stable component of Antarctica's glacial system since it formed during rising sea levels 10,000 years BP. This conclusion, if supported by observations from our work, is an important first step in establishing the uniqueness and consequences of rapid regional warming currently taking place across the Peninsula. Our previous work in the Larsen A and B embayments has allowed us to recognize the signature of past ice shelf fluctuations and their impact on the oceanographic and biologic environments. We have also overcome many of the limitations of standard radiocarbon dating in Antarctic marine sequences by using variations in the strength of the earth's magnetic field for correlation of sediment records and by using specific organic compounds (instead of bulk sediment) for radiocarbon dating. On this cruise, we intended to pursue these analytical advances and extend our sediment core stratigraphy to areas uncovered by the most recent collapse of the Larsen B Ice Shelf and areas immediately adjacent to the Larsen C Ice Shelf. In addition to the core recovery program, we intended to utilize our unique access to the ice shelf front to continue our observations of the snow/ice stratigraphy, oceanographic character, and ocean floor character. Sediment traps would be deployed in order to measure the input of debris from glaciers that are now surging in response to the ice shelf collapse. This project is a multi-institutional, international (USAP, Italy, and Canada) effort that combines the established expertise in a variety of disciplines and integrates the research plan into the educational efforts of primarily undergraduate institutions but including some graduate education. This is a three-year project with field seasons planned with flexibility in order to accommodate schedules for the RVIB *L.M. Gould*. The Antarctic Peninsula is undergoing greater warming than almost anywhere on Earth, perhaps associated with human-induced greenhouse effects. Our work contributes to understanding of these changes where they are occurring first and with greatest magnitude and impact upon the environment.

Cruise LMG04-04
Executive Summary

Due to severe ice conditions (in late April-early May) and the limitations of the *LM Gould* none of the original scientific objectives of LMG04-04 as outlined in OPP-0338142 were accomplished. The timing of Cruise LM Gould 04-04 was accelerated from the normal time frame of fieldwork, allowing for a field season in 2004. The educational aspects of the cruise were accomplished through onboard course work (see Hamilton College Antarctic Website: http://www.hamilton.edu/news/exp/antarctica/2004/).

We had the opportunity to address one of the objectives when we conducted a video (SCUD) survey across the southern end of the Prince Gustav Channel but the video scud failed due to mechanical errors (Figure 1).

One set of observations was made regarding the ice shelf system of the NW Weddell Sea that was useful in our overarching project. This related to the mapping of an ice shelf lateral moraine along the western side of the Prince Gustav Channel (Figure 2). This is an important documentation, which should aid in the understanding of ice shelf formation in the region if field geologists/glaciologists can access the area in the future.

Other science was conducted on an exploratory basis with the following significant results:

1) A new volcanic eruptive center was documented within Antarctic Sound (Figure 3). Bottom videos, dredging, and near bottom temperature measurements confirm the recently active nature of this submarine eruptive center. Studies are currently underway by igneous petrologists on the dredge samples. Samples from and video of the feature have been shared with the British Antarctic Survey (J. Smelie) and biologists at Woods Hole Oceanographic Institution. The later group reports that some hydrothermal vent communities were identified on the video footage (Tim Shank, personal communication).
2) We tested our working hypothesis for sediment drift formation on the Antarctic Shelf (Harris et al., 1999) by conducting a survey of the Joinville, D'Urville Trough (Figure 4). A significant sediment drift (up to ~100 m thick) was discovered along the seaward flank of the trough. Surface sediments, bottom photographs, 3.5 kHz Chirp seismic survey and short cores were collected from the drift. Sedimentologic analyses of this data set are currently underway by students at the participating institutions. We utilized a new bathymetric mapping software system to map the depths of this relatively unexplored region of the Antarctic Peninsula Shelf.
3) Short cores collected in over 500 m water depth in Antarctic Sound recovered 10 cm thick beds of macroalgal (kelp) detritus. These are unusual sediments and represent the first known deep-water peat accumulations from the southern hemisphere. Studies are underway at Hamilton College to characterize the organic matter and sedimentology of these interesting deposits.

