GeoPRISMS

Newsletter - Issue No. 33, Fall 2014

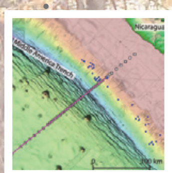
In this Issue

Report from the Field - ENAM Community Seismic Experiment
Volcanoes of Virginia: Window into the Evolution of the ENAM Site
Imaging the Nicaragua Subduction Zone with Marine Electromagnetic Methods
GeoPRISMS at AGU Fall Meeting

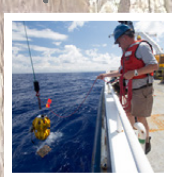
In this Issue

Volcanoes of Virginia: A Window into the Evolution of the ENAM Site 6

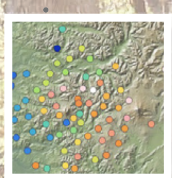
Education & Outreach: DLP 2014 - 2015 MARGINS Mini-Lessons 9



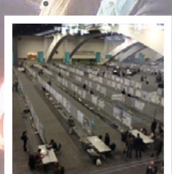
Imaging the Nicaragua Subduction Zone with Marine Electromagnetic Methods 12



Report from the Field: ENAM Community Seismic Experiment 16



Status Report on the GeoPRISMS Data Portal Report 22



GeoPRISMS at AGU: Mini-Workshops, Townhall Meeting & Sessions of Interest 24

The GeoPRISMS Newsletter is published twice a year and is designed to provide to the GeoPRISMS community summaries of recent GeoPRISMS activities and meetings, synthesis articles, editorials, and discussion of science opportunities. Archives of the Newsletter are available on the GeoPRISMS website.

From the Chair

It is a pleasure for me to introduce to you the first ever electronic-only version of the GeoPRISMS newsletter. The distribution of the Spring newsletter will remain in both print and electronic versions but the Fall newsletter, which contains more time-sensitive information particularly related to the Fall Meeting of the American Geophysical Union, will not be provided in print anymore. Of course reasons related to the budget and environmental concerns played a role in this decision too.

I look forward to see our GeoPRISMS community together again in San Francisco. I hope to see you at our annual Townhall on Monday. We will also host two workshops related to the New Zealand field site on Sunday before AGU. Throughout the week we will be assessing posters and talks from students who have entered the GeoPRISMS Student Prize competition and I would like to thank in advance the many judges who volunteer their time and make this important educational effort possible.

You may have noticed the new design of the GeoPRISMS website. The transition was made possible by a significant effort on the part of Anaïs Férot with help from Peter Knoop (University of Michigan). Thanks much to both Anaïs and Peter for a greatly improved, modernized and faster website and website maintenance software!

Another change that happened this year is the frequency of meetings of our GeoPRISMS Steering and Oversight Committee (GSOC). We have gone to an annual meeting at NSF in the early Spring and as such the standing item of 'GSOC Highlights' will not appear in this issue. The GSOC will next meet at NSF on March 12 and 13, 2015. Our Office (which is now scheduled to operate out of Michigan through AGU 2016) will also organize the first of two scheduled Theoretical and Experimental Institutes in late Summer or early Fall 2015. This first TEI will cover the SCD initiative with a second TEI in 2016 that will explore the advances of the RIE initiative.

Changes also occurred at NSF. Jenn Wade became a permanent program manager at NSF (congratulations, Jenn!) and program manager Bil Haq retired. Bil of course has been behind the heart and soul of the GeoPRISMS and MARGINS programs. He has been instrumental in the launch and continuation of these two decadal programs. We will take some time at the Townhall to celebrate Bil's contributions and achievements. Bil will continue to be involved with NSF and GeoPRISMS as specialist and will split his time between the US and Paris, where he is an Adjunct Research Professor at the Université Pierre et Marie Curie.

I'd like to close off with a final comment on exciting discussions between IRIS, Unavco and GeoPRISMS, along with international partners, that have been initiated on a Subduction Zone Observatory. Current discussion is entirely conceptual but would build on the strengths of our programs and ideally provide a new mechanism to enable research on the subduction zone system and the physical-chemical processes that cause natural hazards and shape the continents. I'd like to encourage everyone interested to participate in these initial discussions. A group discussion will be held at AGU on Thursday afternoon (3:30-5pm) in the City Club of San Francisco.

Peter van Keken
Chair, GeoPRISMS Program

Cover Photograph:
The R/V Endeavor at dock, ready to sail across the Eastern North American Margin.
Photo Credit: Dylan Meyer

Newsletter Production:
Anaïs Férot
Jeanne Bisanz

info@geoprisms.org
www.geoprisms.org

Funding Opportunities for GeoPRISMS-Related Proposals

OCE Postdoctoral Research Fellowships (solicitation # NSF 14-607)

Submission Deadline: December 8, 2014

http://www.nsf.gov/pubs/2014/nsf14607/nsf14607.pdf

This fellowship is intended to recognize beginning investigators of significant potential and provide them with experience that will establish them in positions of leadership in the scientific community. The grant provides a $62k/yr stipend for up to 24 months, up to $25k/yr for expenses and benefits, and up to $10k/yr for international collaboration. Applicants must be US citizens or permanent residents of the USA. They must have received their PhD by the start of the fellowship, must be within 2 years of getting their PhD, must not have concurrently submitted the same project to another postdoctoral program, and must be doing research within the spectrum of the sciences funded by the Division of Ocean Sciences.

OCE Research Initiation Grants (solicitation # NSF 13-606)

Submission Deadline: January 12, 2015

http://www.nsf.gov/pubs/2013/nsf13606/nsf13606.pdf

This program provides startup funding for researchers who have been recently appointed to tenure track (or equivalent) positions at US academic institutions, with the twin goals of enhancing their research careers and broadening the participation of under-represented groups in ocean sciences. Award amounts are up to $100k total for 12 to 24 months and no salary can be involved. Applicants must be US citizens, nationals or permanent residents of the USA, are in or have been accepted to a tenure track Assistant Professor/Researcher or equivalent position at a US academic institution, and have not been in that position for more than 3 years. Qualified applicants must have no salary support as a Principal Investigator (PI) on any federal research grant since starting their position and must be doing research within the spectrum of the sciences funded by the Division of Ocean Sciences.

Message from NSF

We write to you from our offices at NSF in the midst of transition. As you'll read elsewhere, Bil Haq, who has guided the MARGINS and GeoPRISMS programs for years, transitioned into a part time position, leaving more of the management to us (Donna and Jennifer). GeoPRISMS is a special program (rather than a core program), which means that support level can be reviewed each year. Division Directors play a role in this, and both OCE and EAR will have new Division Directors coming on board in early 2015: Rick Murray of Boston University will lead Ocean Sciences, and Carol Frost of the University of Wyoming will lead Earth Sciences. We look forward to working with them, particularly on this shared program, whose cross-coast science resides within a part of the recently released GeoVision frontiers. The Division Directors will face budgetary challenges: 1) The Foundation is still under sequestration by Congress. 2) As we write this, the government is funded on a Continuing Resolution, which means that planning for 2015 will start out conservatively, and the full scope of what we can take on this GeoPRISMS cycle may not be certain until later in the fiscal year. The program received a strong batch of proposals for FY15 funding, and one challenging aspect of this positive situation is that the requests totaled nearly seven times the money we expect to have available. We will do our best to push forward with time-sensitive projects that are top priority. Next summer, we expect to retain the option of supporting a joint field logistics platform in the Aleutians, aiming to optimize results and enhance multi-disciplinary collaboration.

We recognize that GeoPRISMS encompasses a thriving community that is pursuing forefront science. We regularly discuss strategy for the program and bring forward ideas for directorate-wide discussion that we think can advance opportunities for this field. The October workshop on the future of the Amphibious Array facilitated great discussions about the role of amphibious science in the broader NSF context. Across the sub-disciplines, the project updates and published papers from funded projects in both GeoPRISMS and related core programs are wonderful to see. It is the exciting science that keeps us going in these challenging times – and GeoPRISMS has accomplished a lot this year.

Donna Blackman and Jennifer Wade
GeoPRISMS Program Managers, National Science Foundation

Au revoir et bonne chance GeoPRISMS!

On the eve of my parting from active program management of the GeoPRISMS Program at NSF, I have been given the opportunity to say a few words of valediction by your Chair and I am indeed honored to do so. After having first instigated the ancestral MARGINS Program in the late 1980s and then directed it since its inauguration in 1998 (and its progeny, the GeoPRISMS Program since 2009), I feel that I may be in a position to say a few words about this major community-driven program with the central objective to resolve some of the fundamental questions about how the Earth works. At the commencement of this expansive amphibious initiative to look at solid Earth and surficial processes along continental margins, there was considerable early debate about the pros and cons of "big" science (= large community-directed projects) vs. curiosity-driven science (= smaller individual investigator-initiated projects) and whether this was the right place for NSF to invest its precious resources. Looking back, I can state categorically that the MARGINS/GeoPRISMS approach has been a resounding success. This program has continuously pushed the boundaries of our knowledge and has often been cited as one of the most productive and best run programs in marine geosciences at NSF. "Big" science therefore has its place, especially when it is recognized that some fundamental questions cannot be answered by individual investigations alone and require larger community-based efforts. Nevertheless, in addition to community experiments, MARGINS/GeoPRISMS has also continuously supported individual investigators and has been cognizant of the need to inject new blood by encouraging young investigators, post-docs and graduate students. Above all the reason for the Program's success has been the active and whole-hearted participation of a large segment of the research community (an amalgamation of investigators with diversified interests who chose to congregate under the MARGINS umbrella) in identifying the fundamental questions, designing the necessary experiments, crafting the Science Plans and continuously self-reviewing their progress and schedule. MARGINS created its own "community", more conversant with shaping large amphibious experiments, at ease with working across disciplinary boundaries, and willing to forgo individual interests to larger projects that have greater impact and a common scientific advantage. The breakthroughs have come from a shared vision. These traditions have continued and have been strengthened in the successor GeoPRISMS Program.

In large part the efficient operation of both MARGINS and GeoPRISMS Programs has been due to the fortunate circumstance that exceptional active researchers were willing (after some gentle persuasion from NSF) to step up as Chairs of the Steering Committee and as directors of the Program Office. The MARGINS-GeoPRISMS community owes these scientists an unstinting vote of thanks for their generous community service. They include (from the first Chair to the current): Dale Sawyer, Brian Taylor, Gary Karner, Julie Morris, Geoff Abers, Julie Morgan and Peter van Keken. My personal thanks to all of them for letting me twist their arms, often at considerable inconvenience to their own careers, to take on the time-consuming charge of leading the MARGINS/GeoPRISMS community and keeping their expectations realistic and on schedule.

After 26 years of directing the Marine Geology and Geophysics Program (that includes GeoPRISMS) at NSF's Division of Ocean Sciences, I have opted for semi-retirement, i.e., spending half of my time at NSF and the other half at Sorbonne's Pierre and Marie Curie University in Paris. So, although I will continue to be involved with GeoPRISMS during the review cycles, the active running of the Program at NSF will be in the extremely capable hands of Donna Blackman (Ocean Sciences) and Jennifer Wade (Earth Sciences). My new role in Ocean Science Division is designated as an "Expert" and I hope to continue to serve the marine geosciences community in this role for a few more years. In the meantime, Paris University has already assigned graduate students for me to look after, which I am also looking forward to with anticipation.

I was touched when GeoPRISMS Office presented me with a collage of all the available mug shots of the MARGINS/GeoPRISMS-related investigators. There are faces, too numerous to count, that I know (though some are almost unrecognizable younger versions of their current selves), but more importantly, there are many new faces on this board that I am not as yet familiar with, which underscores the continued vitality of this Program. My thanks to Peter and GeoPRISMS Office, and especially to Anaïs Férot, for this very thoughtful gesture.

Au revoir et bonne chance, mes amis!

Bilal Haq
OCE/GEO/NSF
and UPMC


Geo PRISMS
MARGINS
Photo Taryn Lopez
Photo Emily Hooft
Photo Erin DiMaggio
Photo Una Miller
Photo Paul Wallace
Photo Dylan Meyer
Photo Anais Férot
Photo Susan Schwartz
Photo James Syvitski
Photo Donna Shillington
Photo Dylan Meyer

Volcanoes of Virginia: A Window into the Post Rift Evolution of the Eastern North American Margin

Sarah E. Mazza[1], Esteban Gazel[1], Elizabeth A. Johnson[2], Brandon Schmandt[3]

[1]Department of Geosciences, Virginia Tech, Blacksburg, VA, [2]Department of Geology and Environmental Sciences, James Madison University, Harrisonburg, VA, [3]Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM

The Eastern North American Margin (ENAM) developed into a passive margin following the breakup of Pangea at the Triassic-Jurassic boundary. However, the definition of "passive" no longer fits traditional tectonic thinking, as is evident from topographic rejuvenation of the central Appalachians since the late Cenozoic (e.g. Rowley et al., 2013). The recent 2011 Mineral, VA earthquake (M5.8) reminded us that the ENAM is not as stable as we would like it to be. Multiple tectonic events have shaped the ENAM and the Appalachians into a complex, lithologically diverse mountain range. The geologic record encompasses several Wilson Cycles, including the Grenville (~1.2-0.9 Ga), Taconic (~550-440 Ma), Acadian (~420-360 Ma), and Alleghanian (~320-260 Ma) orogenic events. The Appalachians and Piedmont has seen its share of magmatic activity, from Alleghanian granitic plutons to the massive Central Atlantic Magmatic Province (CAMP) occurring at 200 Ma (e.g. Blackburn et al., 2013).

