MARGINS

Program Announcement

DIVISION OF OCEAN SCIENCES
DIVISION OF EARTH SCIENCES
OCEAN DRILLING PROGRAM

NATIONAL SCIENCE FOUNDATION

MARGINS: ANNOUNCEMENT OF OPPORTUNITY

The MARGINS research program has been formulated to understand the complex interplay of processes that govern continental margin evolution globally. Mechanical, chemical, biological and fluid processes act in concert to govern the initiation, evolution and eventual destruction of continental margins, as well as the accumulation of resources in these regions.

The MARGINS program was initiated by the scientific community and the National Science Foundation and has been designed to elevate our present largely descriptive and qualitative knowledge of the ocean margins to a level where theory, modeling and simulation, together with field observation and experiment, can yield a more systemic understanding of the processes that control margin genesis and evolution.

Although continental margins have been traditionally assigned to three distinct tectonic settings, i.e., convergent, divergent and translational, the approach used by the MARGINS program recognizes that a range of fundamental physical and chemical processes that form and deform the surface of the Earth operate at all margins. Tectonic setting may govern the specific expression of a particular process that may vary in different environments. However, a relatively small number of processes, i.e., lithospheric deformation, magmatism, other mass/energy fluxes, sedimentation, and fluid flow, are fundamental to the evolution of the margins. Study of these processes, wherever they are best expressed, provides a more logical line of inquiry for understanding the complex nature of continental margins.

This process-oriented approach to understanding the entire system of margin evolution requires broadly based interdisciplinary studies and a new class of major experiments. The MARGINS science plan, developed from a series of well-attended workshops over the past decade, advocates concentration on several study areas targeted for intensive, multidisciplinary programs of research in which interaction between field experimentalists, numerical modelers and laboratory analysts would be necessary. Thus, at least initially, the MARGINS program will concentrate on special-focus experiments - this list will be periodically supplemented as new experiments are identified and planned in detail to achieve the scientific objectives of the program. MARGINS will not replace individual investigator studies related to the broader MARGINS science objectives. For example, in FY 1998 NSF made the decision to fund 13 MARGINS and Margins-related projects that will cost approximately $ 5 million. It is expected that such funding level will be sustained pending availability of funds. MARGINS plans to foster the involvement of a broad cross-section of investigators in focused, multidisciplinary experiments, to achieve the objectives that could not be accomplished otherwise.

The National Science Foundation (NSF) will support the development of the MARGINS Program and invites proposals directed towards the program elements listed below in the special-focus section. NSF funding will be provided by the Divisions of Earth and Ocean Sciences. Proposals submitted to the MARGINS program should be prepared in accordance with the guidelines provided in the NSF publication *Grant Proposal Guide* (GPG), NSF-99-02. Single copies of the GPG are available at no cost from: NSF Publications Clearinghouse, P.O. Box 218, Jessup, MD 20794-0218, phone (301) 947-2722, or via the Internet: pubs@nsf.gov.

Proposals submitted to MARGINS Program should also include a statement addressing the relevancy of the proposed study to the overall goals of the MARGINS initiative and their relationship to identified special-focus experiments. Proposals will be reviewed in accordance with established Foundation procedures and the criteria described in the GPG. Competition for MARGINS funding will take place once a year and be evaluated by a joint Earth and Ocean Sciences panel. **The deadline for proposal submittal is January 15th**. Proposals can be submitted to any of the three programs named below, depending on their degree of relevance to marine or on-land work. In addition, proposals submitted for support from the Ocean Drilling Program should contain a section that addresses the potential of the proposed research to enhance the effectiveness or planning of proposed drilling activities. Questions regarding proposal preparation and target dates may be directed to the following program officers:

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Details of the MARGINS planning process and research focus can be found in three documents: 1) *The MARGINS Initiative - Report of Three Thematic Workshops (1991-1993)*; 2) *The MARGINS Initiative - Initial Science Plan, 1996*; and 3) the 3/17/98 *EOS* article (v.79, p.137-143). These documents can be obtained from the MARGINS Planning Office, SOEST, University of Hawaii, 2525 Correa Road, Honolulu, Hawaii 96822. These documents, MARGINS program plans, and news about workshops and meetings are also located on the Web at: http://www.soest.hawaii.edu/margins/.

SCIENTIFIC OBJECTIVES OF THE MARGINS PROGRAM

The MARGINS objectives were established in the context of three basic criteria: scientific merit; societal relevance; and feasibility. MARGINS investigations must be aimed toward a comprehensive understanding of the observable system properties, together with self-consistent theory (or models) that relate these properties to processes which govern the evolution of the system. MARGINS projects should also enhance an understanding of the key processes relevant to societal concerns. For example, understanding fluid flow is critical to effectively managing the world's energy and water resources. Sedimentary successions are permanent recorders of past history and climate change. Understanding active tectonics provides the basis for earthquake and volcanic hazard assessment. Finally, MARGINS objectives must be achievable with existing technological capabilities or reasonable increments beyond present capabilities, even though a new class of experiments will clearly be needed.

