GeoPRISMS

Newsletter - Issue No. 40, Spring 2018

In this Issue

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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

I'm pleased to introduce the Spring 2018 issue of the GeoPRISMS newsletter. As has been the case for the past few years, the Spring edition will be distributed in print and be available online, while the Fall issue remains electronic only. We are fortunate to have an exciting set of articles for the current edition, featuring several short summaries of ongoing and upcoming projects at the New Zealand primary site. This issue also includes a number of updates on Fall 2017 AGU mini-workshops and student awards, descriptions of newly funded GeoPRISMS projects, and announcements about upcoming opportunities.

The past year has been an active time for the office and the GeoPRISMS Community. At the Fall AGU meeting in New Orleans, we sponsored three mini-workshops (see reports on page 40 of this issue) and hosted a well-attended townhall event. The meeting was also marked by numerous special sessions of interest to the GeoPRISMS Community. The Spring 2018 GeoPRISMS Steering and Oversight Committee then held its annual meeting in early February at NSF's new headquarters in Alexandria, VA, with much of the discussion focused on facilitation of upcoming synthesis and integration efforts, identification of future directions, and laying the groundwork for the program's legacy.

I'd like to thank the GeoPRISMS Steering and Oversight Committee (GSOC; see p. 46 of this issue) for their continued contributions to our science, planning, and outreach activities. In particular I'd like to extend thanks to Kerry Key (LDEO) and Sarah Penniston-Dorland (Univ. Maryland), who are rotating off of the GSOC this year, for their efforts on behalf of the program over the past three-plus years. I'm also pleased to introduce two new members of the GSOC who will join the committee this summer: Emily Rowland (Univ. Washington) and Mark Caddick (Va. Tech).

The Distinguished Lecture Program remains an important venue for outreach, engagement, and dissemination of GeoPRISMS science to universities, two and four-year colleges, and museums across the U.S. Thanks to speakers Esteban Gazel, Heather Savage, and Brandon Schmandt, who have all completed highly successful two year tours, and to Cindy Ebinger who will serve as a lecturer for a second year beginning this fall. I am also excited to announce three new speakers who will begin their tours this fall: Jaime Barnes (UT Austin), Anne Bécel (LDEO), and Abhijit Ghosh (UC Riverside).

I look forward to the next several months as we prepare for AGU events, including mini-workshops and our community forum, in yet another new location. We are also moving forward with planning of a major Theoretical and Experimental Institute focused on cross-cutting themes that span both the RIE and SCD initiatives, to be held in San Antonio, TX in February of 2019 (see meeting announcement on page 47 of this issue). This important meeting will focus on defining advances and emerging opportunities, and shaping the legacy of the GeoPRISMS and MARGINS programs. The meeting will be an exciting chance to develop connections across primary sites and between the rifting and subduction initiatives, and should have great impact on shaping future directions for our community. I hope to see you at one of these upcoming events!

Demian Saffer
Chair, GeoPRISMS Program

Cover Photograph:
View of Mount Nguarahoe along the Tongariro Crossing.
Photo credit: Kari Cooper.

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2018 is a year of change in the leadership of the EAR and OCE Divisions, which are in the process of wrapping up the recruitment of new Division Directors to replace Carol Frost in EAR and Rick Murray in OCE, whose terms end this year. In fact, Carol Frost has already departed and Lina Patino has taken over as acting Division Director in EAR for the time being while Rick Murray ends his stint as OCE Division Director in June. Hopefully, by the time this newsletter is published, there will be news of the two incoming Division Directors. This issue will also be Maurice Tivey's last as a Program Director for GeoPRISMS as he finishes his IPA in August and returns to Woods Hole. It is expected that Debbie Smith will be taking over as the OCE GeoPRISMS representative.

In terms of science, the beginning of the year saw completion of the first of two legs of IODP drilling on the Hikurangi subduction zone off the North Island of New Zealand GeoPRISMS primary site, and the start of a 3D community multichannel seismic program. That seismic survey was successfully completed in February, and the second Hikurangi IODP drilling leg has also just finished. As summer rolls around, GeoPRISMS funded research will be looking north as ocean bottom seismometers are deployed as part of the Alaska Aleutian Seismic Community Experiment, and other related seafloor geodetic instrumentation makes its way into the field as well. Your Program Directors always like to hear updates about what's happening in all of the ongoing projects, so be sure to send us news or any cool images and alert us to coming publications as you make progress.

Federal budget update & the 2018 funding round

Congress agreed on Mar 23rd to a massive $1.3 trillion omnibus budget plan to fund the federal government through the rest of FY18 (until Sept. 30) and perhaps more importantly there is also a bipartisan budget agreement for FY19. The good news is that FY18 NSF funding looks to be slightly up from 2017 levels. FY19 is essentially flat at the 2017 level. But internally to NSF, budgets are not quite settled and that of course impacts our decision-making for the last round. We hope that we can finalize decisions for the fiscal year by June. So far, this year's crop of supported projects covers a wide range of research in Alaska, ENAM, EARS, and offshore geodetic work in New Zealand.

New GeoPRISMS solicitation

The FY 2019 GeoPRISMS solicitation has been released as NSF 18-559, and the Full Proposal Target Date is August 13 (see page 35 of this issue). As always, make sure you give it a deep read before submitting to the program. Important revisions this year include:

- Large field projects that involve ship time, significant resources, or where the fieldwork is a significant fraction of the budget (>15%) are no longer accepted to the program;
- In order to encourage synthesis and integration of multidisciplinary datasets and models, we will welcome conference proposals throughout the year, separately from the full proposal Target Date;
- Postdoctoral proposals now only require two letters of reference
- Postdoctoral Fellows are now called Postdoctoral Scholars

If you have any questions about the new solicitation, don't hesitate to get in touch with one of the Program Directors. This community should also note that Letters of Intent for PREEVENTS (Prediction of and Resilience against Extreme Events) are due July 27, with Full Proposals due September 18. Conference proposals to that program are accepted anytime, so if you have an idea that fits well within that hazards-focused solicitation, do submit!

Best wishes for a successful summer of science,

Maurice Tivey & Jennifer Wade
GeoPRISMS Program Managers, National Science Foundation

WINNER

GeoPRISMS Photo Contest

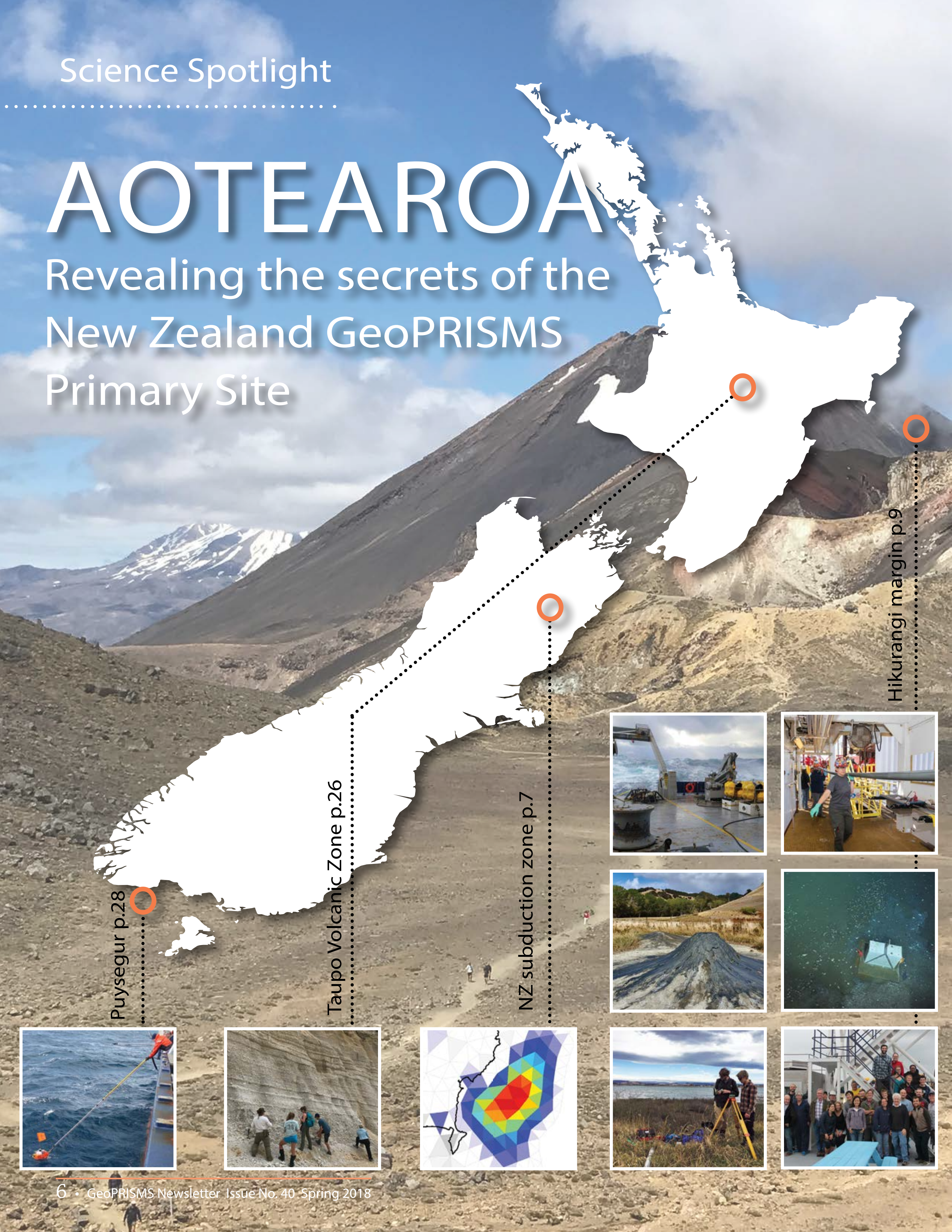
Congratulations to Gene Yogodzinski winner of the GeoPRISMS Photo Contest at the 2017 AGU Fall Meeting

Gene took this photo during a field campaign conducted on Unalaska Island in the Eastern Aleutians. Pillow lavas can be observed in the lower part of the outcrops behind Gene's colleague Merry Cai (Lamont) who provides the scale for the photo. The mottled appearance is produced by the reddish-brown pillow interiors, surrounded by green, inter-pillow sediment and altered pillow rinds. The upper part of the outcrop is an andesite sill with short, columnar joints at 90° to the horizontal contact. These rocks were formed prior to effects of crustal thickening by magmatism and accretionary tectonics, which eventually led to the emergence of the large islands that we see in the eastern Aleutians today. Gene received a framed copy of his photo. Visit the contest page at geoprisms.org to see all the photographs from this year.

Science Spotlight

AOTEAROA

Revealing the secrets of the New Zealand GeoPRISMS Primary Site



Slow slip and future earthquake potential in New Zealand and Cascadia

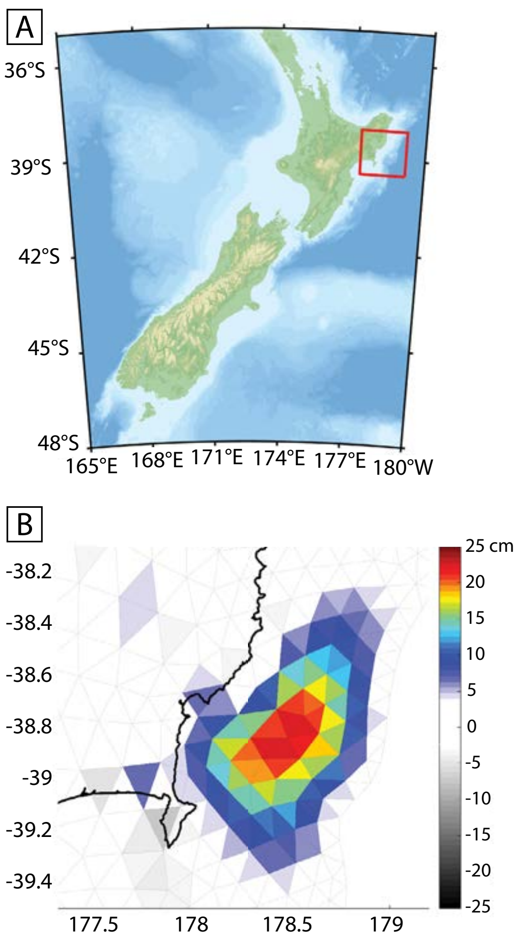
Noel Bartlow (University of Missouri), Laura Wallace (UT Austin & GNS Science),
Ryan Yohler (University of Missouri), and Charles Williams (GNS Science)

The New Zealand and Cascadia subduction zones are two GeoPRISMS primary sites that have captured the interest of geophysicists from around the world. Both subduction zones feature significant geological hazards, including the potential for large earthquake ruptures and tsunamis. In New Zealand, the capital city of Wellington sits directly atop a large patch of the main subduction plate interface which is frictionally locked, with the potential to rupture in future earthquakes. In Cascadia, there is also potential for a large earthquake on the main subduction interface, which may impact cities such as Portland, OR and Seattle, WA.

Both New Zealand and Cascadia also host slow slip events (SSEs). Slow slip events consist of slip on the subduction plate interface – just as would occur in an earthquake – except the slip takes place more slowly than it would during an earthquake. Now that slow slip events are widely recognized at many subduction zones, it is critical to better understand their role in the accommodation of plate motion. Many questions also exist regarding implications of slow slip for subduction zone mechanics, and the relationship between slow slip events and seismic slip events on the plate boundary.

In New Zealand, slow slip events have been shown to trigger regular earthquakes up to magnitude 6 (e.g. Wallace et al., 2017). Additionally, some evidence exists from the 2011 Tohoku-Oki Mw 9.0 earthquake (e.g. Ito et al., 2013) and the 2014 Mw 8.1 Iquique earthquake (Ruiz et al., 2014) that slow slip events may be able to trigger damaging megathrust events. Most slow slip events do not trigger earthquakes and we currently cannot differentiate slow slip events that might trigger large earthquakes from those that will not. It is possible, however, that further study will lead to methods that allow slow slip events to be used as reliable earthquake precursors.

PIs Noel Bartlow (Univ. of Missouri) and Laura Wallace (UTIG), along with collaborator Charles Williams (GNS Science New Zealand) and graduate student Ryan Yohler (Univ. of Missouri) are studying slow slip events and frictional locking in New Zealand and Cascadia.