The youngest known magmatic rocks in the ENAM are Mid-Eocene (Southworth et al., 1993; Tso and Surber, 2006; Mazza et al., 2014), located in the Valley and Ridge Province of Virginia and West Virginia (Fig. 1a). Over the past three years we have been conducting extensive field work, sampling over 50 different locations thus far. The Eocene volcanic rocks occur as dikes, sills, plugs, and diatremes, up to ~400 m in diameter (Fig. 1b, and c). The volcanic rocks are bimodal in composition, including mostly basalt and trachydacite. Mafic end members are generally fresher, with well-preserved mafic minerals, and some carrying lower crustal and mantle xenoliths. The felsic samples are typically rich in amphibole and biotite, both of which are useful for $^{40}Ar/^{39}Ar$ age dating.

New $^{40}Ar/^{39}Ar$ age dates have confirmed that the Virginia/West Virginia volcanics are the youngest magmatic event in the ENAM at ~48 Ma (Mazza et al., 2014). The Eocene magmatic pulse is an example of continental intraplate volcanism. Intraplate volcanism can be explained by mantle plume activity, lithospheric delamination, or simple extension. Plume-generated volcanism has elevated productivity, high mantle temperatures, and geochemical signatures indicative of deep sources (e.g. Hawaii; Herzberg et al., 2007). Lithospheric delamination can explain similar geochemical signatures as plume-derived volcanism, but with lower melting temperatures and productivity (e.g. New Zealand; Hoernle et al., 2006).

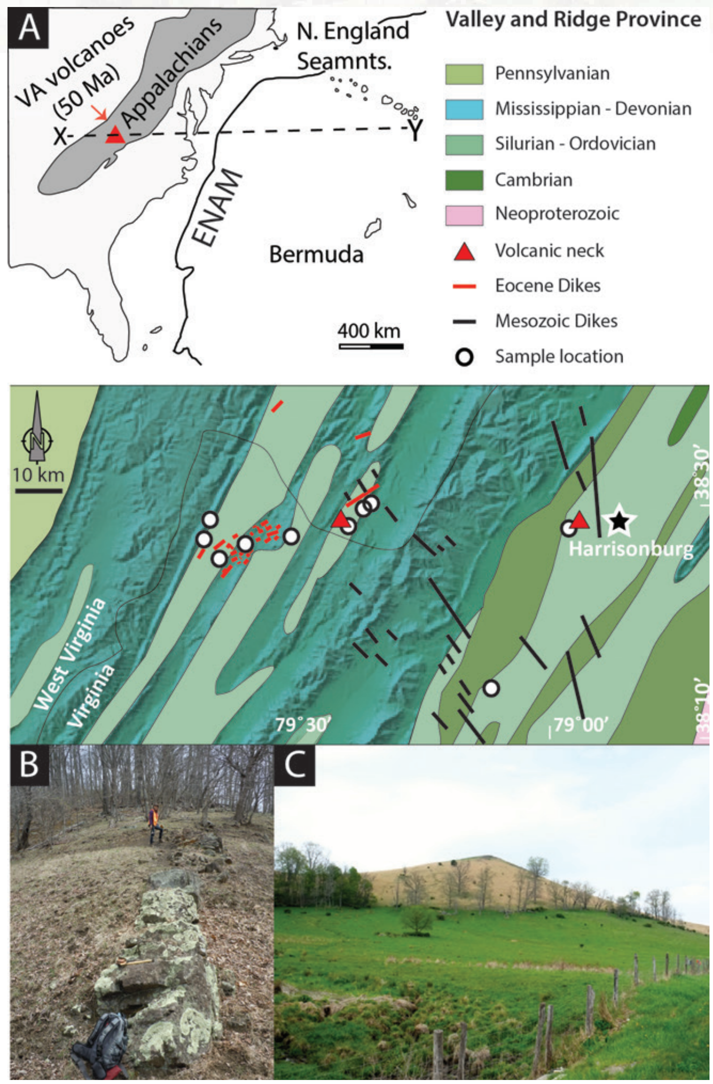


Figure 1. A) Simplified geologic map showing sample locations of Eocene magmas. Note the orientation of the Mesozoic Central Atlantic Magmatic Province dikes towards the northwest and Eocene dikes towards the northeast. Cross section X-Y is shown in Figure 2. ENAM – Eastern North American margin; VA – Virginia; N. – New. B) Example of basaltic dike found in Highland County, Virginia. C) Trimble Knob, an example of a diatreme in Highland County, Virginia.

Education & Outreach

We have been striving to use the story of the "youngest volcanoes in the ENAM" as a teaching example. Just recently, we participated in the Virginia Science Festival with the goal of furthering the general public's understanding of geologic processes right in their own backyard. From volcanic diking experiments to hands on exhibits, we have been encouraging the public's interest in the geologic processes that helped shape the state they live in. At the college level, this project has funded several undergraduate research projects at James Madison University. Several of these undergraduates have been able to present their research at national and regional conferences. Reaching a broader, non-scientific audience can be challenging. We have been able to overcome the hurdle by communicating with the press, through organizations such as NPR, Scientific American, LiveScience, and the Washington Post.

Virginia Science Festival Exhibit "Volcanoes form the inside out". PhD Student Pilar Madrigal in the inner exhibit about melt generation and formation with examples form the VA Eocene Volcanoes and dikes in the Santa Elena Ophiolite in Costa Rica.

Continental extension can also produce intraplate magmas, thinning the lithosphere and allowing for decompression melting. In the case of extension, melting temperatures are expected to be close to ambient mantle and the geochemical signature would be less enriched compared to those magmas produced from mantle plume or delamination (e.g. the Basin and Range, western US; Gazel et al., 2012).

Our results show that the Eocene magmatic pulse is mantle derived and record an equilibration temperature of 1412 ± 25 °C at a pressure of 2.32 ± 0.31 GPa. Thus, melting conditions of the Eocene magmatic pulse indicates that conditions were too cold to be mantle plume derived (>1500 °C; Herzberg et al., 2007) and too hot to be related to the mantle at mid-ocean ridge systems (~1350 °C; McKenzie et al., 2005).

In order to determine a mechanism for melting, we turned to the available geophysical data. Prior to the arrival of the USArray to the east coast, Wagner et al. (2012) proposed the presence of a fossilized slab beneath North Carolina. From their Appalachian Seismic Transect, they found evidence for a westward dipping fossilized slab, which they interpret as an eclogized remnant of a west-vergent subduction zone associated with the accretion of Carolinia. However, contrasting seismic data from the TEENA Array (Test Experiment for Eastern North America; Benoit and Long, 2009) suggests a single Moho below the Shenandoah Valley of Virginia (at a depth of ~40 km). Thus, between Virginia and North Carolina, the remnant eclogized slab is lost.

Based on the geochemistry, average temperatures and pressures of melting (Mazza et al., 2014), the presence of a thickened, eclogized root in North Carolina (Wagner et al., 2012), and the lack of a thick crust in the Shenandoah Valley of Virginia (Benoit and Long, 2009) leads us to suggest that the ENAM Eocene magmatism was the result of localized upwelling in response to delamination (Fig. 2; Mazza et al., 2014).

A recent seismic study using seismic waveforms initiated from the 2011 Mineral, VA earthquake and the USArray in the Midwestern US suggested that a hidden hotspot trail may exist beneath the ENAM (Chu et al., 2013). They modeled the possibility of a thermal anomaly's retention over the course of tens of millions of years and predicted that it is possible for a thermal anomaly from ~50-75 Ma to still exist today. However, Chu and coauthors suggest that this thermal anomaly was the result of a plume track that passed under Virginia 60 Ma, which is ~12 m.y. too early based on the new age evidence. Our ages are younger and our calculated mantle potential temperatures are lower than expected for a plume environment.

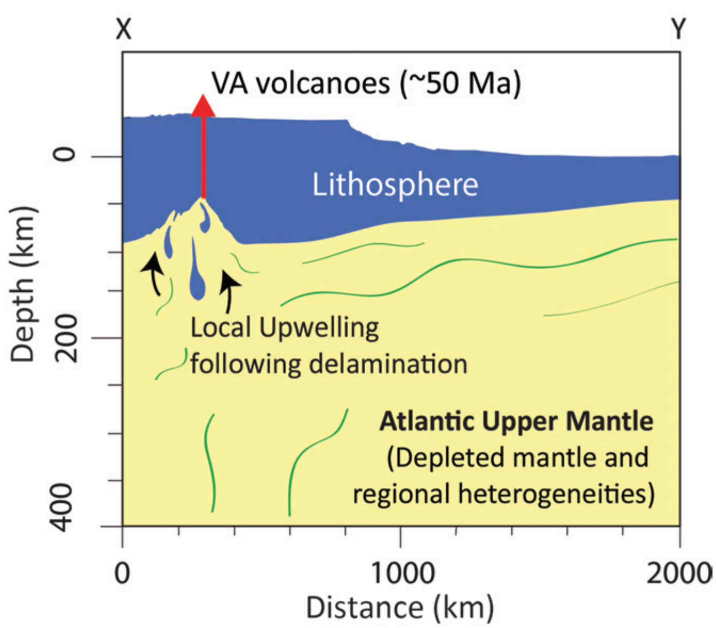


Figure 2. Schematic model of melting mechanism by lithospheric delamination and possible mantle sources of Virginia (VA) volcanoes. Line of cross-section X-Y is shown in Figure 1A.

Because of these discrepancies, the data Chu et al. (2013) presented could also be interpreted as a delaminated lithosphere. Recent tomography of the ENAM using the newly arrived USArray (up to May 2014) from Schmandt and Lin (2014) shows a low-velocity anomaly at ~60-300 km depths beneath the central Appalachians (Fig. 3). Schmandt and Lin (2014) agree with our interpretation of delamination, suggesting that the Eocene delamination could have left the "thermal scar".

If the Eocene intraplate magmatism was produced by delamination and localized mantle upwelling, then one would expect to see localized change with the topography in response to the influx of a hotter mantle. There is well documented Neogene landscape rejuvenation along the ENAM passive margin (Rowley et al., 2013 and references within), from elevated erosion, increased sedimentation rates, and alteration of drainage patterns. Due to the thermal potential of mantle derived Eocene magmas in the Virginias, there could have been a larger pulse of dynamic topographic change in the central Appalachians. Unfortunately, no indication of Eocene landscape rejuvenation has yet been identified.

With further collaboration between geochemists, geophysicists, and geomorphologists, we plan to continue to evolve our understanding of the post-rifted ENAM. Not only do we aim to better understand the evolution of the ENAM, but we hope that our future work will expand our knowledge of the mantle beneath cratons and passive margins worldwide. This project has the potential to be an excellent teaching aid, showing the complexity of the physical world we live in and thus sparking interests in the next generation of geoscientists. ■

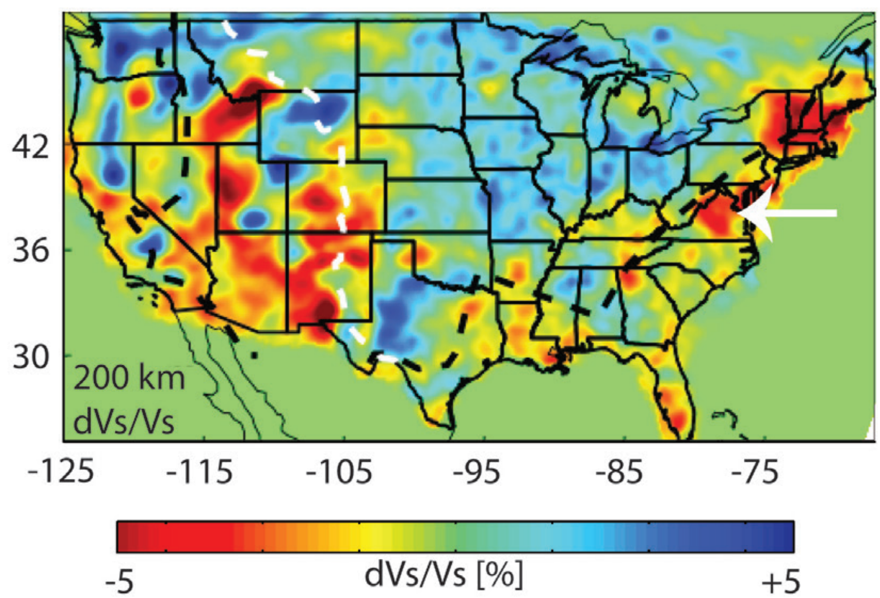


Figure 3. S wave tomography at 200 km depth from Schmandt and Lin (2014). White arrow points to the location of the Virginia Eocene magmatism.

