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Geodynamic Processes at Rifting and Subducting Margins

In This Issue:

Rupturing Continental Lithosphere in the Gulf of California & Salton Trough

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How and why do continents break apart? Under what conditions does rifting progress to rupture of the lithosphere and formation of a new ocean basin? Can we identify the state parameters, physical properties, and forces that control this process? The Rupturing Continental Lithosphere (RCL) initiative of the NSF-MARGINS program was implemented to address these and related questions through integration of onshore-offshore geophysical, geological, and modeling studies. After marine investigations of the Red Sea rift became impractical due to geopolitical factors, the Gulf of California and Salton Trough became the sole focus site for the RCL initiative.

In this report, we highlight some of the key findings that have emerged from 10 years of RCL research along the Gulf of California - Salton Trough oblique divergent plate boundary (Fig. 1). A central goal of these studies was to better understand the spatial and temporal evolution of rifting and rupturing processes by linking data and observations with insights from numerical models and experiments. Researchers addressed questions regarding: forces and processes that govern rift initiation, localization, and evolution; key controls on deformation as it varies in time and space; physical and chemical evolution of the crust as rifting proceeds to sea-floor spreading;

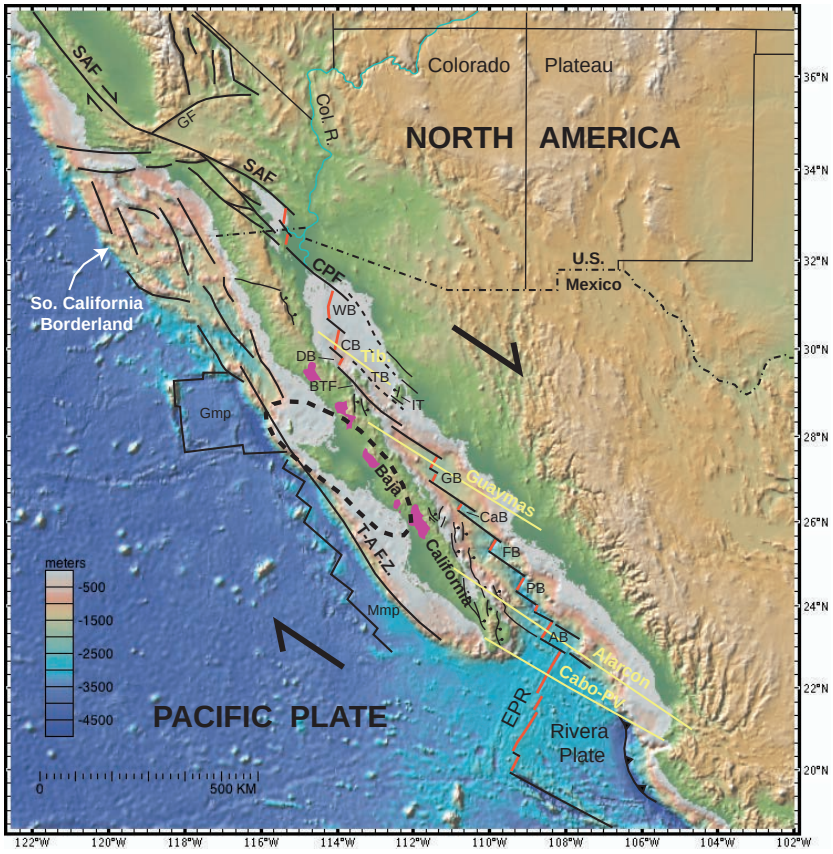

Figure 1. Map of topography, bathymetry, faults, and geophysical transects (Gonzalez-Fernandez et al., 2005; Lizarralde et al., 2007) in the Gulf of California - Salton Trough region. Caption continues on next page.

and the role of fluids and magmatism in continental extension. The following summary highlights results of recent studies, many of which have changed the way we think about continental rifting, rupture, and the underlying controls on these processes.

Upper-Mantle Structure

Complex upper-mantle structure beneath the Gulf of California - Salton Trough region reflects evolution of the plate boundary from a convergent-margin subduction zone and magmatic arc to the modern system of short spreading centers linked by long transform faults. Using Rayleigh-wave tomography, recent studies identify a fast anomaly in seismic velocity beneath the central Baja California peninsula and western Gulf (Wang et al., 2009, in press; Zhang et al., 2009). This anomaly is interpreted to be a fragment of the former Farallon plate that became stranded by slab detachment at a depth of ~100 km during failed subduction of the Farallon-Pacific spreading center. A discontinuous belt of post-subduction high-Mg andesites (bajaites) coincides with the landward edge of the stranded slab segment (Figure. 1), and is interpreted to record partial melting of ocean crust and upper mantle due to upwelling associated with opening the Gulf of California and/or replacement of detached lithosphere with hot asthenosphere at the end of the broken slab (Burkett and Billen, 2009; Wang et al., in press). Brothers et al. (2012) used seismic refraction data to identify another, shallower segment of stalled ocean crust at ~20 km depth beneath the southern peninsula. They concluded that slab detachment at ~12 Ma, and subsequent isostatic and thermal response, controlled the late Neogene history of uplift, erosion, subsidence and sedimentation on the Magdalena shelf off southern Baja California.

Receiver function studies show that continental crust of the Peninsular Ranges and Baja California microplate thins dramatically from about 40 km in the west to 15-20 km in the east, at the western margin of the Gulf Extensional Province (Lewis et al., 2000, 2001; Persaud et al., 2007). These results show that the eastern Peninsular Ranges lack an Airy crustal root, and that high topography in this area is instead supported by upper mantle buoyancy and a thinned mantle lithosphere. The geometry, distribution and post-Pliocene timing of rift-flank uplift suggest that removal or modification of mantle lithosphere is related to the modern phase of crustal extension driven by transform tectonics (Mueller et al., 2009), and is not inherited from an earlier period of Miocene extension. Mechanisms accommodating regional deformation of the lower crust and upper mantle are uncertain but may include lower crustal ductile flow, low-angle normal faulting, and convective instabilities in the lithosphere (Gonzalez-Fernandez et al., 2005; Persaud et al., 2007; Mueller et al., 2009).

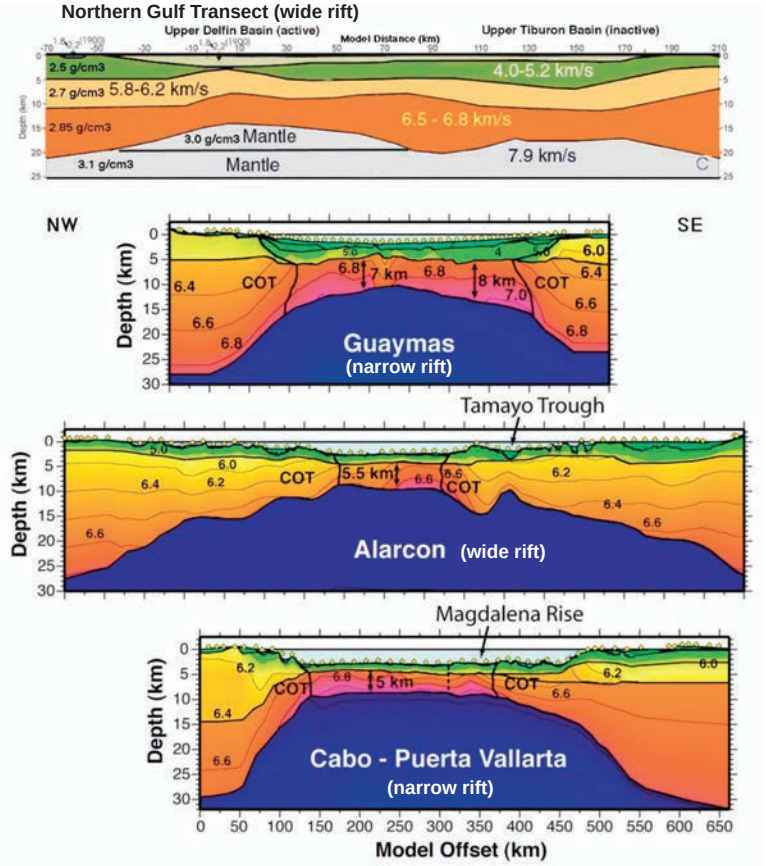

Figure 2. Seismic velocity models showing crustal-scale structure for 4 transects in the Gulf of California. The top, northernmost transect is from Gonzalez-Fernandez et al. (2005), and the lower 3 transects are from Lizarralde et al. (2007; PESCADOR experiment). Velocity contours in the lower 3 panels are color-coded and labelled in units of km/s. Yellow diamonds indicate instrument locations. COT is the interpreted continent/ocean transition. See Figure 1 for location of transects. The rift architecture seen in these transects alternates abruptly along the rift between wide-rift and narrow-rift mode. The observed variations in rift architecture likely reflect some combination of pre-rift magmatism and thickness of sediments in the basins.

Figure 1 (continued). Systematic shallowing of water depth from south to north along the plate boundary is due to voluminous input of sediment from the Colorado River (Col. R.) in the north. Bold dashed line shows area of high-velocity anomaly at a depth of 100 km that indicates the presence of a stalled fragment of the Farallon plate in the upper mantle; purple color shows areas of post-subduction high-Mg andesites (Wang et al.) Abbreviations: AB, Alarcón basin; BTF, Ballena transform fault; CaB, Carmen basin; CB, Consag basin; CPF, Cerro Prieto fault; DB, Delfin basin; EPR, East Pacific Rise FB, Farallon basin; GB, Guaymas basin; GF, Garlock fault; Gmp, Guadalupe microplate; IT, Isla Tiburón; Mmp, Magdalena microplate; PB, Pescadero basin; SAF, San Andreas fault; T.A.F.Z., Tosco-Abreojos fault zone; TB, Tiburón basin; WB, Wagner basin.

Localization of Strain

One of the major questions that motivated RCL research was: how, where, and why does strain localize as rifting progresses to continental rupture (Umhoefer, 2011)? It has long been known that in some regions (such as the Basin and Range) the crust undergoes extension over large areas for 10's of millions of years without breaking the continent. So why does strain rapidly become localized in some settings to rupture the lithosphere and form a new ocean basin? A decade of research in the Gulf of California - Salton Trough region generated new understanding of several key processes that control localization of strain in rift systems: (1) magmatism; (2) microplate coupling; (3) strike-slip faulting; and (4) sedimentation.

Magmatism

Marine-seismic studies in the northern Gulf (Gonzalez-Fernandez et al., 2005) and central to southern Gulf (Lizarralde et al., 2007) investigated crustal-scale structure and controls on rift architecture. Four transects reveal surprisingly abrupt variations in the geometry of rift segments and the width of extended continental crust (Figs. 1, 2). The northern Gulf transect is characterized by a broad diffuse crustal geometry, intermediate seismic velocities in the mid to lower crust, and lack of well defined ocean crust that may reflect the influence of thick sediments and lower crustal flow during extension (Gonzalez-Fernandez et al., 2005). Rift segments in the central to southern Gulf alternate between wide- and narrow-rift geometries that Lizarralde et al. (2007) proposed are controlled by the presence or lack of pre-rift magmatism. According to this hypothesis, the upper mantle became chemically depleted in areas of early to middle Miocene, pre-rift ignimbrite eruptions. Chemically depleted mantle resulted in sparse syn-rift magmatism, thin basaltic crust, and a wide-rift architecture (Alarcon segment) that reflects the paucity of magma and a relatively strong lithosphere. Conversely, areas that were *not* affected by Miocene ignimbrite magmatism were inferred to have retained a fertile upper mantle that enhanced production of syn-rift magma, thus weakening the lithosphere and promoting a narrow-rift architecture (Lizarralde et al., 2007).

Behn and Ito (2008) used 2-D numerical models to explore the thermal and mechanical effects of magma intrusion on fault initiation and growth at slow and intermediate spreading ridges. Faulting is influenced by competing factors of lithospheric structure, rheology, and rate of magma accretion at the ridge axis, and that faulting typically follows a predictable pattern of initiation, growth, and termination. Fault growth in these models generates a strongly asymmetric thermal structure that can stabilize slip on large-offset normal faults, and may localize hydrothermal circulation into the footwall of evolving core complexes. Through integrated modeling and experimental studies, Takei and Holtzman (2009) found that, for a solid-liquid system in which solid grains deform by grain-boundary diffusion creep, addition of a very small amount of melt (phi < 0.01) results in significant reduction of effective bulk and shear viscosities. This means that very small melt fractions in the upper mantle will lead to substantial weakening and localization of strain. Bialas et al. (2010) used a 2-D numerical model to better understand how magma-filled dikes influence the evolution of fault stresses, heat, and lithospheric weakening. They found that only a small amount of magma is needed (<4 km of cumulative dike opening) to weaken the lithosphere such that strain may become localized and continue to ocean spreading by tectonic extension without input of additional magma.

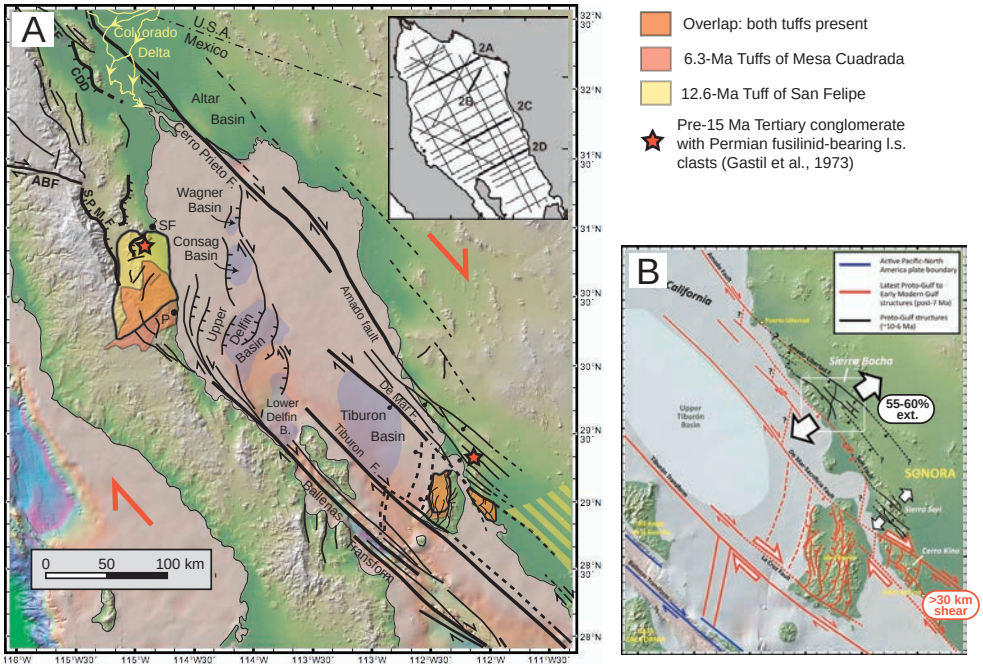

Figure 3. (A) Map of topography, bathymetry, faults and basins in the northern Gulf of California, compiled from numerous published sources. The northern Gulf contains several pull-apart basins bounded by large transform faults. Active diffuse deformation in the Delfin basin occurs on closely-spaced oblique-slip faults, and there is no evidence for existence of oceanic crust at depth. Much of the crust is sedimentary due to the high rate of input from the Colorado River. ABF, Agua Blanca fault; CDD, Canada David detachment; SPMF, San Pedro Martir fault. P, Puertecitos; SF, San Felipe. (B) Simplified tectonic model for late Miocene to modern kinematic evolution of the northern Gulf of California. Geologic relations in coastal Sonora record a period of NE-SW extension between about 10 and 6 Ma (black faults; Darin, 2010), and rapid focusing of strain into a narow zone of dextral transtensional deformation and related offshore faults at ca.7-8 Ma (red faults; Bennett et al., in press). Plate boundary motion now occurs on the Ballenas transform (blue faults).

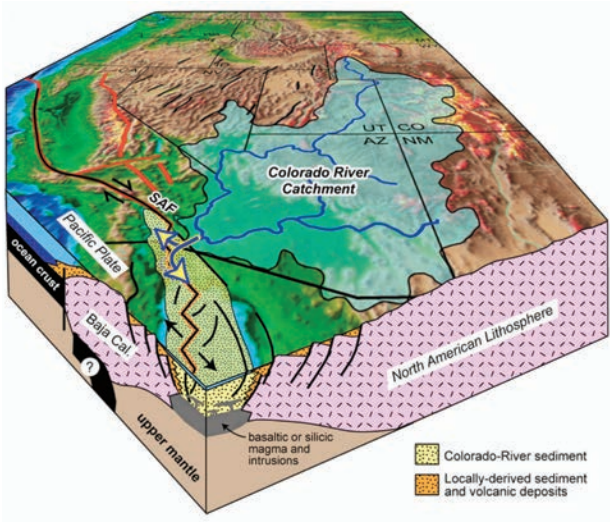

Figure 4. Diagram illustrating a conceptual model for lithospheric rupture and sedimentation in the Salton Trough and northern Gulf of California (Dorsey, 2010). Deep basins are filled with synrift sediment derived from the Colorado River to form a new generation of recycled crust along the oblique-divergent plate boundary.

