GEOSCIENCE EDUCATION

Program Announcement

DIRECTORATE FOR GEOSCIENCES

PROPOSAL SUBMISSION DEADLINE*: March 9, 1999*

NATIONAL SCIENCE FOUNDATION

ANNOUNCEMENT OF OPPORTUNITY

Geoscience Education

OVERVIEW

In 1998, NSF's Directorate for Geosciences (GEO) conducted a special competition titled "Awards to Facilitate Geoscience Education" (AFGE). Proposals for research in geoscience education at all levels were invited through a program announcement (NSF 97-174).

In FY 99, through the present program announcement, that competition will be repeated as one of two elements of a larger grants program. The second element is a special emphasis area titled "Application of Digital Libraries to Undergraduate Earth Systems Education;" review will be conducted jointly by GEO and the Division of Undergraduate Education (DUE) of the Directorate for Education and Human Resources (EHR).

This special emphasis represents an intersection of interests of the two NSF directorates, and will form an integral part of the overall FY 99 competition. Both directorates seek to facilitate the involvement of leading researchers in efforts to improve the quality of geoscience education, thereby facilitating the effective integration of research and education.

ELEMENTS OF THE COMPETITION

The two elements of the FY 99 program are described in this section.

Element 1: Awards to Facilitate Geoscience Education (AFGE)

An overview of the FY 98 AFGE competition and abstracts of the successful awards are available via http://www.geo.nsf.gov. The comprehensive scope of AFGE and the emphasis on the integration of research and education follow the recommendations of the report of the Geoscience Education Working Group titled *"Geoscience Education: A Recommended Strategy"* (NSF 97-171). The report is also available at www.geo.nsf.gov or in hard copy by request to mmayhew@nsf.gov. Proposers are encouraged to consult the report, which the AFGE competition follows closely in scope and philosophy.

Proposals may target any educational level: 1) graduate and postdoctoral education and training (outside the framework of normal NSF research grants), 2) undergraduate education, 3) elementary and secondary education, and 4) education outside the classroom.

Awards made under this element are intended to facilitate the initiation or piloting of **highly innovative** educational activities that involve leading geoscience researchers where support may not otherwise be available. In appropriate cases, awards could be made by supplementing active research grants. Examples drawn from the Geoscience Education Working Group report of possible activities that might be supported are:

- initiation of novel approaches to creating geoscience curricula, especially those involving new technologies,
- bringing cutting-edge research to the classroom or to the public,
- partnerships to implement the National Science Education Standards,
- technologies to reach small and community colleges more effectively,
- development of Web-based pedagogy,
- opportunities for teachers to work with scientists,
- workshops for training of geoscientists in educational issues,
- planning grants for interdisciplinary research on geoscience education,
- workshops to organize precollege data collection programs,
- partnering for initiation of museum exhibits,
- support for outreach activities of professional societies,
- distinguished geoscience education lecture series,
- initiation of state-based alliances of geoscience researchers, educators, and practitioners, and
- innovative use of university consortia networks for sharing of resources.

A major motivation of the present competition is to foster collaborations that integrate research and education. Projects that involve active linkages which serve this purpose, either currently in place or to be developed, are particularly encouraged. Experience has shown that major facilities such as ships, aircraft, museums or aquariums, analytical or computational facilities, national centers, and repositories of samples or data can be particularly successful as focal points for linking research and education; such use of these facilities is encouraged (though not a precondition for participation in the competition).

Achieving full and effective integration of geoscience research and geoscience education requires that project teams have a combination of expertise in each of these

areas. Projects are expected to be focused as well as to have potentially broad impact that may lead to innovative intellectual developments or that involve innovative partnerships. Funding provided through these awards should be catalytic; long-term funding will not be provided. Instead, these awards will provide start-up funding to enable projects to reach a level of maturity so that they can compete successfully for long-term funding from other sources. These awards are intended to complement but not replicate activities supported by NSF's Directorate for Education and Human Resources.

Institutional commitment to a proposed project is important, and evidence of such commitment will be a factor in review.

Element 2: Application of Digital Libraries to Undergraduate Earth Systems Education

This element represents the intersection of two priority initiatives: 1) development of innovative Earth system science curricula at the undergraduate level and 2) development of digital libraries as a national resource in support of science, mathematics, engineering, and technology (SMET) education.

