The ANTARCTIC MARINE GEOLOGY RESEARCH FACILITY

Core Repository

A Call for Expansion

Housing for Cores

In 1963, in recognition of the steady acquisition and accumulation of deep-sea cores and related bottom materials by U.S. Antarctic Program (USAP) research vessels, the National Science Foundation Office of Polar Programs (NSF/OPP) awarded a competitive grant of $230,600 ($1.8M in 2005 dollars) to Florida State University (FSU) to provide a suitable repository to house these collections. This grant resulted in the construction of the Antarctic Marine Geology Research Facility (AMGRF) as a 10,000 sq. ft. one-story annex to the Carraway Building on the central FSU campus in Tallahassee, Florida. Of the total space available, 6000 sq. ft. is devoted to refrigerated space for core storage, with the remaining space used for core processing, description, research, and administration. For more than forty years, the AMGRF has served and supported the USAP geoscience community, its international partners, and qualified investigators around the globe through curatorial activities associated with its refrigerated core repository. To date, over 200,000 samples have been dispensed to investigators throughout the global scientific community.

AMGRF holdings presently include more than 20,000 m of cored sediment and over 5000 kg of dredge, trawl, and grab samples—the largest such Southern Ocean collection in the world. These materials have been acquired from over 90 USAP research-vessel cruises. The AMGRF also curates nearly 3000 m of rotary cored material acquired by NSF-supported drilling programs such as the Dry Valley Drilling Project (DVDP), Cenozoic Investigation of the Ross Sea (CIROS), the Cape Roberts Project, and Shallow Drilling Along the Antarctic Continental Margin (SHALDRIL) 1 and 2 cruises. In 2007 and 2008, the AMGRF is due to receive all drill cores from the new Antarctic Drilling Program (ANDRILL).

The scientific value of these collections is enormous. Research studies on these collections have resulted in hundreds of publications. Many of these studies have had a significant impact on our understanding of Southern Ocean biostratigraphy, paleoceanography, sedimentology, and Antarctic geologic and climatic history (Anderson, 1999). Replacement cost of cores in terms of ship and ice-based drilling is conservatively estimated to be $150M to $200M. Operational funding for the AMGRF over the years

The AMGRF has played a vital supporting role in the acquisition, description, and long-term accessibility of cores from sea-going expeditions to the Antarctic, from *Eltanin* (1962–1975) cruises to more recent *Nathaniel B. Palmer* cruises. Despite its modest size, qualified users the world over visit the AMGRF to study samples from its extensive collections. Photos courtesy of (left) the National Science Foundation and (right) Tyler Smith.

The AMGRF has long been one of the cornerstones on which the U.S. Antarctic marine geology program has been built. The facility, which stores Antarctic cores and related bottom materials, is near capacity. The AMGRF will not be able to receive cores after the 2008 or 2009 Austral field seasons if expansion of the facility does not begin soon.

has exceeded $11M in grant-adjusted 2005 dollars. Research grants to investigators working on these collections since the late 1960s total in the tens of millions of dollars.

The vast holdings of the AMGRF, which include the entire decades-old *Eltanin* and *Islas Orcadas* piston-core collections, have provided critical data that inspired many follow-up or expanded investigations. Notable are the "ground-truth" data that led to major initiatives by the Deep Sea Drilling Project (DSDP), its successor, the Ocean Drilling Program (ODP), and other national and international groups. That new scientific initiatives have sometimes sprung from investigations of the oldest cores of the AMGRF collections demonstrates the need for a well-curated archive of cores from the remote reaches of the Southern Ocean regardless of when the cores were taken.

An efficient and effective AMGRF has supported the advancement of Antarctic science despite its limited space on a relatively small (450-acre) university campus. Space assessments based on present core input rates show that the AMGRF will soon reach its storage capacity and will not be able to accept additional materials after the 2008 or 2009 Austral field seasons. The inability to accept new core acquisitions within the next two to three years will have major negative consequences for future USAP operations.