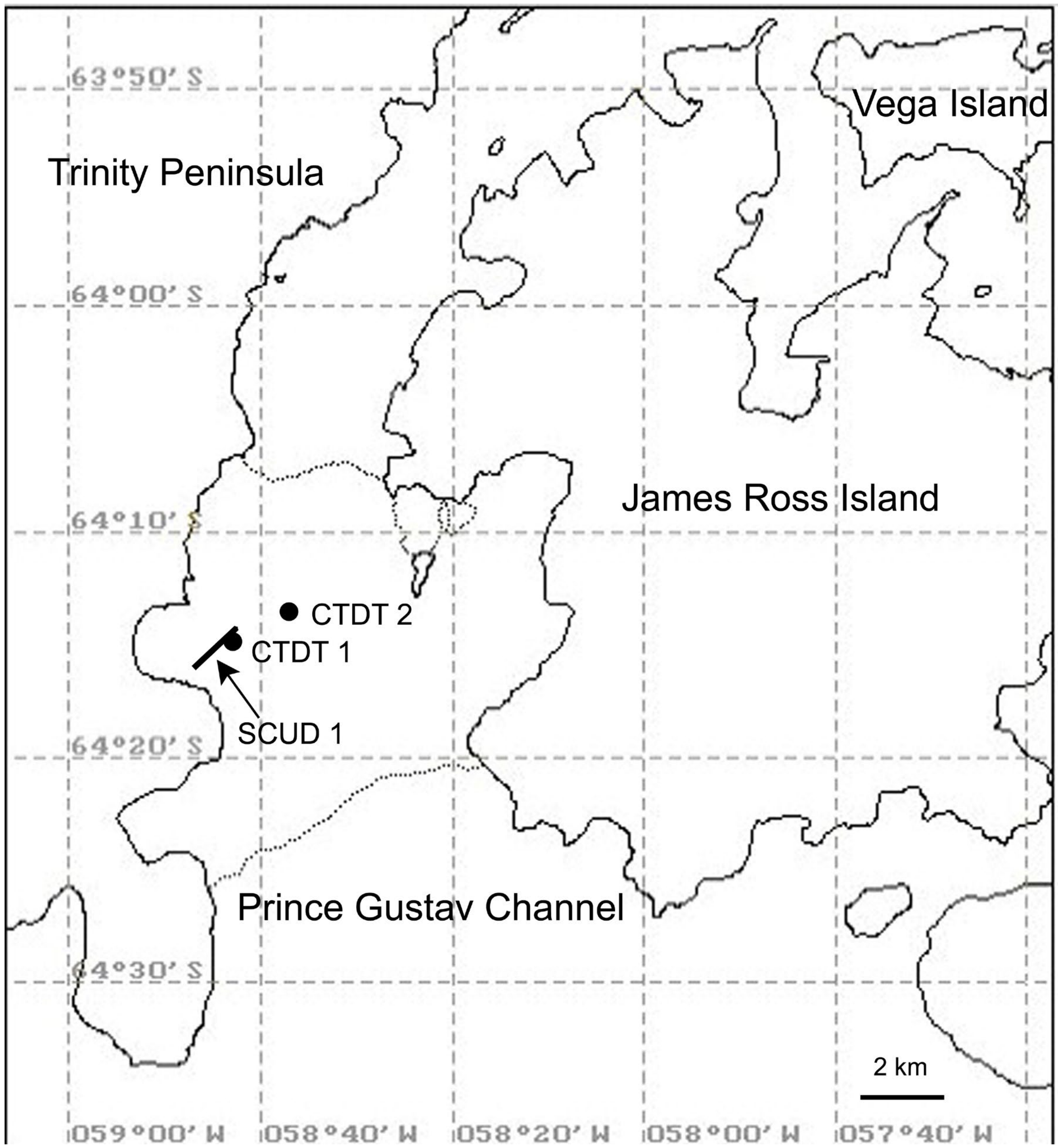


Figure 1. Map of Prince Gustav Channel, including CTDT and SCUD Stations.

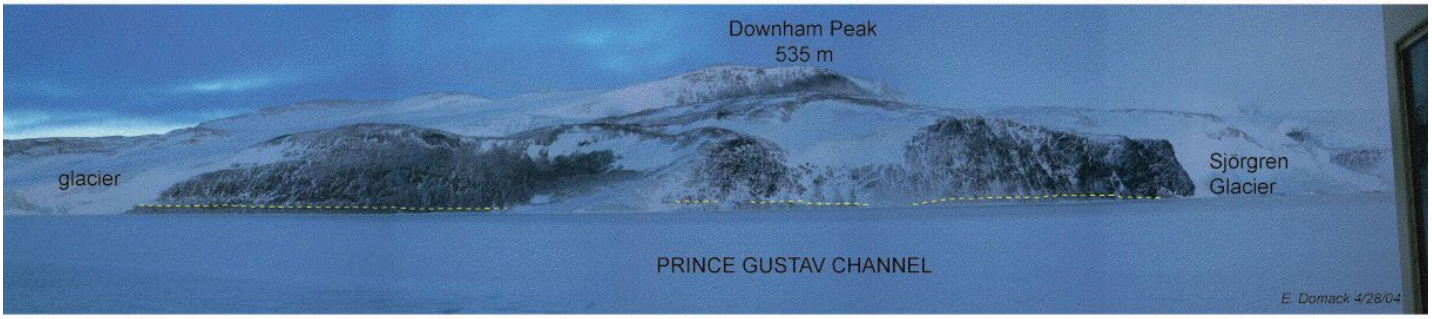


Figure 2. This image is a mosaic of the shoreline along the western side of Prince Gustav Channel. The area represents the former extent of the Prince Gustav Ice Shelf that began its retreat/disintegration in the late 1980's and was completely gone by 1995. The Sjorgren Glacier drains from the Detroit Plateau Ice Cap and is one of the main tributaries that fed into the system, it is labeled here on the north (right side of photo). A glacier of local drainage is seen to the south (left side of the photo). Of interest is the fine yellow line, which delineates the former surface of the ice shelf by a prominent band or terrace of morainal debris that lies an estimated 10-15 m above sea level. While not deposited by the ice shelf directly the moraine/terrace formed by the downslope transfer of rock and its accumulation along the edge of the ice shelf. It is therefore not a moraine in the classic sense of ice shelf moraines described elsewhere in Antarctica, where ice shelves flow up against a shoreline depositing debris via ablation. It therefore is a unique feature worthy of description and documentation. Further information on the Prince Gustav Ice Shelf and its historical confluence with the Larsen Ice Shelf can be found in papers by Cooper (1997), Rott et al. (1996; 1998) and DeAngelis and Skvarca (2003).

Cooper, A.P.R., (1997). Historical observations of Prince Gustav Ice Shelf. Polar Record, 33, 285-294.

De Angelis, H. and Skvarca, P., (2003). Glacier surge after ice shelf collapse. Science, 299, 1560-1562.

Rott, H., Skvarca, P. and Nagler, T. (1996). Rapid collapse of Northern Larsen Ice Shelf, Antarctica, Science, 271, 788-792.

Rott, H., Rack, W., Nagler, T., Skvarca, P., (1998). Climatically induced retreat and collapse of northern Larsen Ice Shelf, Antarctica Peninsula, Annals of Glaciology, 27, 86-92.