The foundation for support of a new emphasis on Earth system science education is a document resulting from a DUE-sponsored workshop, "Shaping the Future of Undergraduate Earth Science Education: Innovation and Change Using an Earth System Approach." Earth system science recognizes that the Earth is a complex system, and that to understand how the Earth works it is necessary to investigate the complex interactions of the components of the system. This means interactions among the atmosphere, hydrosphere, biosphere, solid Earth, cryosphere, and the solar-terrestrial environment, but also means the interaction of human activities with these components.

Applied to the quest for improving science education, the Earth system framework provides a rich context for inquiry-based learning, development of skills in applying modern communications technologies to analysis of large, real-world data sets, and nurturing of the critical thinking that underlies scientific investigations. The goal is a better-informed and scientifically more literate citizenry, able to critically analyze the multitude of problems facing society that are rooted in the natural world. As noted in the "Shaping" document, "[a]n integrated Earth system science approach, incorporating all disciplines in the Earth and space sciences, provides the knowledge base, methodologies, and global context that can make science accessible, relevant, and meaningful for all students."

The concept of a national digital library and associated networks is articulated in the document "Developing a Digital National Library for Undergraduate Science, Mathematics, Engineering, and Technology Education," National Academy Press, 1998. Proposers should also consult the digital libraries section of the DUE Web page (www.ehr.nsf.gov/EHR/DUE/start.htm). This Web-based library would be based on a distributed and open architecture, and will add value to the Web by increasing interoperability, reliability, and stability; by adding rich mechanisms to help users find appropriate and high-quality resources based on content, metadata, citations, and reviews; and by facilitating multidisciplinary perspectives and cooperation.

The Earth sciences are a particularly fertile area in which to develop a digital library. They are characterized by rich data and tools and by multidisciplinary work and leadership in exploiting new technologies. An educational element is envisioned which would support and promote high-quality undergraduate education in the geosciences, in particular innovative Earth systems curricula, associated archive data sets, and tools for handling real-time data. Geoscience data typically comes from a wide variety of sensors, and interoperability for multiple data sets is a desirable characteristic of digital library systems.

This element of the library is expected to further the goal of greater integration of research and education by enabling students at all levels to have experience using research quality data and tools. It could provide a number of resources, including:

- collections or registries of research quality data and tools for its analysis,
- collections or registries of course and curriculum materials,
- mechanisms for faculty to find, combine, and adapt resources from a variety of sources,
- mechanisms for assessing the effectiveness of materials and practices, and
- mechanisms for disseminating best materials and practices.

Individual focused proposals are invited that address at least two of the elements above. It will be important for proposed work to go beyond simply collecting and cataloging information. In addition, larger-scale collaborative proposals are invited that establish a framework and begin a process of integrating diverse separate efforts in Earth system education into a coherent and accessible whole. These efforts would involve a central coodinating entity and make use of appropriate existing networks. Successful projects would be expected to:

- establish a management plan that provides stability and reliability for their collections,
- follow accepted standards for interoperability, and
- provide mechanisms that encourage reuse of data, tools, and materials.

NSF will assist in facilitating coordination among the funded projects so that collectively these projects will provide a comprehensive digital library for the improvement of undergraduate Earth science education.

PROPOSAL SUBMISSION AND EVALUATION

Investigators seeking support through this special competition are *strongly encouraged* to outline their plans and contact one of the following individuals well in advance of their submission of a formal proposal:

For Element 1:
Dr. Michael A. Mayhew
Directorate for Geosciences
mmayhew@nsf.gov, 703-306-1557

For Element 2:
Dr. Frank Wattenberg
Division of Undergraduate Education
Directorate for Education and Human Resources
fwattenb@nsf.gov, 703-306-1667 x5912

The primary purpose for this preliminary contact is to enable investigators to learn whether their proposed activities are appropriate for consideration in this competition or in any other NSF competition.

The competition will be based on the evaluation of formal proposals submitted to NSF by institutions on behalf of investigators. Proposals should be prepared in accordance with requirements specified in the NSF Grant ProposaI Guide (NSF 99-2). Be sure to adhere to page limitations specified in that document. Note that no appendices are permitted. The cover sheet for the proposal should bear the original signature of the principal investigator, any co-principal investigators, and an authorized organizational representative. Please refer to "Geoscience Education" in the top left box of the proposal cover sheet and to the number of this announcement (NSF 99-44) in the second box.