References

Benoit, M.H., Long, M.D. (2009). The TEENA experiment: a pilot project to study the structure and dynamics of the eastern US continental margin: AGU Fall Meeting Abstracts.

Blackburn, T.J., Olsen, P.E., Bowring, S.A., McLean, N.M., Kent, D.V., Puffer, J., McHone, G., Rasbury, E.T., Et-Touhami, M. (2013). Zircon U-Pb Geochronology Links the End-Triassic Extinction with the Central Atlantic Magmatic Province. Science, 340(6135), 941–945.

Chu, R., Leng, W., Helmberger, D.V., Gurnis, M. (2013). Hidden hotspot track beneath the eastern United States. Nat. Geosci., 6, 963–966.

Gazel, E., Plank, T., Forsyth, D.W., Bendersky, C., Lee, C.T.A., Hauri, E.H. (2012). Lithosphere versus asthenosphere mantle sources at the Big Pine Volcanic Field, California. Geochem. Geophys. Geosys., 13(6).

Herzberg, C., Asimow, P.D., Arndt, N., Niu, Y., Lesher, C.M., Fitton, J.G., Cheadle, M.J., Saunders, A.D. (2007). Temperatures in ambient mantle and plumes: Constraints from basalts, picrites, and komatiites. Geochem. Geophys. Geosys., 8(2).

Hoernle, K., White, J.D.L., van den Bogaard, P., Hauff, F., Coombs, D.S., Werner, R., Timm, C., Garbe-Schönberg, D., Reay, A., Cooper, A.F. (2006). Cenozoic intraplate volcanism on New Zealand: Upwelling induced by lithospheric removal. Earth Planet. Sci. Lett., 248(1-2), 350–367.

Mazza, S.E., Gazel, E., Johnson, E.A., Kunk, M.J., McAleer, R., Spotila, J.A., Bizimis, M., Coleman, D.S. (2014). Volcanoes of the passive margin: the youngest magmatic event in Eastern North America. Geology, 42, 483–486.

McKenzie, D., Jackson, J., Priestley, K. (2005). Thermal structure of oceanic and continental lithosphere. Earth Planet. Sci. Lett., 233(3), 337–349.

Rowley, D.B., Forte, A.M., Moucha, R., Mitrovica, J.X., Simmons, N.A., Grand, S.P. (2013). Dynamic topography change of the Eastern United States since 3 million years ago. Science, 340, 1560–1563.

Schmandt, B., Lin, F.C. (2014). P and S wave tomography of the mantle beneath the United States. Geophys. Res. Lett., 41(18), 6342–6349.

Southworth, C. S., Gray, K., Sutter, J.F. (1993). Middle Eocene Intrusive Igneous Rocks of the Central Appalachian Valley and Ridge Province. Setting, Chemistry and Implications for Crustal Structure.

Tso, J.L., Surber, J.D. (2006). Eocene igneous rocks near Monterey, Virginia; A field study. Virginia Minerals, 49(3-4), 9–24.

Wagner, L.S., Stewart, K., Metcalf, K. (2012). Crustal-scale shortening structures beneath the Blue Ridge Mountains, North Carolina, USA. Lithosphere, 4(3), 242–256.

Distinguished Lectureship Program

2014 - 2015

An opportunity for US colleges, universities, museums, and other institutions to host lectures by outstanding scientists.

The distinguished speakers present technical and public lectures on subjects related to the two GeoPRISMS science initiatives: Subduction Cycles and Deformation and Rift Initiation and Evolution.

Heather DeShon in Georgia Southwestern State University in 2013.

As usual, we received a strong interest in the program with applications from 60 institutions.

Thank you for making this year's GeoPRISMS Distinguished Lectureship Program successful!

Questions?
Email info@geoprisms.org

Applications to host a DLP Speaker for the Academic Year 2015-2016 will be available in the Spring semester on the GeoPRISMS Website.

Visit the GeoPRISMS website to learn more about the DLP schedule for 2015.

University of Oregon
California State University, Chico
University of Wisconsin – River Falls
University of Maine

RICHARD ALLEN
UC Berkeley

Michigan State University
Wayne State University
University of Southern California
Portland State University

REBECCA BENDICK
University of Montana

The Comm. College of Baltimore County
Drexel University
Florida State University
University of Vermont

ELIZABETH COTTRELL
Smithsonian Institution

UMASS Amherst
University of Connecticut
University of Wisconsin Oshkosh
University of New Hampshire

BRADLEY HACKER
UC Santa Barbara

UC San Diego, SCRIPPS Institution
Utah Valley University
Southern Methodist University

ANDY NYBLADE
Penn State University

Rutgers University, New Brunswick
Colorado State University
University of California, Berkeley

JOSH ROERING
University of Oregon

Kansas State University
University of Iowa
Dickinson State University

ROBERT STERN
UT Dallas

University of Nevada, Reno
University of California, Riverside
University of Oklahoma

KYLE STRAUB
Tulane University

New MARGINS Mini-Lessons

Coming Soon January 2015

MARGINS Mini-lessons are modular learning materials that take advantage of data resources, imagery, and other information gained through more than a decade of MARGINS research. They provide unique data-rich tools for students to examine fundamental Earth processes in undergraduate classrooms from a multidisciplinary perspective. Mini-lessons are based on best practices in geoscience pedagogy, benefitting from a strong partnership between MARGINS researchers and the Science Education Resource Center at Carleton College (SERC).

New MARGINS Mini-lessons from four initiatives

Rupturing Continental Lithosphere

Modules explore the processes that control rifting through discoveries from the Gulf of California focus area.

- Bathymetry of Rifted Margins
- Styles of Extension
- Rift Tectonics and Sedimentation
- Plate Motion Obliquity in Rifting

Seismogenic Zone Experiment

Comparative subduction zone tectonics and fault slip processes are examined through case studies from around the world.

- Accretionary vs. Erosive Margins
- The Spectrum of Fault Slip
- The Plate Boundary Fault of the 2011 Tohoku Earthquake

Source to Sink Lessons

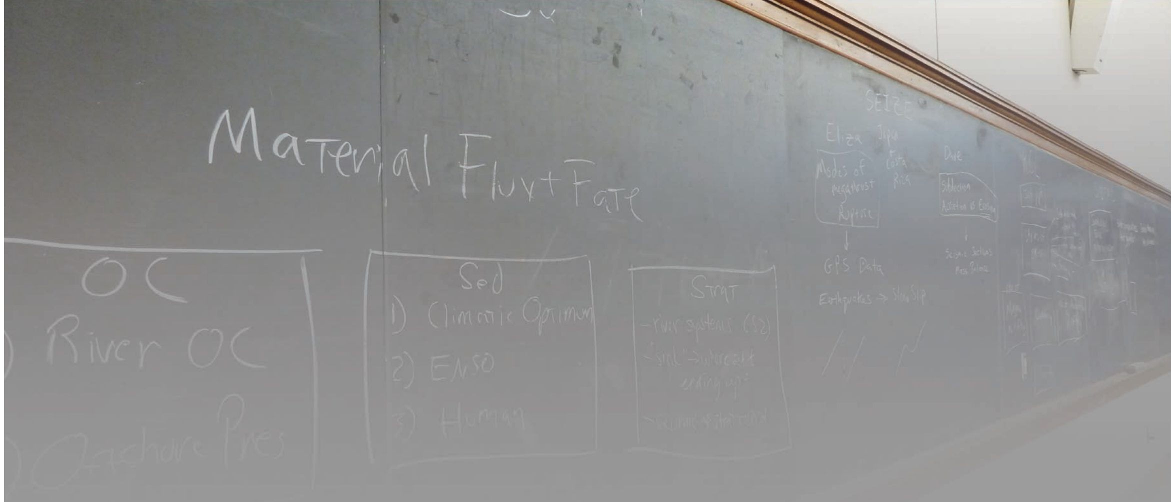
Exploration of the characteristics of some key “hot spots” in the sedimentary cycle.

- How Sediment Reflects the Journey from the Mountains to the Sea
- Sediment Dispersal and Continental Margin Stratigraphy
- Sediment and Carbon Burial on the Continental Margin
- Holocene Optimum: A Time of Massively Increased Sediment Discharge for Asian Rivers
- ENSO and the Huanghe River

Subduction Factory Lessons

Hands-on examinations of data sets representing different parts of the subduction zone system, and the processes that operate within them

- Subduction Zone Metamorphism
- Central American Arc Volcanoes, Petrology, and Geochemistry
- Controls of Slab Temperature in Subduction Zones



For more information contact:

Julia Morgan, Rice University (morganj@rice.edu)
Gus Costa, Rice University (agc4@rice.edu)

To browse the collection, visit:

serc.carleton.edu/margins/lesson_descript.html

Project Leads:

Julia Morgan, Rice University (morganj@rice.edu)
Ellen Iverson, SERC, Carleton College
Andrew Goodliffe, University of Alabama
Jeff Marshall, California State Polytechnic Pomona

Imaging the Nicaragua Subduction Zone with Marine Electromagnetic Methods

Samer Naif[1], Kerry Key[1], Steven Constable[1], Rob L. Evans[2]

[1]SCRIPPS Institution of Oceanography, [2]Woods Hole Oceanographic Institute

In April and May 2010, we conducted the Serpentinite, Extension and Regional Porosity Experiment across the Nicaraguan Trench (SERPENT). During the 28 day cruise on the R/V Melville we collected seafloor electromagnetic data sensitive to electrical conductivity variations in the crust and mantle. Because electrical conductivity depends on pore fluid content, the data from SERPENT provide unique constraints on porosity across an active subduction zone. The entire SERPENT data set consists of 54 stations of marine magnetotelluric (MT) data and nearly 800 km of deep-towed controlled-source electromagnetic (CSEM) data. This is a huge milestone for marine electromagnetic (EM) studies as we collected significantly more seafloor MT stations than previous offshore surveys of subduction zones. Furthermore, our survey is the first to collect marine CSEM data at a subduction zone. The results showed here demonstrate the ability to image porosity and pore fluids in crustal bending faults and along the plate interface beneath the forearc using this technique.

Electrical conductivity is a material property that can vary by several orders of magnitude in geologic systems. While metallic ore bodies can be very conductive, the silicate rocks that dominate the crust and upper mantle are relatively poor conductors (<10^{-5} S/m). However, fluids such as seawater and basaltic melt are significantly more conductive (>10^{-1} S/m). Given this large contrast, even small amounts of conductive pore fluids in an otherwise resistive matrix can produce a notable increase in bulk electrical conductivity, making a suitable target for EM exploration.

Electrical and electromagnetic (EM) methods have been used for onshore prospecting for about a century. Their use offshore came later with pioneering efforts at the Scripps Institution of Oceanography, where an ocean-bottom EM recorder was developed in the 1960's , followed by the development of a deep-towed EM transmitter system in the 1970's and 1980's to map the high resistivity of the oceanic lithosphere (Constable, 2013). While this early work was largely funded by the Office of Naval Research, the recognition that this technology could be used to map resistive hydrocarbon reservoirs on the continental shelves led to a significant influx of industry support starting around 2000, resulting in major strides in instrumentation design, numerical modeling algorithms, and data interpretation tools. In particular, industry support allowed Scripps to develop a fleet of 60 broadband ocean-bottom EM receivers and two deep-towed EM transmitter systems. We leveraged this equipment for the NSF-funded SERPENT project, resulting in the largest marine EM experiment at a subduction zone to date.