Microplate Coupling & Strike-Slip Faults

Recent GPS studies provide new constraints on modern plate motions, plate rigidity, surface velocities, and kinematic boundary conditions in the Gulf of California - Salton Trough region. The Baja California microplate behaves as a rigid block that moves in approximately the same direction as the Pacific plate but ~10% slower than the Pacific plate (Plattner et al., 2007). Thus the microplate is incompletely coupled to the Pacific plate along the offshore Tosco-Abreojos fault zone (Fig. 1), and this "neighbor-driven" motion of the microplate drives northwest-directed rifting and seafloor spreading in the Gulf of California (Plattner et al. 2009). Mechanical coupling to the Pacific Plate is likely enhanced by the presence of shallow-dipping fragments of the former subducting Farallon plate beneath the Baja peninsula (Zhang et al., 2007; Wang et al., 2009; Brothers et al., 2012).

Existing regional seismic profiles run between and parallel to long transform faults that link short spreading centers (i.e. Gonzalez-Fernandez et al., 2005; Lizarralde et al., 2007), and therefore do not fully address questions about complex 3-D strain and regional strain partitioning in oblique rifts. A recent study by Brune et al. (2012) explored this question using a simple analytic mechanical model and advanced thermomechanical numerical techniques. They found that oblique extension is favored, and more efficient, than orthogonal rifting because it requires less force to reach the plastic yield limit of the lithosphere. This result suggests that oblique extension can exert a major control on localization of strain that evolves to lithospheric rupture, and may explain why continental extension progressed rapidly to rupture in the Gulf of California and Salton Trough (Umhoefer, 2011).

The prediction that oblique rifting controls strain localization is supported by recent geologic mapping and structural studies in the northern Gulf of California and coastal Sonora region (Fig. 3). Geologic mapping and fault-kinematic analysis provide evidence for large magnitude (55-60%) NE-SW extension between about 10 and 6 Ma in the Sierra Bacha, immediately northeast of a major dextral shear zone (Darin, 2011). During this time, at ~7-8 Ma, strain became focused into a narrow zone of strong transtensional deformation and related transform faulting (up to ~100% local extension) in coastal Sonora and Isla Tiburon (Bennett et al., in press). These studies highlight the important role that strike-slip faults played in localizing transtensional strain into the northern Gulf of California shortly prior to lithospheric rupture. In addition, normal faults remain active - but generally at low slip rates - along the Gulf Margin fault system in the northern Gulf region (e.g. Sierra San Pedro Martir; Mueller et al., 2009; Seiler et al., 2010) and in the southern Gulf near La Paz (Busch, et al., 2011, 2013).

Sedimentation

Recent studies call attention to the critical role that sediments play in continental rifting, lithospheric rupture, and formation of new ocean basins. Bialas and Buck (2009) developed a two dimensional mechanical model that explores the buoyancy effects of adding a load of non-locally derived sediment to an evolving rift system. In the absence of a sediment load, the buoyancy force contrast between areas of thinned and un-thinned crust hinders rift localization and promotes a wide-rift mode of extension. Conversely, if non-locally derived sediment is added to the rift zone, this reduces the contrast in buoyancy force and allows extension to persist within the rift, causing strain to become localized and hastening the time to rupture (Bialas and Buck, 2009). It is not clear, however, how the effect of buoyancy forces compares to the thermal effect of adding sediments, which may warm and weaken the lithosphere due to thermal blanketing (e.g. Lizarralde et al., 2007) or cool and strengthen a rift by adding a large volume of cold material to the crust.

Sediments and Crustal Recycling

It is now clear that voluminous input of sediment from the Colorado River exerts a first order control on rift architecture, crustal composition, and lithospheric rupture in the northern Gulf of California and Salton Trough region. We observe a pronounced change from sediment-starved, deep-marine seafloor spreading centers with thin basaltic crust and magnetic lineations in the southern Gulf, to overfilled shallow-marine and nonmarine pull-apart basins in the north that contain thick sediments above a quasi-continental lower crust (Fig. 1; Dorsey and Umhoefer, 2012; Fuis et al., 1984; Gonzalez-Fernandez et al., 2005; Lizarralde et al. 2007). Thus the degree to which basins have completed the transition from continental rifts to ocean spreading centers changes dramatically from south to north, even though there

has been roughly the same amount of extension across the plate boundary since either ca. 6 Ma (Oskin and Stock 2003) or ~12 Ma (Fletcher et al., 2007). Although pre-rift continental lithosphere has ruptured completely in the north, as it has in the south, the northern rift segments lack normal basaltic spreading centers, and deep sediment-filled basins are floored by young crust composed of Colorado River-derived sediments and mantle-derived intrusions (Fuis et al., 1984).

Recent studies have tested and appear to confirm the crustal model of Fuis et al. (1984). Using Sp receiver functions, Lekic et al. (2011) found that the lithosphere-asthenosphere boundary (LAB) beneath the Salton Trough is very shallow (40 km), and that the lateral edges of shallow LAB coincide approximately with major active faults. They proposed that the entire pre-Tertiary lithosphere beneath the Salton Trough has been replaced, and that the LAB represents the base of newly formed mantle lithosphere generated by rift-related dehydration and mantle melting. New results from the Salton Seismic Imaging Project provide additional constraints on crustal and upper mantle structure beneath the Salton Trough. Seismic velocity models reveal a ~40 km-wide basin bounded by the San Jacinto fault zone on the southwest and paleo San Andreas fault on the northeast (Han et al., 2012a,b). Crystalline "basement" at depths of ~4 to 10-12 km consists of metamorphosed Plio-Pleistocene sediment on the basis of intermediate P-wave velocities (~5.0-6.2 km/s). High heat flow results in vigorous hydrothermal circulation and emplacement of Quaternary rhyolites produced by episodic remelting of hydrothermally altered basalts (Schmitt and Vazquez, 2006; Schmitt and Hulen, 2008).

Crustal extension during mid to late Tertiary time led to collapse of a pre-existing orogenic plateau, reversal of regional drainages, and diversion of the Colorado River into subsiding basins along the fault-bounded tectonic lowland (Dorsey, 2010, and references therein). In this setting, continental crust is rapidly recycled by a linked chain of processes: erosion and fluvial transport of sediment off the Colorado Plateau, followed by deposition, burial, and metamorphism in deep rift basins (Fig. 4). Dorsey and Lazear (in press) found that the volume of sediment in the basins is, within error, equal to the volume of crust (ca. 310,000 km^3) eroded from the Colorado Plateau over the past ~6 m.y., but *only if* the calculated sediment volume includes metasedimentary crust between 4-5 and 10-12 km deep in the basins. These studies challenge geologists to think about what the middle to lower crust will look like in a setting like this if the Salton Trough were uplifted and exhumed.

Recent insights from the northern Gulf of California and Salton Trough permit recognition of a new type of rifted continental margin (in addition to popular volcanic and non-volcanic end members): one where the continent-ocean transition consists of thick, largely non-volcanic crust constructed from syn-rift to post-rift sediments (Sawyer et al., 2007). This may help explain the origin of "transitional" crust at some ancient rifted margins. Recycled sedimentary crust of this type may be recognized by an overall geometry similar to that of volcanic rifted margins but with intermediate seismic velocities that are not consistent with a simple basaltic composition (e.g. Nova Scotia margin; Funck et al., 2004; Wu et al., 2006).

Conclusions

The past decade of research in the Gulf of California - Salton Trough focus site generated new insights into the processes that control continental rifting and transition to lithospheric rupture. Several key factors - upper mantle structure, magmatism, rift obliquity, and sedimentation - were found to be especially important. An unexpected result was the discovery of abrupt contrasts in rift architecture and evolution that reflect extreme variability in governing processes and conditions along the rift axis. For example, magmatism played a major role in the south, whereas sedimentation has strongly perturbed the system in the north due to voluminous input from the Colorado River. We see a change from large-scale simple shear and lower crustal flow associated with low-angle detachment faults in the north, to early localization of strain in the central Gulf (Guaymas basin) and southern Gulf (Cabo San Lucas), to protracted, pure-shear style extension and delayed continental rupture in the south. The role of upper mantle processes is one aspect that we expect will be more fully understood by tracking the complete evolution from active rifting through the thermal-subsidence phase at ancient rifted margins.

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GeoPRISMS Planning Workshop for East African Rift System

Morristown, NJ - October 25 - 27 2012

Workshop conveners: Ramon Arrowsmith (Arizona State University), Estella Atekwana (Oklahoma State University), Maggie Benoit (The College of New Jersey), Andrew Cohen (University of Arizona), Rob. Evans (WHOI), Matthew Pritchard (Cornell University), Tyrone Rooney (Michigan State University), Donna Shillington (Lamont Doherty Earth Observatory)

Background and Motivation

The planning workshop for the East African Rift System (EARS) GeoPRISMS primary site was held in Morristown, NJ, on October 25-27th 2012, mere days before Hurricane Sandy made landfall. An international group of ~115 attendees took part, including a gratifyingly large number of graduate students (~40). Overall, 15 different countries were represented, with a large number of participants from several African countries, including Tanzania, Uganda, Kenya, Ethiopia, Malawi, and the Democratic Republic of Congo (Figure 1).

Figure 1. Participants at the GeoPRISMS EARS Workshop in Morristown, NJ, October 2012.

The East African Rift System was chosen as a primary site for GeoPRISMS because it offers significant opportunities to study a wide range of questions outlined in the GeoPRISMS Science Plan for the Rift Initiation and Evolution (RIE) Initiative, as outlined in the GeoPRISMS Science Plan and the Draft Implementation Plan (http://www.geoprisms.org/science-plan.html); these documents served as the starting point for this workshop.

The main goals of the workshop were to clarify the community research objectives in the EARS, to discuss candidate focus areas for concentrated research, to identify opportunities for international partnerships, and to develop a detailed Implementation Plan for GeoPRISMS research in EARS to guide GeoPRISMS proposers and reviewers, considering the available resources and infrastructure.

Student Symposium

Prior to the formal meeting, a student symposium was organized by Maggie Benoit (The College of New Jersey). Interested students were given an introduction to the East African Rift System and associated projects, a chance to present their own research to their peers, and an opportunity to meet some of the meeting conveners in an informal setting. More than just providing information on the existing state of knowledge in the region, this event facilitated team building and critical thinking, which allowed the student participants to produce a well-thought out plan of their own during the formal meeting. A field trip to the Newark Basin, led by Martha Withjack and Roy Schlische (both of Rutgers University), visited some local rift features (Figure 2).

Post-workshop field trip

The day after the workshop, Paul Olsen, from LDEO, led a field trip for all interested workshop attendees, exploring the northern part of the Triassic-Jurassic Newark basin. This trip provided an overview of this ancient rift basin, analogue to the active East African Rift basins, highlighting similarities and major differences between the two systems (Figure 3).

Workshop Plan

The planning workshop itself was structured around 5 key questions from the RIE component of the GeoPRISMS science plan pertinent to the East African Rift. Talks were organized around these topics to give the audience an overview of what is known of the rift system and, more critically, what remains unknown. Presentations from selected talks below are available on the GeoPRISMS website (Figure 4).

Topic 1: How does the presence or absence of an upper-mantle plume influence extension?

- Seismological imaging of plumes and associated magmatism in rifts – Gabriel Mulibo and JP O'Donnell.
- Origin of magmas from geochemical perspective – Tyrone Rooney
- Plume dynamics and surface uplift – D. Sarah Stamps

Figure 2. Students gathed around Roy Schlische and Martha Withjack, from Rutgers University, leaders of the student field trip in the Newark Basin

Topic 2: How does the mechanical heterogeneity of continental lithosphere influence rift initiation, morphology, and evolution?

- Mechanisms for thinning the lithosphere, including thermal/chemical erosion, and interaction with large scale lithospheric structures –Ben Holtzman
- Control of pre-existing structures on early rifting –Aubreya Adams
- Geochemical heterogeneity of the lithosphere – Wendy Nelson

Topic 3: How is strain accommodated and partitioned throughout the lithosphere, and what are the controls on strain localization and migration?

- Magmatism during rifting events - David Ferguson
- Modeling and observations of faulting and magmatism during rifting - Juliet Biggs
- Active deformation processes – Becky Bendick

Topic 4: What factors control the distribution and ponding of magmas and volatiles, and how are they related to extensional fault systems bounding the rift?

- Geochemical studies of magmas and volatiles – Tobias Fischer
- Geophysical imaging of magmas and fluids (MT, seismic): Derek Keir
- Shallow dynamics of magma chambers/dikes and eruptions – Manahloh Bechalew

Topic 5: How does rift topography, on either the continental- or basin-scale, influence regional climate, and what are the associated feedback processes?

- Climate and tectonics and feedbacks - Manfred Strecker
- Modeling perspective - Joellen Russell
- Tectonics and sedimentation at basin scale - Chris Scholz

Topic 6: Hazards and Resources in the EAR and Links to Rifting

- Seismic hazard – Ataley Ayele
- Volcanic hazard – Nicolas d'Oreye
- Oil/gas exploration – Dozith Abeinomugisha

In addition, presentations were organized around synergies with other agencies and international projects, and a panel

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  Lonnie Leithold (North Carolina State University)
- ***A Decade of Research Findings about the Seismogenic Zone Experiment (SEIZE)***
  J. Casey Moore (University of California, Santa Cruz)
- ***A Decade of Research Findings about Subduction Factory Studies (SubFac)***
  Robert J. Stern (University of Texas at Dallas)

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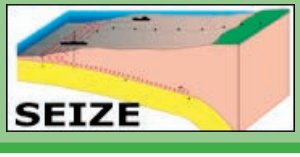

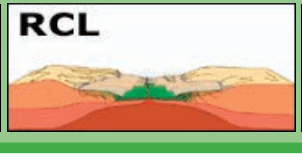

Figure 3 (left). Workshop attendees participate in post-workshop field trip to the northern part of the Newark Basin. Figure 4 (right). Julia Morgan, GeoPRISMS Chair, introduces the GeoPRISMS Program.

of African partners spoke about research collaborations & opportunities in Africa. Break-out discussions were interspersed with the plenary sessions, enabling more focused discussions about potential topics of future research. Breakout sessions on Day 1 focused on identifying the most compelling science, the highest priorities for GeoPRISMS program funds, and which types of experiments or observations might be needed. Participants were also asked to identify which themes, if any, require focusing of effort with concentrated, collaborative investigations at specific sites.

Recognizing that the East African Rift offers significant broader impacts, both in terms of hazards and resources, and in terms of education and capacity building opportunities, plenary sessions were organized to cover these topics. A session at the end of Day 1 focused on seismic and volcanic hazards, as well as opportunities that might arise from oil and gas exploration activities. On Day 2, a panel of African colleagues gave valuable insights into what needs to be considered when entering into partnerships with scientists in African nations, and thoughts on how to build successful collaborations. The conveners also recognized that work in EARS will require PIs to initiate international collaborations and, in some cases, seek funds from other programs at NSF and elsewhere, in order to accomplish their goals, and the goals of the GeoPRISMS Program. Overviews of existing programs and other opportunities for funding were given both by invited speakers and through "pop-up", sessions in which participants were given the opportunity to express their own thoughts and interests to the meeting. Student participants were also given the opportunity to highlight their own work through brief "pop-up" presentations.

Breakout sessions on Day 2 started to focus in on identifying target areas where the key questions could best be addressed, with the aim of narrowing in on a few locations. In addition, the student participants organized an additional session in the evening (and into the early hours) distilling the information they had gained throughout the workshop, into a decision matrix which they presented on Day 3. The final breakouts attempted to gauge interests in the various sites identified as candidates for focused effort.

Workshop Outcomes

Following the meeting, the conveners distilled the feedback and outcomes of all the discussions to identify the following as the potential areas for GeoPRISMS effort.

Primary focus area: The Eastern Rift :The Eastern Branch of the EARS was identified in breakout groups and by the graduate students as a location where a focused inter-disciplinary effort could substantially impact our understanding of rift processes and effectively address the majority of the science questions that form the core of the science plan. This region would encompass the rift from the Tanzanian divergence in the south to Lake Turkana and southern Ethiopia to the north. Particular opportunities highlighted by discussion and relevant to the science plan include (but are not limited to) the role/origin of a plume in this part of this rift; the interaction of the rift and plume with major lithospheric structures; an active magmatic system; along-strike variations in the amount of cumulative extension and lithospheric thickness (from thin in the north to thick in the south); the preservation of a record of the interplay of climate and tectonics. The existing studies characterizing this region provide a rich framework upon which GeoPRISMS science will build.

The conveners also identified what they termed "Collaborative Targets of Opportunity" where we recognize that efforts have been ongoing, offering leveraging opportunities for future programs.

Target 1: The Afar and Main Ethiopian Rift.. This part of the rift system is the focus of intense recent and ongoing international and US efforts. Further

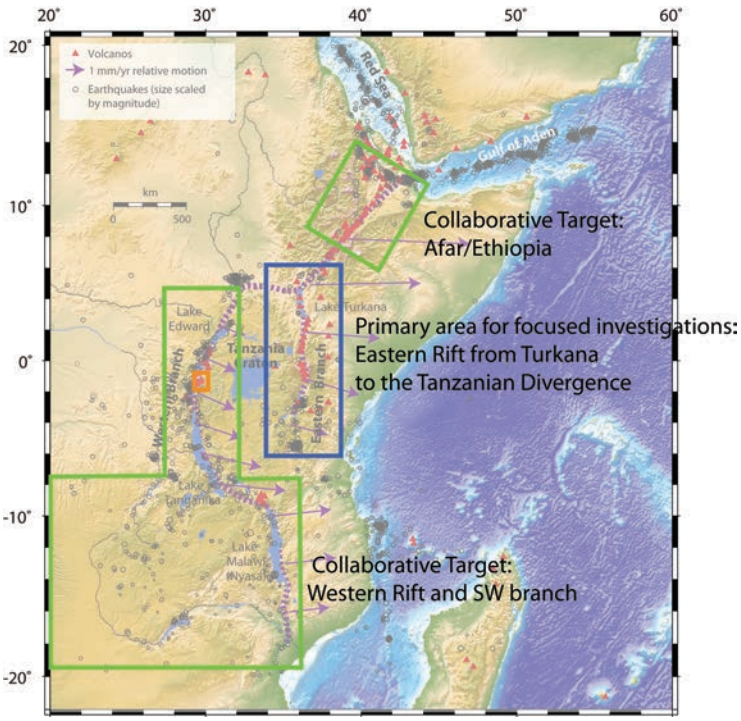

Figure 5. A map of the East African Rift System (EARS) highlighting the primary focus area and the Collaborative Targets of Opportunity discussed in the Implementation Plan.