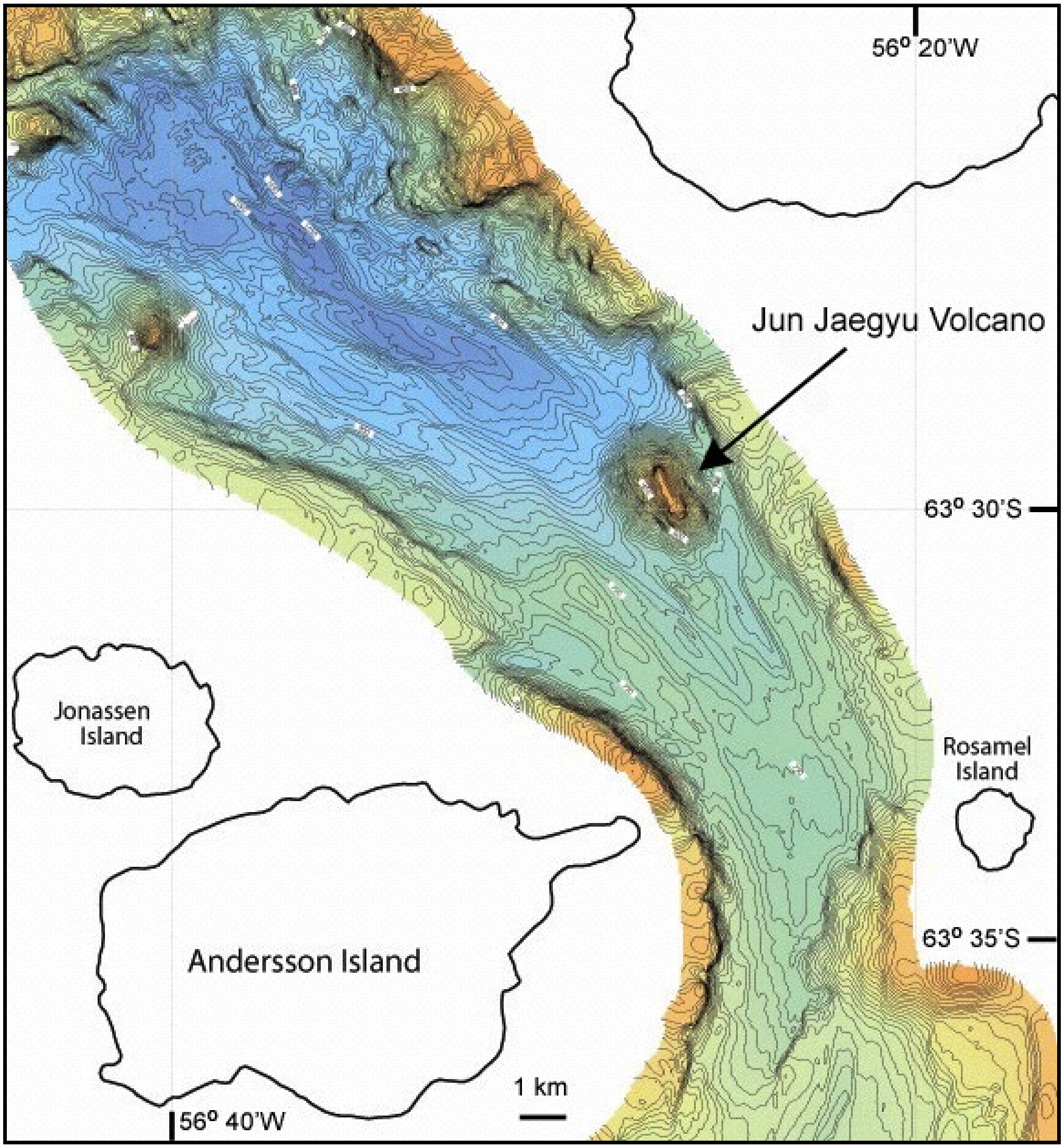


Figure 3. Bathymetric map of Jun Jaegyu Volcano located to the northwest of Rosamel Island (Hatfield et al., 2004).

Hatfield, A., Bailey, D., Domack, E., Brachfeld, S., Gilbert, R., Ishman, S., Krahmann, G., Leventer, A., (2004), Jun Jaegyu Volcano: A Recently Discovered Alkali Basalt Volcano in Antarctic Sound, Antarctica, *EOS Trans. AGU*, 85(47), Fall Meet. Suppl., Abstract T11A-1248.

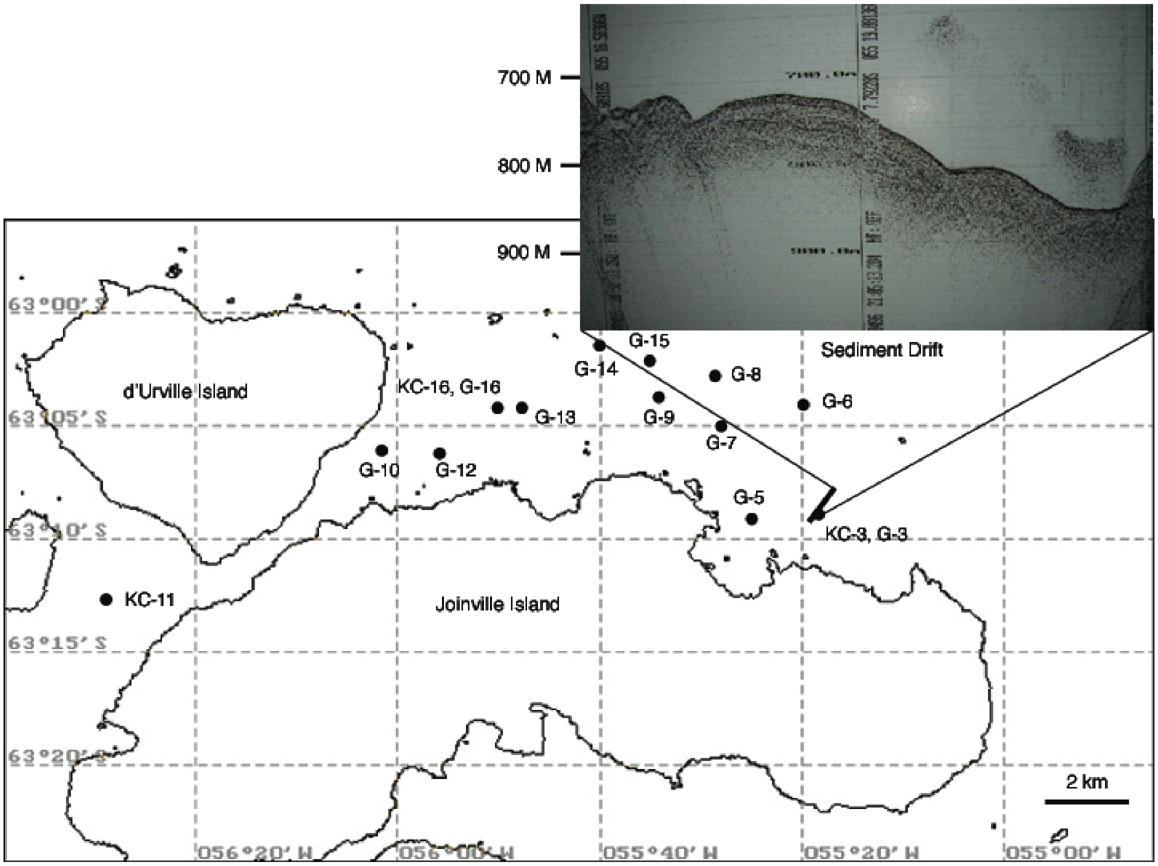


Figure 4. Map of Joinville, D'Urville Trough Survey area including grab and kasten core locations and sub-bottom profile of sediment drift.

For the reader's information we are providing three weekly synopses of Cruise LMG04-04 that were submitted to members of the Polar community.

Cruise *LM Gould* '04-04, First Weekly Synopsis

It has been a week since *LMG*04-04 departed Punta Arenas on schedule and we are currently completing a physical oceanographic survey adjacent to the South Orkney Plateau. *LMG*04-04 sails in support of two projects (GO-096 Paleohistory of the Larsen Ice Shelf Phase II) and (CORC/Arches). The latter program is a NOAA-Lamont Doherty initiative under the ship-board direction of Gerd Krahmann. Its goal on *LMG*04-04 is to recover three oceanographic moorings that have been collecting data since 2001 from the South Orkney Plateau. The Paleohistory of the Larsen Ice Shelf is a collaborative NSF program involving six institutions that aims to collect a multidisciplinary data set from beneath or adjacent to the former and existing Larsen Ice Shelf systems. This is the first of three cruises for the Larsen project.

