



# GeoPRISMS

## Draft Science Plan

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## 9. Education & Outreach for the GeoPRISMS Program

### 9.1. Focus and Goals of the GeoPRISMS Education and Outreach Program

MARGINS research over the last decade, and the enhanced GeoPRISMS 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, enhancements to education efforts can be accomplished most effectively through

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

Accomplishing these goals will require a full-time Education and Outreach Coordinator who will oversee GeoPRISMS-wide student activities, the REU program and mini-lesson infrastructure. In many cases, additional funds to operate these and other programs will be sought from external

sources, including relevant NSF education and outreach programs, as detailed below. The E&O Coordinator will 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 facilitate partnerships with geoscience education and outreach activities more broadly. This strategy will ensure the needed support both for the GeoPRISMS student community to foster their successful growth into the GeoPRISMS research leadership of the future, and for the GeoPRISMS PI community to develop highly effective broader impacts that in aggregate create a robust education and outreach program. The proposals below are based on a well-thought out Vision Statement developed by the MARGINS Education Advisory Committee (MEAC), presented in full in Appendix D.

### 9.2. Focus on Undergraduates: REU and Other Programs

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

The most effective vehicle for bringing undergraduate students and their departments into GeoPRISMS is a Research Experience for Undergraduates (REU) program. GeoPRISMS can provide strong opportunities for students to engage in large scale, interdisciplinary, amphibious research focused on understanding plate boundary processes in a systemic way. Much of the science described in this Science Plan is accessible and exciting

to undergraduates and provides opportunities to engage students in experiences that complement those currently offered through the REU program and other solid earth consortia such as IRIS. The GeoPRISMS program will be based on the successful IRIS model of distributed hosts with important modifications for the unique aspects of the GeoPRISMS community. Key features will be:

- At least 2-3 distributed sites will host individuals or groups of students.
- Freshmen, sophomores and juniors will be eligible to participate, allowing students to learn about geoscience with enough time to major in the field. Special attention will be paid to recruiting students from institutions that have not been involved in GeoPRISMS research, including those from 2-year, 4-year, and minority serving institutions, and to recruiting a diverse pool of student participants.
- The students are encouraged to have advisors at their home institutions be actively involved in the research. This will provide a pathway for new faculty to enter the research program, expand awareness of GeoPRISMS, 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 the GeoPRISMS central office or designated affiliate will coordinate activities. One possible model would be to link the initial GeoPRISMS REU to the IRIS site REU or similar programs.
- The GeoPRISMS 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 9.8.2).

Funding mechanisms will be explored with NSF. It is anticipated that funding for specific research sites

or students can be included in individual research proposals or obtained through proposals to the NSF-REU program, while coordination activities will be as part of the GeoPRISMS E&O Coordinator's responsibility.

### 9.3. Building the Student / Post-doc / Early Career Community

MARGINS and GeoPRISMS 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 GeoPRISMS PIs. These efforts will be enhanced by further development of two programs, the Postdoctoral Program and a new Graduate Student Forum funded and managed by the Education and Outreach Coordinator at the GeoPRISMS central office.

#### 9.3.1 .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 GeoPRISMS Program could develop a structured 1-day student symposium, typically occurring before a larger GeoPRISMS 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 independent scientists and effective communicators within both groups. 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.

### 9.3.2. 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. This program should continue, as recommended by the DRC. Although participants have done exceedingly well, there has been a small applicant pool that should be expanded. Participation might be increased by communicating more thoroughly with the graduate student population (see Section 9.3.1). 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 GeoPRISMS 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 model.

The GeoPRISMS postdocs could be integrated more specifically in supporting GeoPRISMS students. For example, they could be required to participate in symposia. GeoPRISMS 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.

(<http://serc.carleton.edu/NAGTWorkshops/careerprep/index.html>) In addition to benefiting the post-docs, this approach could build broader awareness of the GeoPRISMS program. These mentoring efforts would directly complement the mentoring requirements now put in place by NSF.

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

Over the last 5 years, efforts to integrate discoveries from MARGINS science with the teaching of 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-GeoPRISMS data and research findings into broadly accessible educational materials. The engagement of undergraduate educators has ensured that the materials developed are well-suited to their audience, while participation by MARGINS PIs ensured cutting-edge content.

This program model capitalizes on the natural tendency of faculty to incorporate their research into their teaching, and is particularly well suited to supporting individual 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., adaptation for middle school Earth Science). Both of these approaches have already been adopted. Two synthesis project proposals in the 2009 MARGINS competition included creation of mini-lessons as mechanisms to broaden the impact of the projects. Independently but following the MARGINS model, an education 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.

These types of activities could be funded either as broader impacts proposed by PIs as part of their scientific proposals or by proposals to appropriate NSF education programs (TUES, GeoED, OGED) for sets of mini-lessons. To enable distributed improvements to the collection through this variety of mechanisms, the GeoPRISMS core funding will support the cyberinfrastructure for ongoing creation and dissemination of mini-lessons, although other support for significant program enhancements will be explored (the original MARGINS Mini-Lessons development was supported by a grant from the NSF's Division of Undergraduate Education). The Education and Outreach Coordinator will work with individual PIs to identify opportunities to enhance the mini-lesson collection. The GeoPRISMS Education Advisory Committee (GEAC) will provide oversight and review the overall health of the collection, and make recommendations for needed developments such as those outlined above.

## 9.5. Expand Education and Outreach Through Strategic Partnerships

Informal (e.g. museum) and/ or K-12 education components are important new direction for the GeoPRISMS Education and Outreach program, and one identified by the DRC. The arena is large, and a program is 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 will yield a major increase in the visibility of MARGINS and GeoPRISMS science and scientists for a relatively modest investment.