GeoPRISMS studies that could enhance our understanding of rifting processes include (but are not limited to) efforts that examine strain localization, and studies probing the origin and role of a plume in rifting. The recent rifting and eruption in this region allows studies of active processes.

Target 2: The Western Rift and SW branch. This site would provide the opportunity to examine the role of magmatism in rifting by comparing this comparatively less magmatic system with the highly magmatic Eastern Rift. It also contains the most weakly extended portions of the rift and thus can be used to tackle questions concerning incipient rifting. Finally, deep lakes along the Western Rift contain the longest continuous record of climate/tectonic interactions available for the EARS. New GeoPRISMS studies in this area can leverage recently funded NSF programs and other previous and ongoing tectonic and climate investigations.

Target 3: Synoptic investigations along the entire rift. As identified in many discussions at the workshop, there are questions in the science plan that are best addressed by examining the rift as a whole. These concern rift-wide variations in the origin and timing of volcanism, the strain field along and across the rift and large scale structure and dynamics underpinning the rift system. Thus, key components of the implementation plan should include broad and open data assimilation efforts, strategic infilling of climatic, geochemical, and geophysical observations, and modeling and experimental work, which would provide a framework for the focused investigations along the rift.

The workshop conveners are currently in the process of wrapping up the first draft of the GeoPRISMS implementation plan for the East African Rift System primary site, which then will be disseminated to the community for input. The conveners thank all participants for their attendance and input to this plan, and the GeoPRISMS Office for coordinating a successful workshop.

Cascadia Initiative OBS Data Availability and Funding Opportunities

Ocean bottom seismometer (OBS) data from the 2011-2012 field season of the Cascadia Initiative (CI) are now available at the IRIS Data Management Center (DMC). Data availability can be viewed at the IRIS DMC MetaData Aggregator (http://www.iris.edu/mda).

Relevant Virtual Network codes are as follows:

- _CASCADIA_OBS: NSF Cascadia Initiative Offshore/OBS data (http://www.iris.edu/mda/_CASCADIA_OBS)
- _CASCADIA-TA: NSF Cascadia Initiative, Earthscope TA (http://www.iris.edu/mda/_CASCADIA-TA)
- _CASCADIA: NSF Cascadia Initiative, Earthscope TA plus Regional Network Stations (http://www.iris.edu/mda/_CASCADIA)

Additional CI Metadata also can be found on the Cascadia Initiative Expedition Team (CIET) web site (http://cascadia.uoregon.edu).

Finally, an updated *"Dear Colleague Letter - Clarification of the proposal submission process for the Cascadia Initiative"* has been released by NSF, providing advice and instructions for requesting NSF funding to work with the Cascadia Initiative data http://www.nsf.gov/pubs/2013/nsf13023/nsf13023.jsp

The next call for proposals under this DCL, for amphibious studies, is the GeoPRISMS Solicitation, July 2, 2013

(Program Solicitation NSF 12-537):http://www.nsf.gov/pubs/2012/nsf12537/nsf12537.htm

From the GeoPRISMS Chair

Julia Morgan, GeoPRISMS Steering and Oversight Committee Chair (Rice University)

It's hard to believe, but the eighth and final GeoPRISMS workshop under my watch is about to take place in Wellington, New Zealand (April 15-17, 2013). The GeoPRISMS Planning Workshop for the New Zealand Primary site was, without a doubt, the most popular, with more than 220 applications. Drawing on a broad mix of funding sources, including NSF, New Zealand Ministry of Science, USSSP, InterMARGINS, and more, we were ultimately able to invite ~150 participants from the US, Japan, New Zealand, Australia, Europe, and elsewhere. There are clearly many exciting scientific targets in New Zealand, and participants will have the chance to build a rich portfolio of research approaches to addressing then, both within and beyond GeoPRISMS. Along with the East African Rift System (EARS), studies in New Zealand provide exciting opportunities for global comparisons, while building critical international collaborations.

As a result of all of these planning workshops, the GeoPRISMS Implementation Plan (IP) is nearly complete. The EARS section will be released this month, and the final update for New Zealand should become available later this year. Given the anticipated longer ramp-up periods for both international sites, their IPs will be open and flexible, allowing new opportunities to be realized as they arise. The updated IP is designed to inform the community and to guide future proposers. So, be sure to take a look at the most recent IP on the GeoPRISMS website (*http://www.geoprisms.org/science-plan.html#implementation-plan*).

This year also marks the third call for GeoPRISMS proposals. The updated GeoPRISMS solicitation (deadline July 1st, 2013) can be reviewed online (see box to right). NSF has also revised a "Dear Colleague Letter" (DCL) regarding proposal deadlines for the Cascadia Initiative Amphibious Array Facility; amphibious projects are invited to the GeoPRISMS solicitation (page 13).

As discussed in more detail in the NSF Update (page 12), a new phased funding approach has been implemented for some proposals, in order to better manage the expectations of the GeoPRISMS community. Each primary site has been assigned an initial 2-year "window of opportunity" during which proposals for large data acquisition projects will be accepted to the GeoPRISMS solicitation. Smaller proposals, e.g., for preparatory studies and less-expensive data acquisition, analysis or synthesis efforts, however, will be accepted at all times. While this approach may seem restrictive, NSF plans to maintain flexibility to accommodate unique situations, opportunities, and time frames.

Importantly, the defined "windows of opportunity" make it feasible, and even imperative, for researchers to coordinate prior to submitting large proposals, to identify opportunities and overlapping research interests, and to enable collaboration and cooperation. The GeoPRISMS Office will facilitate to the degree possible, e.g., organizing informational sessions or virtual workshops, compiling lists of projects and opportunities, etc. As an example, researchers interested in working in the Aleutians should keep an eye open for an upcoming AGU mini-workshop to design a proposed "community expedition" to coordinate logistics for a range of possible projects, serving GeoPRISMS as well as other communities.

AGU 2012 was again a busy time, including the popular GeoPRISMS Townhall and Student Forum, numerous GeoPRISMS-related special sessions, and the week-long judging for the best student presentation. GeoPRISMS also sponsored two well-attended mini-workshops during the meeting (page 7), and the first Early Career Investigators Luncheon, jointly sponsored with EarthScope (page 30). Please consider proposing an AGU 2013 Mini-Workshop (page 26), which provide inexpensive, interactive opportunities to discuss highly topical issues of interest to the broader community.

Our education and outreach programs also continue to blossom: we launched the new NSF TUES Mini-Lesson Project, "*Bringing NSF MARGINS/GeoPRISMS Continental Margins Research Into the Undergraduate Curriculum*", led by several members of the GeoPRISMS Education Advisory Committee, along with key MARGINS/GeoPRISMS researchers and On the Cutting Edge geoscience faculty. The opening activities included four well-designed webinars highlighting the four MARGINS Initiatives, given by Becky Dorsey (RCL), Lonnie Leithold (S2S), Casey Moore (SEIZE), and Bob Stern (SubFac). These webinars, now available as webcasts (page 8), define an extraordinary resource for

Upcoming NSF Solicitations

GeoPRISMS Program
[Program Solicitation NSF 12-537]
http://www.nsf.gov/pubs/2012/nsf12537/nsf12537.htm
Deadline: July 1, 2013

EarthScope Program
[Program Solicitation NSF 12-550]
http://www.nsf.gov/pubs/2012/nsf12550/nsf12550.htm
Deadline: July, 2013

Integrated Earth Systems (IES)
[Program Solicitation 12-613]
http://www.nsf.gov/pubs/2012/nsf12613/nsf12613.htm
Deadline: November 14, 2013

students, educators, and researchers, containing informative summaries of the best MARGINS science of the last decade, as well as new directions forward. All speakers and organizers are commended for their efforts!

The Distinguished Lectureship Program is well underway, and I would like to thank all of the 2012-2013 speakers for taking the GeoPRISMS story on the road! We are now in the process of organizing next year's slate of speakers, and an announcement should come out shortly.

Finally, I would like to thank Mike Oskin, Katie Kelley, and Cliff Thurber for their service on the GeoPRISMS Steering and Oversight Committee (GSOC), following their rotations off the GSOC last fall. All three played key roles organizing community planning workshops, and synthesizing those discussions into the living GeoPRISMS Implementation Plan, without which GeoPRISMS research could not go forward. I would also like to welcome Harold Tobin, Gene Yogodzinski, and Maureen Long as new members of the committee.

And a much broader thank you goes out to all other members of GSOC and GEAC who have been instrumental in running recent workshops and student symposia, along with volunteers from the community. All of you are what makes GeoPRISMS work!

NSF Update

Bilal Haq Program Director, (National Science Foundation)

In the last couple of GeoPRISMS Newsletters (Numbers 26 and 28, Spring 2011 and 2012), I underscored the need for GeoPRISMS community to cast a wider net for funding, i.e., proposing not only to the GeoPRISMS Program (for the program's sequestered funds) but also to Core and other special programs within the Divisions of Earth and Ocean Sciences. This strategy seems to be working. and GeoPRISMS-related proposals have been received by several programs and initiatives within NSF. While a large share of the sequestered funds have gone toward funding large (often community-wide) data gathering efforts, Core programs are helping out with individual proposals for data analysis and thematic studies.

In the last issue of the Newsletter, I also emphasized the need for a phased approach to funding, because the relatively modest ear-marked GeoPRISMS funds can sustain only a limited number of large-scale, expensive data-gathering efforts at any given time. Thus, we envisioned that as we ramp in new primary sites, by necessity, we would ramp down older sites where the resources were focused previously. And now that the operational plans for nearly all primary sites are in hand (with the exception of New Zealand, which is currently being finalized), NSF has formalized this phased funding schedule. Readers are referred to the revised GeoPRISMS Program solicitation for a complete text (see box on page 13, with link to solicitation).

Under this time table, large-scale data-gathering activities for GeoPRISMS' primary sites (which in some cases might require planned community efforts) will be afforded "windows of opportunity" for proposal submittal (based on due consideration of program priorities and logistics) that lasting up to two funding cycles. By fiscal necessity, this is meant to constrain large-scale (million to multi-million dollar) efforts, but not necessarily smaller sampling excursions. The major data acquisition phase for Cascadia (that is, under the aegis of GeoPRISMS) is now considered to be complete. Thus, the major GeoPRISMS resources will now be focused on ENAM in FY13 and 14, Alaska/Aleutians in FY14 and 15, EARS in FY15 and 16, and New Zealand primary site in FY 16 and 17. Note, however, that additional data acquisition activities at these sites can continue, if necessary, with the support of Core and other special programs. We need to emphasize that this framework is meant to be a guideline and we will remain flexible enough to modify the schedule as changing needs or situations might dictate. Under the new revised Program Announcement, the deadline for the next GeoPRISMS funding cycle (for funding in FY14) is July 1st, 2013.

On another note, the community is aware that the GeoPRISMS Office will move from Rice to the University of Michigan in October 2013 and the leadership of the GeoPRISMS Steering and Oversight Committee (GSOC) will pass from Juli Morgan to Peter van Keken. The first three busy years of the GeoPRISMS Program, when it went through a very active planning phase, have been extremely successful due to the tireless efforts of the GSOC members and its chair, Juli, as well as the office staff (Alana Holmes, Charles Bopp, Alison Henning, Susi Haveman, Anaïs Férot, and August Costa). We at NSF would like to acknowledge the time and efforts that the members and chair have devoted to the Program, which ultimately shows in the high quality of science being accomplished under its banner.

We would also like to take this opportunity to welcome Peter as the incoming chair of the GSOC (starting on October 1, 2013) and wish him all the best for the challenges ahead, when both the GSOC and the Program at NSF will have to grapple with limited resources and an evolving science funding climate in Washington. The GSOC, as the representative of the wider research community interested in the amphibious geoscience at the continental margins, will be called upon for advice on the daunting task of identifying priorities that can produce the best output given the available resources. GeoPRISMS (and MARGINS before it) is often cited as a Program that has adhered to best practices in promoting new and ground-breaking science, has built an important interdisciplinary community that is heavily involved in planning and execution, and has actively recruited new generations of researchers to its fold. With your help, we hope to keep it that way!

NSF GeoPRISMS Proposal Deadline
July 1, 2013

GeoPRISMS Program (Program Solicitation NSF 12-537)
http://www.nsf.gov/pubs/2012/nsf12537/nsf12537.htm

NSF GeoPRISMS will be accepting research proposals for the FY14 solicitation, subject to the following advice:
In order to target the limited available resources in a practical and cost-effective manner, NSF is implementing a phased funding model to address the extensive science objectives and numerous primary research sites identified by the community during their planning activities. According to this phased implementation model, NSF advises the community that some of the primary sites will be prioritized for certain types of proposals each year. This model allows proponents to self-organize, plan, and coordinate their research. This also allows GeoPRISMS program officers to better leverage the limited available funds each year. The community will continue to provide recommendations to the Foundation through community workshops and the GeoPRISMS Steering and Oversight Committee (GSOC). Based on this input, program funding priorities and focus may continue to evolve. The GSOC is tasked with continually monitoring the operations and reviewing progress towards the stated goals within each initiative's science plan, as well as developing the next set of priorities with the community's involvement, while encouraging attempts at integration and syntheses of results.

The phased funding model adopted by GeoPRISMS has defined "windows of opportunity" during which proposals of certain types will be accepted for given primary sites. Large and costly field experiments can only be supported in one site at a time, for up to two sequential years. Smaller studies (such as preparatory work, data analysis, and synthesis, or thematic studies), requiring a lower percentage of the overall annual budget, will be considered for all sites each year. For example, during the early years of GeoPRISMS, the Cascadia primary site received high levels of funding. So while data acquisition for that site will now be phased out within this program, data synthesis may still be supported. The windows of opportunity for large-scale data acquisition projects are thus defined, by site:

- **Cascadia:** [completed for GeoPRISMS, but will continue to be accepted in Core Programs]
- **ENAM:** FY13-14 (July 2012 and 2013 deadlines)
- **Alaska/Aleutians:** FY14-15 (July 2013 and 2014 deadlines)
- **EARS:** FY15-16 (July 2014 and 2015 deadlines)
- **New Zealand:** FY16-17 (July 2015 and 2016 deadlines)

It is important to note that these dates serve only as guidelines, and that NSF is open to accepting proposals that fall outside of these guidelines when justified by unique and time-limited opportunities. In such cases, PIs must contact the program officers ahead of submission.

In addition, workshop proposals for science or implementation and post-doctoral fellowship proposals relevant to GeoPRISMS science plans will continue to be accepted to the GeoPRISMS Solicitation each year.

For more info visit:
http://www.geoprisms.org/research.html
http://www.geoprisms.org/program-announcement.html

For information about submitting proposals to work with Cascadia Initiative data:
http://geoprisms.org/cascadia/cascadia-dcl.html

Workshop Report: "Ultra-Deep Drilling Into Arc Crust: Genesis of Continental Crust in Volcanic Arcs"

Waikoloa, Hawaii, September 18-21, 2012

Workshop Conveners: Yoshihiko Tamura (JAMSTEC, Japan), Shuichi Kodaira (JAMSTEC, Japan), Susan M. DeBari (Western Washington University, U.S.A.), Jim Gill (University of California, Santa Cruz, U.S.A.)