AMGRF Support Functions

The AMGRF receives 500–1,000 m of new core each year. AMGRF staff routinely splits and labels the cores, processes them through a Multi-Sensor Core Logger for geotechnical properties, and produces a graphic-core log of each core. Sediment description volumes are published on the AMGRF's web site (http://www.arf.fsu.edu) and serve as the basis for many of the 5,000 core samples distributed each year. Some of these operations are completed aboard ship or in Antarctica itself if real-time data are required by participating scientists.

AMGRF staff maintain a web site that contains a robust core and sample database and a searchable bibliography of publications related to the cores. AMGRF staff also provide x-radiographs of cores upon request. The AMGRF serves as a satellite facility for the Integrated Ocean Drilling Program (IODP) Micropaleontological Reference Center. The AMGRF has over 30,000 calcareous nannofossil and diatom reference slides for use by visiting investigators, who are also provided access to the necessary microscope equipment.

The AMGRF provides analytical equipment to all users at no cost so that they have access to the necessary tools to rapidly and objectively analyze the piston and drill cores. Key AMGRF equipment includes a Geotek Multi-Sensor Core Logger, Rigaku Miniflex x-ray diffraction unit with search/match software, Norelco core x-ray unit, Quantachrome Multipychnometer, Zeiss Axioskop II light microscope, a high-quality digital photographic camera for core photography, and a computer network of high-end personal computers with the latest analytical software.

The AMGRF hosts a variety of meetings for Antarctic specialists, interested scientists, and students. In the past, the AMGRF has hosted workshops on Glacial Marine Sediments and Polar Diatoms, and planning meetings of the SHALDRIL Committee. ANDRILL plans to use the facility for its post-season core workshops to view and sample collected drill cores.

If shipboard scientists require real-time data on geotechnical properties, the Multi-Sensor Core Logger can be transported for use on board ship. Most recently, this instrument was used on the SHALDRIL I and 2 cruises. It will be used during drilling operations of the ANDRILL project in 2006 and 2007.

In addition to hosting visiting scientists, the AMGRF staff gives tours and lectures to over 1000 visitors per year, many of these K-12 students or FSU undergraduates carrying out laboratory exercises that use the collections. An expanded facility would include dedicated instructional and exhibit space to enable increased outreach activities.

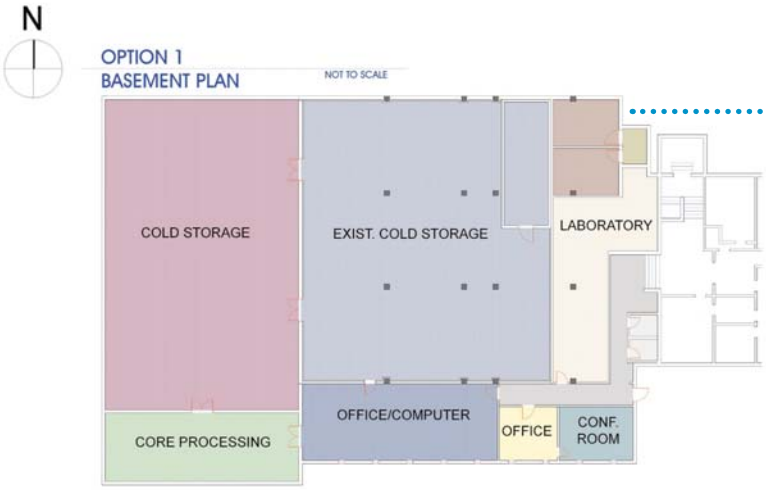
Community Response

The inability to accept new cores after the 2008 or 2009 Austral field season will have major consequences for future USAP operations. In response to this rapidly approaching crisis, an NSF-sponsored workshop on future repository needs of the USAP marine community was held on August 13, 2004 at the AMGRF. Thirty experts (see p. 10), representing a broad spectrum of marine geological disciplines within and outside the Antarctic user community, focused on three primary goals: (1) inspect the AMGRF, (2) assess its operations and current state of utilization, and then (3) address the long-term repository needs of USAP investigators and make recommendations to NSF.