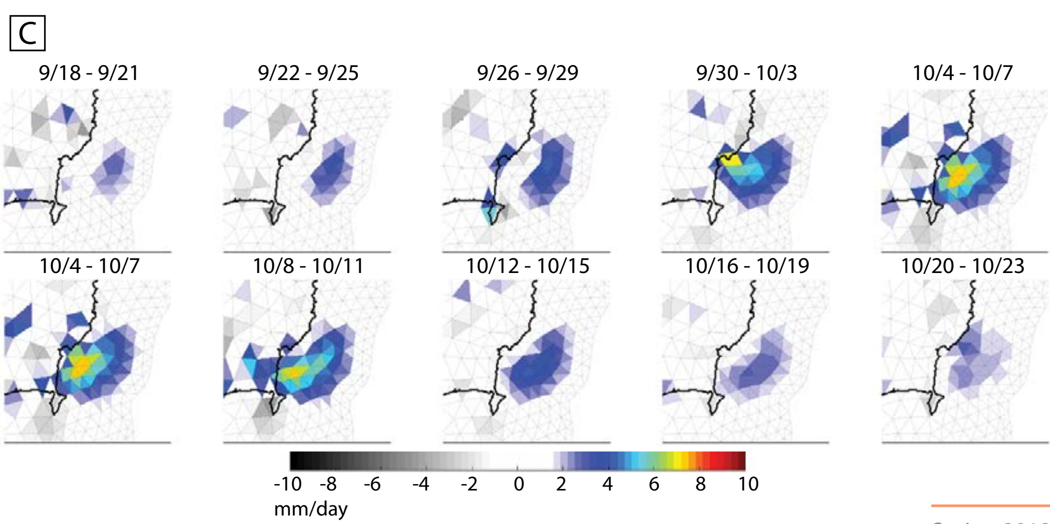


Figure 1. (A) Map of New Zealand. Red box indicates area shown in panels (B) and (C). (B) Total slip on the subduction plate interface during the 2014 slow slip event near Gisborne, New Zealand, from both onshore GPS and offshore ocean bottom pressure data. (C) Snapshots of slip rate on the subduction plate interface during the 2014 slow slip event. The addition of the ocean bottom pressure data catches the onset of the slow slip several days earlier than based only on the onshore GPS data.

One goal of the project is to create self-consistent catalogs of slow slip events in both subduction zones that capture the time varying behavior of slow slip, including how these events grow and decay and move along the subduction plate interface. The data used for these models consists of land-based geodetic GPS time series, and in New Zealand, we also use vertical deformation of the seafloor recorded for one slow slip event using absolute pressure sensors (Wallace et al., 2016).

Previous time varying slow slip event modeling studies usually assume a uniform, elastic half-space (e.g. Bartlow et al., 2014). These new models utilize spatially-varying elastic properties within the earth based on seismic velocity models in both New Zealand and Cascadia, calculated using the PyLith finite element code. This leads to more accurate models of slip during slow slip events, and therefore, more accurate estimates of the amount of slip taken up in slow slip as opposed to being available for release in future earthquakes. Preliminary models for both New Zealand (Williams et al., 2017) and Cascadia (Bartlow et al., 2017) were shown at the American Geophysical Union 2017 Fall meeting. Additionally, a time-dependent model incorporating both onshore GPS and offshore pressure measurements for the 2014 Gisborne, New Zealand slow slip events was shown at the meeting by graduate student Ryan Yohler (Yohler et al., 2017). This model is shown in Figure 1. This slow slip event occurred near the locations of two historical 1947 earthquakes that caused damaging tsunami waves. This is the first time that seafloor geodetic data have been used in a time-dependent deformation model.

As part of this project, a team led by Laura Wallace, including Bartlow and other collaborators, have recently reported the occurrence of a large, shallow (<15 km), two-week slow slip event at the Northern Hikurangi margin triggered dynamically by passing seismic waves from the November 2016 magnitude 7.8 Kaikōura earthquake, over 600 km away (Fig. 2; Wallace et al., 2017). Long-duration (>1 year), deep (>25 km) slow slip was also triggered at the southern Hikurangi margin (Kapiti region), and afterslip occurred on the subduction interface beneath the northern South Island of New Zealand (Fig. 1).

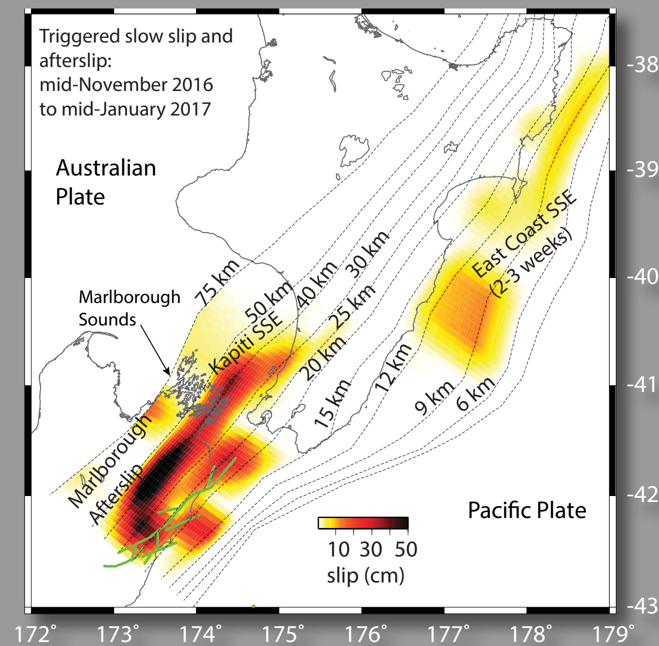


Figure 2. Total slow slip (colors) on the subduction plate interface over the year following the 2016 magnitude 7.8 Kaikōura earthquake (Wallace et al., in 2017, 2018). The green lines show the surface traces of faults that ruptured in the earthquake. The black dashed contours represent the subduction plate interface, with depths in kilometers below sea level.

Triggered slow slip at southern Hikurangi is more likely due to large static stress changes induced by the Kaikōura earthquake, given that area's closer proximity to the earthquake (Wallace et al., 2018). Prior studies had already identified cases of slow slip events triggering earthquakes, and nearby earthquakes prematurely stopping ongoing slow slip events, but these studies are the first to show that dynamic and/or static stress changes from passing seismic waves may also trigger large-scale, widespread slow slip events. We are still discovering the wealth of possible complex interactions between slow slip events and earthquakes, and what they might mean for hazards. ■

NSF GeoPRISMS Awards #1551876, 1551929

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Probing the nature of the Hikurangi margin hydrogeologic system

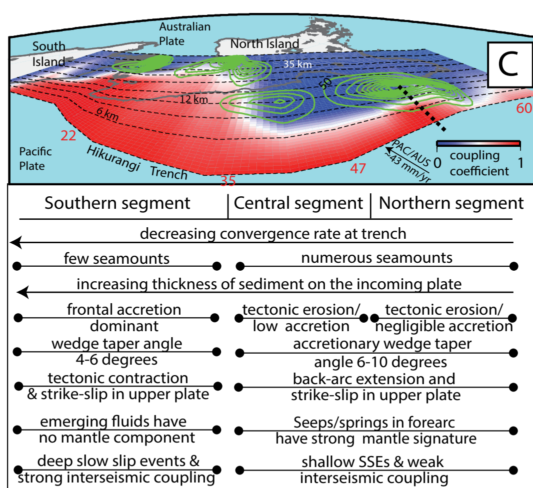
Evan A. Solomon (University of Washington), Marta Torres (Oregon State University), and Robert Harris (Oregon State University)

Fluid generation, migration, and pore fluid pressure at subduction zones are hypothesized to exert a primary control on the generation of seismicity, low-frequency earthquakes, and slow slip events (SSEs) (e.g. Ranero et al., 2008; Obana and Kodaira, 2009; Saffer and Tobin, 2011; Saffer and Wallace, 2015). The SAFFRONZ (Slow-slip and fluid flow response offshore New Zealand) project addresses the GeoPRISMS Subduction Cycles and Deformation Initiative Science Plan by testing interrelationships among fluid production, fluid flow, and slow slip at the Hikurangi Margin. The recognition of dramatic changes in the along-strike distributions of SSEs and their recurrence intervals, interseismic coupling, inferred pore pressure, and other subduction-related parameters (Fig. 1) have resulted in a concerted international effort to acquire seismological, geodetic, other geophysical, and geomechanical data both onshore and offshore the Hikurangi margin. This effort includes recent scientific ocean drilling, logging, and the deployment of two subseafloor observatories during IODP Expeditions 372 and 375 (see page 16 of this issue), as well as a 3-D seismic reflection survey on the northern margin. (p. 14).

SAFFRONZ will complement and extend these efforts by providing:

1. A continuous two-year record of fluid flow rates and composition over the timeframe of the next expected SSE,
2. Information on the present background state and past locations of fluid flow and how they relate to inferred pore fluid overpressure along the plate boundary, and
3. Comparative geochemical and hydrologic data between the northern and southern sections of the margin.

The SAFFRONZ field program is scheduled for January 10 to February 14, 2019 on the *R/V Revelle*. Our field strategy employs a nested approach to constrain the margin-wide fluid flow distribution tied to estimated pore pressure evolution along the plate boundary from modeling studies and seismic attributes.



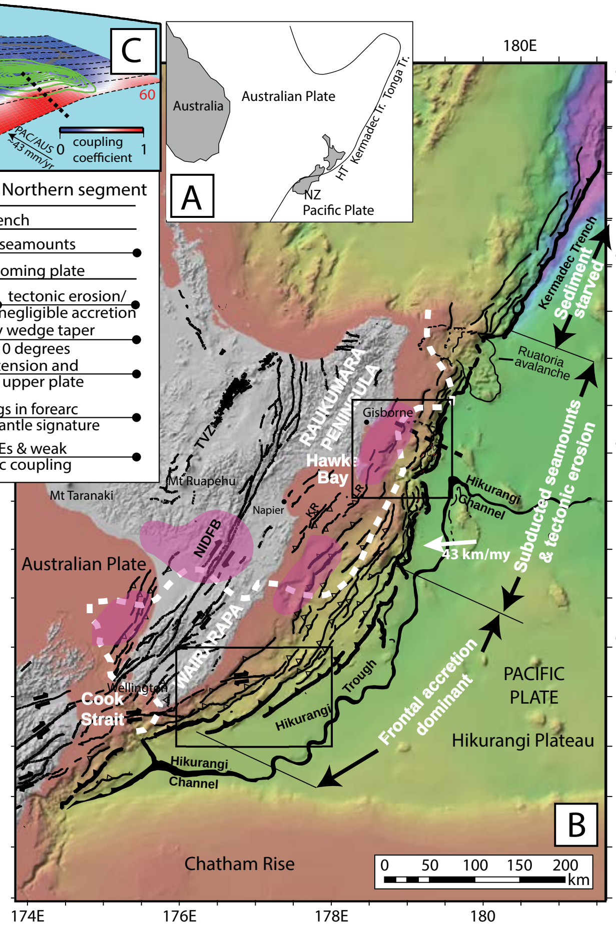
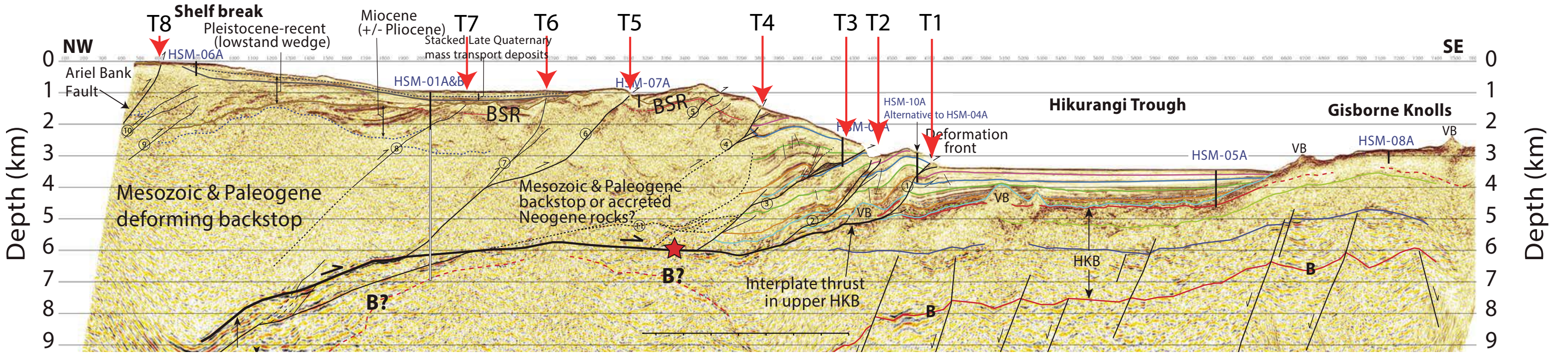


Figure 1. Overview and tectonic setting of the Hikurangi margin (Barnes et al., 2010). A) New Zealand within the context of the SW Pacific. B) Bathymetry, topography, and active faulting of the onshore and offshore margin. White arrows show plate convergence rate and azimuth. Bold white dashed line shows position of 20 mm/yr slip deficit (Wallace et al., 2004). Magenta areas show region of observed slow slip events. Boxes show locations of our northern and southern survey areas shown in Figure 2. C) Perspective view of the Hikurangi margin (modified from Wallace and Beavan, 2010) illustrating the portions of the subduction interface that undergo stick-slip and aseismic slip in terms of the coupling coefficient. Coupling coefficients of one indicate locked areas and coefficients near zero indicate regions of steady aseismic slip. Green contours show areas of slip in slow slip events since 2002. Along strike variations in margin properties are summarized below the figure.



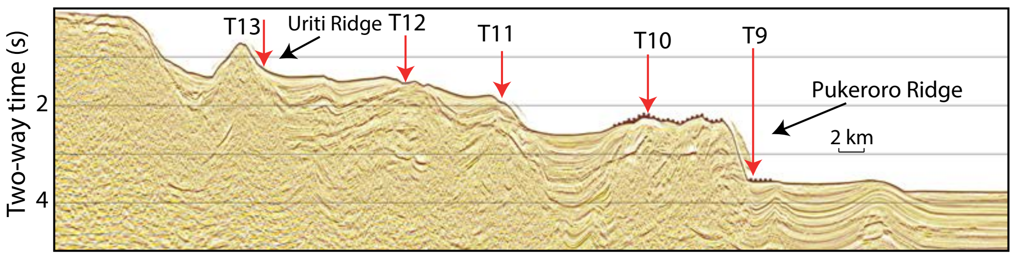
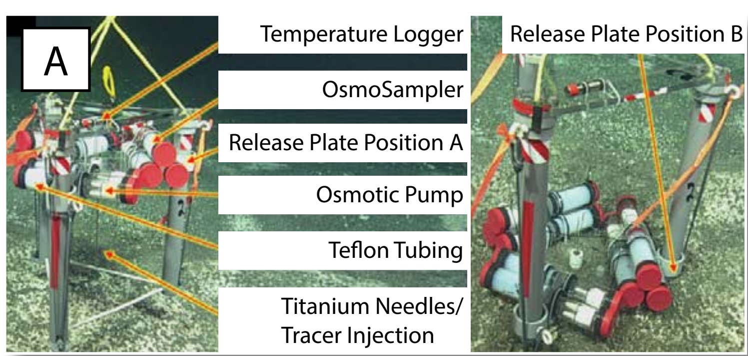
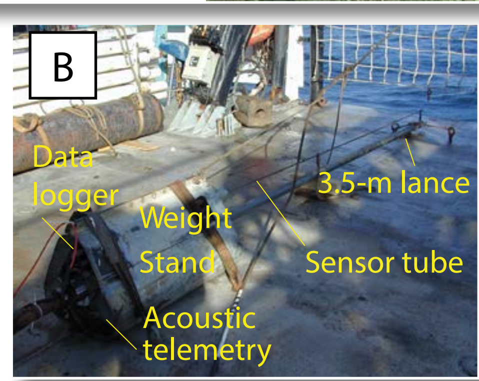


Figure 2. Seismic transects in the Top) northern field area along the IODP Expedition 375 drilling transect (Saffer et al., 2017), and Bottom) southern field area along seismic line PEG09-23. Locations shown as boxes in Figure 1. Arrows T1-T13 in the seismic reflection profiles are primary fault targets for surveys, sampling, and fluid flow meter deployments. Note that flow meters will also be deployed in off-fault locations to monitor local volumetric strain associated with SSEs.

