



GeoPRISMS

Implementation Plan

1. Executive Summary

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GeoPRISMS (Geodynamic Processes at Rifting and Subducting MarginS), successor to MARGINS, will guide a decade of community-driven, interdisciplinary research on the origin, evolution, and active processes at continental margins. Building upon a decade of community-driven continental margin science guided by the MARGINS Program, GeoPRISMS will develop a fundamental understanding of these shoreline-crossing systems and their importance in global Earth processes, resource distribution, and geohazards. Over the next decade, GeoPRISMS will support a wide range of broadly integrated research approaches, including marine and terrestrial field campaigns, along with experimental and modeling studies, and projects both large and small. GeoPRISMS research will utilize major NSF and related infrastructural investments, and leverage strong international collaborations, while continuing to build and educate a broad research community that will elevate continental margin studies to a new level.

The scientific reach of GeoPRISMS is outlined in the Draft Science Plan (DSP), submitted to NSF in April 2010 (<http://geoprisms.org/science-plan.html>). The document enclosed here (also found on that site) is an addendum to the DSP, and outlines the specific implementation plans for the GeoPRISMS initiatives. These plans arose from two community workshops, held in Santa Fe, NM (Nov 4-6, 2010) and Bastrop, TX (Jan 5-7, 2011). At these workshops, each attended by more than 120 participants, the community prioritized the scientific goals of the program, selected primary sites at which major research efforts will be concentrated, identified immediate and long-term research needs and strategies for these sites, and outlined thematic studies to complement and integrate GeoPRISMS primary site and MARGINS focus site investigations. The overarching aspects of GeoPRISMS science, partnerships and collaborations, education and outreach, and data management, are summarized in the DSP and not repeated here.

The *Subduction Cycles and Deformation (SCD) Initiative* will focus holistically on long-term margin evolution and material transfer, as well as short-term plate boundary deformation. The initiative will enable studies of strain build-up and release along the plate boundary, the role of volatiles, and the growth and evolution of volcanic arcs and continents. But more importantly, SCD research will explore the interplay of processes across the system, for example: How does the transport and release of fluids regulate the occurrence of great earthquakes? How efficiently are volatiles returned to the Earth's surface over geologic time? What are the linkages among surficial processes, fault-slip behavior, volatile release, and magmatism? Addressing these questions requires an interdisciplinary approach, and the integration of observations from many settings representing the range of subduction zone conditions and stages.

Three primary sites were selected for SCD, listed in order of priority: *Alaska* (including the southern mainland and extension into the Aleutian Islands), *Cascadia*, and *New Zealand*. These three sites offer tremendous potential to address major questions about subduction earthquake and fault slip processes in societally critical settings, and to carry out comparative studies of deep-seated interactions that drive volatile release and magmatic processes to build the continents. The three sites provide immediate and long-term opportunities to leverage recent and upcoming investments in infrastructure, through EarthScope and the Cascadia Initiative at the US sites, and through collaborations with international researchers, in particular in New Zealand.

Five process-based themes were identified within SCD that require broader research approaches than can be achieved at the primary sites. Such thematic studies are fundamental to constraining

and contextualizing observations made at the primary sites, and will enable complementary global geochronological, petrological, structural, and geochemical studies, as well as laboratory experiments and computational modeling efforts. The five themes include:

- *Theme 1: Identifying controls on fault slip behavior and deformation history*
- *Theme 2: Understanding mantle wedge dynamics*
- *Theme 3: Fore-arc to back-arc volatile fluxes*
- *Theme 4: Metamorphic and igneous conditions and processes at depth*
- *Theme 5: Subduction initiation*

Focused primary site planning workshops must be carried out in the near-term for all three primary sites, with particular urgency for Cascadia to decide how to take scientific advantage of the new infrastructure provided through the Cascadia Initiative, and for Alaska to ensure coordination between future EarthScope and GeoPRISMS activities, e.g., planning the USArray deployment across the state and integrating the maturing observations of deformation by Plate Boundary Observatory. Both workshops should take place within the year. An international planning workshop should precede any major GeoPRISMS investments in New Zealand, to establish the status of activities in the area, and to prioritize targets to build most effectively upon existing and future infrastructure. This workshop should take place in 2012 or 2013.

