8. Education & Outreach for the PRISMS Program

8.1. Focus and Goals of the PRISMS Education and Outreach Program

MARGINS research over the last decade, and the enhanced PRISMS Program, create a number of opportunities for enhancing geoscience education and public understanding of the Earth and nature of geoscience. Key assets are a thriving interdisciplinary research community, science that integrates theoretical, experimental, and observational approaches, and amphibious study of key solid Earth processes. Based on recent experience, this can be accomplished most effectively through

- A set of programs that engage and support students in the PRISMS community. These programs should not only contribute to the successful professional growth of the students but also enhance the diversity of the PRISMS community.
- Activities that provide leveraged opportunities for enhancing the broader impact of individual projects. In particular, establishment of a new PRISMS wide REU program and continuation of the mini-lesson program.
- Partnerships with existing programs to extend the reach of PRISMS science into informal, K-12 and undergraduate education.
- Continuation of the Distinguished Lecturer program as a mechanism for disseminating PRISMS science throughout the geoscience community.

Accomplishing these goals will require a full-time staff member dedicated to educational activities. This person should work within the central office to manage the core Education and Outreach activities, support the PI community in leveraging the efforts of their education and outreach efforts and facilitating partnerships with geoscience education and outreach activities more broadly. This staff member will work with those writing proposals to create a product with the best possible broader impacts. This will be a new and invaluable resource for the research community.

8.2. Focus on Undergraduates - REU and Other Programs for Undergraduates

The PRISMS Program should sustain and grow the present undergraduate-centered efforts, with goals of entraining students and faculty in geoscience departments not currently engaged in MARGINS or PRISMS research and increasing the diversity of the PRISMS community. These activities will provide opportunities to experience PRISMS interdisciplinary science and create a natural pipeline into graduate education.

We recommend that the flagship program for undergraduate education be an REU program introducing students to PRISMS strengths in interdisciplinary research. The REU program will be based on the successful IRIS model of distributed hosts with important modifications for the unique aspects of the PRISMS community. Key features will be:

- At least 2-3 distributed sites will host individual or groups of students.
• Freshmen, sophomores and juniors will be eligible to participate allowing students to
learn about geoscience in time to major in geoscience. Special attention will be paid to
recruiting students from institutions that have not been involved in PRISMS research,
including those from 2-year, 4-year, and minority serving institutions, and to recruiting a
diverse pool of student participants.

• The students will have an advisor at their home institutions who will be actively involved
in the research. This will provide a pathway for new faculty to enter the research
program, expand awareness of PRISMS, and provide needed staffing for the REU sites. It
may be valuable to engage graduate students in advising and mentoring the students as
well. Funding for graduate students might motivate researcher participation.

• Cohort building of the entire REU group across the sites will be emphasized through a
week of introductory activities at a central site, which may include the novel use of ship-
based or field camp-based experiences.

• Support from a central office or designated affiliate will coordinate activities. One
possible model would be to link the initial PRISMS REU to the IRIS site REU or similar
programs.

• The PRISMS office will track the REU students after their summer program so that that
community can be encouraged to participate in the bridge programs (see Section 8.2.3).

8.3. Build Student / Post-doc / Early Career Community

MARGINS and PRISMS research involves an interdisciplinary team-based approach to studying
systems using multiple methods, with notable success in fostering this approach in graduate
students who then continue on to become PRISMS PIs. These efforts could be enhanced by
further development of two programs, the Postdoctoral Program and a new Graduate Student
Forum.

8.3.1 Student Forum and Pre-Meeting Symposium

Current graduate student community building events supported by the MARGINS program
include a student forum and student prizes at the fall AGU meeting. Since 2003, 39 students have
been honored as winners or honorable mentions. The awards are viewed as honors that are highly
valuable on students' CVs. This program should continue. More undergraduate students should
be encouraged to apply.