We are specifically targeting fault zones and off-fault locations between the deformation front and the shelf-break (Fig. 2). Site locations will be guided by pre-existing multi- and single-beam sonar data (including seafloor backscatter and water column indicators of gas seepage), 2D/3D seismic reflection data, and real-time water column multi-beam sonar surveys during the research expedition. Violin-bow heat flow measurements and piston coring will guide *ROV Jason* hydroacoustic surveys, *Jason* heat flow probe measurements, and the collection of push cores to further identify sites of active fluid discharge. Finally, the ROV surveys will guide the deployment of benthic fluid flow meters (Fig. 3) to generate a record of fluid flow rates and composition over a two-year period - the approximate recurrence interval for SSEs in this region. We anticipate deploying about sixteen benthic fluid flow meters, some co-located with seafloor bottom pressure recorders managed by GNS Science, during the 2019 field program.Although our focus is on the northern margin, the location of shallow SSEs and most research activity, we will also conduct ship and ROV operations and deploy a subset of fluid flow meters in the southern region of the margin.





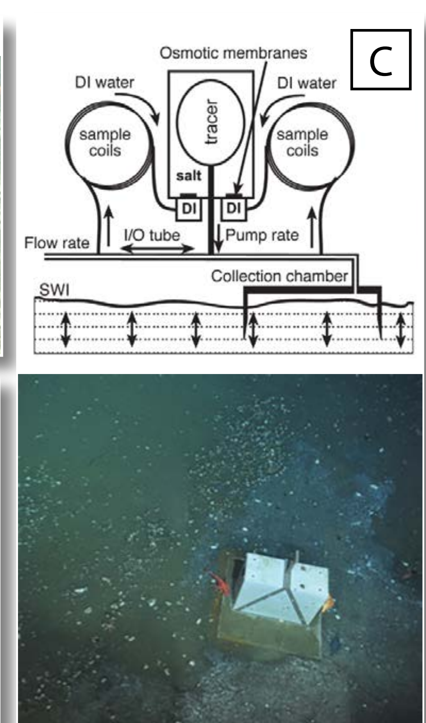


Figure 3. A) The Mosquito benthic fluid flow meter (Solomon et al., 2008). The Mosquito uses OsmoSamplers and a tracer injection device to continuously measure fluid flow rates and sample for fluid composition at multiple depths beneath the seafloor. Picture shows Mosquito prior to tripping the release plate that pushes the sampling needles into the sediment and during recovery after sampling for one year at Hydrate Ridge, offshore Oregon. B) OSU violin heat flow probe that will be used to further constrain the thermal state of the forearc and to identify locations of fluid transport during the SAFFRONZ experiment. C) Schematic of the CAT meter and a CAT meter deployed in the vicinity of the Mosquito at Hydrate Ridge (Tryon et al., 2002; Brown et al., 2005). The CAT meter uses dilution of a chemical tracer to measure fluid flow through outlet tubing exiting the top of a collection chamber. An osmotic pump injects the tracer at a constant rate into the water stream as it moves through the outlet tubing. Both Mosquitos and CAT meters will be deployed during the SAFFRONZ experiment.

Comparison of fluid flow pathways, fluid composition, fluid flow rates, and flow transients between the northern and southern areas will provide information on the differences in the nature of dewatering between the accretionary southern portion of the margin hosting deep SSEs and the dominantly non-accretionary northern portion with shallow SSEs. The along-strike comparison will also provide a control (reference) transect to compare regional (i.e. flow in response to SSEs in the north) to other hydrologic phenomena.

From both scientific and societal perspectives, results from this project will contribute to our understanding of fault slip behavior offshore New Zealand that have global implications for the postulated interdependence of temperature, pore pressure, fluid flow, and SSEs at subduction zones. The ability to integrate the SAFFRONZ experiment with concurrent bottom pressure recorder deployments, onshore cGPS data, IODP borehole monitoring experiments, 2D and 3D seismic reflection data, and other data to be collected along the margin in the next few years greatly enhance the outcomes of this project. The synthesis of the results from all the concurrent experiments being conducted at Hikurangi promises to be very exciting and the integration of the hydrologic data produced from this project will result in an unprecedented view of deformation and hydrological responses to slow slip at subduction zones. ■

NSF GeoPRISMS Awards #1753617, 1753665

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GeoPRISMS Data Portal

Visit the GeoPRISMS Data Portal to find information for each Primary Site:

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- Data sets ready for download
- Links to partner programs and resources
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To submit missing data sets, field programs or publications to the GeoPRISMS portal, contact info@marine-geo.org

Volatile cycling through the Hikurangi forearc, New Zealand

Jaime D. Barnes (UT Austin), Jeffrey Cullen (UT Austin), Shaun Barker (Univ. of Waikato), Samuele Agostini (Istituto di Geoscienze e Georisorse), Sarah Penniston-Dorland (Univ. of Maryland), John C. Lassiter (UT Austin), Andreas Klügel (Univ. of Bremen), Laura Wallace (UT Austin & GNS Science), Wolfgang Bach (Univ. of Bremen)

Mangapakeha.
Photo credit: Jeff Cullen

Much work has focused on defining the elemental concentration and isotopic composition of subduction zone inputs (e.g., sediments, altered oceanic crust, serpentinites), as well as outputs (e.g., volcanic gases and melt inclusions), in order to assess global cycling of volatiles. However, with most work focused on outputs from the volcanic front, poor constraints on the geochemistry of forearc outputs hamper global volatile flux calculations. In fact, most global flux calculations ignore contributions from the forearc because their outputs and the subducted sources contributing to the fore-arc outputs are poorly constrained (e.g., Barnes et al., 2018). The Hikurangi margin of New Zealand has a largely subaerial forearc which hosts numerous fore-arc seeps and springs (Fig. 1). This portion of the forearc is typically submerged beneath the ocean at most other subduction zones. Easy access to fore-arc springs along the margin allows for quantification of volatile flux and sources through the shallow portion of the subduction system (< 50 km).

In addition, there are dramatic along strike variations in subduction parameters along the length of the Hikurangi margin (Fig. 1). The northern portion of the margin has a thin layer of sediments (~ 1 km thick) and many seamounts on the subducting plate, a steep taper angle (7° to 10°) for the accretionary wedge, and shallow (< 15 km depth) aseismic creep. In marked contrast, the southern portion of the margin has a thick (3 to 6 km thick) package of sediments on the incoming plate, low taper angle (4° to 6°), and undergoes stick-slip behavior (e.g., Wallace et al., 2009). Interestingly, previous studies have documented an overall decrease in the Cl, B, Br, Na, and Sr concentrations in fore-arc spring waters from the north to the south (Giggenbach et al., 1995; Reyes et al., 2010). These observations raise numerous questions, such as: the amount of slab-derived fluid component to the springs; whether fluid sources vary along the length of the margin; and particularly whether any chemical variations in the spring fluids record dehydration metamorphic reactions that may be linked to changes in slip behavior along the margin. In order to address these questions, we have sampled fluids from sixteen cold and two thermal springs from along the Hikurangi margin and analyzed them for their cation and anion concentrations, as well as their B, Li, and Cl stable isotope compositions. Because Li, Cl, and B are highly fluid-mobile elements, their incompatibility limits modification by fluid-rock interaction making them excellent tracers of fluid source.

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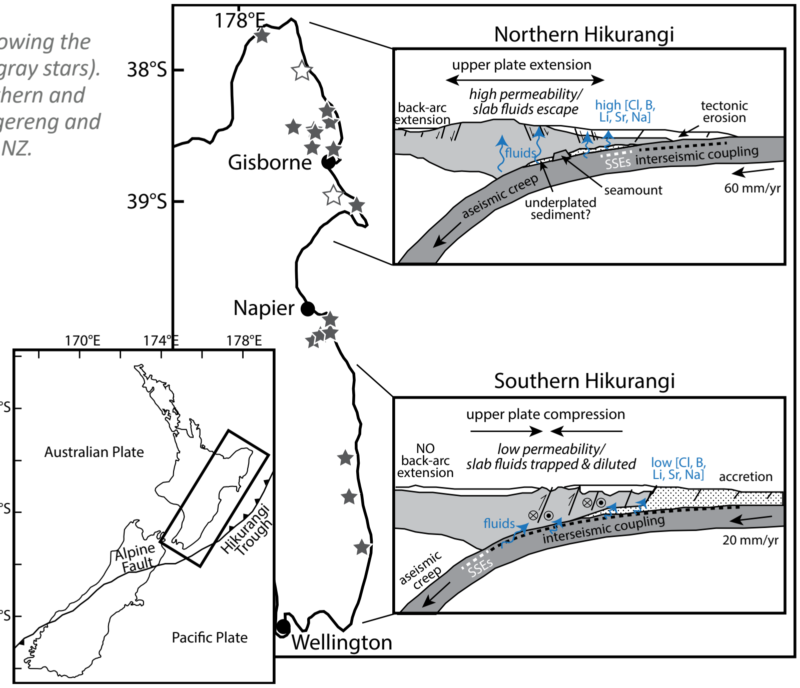

Figure 1. Map of the Hikurangi margin of the North Island of New Zealand showing the location of sampled cold springs (solid gray stars) and thermal springs (open gray stars). Variations in subduction parameters and margin properties between the northern and southern portions of the Hikurangi margin are highlighted; modified from Fagereng and Ellis (2009) and Wallace et al. (2012). Inset map shows the tectonic setting of NZ.

Data show that Cl, Br, I, Sr, B, Li, and Na concentrations are high in the forearc springs, consistent with previous studies. Most of these elements show a general decrease in concentration from north to south, a high in the central part of the margin, and limited variability through time. Despite the dramatic change in concentration along the margin, there is no corresponding trend in isotopic composition. Cl and B isotope compositions are remarkably consistent along the margin, suggesting fluids dominated by seawater and sedimentary pore fluids. Lithium isotope compositions are highly variable, suggesting fluids sourced from seawater and locally modified by interaction with host rock. High Br/Cl and I/Cl weight ratios also support a dominant seawater and pore fluid source.

The decrease in the absolute volatile concentrations along the margin is therefore not due to changes in subduction parameters (e.g., convergence rate, sediment subduction) altering the fluid source along the strike. In addition, the shift in seismic behavior along the margin is not linked to a change in fluid source within the forearc region. Instead, we hypothesize that the shift in volatile concentrations along the margin is controlled by fluid flux through the upper plate, due to increasing upper plate permeability from south to north. In the northern portion of the margin, the upper plate is undergoing extension, whereas in the southern portion, the upper plate is undergoing transpression (Fig. 1) (Wallace et al., 2004). The extension in the northern section of the margin could increase the permeability of the upper plate allowing for fluid loss along normal faults, and possibly lower fluid pressure within the forearc and near the interface. In contrast, the transpressional regime in the south could decrease the permeability of the upper plate, trapping fluids and increasing fluid pressure in the upper plate (Fagereng and Ellis, 2009). This model of changing permeability from north to south explains the decrease in volatile concentrations in spring fluids along strike. In the south, trapping of expelled seawater and pore fluids in the upper plate will allow the fluids to become diluted by meteoric groundwater, but their isotopic compositions will remain unchanged. Whereas in the north, the seawater and pore fluids will be able to pass through the upper plate with less dilution by groundwater. Seismic tomographic and attenuation data also suggest that more fluids are present in the northern and central portions of the upper plate of the Hikurangi subduction zone, compared to the south (Eberhart-Phillips et al., 2017; Eberhart-Phillips et al., 2005; Eberhart-Phillips et al., 2008). Springs with the highest concentrations of volatile elements are located in regions with some of the highest seismic attenuation (which can be interpreted as abundant inter-connected fluids). It is possible that the fluid pressure conditions in the upper plate may play an important role in seismic behavior along the Hikurangi margin. Higher fluid pressures in the south suppress the transition from brittle to viscous deformation, resulting in a deeper brittle-viscous transition and the occurrence of stick-slip behavior to greater depths (Fagereng and Ellis, 2009; Wallace et al., 2012). Greater structural permeability in the northern Hikurangi margin may allow fluids to bleed off, without building significant overpressures in the forearc — this could lead to a comparatively shallower brittle to viscous transition. This work highlights the role of the upper plate tectonics and permeability in controlling the flow of fluid through the forearc and the geochemical consequences on shallow outputs through the subduction system. ■

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The NZ3D Experiment – Adding a new dimension for understanding slow slip events

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The NZ3D science party, technical staff and crew of the R/V Langseth.

When the Pacific plate slips beneath the Australian plate along the northern Hikurangi margin, the subduction megathrust does not typically generate earthquakes as it often does in subduction zones. Instead, stress accumulated on the megathrust is released within patches every 2-4 years over a period of weeks in well documented slow slip events (SSEs) (i.e. Wallace and Bevean, 2010). While SSEs are not unique to the Hikurangi margin, SSEs often occur at depths of 30-40 km down dip of the seismogenic zone. This makes them difficult to access and thus difficult to examine the physical conditions that control whether the megathrust slips quickly in regular earthquakes or instead slips slowly. However, the Hikurangi margin has documented regular patterns of SSEs that extend updip along the megathrust to unusually shallow depths of ~2 km below the seafloor. This unusually shallow setting and the well documented distribution of slip makes these SSEs accessible with geophysical tools and even drilling.

From January 6th to February 9th 2018, a team of marine geologists and geophysicists from the US, UK, Japan, and New Zealand sailed on the *R/V Langseth* to acquire a new 3D seismic reflection data volume across the northern Hikurangi margin offshore of the North Island of New Zealand (Fig. 1). Previous seismic surveys have imaged the subsurface structures and offered hints into the unusual megathrust slip behavior along the Hikurangi margin. Bell et al. (2010) showed large seamounts on the subducting plate that can generate thrust faults within the upper plate, and entrain fluid rich sediments and carry them below the megathrust deep into the subduction zone. It is these impacts on the shallow subduction zone that are thought to generate conditions for high fluid content along the megathrust and fluid migration pathways from the megathrust through the upper plate. It is this fluid supply and flow system that is thought to lead to high fluid pressures and control effective stresses along the megathrust, which are also considered critical controls for slip behavior (Saffer and Wallace, 2015). However, it was also evident from earlier 2D seismic images that this complex setting required 3D data to correctly image the shallow megathrust and upper plate structures. Such high resolution 3D data can map out fluid content and faults to fully characterize this system.