MT passive method utilizes a natural source field generated by the interaction of the solar wind with

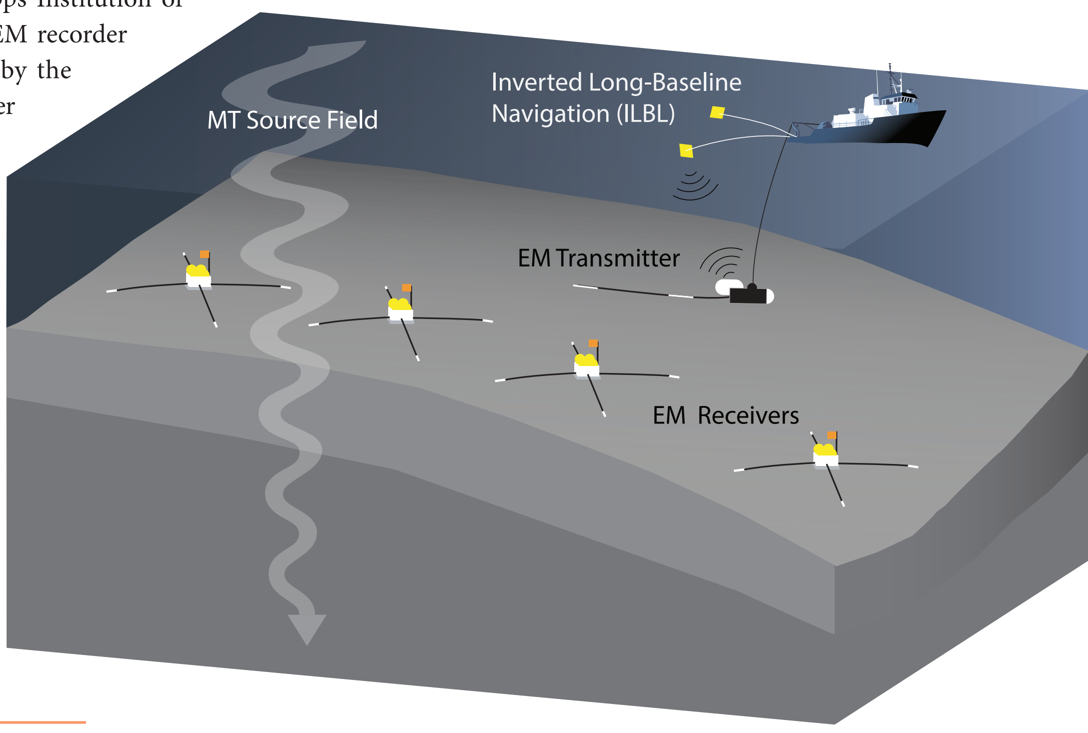


Figure 1. Marine EM survey operations. Broadband EM receivers are deployed from the ship to record electric and magnetic fields generated by both active and passive sources. An EM transmitter, deep-towed behind the ship near the seafloor, emits the high-frequency active source energy. The transmitter position is acoustically navigated with an inverted long-baseline configuration. A large-scale survey spanning several hundred kms can be performed in a single month long cruise voyage.

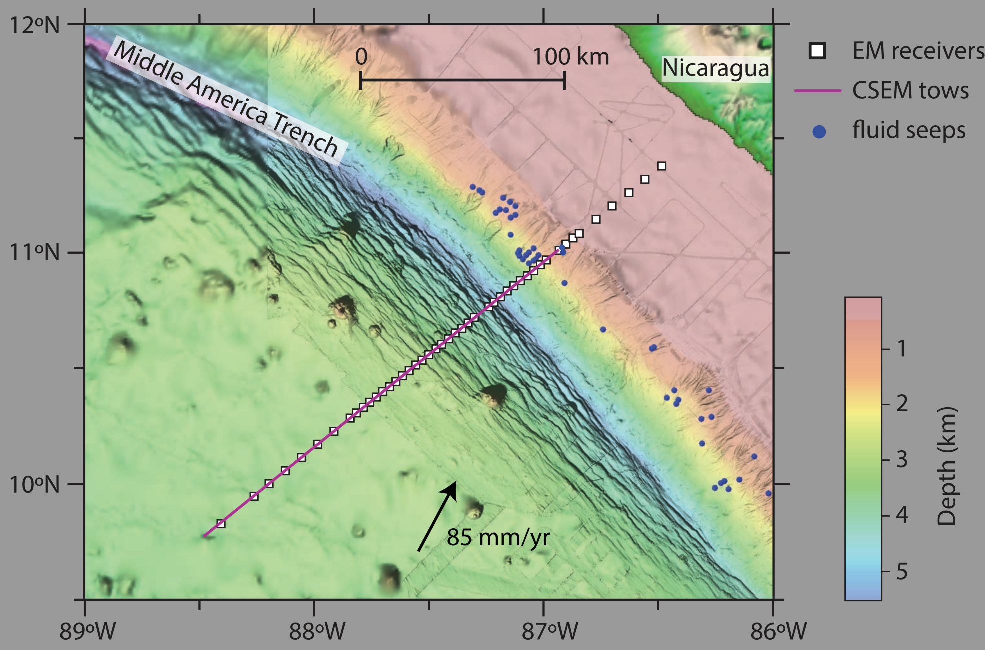


Figure 2. Map of the SERPENT survey transect. A total of 50 EM receivers were deployed across the Middle America Trench offshore Nicaragua, where the 24 Ma Cocos plate subducts beneath the Caribbean plate. Receiver locations spanned the abyssal plain, the visibly faulted outer rise, and the continental slope and shelf at 10 and 4 km spacing. A cluster of active forearc seeps are located adjacent to the survey transect (blue circles).

the geomagnetic field. This interaction leads to the formation of time varying ionospheric current systems that emanate plane EM waves diffusing down to the surface through the resistive atmosphere. As these EM fields diffuse into the solid Earth, they attenuate in response to the subsurface conductivity structure. By measuring both electric and magnetic fields on the seafloor for several days to weeks, the MT method can estimate frequency dependent impedances over several decades of frequency, which in turn can be inverted for conductivity structure. In marine environments, the highly conductive ocean attenuates the source energy at frequencies above about 0.1 Hz, reducing the sensitivity of marine MT to shallow structure and making it more suitable for recovering upper mantle conductivity structure. In order to better resolve structure in the upper 10 km, we can supplement the MT method with the CSEM method, which involves deep towing a transmitter that emits 300 amps of time varying current across a 250 m dipole antenna, giving EM responses in the 0.25 to 10 Hz band (Fig. 1).

The SERPENT survey was conducted along a 280-km transect crossing the Middle America Trench offshore Nicaragua (Fig. 2). Previous seismic imaging detected deep Moho-crossing bending faults that could provide pathways for water to serpentinize the uppermost mantle (Ranero et al., 2003). We collected marine MT and CSEM data in order to probe the subsurface electrical conductivity structure for anomalies associated with fluid-tectonic processes at the subduction front, such as plate hydration beneath the outer rise bending faults as well as diagenetic dehydration of the subducted sediments. Our goal was to quantify the lateral and depth variations of porosity in the incoming oceanic plate and the forearc margin so that we could infer fluid content and identify migration pathways and circulation patterns.

We specifically designed the survey transect to include data coverage over the Cocos plate abyssal plain, far enough seaward of the outer rise so we would image what was expected to be a simple one-dimensional conductivity structure of "normal" oceanic mantle. This measure was meant to serve as a background measurement of the oceanic lithosphere from which we could better quantify conductivity changes associated with faulting and hydration at the deformation front. With a stroke of luck, the MT data from the abyssal sites were far more valuable than we predicted, aiding our discovery of a surprising horizontally extensive high conductivity layer at depths of 45-70 km (Fig. 3). The observed layer led us to consider a fundamental question regarding plate tectonics that was unrelated to the originally proposed goals of the survey: what rheological mechanisms govern the lithosphere-asthenosphere boundary (LAB) allowing rigid tectonic plates to slide?

SERPENT team members deploy the Scripps Undersea EM Source Instrument (SUESI), a deep-towed horizontal electric dipole transmitter used for the CSEM method. SUESI will only work if she is smiling.

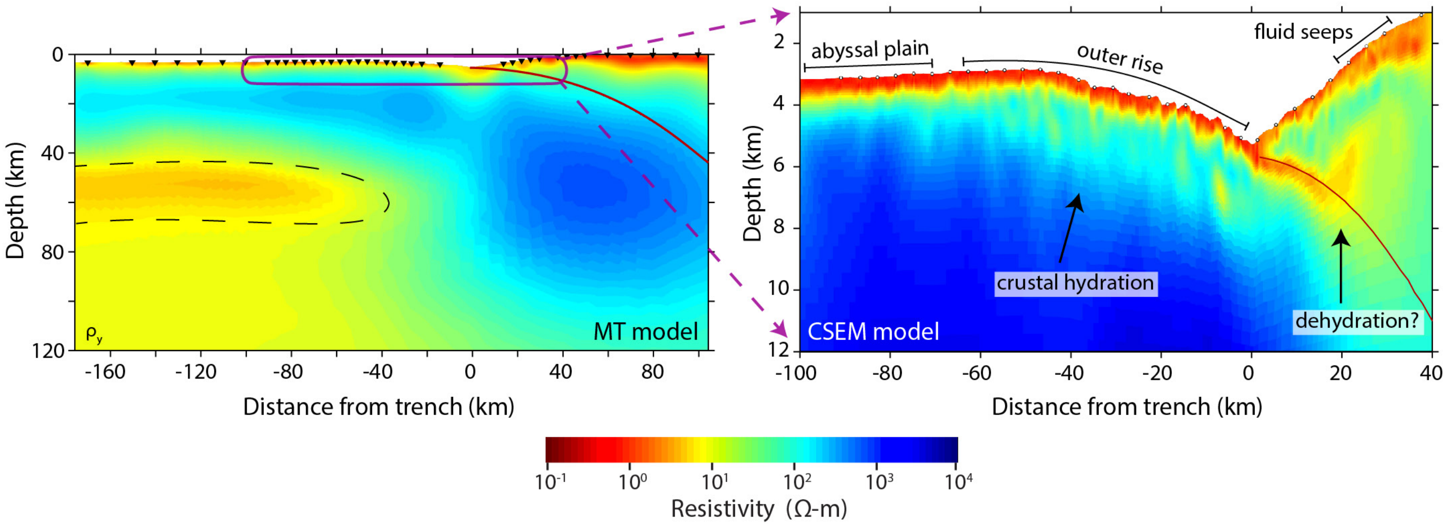


Figure 3. Non-linear 2D inversion of MT and CSEM data. Left: converged MT data inversion. The dashed black lines enclose the prominent low resistivity channel interpreted as partial melt at the LAB. Right: converged CSEM data inversion that shows decreasing resistivity beneath fault scarps at the outer rise and a low resistivity channel that follows the plate interface in the forearc margin, and which represent hydration and sediment subduction, respectively.

There are three competing hypotheses often invoked to explain the oceanic LAB that is prominent in seismic and EM observations: 1) a thermal boundary, 2) a hydration boundary, 3) a partial melt boundary (Fischer et al., 2010). From the existing laboratory studies of the electrical conductivity of expected mantle phases, the signature of our observed channel is too conductive to be explained with either temperature or hydrated olivine alone. Such high conductivity measurements require an interconnected network of 1-2% hydrated basaltic melt. Alternatively, a recent study suggests that 0.3-0.5% of highly enriched incipient melt is a more plausible interpretation (Sifré et al., 2014). In light of other recent results that infer or are compatible with partial melt at the LAB (Mierdel et al, 2007; Sakamaki et al., 2013; Yamamoto et al., 2014) it is tempting to conclude that partial melts are ubiquitous and the dominant cause of a rheologically weak asthenosphere. However, a number of competing interpretations derived from compelling observations continue to spark exciting debate regarding the origin of the asthenosphere (Karato, 2012; Beghein et al., 2014; and references therein).

While the MT results are enticing food for thought, we have yet to address our survey's core objective, to investigate the hydration and dehydration of a subducting slab. This is where the potential of the CSEM method really shines. In the right panel of figure 3, we offer a glimpse of our 2D CSEM conductivity model, created by a non-linear two-dimensional inversion of the observed data (Naif et al., in review). This model depicts three important fluid-tectonic processes within the framework of a single coherent image:

A. At the outer rise, multiple sub-vertical conductive channels correlate with seafloor fault scarps that extend into the lower crust. This observation confirms previous conjecture that outer rise faults behave as porous permeable pathways for seawater to penetrate the plate and further suggests that significantly more crustal pore water is subducted than previously thought.

B. At the forearc, a thin conductive channel that persists along the plate-interface is caused by the complete subduction of porous sediments with the sinking oceanic plate. This observation suggests that a considerable amount of water is available to generate extreme pore pressures and is consistent with seismic observations and numerical models at the erosive Nicaraguan margin (Spinelli et al., 2006; Ranero et al., 2008; Saffer & Tobin, 2011).

C. Approximately 20 km into the margin, a prominent sub-vertical conductive channel propagates from the plate-interface into the overlying continental crust in the same region where numerous active seafloor seeps and mud mounds exist (Sahling et al., 2008). This is potentially the first observation to image the migration of subducted fluids to forearc vents.

The outcomes of the SERPENT survey we described above may signify a new era for marine EM exploration that is well suited for the study of fluid-tectonic processes. The interpretation of our conductivity models in terms of faulting and fluid processes builds upon an abundance of geophysical, geochemical, and geological research focused on the Nicaragua and Costa Rica region, testifying to the critical advantages that collaborative multidisciplinary efforts have to offer. ■

Modified from Naif, S., Key, K., Constable, S., Evans, R.L., 2013. Melt-rich channel observed at the lithosphere-asthenosphere boundary. Nature 495, 356-359.

References

Beghein, C., Yuan, K., Schmerr, N., Xing, Z. (2014). Changes in seismic anisotropy shed light on the nature of the Gutenberg Discontinuity. Science, 343(6176), 1237–1240.

Constable, S. (2013). Review paper: Instrumentation for marine magnetotelluric and controlled source electromagnetic sounding. Geophys. Prospect., 61(s1), 505–532.

Fischer, K.M., Ford, H., Abt, D., Rychert, C.A. (2010). The lithosphere-asthenosphere boundary. Annu. Rev. Earth Planet. Sci., 38, 551–575.