The following broad themes of research are included in the initial scientific objectives of the MARGINS Program:

1. The Low-Strength Paradox of Lithospheric Deformation

Very large fault structures accommodate a major component of strain at continental margins along subduction zone thrusts, major transforms, and normal detachments. Earthquakes on these faults are some of the most destructive. These structures, however, move at resolved shear stresses far smaller than those expected to cause failure, and we currently lack a viable theory to account for them. Although mechanisms may exist that allow a strong lithosphere to be deformed by weak forces through concentration of stresses into narrow regions, those mechanisms are not yet understood.

2. Strain Partitioning During Deformation

Strain measured at the surface by geological techniques may be significantly different from that inferred to be taking place in the lower crust and upper mantle from geophysical observations. One possible explanation is that the rheology of the lower crust is viscous and weak relative to mechanically strong layers above and below. Such a model would allow the upper and lower crust to behave essentially independently. Such models, however, remain largely conjectural and even a basic description of how the lower crust and upper mantle behave during deformation remains incomplete.

3. Magma Genesis and Recycling

Models of mantle flow, melt generation, and melt migration for margin settings have lagged behind those for mid-ocean ridges due to the more complex boundary conditions and uncertainties about the relative roles of subducted and upper mantle material. Tracing and balancing mass, volatiles, and energy across a convergent margin are promising paths to better understanding the mechanisms of thrusting and seismicity, the cycling of crustal materials through the subduction zone, and the magmatic fluxes that ultimately lead to continental crust formation. Very large volumes of magma

emplaced over short time intervals in mafic "Large Igneous Provinces" may be another primary mode of continental growth. We lack a theory, however, that can adequately explain the spatial and temporal aspects of melt generation and migration at margins.

4. Stratigraphic Preservation of Geological Events

Continental margins are the Earth's principle loci of sediment accumulation and contain one of the best-preserved records of global sea-level variations, climatic fluctuations, lithospheric deformation, ocean circulation, geochemical cycling, organic productivity and sediment supply. Margins, therefore, record the variations in the solid Earth-ocean-atmosphere system essential to evaluating today's global changes. Margin sedimentary prisms are also the crucibles and repositories of oil, gas and hard mineral deposits. The complex and dynamic interplay of processes responsible for the erosion, transport, accumulation, and preservation of margin sediments is poorly understood, thereby limiting our decoding of the encrypted records and our use of the available resources.

5. Fluid Fluxes

Large-scale fluid circulation is the most important chemical transport mechanism through margin sediments and igneous forearcs. Water/rock/organic matter interaction changes fluid composition. By altering rock porosity/ permeability and shear strength, this creates a feedback mechanism affecting fluid pathways and flow rates, fluid pressure and deformation. These fluid flow and diagenetic processes represent important contributions to the global geochemical inventory. Fluid fluxes to the mantle wedge may trigger continent-building volcanism at convergent margins and mantle volatiles may play an important role in large volume melting at some divergent margins. These mechanisms, their rates and their fluid pathways remain largely unknown. Computational advances, however, now allow integrated, predictive modeling of the fluid-rock complex that will need to be undertaken to glean a basic understanding of this closely coupled system.

SPECIAL-FOCUS EXPERIMENTS

MARGINS has identified special-focus experiments on the "seismogenic zone," "subduction factory," "rupturing continental lithosphere," and "sediment dynamics and strata formation." Workshops to define the first two experiments have been held in 1997 and 1998 and science plans for these have been formulated (see below and http://www.soest.hawaii.edu/ margins/). Workshops and science plans for the second two experiments will be forthcoming. Additional experiments may be added to this list as they are identified and planned in detail by the scientific community.

Seismogenic Zone Experiment (SEIZE)

Subduction zone megathrusts produce the largest and potentially most destructive earthquakes and tsunamis on Earth by shear along converging plate boundaries. Despite the societal and economic importance of great earthquakes, little is known about the seismogenic zone that produces them. A shallowly dipping subduction zone thrust provides a large fault surface, partly seismic and partly aseismic, that is accessible to study by a combination of selective drilling and extensive ongoing monitoring, using passive and active seismology. The zone lies in the forearc, and the processes that control the partitioning of strain, the flow of water and other volatiles, the formation and behavior of faults, and the onset of seismic slip are relatively accessible to geophysical imaging and direct sampling. This experiment represents an opportunity to address primary MARGINS objectives related to mechanics of seismic and aseismic faulting.

SEIZE objectives include: 1) to measure stress and strain across a seismogenic subduction margin; 2) to determine the physical and chemical nature and the fluxes of the fluids throughout the forearc; 3) to establish the relationships between earthquakes, fault geometry, and the mechanical state of fault materials; and 4) to determine the thermal structure and its influence on fluid-rock interactions and mechanical properties. In concert with field data acquisition, investigators will conduct laboratory experiments and formulate testable quantitative models of how the subduction earthquake cycle works, including the complex interactions among various chemical and mechanical processes.