Leading up to the cruise we received excellent satellite views of the sea ice conditions from the Terra Scan facility at Palmer Station (thanks to Glenn Grant of RPSC). These data allowed science parties, the RPSC Marine Projects Coordinator, and Mike Terminal (Master of the *L M Gould*) to make an informed decision to attempt recovery of the NOAA-Lamont moorings first, on the southbound transit. At the time we left PA the Weddell Sea pack ice was encroaching upon the mooring locations, along the southern slope of the South Orkney Plateau. At the same time the sea ice conditions adjacent to the Larsen Ice Shelf showed progressive improvement (access to Larsen A and B regions) from a rather severe ice cover during the austral summer. Our transit across the Drake Passage and into the Scotia Sea took five days under calm seas and rising barometric pressure. During this time, preparations and fabrication kept the marine tech and science staff busy while Tim Newberger (Lamont Doherty) installed a new system for underway pCO_2 measurements. A temporary failure of the ship's radar was remedied in a timely fashion by Kevin Pedrigo (RPSC) assisting the ECO crew.

We entered the sea ice marginal zone on April 20th and made reasonable progress through a diverse mixture of first year and two year pack ice. At times the *Gould* made a steady 5-6 kt in 6-8" of new ice. Yet with a shift to southerly winds and clear skies, temperatures plummeted to -22 to -24 ^{o}C (with a -40 ^{o}C wind chill) and our progress to the first of the three moorings was halted by a formidable barrier of multiyear pack ice and icebergs, marking the leading edge of the Weddell Sea pack ice zone. During our transit this ice edge had crept northward over the mooring sites. We have been unable to recover any of the moorings and instead utilized the three days dedicated to this task to a series of CTD casts (with an on line ADCP system) and deployment of a new oceanographic mooring at S 60^{o} 39.14', W 42^{o} 04.60'. Science in support of the CORC/Arches program will end today (4/23) at 6:00 PM local time, when we will transit to the Erebus and Terror Gulf. In addition to the CORC/Arches sampling, underway sampling for phytoplankton analyses have been conducted every 6 hours as part of GO-096. At present ice conditions are beginning to deteriorate in the vicinity of the Larsen Ice Shelf with consolidation of new first year ice. However, sufficient leads and the unexpected performance of the *Gould* in thin, new ice give us an optimistic expectation of gaining access to our primary survey sites.

Both RPSC staff and the ECO crew have been extremely helpful, enthusiastic, and professional in support of our work. We look forward to three more weeks of working with Captain Mike Terminal, Ashley Lowe (Marine Project Coordinator) and their crew/staff. We are also appreciative of the pre-cruise planning and support provided by Jim Holik and Stephanie Shur-Sliester of RPSC. You can follow our progress in a more timely fashion on the following web sites where you will also find information about the participating scientists and students. http://www.hamilton.edu/news/exp/antarctica/2004/

Cruise *LM Gould* '04-04, Second Weekly Synopsis

Suffice to say that in the last week those of us on LM Gould 04-04 have faced the full compliment of Antarctica's furies (ice, wind, and cold), as well as an unusual number of mechanical gremlins. I provide this weekly synopsis in somewhat more detail than usual in order to accurately convey the extreme conditions under which we have attempted to work in the past week. At present we are conducting exploratory science along the north coast of Joinville and d'Urville Island, with the hope of extracting some useful sediment sequences from the Larsen Channel Trough. We continue under the safe and professional navigation of Captain Mike Terminel and his crew. Because of sea ice, extreme cold, and the limited capabilities of the LM Gould, we have not been able to, nor will we, achieve a single objective of GO-096. This disappointing result is not at all due to a lack of preparedness or effort on the part of ECO crew and RPSC staff, indeed they have done their utmost in order to help us in our scientific endeavor.

During the last week we completed a long, northward arcing transit from the South Orkney Plateau that brought us into our study region early in the morning of April 26. The long transit was needed to avoid heavy pack ice, which was spinning out of the Weddell Sea into the eastern end of the Bransfield Strait. At the southern end of Antarctic Sound we attempted to collect a jumbo kasten core on the Vega Drift. Despite wind chill temperatures in the -30 degree C range and winds of 12 kt, the deployment was considered safe after 2" of ice was cleared from the unheated deck. We came on station and as soon as we pulled tension on the ½" wire it quickly bound up within loose wrappings along the side of the drum on the DUSH 6 winch. This necessitated abandoning the first station and tasked the MT staff to a lengthy repair that was not completed and tested until 12-15 hours later. Because we could not core we began our quest to the Larsen A-B region. The best satellite images suggested a possible route around to the east of James Ross Island, via Admiralty Sound. The Gould made good way through 6-8 inches of new ice until 11:30 AM (4/26), when the entrance into Admiralty Sound was found to be impassable due to an amalgamation of large tabular icebergs, multiyear ice, and low pressure ridges.

We then opted to access the Larsen region via the Prince Gustav Channel, which would take us back north, then west, for the next 24 hours. Before we were underway, repairs were needed for lights on the Stern A-frame which had become non operational during our transits, but were needed for safe work off the stern during the long hours of darkness. As we transited the Prince Gustav Channel, a brief slow down was needed in order to play out the ½" wire off the DUSH 6 winch. Approximately 1200 m of wire was spooled off in a deep region and was re-wound under sufficient tension to give us a tight wire wrap of 1500 m for subsequent deployments. A difficult job of ice breaking took us to the southern end of the Prince Gustav Channel by the morning of April 27th. Here, thin new ice of 6" to 12" covered the sea that almost a decade ago was beneath the Prince Gustav Ice Shelf. It appeared that the way south was corked by a large armada of icebergs and multiyear ice. So we decided to conduct a series of bottom video surveys of the floor of the channel in order to detect and document the nature of sub ice shelf debris stripes, a phenomenon proposed for investigation in the Larsen Ice Shelf region as part of our work. Ideally a side scan sonar would be the tool of choice for this work but the Dush 6 winch can be configured with either ½" mechanical wire (for coring and scud video) OR conducting cable (for the Datasonics side scan), but not both on the same cruise. So the Gould proceeded to cut a very nice channel through the ice in order to enable a smooth-steady tow of the scud camera across the seafloor. A southwest to northeast transect of some 9 miles was accomplished. The first scud deployment failed because the ballast weight on the camera broke its tether upon reaching the seafloor. Only 1.5 mins of stationary footage was recovered. The second scud deployment went smoothly and the system was carefully guided at the correct depth above the bottom thanks to the careful winch operations of Elfren but upon retrieval it was learned that the scud battery did not hold its charge; no data were acquired. In such extreme deck temperatures of -23 to -21 degrees C, its important that batteries have deep charge cycles, are new, and that the staging areas are warm. Two CTD stations were occupied between scud deployments. After extensive examination of the scud electronics and battery status, several problems emerged with fuse connections, this necessitated lengthy repair. During the night and early morning (April 27-28) attempts were made to deploy the Benthos camera. Wire wraps again were an issue but this time with the DUSH 4 winch, and it took some time to reconfigure the wire on this system. The camera was finally deployed but improper weight balance resulted in excessive instability so a complete roll of film was advanced during its decent and recovery.