Karato, S. (2012). On the origin of the asthenosphere. Earth Planet. Sci. Lett., 321, 95–103.

Mierdel, K., Keppler, H., Smyth, J.R., Langenhorst, F. (2007). Water solubility in aluminous orthopyroxene and the origin of Earth's asthenosphere. Science, 315(5810), 364–368.

Ranero, C. R., Grevemeyer, I., Sahling, H., Barckhausen, U., Hensen, C., Wallmann, K., et al. (2008). Hydrogeological system of erosional convergent margins and its influence on tectonics and interplate seismogenesis. Geochem. Geophys. Geosys., 9(3).

Ranero, C.R., Phipps Morgan, J., McIntosh, K., Reichert, C. (2003). Bending-related faulting and mantle serpentinization at the Middle America trench. Nature, 425(6956), 367–373.

Saffer, D.M., Tobin, H.J. (2011). Hydrogeology and Mechanics of Subduction Zone Forearcs: Fluid Flow and Pore Pressure. Annu. Rev. Earth Planet. Sci., 39(1), 157–186.

Sahling, H., Masson, D.G., Ranero, C.R., Hühnerbach, V., Weinrebe, W., et al. (2008). Fluid seepage at the continental margin offshore Costa Rica and southern Nicaragua. Geochem. Geophys. Geosys., 9(5).

Sakamaki, T., Suzuki, A., Ohtani, E., Terasaki, H., Urakawa, S., Katayama, Y., et al. (2013). Ponded melt at the boundary between the lithosphere and asthenosphere. Nat. Geosci., 6(11), 1–4.

Sifré, D., Gardés, E., Massuyeau, M., Hashim, L., Hier-Majumder, S., Gaillard, F. (2014). Electrical conductivity during incipient melting in the oceanic low-velocity zone. Nature, 509(7498), 81–85.

Spinelli, G.A., Saffer, D.M., Underwood, M.B. (2006). Hydrogeologic responses to three-dimensional temperature variability, Costa Rica subduction margin. J. Geophys. Res., 111(B4).

Yamamoto, J., Korenaga, J., Hirano, N., Kagi, H. (2014). Melt-rich lithosphere-asthenosphere boundary inferred from petit-spot volcanoes. Geology, G35944.1.

The brand new R/V Sonne, inaugurated by Angela Merkel in Summer 2014, is 20 m longer and few meters wider than the old Sonne.

Meet the new R/V Sonne!

The expedition planned by GEOMAR "*The Life Cycle of the Vitiaz-Kermadec arc/backarc system: From arc initiation to splitting and backarc basin formation*" has been approved for scheduling. The cruise will be carried out by the new Sonne, potentially starting early 2016.

More information will be available soon, so stay tuned!

Deployment of a SCRIPPS Ocean Bottom Seismometer from the R/V Endeavor. Photo credit: Dylan Meyer.

From the Mudline to the Mantle: Investigating the Eastern North American Margin

Brandon Dugan (Rice University), Kathryn Volk (University of Michigan), Dylan Meyer (UT, Austin), Kristopher Darnell (UT Austin), Afshin Aghayn (Oklahoma State), Pamela Moyer (University of New Hampshire), Gary Linkevich (Rice University)

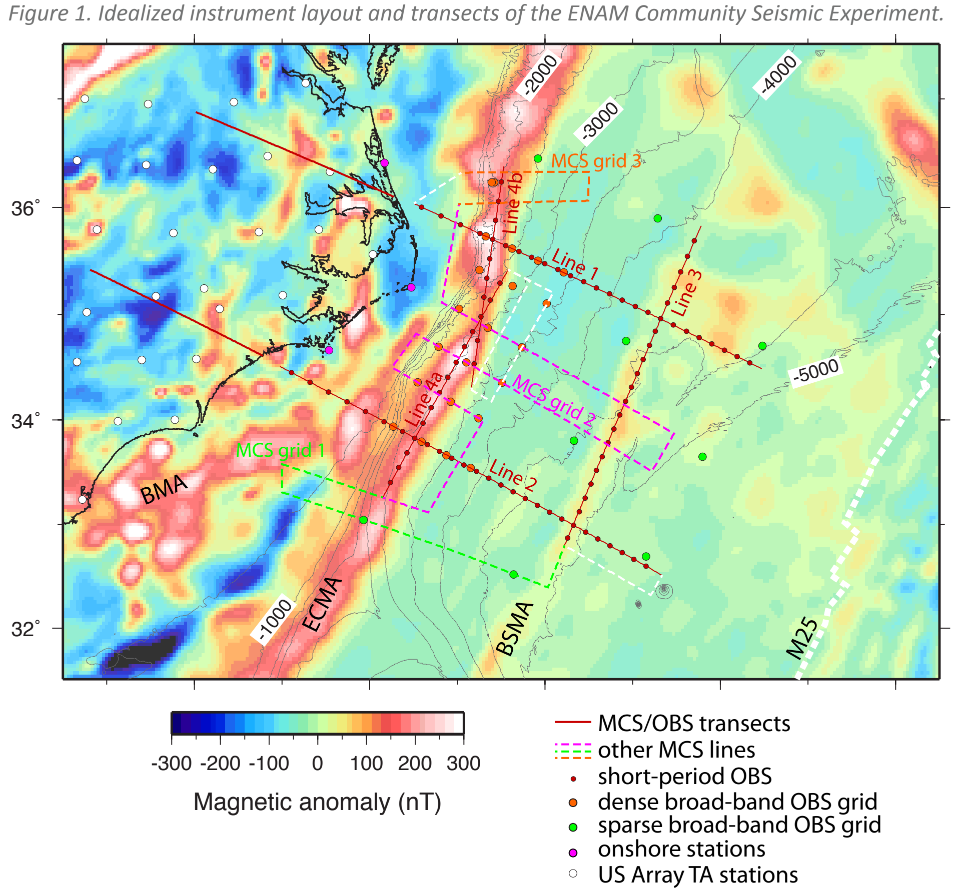
The NSF-GeoPRISMS-funded Eastern North America Margin (ENAM) Community Seismic Experiment (CSE) is a community-driven research project aimed to study continental breakup and the evolution of rifted margins. The ENAM CSE includes acquisition of passive and active-source data from broadband ocean bottom seismometers (OBSs), short-period OBSs, multi-channel seismics (MCS), and onshore seismometers (Fig.1). Data are augmented by the onshore EarthScope USArray seismometers. Together they provide coverage across the shoreline and over a range of length scales. Project data will facilitate detailed studies of the early rifting between eastern North America and northwest Africa in the Mesozoic including processes associated with the Central-Atlantic Magmatic Province (CAMP), the East Coast Magnetic Anomaly (ECMA), and the Blake Spur Magnetic Anomaly (BSMA), as well as high-resolution studies of shallow sedimentary and fluid-flow processes including Quaternary landslides and gas hydrate systems.

Another component of the ENAM CSE was engaging young scientists in the field geophysical program so they could study the eastern North America margin and be educated about the planning and implementation of a multi-investigator, multi-component research program. To accomplish this, we included young researchers (undergraduate and graduate students, post-docs, and assistant professors) in all onshore and offshore field programs. The final stage of training and education will be seismic processing workshops for the OBS and the MCS data in summer 2015. Information for applying will be distributed via GeoPRISMS and other community list-servers.

In this phase of the ENAM CSE we conducted onshore and offshore operations in September 2015. Onshore activities (led by Beatrice Magnani and Dan Lizarralde) included deploying 80 short-period seismic stations to record our offshore shots and recovering the instruments.

Offshore activities included deploying and recovering 94 short-period OBSs from the R/V Endeavor (led by Harm Van Avendonk and Brandon Dugan) and shooting MCS seismic data and providing active sources for the short-period OBSs and land seismic stations from the R/V Marcus G. Langseth (led by Donna Shillington, Matt Hornbach, and Anne Becel). Together these activities yielded high quality seismic reflection and refraction data across the shoreline and down to the mantle.

Figure 1. Idealized instrument layout and transects of the ENAM Community Seismic Experiment.



"

When I first heard about the ENAM CSE, I was very excited by the available cruise opportunities. I have been on several cruises before, ranging from 5 days to 5 weeks, and had been aching to get back out to sea again. Considering my prior experience collecting, processing, and interpreting MCS data, I decided it would be a good idea to expose myself to an alternative data type so I applied for the OBS deployment cruise on the R/V Endeavor. From getting accepted to actually boarding the vessel was really a blur. The next thing I knew, we were casting off the deck lines and heading out into the wild blue yonder. We all settled into our daily routine during the first week and it was great getting to know the crew and research staff. Sadly, the 12-hour watch schedule made it difficult to cross over with those on the other watch, but we were still able to see them at some meals and during watch changes. As the cruise went on and days blurred together, morale and energy remained elevated. We enjoyed our primary task of deploying and recovering OBSs and we filled our free time with reading, card games, and mingling. I had read all the information available on the ENAM CSE website and had chatted with the chief scientists about the project, but lacked the tangible connection between the activities that controlled every day of our lives at sea and the research goals of the ENAM CSE. Then, approximately two weeks after starting the voyage, we started getting data back from the OBSs we had deployed. The link between the physical (data collection) and theoretical (objectives and hypotheses) composition of the ENAM CSE research goals began to take form.

Kathryn Volk, Gary Linkevich, and I met with Dr. Harm Van Avendonk in the main lab soon after the first data from the deployment became available. As a result of my past experience with port-processed MCS data I found that I had difficulty readjusting my perspective to data showing migrated time once the velocity structure been applied to convert time into depth. Through careful explanation, it became apparent that the data could be used to identify structure marking large changes in seismic velocity - so large that material with a velocity of 7 km/s would display as a horizontal layer. The purpose of this was to confirm that the seismic source had penetrated to the crust-mantle boundary. These data helped us identified the direct arrival, along with the position and depth of the OBS, the seismic multiple, and additional arrivals with increasing seismic velocity (a more in-depth description of these interpretations can be found in the ENAM CSE blog post put up on 9/30/14). From this conversation, the theory behind the data we were collecting and the physics behind the instrumentation we were working with became clear to me: combining the data from each line together will produce a seismic velocity model down to the crust-mantle boundary beneath the ENAM CSE study area. This will allow us to infer information concerning the crustal structure within the study region. With this connection drawn, we continued our work with a better-informed sense of purpose and finished the cruise in high spirits knowing that we helped obtain a dataset that will prove to be very important for the scientific community.

My experience aboard the R/V Endeavor was very rewarding. Beyond the excitement of being out on an adventure at sea, I had a unique experience, from learning the construction and operation of OBSs to the important interpretations that can derive from the data. I am looking forward to the data workshops that are being offered next year to continue my education in this area.

- Dylan Meyer, University of Texas at Austin

No break for the Endeavor! Day and night crews worked hard deploying and recovering OBSs. From left to right, left page: day shift assembling the components of the SCRIPPS OBS, then hooking up the instrument for deployment. Right page: the night shift deploys the OBS using the crane; once at the surface, the OBS is recovered using a six feet long pool.

"

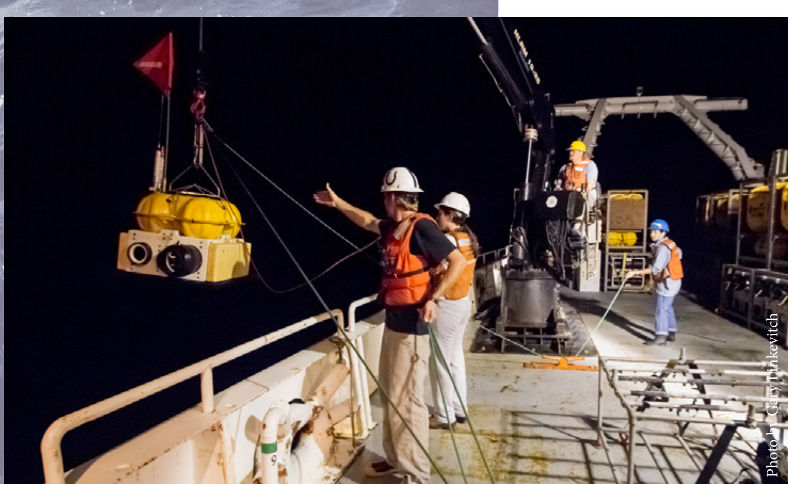
Six students from across the country came together to participate in the R/V Endeavor cruise, and I was one of them. I had never been out to sea before in my life, so I was both excited and nervous for what was to come as we pulled away from port. We started our shifts right away, three students - including me - working the noon to midnight shift, and three other students working from midnight to noon. It took a few days to get to our first line where we would start deploying ocean bottom seismometers. The first task we learned, and one we would repeat many times, was the ocean bottom seismometer assembly. We would work with our shift to attach the metal grate, the instrument box, the ratchet on the side floats, and finally we would secure the top float. The final touch to the assembly included a strobe light, a radio, and a reflective flag to detect the instrument once at the surface. When assembled, the OBS was ready to be deployed off the side of the ship, or as the Captain referred to it, 'pick her up and put her in'. At night, we could distinguish the flashes of the strobe light before the instrument disappeared under the waves. We would repeat this task, moving from one site to the next until we finished a line.