Proposers are encouraged to submit their proposals electronically via FastLane; further information is given below. Alternatively, an original plus twenty (20) paper copies of the full proposal may be submitted.

Proposals must be received at NSF no later than Tuesday, March 9, 1999.

The evaluation of proposals will be based on the written reviews and verbal comments by members of a specially convened panel, although written reviews from external experts may also be solicited. Proposals will be evaluated using the Merit Review Criteria, as specified in the section below.

Electronic Submission

Proposals may be submitted electronically using the NSF FastLane system for electronic proposal submission and review, available through the World Wide Web at the FastLane home page (http://www.fastlane.nsf.gov). Instructions for electronic submission can be found by accessing the FastLane home page. The Sponsored Research Office (SRO) or equivalent must provide a FastLane Personal Identification Number (PIN) to each Principal Investigator to gain access to the FastLane "Proposal Preparation" application. PIs who have not submitted a proposal to NSF in the past must contact their SRO to be added to the NSF PI database. General information about NSF's policies and procedures on proposals, declinations, and awards is contained in Grant Proposal Guide (NSF 99-2) and can be located on the NSF homepage (http://www.nsf.gov).

In order to use NSF FastLane to prepare and submit a proposal, you must have the following software: Netscape Navigator 3.0 or above or Microsoft Internet Explorer 4.01 or above; Adobe Acrobat Reader 3.0 or above for viewing PDF files; and Adobe Acrobat 3.X or Aladdin Ghostscript 5.10 or above for converting files to PDF.

In order to use the FastLane "proposal preparation" application, your institution needs to be a registered FastLane institution. A list of registered institutions and the FastLane registration form are located on the FastLane Home Page.

For questions or problems concerning submission of a proposal via FastLane, please contact fastlane@nsf.gov.

REVIEW CRITERIA

Proposals will be reviewed in accordance with two sets of criteria: 1) the NSF Merit Review Criteria and 2) criteria specific to this announcement, as stated above in the description of the two program elements.

The NSF Merit Review Criteria are:

1. What is the intellectual merit of the proposed activity?
The following are suggested questions to consider in assessing how well the proposal meets this criterion: 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, please comment on the quality of 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 to consider in assessing how well the proposal meets this criterion: 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, disability, 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 the proposed activity to society?

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. Principal Investigators should address this issue in their 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. Principal Investigators should address this issue in their 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.

AWARD ADMINISTRATION AND CONDITIONS

Contingent on the availability of funds and on the quality of proposals received, it is anticipated that in FY 99 approximately $1M in each of the two elements of this announcement will be available ($2M total). A range of award sizes is anticipated. It is anticipated that at least 25 awards will result from this competition, although the actual number will vary. Most projects funded via this competition will be for a duration of 12 to 18 months, although longer-term funding will be considered if the justification is compelling.

Grants awarded as a result of this announcement will be administered in accordance with the terms and conditions of NSF-GC-1 (10/98) or FDP III (7/97), *Grant General Conditions.* Copies of these documents are available on the NSF Web site (access this site at http://www.nsf.gov, select "Grants and Awards," then select "Online Document System") or from the NSF Forms and Publications Unit (by e-mail at pubs@nsf.gov, or by phone at 301/947-2722). More comprehensive information is contained in the *NSF Grant Policy Manual* (NSF 95 -26), for sale through the Superintendent of Documents, Government Printing Office, Washington, DC 20402, available online at the above address.

OTHER POSSIBLE SOURCES OF SUPPORT FOR GEOSCIENCE EDUCATION ACTIVITIES

The geoscience community is encouraged to explore other sources of support within NSF, such as the following:

Research Experiences for Undergraduates (REU)

The long-standing NSF-wide Research Experiences for Undergraduates (REU) Program has been an effective vehicle for the integration of research and education by supporting the substantive involvement of undergraduate students in research projects. As part of its effort to enhance the quality of geoscience education, GEO intends to increase its support for REU Sites projects, which provide opportunities for small groups of undergraduate students to work on specially formulated research projects. In providing this additional REU Site funding, GEO is especially interested in supporting innovative multidisciplinary projects, increasing the involvement of K-12 teachers, exploring innovative educational approaches, and significantly increasing the participation of minority students in the geosciences. GEO also is interested in supporting the innovative involvement of undergraduates as members of research teams through the use of REU supplements to existing awards.