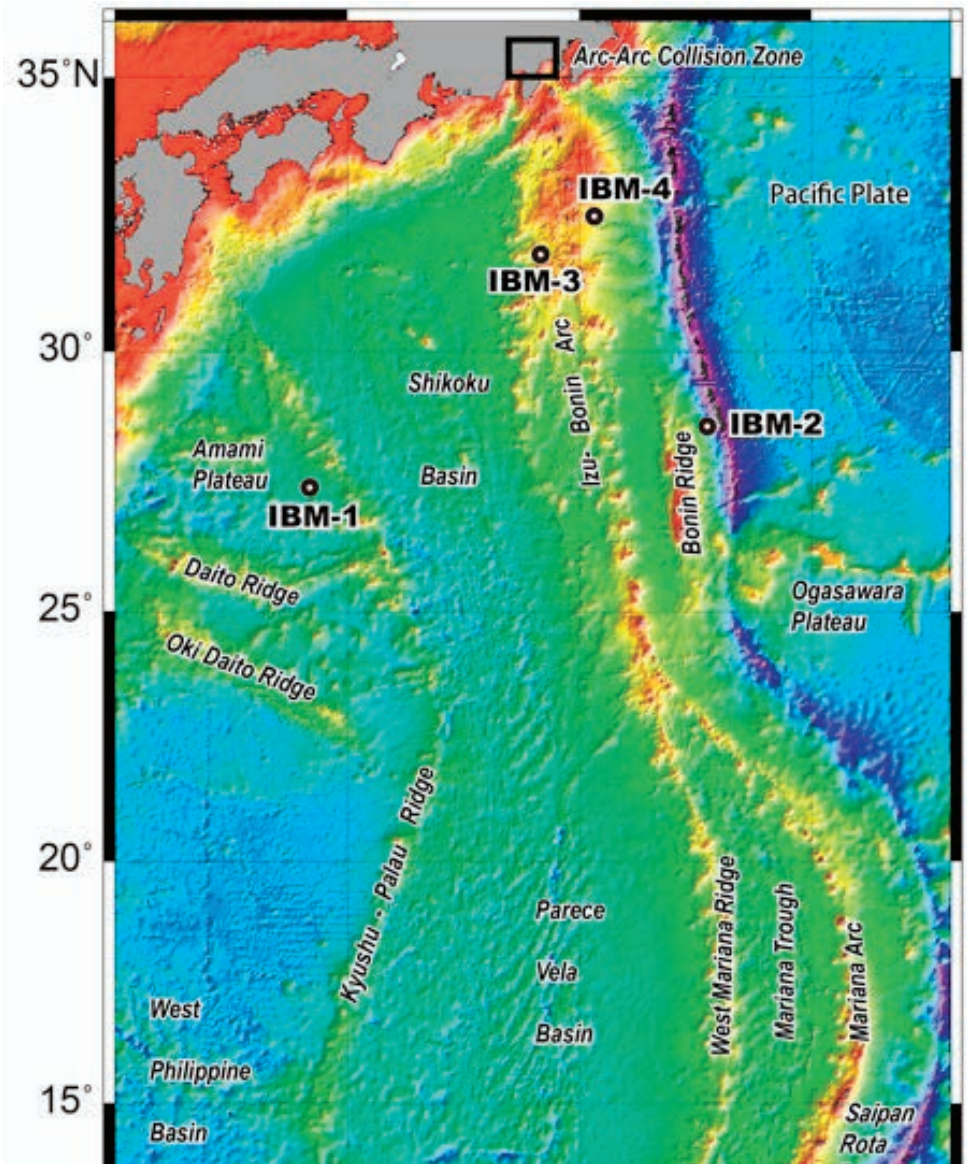

Figure 1. Location map of the Philippine Sea Region. Numbers show proposed drilling sites IBM-1, IBM-2, IBM-3, and IBM-4.

A workshop was held September 18-21, 2012, in Kona, Hawaii, with the goal of soliciting international support for the endeavor of understanding continental crust formation in the Izu Bonin arc in the northwest Pacific ocean. Central to this project is riser-based deep drilling into the mid-crust of the Izu Bonin arc using D/V CHIKYU. The workshop was primarily sponsored by a Grant-in-Aid for Creative Scientific Research 19GS0211 to Y. Tatsumi and JAMSTEC. Additional funds to support attendance of U.S.-based scientists were obtained from the U.S. Scientific Support Program (through the Consortium for Ocean Leadership) and the GeoPRISMS Program.

The ~3000 km long intra-oceanic Izu Bonin-Mariana arc (IBM) has been long recognized as a primary site for understanding the formation of the continental crust (Fig. 1). A long history of past multidisciplinary exploration revealed the ubiquitous presence of a conspicuous low-Vp velocity (6.0-6.5 km/s) mid-crust layer that seismically resembles continental crust. This layer is common in arc crust, and, as such, is crucial in interpreting arc crustal structure globally. In the northern part of the IBM system (the Izu Bonin arc), the low-velocity mid-crust layer is within reach of ultra-deep riser-drilling and has been a dedicated target of the International Ocean Discovery Program (IODP). The IODP Science Plan for 2013-2023 "Illuminating Earth's Past, Present, and Future" highlights the formation of continental crust as high-priority scientific Challenge 11 "How do subduction zones initiate, cycle volatiles, and generate continental crust?" as part of the main theme "Earth Connections: Deep Processes and Their Impact on Earth's Surface Environment".

Deep-drilling a single hole into the Izu Bonin arc is a major commitment in time and resources. Success is reliant on three companion riserless drilling expeditions in the arc by D/V JOIDES Resolution that are scheduled for 2014. These expeditions will provide crucial new data for the overarching goal of obtaining a complete temporal and spatial petrologic cross-section of Izu Bonin arc magmatism. These expeditions provide vital support for the planned CHIKYU drilling (IODP Proposal 698-Full3 at Site IBM-4) that will be discussed as a priority project at the CHIKYU+10 workshop on 21-23 April 2013 in Tokyo, Japan (http://www.jamstec.go.jp/chikyu+10/index.html). This workshop will prioritize the future activities of the CHIKYU.

Figure 2. All participants at the conference venue, Waikoloa Beach Marriott, on the Big Island of Hawaii.

Overview

The workshop was attended by 58 participants (34 from US, 13 from Japan, 4 from UK, 2 from Switzerland, and 1 each from Mexico, Canada, Taiwan, New Zealand, Australia, Figure 2).

Attendees included a wide range of geophysicists, geologists, geochemists and petrologists whose research involves the genesis of arc crust. A primary goal of the workshop was to inform the broader geologic community about the goals of drilling in the Izu Bonin arc, as well as to solicit a very broad, international base of participation in proposed IODP expeditions, to rally support for the planned CHIKYU deep-drilling, and to obtain input on objectives and corollary studies.

The first day opened with background talks and discussions aimed at providing a framework for the proposed drilling. Talks focused on the physical and geochemical evolution of the Izu Bonin Mariana arc through time, the geophysical framework (including the enigmatic seismic properties of the middle crust and comparison to the Aleutian arc), and an overview of the goals of the three scheduled IODP drilling legs (subduction initiation, arc foundations, rifted rear arc).

The second day focused specifically on the CHIKYU deep drilling proposal and potential outcomes. This theme was supported by talks on the processes of crustal growth and evolution from exposed crustal sections and from thermal modeling.

The third day provided a break from talks in the conference room and allowed more informal discussions among participants during a field trip to observe the geology of the active Kilauea Volcano eruption (Figure 3).

The forth and final day focused on specific scientific objectives for deep drilling in the Izu Bonin arc and what at-sea drilling strategies and shore-based studies would best support those objectives.

Workshop Program

The key question that motivates deep drilling in the Izu Bonin Mariana arc is how the middle crust evolves and how the processes of its growth relate to the growth of continental crust. Deep drilling in the IBM arc offers the opportunity to examine the critical relationships between magmatic processes and resulting geophysical structure. The linkages established here can also be used as a template to interpret active arc processes globally from geophysical surveys.

The workshop was structured around several key topics, and the key results are as follows:

(1) Geophysical overview of the Izu-Bonin-Mariana arc-back-arc system

More seismic surveys have been acquired over the IBM arc-back-arc system than any other island arc setting on Earth. Consequently, it is possible to contrast seismic velocity models across the arc representing different evolutionary histories, and to constrain them with strike lines where available. A multi-channel seismic reflection (MCS) survey was acquired in 2008 around the proposed drilling site of IBM-4 revealing a well-resolved domal basement high beneath the proposed drilling site. Comparison of MCS data with core recovered from ODP Site 792 indicates the section above the basement is comprised of Quaternary to upper Eocene volcaniclastic sediments. At the top of the basement high, andesitic lavas were sampled at 886 meters below seafloor (mbsf). A seismic refraction survey using densely deployed ocean bottom seismographs (OBSs) was also conducted along the MCS profile and clearly show a domal structure in the 6 km/s Vp iso-velocity contour. These Vp values, which are critical to identification of the middle crust, are located 3.5 km below sea floor at Site IBM-4, within reach of CHIKYU drilling.

(2) The generation of intermediate composition (andesitic) magmas and their relevance to growth of continental crust

The workshop presentations and discussions reinforced consensus that the Izu Bonin arc was the ideal place worldwide to study juvenile mid-crust formation, as there is minimal sediment recycling and minimal pre-existing continental crust. Hence, the net flux from the mantle/subduction zone to the crust is visible with the greatest possible clarity.

Specifically questions to address include the following:

- What is the origin of the mid crust (test various hypotheses)
- Are intrusive and extrusive rocks genetically related (i.e., does the mid crust form in a distinct manner from the extrusive rocks)?

- Do all arc magmas stall at mid-crust levels before eruption?
- How fast do magmas ascend from mantle to crust?
- How are mafic magmas expressed within the crust – are they long-lived evolving bodies or rapidly solidifying small plutons?

(3) Using exposed arc sections in conjunction with IBM deep crustal drilling to understand the generation and growth of arc crust, and transferability to other active arc settings

Investigation of arc crustal sections exposed on land provide an important companion study for deep crustal drilling. The study of paleo-arcs provides a larger, more volumetrically abundant record of both the intrusive and extrusive record of the processes that generate continental crust from mantle-derived magmas. In turn, deep crustal drilling can answer many questions that remain unanswered after examination of exposed sections, the activity of which ended long before they were amassed in their current locations. For example, through the direct petrological, geochemical, and geophysical characterization of the crust at site IBM-4, a reference section of intraoceanic arc crust can be generated. The cored rocks and borehole properties can be directly linked to the seismic velocity structure of the crust, providing the first in situ test of seismic velocity models against known rock types and structures within the deep arc crust. The IBM-4 site will provide an essential reference both for active arc crust and for accreted arc crustal terranes.

(4) Other salient points related to drilling operations

- Temperature estimates for the proposed drilling depth of 5500 mbsf at IBM-4 do not exceed 170°C
- All coring cannot reasonably be obtained throughout the 5500 m drilling depth so borehole imaging technology will be critical. Drilling operations will also include sidewall coring (sampling from uncored intervals) and vertical seismic profiles.
- Costs for drilling with Chikyu will be on the order of $600,000 - $700,000 per day, with an estimate of roughly 9 months to reach 5500 mbsf. The total cost is thus as much as $200 million.

(5) Scientific objectives

At the end of the workshop, participants formalized ten of the most important scientific objectives of drilling at Site IBM4. These objectives are as follows:

1. What is the tempo of constructing arc juvenile continental crust?
2. How does arc crust composition change with time?
3. Is there older (pre-51 Ma) crust that makes up significant parts of the Izu arc?
4. How do the results of ultradeep drilling into the Izu forearc fit with perspectives gained from other drill sites and from arc crustal sections?
5. What is the relationship and proportion between volcanic and plutonic rocks in ultradeep juvenile arc crust?
6. What was the role of fluids in the evolution of the rocks that we will penetrate?
7. What is the nature of the ultradeep biosphere?
8. What can we learn about convergent margin mineralization by ultradeep drilling into arc crust?
9. What is the paleomagnetic record preserved in Izu arc crust?
10. How well can we use surface geophysical measurements such as heat flow and seismic velocity to infer properties at depth?

Given the distinct core recovery rate in riser-drilling platforms (i.e. targeted sampling) compared to riserless drilling (i.e. almost continuously coring possible) the workshop discussions also revolved extensively around how to prioritize sample recovery strategies. Workshop participants made recommendations for prioritizing sample recovery, in particular around transitional zones derived from geophysics as well as extensive coring at the base of the drillhole. Further discussion is likely to occur at Chikyu+10.

For a more detailed report on the workshop see http://www.jamstec.go.jp/ud2012/

Figure 3. Participants looking over at the summit caldera of Kilauea and the active eruption in Halema'uma'u crater during the field trip led by Don Swanson.

Roadmap to Future scientific drilling in the Izu Bonin arc

In 2014 three-riserless expeditions with JOIDES Resolution are scheduled in three sites (IBM-1, IBM-2, IBM-3) of the Izu-Bonin Arc. A call to participate in these expeditions has been made with application deadlines of May 1, 2013. The three legs (each about two month duration starting in April 2014)

are designed to address key questions of crust generation and modification. The expeditions will be kicked off at site IBM-3 in the rear Izu arc to generate data on the missing half of the subduction factory, as most drilling efforts have focused on the IBM forearc (697-Full3; http://www.jamstec.go.jp/ud2012/img/IBM3(697-full3).pdf). This leg will document across-arc variation in magma composition from Eocene to Neogene time to test models of mantle flow, intra-crustal differentiation, and magma generation during the arc evolution. The following two months are scheduled to drill into a section of pre-arc oceanic basement at site IBM-1 (695-Full2; http://www.jamstec.go.jp/ud2012/img/IBM1(695-Full2).pdf). This site is located beneath the 1-1.5 km of sediments in the Amami Sankaku Basin west of the Kyushu-Palau Ridge remnant arc. Such basement may make up an important part of the lower-arc crust, and contribute to arc magma chemistry through assimilation and partial melting. The 2014 drilling campaign in the Izu-Bonin arc will finish at Site IMB-2, close to the Bonin Ridge (696-Full3; http://www.jamstec.go.jp/ud2012/img/IBM2(696-Full4).pdf). The goal at this site is to unravel subduction initiation and test the supra-subduction zone ophiolite model.

Although each of the three scheduled JOIDES Resolution expeditions stand on their own merits, they will also deliver crucial complementary data for the ambitious ultra-deep drilling proposal (IBM-4; 698-Full3). The ultra-deep drilling project itself would provide first-ever in-situ unaltered samples from the region in the arc crust where crustal differentiation and evolution is most dramatic. The "transferability" of a direct view of the nature of the middle crust in the Izu-Bonin arc with crustal studies from exhumed sections has the potential of being mutually transformative. Ground-truthing potential exists for a large variety of techniques. How do seismic velocities and densities vary locally in the borehole and how are those parameters recovered from surface observations? How accurate are surface heat flow measurements in projecting the thermal evolution in the borehole? In addition, deep drilling provides tremendous opportunities to obtain new insights on fluid compositions and distribution in the crust, the presence of a deep biosphere, and the potential for observing in-situ mineralization processes.

The new data from all these drilling expeditions will provide for innovative cross-disciplinary research through the integration of many subdisciplines and multinational specialists. The extraordinary collaborative effort made at sea will culminate in extensive post-cruise shore-based studies (e.g., isotope geochemistry, thermo- and geochronology, geophysical experiments with core samples) that are set to transform our understanding how juvenile arc crust forms and differentiates with time.

Compiled by Susan DeBari, Philipp Ruprecht and Susanne Straub

AGU Mini-Workshop: Marine Geophysics in the Cascadia Primary Site

Convened By: W.S. Holbrook, G. Abers, M. Tolstoy, S. Carbotte, A. Trehu, H. Tobin, D. Toomey, K. Keranen, P. Johnson

This mini-workshop, held on Sunday, December 2, 2012, focused on recent marine and "amphibious" geophysical activities in the Cascadia Primary Site. Projects (and presentations) included:

- Cascadia Initiative OBS Passive-Source Deployment & Data (Doug Toomey & Spahr Webb)
- COAST Open Access Marine Seismic Project (Steve Holbrook)
- Ridge2Trench Marine Seismic Project (Suzanne Carbotte)
- Onshore-offshore Integration of Seismic Data Sets (Geoff Abers)
- Review of Legacy Seismic Data in Cascadia (Anne Trehu)

In addition, several contributions from the floor reviewed related projects, including

- Models of subduction and continental accretion in Cascadia (Haiying Gao)
- Cascadia Forearc Faults (Katie Keranen)
- Review of Magnetotelluric studies in Cascadia (Adam Schultz)
- OOI Geophysics (Will Wilcock)

The mini-workshop allowed the community to review progress, coordinate activities, and plan future work in Cascadia, leveraging the current momentum from the present marine geophysical studies in Cascadia, and providing the underlying context for the next decade of interdisciplinary studies of the area.

For more information about the mini-workshop, links to related projects, and to download presentations, visit: **http://www.geoprisms.org/agu-mini-workshops/cascadia-2012.html**

Leveraging IODP Scientific Drilling in Support of Subduction Cycles & Deformation Science Objectives: AGU Mini-Workshop 2012

AGU 2012 Fall Meeting, San Francisco

Robert Stern (U. Texas, Dallas), John Jaeger (U. Florida), Brian Jicha (U. Wisconsin), Terry Plank (Lamont-Doherty Earth Observatory), Dave Scholl (U.S. Geological Survey), Gene Yogodzinski (U. South Carolina)

About 25 scientists attending Fall AGU meeting in San Francisco took a couple hours out of their busy schedules to participate in a Thursday evening mini-workshop at the Grand Hyatt about how to best use seafloor drilling to address GeoPRISMS Subduction Cycles and Deformation (SCD) science objectives. A new decade of scientific ocean drilling will occur when the new International Ocean Discovery Project (IODP) gets underway; this is planned for 2013-2023 (For more information about IODP and GeoPRISMS, look at the GeoPRISMS Fall 2012 Newsletter). The primary goal of the AGU mini-workshop was to stimulate interested geoscientists to consider how IODP drilling in the Aleutians, Cascadia, and Hikurangi margins can attack the seven "key questions" in the SCD Initiative draft Science Plan (*see http://www.geoprisms.org/images/stories/documents/DSP/4.pdf*). The two-hour brainstorming session was fueled by hors d'oeuvres, a cash bar, and six brief (5 minute presentations plus 10 minutes discussion) talks.