Harm Van Avendonk leading the science party meeting on board.

Once the R/V Langseth had shot active-source seismic across a line, we had to go back and recover the OBSs by fishing them back out of the Atlantic. We would first return to the drop site and send a remote command telling the OBS to start burning through the wire attaching the metal grate to the buoyant OBS. Fifteen minutes later, the metal grate would detach allowing the OBS to rise back up to the surface. In extra deep water (~5000 m depth) it could take an OBS over an hour to surface. Just before the instrument reached the surface, the students would head up to the bridge, grab a pair of binoculars, and start looking around to locate it, which was harder than expected! Sometimes, the OBS would surface far from the ship, the bright orange flag being no more than a small, orange dot on the horizon, bobbling in and out of view. Fortunately, the combination of radio, flag, and strobe light, along with a handful of eyes was helpful to spot the instrument. The task was then up to the Captain or the First and Second Mate to drive the boat right towards it and the OBS technicians or the students would retrieve the OBS using six feet long pools equipped with hooks at the end. It usually took a bit of strength and good hand eye coordination to snag the OBS with the hook. The knuckle boom would finally drag the instrument up out of the water and onto the deck. And then move onto the next site.

One of the most valuable things I learned on this cruise was what it takes to collect data. We needed a team of people willing to spend a month together in the ocean, repeating a task over a hundred times in rain or shine, calm seas or stormy, to acquire large amounts of new data that will generate new research, publications, and discoveries, and that's pretty cool.

- Kathryn Volk, University of Michigan



"My first time at sea and I will never forget the sight of the vast ocean and endless sky - there were more colors, sounds, and motions than I ever imagined.

- Pamela Moyer, University of New Hampshire

"My first few hours aboard the R/V Langseth were spent walking in circles trying to identify the rooms of the ship and trying to navigate from my bunk to the galley, then from the galley to the lab, then to the muster deck, and finally back to my bunk. It seemed that the combination of identical walls and floors, narrow stairwells, and tight turns created a maze. After a few days, the ship started to look more like a structured, intimate home. Once I began my midnight shift (12am-8am) a set routine developed. My primary job was to maintain watch—that is, stay awake during my shift and report data losses, animal interferences, equipment malfunctions, science-related decisions, and major changes. I performed this job in front of the ship's 30 computer monitors alertly glancing between monitors at the continuously streaming data.

The science mission was to collect seismic data on the ship's 8 kilometer-long streamer, a cable containing hydrophones (Fig.2). We did this by generating a large source of pressure directed towards the seafloor. This pressure pulse travelled towards the seafloor and reflected some energy back towards the hydrophones at every significant sediment interface. However, the science team did little to alter the fundamental operation of the ship. Instead, we simply modified many small parameters. For instance, the streamer was sometimes 11 m deep, while other times it was 9 m deep. Sometimes, pressure pulses were fired every 90 sec and at other times were fired every 20 sec. These little tweaks kept the work interesting. But, much of what was happening aboard the ship was repetitive, and it was easy to sink into a lull.

Yet, the cruise progressed and we processed more and more data, and built an increasingly complex image of the subsurface. I became interested in the Cape Fear Slide, and entered into intense discussions with Derek Sawyer, Matt Hornbach, and Ben Phrampus. While simultaneously looking at the processed seismic data, we started piecing together maps, background literature, pore-pressure model predictions, and BSR estimates. My experience became active and exciting with the inclusion of real-time data acquisition and interpretation. Suddenly, we were really focused on internal reflectors within the main portion of the slide and we kept asking if we were seeing faults or sediment waves. It was this basic science question that helped translate our terrabytes of data into a rewarding and focused experience. Back on land now, I'm helping to piece together the puzzle and seeing the value of the data that I helped collect. It's this tangible portion of my experience that seems most important. The beauty, though, is that with such a large project and so much data across varied sedimentary structures, there are little nuggets of excitement for us all to find.

- Kristopher Darnell, University of Texas at Austin

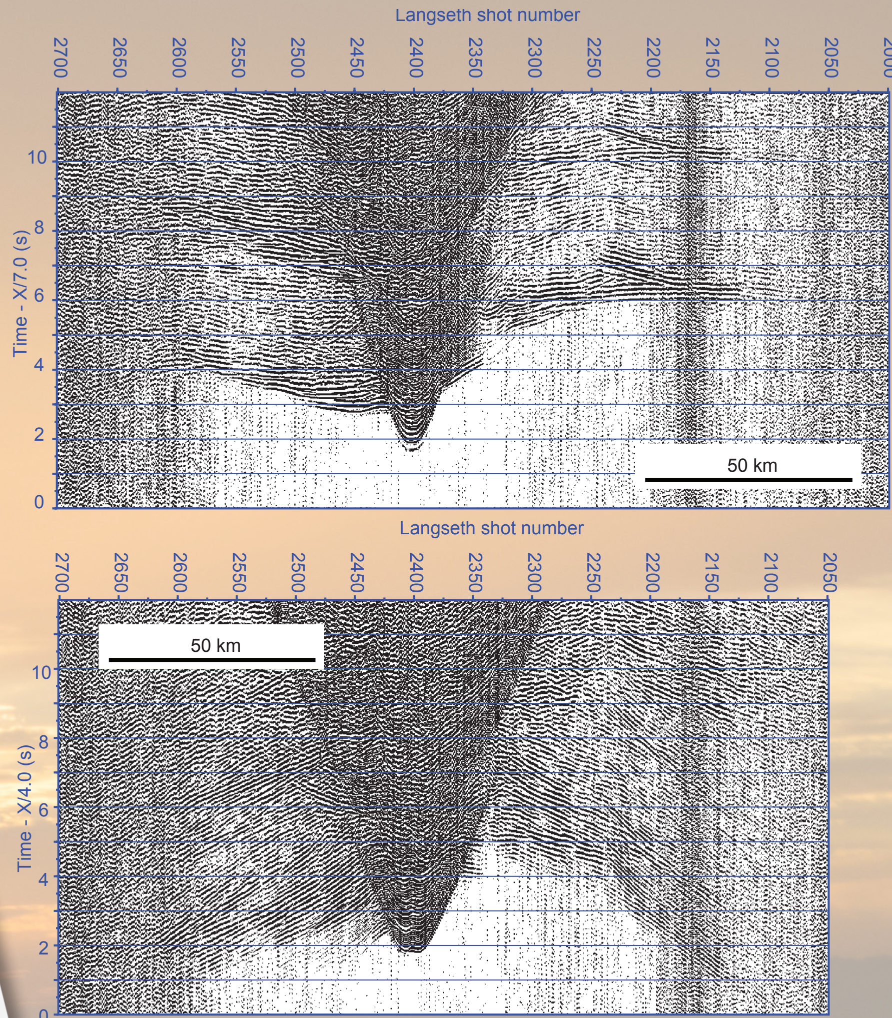
"You can learn so much from the PIs and the other students being in a such a stimulating research environment.

- Gary Linkevich, Rice University

"It was my pleasure to work with such professional scientists and R/V Endeavor crews. I learned several things from each of them and every minute was enjoyable.

- Afshin Aghayn, Oklahoma State University

Figure 2. Record sections of hydrophone (top) and geophone (bottom) of OBS207. This was an instrument from the WHOI OBSIP group.



The R/V Endeavor Science Party, from left to right: Peter Lemmond, Jenny Harding, Dave Dubois, Harm Van Avendonk, Brandon Dugan, Pamela Moyer, Dylan Meyer, Afshin Aghayan, Gary Linkevitch, Kate Volk, Mark Gibaud, Ernie Aaron.

Additional ENAM CSE Information

To learn more about the ENAM CSE, check out the project blog at:
http://enamseismic.blogspot.com/

Follow updates on the ENAM website:
http://www.ig.utexas.edu/enam/

Check out the preliminary summary at AGU:
T53B-4683 - ENAM: A community seismic experiment targeting rifting processes and post-rift evolution of the Mid Atlantic US margin

Status Report on the GeoPRISMS Data Portal: October, 2014

Andrew Goodwillie and the IEDA Database Team

Lamont-Doherty Earth Observatory, Columbia University

The 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 other data resources. Since the last newsletter report, highlighted below are recent contributions of data sets and field program information of interest to the GeoPRISMS community.

Aleutian Arc

The EarthChem-PetDB database, now in release version 2.8.1, is part of the NSF-funded IEDA data facility and provides a global synthesis of chemical, isotopic, and mineralogical data for rocks, minerals, and melt inclusions. Guidance from a group of Aleutian arc investigators has helped identify high-profile geochemical analytical data sets for the Aleutian Primary Site to aid the GeoPRISMS community with data synthesis and interpretation. Geochemical data sets and sample information from more than twenty articles published between 1971 and 2010 have so far been added to the database by the EarthChem team (Fig. 1) and can be accessed via PetDB *http://www.earthchem.org/petdb/search* (Search by "Feature Name >Volcanic Arc > Aleutian") or via the EarthChem Portal *http://www.earthchem.org/portal* (use the map-based 'Set Location' to define a polygon around your area of interest).

A second upload of Aleutian arc data will follow in early 2015, bringing the compilation of geochemical and mineralogical data sets to a total of nearly sixty publications. If you have suggestions for additional data sets or comments about the current data please contact the PetDB team at info@petdb.org.

Cascadia

High-resolution processed multibeam bathymetry grid surveys covering part of the continental shelf and slope offshore Washington state were contributed by GeoPRISMS investigator Paul Johnson. The swath data sets were collected during the seafloor mapping phases of cruises TN177 (2005) and TN207 (2007) cruises. Information on Cascadia Initiative Year 4 ocean bottom seismometer operations is also available. In addition, following a successful permitting process and an intensive installation program during the summer of 2014, station information for the

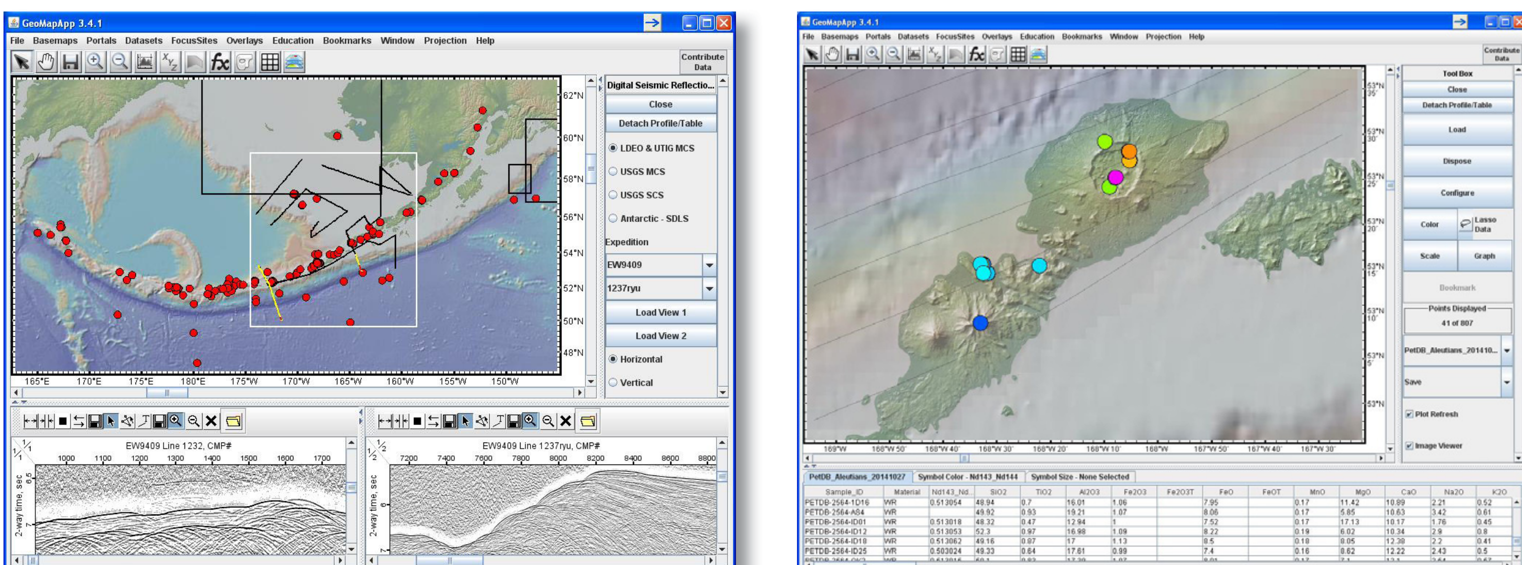


Figure 1. Recently added to the EarthChem-PetDB database are geochemical data sets along the length of the Aleutian arc. (Left) GeoMapApp screenshot showing the geographical extent of the newly-available geochemistry data (red dots). Black rectangles outline areas of multi-channel seismic reflection data, with the white rectangle showing the bounds of MCS profile lines from the 1994 cruise EW9409 led by Susan McGeary and John Diebold. Yellow lines are the locations of MCS profile EW9409-1232 (west) and EW9409-1237ryu (east) shown in the lower panel. (Right) On the Aleutian island of Unmak, Okmok caldera dominates the island's northeastern landscape and is one of the most active volcanoes in the Aleutian chain. Here, a second GeoMapApp screenshot shows Nd^{143}/Nd^{144} ratios that were recently added to the PetDB database and are color-coded with warmer colors indicating higher values. Faint black lines trending NE-SW represent depth contours to the top of the subducting slab from Syracuse and Abers (2006). Contours are at 10 km intervals with the 60 km contour passing through Okmok caldera. Land elevations, in shades of green, are from the USGS-NED and ASTER elevations models.