At daybreak on April 29th we had clear visibility to the south along with a good satellite image that suggested a path to the Larsen A system, via the western side of the Prince Gustav Channel. With proper caution and excellent visibility the bridge crew guided us south. We made steady progress for about 10 miles and finally ended up cutting 10" of new ice at 4 kt. Yet, this required

100% power so Capitan Terminel properly decided to stop our southward transit and exit back to the north in the PGC. Our furthest south was Lat. -64 degrees 21.364', some 60 miles from our closest objective. We had planned to complete the scud video survey of the channel on our way back north but the scud was still inoperable at this point, so we continued to exit out of the PGC in order to begin an alternate, yet important sampling, survey of the Erebus & Terror Gulf (the Vega Drift).

It took a long, hard night and morning of April 28th-29th to exit the channel. The skill and professional attitude of the bridge crew were more than adequately tested, they did a superb job bringing us safely out of harms way. The scud system was skillfully brought back to life during the night by Andy Archer (ET extraordinaire). Yet because of several days of intense southerly winds and -20 degree C temperatures the Erebus and Terror Gulf presented us with a different scene than it did just two days prior. Ice and increased winds (to 70+ kt) forced us to abandon the well thought out Vega Drift survey and our long kasten core site, to the safe cover of Antarctic Sound. In the vicinity of Antarctic Sound there remains one exploratory survey that might provide some new and interesting data. Hence, we decided to conduct a reconnaissance study of the Larsen Channel trough, a deep outlet from the channel that lies between d'Urville and Joinville Islands. We began this survey as winds began to build with the approach of a strong low-pressure system off to the northwest. This pattern accelerated cold winds out of the south to gusts that briefly exceeded 90 kt and prevented a safe passage through the Larsen Channel. We then properly decided to complete a bathymetric survey off the western end of the channel. At approximately 2:00 PM (April 29th) one engine had to be shut down due to a malfunction that needed extensive repair. Captain Mike moved the ship out into the protected portion of Antarctic Sound as winds built, temperatures continued to drop, and the engineers began their repairs. Remarkably and with expected efficiency the engine was brought back on-line by 9:30 PM (4/29). We then began our transit to the east end of Joinville Island. We have 5 days of science left on LMG04-04 and it is the sincere hope of all on board that we can indeed collect some meaningful and useful observations of the seafloor. Yet we must admit that none of our original objectives for this year have been accomplished.

Respectfully submitted,

Eugene Domack
Chief Scientist, LMG04-04

Cruise LMG04-04, Third Weekly Synopsis

We are currently a day out of PA after a rather rough crossing of the Drake Passage. The last week of science upon the *Gould* found us focusing our work within the straits and channels of Antarctic Sound, between d'Urville and

Joinville Island. We had to abandon our primary and secondary objectives due to ice conditions outlined in last week's synopsis. Our exploratory work in the Larsen Channel was designed to test the hypothesis that sediment drifts on the Antarctic shelf form at the opening of channels or straits, where tidal and/or geostrophic currents decelerate. Support was found for this idea in the form of a thick (greater than 100 m) drift deposit within the Larsen Channel Trough (the eastern opening of the Larsen Channel). Between 4/30 and 5/4 we successfully recovered two kasten cores from the drift, along with 14 surface grabs, bottom photographs, and a 900m deep CTD station within the trough. That these drift deposits record not only a local signal but a regional one, was attested to by the magnetic measurements of susceptibility. These data provided a condensed record in one core nearly identical to the Palmer Deep stratigraphy, some 540 km to the south. The sediment regime at the western end of the Larsen Channel was dominated, not by drift deposition but rather, by a thin drape consisting of sandy mud and macroalgal (kelp) mats up to several decimeters thick. We recovered one kasten core of this unusual lithofacies in 500 m water depth (saltwater peat if the term can be applied). Because of the unusual nature of the sediment regime we twice attempted to SCUD video the channel but technical malfunctions of the SCUD and then maneuverability of the *Gould* prevented the bottom processes of sediment transport from being directly observed.

As weather allowed we shifted focus to a submarine cone suspected of being recent volcanic vent located in the southern reaches of Antarctic Sound. Our strategy was first to resurvey across the top of the feature (first identified in swath maps of the region collected in 2002 off the *NB Palmer*), and then deploy the SCUD video camera coupled with a mini-cat TS profiler. Between windows in an increasingly deteriorating weather system we successfully deployed the SCUD video on May 5th and viewed the spectacular imagery thus provided. The patches of bare, rock with ribbon and bulbous character gave us encouragement to dredge the top of the cone with a small basket dredge. We deployed the dredge strategically on the center of the cone in such a way as to scour the fresh rock surfaces. We succeeded in recovering 100 + lbs of fresh basaltic (olivine bearing) volcanic rock along with a few exotic and glacially faceted cobbles of Trinity Peninsula affinity. The temperature records also showed interesting positive anomalies along the edges of the cone. The data, when taken together with the highly symmetrical morphology of the feature, led us to release a notice to our institutional media and NSF that a new submerged volcano had been discovered in Antarctic Sound. Upon completion of the dredge we moved our science efforts to a trough that runs out across the Trinity Peninsula shelf where we intended to recover one or two kasten cores in a region of sparsely sampled stratigraphy. However, the barometer continued its nearly 40 mb drop in 18 hours and a severe weather system prevented any deck operations from being completed. With the size and strength of the storm well aware to all on board the bridge gave advice that we would arrive late in PA if we continued an additional day of science. Weather did not allow us to deploy any kind of gear whatsoever over the next 24 hours, so the consensus was to set course to PA, thus ending GO-096 in the late hours of 5 May.

Since then we have been fighting, steady westerly winds of 20-40 kts, swells of 12 -20', and crossing seas from the port side bow. Severe motion caused bolted furniture in several cabins to come loose. The Chief Scientist's table was jolted from its fasteners on the portside bulkhead and thrown against the desk, smashing several drawers. Fortunately there were no injuries. This final five days has been a topsy-turvy reminder of how stingy Antarctica has been with us during LMG04-04. The science staff is extremely grateful for the professional and willing support of ECO crew and RPSC staff as they worked with us toward our scientific goals, despite the severe conditions during our cruise.

Respectfully submitted,

Eugene Domack
Chief Scientist LMG04-04

PERFORMANCE OF *LM GOULD*

In general the LM Gould performed better in ice than we had all anticipated. Captain Mike Terminel was able to cut into new ice of 6-8" at 5-6 kts consistently and sometimes thicker new ice (up to 10") for brief periods of time. This gave us the opportunity, at least of approaching, if not reaching our intended area of operation and if we were a month earlier we would likely have succeeded in reaching the Larsen Ice Shelf area. Maneuverability and keeping station was a somewhat different issue that was partly solved by some mid-cruise adjustments in bridge operations. However in thick, multi-year ice and even slushy first year ice the Gould has difficulty maneuvering and certainly and understandably cannot cut far into such ice. Thus we were blocked in three attempts to reach targets. Once for the South Orkney Islands mooring recovery, and twice when we attempted to navigate around James Ross Island (to the east via Admiralty Sound and to the west via Prince Gustav Channel).