Workshop attendees discussed at length the advantages and disadvantages of moving the legacy core collections from the AMGRF to another NSF-supported repository or dispersing the collections to a series of "mini-repositories." After deliberation, the clear consensus of the participants was to maintain one centralized facility. The participants concluded that new construction is necessary to address future storage problems and the AMGRF should be expanded at its present location on the central FSU campus. The complete workshop report is available at http://www.arf.fsu.edu/publications/amgrf.workshop.report.pdf.

FSU Administration's Response

The FSU Administration supports the recommendations of the August 2004 community workshop and has underwritten the in-depth architectural cost and feasibility study carried out by the architectural firm of Lewis and Whitlock (2005), which presents two expansion options.



Option 1

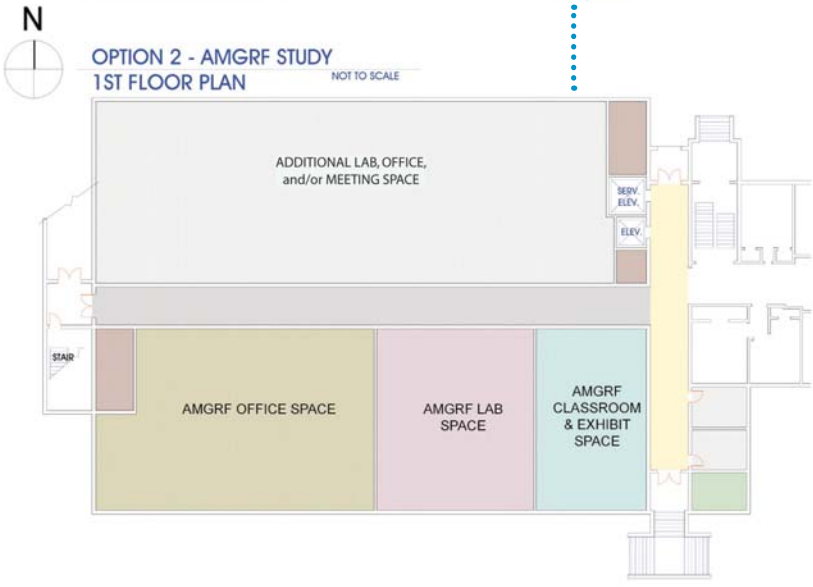
A one-story expansion at ground level of the existing repository would add 4,831 net sq. ft. of refrigerated storage plus 1,072 sq. ft. of space for core processing. This option would include a complete renovation of the existing 42-year old building plus add 55 ft. to the west on the same ground-floor level. This option would extend the useful life of the repository for 20 years.

Option 2

A two-story expansion would add:

a) 7,449 net sq. ft. of refrigerated storage space at ground level by extending the refrigerated areas (in phases) into space that would otherwise be designated for core processing, offices, and computer labs.

b) a second-story addition that would consist of 18,800 sq. ft., half of which would be used for AMGRF offices and labs displaced by an expansion of the refrigerated storage space on the basement level.



The second option is strongly preferred in that it would extend the useful life of the repository at least another 40 years at current core-acquisition rates. Such an expansion and the services to be provided are in keeping with many of the goals of the upcoming International Polar Year (IPY), which include the creation of a polar legacy for the next 50 years, improving data sharing and data management, training the next generation of scientists, advancing international cooperation, and renewing infrastructure and developing new infrastructure (National Research Council, 2004).

In keeping with the IPY goals, Option 2 would also provide the AMGRF with exhibit and instructional space for the more than 1,000 visitors that use its facilities each year. This space is considered vital if the AMGRF is to expand its education and outreach initiatives. Sufficient exhibit space, to include hands-on activities for secondary-school students modeled after some of those at the widely popular Antarctic Center, Christchurch, New Zealand (http://www.iceberg.co.nz/), would greatly increase the interest and visibility of the AMGRF. It will also provide adequate office space for visiting scientists engaged in short- and long-term studies of the AMGRF core collections.