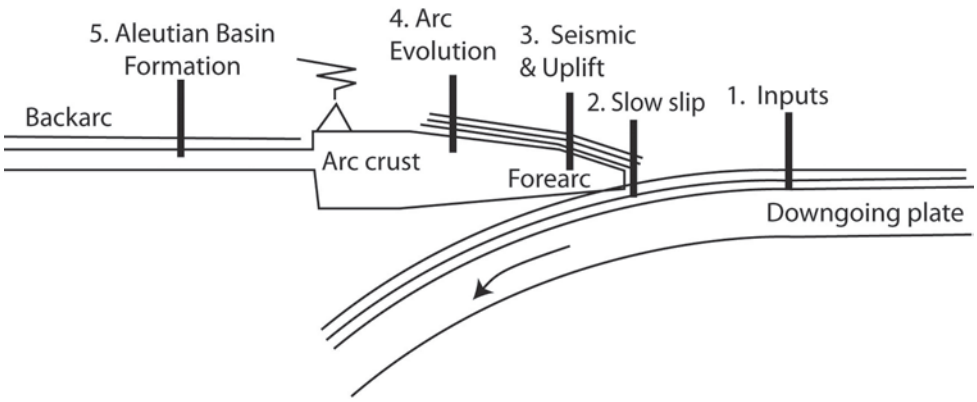

Figure 1. General diagram showing tectonic locations being discussed for IODP drill sites in support of GeoPRISMS science objectives. Site 1: sediment and basement inputs to subduction factory and seismogenic zone, important for Cascadia, Aleutians, and Hikurangi; Site 2: Shallow drilling to understand slow slip events, suggested for Hikurangi margin. Site 3: forearc drilling to reconstruct megathrust events and mountain growth, suggested for Aleutian and Cascadia margin; Site 4: Volcanic history (via tephra) and early arc basement, suggested for Aleutian arc; Site 5: Aleutian Basin formation and evolution.

Terry Plank discussed how to use the drillship to determine subduction zone inputs. It is essential to sample the oceanic crust and sediments that are subducted at each margin, in order to understand how these inputs affect the mechanical properties of fault zone rocks, the generation of fluids in the subduction zone, and the formation of arc magmas (Fig. 1 site 1). Terry noted that for Cascadia there are already several sediment reference sites, and there are even sites in the northern Juan de Fuca plate where basement has been well-sampled and studied hydrologically. These materials need to be analyzed in order to establish the chemical composition of what is being fed into the Cascadia subduction zone. A major uncertainty is what is accreted in the fore-arc and what is swept down to ~100 km to feed the arc magmatic system. Understanding inputs to the Aleutian-Alaskan subduction factory is a bigger problem: this convergent margin is much longer than Cascadia (~3000 km vs. ~1000 km) and sedimentation on the downgoing plate changes along strike from thick, abyssal plain and trench-axis turbidite deposits in the east to thin pelagic sediments overlain by thinning trench-axis deposits in the west. For the eastern Aleutians, we have good but very incomplete DSDP sampling of the Zodiac Fan and more sediment coring in the Gulf of Alaska is expected from scheduled drilling. In contrast, not much is known about sediments on the downgoing plate feeding the intra-oceanic Aleutian arc, west of the Bering shelf break. Fracture zones (FZ) like the Amlia FZ provide additional complexity: these may mark unusual zones of thick sediments, altered oceanic crust, and serpentinized mantle. Can we recognize these inputs in the resultant arc magmas? The subducted oceanic crust appears to become ever more important to arc outputs toward the west, but less than 20 meter of basaltic basement have been recovered from the entire 3000 km Aleutian sector. We need to recover several hundred meters of oceanic crust, because we cannot constrain how much H_2O and CO_2 is carried down into the subduction zone unless we understand alteration of the subducting oceanic crust. For the Hikurangi margin, ODP Leg 181 sampled the upper sediments, but the lower km (related to Hikurangi Plateau volcanism) has not yet been sampled. Plans are underway, however, to drill a new section of sediment and basement input to the Hikurangi margin (see below).

Dave Scholl outlined how we could obtain a long-term history of major Aleutian seismogenic zone earthquakes by drilling into the forearc to core the deposits of landslides and turbidites that shallow earthquakes create (Fig. 1 site 3). There are two challenges here: to distinguish seismogenic deposits from those produced by other causes, such as non-seismic forearc slope collapse; and how to date these deposits - once identified - with the precision needed at the scale of the seismic cycle? It was also noted

that we have a better understanding of the Cascadia seismogenic record than we know the Alaskan record, in spite of the fact that major (M>8 to 9.2) earthquakes (eight have occurred since 1899) are more frequent along the Alaskan-Aleutian margin.

John Jaeger continued on the theme of how we could interpret tectonic history from studying deep sediment cores (Figure 1, site 3). He outlined how these sedimentary records could illuminate linkages between uplift and deformation on the one hand and climate-mediated erosion of growing mountains on the other hand. He further noted how these could combine to create a high sedimentary flux that can turn off forearc deformation.

Brian Jicha explored how the drillship could be used to understand the early Aleutian subduction zone development, and how the arc magmatic system has since evolved (Figure 1, site 4). Aleutian arc subduction is thought to have begun in Eocene time - perhaps along an E-W trending fracture zone - capturing part of the Mesozoic Kula or Resurrection plates to form the Aleutian Basin (see below). We should be able to find a suitable place in the Aleutian forearc where a continuous tephra record – the products of Aleutian and Alaskan explosive eruptions – is preserved. The tephra record – which has wind-direction and compositional bias - could be supplemented by volcaniclastic sediments, which is less compositionally biased but which would preserve the magmatic record of a few upslope volcanoes. Drilling through sedimentary cover to sample forearc basement should recover magmatic products accompanying formation of the Aleutian subduction zone. It is possible that the Aleutian Basin formed by Paleogene backarc spreading, instead of being trapped Pacific/Kula/Resurrection plate. Recovery and study of Aleutian Basin crust would be a primary constraint on timing and nature of Aleutian arc subduction initiation.

Bob Stern outlined using the drillship to understand the age and origin of the Aleutian Basin, and use this information

Figure 2: Participants of the GeoPRISMS/IODP mini-workshop take a break between sessions.

to constrain interpretations of surrounding regions (Fig. 1 site 5), such as the early history of the Aleutian Arc as well as the thermal history of the Aleutian Basin and basement-rock beveled Beringian Shelf. The issue is that there is a lot of sediment in the Aleutian Basin (km's), but there might be regions where the sedimentary section is thinner. By drilling to basement though 1.5 km of sediments, we should recover a complete high-latitude record of Cenozoic climate history as well as direct age of Aleutian Basin crust.

After these five samplers, we heard briefly about more advanced plans for drilling in the Hikurangi SCD focus site to understand slow slip events (Figure 1, site 2) from Laura Wallace. Hikurangi slow slip events are unusually shallow and may propagate all the way to regions near the trench that are accessible to drilling. Drilling may thus give us direct access to sampling rocks and fluids formed in association with slow-slip events. A riserless drilling proposal currently in the review and ranking process has a coring transect from the subducting plate (inputs) across the overriding plate above the SSE source. There is an input site planned: 1 km of sediments followed by ~200 m penetration into basement. The input site will provide protoliths of the fault zone rock at depth in the slow slip event source area. A proposal to drill a ~5 km riser hole will be submitted in April 2013. Hikurangi drilling will collect samples related to the former MARGINS "Source to Sink" site in the nearby Waipaoa catchment.

We were also told about an interesting Brothers volcano (Kermadec Arc) IODP pre-proposal in the works, and a full IODP proposal to drill at the Lord Howe Rise and New Caledonia Basin to look at the consequences of subduction initiation along the Tonga/Kermadec/Hikurangi subduction system. These two proposals are likely to be submitted in April 2013.

Following these presentations, the floor was open to other inputs. Gene Yogodzinski led the group in broad discussions, from Cascadia sediment input, the need for coring into oceanic basement at all sites, the importance of water-rich saponite in oceanic crust, the importance of studying input material to understanding the rheology of the plate interfaces, to the opportunity presented by drilling into the Amlia fracture zone because of unusual sediments and ocean crust alteration, to the importance of biogenic silica as a fluid source, to further discussion of the significance of the tephra record, to engineering considerations for drilling in the Aleutian Trench, to the Cascadia forearc slope basins being obvious targets for sampling the paleoseismic record.

After the open discussion, John Jaeger outlined how to propose an IODP workshop, which is useful for moving from broad ideas to specific drilling proposals. Since the workshop, we have learned that guidelines for preliminary proposals are being revised and will be in place for the Oct. 1, 2013 deadline. Some groups interested in similar drilling objectives gathered to begin planning.

Status Report on the GeoPRISMS Data Portal: February, 2013

Andrew Goodwillie and the MGDS/IEDA Database Team (Lamont-Doherty Earth Observatory, Columbia University)

GeoPRISMS data portal (www.marine-geo.org/portals/geoprisms) was established in 2011 to provide convenient access to data and information for each primary site as well as to useful data resources.

Since the last newsletter report, the database group participated in the GeoPRISMS East African Rift System implementation meeting, holding a hands-on data workshop there, and in the AGU mini-workshop on Cascadia science. The on-line GeoPRISMS bibliography was also much expanded. Highlighted below are some recent contributions of field program information and data of interest to the GeoPRISMS community.

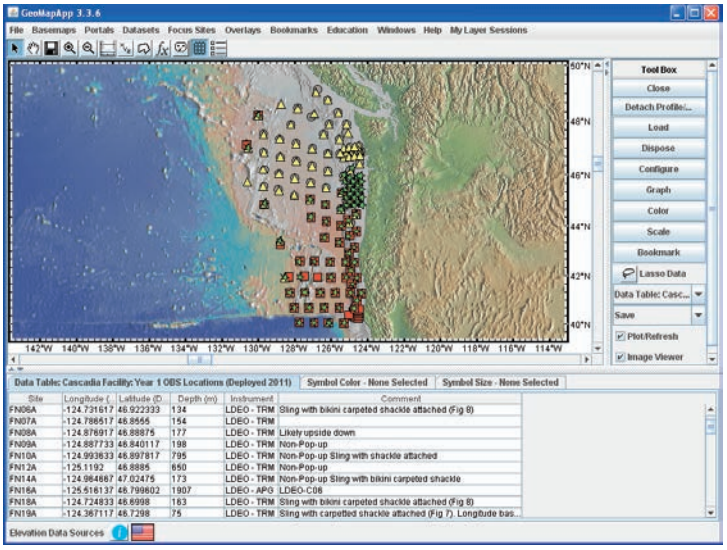

Figure 1. Four years of Cascadia Initiative OBS deployments covering much of the Juan de Fuca and Gorda plates along the Cascadia margin are plotted on the most recent bathymetry and land elevation compilation of the Global Multi-Resolution Topography synthesis. Grey circles – Year 1 surveyed-in OBS locations; red squares – year 2 best-available locations; yellow triangles and green stars – year 3 and year 4 planned OBS deployment locations, respectively.

Cascadia

Cascadia Initiative Year 2 OBS operations continued throughout the autumn (Fig. 1). Oceanus cruise OC1208B led by Doug Toomey and Susan Schwartz oversaw the deployment of 15 trawl-resistant OBS instruments which are designed to avoid snagging from commercial fishing nets. That was followed by the last cruise of the field season, leg 6 – Oceanus cruise OC1209A – during which chief scientists Anne Tréhu and Jeff McGuire and their team deployed a further 14 trawl-resistant devices along with 10 traditional OBSs. Year 2 OBSs will be recovered in 2013. Field program information and links to data for each Cascadia Initiative cruise are available via the GeoPRISMS data portal.

The focus upon adding more multibeam swath data to a bathymetric compilation for Cascadia has continued. Due out in April 2013, version 2.4 of the Global Multi-Resolution Topography synthesis is used as the base map in GeoMapApp and will incorporate sonar data from an additional 8 cruises, including the dedicated survey done in summer 2011 by OSU's Chris Goldfinger and Chris Romsos aboard Thompson leg TN265.

ENAM

The summer 2012 survey cruise RB1202 (chief scientists Armstrong, Calder, Gardner, and Johnson, all at UNH) completed sonar imaging of the ENAM region under the Law of the Sea program. The resultant bathymetry and backscatter grids can be viewed in GeoMapApp under the ENAM focus site menu (Fig. 2) with examples shown in Fig 3.

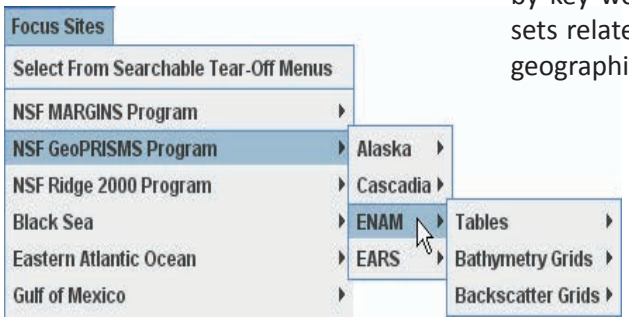

Figure 2. In GeoMapApp, GeoPRISMS Focus Site menus provide access to a range of data and instrument station information for each primary site.

GeoPRISMS Data Portal Tools & Resources

Search For Data. With this customised GeoPRISMS interface, search for data by key word, NSF award number, data sets related to publications, or within a geographical box.

Data Management Plan tool (www.ieda-data.org/compliance). Generate a data management plan for your NSF proposal. The on-line form can be quickly filled in, printed in PDF format and attached to a proposal. We also have developed a tool to help PIs show compliance with NSF data policies.

GeoPRISMS Bibliography (www.marine-geo.org/portals/geoprisms/references.php). This integrated, searchable GeoPRISMS bibliography now contains all references from the GeoPRISMS Science Plan, bringing the total citations to more than 600, with papers tied to associated data sets. Searching can be done by primary site, paper title, author, year, and journal. The lists of publications can also be exported to EndNote™. To help grow the number of relevant citations, community members can submit references information using a handy web form linked to the bibliography web page.

GeoMapApp and Virtual Ocean GeoMapApp (www.geomapapp.org). It is a free map-based data exploration and visualization tool. Enhancements in version 3.3.6 include improved caching of menus for faster start-up times, better handling of imported Excel™ spreadsheets and, for GeoPRISMS, additional data sets and

tables available through the Focus Site menus (see Fig. 2). Coming in April is an updated multi-resolution base map.

Use GeoMapApp to generate custom maps, to explore built-in data sets and to import your own data tables, spreadsheets, grids, images and shapefiles. Multimedia audio-visual tutorials are available on the GeoMapApp web page and on YouTube™. Virtual Ocean (www.virtualocean.org), version 2.5.6, offers GeoMapApp-style capabilities in a virtual globe environment.

Contribute Data (http://www.marine-geo.org/contribute.php). This simple web tool allows users to submit grid files, tabular data sets including those in spreadsheet format, and shapefiles. Once added to the GeoPRISMS database, these data sets become available to the broader community immediately or can be placed on restricted hold until made public.

GeoPRISMS MediaBank (media.marine-geo.org). Access GeoPRISMS-related images including photos from field expeditions. Please send compelling images for inclusion in the gallery!

The GeoPRISMS data portal team is here to help the community. Please contact us at info@marine-geo.org.

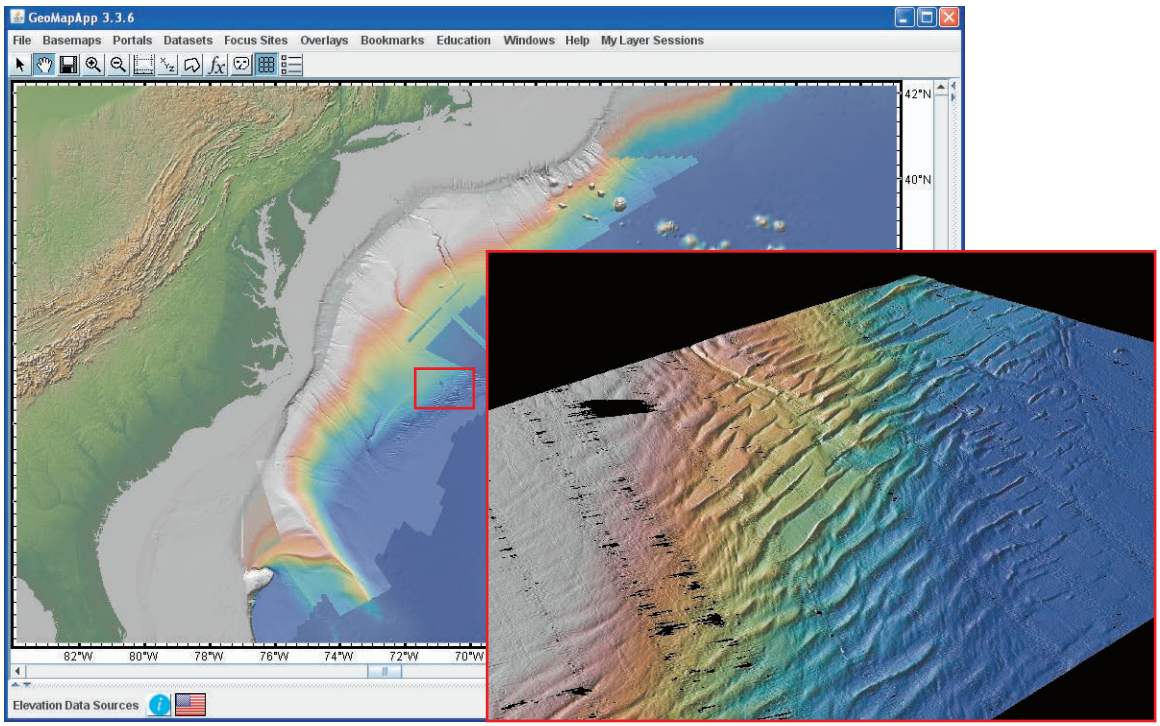

Figure 3. In GeoMapApp's 3-D perspective viewer (lower right image), large ENE-WSW-trending current-generated sand waves with amplitudes of up to 150m are clearly visible in the built-in Law of the Sea bathymetry data. The perspective view is from the SW for the area shown by the red box, and artificial illumination is from the north. In the GeoMapApp map window (upper left), the full extent of the Law of the Sea bathymetry grid is made visible by the lighter hues along the margin. Law of the Sea backscatter data covers the same area. Onshore, high-resolution USGS NED elevation data delineates the Appalachians and coastal plains.