EQUIPMENT

Smith McIntyre Grab

This is a standard tool for seafloor sediment sampling and it is important to maintain the working grab in good condition. Some years ago a new Smith McIntyre Grab sampler was acquired and built of stainless steel. We did not use this sampler because our past experience has not shown the grab to function adequately. Instead we relied on the "old beat up" grab which has a more consistent record of reliable trips and good sampling. Yet the old grab needed some significant repair work while at sea, which while not slowing down our work did present itself with unsafe working conditions prior to making the repair. It is highly recommended that the sampling equipment such as this be brought up to standards in PA prior to departure. The space and mechanical capabilities should be there in the PA warehouse to upgrade, test, and repair such equipment prior to sailing. Port calls are not the best time to do this as the cargo tasks are more or less overwhelming upon the MT staff. Specific issues with the Mac grab are:

1) making sure the safety mechanism is functional
2) making sure the trip mechanism operates smoothly
3) clean and regrease all moving parts.
4) sand blast and repaint all surfaces
5) repair cover/lids and replace current solid plates with stainless screen mesh (this would recover the original concept of the doors functionality in allowing the sediment water interface to be collected in an undisturbed fashion when the grab is placed upon the seafloor, yet retaining the baffling effect need upon retrieval).
6) Restring 3/8" wire rope and reterminate cable loops.
7) Sharpen or file jaw fitting to assure tight closure.

It should also be noted that the functionality of the new stainless Smith McIntyre grab be evaluated. The time is quickly approaching when it will be needed, it should be a well working system before we are forced to use it. My only experience with it, in 1998, demonstrated some issues related to its inability to trip upon contact with the seafloor.

Kasten Core

The kasten core is a fine mechanism to retrieve undisturbed cores of fine-grained sediment of 3 to 6 m in length. We were pleased with the maintenance and functionality of the barrels for the core but there are pressing issues with the core catchers. As requested three replacement core catchers were provided in PA for our cruise. But these were not manufactured to original specifications. The core catcher mechanics are absolutely critical to the functionality of the system. We in fact had only one proper core catcher with which to work and it was not properly fitted for the 6 m barrel. Specific aspects of the core catcher are:

1) flappers that are made of thin stainless steel. The new catchers were made with thick stainless stock. The thin steel is need so some flexibility in the flappers is maintained AND so the flappers can be bent inward along their centers in order to catch the mud and provide proper closure upon core retrieval.
2) The flipper mechanism built into the new core catchers is an inoperable design in the sediments, which we core. This mechanism may indeed prove workable in very soft oozes but the silty muds and diamicts we typically target, will not be sampled properly by such a core design.
3) Lead weights were again an issue. Most of these remain on the NB Palmer and we only had one full set of 12 weights with which to work. The weights are used for the triple core as well and we typically have to change the number deployed depending upon the sediment. We had three core heads but only one set of weights so if we had lost a core, we could not continue to place proper mass upon the replacement.
4) New sets of stainless screws are needed. All threads need to be cleaned of grit and a <u>non-carbon</u> lubricant such as silicon needs to be applied. Sets of replacement plates that are custom fit to the existing barrels need to be provided, or at least three or four that can be drilled to fit a gap if needed.
5) A dedicated large miller swivel needs to be provided within the box of pins and ties for the kasten core.
6) Large slip pins are needed to fit the barrel fasteners, which themselves need to be duplicated. Only one set of large barrel pins was available. Large stainless washers are needed in quantity (2 dozen), it was surprising not to find these in the fittings drawers of the MT shack.
7) Most critical was the lack of a collar weight, which is needed to provide stability to the bottom of the core upon decent to the seafloor. One had to be manufactured from the two lead weights, again depleting the very limited replacement stock we had to work with. The original collar weight is properly designed to rest just above the core catcher and is held in place by sturdy rope bridals. These need to be provided and or manufactured before each cruise because of the need to use non binding rope, which rots with time.

The use of a large Miller Swivel is recommended despite the occasional cramping of the shackles and swivel upon the cores top bar (loop) upon retrieval. If a smarter (as opposed to dumber) set of shackles and a shorter but more robust swivel were used this problem can be avoided. A swivel is needed in order to prevent the core from twisting upon pull out, which for a square barrel core would be difficult. It also keeps the core from spinning on the line prior to the moment of penetrating the seafloor hence enabling greater length of core from being recovered.

SCUD Camera
This was the one instrument that provided the most frustration during our cruise. It is a simple design that has proven itself over the years. Yet the video electronics proved troublesome and unreliable during LMG04-04. No replacement parts were available for:

1) the lights
2) the batteries
3) the video camera itself
4) the laser lights

It is high time that the SCUD video camera undergos semi-annual maintenance including replacement of batteries, overhaul of electronics, and checking o-rings, seals and sleeves. The video footage we have recovered from the seafloor has been an invaluable aid in understanding depositional processes, however it's a time consuming station and takes the dedication of the entire ship's capabilities for up to four hours. Such an expensive investment of time should not go to waste because of minor, inexpensive maintenance issues on site. Because the lights on the system generate a great deal of heat the system can not be turned on manual since the delay in placing into the water would burn out the lamps. Some procedure needs to be developed to overcome this problem, perhaps a water-tight switch on the outside of the housing.

One easy improvement is in the type of ballast weight that is employed to keep the scud housing neutrally buoyant. On our cruise the ballast weight caught on rough bottom and broke the line causing the camera to float out of sight of the bottom. A different type of anchor should be used, a heavy elongate anchor, perhaps with vinyl coating would be ideal. This way proper balance is kept with the towed SCUD and the likelihood of catching, even on rough, bottom is minimized. An anchor like this could easily be fashioned out of lead or purchased through a marine supply house. The vinyl coating would also lessen friction if the anchor did indeed purchase the bottom briefly. The anchors used by the MTs were lead donuts or diving weights tied together with a rather large loop, ideal sort of snare for a boulder.

BENTHOS Still Camera
Although the system still provides usable and high definition still images of the seafloor, the technology is there to collect close to real time photos. The

images are needed to help evaluate depositional process and would be even more useful if a digital format is adopted so that the collection of the images could be evaluated as a guide to further sampling in the field. Without replacing the system there still needs to be a standardized set of maintenance procedures. The largest problem is the lack of consistent ballast, as the weights employed in this fashion change from cruise to cruise. The weights help in balance and thus prevent the camera from tripping. The camera takes a picture and flashes every time momentum is shifted on the trip wire. This causes expensive use of film and a guessing game essentially every time the camera is deployed in order to figure out how many exposures are consumed. It also drains the batteries. Other problems arise when the compass breaks, this has happened several times over the last couple of years and a spare compass needs to be on the ship. The camera and flash trigger were not rigged with a proper lead, resulting in bottom images that were out of focus.