Construction Considerations

Pre-Planning Schedule Projections

Option 1	
Design	4 Months
Construction	10 Months

Option 2	
Design	8 Months
Construction	12 Months

The Lewis and Whitlock architectural cost and feasibility study includes a construction schedule plus a variety of related investigations and analyses relative to the design and construction of the proposed new facility. This study addresses necessary improvements and innovations, such as a badly needed loading dock, a passenger/service elevator, restroom facilities (currently lacking), and standby electrical power for refrigeration equipment in the core and sample storage areas in case strong storms cut power for significant periods. Other recognized improvements include a high-capacity track and carriage core storage system to maximize cold storage space, complete replacement of air handling equipment and a variety of other systems (e.g., under-floor drainage; laboratory gas, air, and soft-water), fire alarm and detection, and telephone and networking.

Cost estimates have been projected out on a five-year schedule, depending on when ground is broken for the construction. For construction beginning in 2007, Option 1 will cost $4,714,424. Option 2 will cost $10,533,760.

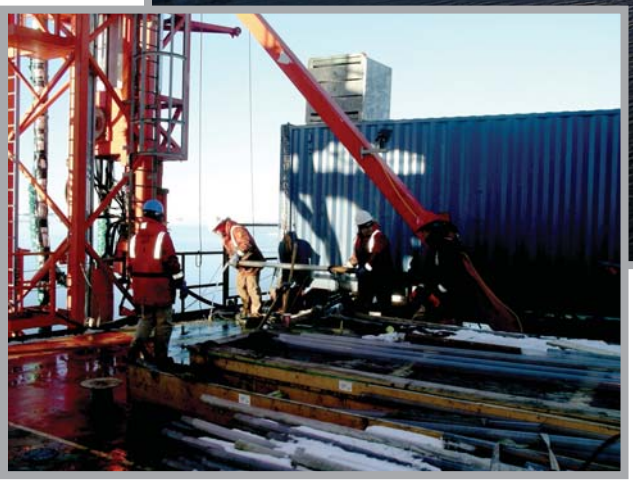
Broader Impacts

The AMGRF has long been a training ground for FSU graduate students and undergraduates. Over 40 of these students have helped acquire the cores in AMGRF collections, filling 75 berths on 58 Antarctic cruises. Many others have frozen their fingers working in the "cold room," carrying out the work of the repository. Beyond the immediate needs of the AMGRF, the training provided has served the broader science community well in that 34 graduate students and undergraduates, most associated directly with the AMGRF, have filled 43 science berths on 39 different DSDP, ODP, or IODP drilling cruises. Ten different AMGRF faculty/staff/research associates have sailed on 21 such drilling cruises. Two of these staff members served as co-chief scientists on three of these cruises (two of them to the Southern Ocean).

Significantly, these numbers are repeated in many other colleges and universities around the country whose students participate regularly in USAP scientific cruises and use the AMGRF core collection for doctoral and master's degrees on Antarctic marine geology. Current participants hail from both undergraduate and graduate institutions such as Colgate University, Middlebury College, Montclair State University, Hamilton College, the Universities of California at Santa Cruz and Santa Barbara, Rice University, Ohio State University, Louisiana State University, University of Nebraska, University of North Carolina, Northern Illinois University, and Southern Illinois University.

The AMGRF receives over 1,000 visitors each year, most of them K-12 students and undergraduates carrying out formal or informal study exercises. These activities will increase significantly if the proposed expansion is carried out, particularly with the addition of exhibit space for public outreach slated for Option 2.

The AMGRF serves as a training ground for students. The majority have been to sea on research vessels, while others have served in the AMGRF in a variety of support capacities. Students associated with the AMGRF have been awarded 5 B.S., 36 M.S., and 22 FSU doctoral degrees.



The AMGRF has served the scientific community for over forty years, providing curatorial and support services for more than 20,000 m of piston core. Drill cores from programs such as SHALDRIL (above) and ANDRILL are adding valuable materials to the collection, but are also placing significant demands on already limited refrigerated storage space. Photos courtesy of Joel Cubley (top) and Lenora Evans (lower left).