GeoPRISMS Data Portal

www.marine-geo.org/portals/geoprisms

Visit the GeoPRISMS data portal to find information for each primary site:

- Pre-existing data sets and field programs
- Data sets ready for download
- Links to partner programs and resources
- References database with papers tied to data

GeoPRISMS references database of relevant publications is now available:
www.marine-geo.org/portals/geoprisms/references.php

To submit missing data sets, field programs or publications to the GeoPRISMS portal, contact *info@marine-geo.org*

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GeoPRISMS Steering Oversight Committee Highlights, Fall 2012

November 9-10, 2012, Rice University, Houston, TX

Edited by Anaïs Ferot, GeoPRISMS Science Coordinator & Julia Morgan, GeoPRISMS Chair

Introduction

The Fall 2012 GeoPRISMS Steering Committee Meeting focused on reviewing the recent Planning Workshops for Cascadia and the East African Rift System (EARS) primary sites and revisions to the associated sections of the Implementation Plan (IP). Extensive consideration of phased funding models for GeoPRISMS primary sites took place, informed by discussions of budgets for upcoming years.

NSF update

Deborah Bronk (VIMS) is the new head of the Ocean Section. Wendy Harrison (Colorado School of Mines) is the new director of EAR. Roger Wakimoto (NCAR) will be the new Assistant Director for GEO Directorate, joining NSF in February 2013. The Office of Polar Programs (OPP) will return to the GEO directorate in 2013.

The GeoPRISMS budget will be flat this fiscal year, at $4.5M, although spending is limited to 80% due to a combination of the continuing resolution and the fiscal cliff. With a (one time) mortgage carryover for previous field programs of 42%, the total left over to spend is about $2.4M.

This year's GeoPRISMS Program solicitation drew 27 proposals, requesting a total of ~$14.4M and 127 days of shiptime. Funding decisions are still pending, but success rate is ~20-25%.

Looking ahead at the probable funding climate in the next few years, NSF would like to start planning for funding now, with the advice of the GSOC. Issues for discussion include (1) the relative priority and timing of costly field programs, including community experiments, (2) the inability to support large projects at all primary sites at the same time, requiring advance planning, for example, phased proposal submissions based on science priority, timeliness, and opportunities.

Cascadia Primary Site Workshop Summary

Brad Hacker, Susan Schwartz and Katie Kelley provided a summary of the GeoPRISMS-EarthScope Science Workshop for the Cascadia Primary Site, held in April 2012 at the World Trade Center in Portland, OR. The two-day workshop had nearly 180 participants, including about 60 graduate students and post-docs, who also took part in a one-day pre-workshop student symposium and regional field trip. Attendees were very enthusiastic about opportunities for GeoPRISMS studies in Cascadia, many of which are still ramping up – including the Cascadia Initiative. [*A workshop report can be found in the Fall 2012 GeoPRISMS Newsletter.*]

EARS Primary Site Workshop Summary

Maggie Benoit and Rob Evans reviewed the East African Rift System Planning Workshop, held on October 25-27, 2012 in Morristown, NJ. There were 110 attendees, including ~30 students and a large number of international participants. Highlights of the meeting include:

- A valuable overview of ongoing research by US and international investigators
- A panel of African participants (including students) showcasing their research and future opportunities
- Productive, phased break-out discussions, defining new and exciting directions for research, through GeoPRISMS and elsewhere.
- Student pop-up presentations, which were inspiring and successful
- The student perspective and implementation plan, which helped to define the scope for the focus areas for future research.

A clear focus area emerged from the break-out sessions and the student perspective, specifically the Eastern rift. This area was chosen because many key scientific questions could be addressed there. In addition, three targets of opportunity were identified that can leverage other efforts. [*A full report on the workshop can be found on page 7 of this newsletter.*] The conveners are currently finalizing the EARS Implementation Plan for release for community review.

New Zealand Primary Site Planning Workshop

Laura Wallace presented plans for the upcoming New Zealand Primary Site Workshop, to be held April 15-17, 2013 at the Te Papa Museum in Wellington, New Zealand, and requested GSOC feedback. Workshop conveners have been defined, representing a mix of US and New Zealand universities and agencies. A Science Steering Committee was established to advise on the program, including several international members. About 100 participants were expected (now revised to ~150), from the US, New Zealand, Japan, Europe, and elsewhere. Funding is from the NZ Ministry of Science (now MBEI), NSF GeoPRISMS, and InterMARGINS has been obtained, and other sources will be approached (e.g., ANZIC, US Science Support Program, InterRidge).

This workshop has great potential for leveraging international partnerships, including IODP linkages. Given the strong multinational research potential (and limitations on NSF funding in the current environment), the approach to the meeting should be to develop a "portfolio" of subduction research goals, and to define within that what GeoPRISMS can best contribute within that, vs. NZ-led and other international partners (Japan, Europe). Importantly, the workshop program should be designed to help write the IP. Speakers and break-out leaders should be given instructions about objectives. Challenges include narrowing the GeoPRISMS focus, and properly representing emerging opportunities.

Cascadia Initiative Update

Geoff Abers, the chair of the Amphibious Array Steering Committee (AASC), provided an update about the Cascadia Initiative (CI), posing some questions for consideration by the GSOC. The onshore instruments have been in place for some time, and are returning data. The offshore OBS instruments are now in year 2 of the deployment plan. The year 3 deployment will essentially follow the year 1 deployment, with the shallow instruments in a tight array around Gray's Harbor.

All year 1 data should be released by the end of November (before AGU), allowing people to look at the data as soon as possible, to assess data quality in time for revisions to the year 3 plans. The AASC is keen to know and announce when proposals can be submitted to analyze these data. The success of this first amphibious community experiment cannot be assessed until the data are analyzed.

A mini-workshop on Cascadia Marine Geophysics is planned for AGU, reviewing a range of recent projects. The overall objectives are to inform the community of related projects and opportunities and to engender new collaborations, but also to discuss CI OBS data for the first time – to get community input about the next state of deployment.

Donna Blackman updated the GSOC about the new Dear Colleague Letter (DCL) explaining how to submit proposals to work with the Cascadia Initiative data. The new DCL has been signed by OCE and EAR and should get final approval before AGU. The call for data QC and metadata generation proposals has been eliminated, although NSF is willing to consider if proponents submit. The two main types of proposals are now: Type A - Derived products (using both onshore and offshore data), e.g., earthquake and tremor catalogues, and Type B - Full science proposals to work with the data. The guidelines about where to submit are provided at http://www.nsf.gov/pubs/2013/nsf13023/nsf13023.jsp.

The Future of the Amphibious Array Facility

Discussion turned to what might happen to the Amphibious Array after the CI data collection will be complete in 2015. There are communities interested in seeing the AA redeployed on the East Coast and in Alaska. NSF is cautious about the costs of deploying another amphibious facility similar to the CI. The community and NSF need to meet to discuss and make decisions, A planning meeting should be held soon – in 2013, perhaps at the EarthScope National Meeting.

Community Experiments and Expeditions

The recent experience of submitting the ENAM community seismic experiment proposal was reviewed, with particular attention to the time commitment for proponents to prepare the proposal and to carry out the project, all in service to the community. There was general consensus that proponents, in particular, early career investigators, should have some priority for working with the data. Possible NSF mechanisms might include EAGER or RAPID proposals, or possibly supplements to the main community proposal.

The concept of Community Expeditions was discussed briefly for Alaska, wherein potential proponents would have the opportunity to coordinate logistics for field work in the Aleutians (similar arrangements could apply elsewhere). Ideally, this approach would decrease the individual cost per project. Proposals could be solicited for a given time window, enabling logistical coordination. NSF personnel were open to considering this model, but the details need to be worked out. [A mini-workshop will likely be scheduled for AGU 2013.]

Initiative Summaries & New Projects
New and ongoing Subduction Cycle and Deformation (SCD) Initiative projects include:

- The large collaborative Mt. St. Helen's imaging project, led by Bachman (now Creager, U. Washington), "Illuminating the architecture of the greater Mt. St. Helens magmatic systems from slab to surface", has started up.
- Brian Jicha (U. Wisconsin) and colleagues are carrying out a reconnaissance investigation of Aleutian Arc inception, sampling and dating rocks of different compositions to constrain the ages of the oldest records of volcanism.
- Peter Kelemen (LDEO) and others are conducting a pilot study of compositional differences between intermediate plutons and lavas in the intra-oceanic Aleutian arc, and their causes.
- Adam Kent (Oregon State U.) and colleagues are funded to study the record of explosive volcanism in the Central Oregon Cascades, to establish the long-term eruptive history over the last 15 My.
- Paul Johnson (U. Washington) and others are using multiple techniques to obtain conductive heat-flux across the offshore Cascade prism, with many graduate and undergraduate student participants.
- A reconnaissance study by Dave Chadwell (Scripps) and others will assess optimal locations for submarine geodetic measurements to determine locking of the subduction megathrust.

New and ongoing Rift Initiation and Evolution (RIE) Initiative projects include:

- Donna Shillington and James Gaherty (LDEO), and Matt Pritchard (Cornell U.) continue their work on rift-related faulting in Northern Malawi. Gaherty presented a poster on InSAR results at the EARS workshop; another presentation will take place at AGU.
- Rob Evans (WHOI) and others (Canales, Atekwana) are carrying out MT and gravity surveys of incipient rifting in the Okavango and Zambia; this project is not funded by GeoPRISMS, but is related.
- Peter Lonsdale (Scripps) and colleagues are collaborating on "Dating Submerged Continental Crust Beneath the Southern Gulf of California, and a Synthesis of the Magmatic and Tectonic History of This MARGINS Focus Site", obtaining U-Pb crystallization ages of volcanic and plutonic rocks recovered from submerged rifted continental crust in the southern Gulf of California.

New and ongoing Source to Sink MARGINS (S2S)-Related Initiative projects include:

- A collaborative project between Kyle Straub (Tulane U.) and Ben Sheets (U. Washington), entitled is generating a series of reduced-scale experiments to quantify the relationship between geomorphic and stratigraphic surfaces.
- Neal Blair (Northwestern University) and Laurel Childress, are involved in a project entitled "The Subduction Margin Carbon Cycle: A Preliminary Assessment of the Distribution Patterns of Multicycle Carbon". This project compares the Alaska, Cascadia and the NZ Hikurangi margins, using Raman spectroscopy to detect thermally mature (ancient) and immature (younger) Carbon. They also are developing a biomarker approach to track terrestrial organic C across accretionary wedges.

Recent Developments at MARGINS Focus Sites
The start-up of GeoPRISMS did not shut down research activities in the previous MARGINS focus sites, and in fact, several exciting events and activities have occurred in recent years, that continue to be of interest to the GeoPRISMS community. Two of these were reviewed during the GSOC meeting, with follow-up discussion about how to integrate these topics and ongoing activities into GeoPRISMS today.

- Arc Drilling in the Izu Bonin Mariana (IBM) Focus Site: Bob Stern presented a summary of the Japanese-funded workshop on "Ultra-Deep Drilling into Arc Crust" that was held in Hawaii September 18-21, 2012, and reviewed the upcoming IODP plans for drilling at IBM. A report on this workshop can be found on page 14 of this newsletter.
- September 5, 2012 Costa Rica earthquake: Susan Schwartz summarized the September 2012 M7.6 Nicoya Costa

Rica earthquake, which occurred in the Central America focus site. This earthquake was anticipated, in large part due to MARGINS research and investment. Tim Dixon, Susan Schwartz and collaborators have an article in Eos entitled "Detailed Data Available for Recent Costa Rica Earthquake" [*which can be found at http://www.geoprisms.org/events/59-costa-rica-eq/326-costa-rica-eq.html*]. GPS and seismic networks, funded by MARGINS, have provided openly available data. The authors also submitted a special session on the Nicoya Earthquake at the AGU Meeting of the Americas, which will be held in Cancun in May 2013. The title of the session was chosen to emphasize MARGINS: "The 2012 M7.6 Nicoya Costa Rica Earthquake: Seismogenic Zone Science at the Bull's Eye in an NSF MARGINS SEIZE Focus Site." [*http://moa.agu.org/2013/scientific-program/sessions/s09/*]

GeoPRISMS Data Portal & Updates

Andrew Goodwillie reviewed progress on the GeoPRISMS Data Portal and Resources since the Spring 2012 GSOC meeting, including updates and improvements to the Data Management Plan tool and Data Submission Form, expanded bibliography, new data additions for the Cascadia and ENAM primary sites, and more. GeoMapApp has been improved, adding new data through March 2012, and bringing centroid moment plots back. A full report is provided on page 20 of this newsletter.

Education and Outreach Updates

The Distinguished Lecture Program subscriptions continue to increase compared with previous years, with 8 speakers now scheduled to visit 32 schools within the academic year. GSOC also considered the possibility of honoring applications for speakers from international schools, but at their own expense when feasible. The GeoPRISMS office was reminded to track down speaker presentations and host school recordings from 2005 on, and to make them accessible on the website.

The proposal submitted to NSF Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics (TUES) Program to develop new MARGINS Mini-Lessons was funded starting in September 2012. The goal of this project is to synthesize and incorporate the decade of MARGINS research into upper level undergraduate geoscience courses. Members of the MARGINS/GeoPRISMS community are invited to join this effort to contribute their expertise to the development and testing of new curriculum materials. The project was detailed in the Fall Issue of the GeoPRISMS Newsletter and also on page 8 of this newsletter.

GeoPRISMS Office Activities & Updates

The GeoPRISMS office experienced a slowdown during the summer of 2012, and several new staff were hired. Office activites, however, still included organizing two GeoPRISMS workshops: Cascadia Science Workshop in April (180 participants) and a small working group meeting for the ENAM Community Seismic Experiment in June (~15 participants). The fall was also dedicated to the organization of the EARS IP workshop held October in New Jersey. Planning has started for the NZ workshop, scheduled for April 2013. In addition, work continues on the Mini-Workshops and Townhall Meeting and other events at AGU, as well as the GeoPRISMS Best Student Presentations. The office also prepared and distributed two newsletters this year.

Integrated Ocean Drilling Program (IODP) Update

- The New IODP: John Jaeger provided a brief update about the new IODP, with implications for GeoPRISMS. NSF has authorized the continuation of the program for one more year. The shiptrack will be driven by proposal pressure, reviewed and previewed by NSF. Brazil is now an active member of the program. An update about IODP activities, written by John Jaeger and Liz Screaton (University of Florida), was prepared for the Fall 2012 newsletter. The GeoPRISMS IODP mini-workshop at AGU will provide information to members of the GeoPRISMS community interested in ocean drilling. The focus will be on Northern Pacific SCD sites (Cascadia and Alaska), although people interested in NZ drilling are also encouraged to participate to hear how things are done.
- The Chikyu+10 Workshop will take place April 22-24, immediately after the GeoPRISMS NZ workshop. The aim of this workshop is to discuss potential future scientific missions using the Chikyu over the next 10 years. The workshop outcomes will be considered by JAMSTEC in long-range planning for Chikyu operations. Meeting goals, themes, format and the application process will be widely publicized soon. More information can be found at http://www.jamstec.go.jp/chikyu+10/.

Funding Strategies – Requirements and Recommendations

NSF is keen to get GSOC input about the optimal timing for funding the data acquisition and science at each of primary sites. This summary reports on the conclusions of GSOC discussions of the matter. At issue is the concern that large field programs (LFPs), viewed as critical data gathering efforts for most primary sites, also have significant impact on the overall science budget, with individual proposal costs on the order of $2-2.5 M (not including ship time). The alternatives anticipated by NSF are:

GSOC discussion focused on how best to provide useful guidance to NSF. Recent planning workshops have provided a better sense of what is likely to happen in each location and when. However, GSOC would like to ensure that good proposals, both large and small, as well as PI- and community-driven, can emerge from the community when the time is right. GSOC recognizes that some projects will have long start-up times, some sites will have greater need for large experiments, and importantly, the entire community should be enfranchised in the process along the way.

A preferred option is to focus the GeoPRISMS solicitation each year to (a) prioritize key big projects each year, based on primary site needs and the readiness of the community and site; (b) Identify in advance and support important projects with long start-up times; and (c) anticipate and encourage non-prioritized projects to be submitted to other programs. Defining priority areas for study each year will also enable coordination, as recognized for the Alaska Community Expeditions concept. Importantly, this needs to be done in an unbiased and fair way, allowing for emergent opportunities and proposals.

During the GSOC meeting, the following approach was explored and discussed:

- Define a rough percentage breakdown for the primary sites for each year based on factors such as readiness and timeliness, necessary lead-time, and need for advanced coordination
- Phase each primary site in and out on these bases, as well as the sequence of the primary site planning workshops,

in order to spread the budgets across the decadal program. For each primary site, a "window of opportunity" for proposals would be defined. Critically, GSOC recommendations would only be used to guide NSF decision-making, not to specify which proposals should be funded.

- Importantly, by developing a phased funding model, the GSOC can advise the community in advance which primary sites will be accepting certain types of proposals. This will allow the community to self-organize, plan and coordinate, potentially enabling the "community expedition" concept to work.