The GeoPRISMS Data Portal team is here to serve the community. Please contact us at info@marine-geo.org

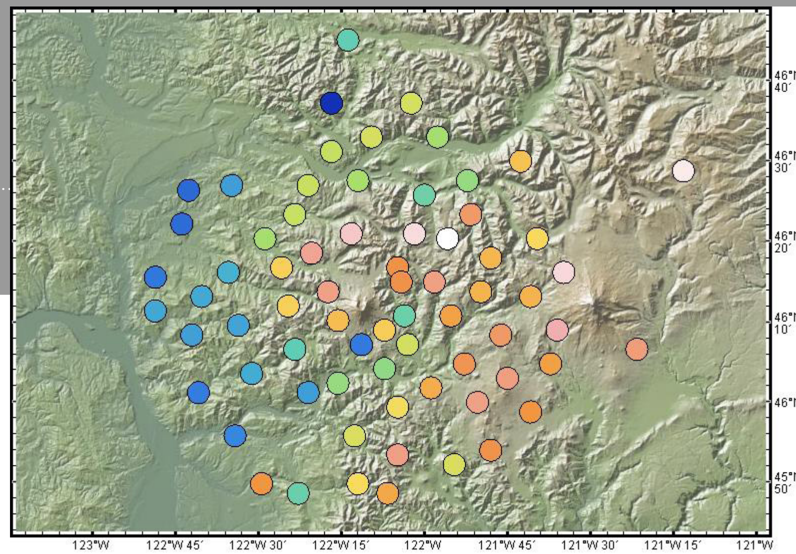


Figure 2. Seismometer station locations for the two-year passive array deployment of the Cascadia iMUSH multi-institution program (lead PI Ken Creager). Stations are plotted in GeoMapApp on a 10-meter GMRT base map and shaded according to station elevation, with warmer colors indicating higher elevations. The array comprises 71 stations centered upon Mount St. Helens and links in GeoMapApp point to detailed station and network information at IRIS.

Imaging Magma Under St. Helens (iMUSH) program has been added to the GeoPRISMS data portal and is accessible in GeoMapApp from the Focus Site menu (Fig. 2).

ENAM

Multichannel seismic field data files, in SEG-Y format, were added for the 1974 International Phase of Ocean Drilling (IPOD) Site Survey line from Cape Hatteras to the Mid-Atlantic Ridge. The data set was collected on cruise GS1974 that was led by John Grow and Rudi Markl. Also for the ENAM region, a Calais et al. (2006) geodetic vertical velocity data set for North America was added to GeoMapApp in both gridded and tabular format. Details of the recently-completed ENAM Community Seismic Experiment aboard R/V Langseth will soon be added to the data portal.

GeoPRISMS Data Portal Tools and Resources

Search For Data - The customised GeoPRISMS search tool (*http://www.marine-geo.org/tools/new_search/index.php?funding=GeoPRISMS*) provides a quick way to find GeoPRISMS data using parameters such as keyword, NSF award number, publications, and geographical extent.

Data Management Plan tool - (*www.iedadata.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. PIs can use an old plan as a template to create a new plan. We also have developed a tool to help PIs show compliance with NSF data policies.

GeoPRISMS Bibliography - With more than 730 citations, many tied to data sets, the references can be searched by primary site, paper title, author, year, and journal. The lists of publications can be exported to EndNote™. Submit your papers – just the DOI is needed – for inclusion in the bibliography!

GeoMapApp - Free map-based data exploration and visualization tool, updated with the release of version 3.4.1 in October 2014. Enhancements include an improved interface for plotting large tabular data sets - GMRT base map tiles that now load sequentially - a beta *Save Sessions/Import Sessions* function that provides limited ability to save, store and re-use an instance of a GeoMapApp session, a better capability to import multiple grids at once, and a range of other modifications and bug fixes requested by the community.

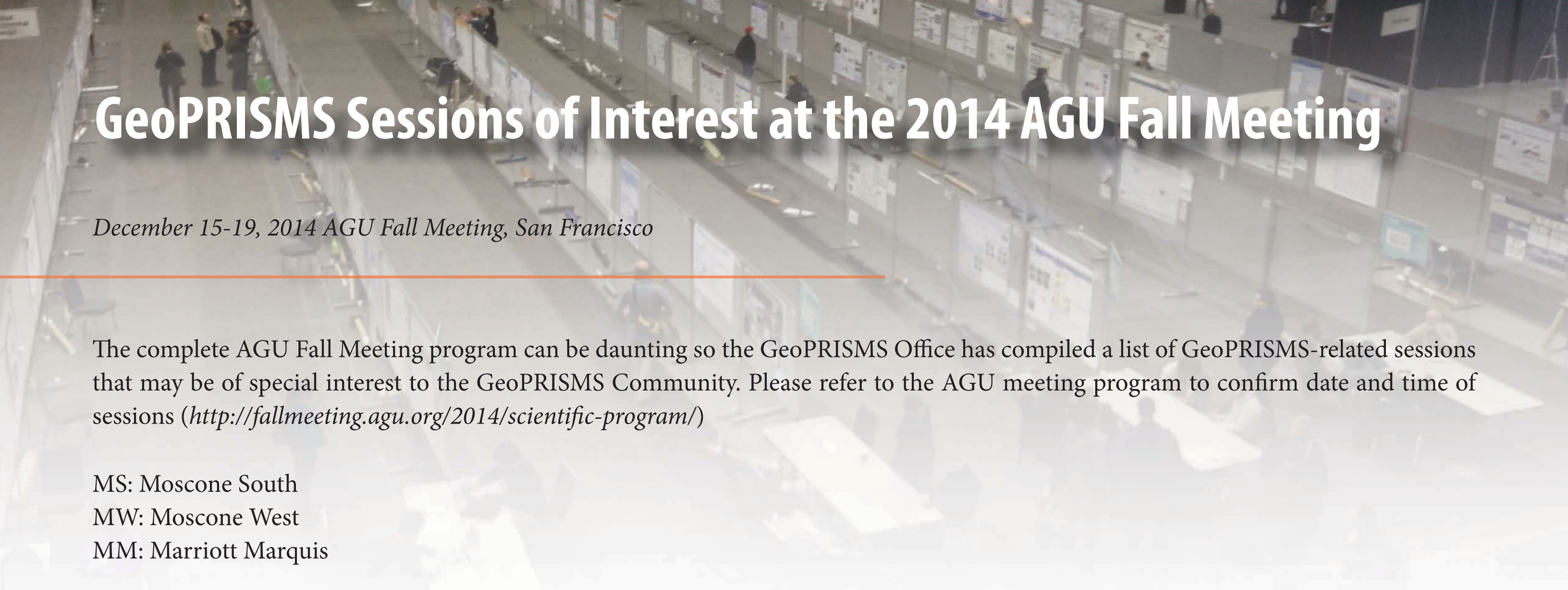
Version 2.6 of the GMRT base map includes newly-added swath bathymetry for the Cascadia, Alaska-Aleutians, and ENAM primary sites. A GeoPRISMS-focused webinar is available on the YouTube GeoMapApp channel and shows how to generate custom maps, how to explore built-in data sets of interest to the GeoPRISMS community, and how to import your own data.

Contribute Data - (*www.marine-geo.org/contribute.php*) This updated web tool provides a simple way to submit grid files, tabular data sets, spreadsheets, and shapefiles. Once added to the GeoPRISMS database, these data sets become immediately available to the broader community or can be placed on restricted hold. ■

References

Calais, E., Han, J.Y., DeMets, C., Nocquet, J.M. (2006). Deformation of the North American plate interior from a decade of continuous GPS measurements. J. Geophys. Res. 111(B6), DOI: 10.1029/2005JB004253.

Syracuse, E.M., Abers, G. A. (2006). Global compilation of variations in slab depth beneath arc volcanoes and implications. Geochem. Geophy. Geosy., 7(5), DOI: 10.1029/2005GC001045.



GeoPRISMS Sessions of Interest at the 2014 AGU Fall Meeting

December 15-19, 2014 AGU Fall Meeting, San Francisco

The complete AGU Fall Meeting program can be daunting so the GeoPRISMS Office has compiled a list of GeoPRISMS-related sessions that may be of special interest to the GeoPRISMS Community. Please refer to the AGU meeting program to confirm date and time of sessions (*http://fallmeeting.agu.org/2014/scientific-program/*)

MS: Moscone South
MW: Moscone West
MM: Marriott Marquis

TECTONOPHYSICS

T11A. Active Tectonics and Magmatism of Alaska, the Aleutians, and Northwest Canada

Monday 8:00AM - 12:20PM (MS Poster Hall)

Conveners: Sean Gulick - University of Texas, Institute for Geophysics, Robert Stern - Univ Texas Dallas, John Jaeger – Univ. Florida, Jeffrey Freymueller - University of Alaska Fairbanks

T41E. T42A. T43D. T51A. Illuminating the Factors That Determine Subduction Megathrust Fault Slip Style

Thursday 8:00AM - 12:20PM (MS304)

Thursday 1:40PM - 3:40PM (MS304)

Friday 8:00AM - 12:20PM (MS Poster Hall)

Conveners: Ake Fagereng - University of Cape Town, Matt Ikari - MARUM, University of Bremen, Kohtaro Ujiie - University of Tsukuba, Laura Wallace - University of Texas at Austin

T43B. T52A. Advances in Subaqueous Paleoseismology and New Insights from the Sedimentary Records into Earthquake Recurrence and Deformation throughout the Earthquake Cycle

Thursday 1:40PM - 6:00PM (MS Poster Hall)

Friday 10:20AM - 12:20PM (MS302)

Conveners: Chris Goldfinger - Oregon State University, Ken Ikehara - Marine Geology Research Group, Maarten Van Daele - Ghent University, Michael Strasser - ETH Zurich

T43A. T53D. T54A. Three-Dimensional Observations and Models of Lithospheric Extension

Thursday 1:40PM - 6:00PM (MS Poster Hall)

Friday 1:40PM - 6:00PM (MS304)

Conveners: Dale Sawyer - Rice University, Timothy Minshull - University of Southampton, Timothy Reston - University of Birmingham

T51C. T52B. T53A. Constructing Crust from the Backarc to the Forearc in the Izu-Bonin-Mariana (IBM) and Other Arc System

Friday 08:00AM - 12:20PM (MS306)

Friday 1:40PM - 6:00PM (MS Poster Hall)

Conveners: Mark Reagan - University of Iowa, Yoshihiko Tamura – JAMSTEC, Carlos J Garrido - IACT, Tomoaki Morishita - Kanazawa University

SEISMOLOGY

S11B. Fault Mechanics at the Brittle-Ductile Transition of Subduction Zones

Monday 8:00AM - 12:20PM (MS Poster Hall)

Conveners: Marine Denolle - Scripps Institution of Oceanography, Justin Brown - James Madison University, Noel Bartlow - Scripps Institution of Oceanography, Nicolas Brantut - University College London

S41C. S44C. Science and Societal Lessons from a Decade of Giant Megathrust Earthquakes

Thursday 8:00AM - 12:20PM (MS Poster Hall)

Thursday 4:00PM - 6:00PM (MS304)

Conveners: Andrew Newman - Georgia Tech, Lujia Feng - Earth Observatory of Singapore, Jamie McCaughey - Earth Observatory of Singapore, Aron Meltzner - Earth Observatory of Singapore

VOLCANOLOGY, GEOCHEMISTRY & PETROLOGY

V24C. V31D. Processes, Pathways, and Properties Along the Subduction Interface

Tuesday 4:00PM - 6:00PM (MM Salon 8)

Wednesday 8:00AM - 12:20PM (MS Poster Hall)

Conveners: Besim Dragovic - Virginia Polytechnic Institute and State University, Tatsuki Tsujimori - Okayama University—Misasa, Alberto Vitale Brovarone - IMPMC - Institut de Mineralogie et de Physique des Materiaux et de Cosmochimie

V31G. V32B. V33B. Arcs from the Inside Out

Wednesday 8:00AM - 12:20PM (MS310)

Wednesday 1:40 - 6:00PM (MS Poster Hall)