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The NZ3D experiment was designed to acquire 3D seismic images to map reflectivity and structures, and it provided an opportunity for a novel wide-angle seismic reflection and refraction component to measure seismic velocities in unprecedented detail and in 3D using full waveform inversion (FWI). The detailed seismic velocity data will reveal rock physical properties and will complement observations of reflectivity and structural geometry seen in 3D seismic images.

In most years this large ambitious geophysical experiment would by itself be a major achievement for any given site; however, the NZ3D project was designed to contribute to larger efforts on the New Zealand primary site that included: The NSF-funded SHIRE active source experiment (Nov–Dec 2017) to examine the crustal scale structure of the Hikurangi margin using ocean bottom seismometers, onland seismic receiver stations, and 2D seismic reflection imaging (p.22); IODP drilling to recover core samples, measure physical properties, and install observatories - Expeditions 372 (Nov 2017–Jan 2018) and 375 (Mar–Apr 2018) (p.16); and other related studies.

During the *Langseth* cruise we surveyed an area 14 x 60 km from the trench to the shelf across the Expedition 375 drilling transect (Fig. 1). *Langseth* fired one of two 3,300 in^3 airgun arrays every 25 m in flip-flop mode and recorded returns on four 6-km-long, 468-channel seismic streamers spaced at 150 m. We made 62 passes through the survey area, fired 145,924 shots and recorded over 5Tbytes of seismic reflection data. With calm seas during most of the 35 days at sea, few equipment issues, and very few interruptions from protected species, we acquired a high-quality seismic data volume that will enable us to examine reflectivity of the megathrust down to more than 10 km in the area of SSEs and map the geometry of faults and stratigraphic horizons. In order to acquire the data needed for FWI, in December 2017, prior to NZ3D acquisition, the *R/V Tangaroa* deployed a hundred ocean bottom seismometers (OBSs) provided by JAMSTEC in a randomized grid with nominal 2 x 2 km spacing (Fig. 1). Shots for FWI were also recorded on stations deployed around the Gisborne area specifically for NZ3D and stations that had been deployed initially for SHIRE and remained for NZ3D (Fig. 1). A total of almost 300 onland stations recorded *Langseth* shots during NZ3D. We were also able to take advantage of the close line spacing during the 3D survey to increase the resolution of multibeam bathymetry and backscatter images across the margin. These data provide some of the best detail of the northern Hikurangi margin seafloor to date.

From here, we will spend the next few years processing the 3D volume (with emphasis on water column multiple removal) and OBS data sets to produce high-quality, detailed 3D images in depth, seismic velocity data, and interpret these results in the context of new results from the coordinated projects. Structures in 3D are already emerging from preliminary results (Fig. 1) and are only going to get better. There are lots of exciting results to come for studies of slow slip along the Hikurangi megathrust. ■

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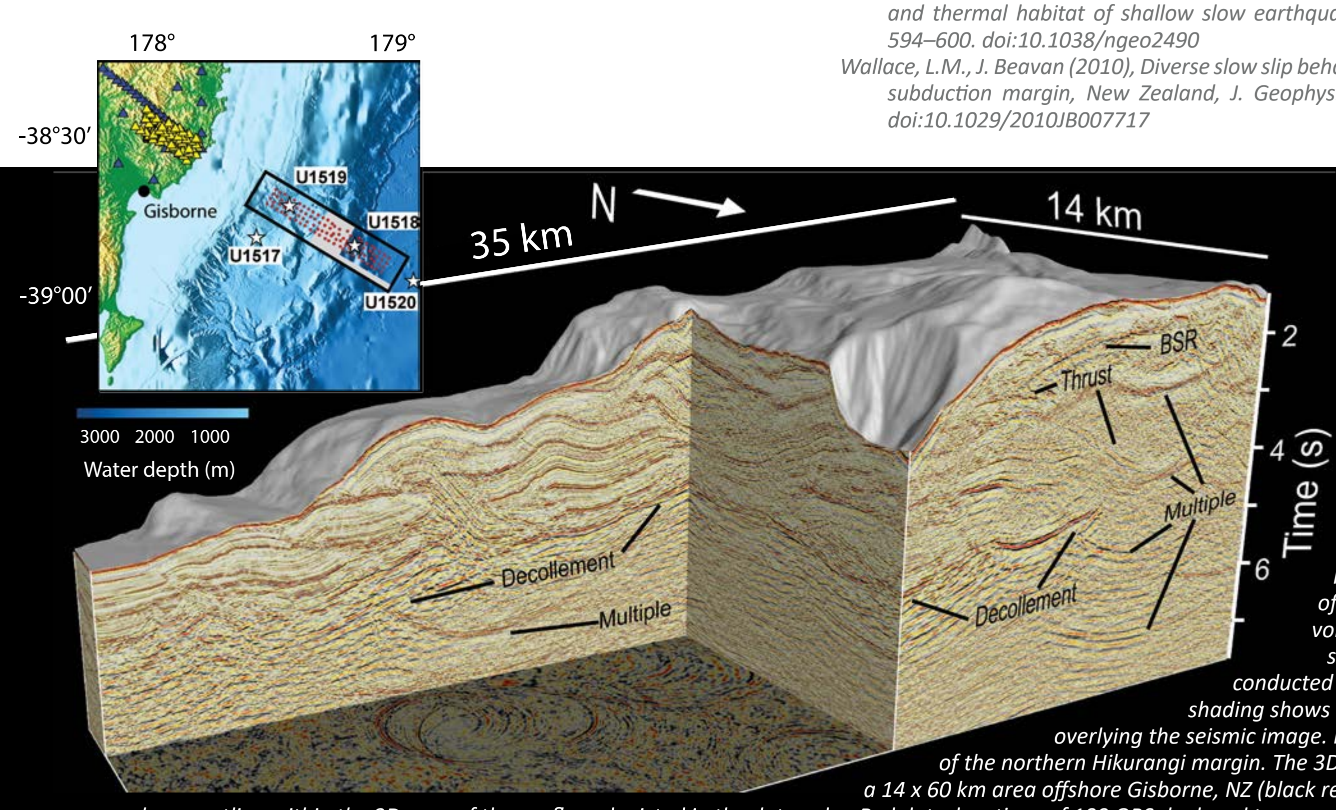

Figure 1. Frontal region of the NZ3D seismic data volume. Preliminary post-stack 3D time migration conducted during MGL1801. Gray shading shows multibeam bathymetry overlying the seismic image. Inset: Bathymetric map of the northern Hikurangi margin. The 3D seismic volume covers a 14 x 60 km area offshore Gisborne, NZ (black rectangle). Gray shading shows outline within the 3D area of the seafloor depicted in the data cube. Red dots: locations of 100 OBS deployed to record Langseth shots during NZ3D; White stars: IODP Expedition 372 and 375 drilling locations; Blue triangles: locations of onshore seismometers deployed for the SHIRE project and left in place to record Langseth shots during NZ3D; Yellow triangles: onshore seismometer locations for instruments deployed for NZ3D.

IODP tackles the Hikurangi Margin of New Zealand with two drilling expeditions to unlock the secrets of slow-slip events

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Phil Barnes (National Institute of Water and Atmospheric Research), and
Laura Wallace (UT Austin & GNS Science)

IODP personnel transferring a sedimentfilled core liner from the rig floor to the core-cutting area.

Documentation of slow-slip events (SSEs) and associated seismic phenomena (tremor, low frequency earthquakes, etc.), largely through recent deployments of dense geodetic and seismic networks, has changed the paradigm of fault-slip behavior on subduction megathrusts (Schwartz and Rokosky, 2007; Peng and Gomberg, 2010; Wech and Creager, 2011; Saffer and Wallace, 2015). SSEs at the northern Hikurangi subduction margin, offshore the North Island of New Zealand (Fig. 1), are among the best-documented and shallowest examples on Earth. In that region, the Pacific plate subducts westward beneath the Australian plate at a rate of 4.5–5.5 cm/y (Wallace et al., 2004). SSEs recur there every 1–2 years over periods of 2–3 weeks at depths of <2–15 km below the seafloor (Wallace and Beavan, 2010; Wallace et al., 2016). The close proximity of Hikurangi SSEs to the seafloor makes them amenable to study using the U.S. drilling vessel *JOIDES Resolution*. This is also an ideal locale for using sub-seafloor observatories to monitor near-field deformation and associated changes in chemical and physical properties throughout multiple slow-slip cycles.

The International Ocean Discovery Program (IODP) directed its attention and resources toward the Hikurangi margin by scheduling two linked expeditions in 2017 and 2018 to investigate the origins of shallow slow-slip events. The development of proposals to drill at northern Hikurangi was facilitated to a considerable extent by a series of workshops sponsored by IODP and GeoPRISMS. Expedition 372 (November 2017 – January 2018) was the first of the two expeditions. Led by Co-Chief Scientists Phil Barnes and Ingo Pecher, that expedition completed Logging-While-Drilling (LWD) holes at three of the primary drilling sites (U1518, U1519, and U1520). During the same expedition, Site U1517 (Fig. 1) was also cored and logged to address objectives from an Ancillary Project Letter (APL) aimed at understanding the role of gas hydrates in "creeping" submarine landslides (Pecher et al., 2018).

Expedition 375 followed in March–May, 2018, to investigate in situ conditions and rock properties that modulate Hikurangi SSEs, and to install sub-seafloor observatories (Saffer et al., 2017). Expedition 375 was led by Co-Chief Scientists Demian Saffer and Laura Wallace. Specific targets for coring during the expedition included a highly active out-of-sequence thrust near the toe of the accretionary prism (Site U1518); a site on the upper plate immediately above the area that undergoes large SSE slip (Site U1519);

the complete succession of incoming sedimentary and volcanic strata on the subducting Hikurangi Plateau (a Cretaceous large igneous province) including the overlying trench-wedge in the Hikurangi Trough (Sites U1520 and U1526) (Fig. 2). Detailed thrust-sequence analysis via core-log-seismic integration will continue post-expedition. In addition to the coring program, borehole observatories were installed at Sites U1518 and U1519 to monitor *in situ* changes of fluid pressure, temperature, fluid-flow rate, and fluid geochemistry in the near-field of the SSEs.

Leg 181 of the Ocean Drilling Program had cored the eastern edge of the Hikurangi Plateau in 1998, largely for paleoceanographic studies (Davy et al., 2008), but those sites are positioned ~600–900 km seaward of the North Island. Many uncertainties remain with respect to correlative stratigraphic successions currently entering the trench, as well as their potential influence on SSEs. Several seamounts are present near the deformation front (e.g., Tūranganui Knoll) (Fig. 1), and they may also play an important, but currently unknown, role in the occurrence of SSEs and tsunami earthquakes (Bell et al., 2014). Where the megathrust extends farther landward, it appears to separate a relatively less-deformed sequence below from an imbricated thrust wedge above (Fig. 2). Near the drilling transect, Barker et al. (2009) showed that the subduction interface 15–40 km inboard of the trench lies <5–6 km below the seafloor. That interface seems to follow the top of a thick zone of high-amplitude reflectivity that coincides with the source areas of some SSEs (Bell et al., 2010; Pecher et al., 2018) (Fig. 2). One testable possibility is that the high-amplitude reflectivity is a manifestation of high fluid pressures and underconsolidation of subducted sediments. Alternatively, the reflectors could represent distinctive lithologic packages (e.g., tectonic slices of altered basalt or volcaniclastic sediments).

Building on that background, *JOIDES Resolution* drilled along the north Hikurangi transect to address three main goals:

1. Documentation of the state and composition of the incoming plate (sedimentary and volcanic rocks), as well as the shallow plate-boundary fault near the trench; these rocks comprise the protolith and capture initial conditions for fault-zone rocks at greater depth, which can then be extrapolated to zones that host SSEs;

2. Quantification of material properties, thermal regime, and stress conditions in the upper plate above the SSE source region; and

3. Direct measurements of temporal variations in deformation, temperature, and fluid flow using borehole observatories in the near-field of the SSEs.

Results from a recent seafloor geodetic experiment near the IODP transect raise the strong possibility of SSE propagation all the way to the trench (Wallace et al., 2016). Site U1518 lies within the possible SSE rupture area (Fig. 1); comprehensive post-expedition analyses of those core samples will provide valuable insights into the fault zone's composition, physical properties, hydrogeology, and structural architecture at multiple scales. The drilling transect also coincides with the region where SSEs were dynamically triggered by passing seismic waves from the November, 2016, Kaikōura earthquake (Wallace et al., 2017). Expedition scientists expect to shed new light on why such large-scale SSEs were triggered by a distant (>600 km) earthquake.

LWD data from Expedition 372 include resistivity-at-the-bit (RAB) images that provide key information about fracture and faulting patterns; those studies will evaluate the relation between fractured intervals and potential geochemical and/or thermal evidence of fluid flow (e.g., Kopf et al., 2003).