Updates to the GeoPRISMS website

- GSOC discussed ways to improve the GeoPRISMS webpages and how to integrate the archival MARGINS pages into the site, particularly with new results coming in for MARGINS focus sites. Planned updates and additions include:
- A new webpage relating to the September 5, 2012 Nicoya, Costa Rica, earthquake was added to the GeoPRISMS website. This is an opportunity to link the GeoPRISMS website to previous MARGINS primary sites content. [*The Costa Rica Earthquake web page can now be found at http://www.geoprisms.org/events/59-costa-rica-eq/326-costa-rica-eq.html*].
- The GeoPRISMS Office is creating a library of all GeoPRISMS-MARGINS DLP presentations to share with the science community. The presentations will be posted as soon as they are available. The goal is to expand the Education & Outreach content. [*presentations can be found at: http://www.geoprisms.org/dlp-current-speakers.html?layout=blog*]
- Additional features of the website can include announcements to participate on cruises (e.g., upcoming CIET cruises, per Susan Schwartz) and other field activities. Another possibility is to create an interactive map presenting the ongoing projects was discussed.

GeoPRISMS Awards 2013

These are the funded GeoPRISMS Proposals for FY 2013; additional awards will be posted on the GeoPRISMS website

NSF Award 1249876

Constraining Slip Distribution of the Cascadia Subduction Zone Offshore Central Oregon with Seafloor Geodesy

C. D. Chadwell (U. California, San Diego)

This project seeks to initiate geodetic measurements of plate motion in the Cascadia subduction zone. Three sites off the Oregon coast, one on the incoming plate to measure relative plate motion and two on the continental slope to measure motions related to fault motions and deformation will be monitored for horizontal displacement at the cm scale. These will be the first offshore monitors of upper-plate Cascadia motion and fault behavior. This work will lead to a better understanding of earthquake and tsunami risk in Cascadia. It implements a new autonomous approach to data collection. It places permanent benchmarks on the seafloor so that monitoring can continue into the indefinite future. Transponders will be recovered and reused and become part of instrument pool that can be used to extend these studies in the future

NSF Award 1249552

Thermal Structure of the Cascadia Subduction Zone, Grays Canyon Discovery Corridor, Washington

R. Harris (Oregon State University)

Heatflow measurements using a 3.5 m probe will be added to a scheduled experiment "Thermal structure of the cascadia subduction zone on the WA margin (PIs Johnson & Solomon, OCE-1144164). The probe temperature and thermal conductivity measurements will enhance the ~1 m depth heatflow determinations the main experiment will obtain. Improved assessment of possible bottom water temperature variation will be documented by deviations from linearity in the uppermost thermal gradient measured by the probe. One day of shiptime to conduct heat probe work is confirmed, a second day is requested if ship schedule allows. Postcruise numerical modeling of these data aims to constrain temperature structure extending down to the subducting plate interface, which is related to deep seismicity patterns.

NSF Awards 1249353, 1249486, 1249703

Collaborative Research: The role of fluids in intermediate-depth seismicity and wedge anisotropy: Case studies for Cascadia and Alaska, with a comparison to Japan

P. van Keken (U. Michigan), B. Hacker (U.Californinia, Santa Barbara), G. Abers (Lamont-Doherty Earth Observatory)

The main goal of this study is to determine whether the presence of fluids within Earth's mantle is a controlling factor determining where earthquakes occur within subduction zones, specifically along the fault that enables the down-going tectonic plate to slip deeper into surrounding viscous mantle. The fact that this seismicity is located within the crust at 'cool' subduction zones, such as Alaska and Tohoku, versus in the mantle at 'warm' subduction zones, such as Cascadia and Nankai, suggests that fluids play an important role. Directional dependence of seismic wave propagation speeds will be assessed, so that possible bias in earthquake locations can be accounted for. Simultaneously, information about deformation within the viscously flowing mantle will be obtained. Ratios of shear and compressional wave velocities will suggest where fluids are present or not. These constraints will guide computer modeling of mantle flow and temperature in the subduction zones. These results will be linked to petrologic models of mineral phase change associated with plate dehydration that introduce fluids near the plate interface and lead to the generation of arc volcanism.

NSF Award 1250148

GeoPRISMS Postodoctoral Fellowship: Geochemical constraints on the source, flux, migration, and seismic signature of volcanic fluids, Katmai Volcanic Cluster, Alaska

T. Lopez (U. Alaska, Fairbanks)

Fluid movement in the subsurface of active volcanoes is frequently thought to produce abundant seismicity (i.e. earthquakes); however the actual type of fluid, including magma, volcanic gases, or hydrothermal waters, and the implications of the fluid movement cannot currently be constrained from seismic data. Knowledge of the type of fluid/s in the subsurface is critical for both forecasting volcanic eruption and estimating the explosivity of the impending eruption. Through comparison of high temporal resolution measurements of volcanic gas composition and seismicity, it may be possible to identify the type of fluid associated with unique seismic signatures. The ability to identify magma movement from seismic data will enable scientists to better determine the likelihood and/or timing of impending eruptions. In this project, geochemical measurements of volcanic fluids and complementary seismic data from three historically-active Alaskan volcanoes will be used to: (1) determine the source

(i.e. subducted slab, mantle, crust) and flux of volcanic gases, (2) determine proportions of magmatic and hydrothermal fluids within the subsurface, and (3) distinguish trends in gas composition and/or flux that correlate with seismic signatures of fluid movement. Gas composition will be combined with total gas flux to help elucidate subduction and magma generation processes. Daily measurements of gas composition and flux will be compared with seismic data collected over a two-month period to help determine the type of fluid movement associated with certain seismic signals. This project will answer fundamental science questions applicable to GeoPRISMS objectives, specifically regarding the storage, transfer, and release of volcanic fluids, and the relationship between subduction and surface processes.
NSF Awards 1249438, 1249412

Collaborative Research: Virginia's Volcanoes: a Window into Eastern North America Mantle Processes

E. Johnson (James Madison University), E. Gazel (Virginia Polytechnic Institute)

The recent magnitude 5.8 earthquakes in Mineral, VA, impacted major metropolitan areas on the East Coast of the U.S. and sparked a need to better understand the geologic characteristics the of Eastern North America Margin (ENAM). A group of more than 100 volcanic bodies approximately 47-49 million years old exposed in Virginia and West Virginia are the youngest known eruptions on the East Coast of the U.S. These magmas and the fragments of rock they collected from the crust and mantle during their ascent and eruption are the only direct samples of the crust and the mantle in recent geologic times. The results from this study will be used in conjunction with data from the EarthScope Transportable Array of seismometers currently being deployed along the East Coast as well as other seismic studies to create a comprehensive picture of the state of the crust and mantle underneath the Eastern U.S., providing context for the potential of future seismic hazards. This project will support graduate and undergraduate research at Virginia Tech and James Madison University. The proximity of the field site to both universities makes field characterization and sampling highly accessible. A field trip for middle and high school students and an outreach course through the Lifelong Learning Institute will be developed in addition to course materials for general education. An exhibit will be created for the Museum of Geociences at Virginia Tech. Data from this research will be shared with the public, the GeoPRISMS and EarthScope communities.

NSF Awards 1250130, 1249909

Collaborative Proposal: Modeling Sediment Production from Glaciers off south-central Alaska during Quaternary Climate Oscillations

B. Hallet (University of Washington), P. Koons and S. Birkel (University of Maine)

The PIs will model the production, transport, and deposition of glacial sediments at the Alaska-Aleutian subducting margin during the last 125,000 years. The Cordilleran Ice Sheet and crustal response to ice loading will be modeled using the University of Maine Ice Sheet Model (UMISM). USISM solutions will be related to existing sediment datasets and glacial power erosion laws to determine temporal and spatial patterns of erosion and sediment distribution. Suspended sediment samples and field measurements of rock strength will be collected and integrated with the modeling efforts.

Call for Interdisciplinary Mini-workshop Proposals

The GeoPRISMS Office and GeoPRISMS Steering and Oversight Committee (GSOC) seek to support early planning activities relating to GeoPRISMS science objectives, both at the new GeoPRISMS primary sites and for initiative thematic studies (see GeoPRISMS science planning documents at ***http://www.geoprisms.org/science-plan.html***). Members of the GeoPRISMS community can apply for support to organize and fund mini-workshops to be held in conjunction with national meetings, to bring together groups of interdisciplinary investigators for these purposes. Such mini-workshops can be associated with GSA, AGU or other national meetings at which the research area is well represented. Options for mini-workshops include 2-4 hour sessions in an evening, or half-day sessions before or after the meeting. Mini-workshops can bring together multiple investigators with interests in one of the primary sites, spanning multiple primary sites within one initiative, or addressing a theme that transcends initiatives, depending on the group's objectives and assessment of the greatest needs.

Mini-workshop proposals should be submitted at least three (3) months prior to the proposed meeting date to info@geoprisms.org. Proposals for mini-workshops during GSA 2012 are due July 1. Proposals for mini-workshops during AGU 2012 are due August 1.

Proposals should include the following:

- Scientific rationale for the workshop and reason for its timeliness
- Sufficient evidence that a wide group of interdisciplinary researchers would be able to attend
- The national meeting with which the mini-workshop would be associated
- Possible meeting dates and desired meeting format
- Proposed number of attendees
- Anticipated costs (meeting space, refreshments, A/V equipment, etc.)
- Note: A detailed budget is not required initially, and participant travel and/or lodging costs cannot not be provided.

Approved proposals will have reasonable costs associated with the meeting covered by the GeoPRISMS Office. The office will also assist with logistical arrangements. Workshop conveners are responsible for developing the science program and communicating with participants on scientific matters. Any GeoPRISMS supported mini-workshop will be open to all interested parties and will be advertised via the GeoPRISMS mailing list and website. Workshop conveners will provide a summary, including major results of the meeting for inclusion on the GeoPRISMS website and newsletter within 60 days of the meeting.

GeoPRISMS Postdoctoral Fellow Biography

Since 2003, MARGINS and GeoPRISMS have funded postdoctoral fellows both within the special MARGINS/GeoPRISMS Postdoctoral fellowship, and within the regular MARGINS and GeoPRISMS Program.

Taryn Lopez
(U. Alaska, Fairbanks)
"Geochemical constraints on the source, flux, migration, and seismic signature of volcanic fluids, Katmai Volcanic Cluster, Alaska"

Changes in the chemical composition and flux of volcanic gases released at the surface of volcanoes can provide insight into subsurface volcanic conditions, such as the approximate magma degassing depth, the presence (or absence) of a shallow water system, and/or relative conduit permeability. Additionally, the chemical and isotopic composition of volcanic gases can be used to determine the source of these volatiles at depth. This knowledge is critical for understanding subduction processes, forecasting volcanic eruptions, and estimating the explosivity of impending eruptions.

I obtained my Bachelor of Science degree in Geology at the University of Wisconsin Eau Claire. I then went on to pursue a Masters degree in Volcanology at Michigan Tech University. My advisor at Michigan Tech, Matt Watson, was a spectroscopist whose main area of study was remote sensing of volcanic emissions. He taught me that volcanic gas geochemistry could be used to understand subsurface volcanic processes and this idea has since been the main motivation of my research. My master's research correlated the sulfur speciation and temperature of volcanic emissions from Cerro Negro Volcano, Nicaragua, where we used a combination of direct sampling and remote sensing techniques. Following completion of my M.S. degree, I went on to pursue my Ph.D. at the University of Alaska Fairbanks, due to its direct involvement with the Alaska Volcano Observatory (AVO) and opportunity for students to participate in daily volcano monitoring and eruption response. My Ph.D. research focused on using repeated volcanic gas measurements throughout varying stages of volcanic unrest to understand both surface activity and subsurface processes at three active volcanoes within the North Pacific: Redoubt (Alaska), Bezymianny (Kamchatka, Russia) and Karymsky (Kamchatka, Russia).

Through regular discussions with my AVO colleagues while pursuing my Ph.D., I gained a strong appreciation for the added value of integrating volcanic gas data with complementary petrologic, geochemical and geophysical datasets to obtain a more complete understanding of volcanic processes. During this time period I was surprised to learn that volcano seismicity is often interpreted to be caused by subsurface fluid movement; however, the actual type of fluid (i.e. magma, gas/volatiles, or hydrothermal waters) is often not well constrained, and these interpretations are often not supported by complementary volcanic gas measurements. This curiosity inspired my current GeoPRISMS postdoctoral project. The aims of this project are to use geochemical measurements of volcanic fluids and complementary seismic data from three historically-active Alaskan volcanoes within the Katmai Volcanic Cluster to: (1) determine the source (i.e. subducted slab, mantle, crust) and flux of volcanic gases, (2) identify proportions of magmatic and hydrothermal fluids within the subsurface, and (3) distinguish trends in gas composition and/or flux that correlate with seismic signatures of fluid movement.

Apply for a

GeoPRISMS Post-Doctoral Fellowship

Applications due at the regular July 2 NSF deadline

For details, see the NSF program announcement

http://www.geoprisms.org/postdoctoral-fellowships.html

http://www. geoprisms.org/program-annoucement.html

The GeoPRISMS Office Will Be Moving!!

On October 1, 2013, the GeoPRISMS Office will be moving to University of Michigan, in Ann Arbor, under the guidance of the next GeoPRISMS Chair, Peter van Keken.

The GeoPRISMS website and listservs will continue to be active, and there should be no major disruptions in operations.

New contact information will be provided when the move occurs.

Congratulations, Peter!

GeoPRISMS Student Prize for Outstanding Presentations

2012 AGU Fall Meeting, San Francisco
December 2012

Congratulations to the winners of the GeoPRISMS 2012 AGU Student Prize. As in previous years, the judges were greatly impressed by the quality of the entrants this year, and awarding individual prizes to just a few in such an outstanding field was very difficult. Here we honor two prize winners and four honorable mentions. The GeoPRISMS Student prize is open to any student who can show a link between their research and the stated aims of the GeoPRISMS Program. We thank all our entrants and judges for making this contest possible and worthwhile.

Oral Presentation Winner

MaryJo Brounce, University of Rhode Island

Title of Abstract: "$Fe^{3+}/\Sigma Fe$ variation in Mariana arc and back-arc magmas and primary fO_2 of the mantle wedge"

Co-Author: Katherine A. Kelley and Liz Cottrell

From the Judges: Maryjo gave a great talk with clear and concise science, and good knowledge of the field. She provided an excellent explanation of a complex topic with important consequences for research relevant to GeoPRISMS.

From the Student: I am honored to be recognized by the GeoPRISMS community and look forward to contributing to GeoPRISMS efforts in the future. I am grateful for the support and encouragement that GeoPRISMS provides to promote student research and encourage excellence in communication.

Poster Presentation Winner

Samer Naif, UC San Diego

Title of Abstract: "An extensive melt layer beneath the oceanic lithosphere-asthenosphere boundary discovered by magnetotelluric data"

Co-Authors: Kerry W. Key, Steven Constable and Robert L. Evans

From the Judges: "Samer was highly knowledgable about his techniques, data, uncertainty, and nuances in the interpretation. He provided a very coherent presentation that fits within the broader context of GeoPRISMS research."

From the Student:"It is a true honor to be acknowledged for this award. The diverse GeoPRISMS community has always inspired me with its wonderful and exciting research. I am grateful to have a platform that fosters and promotes student research."

Honorable Mention

Erin DiMaggio, Arizona State University

Title of Abstract: "Late Pliocene - Early Pleistocene geologic history of Eastern Ledi-Geraru, Ethiopia: implications for the evolution of the southern Afar Depression and hominin paleoenvironments"

Co-Authors: Ramon Arrowsmith, Christopher J. Campisano, Kaye Reed and Alan Deino

From the Judges: "Erin gave an excellent talk that included good graphics and a clear rational. She provided excellent context and discussion for science with important implications."

From the Student:"I am honored to have my research acknowledged by GeoPRISMS, and thank the entire GeoPRISMS community for their continued efforts to support and promote student research."

Honorable Mention

Kristina Walowski, University of Oregon

Title of Abstract: "Understanding magma formation and mantle conditions in the Lassen segment of the Cascade Arc: Insights from volatile contents of olivine-hosted melt inclusions"

Co-Author: Daniel J. Rasmussen, Paul J. Wallace and Michael A. Clynne

From the Judges: "Kristina gave a complex and polished talk, very clearly presented. Her topic is timely and pertains to a GeoPRISMS area of focus."

Student's Comment: "I am delighted and very honored to be recognized by GeoPRISMS for my presentation. I greatly appreciate the efforts made by the GeoPRISMS community to encourage interdisciplinary collaboration and thank them for their support of graduate student involvement."

Honorable Mention

Brad Pitcher, Oregon State University
Abstract Title: "The Evolution of the Historic Mt. Etna Magma Plumbing System: A Comprehensive in situ Plagioclase Compositional and Isotopic Study"
Co-Author: Wendy Bohrson and Marco Viccaro
From the Judges: Brad had one of the best undergrad studies I have seen. Excellent science along with good graphics; very energetic and engaging presentation.
Student's Comment: "Thank you so much for awarding me with this distinction. I am very grateful to be recognized by the esteemed community of GEOPRISMS scientists."

Honorable Mention

Sarah Stamps, Purdue University
Abstract Title: "Minimal Role of Basal Shear Tractions in Driving Nubia-Somalia Divergence Across the East African Rift System"
Co-Authors: Eric Calais, Giampiero Iaffaldano and Lucy M. Flesch
From the Judges: "Sarah was animated, articulate and highly knowledgeable regarding the subject. She was able to provide thoughtful answers to many difficult questions."
Student's Comment:"I am honored the presentation by my colleagues and me on the dynamics of rifting in East Africa was recognized by the GeoPRISMS community. I look forward to continuing research aligned with GeoPRISMS initiatives using GPS observations and geodynamic modeling.