To further provide students with opportunities for interaction, the PRISMS program could
develop a structured 1-day student symposium, typically occurring before a larger PRISMS
meeting or workshop. As one model, this symposium could include oral and poster presentations,
organized by senior graduate students or mentors. The experience will provide leadership
opportunities for senior students and first-exposure opportunities for more junior students, which
will help in developing both groups as independent scientists and effective communicators. The
meetings could include career development opportunities, such as talks on proposal writing or
postdoctoral opportunities (especially the postdoctoral program) as well as group discussions
about how to succeed as a graduate student. Post-doctoral fellows could be an important source
of speakers and information for this activity. Online social networking (e.g., Facebook, twitter) could be promoted as an additional low-to-no-cost avenue for student communication and enhanced program awareness.

8.3.2. Postdoctoral Program

The MARGINS postdoctoral program has been highly successful in providing a pathway between graduate school and academic positions. To the awardees, the named postdoctoral fellowship is viewed as a prestigious honor, and is recognition of early independence, established capability, and high scientific potential. Although participants have done exceedingly well, there has been a small applicant pool which should be expanded. Participation might be increased by communicating more thoroughly with the graduate student population (see Section 8.3.1). Special attention should be paid to maximizing the diversity of the applicant pool. Also, the NSF solicitation process could be modified to increase its competitiveness in two ways:

- Increasing application deadlines to twice per year (autumn and spring), with expedited review and decision process, thus removing direct competition between regular PRISMS PIs and the postdoctoral applicants.
- Potential postdocs, after identifying a prospective advisor, will write and submit the fellowship application directly to NSF. A fellowship issued directly to the student (postdoc to-be) will greatly enhance a CV. The newly developed NSF-EAR postdoc program may serve as a good structure.

The PRISMS postdocs could be integrated more specifically in supporting PRISMS students. For example, they could be required to participate in the symposium. PRISMS could also provide more support for their professional development, for example, capitalizing on the On the Cutting Edge workshop for post-docs and graduate students. In addition to benefiting the post-docs this could build broader awareness of the PRISMS program. These mentoring efforts would directly complement the mentoring requirements now put in place by NSF.

8.4. Develop Educational Resources and Foster Faculty Involvement: Mini-Lessons

Over the last 5 years of the MARGINS program, efforts to integrate discoveries from MARGINS science with teaching fundamental concepts in geoscience have been propelled by development of web-accessible classroom and teaching laboratory activities and visualizations called 'mini-lessons'. [http://serc.carleton.edu/margins/index.html] Mini-lessons capitalize on cyberinfrastructure resources to integrate MARGINS data and research findings into broadly accessible educational materials. The engagement of undergraduate educators has ensured that the materials developed were well-suited to their audience, and participation by MARGINS PIs ensured cutting-edge content.

This program model capitalizes on the natural tendency of faculty to incorporate their research in their teaching, and is particularly well suited to supporting individual MARGINS projects in moving their research results into undergraduate teaching. In addition, mini-lessons can form the foundation for independently funded projects addressing specific educational needs (e.g. adaption for middle school Earth Science). Both of these approaches have already been adopted.
Two synthesis project proposals in the 2009 competition included creation of mini-lessons as mechanisms to broaden the impact of the projects. A grant has been awarded to IRIS to develop a set of mini-lessons to teach seismologic concepts.

Several approaches could enhance the effectiveness of mini-lessons:

- Mini-lessons should address curriculum needs as defined by educators.
- Team approaches to the development of mini-lessons, or curricula comprising mini-lessons, could be fostered to engage career and 2-year college faculty.
- Gaps in the existing mini-lesson collection should be identified and filled.
- Some mini-lessons should be designed for easy adoption into lower division, gateway courses. Such courses are often taught by faculty outside of their expertise, therefore, these mini-lessons must be self-contained educational resources.
- Interested graduate students could be engaged with faculty in developing mini-lessons enhancing their preparation for faculty appointments that involve teaching.
- Continue formalizing the assessment of materials across the undergraduate curriculum for content accuracy and pedagogical effectiveness.
- Improve dissemination of mini-lessons through professional organizations, meetings, workshops, professional journals, and education and outreach resources.
- Construct a Developer's Toolkit compiling best pedagogical practices and resources for developers (e.g., GeoMapApp, EarthChem) and access points to basic research results.