Triple core

This is not a standard coring system but has proven itself effective in soft sediments. It provides a triplicate of the sediment water interface down to about a meter. The core works best when there is a maximum amount of weight added to it in order to allow the three core tubes to properly penetrate the sediment. We were reluctant to use it in this fashion during LMG04-04 because of the lack of replacement weights. It uses the standard kasten core head (and weights) as a support for the triples core tubes and plates. The largest problems are the ineffective core catchers, which are the standard stainless steel ones used for the jumbo piston core. There needs to be a variety of core catchers available such as soft plastic ones right on up to the more rigid stainless steel ones. This is especially easy to provide as there are standard manufacturers of core fingers, catchers that are inexpensive. There should be no excuse for not having a variety of them on board and ready to use. Standard maintenance of this system would include a sand blast and repaint every year, replacement of rubber flappers.

CTDT

We encountered no major problems using the shipboard CTD system because the Lamont Doherty Group trouble shot the unit prior to our use and the equipment is extremely well maintained. It gets heavy use by multiple investigators and so has a good maintenance schedule. However we would like to see a short path length (deep rated) transmissometer added to the instrumentation. We have used a SEATECH 10 cm path length unit for some time but that unit recently failed and SEATECH is no longer in business. Wet Labs makes a 10 cm path length but it is not rated for water depths greater than 600 m. Raytheon should be able to find a supplier or have a unit custom made. A 10 cm path length is crucial in working in fjords and bays because the longer path lengths are often maxed out by the suspended sediment in the water column. We have decades worth of data from a similar system and it would be nice to be able to continue collecting the same kind of information in the future.

Of course the timely return of post-cruise calibration standards would be nice, in the past we have had to go calling and begging for these numbers.

12 kHz Pinger

We needed the use of a pinger for the SCUD video sled and the CTD. While one was always available it might easily not have been the case had the two failed us, as they have in the past. Three operational pingers should be standard, not only to prevent down time if batteries are needed but also in case one is lost on a deployment.

Knudsen Chirp 3.5/12 kHz echo sounder

At best we found the Knudsen to be an adequate echo sounder for bottom records and it is true that it never failed to find us a bottom when we needed to. However detecting a sub-bottom was next to impossible with the lower frequency channel. To be honest we did detect weak reflections to depths in the sediment column of several tens of meters but these were difficult to resolve and provided no information on reflection character other than that the sediment was extremely soft. The post collection software is a cheap program that simply allows one to redisplay a collected record with no capability to fine tune, amplify, or otherwise highlight the key reflectors, even if there were any resolved.

Acquisition of BATHY2000W system for LM Gould

The BATHY2000W system on the NB Palmer is far superior in all of the above respects and we emphasize that a BATHY2000W be acquired for the *LM Gould* AND that the installation of the system be made from the transducers up. Replacement of existing transducers may be needed as there is currently no room in the sea chest for another array. In many respects the strength of the BATHY2000W system is that it is built around a very sound set of transducers as ODEC, if not anything else, is known for excellent stability in their transducers. At minimal compatibility of the existing transducers with the ODEC-BATHY2000W should be done while the ship is in dry dock so the sea-chest is accessible. Installation of only the deck unit (of the BATHY2000W) after the dry dock period, only to discover some problem in transducer compatibility (including power limitations) would be an expensive mistake.

Equipment Deployment Issues

Safety has always been a must for our group given the large number of student participants and it was refreshing to see the standardization of safety previews at each shift change. However these should more directly involve the chief scientist in the briefing of each deployment, especially for the first time. Much of this is my fault and I should have been more proactive in calling these meetings, and later in the cruise they did prove helpful. Had I understood some of the experience issues with the gear I would have certainly done so from the start.

For kasten cores the stern gates should be opened in calm seas because the core is so long with that the fitting and swivels often are pulled into the block as the core is raised causing some damage to the fitting each time and concern on the part of the winch operators who are very conscientious. Extra display screens are needed on the bridge so that the wire out is displayed and the stern camera can be seen.

The winch display screen is a real gem (designed by Andy Nunn) and is exactly the kind of information that we needed in the past, BUT a much larger display is needed in the Electronics Lab (or I have to get my cataracts fixed). Wipers are needed for the main window in the aft control/winch room. We had operations in pelting rain and the deck operations were difficult to see with the rain dripping down the panes. Window defroster would be a good idea as well.

The use of longer cores (such as the double barrel kasten and double barrel 4” PVC) would be and were difficult. We tried to deploy the later once and it failed to acquire any sediment having laid down flat on the bottom by drifting off-station. Recovery, if it had recovered 20 feet of mud, would have been difficult still. Given the seas we were encountering, we did not attempt another such core. The double barrel kasten core, because of its steel construction, would have posed fewer problems, but still been done with trepidation and sliding off the stern edge with the gates open. We did not use this system because the lab layouts would not accommodate such a long core except to have placed it upon the floor, an obviously unsatisfactory sampling procedure.

SAFTEY CONCERNS

Although there was one trained and certified cold water diver on board there was no dive equipment. Both should be standard for any cruise in remote ice covered seas where underwater inspection of hull damage, if it takes place, is crucial. This exact scenario took place on the *Polar Duke* in 1992 and Langdon Quetin’s group happened to be on board so the damage was easily assessed. Also if someone should become disabled in the water for some reason a dive may be the only way to reach them quickly and effectively. Hence one of the ECO, Raytheon or even Science staff should be cold water certified for each cruise. This would be easiest if Raytheon mandated a minimum number of its MPCs, MTs or MSTs take cold-water diving certification. Diving equipment should be on board, maintained and close at hand. Mandating an EMT on board does little good if the person in trouble can’t be reached.