Conclusion

The AMGRF currently houses the largest collection of Southern Ocean piston cores in the world. Its collection of drill cores is growing rapidly with each new initiative, such as SHALDRIL and ANDRILL. These programs involve AMGRF staff and students in the field, and also place significant demands on the facility's refrigerated storage capacity—the critical problem that needs to be addressed in the near term. But more importantly, the 40-year legacy of collections, service, and support provided by the AMGRF should be continued for the benefit of future generations.

Related Programs and Initiatives

The AMGRF is a member of U.S. Core Curators of Marine and Lacustrine Geological Samples and has links to variety of other U.S. and SCAR Antarctic initiatives and projects. It is important to maintain close ties with such projects, and to seek means of mutual assistance and cooperation to achieve cost savings, avoid duplication, and where possible, to share equipment.

ANDRILL: Antarctic Drilling Program. ANDRILL, an outgrowth of the ice-based Cape Roberts Project, is a multinational initiative to investigate the Antarctic's role in Cenozoic to Recent global environmental change. http://andrill.org/home.html

SHALDRIL: Shallow Drilling Along the Antarctic Continental Margin. SHALDRIL placed a diamond-coring rig on the RV/IB *Nathaniel B. Palmer* for demonstration cruises during the Austral summers of 2005 and 2006. http://www.arf.fsu.edu/shaldril.cfm; www.shaldril.rice.edu

IMAGES: International Marine Past Global Changes Study. IMAGES is an initiative to understand the mechanisms and consequences of climatic changes using oceanic sedimentary records. http://www.images-pages.org

MARGINS: MARGINS seeks to understand the complex interplay of processes that govern continental margin formation and evolution. http://www.margins.wustl.edu

IODP: Integrated Ocean Drilling Program. IODP is an international partnership of scientists and research institutions organized to explore the evolution and structure of Earth using deep-ocean drilling, coring, and logging technology. IODP's predecessor, the Ocean Drilling Program (ODP), grew out of the Deep Sea Drilling Project (DSDP). http://www.iodp.org

PAGES: Past Global Changes. PAGES is the International Geosphere-Biosphere Programme (IGBP) core project charged with providing a quantitative understanding of Earth's past climate and environment. http://www.pages-igbp.org

STRATAFORM: Strata Formation on the Margins. STRATAFORM is a multiyear, integrated investigation of modern processes and seismic stratigraphy on the shelves and slopes of northern California and New Jersey.

WAIS: The West Antarctic Ice Sheet Initiative. WAIS is an initiative to investigate the influence of the West Antarctic Ice Sheet on climate and sea-level change. http://igloo.gsfc.nasa.gov/wais

SCAR: Scientific Committee on Antarctic Research. SCAR is an interdisciplinary committee of the International Council for Science (ICSU). SCAR is charged with initiating, developing, and coordinating high-quality scientific research in the Antarctic region and on the role of the Antarctic region in the Earth system. http://www.scar.org.

Current SCAR programs are:

ACE: Antarctic Climate Evolution. The successor to ANTOSTRAT, ACE's primary goal is to enhance knowledge and understanding of the history and behavior of Antarctic ice sheets and climate through the Cenozoic by facilitating analysis and synthesis of existing Antarctic geoscience and ice-core data, and promoting collection of new data for integration with ice-sheet and paleoclimate modeling studies. http://www.ace.scar.org

SALE: Subglacial Antarctic Lake Environments. SALE will extend from 2005–2013, and is a key element of the IPY scientific theme "exploring new frontiers." The scientific objectives of SALE are to (1) understand the formation and evolution of subglacial lake processes and environments; (2) determine the origins, evolution, and maintenance of life in subglacial lake environments; and (3) understand the limnology and paleoclimate history recorded in subglacial lake sediments. http://salepo.tamu.edu

Past SCAR programs include:

ANTEC: Antarctic Neotectonics. http://www.scar.org/about/history/pre2002/specialist/antec.html

GLOCHANT: Global Change and the Antarctic (http://www.scar.org/about/history/pre2002/specialist/glochant.html) includes the programs ANTIME (Antarctic Ice Margin Evolution) and PICE (Paleoenvironments from Ice Cores).