Conveners: Terry Plank - Lamont -Doherty Earth Observatory, Richard Gaschnig - University of Maryland College Park, Esteban Gazel - Virginia Tech, Jonathan Miller - San Jose State University

V51E. V52B. V53B. Melt, Volatiles, and the Oxidation State of Iron in Planetary Mantles

Friday 8:00AM - 12:20PM (MS308)

Friday 1:40PM - 6:00PM (MS Poster Hall)

Conveners: David Kohlstedt - University of Minnesota Twin Cities, Glenn Gaetani - WHOI, Elizabeth Cottrell - Smithsonian, NMNH, Anthony Withers - University of Minnesota

EARTH AND PLANETARY SURFACE PROCESSES

EP12A. EP13B. Signal Propagation and Preservation: Routing Information from the Geomorphic Engine to the Stratigraphic Record

Monday 10:20AM - 12:20PM (MW2003)

Monday 1:40PM - 6:00PM (MS Poster Hall)

Conveners: Kyle Straub - Tulane University, Nicole Gasparini - Tulane University, Andrea Fildani - Statoil Gulf ASA, Daniel Stockli - University of Texas

NATURAL HAZARDS

NH11B. NH14A. Satellite Remote Sensing and Management of Natural Disasters

Monday 8:00AM - 12:20PM (MS Poster Hall)

Monday 4:00PM - 6:00PM (MM Salon 7)

Conveners: Ramesh Singh - Chapman University, Amir AghaKouchak - University of California Irvine, Cathleen Jones - NASA Jet Propulsion Laboratory, David Tratt - The Aerospace Corporation

OCEAN SCIENCES

OS31E. OS32A. OS33A. OS33B. Marine Geohazards

Wednesday 08:00AM - 12:20PM (MW3010)

Wednesday 1:40PM - 06:00PM (MS Poster Hall)

Daniel Brothers - Pacific Coastal and Marine Science Center Santa Cruz, Jason Chaytor - USGS, Uri Ten Brink - US Geological Survey, Katie Maier - Pacific Coastal and Marine Science Center Santa Cruz

STUDY OF THE EARTH'S INTERIOR

DI13B. DI23C. Collaborative Studies on Mantle Melting

Monday 1:40PM - 6:00PM (MS Poster Hall)

Tuesday 1:40PM - 3:40PM (MM Golden Gate C1-C2)

Conveners: Maxim Ballmer - University of Hawaii, Esteban Gazel - Virginia Tech, Catherine Rychert - University of Southampton

DI43B. DI53B. Dynamic Evolution of the Lithosphere-Asthenosphere Boundary System in Diverse Geological Settings: An Integrated Approach

Thursday 1:40PM - 3:40PM (MS301)

Friday 1:40PM - 6:00PM (MS Poster Hall)

Conveners: Anne Pommier - University of California San Diego, Edward Garnero - Arizona State University, Huaiyu Yuan - Macquarie University, Samer Naif - Scripps Institution of Oceanography

GeoPRISMS at AGU Fall Meeting 2014
Mini-Workshops - New Zealand Primary Site

Sunday December 14, starting at 9:00AM

Morning: Workshop to cultivate and coordinate GeoPRISMS studies of the Hikurangi subduction margin
Conveners: Laura Wallace, Mike Underwood, Samer Naif, Bill Fry, Stephen Bannister, Nathan Bangs

Afternoon: Mini-Workshop for the South Island, New Zealand Primary Site coordination
Conveners: Mike Gurnis, Sean Gulick, Ellen Syracuse, Tim Stern, Phaedra Upton

Grand Hyatt San Francisco
345 Stockton Street, San Francisco, CA
Union Square Room – 36th Floor

Questions should be directed to the GeoPRISMS Office:
info@geoprisms.org
More information can be found at:
http://geoprisms.org/meetings/mini-workshops/
A detailed description of the workshops is available p. 29

Geo PRISMS

GeoPRISMS Prize for Outstanding AGU Student Poster and Oral Presentations

The GeoPRISMS Program is offering two $500 prizes for Outstanding Student Presentations on GeoPRISMS- or MARGINS-related science at the AGU Fall Meeting in San Francisco, December 15-19, 2014.

The two prizes, one each for a poster and an oral presentation, will be awarded to highlight the important role of student research in accomplishing MARGINS- and GeoPRISMS-related science goals, and to encourage cross-disciplinary input.

This presentation participates in GeoPRISMS Outstanding Student Prize

GeoPRISMS AGU Townhall & Community Forum

Monday December 15 at 6:00PM

Westin Market Street San Francisco Hotel, 50 Third Street - Franciscan Ballroom

The event is open to all with interests in the GeoPRISMS Program and GeoPRISMS (or MARGINS) research. Come hear updates about the GeoPRISMS Program, the latest GeoPRISMS research projects & study areas, and ongoing GeoPRISMS research from student presenters.

* A short formal session (starting at 6:30PM) will include welcome opening remarks from the GeoPRISMS Chair Peter van Keken and updates from NSF Program Managers Jenn Wade and Donna Blackman.
* Andrew Goodwillie, LDEO University of Columbia, will give a short presentation on the GeoPRISMS Data Portal and how it can help you find your data.
* Jeffrey Freymueller, University of Alaska Fairbanks, will give an overview of GeoPRISMS Science in the Alaska and Aleutian Primary Site.

Students, welcome!

Student entrants for the GeoPRISMS Prize for Outstanding Student Presentations are also invited to display their AGU posters (or poster versions of their AGU talks) and discuss their research with event participants. This will be a great opportunity for students to share their results further and to interact with a wide spectrum of GeoPRISMS scientists.

Stay informed, get involved

There will be ample time to mingle and refreshments will be available. Among those present will be Peter van Keken (GeoPRISMS Chair), members of the GeoPRISMS Steering and Oversight Committee, and Program Managers for GeoPRISMS from the National Science Foundation.

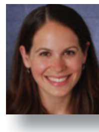
We hope to see you there!

Questions should be directed to the GeoPRISMS Office:
info@geoprisms.org
More information can be found at:
http://geoprisms.org/meetings/agu-townhall-and-student-forum/

GeoPRISMS Steering and Oversight Committee

Peter van Keken*, GeoPRISMS Chair, University of Michigan, keken@umich.edu

Estella Atekwana
Oklahoma State University
estella.atekwana@okstate.edu



Maureen Long
Yale University
maureen.long@yale.edu

Paul Wallace
University of Oregon
pwallace@uoregon.edu

Brandon Dugan
Rice University
dugan@rice.edu

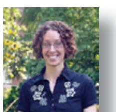
Sarah Penniston-Dorland*
University of Maryland
sarahpd@umd.edu

Tony Watts
University of Oxford
tony@earth.ox.ac.uk

Jeff Freymueller
U. of Alaska - Fairbanks
jeff.freymueller@alaska.edu

Tyrone Rooney
Michigan State University
rooneyt@msu.edu

Gene Yogodzinski
University of South Carolina
gyogodzin@geol.sc.edu



Liz Hajek
Penn State University
hajek@psu.edu

Harold Tobin
University of Wisconsin
htobin@geology.wisc.edu

Kerry Key
SCRIPPS Institution of Ocean.
kkey@ucsd.edu

Harm Van Avendonk
U.T. at Austin
harm@ig.utexas.edu

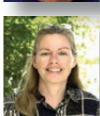
**Also member of GEAC*

GeoPRISMS Education and Advisory Committee

Andrew Goodwillie
LDEO, Columbia U.
andrewg@ldeo.columbia.edu

Cathy A. Manduca
Carleton College
cmanduca@carleton.edu

Juli Morgan
Rice University
morganj@rice.edu



Rosemary Hickey-Vargas
Florida International U.
hickey@fiu.edu

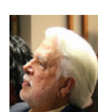
Jeff Marshall
Cal Poly Pomona
marshall@csupomona.edu

NSF Program Directors & Expert

National Science Foundation, 4201 Wilson Boulevard, Arlington, VA 22230

Donna Blackman
Division of Ocean Sciences
dblackma@nsf.gov

Jennifer Wade
Division of Earth Sciences
jwade@nsf.gov



Bilal Haq
Division of Ocean Sciences
bhaq@nsf.gov

GeoPRISMS Office

University of Michigan | Earth and Environmental Sciences
2534 C.C. Little Building, 1100 North University Avenue, Ann Arbor, MI 48109-1005 Tel: +1 (734) 255-1228
Program Chair: Peter van Keken; Science Coordinator: Anaïs Férot; Administrative Coordinator: Jeanne Bisanz
E-mail: info@geoprisms.org - Website: www.geoprisms.org

GeoPRISMS Mini-Workshops at AGU 2014

Grand Hyatt San Francisco, 345 Stockton Street
Union Square Room - 36th Floor

Sunday December 14, 2014 • 9-12PM

Cultivate and coordinate GeoPRISMS studies of the Hikurangi subduction margin

Conveners: Laura Wallace[1], Mike Underwood[2], Samer Naif[3], Bill Fry[4], Stephen Bannister[4], Nathan Bangs[1]
[1]Univ. Texas Institute for Geophysics, UT-Austin; [2]Univ. of Missouri; [3]Scripps Institution of Oceanography, UC San Diego; [4]GNS Science

The Hikurangi subduction margin in New Zealand offers an outstanding opportunity to address many fundamental questions on subduction margin deformation and megathrust behavior. The objectives of the Hikurangi mini-workshop will be to foster new relationships among researchers who will develop amphibious projects across a spectrum of geophysical, geological, and geochemical approaches. Discussion will occur within the context of existing planned projects, including a proposed IODP transect. Data acquisition activities are ongoing by New Zealand, United States, Japanese and European scientists. We will discuss ways of leveraging and coordinating these existing efforts with new efforts to maximize potential GeoPRISMS outcomes at the Hikurangi focus site.

We encourage all researchers interested in subduction processes at the Hikurangi margin to attend. We also encourage attendees interested in subduction deformation and megathrust processes in Cascadia and Alaska, to cross-fertilize ideas and implementation strategies among all three of the GeoPRISMS primary sites. Some of the topics to be discussed include (1) the state of the incoming plate and the role of incoming sediment properties in subduction thrust behavior and margin evolution; (2) physical properties of the megathrust and the influence of this on megathrust behavior; (3) fluid sources and fluxes, with emphasis on the forearc; (4) microseismicity, episodic slip, and tremor.

Attendees will collectively identify new research activities that address these topics most effectively, with an emphasis on leveraging existing studies/datasets.

Sunday December 14, 2014 • 1:30-5:00PM

South Island, New Zealand Primary Site coordination

Mike Gurnis[1], Sean Gulick[2], Ellen Syracuse[3], Tim Stern[4], Phaedra Upton[5]
[1]Caltech; [2]Univ. of Texas Institute for Geophysics; [3]Los Alamos National Laboratory; [4]Victoria Univ. of Wellington; [5]GNS Science

The South Island of New Zealand offers a wealth of prospects for subduction zone research. The Puysegur Trench region — a juvenile subduction zone "caught in the act" of initiation — provides unique opportunities to investigate the geodynamics of the process. In Fiordland tectonic motions have led to deep exhumation of the only pristine Cretaceous arc section in the circum-Pacific and offers a prime locale to investigate the root zones of an ancient arc at outcrop scale. Excellent opportunities exist in both regions to address fault slip and its spatial variability. Addressing questions on subduction initiation, exhumed terranes, and subduction thrust slip behavior in one region is an exciting opportunity, and will require large geophysical field deployments, targeted geological fieldwork, sampling, geochemical analysis, multi- scale geodynamic models, and integration of diverse data types. Solving the questions may require ocean drilling and sampling through IODP. The South Island mini-workshop will focus on: 1. Brief reviews and discussion of latest work on GeoPRISMS science questions within Puysegur and Fiordland; 2. Presentation of specific plans on a wide range of studies (including geological sampling, passive and active geophysical experiments, and IODP drilling); 3. Review and discuss the capabilities of facilities from the US, NZ and other countries and how they could be used to address plans; and 4. Make plans for science collaboration. Researchers in any geoscience field are invited to participate in the workshop, including those who have not worked in the region previously.

Contact Us

The GeoPRISMS Office
2534 C.C. Little Building
1100 N. University Ave.
Ann Arbor, MI 48109-1005
Tel: +1 734-255-1228

Questions? Email:
info@geoprisms.org

Stay Informed!

Sign up for the GeoPRISMS Newsletter
Like us on Facebook
Follow us on Twitter
Follow all the opportunities through our Listserv
Attend the annual GeoPRISMS Townhall Meeting at AGU
Visit our website

www.geoprisms.org

University of Michigan | Earth and Environmental Sciences
GeoPRISMS Program
2534 C.C. Little Building
1100 N. University Avenue
Ann Arbor, MI 48109-1005

Sunset on the Atlantic. Photo credit Kate Volk.

In Fall 2015 and Fall 2016, The GeoPRISMS Office will organize Theoretical and Experimental Institutes (TEIs) which will focus on intermediate synthesis of SCD and RIE projects. More to come on the GeoPRISMS website so stay tuned!