Broader Impacts

The GeoPRISMS Office, along with the GeoPRISMS Education and Outreach Committee (GEAC), would like to offer suggestions to proposers responding to NSF solicitations, to help you plan and achieve your broader impacts. Here are a number of strategies to consider:

- Submit your GeoPRISMS data to the data portal hosted by IEDA in a timely manner to efficiently disseminate your data to the scientific community. Also, you can download publicly-available data from the data portal to enhance your own research.
- Include the development of mini-lessons in your proposal as a way to expose undergraduate students to your research. The GeoPRISMS Office can help you develop these lessons.
- Invite your students into the GeoPRISMS community, where they can take advantage of many student resources. Examples include:
    - Participate in the GeoPRISMS Student and Community Forum at AGU.
    - Attend GeoPRISMS workshops and mini-workshops, and student symposia.
    - Apply for the GeoPRISMS Best Student Presentation at Fall AGU.
    - Stay informed through the GeoPRISMS listserv. Sign up: geoprisms.org/contact-us.html.
    - Visit our website regularly for updates on these resources.
- Include support for an REU on a new grant, or applying for a supplement on an existing grant, to involve undergraduates in GeoPRISMS research projects. Undergraduates are encouraged to use the resources listed above.
- Apply for a Research Experience for Teachers (RET) Supplement to an existing grant or include one in future proposals. You can receive up to $12,500 per teacher to support their participation in your NSF-funded research project. Encouraging active participation of teachers in NSF projects is an excellent way to strengthen the science expertise of our nation's educators. The GeoPRISMS office can help you design the supplement and coordinate with other PIs who are applying for RETs.

For more information, contact the GeoPRISMS Office (info@geoprisms.org) or visit http://geoprisms.org

GeoPRISMS/EarthScope Early Career Investigators Networking Luncheon

AGU 2012 Fall Meeting, San Francisco

Harmony Colella (Miami University), Danielle Sumy (LDEO), Andy Frassetto (IRIS) and Derek Schutt (Colorado State University)

On December 4, 2012, GeoPRISMS and EarthScope co-sponsored an Early Career Investigators (ECIs) mini-workshop and luncheon in the Bayview Room of the Grand Hyatt San Francisco. The purpose of this function was to discuss research interests and explore potential collaborations based on shared GeoPRISMS and EarthScope focus sites and themes. This workshop also served as a networking function for ECIs to stimulate cross-disciplinary interaction and raise awareness of available professional resources for young geoscientists. The annual AGU meeting was an opportune time to hold such a workshop because it is the most attended conference of the year. This allowed for participation of ~60 ECIs from a wide range of academic disciplines, which include geophysics, geochemistry, and geology.

ECIs are loosely defined as senior graduate students through pre-tenure faculty. The IRIS ECI working group serves to interact with, understand the needs of, and develop resources for this community. The mission of the working group is to organize a suite of resources and mentorship opportunities for ECIs as they navigate professional challenges such as completing graduate school, applying for a post-doc or first professional job, and acquiring permanent employment or tenure at an academic institution. The general goal of this effort is to lower the energy and knowledge barriers necessary to thrive in a range of environments as a newly minted educator or researcher.

The luncheon began with an introduction from the members of the IRIS ECI Working Group (Harmony Colella, Andy Frassetto, Derek Schutt, and Danielle Sumy) who organized the function. This was followed with an overview of the GeoPRISMS and EarthScope programs from Juli Morgan and Ramon Arrowsmith, respectively. Then three ECIs, Michael Rowe, Donna Shillington, and Maggie Benoit, provided summaries of the objectives for the primary sites where GeoPRISMS and EarthScope programs overlap: Cascadia, Alaska, and Eastern North America, respectively. The remainder of the time allowed ECIs to divide into groups based on their interest in a particular primary site. ECIs discussed the scientific questions of common research interests with potential collaborators.

An unexpected, but positive, outcome of the networking function was 40% and 56% of participants had little to no previous knowledge of the science programs organized by GeoPRISMS and EarthScope, respectively. Additionally, 83% of the participants were exposed to the IRIS ECI program and its available resources for the first time. Surveys conducted immediately after the workshop suggest that the networking function succeeded in laying the groundwork for future interactions through ECI programs, future meetings, and one on one. Many ECIs were brought together for the first time and introduced to the scientific questions that are the core of the EarthScope and GeoPRISMS programs. They were exposed to the resources available through each of the programs as well as those being developed by the ECI working group.

The organizers wish to thank several of the more experienced scientists who attended the workshop and helped to inform the primary site breakout sessions. Their knowledge and insight was much appreciated by the working group and participants alike.

Figure 1 (left). Andy Frassetto (IRIS) introduces the current ECI webpage and plan for the mini-workshop. Figure 2 (right). Harmony Colella (Miami University) discusses Alaska-related topics during the break-out session.

Welcome to a field season at Ledi-Geraru, Afar, Ethiopia!

Erin DiMaggio (Arizona State University)

This is the fifth in a series of field blogs, to inform the community of real-time, exciting GeoPRISMS-related research. If you would like to contribute to this series, please contact the GeoPRISMS office at nfo@geoprisms.org.

Foreword: The 2013 Ledi-Geraru Research Project field season brought together geologists, paleontologists, and archaeologists from multiple universities to study the environmental context of human evolution in the Afar Depression, Ethiopia. Our field area is located in the southern Afar Depression, near the famous early hominin sites of Hadar and Dikika. This season we focused our efforts on the eastern portion of Ledi-Geraru (ELG) because of its fossiliferous sediments, presence of stone tools, and extensive outcrops. We also targeted this location because the time period represented by the sediments at ELG is scarcely represented in the sedimentological record in Ethiopia and in East Africa in general. As a result, we lack knowledge about important events during this time period including major changes in faunal (animal) populations, and the beginning of stone tool manufacture. Furthermore, the faulting history of the Afar Depression since the late Pliocene (<3.0 Ma) is captured in the structure and geomorphology of the region, all nicely exposed along tributaries of the Awash River. Below I organized some of my field notes to provide a short preview into the daily life and culture at the Ledi-Geraru Camp. Enjoy!

Figure 1. NASA MODIS imagery of the Afar Depression highlighting the location of the Ledi-Geraru Research Project.

Life at Camp (1/24/2013)

"I am dirty, smelly, and have obviously not showered in three days of field work, but I had a chocolate donut for breakfast. This camp is great!" I mentioned this to my advisor, Ramón Arrowsmith one morning after finishing a freshly made donut and gearing up for another day in the field. It's true! Aside from the constant barrage of dust that coats anything left out for more than 30 seconds, and afternoon temperatures that make me want to join the Afar hiding under the Land Cruiser for a quick shady nap, I have to admit that our camp life is pretty plush. Our cooks are pros at setting up a fully functional and clean kitchen, including a bread baking station, a deep fryer for our nightly fill of fried potatoes, and a food storage system that somehow defies the laws of spoilage and bug infestation. I can't even manage to keep a bottle of contact solution in my tent without somehow attracting a line of ants! We are served dinners that include a range of pasta dishes, fried eggplant, and my personal favorite, goat kebobs and tomato salad, all of which are served with soup, fried potatoes, fresh bread, and veggies.

All Under One Tent (1/21/2013)

Today, Brian wanted to better understand the geologic context for some of the fossils found in a particular region earlier in the day. Brian Villmoare (George Washington University) and Dominique Garello, a geology graduate student (Arizona State University), are sporting stylish red/blue 3D glasses because I do most of my geology mapping on anaglyphs created from aerial photographs. I also use high resolution (0.5 meter) satellite imagery for mapping faults or the extent of a volcanic ash deposit, which I later check in the field. It was not until I arrived in the field and completely immersed myself in multiple research worlds that I genuinely understood interdisciplinary research. Geologists, archeologists, and paleontologists all actively collected data with-

Figure 2. (left) Cook Getachew Senbeto is preparing a great dinner for 40 in our well-organized cook tent.

Figure 3. (right) Brian (left), Dominique (right) and I (center) look over the days mapping using anaglyphs (hence, the 3D glasses) to investigate the geology of a fossiliferous area.

From top to bottom:
Figure 4. Land Cruiser vs. ostriches – a morning race to our field site.
Figure 5. Omar Abdullah showing us stone carvings in basalt boulders.
Figure 6. Tephra deposits (white and yellow layers) faulted by a beautifully exposed normal fault.

in one shared field area and organized, planned, and analyzed results under one central work tent. For example, our geologic mapping helps to determine which archeology sites the archaeologists will focus their efforts on, and faulting patterns that we map one day may direct where paleontologists survey or collect fossils the next day. We are continually communicating our results and changing our plan for the following day based on what we have learned.

The Wild Life (1/22/2013)

This morning we were greeted by a large group of ostriches and gazelle hanging out by the road. There is nothing wilder than an early morning race to the field against a half dozen ostriches! We are also fortunate to see baboons, warthogs, and occasionally a hyena. Later in the day, Dominique and I were taking measurements of faults along a steep cliff outcrop on the banks of the Mille River. Our Afar friend, Ali Yasin, and our representative from the National Museum of Ethiopia, Tesfaye (ARCCH), informed us not to proceed further along the water. We were confused and thought it might be due to that fact we were on loose slopes. We were wrong. Ali had been watching a crocodile slowly approach where we were working. Needless to say, the strike and dip measurement I was after will have to wait for another day!

Ancient Rock Art (1/26/2013)

The Afar are proud of their heritage and were very excited to take us on a trip to show us a place near the Awash River where ancient people had created rock art along the sides of one of the basalt hills. In this photo, Omar Abdullah is pointing out a particularly beautiful etched rock with numerous animals including gazelle, camels, pigs, and monkeys! It was relaxing to take a day away from work and play tourist in this beautiful land guided by our Afar friends who were proud to share their land and its history with us.

Geology at ELG (1/27/2013)

The lack of vegetation at ELG, and in the Afar in general, is a blessing and a curse. A blessing because, well, I'm a geologist and there is no shortage of exposed rock! The only hindrance to acquiring a fault plane measurement or measuring and describing a 30 meter stratigraphy section is the sometimes thick cover of eroded sediment – all remedied by good shovel and geology pick. The curse is trying to find a suitable location for lunch, when "Me'e silalo" (good shade in the Afar language) is hard to come by midday, often taking the shape of a few feet of shade provided by the Land Cruiser. Today after lunch we found this beautifully exposed fault that slices through two volcanic ash deposits. There is no shortage of faults in the ELG thanks to its proximity to the Afar Triple Junction. In fact, sometimes it is hard to find a complete stratigraphy section to measure that is not interrupted by a fault! Luckily, there are also abundant volcanic ash deposits (or tephras) interbedded in the sediments (see white layers in the photo). Tephras are extremely valuable to the project because they serve as marker beds across the landscape, and some contain crystals that can be dated using 40Ar/39Ar methods, or fresh glass shards that we can use to 'fingerprint' the tephra for possible correlation to other areas within ELG or Afar.

Figure 7. Local Afar children.

Afar Kids (2/1/2013)

The Afar children living and working around our camp site (most Afar children have shepherd responsibilities) love to see what we are up to. Hiding behind trees at a set distance, the kids are curious but shy and quickly warm up when approached. Today we brought out our cameras and had some fun with them taking photos. I realized during my

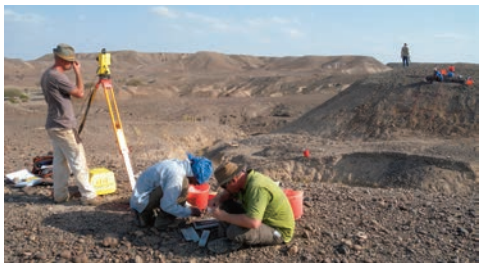

Figure 8. (top) John, Kaye, and Brian (left to right) head out for an exciting day of fossil collecting. Figure 9. (bottom) Mohammed Ahameddin (sitting, center), Kadar Mohammed, Mohammed Ibrahim, and Ali Yasin (left to right) spell and explain the meaning of local place names for our project gazetteer. Figure 10 (right) Archaeologists prepare for excavation of a site in the Ledi-Geraru

first field season in the Afar a few years back that the Afar kids didn't seem to smile when I took their photo. Why? Well, simply, we teach kids to smile for the camera from the time they are born, and it becomes second nature. The Afar kids had huge grins on their faces *after* we took their photo, when they see themselves and their friends on the digital screen. They point at themselves and their friends and giggle, giggle, giggle!

The Fossil Hunt (2/2/2012)

Today the geologists all headed out with paleontologists Kaye Reed, Brian Villmoare (right), graduate student John Rowan (left), and the best Afar fossil hunters to survey and collect fossils (left photo). I learned quite a bit from them including that some fossils are more important than others. What do I mean by that? Because of their size, elephant fossils are commonly found throughout ELG. But collecting elephant fossils is laborious (they are huge!) and are not a very diagnostic species (in contrast to, say, pig fossils). While a few elephant fossils were collected (mostly teeth), elephant and hippopotamus fossil abundance is only noted so that it can be included in later descriptions the region's paleoecology. In this photo, John and Kaye are holding small yellow ruggedized computers called Nomads. The Nomads are used to store and catalog information (GPS coordinates, element, genus, etc.) about each fossil to a centralized digital database.

Location, Location, Location (2/3/2013)

One of my tasks this season was to complete a gazetteer of Afar place names within the eastern Ledi-Geraru (ELG), including the most 'correct' Afar to English spelling and the meaning of the place name. Last night I spent an entire evening with our kind Afar Regional State Representative, Mohammed Hameddin, who did an excellent job of aiding in my not-so-easy quest. Hands down, my favorite place name (and story) is a location in the southern part of ELG, referred to as Dabali Isi. Mohammed spelled out the name for me, while our two best Afar geographers, Ali Yasin and Subudo Baro, explained the meaning of the place name to Mohammed. I knew this was going to be an amusing story because all three men had a smirk on their face during the exchange. Mohammed smiled, stood up and said, "The Afar are telling me that Dabali Isi is named after a woman who was passing through that area. She was very, very beautiful and had…" Mohammed stopped speaking and proceeded to caress his sides and top of his rear end. I was brought to laughter (Mohammed is a very funny man!) and awkwardly had to try and guess the meaning of his gestures. "Does it mean rear end?" Nope. "Sides?" Nope. "Shape?" Yes. As the story goes, Dabali Isi was a very beautiful woman passing through that particular area who had a very, very, memorable womanly form. The Beyoncé of the Afar Depression!

"Lucy Dinga", a.k.a. Archaeology (2/1/2013)

The Afar people have played an integral role in the work that is conducted in the Afar, some as fossil hunters, others as guides and geology field assistants. Many of the same men return year after year to help in our project, and know well the history that surrounds the search for early humans and stone tools in the outcrops along the Awash that began in the 1970's. In the Afar language "Dinga" means rock, and almost all of the Afar in the Mille and Elowa region know about the famous discovery of Lucy at Hadar in 1974. As a result the Afar refer to stone tools as "Lucy Dingas". Today, Dominique and I wanted to see the process of a site excavation and so we spent the afternoon with the archaeologists learning about excavation techniques. We also learned about how to identify "Lucy Dingas" among a wealth of stream fractured cobbles that blanket surfaces across the Ledi-Geraru. In the photo above, from left to right, archaeologists, Will Archer, Yonatan Sahle, and David Braun (U. of Cape Town), prepare for excavation of a site in the Ledi-Geraru. The site is located on the slope on the right, while the total station is located across such that each point is visible and can be accurately measured. Overall, we had a very successful field season - we collected new fossils and artifacts, geologic observations, and hundreds of pounds rocks to be analyzed! We hope that this brief glimpse into life at camp, the culture of the Afar people, and the work conducted by Ledi-Geraru researchers opened a door to the process and excitement of conducting field work in Ethiopia.

Distinguished Lectureship Program

The GeoPRISMS office announces the annual Distinguished Lectureship Program for academic year 2013-2014 with an outstanding speakers guild. Distinguished scientists involved with GeoPRISMS science and planning are available to visit American colleges and universities to present technical talks and public lectures on subjects related to GeoPRISMS science.

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Any college or university wishing to invite a GeoPRISMS speaker may apply via *www.geoprisms.org/distinguished-lectures.html*. Applications are due **July 1, 2013**. Institutions that are not currently involved with GeoPRISMS research are strongly encouraged to apply, including those granting undergraduate or masters degrees, as well as those with Ph.D. programs. Institutions may request a technical and/or public lecture. The GeoPRISMS Office will cover airfares for speakers' travel and will coordinate travel and off-site logistics. Host institutions are responsible for local living costs for the duration of the visit. Questions? Email info@geoprisms.org

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Geodynamic Processes at Rifting and Subducting Margins

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The scientific goals of the CI and expedition details can be found at ***http://cascadia.uoregon.edu.***

For more information and to apply:
http://www.geoprisms.org/cascadia-cruises

Upcoming GeoPRISMS Related Meetings

- **GeoPRISMS Planning Workshop for New Zealand**
  April 15-17, 2013 - Wellington, New Zealand
  http://geoprisms.org/meetings/newzealand-apr2013.html
- **ExTerra 2013: Understanding subduction through the study of exhumed terranes**
  August 24-25, 2013, Goldschmidt Conference - Florence, Italy
  http://geoprisms.org/scd/exterra.html

Other Meetings and Workshops

- **Chikyu+10 International Workshop**
  April 21-23, 2013 - Hitotsubashi, Japan
  http://www.jamstec.go.jp/chikyu+10/
- **2013 EarthScope National Meeting**
  May 13-15, 2013 - Raleigh, North Carolina
  http://www.iris.edu/hq/earthscope_meeting
- **AGU Meetings of the Americas**
  May 14-17, 2013 - Cancun, Mexico
- **Ocean Bottom Seismograph Workshop**
  October 21-22, 2013 - Redondo Beach, California