### 9.5.1. 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 GeoPRISMS science concepts, scientists-in-action, interesting investigative techniques, and/or exploration efforts. Developed through partnerships with groups focused on outreach, the GeoPRISMS 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 GeoPRISMS Office initiating a web-based live interview from a drill ship working in a GeoPRISMS 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, and opportunities for event participants to control or provide input on investigations. Additional materials, such as podcasts and video-clips could be captured and incorporated during the event. The central GeoPRISMS 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. PIs on individual proposals who anticipate that they will have important materials for this type of outreach could include funding for the development of materials in their proposals and emphasize this contribution as part of their broader impacts.

### *9.5.2. Other Partnership Opportunities*

There are opportunities to partner with geoscience education programs and education PIs to bring GeoPRISMS science into the middle and high school curriculum. Partnerships with other geoscience research initiatives (e.g. IRIS, UNAVCO, EarthScope, OOI) professional societies, curriculum development projects, and professional development programs could provide opportunities to adapt mini-lessons (Section 8.4) to the K-12 audience for use by teachers, to incorporate GeoPRISMS 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.

### **9.6. 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 with core support, as recommended by the Decadal Review Committee (DRC), and its impact extended by

- Requiring that speakers be willing to give a public lecture and emphasizing the value of a

public lecture. To some extent this is already being done, but the opportunity could be better emphasized and more appropriate venues selected (museums, etc.). Speakers could be supported with professional development opportunities to improve their speaking.

- Incorporating information about the MARGINS and GeoPRISMS mini-lessons. This could include demonstrations of mini-lessons for area teachers.
- Advertising opportunities to participate in GeoPRISMS through the REU program, graduate programs, and post-doctoral program.

The Education Advisory Committee was eager over the long term to explore ways to expand this program internationally, as recommended by the DRC. This likely would require some other source of funding than present, which is aimed at educating the domestic student body, but there may be opportunities in conjunction with GeoPRISMS International Partnerships (Section 8.2).

### **9.7. Managing and Supporting an Effective Education Program**

The 2009 Decadal Review Committee recommended greater visibility and awareness of the successor program both within the broader geosciences community and the general public. The program enhancements proposed above address these recommendations directly, and define a roadmap for expanding the educational impacts of the GeoPRISMS Program. Currently, a half-time education staff position in the MARGINS Office has responsibility for all of the 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: e.g., coordinating with the data management group, and writing education pieces in the twice yearly newsletter). Increasing the scope of the GeoPRISMS Education and Outreach program as described above will require added responsibilities, including:

- Providing a support structure and services for potential PIs in designing and achieving broader

impacts in their proposals including building partnerships between GeoPRISMS PIs and experts in educational activities and outreach.

- Managing the core support for the REU program (or overseeing a contract for this management) including GeoPRISMS wide activities for participating students.
- Managing new programs supporting students and post-docs within the GeoPRISMS community including the Graduate Student Forum.
- Coordinating with other research initiatives and programs and in particular seeking out and serving as contact point for partnerships in informal and K-12 education and outreach.
- Coordination of a more formal Education and Outreach advisory structure.
- Assisting in attracting external grant funds to support the expanded programs.

In addition, it will be desirable for the Education and Outreach Coordinator to explore new opportunities to bring GeoPRISMS science into wider use in education and outreach. GeoPRISMS education and outreach efforts will be best achieved through one dedicated full-time education specialist within the office of the GeoPRISMS Program, along with direct support for basic program functions as done presently (e.g., the Distinguished Lectureship Program, the mini-lesson Collection, the Graduate Student Forum, and Student Prizes. More ambitious expansions of the program will be achieved through additional grants, for example to the REU programs, TUES for development of sets of mini-lessons (original development was funded separately by CCLI), and the IGERT program for mentoring and graduate traineeships.

Location of the education and outreach 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 MARGINS 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 GeoPRISMS Office moves from place to place. Concurrently the MARGINS Office, and ultimately, the GeoPRISMS 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.

The Margins Education Advisory Committee (MEAC) has played a critical role in the development of MARGINS education activities by bringing together leadership in education and in the use of MARGINS science in education to advise the Steering Committee and the MARGINS Office. A new GeoPRISMS Education and Advisory Committee (GEAC) will be put in place to continue to provide such guidance. Membership will be selected to provide needed expertise in undergraduate education, mentoring students, increasing diversity, and expanding the reach of programming to K-12 and informal venues through partnerships.

## 9.8. 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 arise.

### 9.8.1. *International Experiences*

The GeoPRISMS 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 GeoPRISMS-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 GeoPRISMS Office can provide coordination and support to facilitate obtaining grants, and to encourage education and outreach activities by individual PIs at international sites and with international collaborators.

### *9.8.2. 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. GeoPRISMS 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, now TUES). 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.

has been successful at introducing students to MARGINS science through vehicles such as mini-lessons. Additional experiences such as a GeoPRISMS 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 GeoPRISMS research will provide a mechanism for broadening the pool of students benefiting from these programs and entering the pipeline. Graduate students entering GeoPRISMS research fields will have new peer-mentoring opportunities at dedicated meetings and throughout the year via social networking sites. The GeoPRISMS 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 GeoPRISMS 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 GeoPRISMS community and a growing community of GeoPRISMS geoscience educators in PI-driven activities and proposals.

## **9.9. Summary Statement and Unifying Vision**

The GeoPRISMS program will be uniquely positioned to help train the next generation of interdisciplinary scientists, while expanding the reach of MARGINS and GeoPRISMS science into the broader community. The programs outlined above 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