Underwater Volcano

Information on Jun Jaegyu Volcano discovered on this cruise can be found at the following websites:
http://msnbc.msn.com/id/5023002/
http://www.nsf.gov/od/lpa/newsroom/pr.cfm?ni=98
http://www.hamilton.edu/news/exp/antarctica/2004/

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LMG04-04 G-096 Station Log

STATION	AREA	DATE & GMT TIME on BOTTOM	ACTIVITY	SAMPLE CODE	LATITUDE (°S)	LONGITUDE (°W)	WATER DEPTH (m)	CORE (SUB-CORE) LENGTH (cm)
1	Prince Gustav Channel	4/27/04 00:18	CTDT Sediment Sample	cast #1	64 14.909	58 43.172	753	-
SCUD #1	Prince Gustav Channel	4/27/04 19:02 (on bottom) to 20:20 (off bottom)	SCUD Camera	ballast line broke	64 15.887 (on bottom) to 64 14.779 (off bottom)	58 46.150 (on bottom) to 58 42.410 (off bottom)	594 (on bottom) to 688 (off bottom)	-
SCUD #2	Prince Gustav Channel	4/28/04 02:18 (on bottom) to 03:11 (off bottom)	SCUD Camera	camera failure	64 14.484 (on bottom) to 64 13.762 (off bottom)	58 41.461 (on bottom) to 58 39.089 (off bottom)	735 (on bottom) to 779 (off bottom)	-
2	Southern Prince Gustav Channel	4/28/04 06:08(CTDT) 08:05 (Camera)	CTDT Benthos camera	cast #2	64 13.490 64 13.512	64 37.262 58 37.300	717 775	-
3	Larsen Channel Trough	5/01/04 13:58 (Grab) 15:35 (KC)	Grab Kasten Core	G-3 KC-3	63 08.109 63 08.137	55 18.838 55 18.759	751 758	15 258
4	Larsen Channel Trough	5/01/04 21:24(MC) 23:25 (JGC)	Multi Core Jumbo Gravity Core	MC-4 (1 of 3 worked) unsuccessful	63 08.331 63 08.338	55 18.667 55 18.246	765 753	60
5	Larsen Channel Trough	5/02/04 02:49	Grab	G-5	63 08.219	55 24.719	687	14
6	Larsen Channel Trough	5/02/04 04:30 (Grab) 05:10 (Camera)	Grab Benthos camera	G-6	63 04.002 63 04.008	55 20.497 55 20.508	285 286	13
7	Larsen Channel Trough	5/02/04 07:11 (Grab)	Grab	G-7	63 05.747	55 28.447	614	16

		08:34 (Camera)	Benthos camera		63 05.664	55 28.462	663	
STATION	**AREA**	**DATE**	**ACTIVITY**	**SAMPLE CODE**	**LATITUDE (°S)**	**LONGITUDE (°W)**	**WATER DEPTH (m)**	**CORE (SUB-CORE) LENGTH (cm)**
8	Larsen Channel Trough	5/02/04 11:34 (Grab) 12:27 (Camera)	Grab Benthos camera	G-8	63 02.973 63 02.844	55 28.732 55 28.299	654 427	single rock
9	Larsen Channel Trough	5/02/04 14:11 (Grab) 15:00 (Camera)	Grab Benthos camera	G-9	63 04.973 63 05.004	55 34.460 55 34.438	623 615	16
10	Larsen Channel Trough	5/02/04 17:48 (Grab) 18:34 (Camera)	Grab Benthos camera	G-10	63 06.742 63 06.734	56 02.029 56 02.023	363 362	pebbles and cobbles
11	Larsen Channel Trough	5/03/04 01:34 (Grab) 02:20 (Camera) 03:04 (KC)	Grab Benthos camera Kasten Core	G-11 KC-11	63 12.773 63 12.762 63 12.785	56 25.275 56 25.289 56 25.325	528 528 528	4 33
SCUD #3	Larsen Channel Trough	5/03/04 05:57 (in water) to 07:45 (off bottom)	SCUD Camera	camera failure	63 12.197 (in water) to 63 10.579 (off bottom)	56 18.875 (in water) to 56 13.470 (off bottom)	476 (in water) to 285 (off bottom)	-
12	Larsen Channel Trough	5/03/04 10:32 (Grab) 11:36 (Camera)	Grab Benthos camera	G-12	63 05.999 63 05.874	55 54.429 55 54.707	430 540	8
13	Larsen Channel Trough	5/03/04 13:11 (Grab) 14:06 (Camera)	Grab Benthos camera	G-13	63 04.226 63 04.259	55 47.987 55 47.970	736 732	15
14	Larsen Channel Trough	5/03/04 15:40 (Grab) 15:58 (Camera)	Grab Benthos camera	G-14	63 02.029 63 02.206	55 40.459 55 40.465	75 75	8
15	Larsen Channel Trough	5/03/04 17:37 (Grab) 18:36 (Camera) 19:53 (CTDT)	Grab Benthos camera CTDT	G-15 cast #3	63 03.315 63 03.328 63 03.337	55 34.017 55 33.968 55 33.763	910 910 912	15

STATION	AREA	DATE	ACTIVITY	SAMPLE CODE	LATITUDE (°S)	LONGITUDE (°W)	WATER DEPTH (m)	CORE (SUB-CORE) LENGTH (cm)
16	Larsen Channel Trough	5/03/04 22:30 (Grab) 23:41 (Camera) 00:36 (KC)	Grab Benthos camera Kasten Core	G-16 KC-16	63 04.235 63 04.456 63 04.283	55 49.468 55 49.824 55 49.407	728 747 743	268
SCUD #4	Larsen Channel Trough	5/04/04 19:12 (in water) to 20:32 (out water)	SCUD Camera	water column imagery, could not hold station	63 12.286 (in water) to 63 12.188 (out water)	56 19.675 (in water) to 56 17.725 (out water)	504 (in water) to 427 (out water)	-
SCUD #5	Southern Antarctic Sound Volcano	5/05/04 00:59 (on bottom) to 01:34 (off bottom)	SCUD Camera	successful	63 30.081 (on bottom) to 63 29.394 (off bottom)	56 26.377 (on bottom) to 56 27.239 (off bottom)	304 (on bottom) to 604 (off bottom)	-
17	Unnamed Volcano Southern Antarctic Sound	5/05/04 03:32 to 4:02	Dredge	D-17	63 29.802 to 63 29.544	56 26.765 to 56 27.016	261 to 332	-

Lamont-Doherty Station Log

LAMONT STATION	AREA	DATE & GMT TIME on BOTTOM	ACTIVITY	SAMPLE CODE	LATITUDE (°S)	LONGITUDE (°W)	WATER DEPTH (m)
1	South Orkney Plateau	4/21/04 18:22	CTDT Sediment Sample	cast #1 no recovery	61 32.942	43 59.022	526
2	South Orkney Plateau	4/22/04 00:36	CTDT Sediment Sample	cast #2 no recovery	61 11.411	44 01.653	397
3	South Orkney Plateau	4/22/04 08:03	CTDT Sediment Sample	cast #3 no recovery	60 52.929	42 59.826	363
4	South Orkney Plateau	4/22/04 12:08	CTDT	cast #4	60 45.949	42 36.846	1648
5	South Orkney Plateau	4/22/04 18:24	CTDT Sediment Sample	cast #5 <1 gram sediment	60 37.690	42 03.570	3567
6	South Orkney Plateau	4/23/04 02:39	CTDT Sediment Sample	cast #6	60 37.375	41 54.902	3240
7	North of South Orkney Plateau	4/23/04 20:03	CTDT Sediment Sample	cast #7	60 11.969	44 14.602	5250