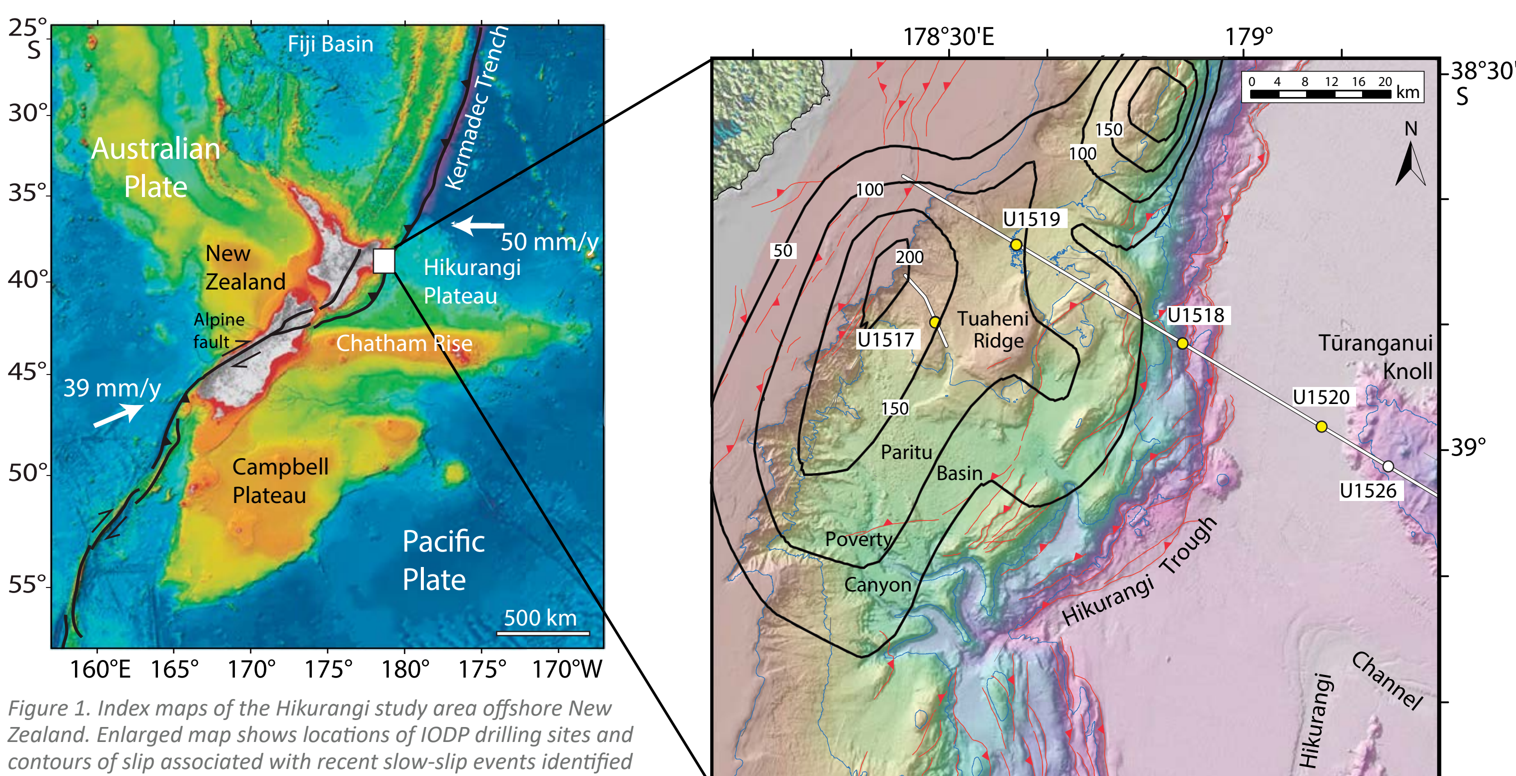

Figure 1. Index maps of the Hikurangi study area offshore New Zealand. Enlarged map shows locations of IODP drilling sites and contours of slip associated with recent slow-slip events identified by Wallace et al. (2016) using offshore geodetic data.

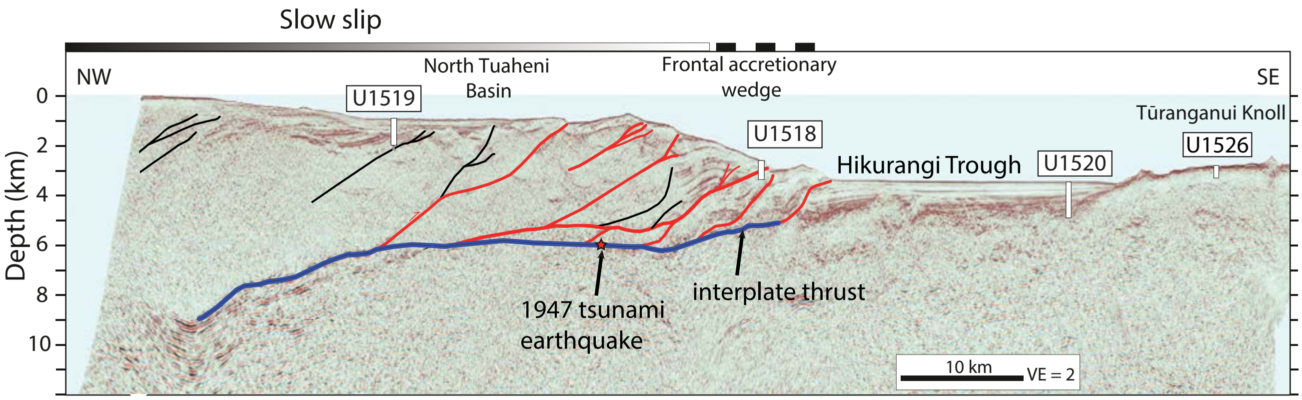

Figure 3. Seismic reflection profile crossing the HIkurangi drilling transect showing locations of IODP sites. Red lines highlight recently active thrust faults. Black lines highlight older, inactive faults. Interpretation is simplified from Pecher et al. (2018). See Figure 1 for position of trackline.

The RAB data also document borehole breakouts, providing information about the orientations of maximum and minimum horizontal stresses. Those data will be used, in combination with rock strength measurements, to estimate horizontal stress magnitudes (e.g., Chang et al., 2010; Huffman & Saffer, 2016).

Cores from Site U1520 on the subducting Pacific Plate will reveal the rock properties, composition, and lithologic and structural character of sedimentary and volcanic materials that are eventually subducted down-dip into the SSE source region. Those tests will pinpoint the "initial conditions" for key lithologies prior to progressive loading and heating within and beneath the accretionary prism. Samples of the inputs will also be used for laboratory experiments to inform numerical models that predict evolving physical and chemical properties. Samples will be measured for elastic and physical properties. Analyses of pore-fluid chemistry will help identify the source regions of fluids and assess whether fluids from greater depths are flowing upward and discharging through the fractured hanging wall (e.g., Hensen et al., 2004; Ranero et al., 2008). Downhole temperature measurements will constrain thermal models and help elucidate potential connections among fault slip behavior, fluid production, and diagenetic/metamorphic dehydration reactions (e.g., Saffer et al., 2008).

The two observatories will monitor volumetric strain (using pore pressure as a proxy), as well as the evolution of physical, hydrological, and chemical properties throughout multiple SSE cycles.

Shipboard activities during IODP Expedition 375. Scientists carefully examining a split core from the main fault zone at Site U1518; IODP personnel working on one of the CORK heads at the moon-pool level of JOIDES Resolution. JOIDES Resolution at the dock in Timura, New Zealand, prior to departure.

The more-complicated observatory at Site U1518 contains multi-level pressure sensing above, within, and below the fault zone, as well as a string of autonomous miniature temperature loggers. OsmoSamplers and an OsmoFlowmeter (see Jannasch et al., 2004; Solomon et al., 2009) will capture time series of fluid-flow rates and fluid chemistry within the fault zone. The observatory at Site U1519 involves a simpler design, with two levels of formation-pressure sensing and a distributed string of temperature loggers. Pressure sensing in the formation provides a sensitive indicator of volumetric strain during SSEs (e.g., Araki et al., 2017); those results will greatly improve the spatiotemporal resolution of offshore Hikurangi SSEs and enable detection of SSEs much smaller than those documented to date. Wellhead sensors in both observatories will provide data on changes in pressure at the seafloor, which will help to resolve vertical deformation of the seafloor during SSEs (e.g., Wallace et al., 2016).

IODP Expeditions 372 and 375 are pioneering because they are the first to target slow-slip event processes. Ultimately, the team of sixty scientists from thirteen countries who participated in these expeditions will integrate their coring, logging, and observatory data with detailed post-expedition lab studies and modeling to test a broad suite of hypotheses concerning the fundamentals of slow-slip events, and their relationship to great megathrust earthquakes. The central theme addresses several important goals of GeoPRISMS. ■

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Hikurangi Ocean Bottom Investigation of Tremor and Slow Slip (HOBITSS) - Revealing the environment of shallow slow slip

Susan Schwartz (UC Santa Cruz), Anne Sheehan (University Colorado, Boulder),
Rachel Abercrombie (Boston University)

Rough seas off the shores of New Zealand during the HOBITSS deployment in 2014. Retrieved from the Fall 2016 issue of the GeoPRISMS Newsletter. Photo credit: Justin Ball

In the last fifteen years, it has become evident that slow slip events (SSEs) are a common and important part of the subduction process. They produce millimeters to centimeters of surface displacement over days to years that can be measured by geodesy and are often accompanied by seismic tremor and earthquake swarms. Slow slip and tremor have been observed in subduction zones in Cascadia, Japan, Mexico, Alaska, Ecuador, northern Peru, Costa Rica and New Zealand.

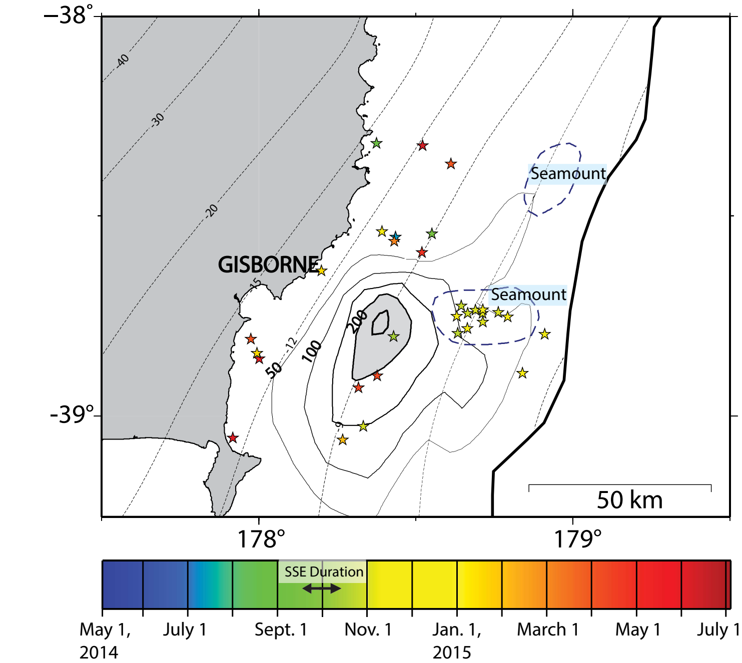
The 2014-15 HOBITSS deployment of 24 ocean bottom pressure sensors and fifteen ocean bottom seismometers (OBSs) at the northern Hikurangi margin, New Zealand captured a M7.0 SSE. The vertical deformation data collected were used to image one of the best-resolved slow slip distributions to date, and indicated slip very close, if not all the way to the trench (Wallace et al., 2016). The Fall 2016 GeoPRISMS Newsletter reported on this experiment and how for the first time, ocean bottom pressure recorders successfully mapped a SSE displacement field (Wallace et al., 2016). The HOBITSS results were instrumental in demonstrating that Absolute Pressure Gauges are a valuable tool for seafloor geodesy. Seismologists from UC Santa Cruz, University of Colorado Boulder and Boston University are now using the seismic data collected during the same experiment to evaluate the spatiotemporal relationship between seismicity (both earthquakes and tremor) and the slow slip event and the role that seismic structure plays in controlling slip behavior. One of our primary goals is to determine if slow and fast interplate slip modes spatially overlap or are segregated.

An initial catalog of local earthquakes was constructed and relocated in a New Zealand-derived velocity model to produce a catalog of 2,619 earthquakes ranging in magnitude between 0.5 and 4.7. Locations indicate that Hikurangi seismicity is concentrated in two NE-SW bands, one offshore beneath the Hikurangi trough and outer forearc wedge, and one onshore beneath the eastern Raukumara Peninsula, with a gap in seismicity between the two beneath the inner forearc wedge. We do not find an increase in seismicity during the 2014 slow slip event, though seismicity is slightly higher in the month following the SSE. The majority of earthquakes are within the subducting slab rather than at the plate interface. The few events that locate close to the plate interface were assumed to be thrust events and used as templates in a waveform matching technique to identify similarly located earthquake swarms within the entire dataset.

Like the general seismicity increase in the month following the SSE, repeating families of interplate events (Fig. 1) also cluster in time at the end of the SSE. They are spatially concentrated within the slow slip patch and associated with a well-imaged subducted seamount (Bell et al., 2010).

Tectonic tremor was also identified toward the end and continuing after the slow slip event. Like the interplate earthquake families, tremor is also co-located with slow slip and localized in the vicinity of subducted seamounts (Fig. 2). The subsequent, rather than synchronous occurrence of tremor and interplate earthquakes and slow slip suggests that seamount subduction plays the dominant role in the stress state of the shallow megathrust. While northern Hikurangi seamounts appear to primarily subduct aseismically, their subduction may generate elevated pore-fluid pressures in accumulated underplated sediment packages and a complex, interconnected fracture network such that tremor and microseismicity occur as seismic components of seamount subduction during shallow slow slip. This study indicates that the location of subducted seamounts is strongly correlated with the distribution of SSE-associated tectonic tremor and repeating earthquakes. The seamounts appear to be responsible for slow slip, tremor, and microseismicity rupturing adjacent regions in a range of slip processes.

Ongoing work more fully utilizes the rich data set of local earthquakes and includes analysis of seismic attenuation using the body wave spectra of local earthquakes, local earthquake seismic velocity tomography, and earthquake source parameter analysis including focal mechanisms and seismic moment. Knowing the physical state of the subducting plate interface is important for the slow slip modeling, and our attenuation and velocity tomography models will be key to infer the physical properties and structure in the area where slow slip occurs. For example, recent work revealed large differences between SSE slip inversions that assume homogeneous elastic properties versus those that utilize a more realistic elastic structure (Williams and Wallace, 2015). ■



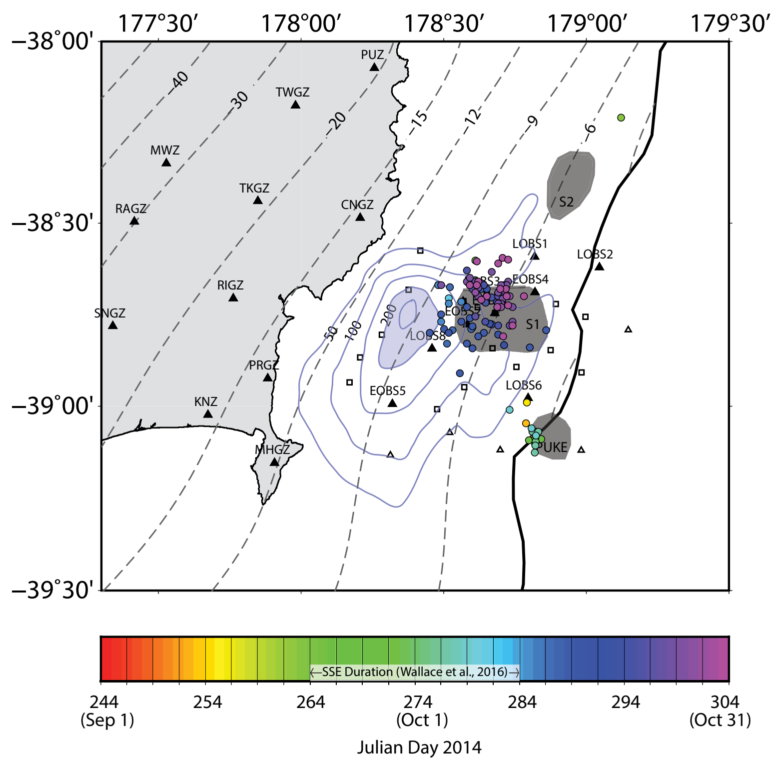


Figure 1. (top) Repeating earthquake families identified near the plate interface color coded by time of occurrence of first earthquake in the family. Note the concentration of events where the seamount is subducting and their timing just after the 2014 slow slip event

Figure 2. (bottom) Tectonic tremor associated with the 2014 Gisborne SSE color-coded by time. Tremor is primarily located on and adjacent to subducted seamounts Puke and S1 and mostly occurs at the end and after slow slip has ended. Triangles indicate the location of the land-based stations of the New Zealand National Seismic Network and HOBITSS OBS used to locate tremor.