8.5. Expand E&O Through Strategic Partnerships

An informal (e.g. museum) and/ or K-12 education component could be an exciting new direction for the E&O program. The arena is large, and a program is probably best developed through partnerships with existing science organizations, consortia, and/or PIs of long-term geoscience education projects who have existing informal or formal education programs. This approach could yield a major increase in the visibility of MARGINS and PRISMS science and scientists for a relatively modest investment.

8.5.1. Partnered "Event-Based" Presentations

One promising model for this approach is the development of "event-based" presentations, planned informal/formal educational events featuring audience-appropriate and engaging PRISMS science concepts, scientists-in-action, interesting investigative techniques, and/or exploration efforts. Developed through partnerships with groups focused on outreach, the PRISMS office would coordinate the science content with PIs for these events. The partner organization would be responsible for the event itself, including advertising and organization, and logistics. An example of such an event might be the PRISMS office initiating a web-based live interview from a drill ship working in a PRISMS area, but using the IODP resources and connections with the educational (principally K-12) community. The goal of the event is both the
communication of science content and the formation of science career role models for K-12 students, undergraduates, graduate students and the general public.

Engaging events for informal education could include live communications with scientists, opportunities for event participants to control or provide input on investigations. Additional materials, such as podcasts and video-clips could be captured and incorporated in the event. The central office can coordinate the collection of material from PIs, whereas the partner organization would contribute their expertise in designing and presenting content. Possible partners include: GLOBE, IODP, the JASON Project, COSEE, TXESS Revolution, and the National Ocean Sciences Bowl.

8.5.2. Other Partnership Opportunities

There are opportunities to partner with geoscience education programs and education PIs to bring PRISMS science into the middle and high school curriculum. Partnerships with other geoscience research initiatives (e.g. IRIS, UNAVCO, Earthscope,) professional societies, curriculum development projects, and professional development programs could provide opportunities to adapt mini-lessons (section IV) to the K-12 audience for use by teachers, to incorporate PRISMS science in textbooks and teacher professional development programs (e.g. GIFT workshops, Research Experiences for Teachers). Opportunities also exist to partner with geoscience education researchers and educational psychologists who could initiate and carry out projects to measure the impact of this type of educational outreach on teachers and students, and museum audiences. Finally, Thematic Earth Institutes, provide a venue for bringing PRISMS science to the broader professional community.

8.6. Distinguished Lectureship Program

The existing Distinguished Lectureship Program has been very successful in raising awareness of the MARGINS program and its contributions to scientific understanding of tectonic processes. The program is oversubscribed and has reached a wide variety of institutions. This program should be continued and its impact extended by

- Requiring that speakers be willing to give a public lecture and emphasizing the value of a public lecture. Speakers could be supported with professional development opportunities to improve their speaking.
- Incorporating information about the MARGINS and PRISMS Mini-lessons. This could include demonstrations of mini-lessons for area teachers.
- Advertising opportunities to participate in PRISMS through the REU program, graduate programs, and post-doctoral program.

8.7. Managing and Supporting an Effective Education Program

The 2009 Decadal Review Committee recommends greater visibility and awareness of the program both within the broader geosciences community and the general public. Currently, a
half-time education staff position in the MARGINS office has responsibility for all educational programs described in Section 8.1, as well as less formal activities (managing online presentation material and other educational content on the web site; coordination with the data management group; writing education pieces in the twice yearly newsletter; etc.). Increasing the scope of an E&O program as described above requires added responsibilities including:

- Establishing partnerships between PRISMS PIs and experts in educational activities and outreach;
- Coordinating with other research initiatives and programs and in particular seek out and serve as contact point for partnerships in informal and K-12 E&O;
- Providing a support structure and services for potential PIs in designing and achieving broader impacts in their proposals;
- Provide logistical and administrative support for the REU effort and possible “bridge” activities;
- Coordinate Graduate Forums and other graduate cohort-building activities;
- Initiate pilot programs to leverage new research into exploratory educational vehicles; and
- Coordination of a more formal E&O advisory structure.