The *Rift Initiation and Evolution (RIE) Initiative* will focus on identifying the key processes that drive continental rifting and margin evolution, from rift initiation to the formation and modification of passive margins, and defining the active interplay of mantle, crustal, and surface processes throughout margin development. Examples of overarching questions include: What are the feedbacks between sedimentation and magmatism, and how does this influence the final form of rifted margins? Are rifted margins net sinks or sources for volatiles, and how does this balance change throughout rift evolution? Continental margins of all ages reflect an active interplay of mantle, crustal, and surface processes that demand the interdisciplinary system-level, amphibious research approach of the GeoPRISMS program. Several of the key RIE questions can only be addressed where active rifting is occurring today, whereas others merit studies of passive margins where rifting has gone to completion and the full history of tectonic, magmatic, isostatic, and surficial processes is preserved.

Two primary sites were selected for RIE investigations: the active *East African Rift System (EARS)*, which exhibits the entire history of continental rupture, and the fully developed *Eastern North American Margin (ENAM)*, which preserves an extensive post-rift evolution. Both systems also exhibit variations in the degree of magmatic activity along strike, and span a north-south climatic gradient with resulting diversity in sediment flux and tectonic-climate interactions. The ENAM site leverages considerable US infrastructure, including EarthScope and the Extended Continental Shelf surveys being carried out by the USGS. The selection of these two sites introduces a new approach for carrying out amphibious studies, where a mostly offshore system is paired with a mostly onshore system, to enable broadly integrated comparisons of the earliest and latest stages of rifting. This exciting approach should lead to strong interactions between marine and terrestrial researchers interested in rift initiation and evolution.

Five thematic studies were identified within RIE to address the influence of parameters poorly represented at the two primary sites. These investigations, intended to be complementary but

subsidiary to primary site studies, enable diverse comparative field, experimental, and numerical investigations, also building upon results of past MARGINS studies. The five themes include:

- *Theme 1: Rift obliquity*
- *Theme 2: Rift processes as functions of strain rate*
- *Theme 3: Volatiles in rift zone processes*
- *Theme 4: Sediment production, routing and transport during and after rifting*
- *Theme 5: Discrete events at rifted margins*

Open community-wide planning workshops are needed for both primary sites before major GeoPRISMS experiments are initiated, to determine where in these expansive primary sites to concentrate GeoPRISMS investments, and to obtain community input and assess existing data. Early planning for the ENAM site is necessary to leverage time-limited opportunities, such as the deployment of EarthScope's USArray along the eastern US and complementary geodetic studies of subsidence and inundation of coastal areas. This workshop should take place within the year. An international planning workshop for the EARS site should take place in 2012 or 2013.

Immediate Opportunities. Both initiatives offer opportunities for immediate GeoPRISMS research. Early research for both RIE and SCD primary sites should focus on data synthesis efforts, utilization of existing and forthcoming data products, and reconnaissance studies that set the stage for subsequent planning and community experiments. The subsidiary thematic studies can also initiate early, particularly those that help to integrate GeoPRISMS primary site and MARGINS focus site results. Ramp-down activities at the previous MARGINS focus sites are also justified, particularly if they contribute to the scientific objectives of the thematic studies.

Integration, Broader Impacts, and Outreach. Proposed research within GeoPRISMS will yield pronounced broader impacts, including improved understanding of geohazards and enhanced education and outreach, international partnerships, training, and data sharing. SCD studies emphasize understanding the causes and distributions of large megathrust earthquakes, capable of generating devastating tsunamis. Volcanic eruptions in subduction and rifting environments can be disruptive and damaging. Continental rifts and passive margins encompass much of the world's population and hydrocarbon resources, and are vulnerable to changes induced by climate change and sea-level rise. Strong international collaborations will arise from GeoPRISMS research, with opportunities to work closely with colleagues in many host countries (e.g., African nations, New Zealand), and to enhance regional training and development. The GeoPRISMS Office will facilitate these transfers of knowledge within the scientific community and more broadly, by running regular workshops, maintaining open channels of communication (e.g., the website, newsletter, publications), and providing direct access to the GeoPRISMS data portal.

Funding Strategies and Priorities. The ambitious scientific objectives of GeoPRISMS require multiple strategies to support them, including leveraging NSF core programs, special programs such as FESD and CD, and international collaborations. Most importantly, GeoPRISMS must make it a priority to engage a broad cross-section of investigators, from experienced PIs to early-career scientists, and do so by maintaining a mix of funding levels and mechanisms, soliciting and supporting both large and small projects, from community experiments to PI-driven proposals. This will ensure that GeoPRISMS continues to foster the strongest, most innovative, interdisciplinary continental margin science.