REU proposals directed to GEO will continue to be reviewed in the GEO divisions as in the past. *Proposal submission should follow the REU guidelines, as outlined in the REU program announcement (NSF 96-102).* More information about the REU Program is available from the NSF Web site (http://www.nsf.gov/home/crssprgm/reu/start.htm).

Related Opportunities for Support from NSF's Directorate for Education and Human Resources (EHR)

Division of Undergraduate Education (DUE). This Division supports curriculum and faculty development at the undergraduate level through the following programs:

- Advanced Technological Education,
- Course, Curriculum, and Laboratory Improvement, and
- NSF Collaboratives for Excellence in Teacher Preparation.

These programs are described in the DUE program announcement and guidelines (NSF 98-45) and at the DUE Web site (http://www.ehr.nsf gov/EHR/DUE/start.htm). [Note: NSF 98-45 is being revised. Applicants should make sure that they have the most current DUE program announcement at the time of proposal preparation.]

DUE, GEO, the Keck Geology Consortium, and the American Geophysical Union (AGU) co-sponsored a workshop on the future of geoscience education titled "Shaping the Future of Undergraduate Education: Innovation and Change Using an Earth System Approach." A printed copy of the workshop report is available from Frank Watt Ireton at the AGU (fireton@kosmos.agu.org). The report also can be accessed from the AGU Web site (http://www.agu.org/sci_soc/spheres).

Division of Elementary, Secondary, and Informal Education (ESIE). This Division offers the following programs to promote student and teacher development at the K-12 level and public science literacy through activities outside the classroom:

- Informal Science Education,
- Instructional Materials Development,
- Teacher Enhancement, and
- Advanced Technological Education.

These programs are described in the ESIE program announcement and guidelines (NSF 98-4) and at the ESIE Web site (http://www.ehr.nsf.gov/EHR/ESIE/index.html). [Note: NSF 98-4 is being revised. Applicants should make sure that they have the most current ESIE program announcement at the time of proposal preparation.]

The Informal Science Education Program recently established a program to competitively provide supplements of up to $50,000 to active NSF research grants "to assist in the broader dissemination of current research results and to promote science literacy for the general public in an out-of-school setting." The announcement of opportunity describing this activity is “Informal Science Education: Supplements to Active Research Awards” (NSF 97-70). Information is also available from the ESIE Web site.

Division of Research, Evaluation, and Communication (REC). The REC program titled Research on Education, Policy, and Practice (REPP) ties together several predecessor programs. The scope of the REPP program is broad and fundamental in nature: to bring new intellectual and technological resources to bear on the problems of educational reform at all levels. REPP seeks to support high-quality, high-risk/high-payoff, long-term opportunities. The REPP program announcement is NSF 96-138. Information is also available from the REC Web site (http://www.ehr.nsf.gov/ehr/rec/repp.htm).

Division of Graduate Education (DGE). The objective of the DGE program titled NSF Postdoctoral Fellowships in Science, Mathematics, Engineering, and Technology Education (PFSMETE) is to provide opportunities for outstanding Ph.D. recipients to develop expertise in some area of science education research in order to qualify them for academic positions which emphasize the full integration of research and education. The program announcement is available from the DGE Web site (http://www.ehr.nsfgov/EHR/DGE/pfsel.htm).

Some Related NSF-Wide Programs

Integrative Graduate Education and Research Training Program (IGERT). This program replaces the Graduate Research Traineeship (GRT) and Research Training Group (RTG) Programs. It supports innovative multidisciplinary graduate programs which integrate education and research, and which provide graduate students with access to stateof-the-art instrumentation and experience in both the academic and non-academic research settings. Its objective is to enhance the broad competency and flexibility of doctoral professionals as part of an increasingly dynamic workforce. The program announcement is NSF 98-96; information is also available at http://www.nsf.gov/home/crssprgm/igert/start.htm

Faculty Early-Career Development Program (CAREER). This program supports new faculty in launching a career which balances educational and research pursuits and seeks to fully integrate the two. The program announcement is NSF 98-103; additional information is available from the NSF Web site (http://www.nsf.gov/home/crssprgm/career/start.htm).

NATIONAL SCIENCE FOUNDATION

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: Suzanne Plimpton, Reports Clearance Officer; Division of Administrative Services; 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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