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"It does not do to leave a live dragon out of your calculations, if you live near him." – Gandalf the Wizard (The Hobbit by J.R.R. Tolkien)

Sizing up the *Taniwha*: Seismogenesis at Hikurangi Integrated Research Experiment (SHIRE)

Jeff Marshall (Cal Poly Pomona) and
Jessica Pilarczyk (University of Southern Mississippi)

"*A Live Dragon*" Beneath the Sea

In Māori culture, the *Taniwha* is a dragon-like beast that lives beneath the water, sometimes protecting seafarers, while at other times wreaking disaster on coastal communities (King, 2007). Māori lore tells of *Taniwha* that cause sudden upheavals and changes in the coastline, altering the shape of the land-ocean interface. In the wake of New Zealand's 2016 Mw7.8 Kaikōura Earthquake, the *Taniwha* was evoked as a supernatural force behind coastal uplift, tsunami, and landslides (Morton, 2018). For New Zealand, the Hikurangi subduction margin is a formidable *Taniwha*, a "live dragon" lurking just offshore, ready to unleash powerful forces locked within its seismogenic zone. With multiple collaborative research efforts now underway, geoscientists are shedding light on the habits of this secretive dragon, revealing new understandings of the earthquake and tsunami hazards that threaten New Zealand's coastline.

REU student Stephen Mitchell with grad student Thomas Kosciuch (USM) surveying sediment sampling sites, Ahuriri Lagoon.

The SHIRE Project

The Hikurangi margin along the east coast of New Zealand's North Island (Fig. 1) provides an optimal venue for investigating megathrust behavior and controls on seismogenesis (e.g., Wallace et al., 2009 and 2014). Along-strike variations in multiple subduction parameters, such as interface coupling, fluid flow, and seafloor roughness, can be linked to observed differences in megathrust slip behavior (seismic vs. aseismic), forearc mass flux (accretion vs. erosion), and upper-plate deformation (contraction vs. extension). Much of the forearc is subaerial and therefore ideal for geodetic and geologic studies, while the submarine areas are easily accessible for geophysical imaging and monitoring. The SHIRE Project, funded by the NSF Integrated Earth Systems (IES) Program, is a four-year, multi-disciplinary, amphibious research effort involving a team of investigators at five US institutions, as well as multiple international collaborators from New Zealand, Japan, and the United Kingdom. This project is designed to evaluate system-level controls on subduction thrust behavior by combining both on and offshore active-source seismic imaging, with onshore paleoseismic, geomorphic, and geodetic investigations. The project results will be meshed with existing geophysical and geological datasets, and analyzed through the lens of state-of-the-art numerical modelling. The overarching goal is to develop an integrated perspective of the physical mechanisms controlling subduction thrust behavior and convergent margin tectonic evolution.

Importantly, this perspective will help to elucidate a clearer picture of megathrust earthquake and tsunami hazards along New Zealand's Hikurangi margin.

The SHIRE Project has three principal components:

1. Geophysical imaging: Harm van Avendonk (UT Austin) and David Okaya (Univ. of Southern California) are leading the shoreline-crossing geophysical imaging investigations. Marine seismic multi-channel reflection data (MCS) and seismic refraction data recorded by ocean-bottom seismometers (OBSs) are being used to characterize the incoming Hikurangi Plateau, map the structure of the offshore accretionary prism, and document subducted sediment variations. Onshore recordings of offshore airgun shots, explosive shots, and local earthquakes will determine the structure of the upper plate and properties of the deeper plate boundary zone.

2. Paleoseismology and morphotectonics: Paleoseismic and geomorphic studies led by Jeff Marshall (Cal Poly Pomona) and Jessica Pilarczyk (Univ. of Southern Mississippi) will collect new field data to supplement ongoing coastal tectonics investigations conducted by collaborators at New Zealand's GNS Science. This integrated data set will help resolve megathrust slip behavior over several seismic cycles, and constrain long-term coastal uplift and subsidence patterns. This component of the project includes a Research Experience for Undergraduates (REU) program, supervised by Marshall, that engages US students in collaborative New Zealand fieldwork.

3. Numerical Modelling: Demian Saffer (Penn State) and Laura Wallace (UT and GNS Science) will coordinate the integration and analysis of project data through numerical modeling conducted by a team of U.S. and international investigators. The geophysical and geological results will be combined with a range of existing data sets from other projects to constrain numerical models of the physical state of the interface and evolution of the margin over both long and short (seismic cycle) timescales. Model results will also quantify linkages between in situ conditions, fluid flow, behavior of the subduction thrust, and subduction margin development.

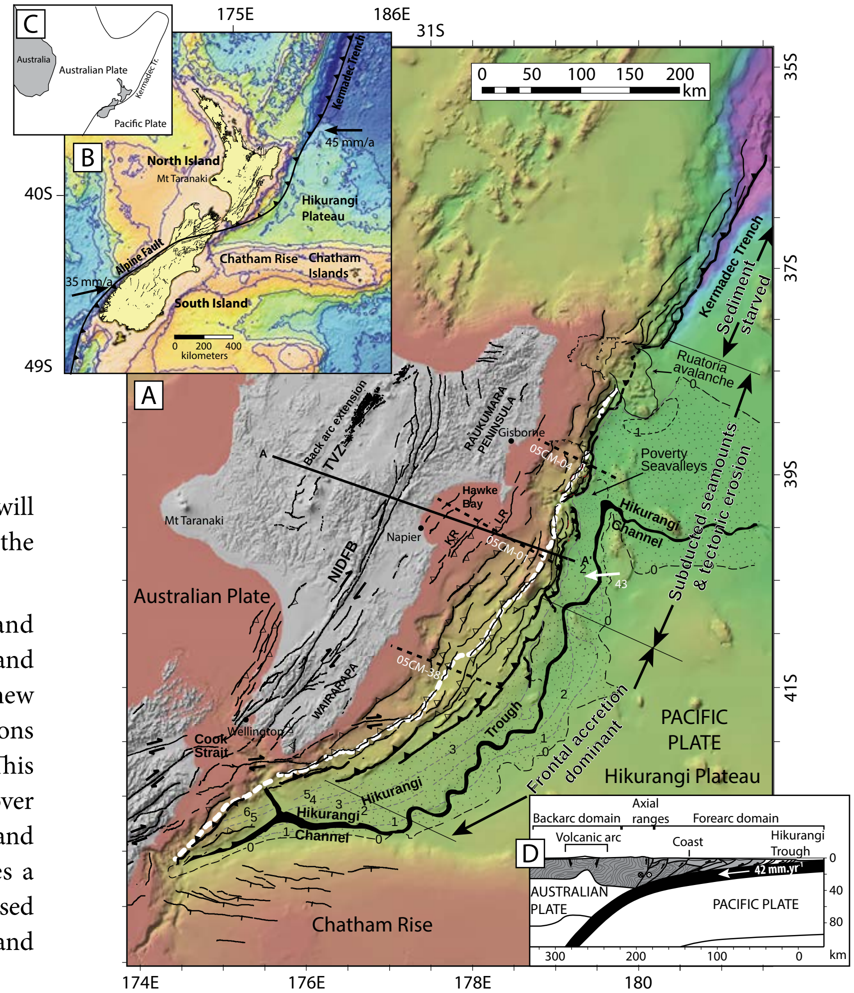

Figure 1. Tectonic setting of the Hikurangi subduction margin along the North Island, New Zealand (from Wallace et al., 2009). A) Map of onland topography (gray) and offshore bathymetry (colored). White arrow shows motion of Pacific plate relative to Australian plate (43 mm/yr). Black lines are major active faults. White dashed line marks back of accretionary prism and front edge of deforming upper-plate basement. B) Regional map of North and South Islands showing major plate boundaries and offshore bathymetric anomalies of Hikurangi Plateau, Chatham Rise, and seamounts. C) Inset map showing location of New Zealand on Australian plate. D) Schematic cross section of Hikurangi subduction margin along line A-A'. See Wallace et al., 2009 for more detail.

SHIRE Spotlight: Geomorphic & Paleoseismic Studies

The SHIRE Project's onshore geomorphic and paleoseismic fieldwork is investigating seismic cycle deformation in the coastal fore arc, focusing on geologic records of land level changes produced by episodes of tectonic uplift and subsidence. Jeff Marshall, Jessica Pilarczyk, and their students are targeting field sites along the North Island east coast (Fig. 2) that compliment ongoing investigations by GNS collaborators Nicola Litchfield, Kate Clark, and Ursula Cochran (e.g., Litchfield et al., 2016; Clark et al., 2015; Cochran et al., 2006). During field seasons in 2017 and 2018, the two research teams conducted parallel studies, with Marshall focused on marine terrace records of coastal uplift, and Pilarczyk on marsh stratigraphic records of subsidence and tsunami.

Marshall and students (Fig. 3A-F) are mapping, surveying, and sampling uplifted paleo-shorelines and marine terraces to identify past earthquakes, and to evaluate net coastal uplift patterns. Their efforts focus on several key locations along the Hikurangi margin, including the Raukumaura Peninsula, southern Hawkes Bay, and central Wairarapa coast. Coseismic uplift events are preserved along much of the Hikurangi coastline as elevated paleo-shore platforms and abandoned beach ridges. Marine shells collected from uplifted platforms and overlying beach sediments provide radiocarbon age constraints on prehistoric earthquakes. In addition to localized fieldwork, the Cal Poly Pomona team is using recently acquired airborne LiDAR imagery (provided by GNS) to correlate uplifted paleo-shorelines between field sites (both from this project and prior studies). The LiDAR data incorporates detailed altitude information, which can be used to track lateral variations in terrace uplift along the coast. Marshall and students are also mapping and sampling flights of uplifted Pleistocene marine terraces along the coast to evaluate longer-term fore arc uplift rates and deformation patterns.

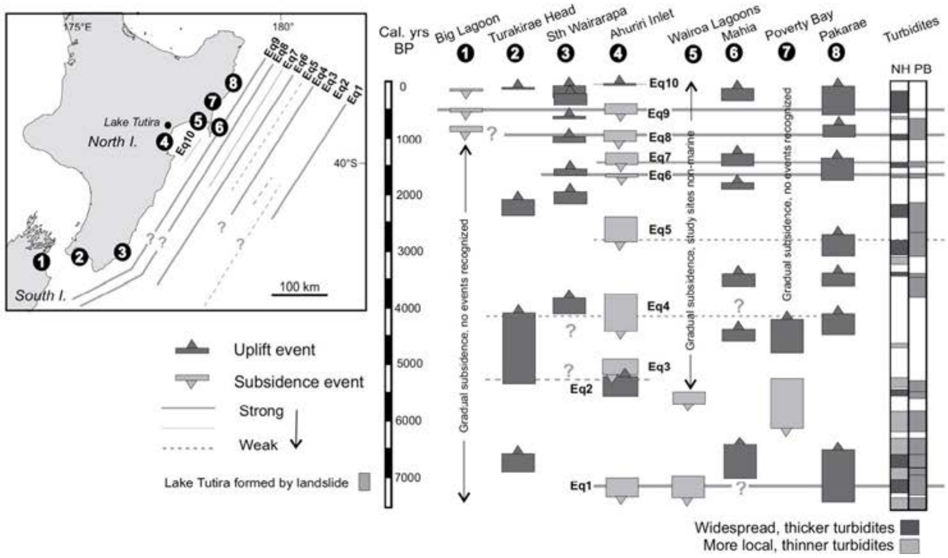

Figure 2. Map showing location of existing Holocene records of coseismic vertical deformation along the Hikurangi margin (Hayward et al., 2016). SHIRE Project paleoseismology study sites are located between 3-4, 4-5, and 7-8. Time line shows the estimated ages and accuracy limits for possible earthquake events known from existing record. Correlation lines between study sites are also shown on the map to indicate potential lateral extent of past earthquake ruptures..

Terrace cover beds have been sampled for optically stimulated luminescence (OSL) geochronology, and for the identification of volcanic tephra and loess deposits of known ages. During the next two years, terrace mapping and sampling will be expanded to new areas and drone imagery will be recorded for structure-from-motion studies. Project students will conduct digital terrain analyses using regional topographic data to evaluate net deformation patterns, calculate morphometric indices, and outline morphotectonic domains. Overall, the efforts of the coastal uplift team will provide new constraints on the timing and spatial distribution of both short-term seismic cycle events, as well as longer-term cumulative deformation.

Pilarczyk and students (Fig. 3 G-I) are using coastal sediments to develop long-term records of Hikurangi earthquakes and tsunamis. Microfossils such as foraminifera are used to recognize both subtle and abrupt changes in sea level along a coastline. An abrupt change in sea level, caused by coseismic subsidence, indicates the occurrence of an earthquake and can be recognized along the coastline as a soil buried beneath subtidal sediments. Because certain microfossils have fidelity to the tidal frame, they can be used to assess how much a coastline subsided during an earthquake. They can also be used to identify tsunami deposits because they indicate transport of marine sediment into a coastal setting where such sediment does not occur naturally. In this way, radiocarbon dating and microfossil analysis on coastal sediments can be used to understand the timing and magnitude of past Hikurangi earthquakes and tsunamis. In 2017 and 2018, Pilarczyk and students embarked on a sediment coring campaign that targeted low-energy depositional centers (i.e., marshes, lagoons) along the Hawke's Bay coastline. Their mission was to find evidence for past Hikurangi earthquakes that would supplement the short-term observational record by expanding the age range of known events to include centennial and millennial timescales. The team's ongoing investigations have led to the identification of newly discovered events that will help to better understand the seismic hazard for coastlines facing the Hikurangi margin. ■

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Figure 3. SHIRE Project fieldwork (2017-18). A-F: Cal Poly Pomona (CPP) coastal uplift team. A) REU students Jessica Valenciano and Janine Angenent (CPP), with Kate Clark (GNS), using RTK GPS for topographic surveying, Glenburn Station. B) REU students Jessica Valenciano and Janine Angenent (CPP), with Thomas Kosciuch and Stephen Mitchell (USM), inspecting uplifted Holocene beach ridge sediments, Tora Farm Settlement. C) REU students Caleb Miller and Jennifer Hamel, with grad student Chris White (CPP), sampling uplifted Holocene paleo-shore platform, Waimarama Beach. D) REU student Caleb Miller, with grad student Noah Zohbe (CPP), collecting OSL samples from Pleistocene marine terrace deposits, Riversdale Beach. E) Students Chris White, Caleb Miller, Jennifer Hamel, and Noah Zohbe (CPP), with Nicola Litchfield (GNS), collecting OSL samples from Pleistocene marine terrace deposits, Riversdale Beach. F) Grad students Noah Zohbe and Chris White (CPP) collecting marine shell samples from uplifted Holocene paleo-shore platform, Waimarama Beach.
G-I: University of Southern Mississippi (USM) coastal subsidence team. G) Jessica Pilarczyk (USM) coring coastal sediment, Wairoa Lagoon. H) Jessica Pilarczyk (USM) and Charlotte Pizer (Durham and GNS) sampling a subsidence event, Ahuriri Lagoon. I) Davin Wallace (USM) and Charlotte Pizer (Durham) sampling marsh sediments, Ahuriri Lagoon.