References and Reading

Anderson, J.B, P. Manley, S.W. Wise, J.S. Wellner, et al. 2005. SHALDRIL, *NBP* 05-02 Cruise Report, 189 pp. http://www.arf.fsu.edu/publications/shaldril2005.pdf.

Anderson, J.B. 1999. *Antarctic Marine Geology*, Cambridge University Press, 289 pp.

Antarctic Marine Geology Research Facility and Core Repository. http://www.arf.fsu.edu.

Barrett, P. 1999. Antarctic climate history over the last 100 million years. *Terra Antarctica Reports* 3:53–72.

Cassidy, D.W., F.A. Kaharoeddin, I. Zemmels, and M.B. Knapp. 1977. USNS ELTANIN: An inventory of core location data with core location maps and Cruise 55 core descriptions. *Sedimentology Research Laboratory Contribution No. 44*, 90 pp.

Lewis and Whitlock. 2005. *Expansion of the Antarctic Marine Geology Research Facility.* Lewis + Whitlock, P.A., Tallahassee, FL. 13 pp. http://www.arf.fsu.edu/publications/amgrf.expansion.report.pdf

National Research Council. 2004. *Planning for International Polar Year 2007-2008*: *Report of the Implementation Workshop.* 41 pp. http://www.nap.edu/catalog/11110.html.

Rack, F.R., S.W. Wise, and F.M. Weaver, eds. 2005. *Future Repository Needs for Marine Cores Retrieved by U.S. Antarctic Program (USAP) Vessels and Drilling Projects.* 38 pp. http://www.arf.fsu.edu/publications/amgrf.workshop.report.pdf.

10

Workshop Participants

Future Repository Needs for Marine Cores Retrieved by U.S. Antarctic Program (USAP) Vessels and Drilling Projects, an NSF-sponsored workshop held at Florida State University, August 14, 2004.

Dr. Frank Rack (Co-convenor), JOI, Inc., Washington, D.C.
Dr. Sherwood W. Wise, Jr. (Co-convenor), Florida State University
Dr. John B. Anderson, Rice University
Dr. Philip J. Bart, Louisiana State University
Dr. Louis R. Bartek, University of North Carolina
Mr. Steven M. Bohaty, University of Santa Cruz
Ms. Rusty Lotti Bond, Lamont-Doherty Earth Observatory
Dr. Stefanie A. Brachfeld, Montclair State University
Mr. Matthew Curren, Florida State University
Dr. Chris R. Fielding, University of Nebraska
Dr. John V. Firth, IODP Gulf Coast Repository
Dr. Phillip N. Froelich, Florida State University
Dr. Ann Grunow, Ohio State University
Dr. David M. Harwood, University of Nebraska
Dr. Scott E. Ishman, Southern Illinois University
Dr. Thomas R. Janecek, IODP Management, International
Dr. Kathy J. Licht, Indiana University
Dr. Patricia L. Manley, Middlebury College
Dr. Chris G. Maples, University of Nevada
Dr. Paul Morin, University of Minnesota
Dr. Maria Mutti, University of Potsdam
Dr. Simon H. Nielsen, University of Florida
Mr. Matthew S. Olney, Northern Illinois University
Mr. Aron Rao, University of Illinois, Chicago Circle
Dr. Reed P. Scherer, Northern Illinois University
Dr. Sophie Waney, Louisiana State University
Dr. David K. Watkins, University of Nebraska
Dr. Fred M. Weaver, Florida State University
Dr. Julia Smith Wellner, Rice University
Dr. Thomas P. Wagner, NSF Office of Polar Programs

For more information on the Antarctic Marine Geology Research Facility visit www.arf.fsu.edu.

Support for this brochure was provided through a grant from the National Science Foundation.
Any opinions, findings, conclusions, or recommendations expressed in this document are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Editing and design by Geosciences Professional Services, Inc.