Subduction Factory Experiment

At convergent margins, raw materials (sediments, oceanic crust and upper mantle) are fed into the "subduction factory" where many processes (including dewatering, metamorphism, melting) under changing physical and chemical conditions shape the final products (magma, volatiles, ore deposits, new continental crust, recycled materials) with some environmental consequences (hazardous seismicity, explosive volcanism, noxious and greenhouse gases). In practice, it has been difficult to investigate processes and estimate fluxes through the "factory" owing to poor constraints on the volumes of magmas, fluids, and volatiles produced. The approach here is to implement an interdisciplinary study of this problem at a margin having characteristics that optimize study of volatile cycling and crustal growth, and where geological and geophysical measurements will constrain ongoing processes in real time.

The Subduction Factory Experiment aims to answer the following questions:

1. What fraction of subducted volatiles (H_2O, CO_2) are returned to the oceans and atmosphere, stored in crustal rocks, and subducted to the deep mantle? Does subduction of carbonate lead to enhanced volcanic CO_2 fluxes to the atmosphere?

2. What is the rate and mechanism of continental growth at convergent margins? How do forcing functions such as convergence rate, volatile input and upper plate structure control magma production rates and composition?

3. How much continental material is recycled to the deep mantle? After processing through the subduction factory, are residual slab compositions suitable to serve as sources for mantle plumes?

Merit Review Process

The National Science Board recently approved new merit review criteria (NSB97-72) for proposals submitted in response to NSF program announcements. These criteria are:

1. What is the intellectual merit and quality of the proposed activity?

The following are suggested questions that the reviewer will consider in assessing how well the proposal meets this criterion. Each reviewer will address only those questions that he/she considers relevant to the proposal and for which he/she is qualified to make judgements.

How important is the proposed activity to advancing knowledge and understanding within its own field and across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of the prior work.) To what extent does the proposed activity suggest and explore creative and original concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

2. What are the broader impacts of the proposed activity?

The following are suggested questions that the reviewer will consider in assessing how well the proposal meets this criterion. Each reviewer will address only those questions that he/she considers relevant to the proposal and for which he/she is qualified to make judgements.

How well does the activity advance discovery and understanding while promoting teaching, training and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of proposed activity to society?

A summary rating and accompanying narrative will be completed and signed by each reviewer. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers, are mailed to the principal investigator/project director by the Program Director. In addition, the proposer will receive an explanation of the decision to award or decline funding.

Awards made as a results of this announcement are administered in accordance with the terms and conditions of NSF GC-1, “Grant General Conditions”, or FDP-III, “Federal Demonstration Partnership General Conditions” (NSF CA-1). Copies of these documents are available at no cost from NSF Publications Clearinghouse.

Integration of Research and Education:

One of the principal strategies in support of NSF's goals is to foster integration of research and education through the programs, projects and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learner perspectives. PIs [You] should address this issue in their [your] proposal to provide reviewers with the information necessary to respond fully to both NSF merit review criteria. NSF staff will give it careful consideration in making funding decisions.

Integrating Diversity into NSF Programs, Projects, and Activities:

Broadening opportunities and enabling the participation of all citizens -- women and men, underrepresented minorities, and persons with disabilities -- is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports. PIs [You] should address this issue in their [your] proposal to provide reviewers with the information necessary to respond fully to both NSF merit review criteria. NSF staff will give it careful consideration in making funding decisions.

The National Science Foundation (NSF) funds research and education in most fields of science and engineering. Grantees are wholly responsible for conducting their project activities and preparing the results for publication. Thus, the Foundation does not assume responsibility for such findings or their interpretation.
NSF welcomes proposals from all qualified scientists, engineers and educators. The Foundation strongly encourages women, minorities, and persons with disabilities to compete fully in its programs. In accordance with federal statutes, regulations, and NSF policies, no person on grounds of race, color, age, sex, national origin, or disability shall be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving financial assistance from NSF (unless otherwise specified in the eligibility requirements for a particular program).

Facilitation Awards for Scientists and Engineers with Disabilities (FASED) provide funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on NSF-supported projects. See the program announcement or contact the program coordinator at (703) 306-1636.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation regarding NSF programs, employment, or general information. TDD may be accessed at (703) 306-0090 or through FIRS on 1-800-877-8339.

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS
The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the review process; to applicant institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies needing information as part of the review process or in order to coordinate programs; and to another Federal agency, court or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records," 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records," 63 Federal Register 268 (January 5, 1998). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding this burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to: Reports Clearance Officer; Information Dissemination Branch, DAS; National Science Foundation; Arlington, VA 22230.

YEAR 2000 REMINDER
In accordance with Important Notice No. 120 dated June 27, 1997, Subject: Year 2000 Computer Problem, NSF awardees are reminded of their responsibility to take appropriate actions to ensure that the NSF activity being supported is not adversely affected by the Year 2000 problem. Potentially affected items include: computer systems, databases, and equipment. The National Science Foundation should be notified if an awardee concludes that the Year 2000 will have a significant impact on its ability to carry out an NSF funded activity. Information concerning Year 2000 activities can be found on the NSF web site at http://www.nsf.gov/oirm/y2k/start.htm.

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