Assessing changes in the state of a magma storage system over caldera-forming eruption cycles, a case study at Taupo Volcanic Zone, New Zealand

Kari Cooper (UC Davis), Adam Kent (Oregon State University), Chad Deering (Michigan Tech), and collaborator Darren Gravley (University of Canterbury, New Zealand)

The largest volcanic eruptions are rare events but when they occur can represent a global catastrophe. Relatively small eruptions may still have significant economic impacts (billions of dollars) and may affect the lives and livelihoods of large numbers of people – even in places quite distant from the erupting volcano (e.g., the relatively small Eyjafjallajokull eruption in Iceland in 2010). In an effort to study the processes that lead to large volcanic eruptions in more detail this project focuses on examining the highly active Taupo Volcanic Zone (TVZ) in New Zealand. Our goal is to develop a better understanding of how the temperature and mobility of a magma body below the surface changes before, during, and after a major eruption. As such the project contributes to an emerging understanding of the volcanoes and magmatic processes that can produce such large eruptions, and provides context for interpretation of hazard monitoring at these and other active volcanoes. The project also includes research experience for two K-12 teachers (one in the US and one in New Zealand), and will lead to development of new standard-based physics, chemistry and mathematics curricula.

Members of the field crew (L to R: Lydia Harmon, Sara Moilanen, Tyler Schlieder, and Jordan Lubbers) sampling a tephra unit in the Mangaone sequence, Okataina Volcanic Center

Our approach is primarily a petrological and geochemical one and will focus on studying full caldera cycles – in addition to studying large eruptions themselves we will also focus on the smaller eruptions that occur before and after major episodes. We will couple age data with compositional data for both crystalline (plagioclase and zircon) and liquid (melt inclusions) parts of the erupted magma at the TVZ to develop constraints on the compositional and thermal variations within magma storage zones prior to eruptions. The project is at an early stage, but we have already compiled preliminary data and conducted a comprehensive sampling campaign during field work in December 2017. The field work was highly successful, bringing together PIs and graduate students from the three US institutions (UC Davis, OSU, and Michigan Tech) with our collaborator at University of Canterbury, along with K-12 science teachers Sara Moilanen (Houghton, MI) and Damien Canney (Christchurch, NZ). Field work also blended sample collection with filming videos of how we conduct field work and brief explanations of volcanic deposits and phenomena, which will be used to develop K-12 course content. The six graduate students in the group (Tyler Schlieder and Elizabeth Grant, UCD; Jordan Lubbers and Nicole Rocco, OSU; Olivia Barbee, MTU; and Lydia Harmon, Vanderbilt Univ.) also maintained a blog on the daily activities of the crew, and participated in the educational videos. The field work also set the stage for monthly video conferences among the graduate students, which helps to maintain coordination between individual thesis projects and the project as a whole.

Moving forward, we will collect a suite of data that will provide the foundation for a novel approach using two primary lines of investigation:

1. Constraints on the thermal history of pre-eruptive magma storage by coupling absolute ages for plagioclase crystal populations derived from U-series measurements with trace element diffusion models to constrain the maximum residence time of crystals at a given temperature; and

2. Quantification of the compositional heterogeneity of crystals and melt components, through in-situ measurements of trace-element and isotopic compositions in primary and accessory minerals and in melt inclusions ($\delta^{18}O$ in zircon, ε_{Hf} in zircon; Pb isotopes in plagioclase and melt inclusions), which will provide a measure of the degree to which the magma system is mixed across time and space within the reservoir as well as variations in the contributions of mantle and crustal sources to this reservoir.

The unique strength of this approach is that it will allow simultaneous characterization of the thermal, compositional, and physical evolution of these silicic reservoirs. Therefore, the results of this study should be broadly relevant to other silicic volcanic systems and will represent an important step forward in improving our ability to interpret volcano monitoring data. Large silicic systems represent an end-member for volcanic activity globally, and more general models of the controls on the thermal conditions of magma storage beneath volcanoes will be developed by linking the results of this study with those from other ongoing projects. ■

NSF GeoPRISMS Awards # 1654506, 1654275, 1654128

From top to bottom: Members of the field team in front of a fumarole on White Island. Left to right: Adam Kent, Nicole Rocco, Kari Cooper, Jordan Lubbers, Damien Cranney, Sara Moilanen, Olivia Barbee, Tyler Schlieder; Darren Gravley sampling a tephra unit in the Mangaone sequence, Okataina Volcanic Center; Graduate students in front of Lake Taupo. Left to right, Jordan Lubbers, Elizabeth Grant, Lydia Harmon, Nicole Rocco, Olivia Barbee, Tyler Schlieder; Tephra sequence from Okataina Caldera Center (including Rotorua eruption, ~15 ka) in quarry section. Left to right, Tyler Schlieder, Lydia Harmon, Elizabeth Grant, Damien Cranney. Photos credit: Kari Cooper

SISIE: South Island Subduction Initiation Experiment

Erin Hightower (Caltech) and Brandon Shuck (UT Austin)

SISIE Science Party in front of the R/V Langseth.

The South Island Subduction Initiation Experiment (SISIE) was an international collaborative active-source seismic survey of the Puysegur subduction margin conducted aboard the *R/V Marcus G. Langseth* with researchers and graduate students from Caltech, the University of Texas, Texas A&M University, Victoria University of Wellington, and the University of Otago, NZ. The SISIE hopes to further our understanding of the processes controlling subduction initiation, which remains one of the last unsolved problems in plate tectonics. There are many existing hypotheses and models that attempt to quantify and understand these processes, but while many of them are plausible, our ideas far outrun our data. Geodynamic modeling of subduction initiation can only go so far in accurately explaining the mechanics and dynamics of the process. Therefore, without sufficient data to substantiate these models, there is no definitive answer to how subduction zones form.

The Puysegur Trench is part of the Pacific-Australian plate boundary and is a uniquely situated margin for such a survey because it is a young subduction zone with a well-constrained kinematic history that currently appears to be making the transition from a forced to a self-sustaining state, a development that is crucial in ensuring the longevity of a subduction system. The SISIE project aims to test this hypothesis with the marine geophysical data we recently collected. We will use these data to model the crustal structure across the margin, which will play an important role in constraining geodynamic models of subduction initiation.

The SISIE took place from mid-February to late March, 2018 and acquired high-quality geophysical data along and around the Puysegur-Fiordland plate boundary (Fig. 1). As we quickly learned, a research cruise in the Southern Ocean is no easy feat, and twice we had to take shelter from storms and relentless ten-plus meter swells behind Auckland and Stewart islands. We were able to collect multichannel seismic reflection, wide-angle seismic refraction, high-frequency chirp, multibeam bathymetry, magnetic, and gravity data across the margin. Students onboard participated in a daily Marine Geophysics Class, taught by the PIs, which familiarized us with the various data types we were collecting and the tectonic history of New Zealand. By combining theoretical lectures with hands-on applications, the class gave us practical skills in processing and analyzing multibeam and seismic data, which was an invaluable experience.

NSF GeoPRISMS Awards #1654766, 1654689

A total of 28 UTIG ocean-bottom seismometers (OBSs) were deployed on two key transects which span from the subducting Australian plate, across the Puysegur trench and ridge, over the Solander Basin, and onto the Campbell Plateau (Fig. 1). Students were involved with all OBS operations including programming, sealing and mounting, deployment, and recovery of the instruments (Fig. 2). The OBS records show coherent arrivals of crustal and mantle refractions and Moho reflections, and hints of reflections from the subduction interface. These data will help constrain the crustal thickness and seismic velocity structure across the margin, which will help guide gravity modeling.

Multichannel seismic (MCS) data were acquired with a 4 or 12 km long streamer, with channels spaced every 12.5 m, and recording airgun shots every 50 m. A standard processing sequence of trace editing, noise suppression, deconvolution, velocity analysis, mute, stacking, post-stack time migration, and multiple suppression was applied, with many of these steps performed as the data were coming in. The resulting subsurface images are of excellent quality, which will allow us to constrain the nature and geometry of the incoming oceanic plate, subduction interface, upper plate faulting, and stratigraphy of the Solander Basin (Fig. 3).

Figure 1. Bathymetry map of the Puysegur region, showing multibeam swath bathymetry collected during the SISIE cruise. Solid blue lines represent MCS lines, and green triangles represent OBS deployments. Colored dots represent onshore seismometers that recorded the Langseth's airgun shots; red: short-period instruments, yellow: broadband stations, orange: NZ network sites. Background bathymetry from NIWA chart (Mitchell et al. 2012).

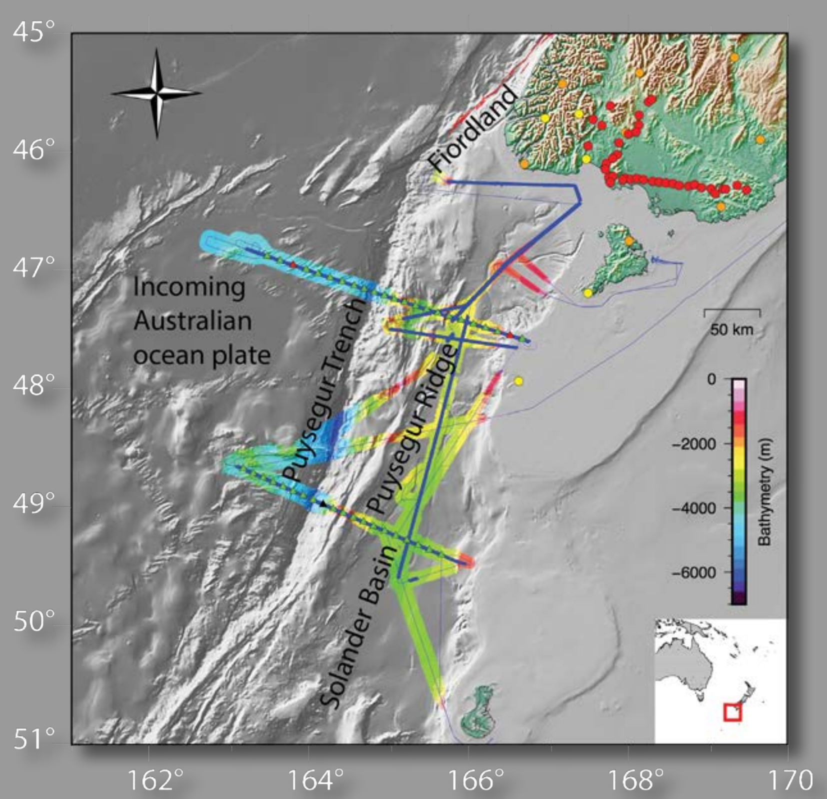


Figure 2. Students were involved with all OBS operations onboard, including (from top to bottom) programming, sealing and mounting, deployment, and recovery of the instruments.

Onshore seismograph deployment with the Takitimu Mountains in the background

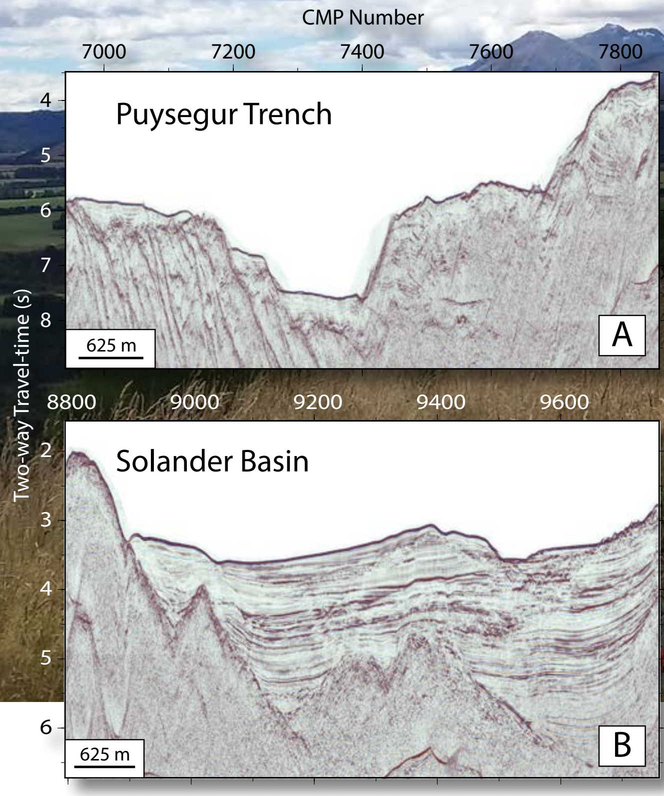


Figure 3. Preliminary post-stack time migrated MCS profiles across the (a) Puysegur Trench and (b) Solander Basin

New multibeam bathymetry data provide high-resolution characterization of seafloor features and topography. Gravity and magnetic data obtained throughout the duration of the cruise will also help provide constraints on crustal densities and structure, and detailed estimates of plate ages and their thermal and kinematic histories, supplementing previous datasets for the region. The gravity data in particular will be integrated with the structural surfaces interpreted from the MCS lines and tomography models to develop a comprehensive view of crustal structure that will shed light on the isostatic state of the Puysegur margin and ridge.

The SISIE onshore seismic array was deployed by a small team comprising students from Victoria University of Wellington, GNS Science researchers, and an American student volunteer. The seismographs consisted of five broadbands and 37 short-period instruments deployed in Fiordland and Southland (Fig. 1). The short period array comprises two approximately north-south profiles and one east-west profile across the Winston and Waiau basins, which were designed to line up with several of the MCS lines shot by the *Langseth* offshore to provide continuous onshore-offshore coverage. The broadbands on the offshore Islands and in those deployed onshore in Fiordland will remain in the field for a year to record earthquakes, a number of which have already been recorded from the Fiordland area. With this array, we hope to record data that elucidates the nature of the crust and the plate geometry beneath southern New Zealand.

The SISIE MCS images are the highest quality data collected in the region, which gives an unprecedented view of the Puysegur subduction zone. In the marine seismic reflection images, we can identify a clear décollement extending from the trench. The image shows some sediment being subducting with the downgoing oceanic plate and some being underplated onto the Pacific plate (Fig. 3a). We were surprised to find stretched continental crust beneath the Solander Basin with the possibility of serpentinized upper mantle (Fig. 3b). Although more work is needed to determine the connection between this stretched crust and the Puysegur subduction system, this is already a major result that likely has great implications for understanding the mechanisms behind subduction initiation. In fact, our preliminary results leave almost no real example of ocean-ocean subduction globally, implying that some component of buoyant continental crust may be necessary for subduction initiation. In the future, we will integrate these data into a more complex and robust geodynamic model of subduction zone formation. SISIE highlights the need to continue marine seismic surveys of subduction margins, especially in areas that are not well explored, and the scientific impact that they bring to our community. Stay tuned for upcoming exciting results from the SISIE researchers and students! ■

Mitchell et al, (2012), Undersea New Zealand, 1:5,000,000. NIWA Chart, Miscellaneous Series No. 92.