This effort will be best achieved through one dedicated full-time education specialist within the Office of the PRISMS program. Core support will be required for the Distinguished Lecturer Program, the Mini-Lesson Collection, coordination of the PRISMS wide REU program, the Student Forum and Symposia, and Student Prizes. This funding should enable leveraging of a core set of programs with additional grants outside the regular PRISMS program. For example specific REU sites could be proposed to the REU programs, development of sets of mini-lessons could be proposed to the CCLI program, or graduate mentoring and traineeships could be proposed to the IGERT program. External funding could be used to pilot new programming as was done with the mini-lesson program.

Location of the E&O program in an office that changes location every three years presents a substantial challenge to program continuity. However, the strength of the program to date reflects the engagement of the research community in the education efforts. This has been accomplished by extensive involvement of the PRISMS office and research leadership in the education programming, which is made possible by the management of these programs in the central office. The partnership with SERC in creation of the mini-lessons provides a model for bringing stability to long-term programs. SERC can continue to host the mini-lesson collection and cyberinfrastructure supporting the contribution, review and dissemination of mini-lessons while the MARGINS office moves from place to place. Concurrently the MARGINS office remains responsible for engaging the community in the development of these lessons, for decisions regarding their content, and for the scheduling of workshops or other faculty development opportunities. A similar model might be used for management of REU program.
8.8. Opportunities for Future Growth

Two additional areas for programming were identified in the development of the Education and Outreach plan. These ideas could be implemented in the future as opportunities are available.

8.8.1. International Experiences

The PRISMS program will have activities in many countries with numerous international colleagues. New programs could encourage and help PIs in obtaining International Research Experiences for Students (IRES) or Doctoral Dissertation Enhancement Projects (DDEP) grants. An IRES or DDEP grant would support a coordinated group of undergraduate and/or graduate students working on PRISMS-related research in the partner country as they work directly with their international collaborators and students. There are also opportunities in the area of International Service Learning. One example is the USAID Higher Education for Development (HED) program that fosters partnerships between USA universities and their partner institutions in host countries. The PRISMS office can provide coordination and support to facilitate obtaining grants, and encourage education and outreach activities by individual PIs at international sites and with international collaborators.

8.8.2. Bridging Experiences

Some “bridge” experiences could fill the gap between undergraduate and graduate school. Current programs generally overlook this interval, funding for research opportunities is scarce and few career-building activities have been developed at this stage. PRISMS could organize a short course or summer field camp that students would take immediately after they graduate with their B.S. degree. A field camp could emphasize the hands on, interdisciplinary tools and data acquisition that students will use in their graduate research. The activity could include both land-based and ship-based experiences, perhaps supported by external funds (e.g., CCLI). Another bridge activity would be to help PIs to obtain supplemental grants to fund incoming graduate students during the summer before they start their graduate career.

8.9. Summary Statement

The PRISMS program will be uniquely positioned to help train the next generation of interdisciplinary scientists, while expanding the reach of MARGINS and PRISMS science into the broader community. The programs outlined in this section will form a unifying broader impacts strategy for the successor program and will create a pipeline of students that reaches from within the K-12 community all the way to early career faculty. We foresee that K-12 outreach will utilize partnerships with already successful programs. At the undergraduate level, the MARGINS program has been successful at introducing students to MARGINS science through vehicles such as mini-lessons. Additional experiences such as a PRISMS REU program and opportunities to participate in international research and service learning programs further enhance the undergraduate experience. Engagement in the mini-lessons program of early career and 2-year college faculty at institutions not currently engaged in PRISMS research will provide
a mechanism for broadening the pool of students benefiting from these programs and entering the pipeline. Graduate students entering PRISMS research fields will have new peer-mentoring opportunities at dedicated meetings and throughout the year via social networking sites. The PRISMS student prize will continue to reward the top graduate students for their exemplary work. At the end of the pipeline, Ph.D. students will be encouraged to apply for the highly successful PRISMS postdoctoral program, and early-career scientists will be provided with tools to create proposals with strong broader impacts. This comprehensive vision rests primarily on the engagement of the PRISMS community and a growing community of PRISMS geoscience educators in PI driven activities and proposals.