GeoPRISMS Postdoctoral Scholarship
Deadline August 13, 2018
For details, visit the GeoPRISMS website:
http://geoprisms.org/education/geoprisms-postdoctoral-fellowships/

4th GeoPRISMS Photo Contest

GeoPRISMS Science through the lens of the Community

2018 AGU Fall Meeting | Washington, D.C.

Share with the GeoPRISMS Community what your GeoPRISMS-related research looks like, whether you are working in the field, or in the lab. Submit your photo now!

The winner of the contest will be announced at the GeoPRISMS Townhall Meeting held on the Monday at the 2018 AGU Fall Meeting and will receive a print out of the photo. The winner's photo will be highlighted on the GeoPRISMS Website and in the Spring Issue of the GeoPRISMS Newsletter.

The GeoPRISMS Photo Contest is open to anyone whose research is related to GeoPRISMS.

For more information about the contest and guidelines, please visit the GeoPRISMS website at:

http://geoprisms.org/geoprisms-photo-contest/

Status Report on the GeoPRISMS Data Portal: April, 2018

Andrew Goodwillie and the IEDA Database Team

Lamont-Doherty Earth Observatory, Columbia University

The GeoPRISMS data portal (*http://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 relevant 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. Many of the data sets described are also available in GeoMapApp (*http://www.geomapapp.org/*) under the *Focus Site* and *DataLayers* menus.

East African Rift System

A new aeromagnetic total magnetic intensity data set collected in 2013 for the Karonga area of the northern Malawi Rift was contributed by investigators Estella Atekwana, Jalf Salima, and Leonard Kalindekafe. In addition, 2-D electrical resistivity tomography profiles acquired in the same area during 2015 were provided by Estella Atekwana, Daniel Lao-Davila, and Folarin Kolawole. The data sets (*http://www.marine-geo.org/tools/search/entry.php?id=EARS_Atekwana*) were used by the researchers in their studies of the early stages of continental extension and active deformation of the Malawi Rift North Basin hinge zone.

Cascadia

As part of a project investigating thermal structure, hydration, and dehydration of the Juan de Fuca plate, stacked receiver function data files and station orientation estimates for Cascadia Ocean Bottom Seismometer stations were received from investigators Helen Janiszewski, Jim Gaherty, and Geoff Abers. The data set (*http://www.marine-geo.org/tools/search/entry.php?id=Cascadia_Janiszewski*) is referenced in Janiszewski and Abers, 2015.

Outreach

The Data Portal team helped convene the GeoPRISMS-sponsored pre-AGU mini-workshop entitled "Early-Career Scientists/Faculty: Introduction to GeoPRISMS/MARGINS Data Resources, Mini-Lessons, and Effective Broader Impacts". During the workshop, participants were exposed to data resources including GeoMapApp and to a number of MARGINS mini-lessons that make use of GeoMapApp and the IEDA EarthChem database.

GeoPRISMS Data Portal Tools and Other Relevant IEDA Resources

Search For Data - (*http://www.marine-geo.org/tools/new_search/index.php?funding=GeoPRISMS*) The GeoPRISMS search tool 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 online 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 – (*http://www.marine-geo.org/portals/geoprisms/references.php*) With more than 1,150 citations, many tied to data sets, the references database can be searched by primary site, paper title, author, year, and journal. The citations can be exported to EndNote™. Submit your papers for inclusion in the bibliography – just the DOI is needed! *http://www.marine-geo.org/portals/geoprisms/ref_submit.php*

Contribute Data - (*http://www.iedadata.org/contribute*) The web submission tools support PI contributions of geophysical, geochemical, and sample data. File formats include grids, tables, spreadsheets, and shapefiles. Once registered within the IEDA systems, the data sets become available to the broader community immediately or may be placed on restricted hold. Additionally, PIs can choose to have a DOI assigned to each submitted data set, allowing it to become part of the formal, citable scientific record. ■

The GeoPRISMS Data Portal team is here to serve the community

Please contact us at info@marine-geo.org

2018 GeoPRISMS NSF Awards

NSF Awards 1754929, 1754767

Collaborative Research: Along strike variation in shallow, offshore strain accumulation and slow slip at Hikurangi Subduction Margin, New Zealand

Spahr Webb (scw@ldeo.columbia.edu), C. David Chadwell (cchadwell@ucsd.edu)

NSF Award 1753660

A proposed study of the dynamics of the Hikurangi New Zealand margin

Harlan Johnson (johnson@ocean.washington.edu), Susan Hautala

NSF Awards 1753734, 1753738

Collaborative Research: East African Rift Tephra Database [EARThD]: A compilation documenting and analyzing explosive volcanism in East Africa

Sara Mana (smana@salemstate.edu), Erin DiMaggio (dimaggio@psu.edu), Karen Fontijn

NSF Award 1753680

Exploring submarine slope failures with seismic data and physical laboratory experiments

Brandon Dugan (dugan@mines.edu), Paul Sava

NSF Award 1824129

Support for a Gordon Research Conference and Gordon Research Seminar on rock deformation

Julia Morgan (morganj@rice.edu)

NSF Awards 1753555, 1753574

Collaborative Research: Effect of contrasting structural and compositional inheritances on the development of rifting margins

Luc Lavier (luc@ig.utexas.edu), Suzon Jammes (suzon.jammes@txstate.edu)

NSF Awards 1753617, 1753665

Collaborative Research: Slow-slip and fluid flow response offshore New Zealand - probing the nature of the margin hydrogeochemical system

Evan Solomon (esolomn@u.washington.edu), Marta Torres (mtorres@coas.oregonstate.edu), Robert Harris

NSF Awards 1753492, 1753518

Collaborative Research: Investigating initiation and history of the Aleutian Arc and composition and significance of North Pacific seafloor via dredge samples from the R/V Sonne

Brian Jicha (bjicha@geology.wisc.edu), Gene Yogodzinski (gyogodzin@geol.sc.edu)

NSF Awards 1753748, 1753696, 1753637

Collaborative Research: Geochemical and geodynamic investigation of lithospheric drip viability beneath the East African Rift

Wendy Nelson (wrnelson@towson.edu), Tanya Furman (furman@psu.edu), James Conder (conder@geo.siu.edu)

NSF Awards 1654619, 1654652

Collaborative Research: Marine EM survey of fluids in the Alaskan megathrust

Kerry Key (kkey@ucsd.edu), Steven Constable, Robert Evans (revans@whoi.edu)

Photo by K. Walowski

All GeoPRISMS NSF Awards are available at: http://geoprisms.org/research/list-of-awards/

GeoPRISMS Steering and Oversight Committee Highlights

Spring 2018

February 8-9, 2018, NSF Headquarters, Alexandria, VA

Edited by Anaïs Férot, GeoPRISMS Science Coordinator & Demian Saffer, GeoPRISMS Chair

Introduction

The annual GeoPRISMS Steering and Oversight Committee Meeting provides GSOC members and NSF representatives the opportunity to share updates on GeoPRISMS and related activities and programs, research funding and outcomes, and to discuss and address programmatic issues and planning. The Spring 2018 meeting included discussion of the Program Solicitation for FY18, updates on the upcoming Alaska Amphibious Community Seismic Experiment (AACSE), planning for the upcoming synthesis and integration TEI to be held in San Antonio, TX in 2019, and discussion of strategies for GeoPRISMS program legacy activities and products. The committee also received updates on the GeoPRISMS office activities, current GeoPRISMS and GeoPRISMS-related research efforts via presentation of materials provided by PIs, the GeoPRISMS data portal, the emerging Subduction Zone 4D (SZ4D) initiative, and AGU workshops and activities.

NSF Update

OCE Division Director Rick Murray, acting EAR Division Director Lina Patino, and GeoPRISMS Program Director Maurice Tivey (OCE) provided updates from NSF. EAR Division Director Carol Frost has departed and Lina Patino is serving as acting EAR Division Director, with a search for the new Division Director underway. Murray's term will end in 2018, and the search for a new OCE Division Director will be announced soon. Regardless of these leadership transitions, both the OCE and EAR Divisions remain strongly committed to GeoPRISMS research directions.

Murray noted that the President's budget request for FY19, anticipated to be released in February, could be more challenging than that for FY18. However, Murray emphasized that NSF does not act on these requests, because budget appropriations are made by congress after considerable negotiation. For example, although the FY18 request for NSF represented a 10% reduction, Congress's appropriation continued funding at the FY17 level. Murray encouraged the Community to contact their congressional delegations to share any concerns about the President's budget request.

Patino summarized reorganizations within the EAR Division. The division is divided into two sections: a Disciplinary Programs Section that includes all of the core programs, and an Integrated Activities Section that includes cross-disciplinary programs such as GeoPRISMS, EarthScope, Education, and Infrastructure. This reorganization is intended to facilitate cross-sectional discussions.

OCE Program Director Maurice Tivey summarized the current state of NSF-GeoPRISMS for both the OCE and EAR divisions, as EAR Program Director Jenn Wade was unable to attend the meeting. Tivey noted that both EAR core programs and OCE-MGG have moved to a model with no deadlines for proposals. NSF is adjusting to this transition, especially for the scheduling of panels in order to deal with the continuous submission of proposals throughout the year. As a solicitation-driven program, GeoPRISMS does not plan to move to this model; however, co-funding of proposals with other EAR or OCE programs will impact the review process. Tivey also noted that he will be leaving in August 2018 as his term as a rotator comes to an end. Whether or not his replacement will serve as the new OCE Program Officer for GeoPRISMS will depend on their background.

GeoPRISMS Solicitation in FY18 and beyond

The phased funding model is now complete. Since 2017, proposals that focus on preparatory work, data analysis & synthesis, and thematic studies are being considered for all primary sites. Last year's solicitation targeted field projects that could fill key gaps in existing datasets. This year's solicitation won't include large field programs, as there are already several field programs underway (one in Alaska and several in New Zealand), but will focus on integrating results and the synthesis of GeoPRISMS Science (solicitation available at *https://www.nsf.gov/pubs/2018/nsf18559/nsf18559.htm*; see also p. 35 of this issue).

AGU Mini-workshop Reports

Three GeoPRISMS mini-workshops were sponsored by GeoPRISMS at the 2017 AGU Fall Meeting in New Orleans, and took place on the Sunday before AGU. Reports from the mini-workshops (p. 40-43 of this issue) are available on the GeoPRISMS website at: *http://geoprisms.org/meetings/mini-workshops/*

ENAM Science Advances: Progress & Outlook
Conveners: Colton Lynner (U. of Arizona) and Zach Eilon (UC Santa Barbara)

Early-Career Scientists/Faculty: Introduction to GeoPRISMS/MARGINS Data Resources, Mini-Lessons, and Effective Broader Impacts
Conveners: Juli Morgan (Rice U.) and Andrew Goodwillie (LDEO, Columbia U.)

Amphibious community experiments in Alaska and related opportunities
Conveners: Lindsay Worthington (U. of New Mexico), Spahr Webb (LDEO, Columbia U.), Susan Schwartz (UC Santa Cruz), Emily Roland (U. of Washington), Aubreya Adams (Colgate U.), and Geoff Abers (Cornell U.)

GeoPRISMS Program Solicitation NSF 18-559

Target date: August 13, 2018

https://www.nsf.gov/pubs/2018/nsf18559/nsf18559.htm

Important revisions this year include:

- Large field projects that involve ship time, significant resources, or where the fieldwork is a significant fraction of the budget (>15%) are no longer accepted to the program
- In order to encourage synthesis and integration of multidisciplinary datasets and models, we will welcome conference proposals throughout the year, separately from the full proposal Target Date
- Postdoctoral proposals now only require two letters of reference
- Postdoctoral Fellows are now called Postdoctoral Scholars

Questions should be directed to:
PO Jennifer Wade: jwade@nsf.gov; (703) 292-4739 or Maurice Tivey: mtivey@nsf.gov; (703) 292-7710

SCD and RIE Initiative updates

GSOC members, with input from GeoPRISMS PIs, provided updates on a wide range of ongoing and recent GeoPRISMS research projects. Updates provide a key opportunity for the GSOC and the NSF Program Officers to see the breadth of exciting science conducted within GeoPRISMS, recognize links with other NSF and major international efforts, assess progress towards key questions in the Science Plan, and identify gaps and new opportunities. These updates provide also an opportunity for the GeoPRISMS community to demonstrate the value of interdisciplinary and societally relevant research to NSF Program Managers in the GEO directorate. All current and previous GeoPRISMS-funded projects, along with brief summaries of results of completed studies, are listed on the GeoPRISMS website: http://geoprisms.org/research/list-of-awards/

RIE Initiative Updates

GSOC members Jessica Warren and Kyle Straub provided updates on RIE GeoPRISMS-funded and related projects at the two GeoPRISMS primary sites (ENAM and EARS). The updates were organized by themes that emerged from discussions at the 2017 RIE TEI, and highlighted studies for each theme. These themes include: (1) Tracking fluids (volatiles and magmas) through the lithosphere and with time; (2) Controls on deformation and localization at different temporal scales; and (3) Surface mass sedimentary fluxes and feedbacks with rifting. The RIE updates included summaries of the CRAFTI project, which aims to quantify the flux of magma and volatiles during early stage rifting and to assess the effects of volatile fluxes on crustal properties along the Kenya-Tanzania border; numerical modeling studies focused on understanding controls on the partitioning of slip on normal faults and investigating the feedbacks between rifting and surface processes using landscape evolution models; a study of rifting in the Salton Trough; and a series of projects making use of active and passive source seismic data collected as part of the ENAM community seismic experiment.

SCD Initiative Updates

GSOC members Kerry Key and Chad Deering provided an overview of active and recent SCD GeoPRISMS-funded and related projects. The summary included updates on projects focused on volcanic processes and volatile cycling, as well as those focused on subduction thrust earthquake and slip processes. Summaries of studies of volcanic systems and volatile fluxes included those aimed at: understanding the flux and migration of volcanic fluids at the Katmai Volcanic Cluster in Alaska via a multidisciplinary geochemical and seismological approach (Taryn Lopez, postdoctoral fellowship); two projects quantifying the origin and ascent processes of volatile-bearing magmas (including Megan Newcombe, postdoctoral fellowship); investigating the relationships among subduction character, volatile cycling and eruptive activity along the Aleutian Arc; assessing variations in magma storage in the Taupo Volcanic Zone, New Zealand; a magnetotelluric and seismic investigation of Okmok Volcano, AK; and an experimental investigation of the electrical properties of hydrous silicate melts, aimed at better understanding the transport properties of melts and volatiles in subduction zones as imaged by geophysical (electromagnetic) surveys.

A number of studies focused on subduction earthquake and fault processes were also summarized, including: postdoctoral fellowships to conduct experimental investigations of sediment deformation behavior in the Nankai, North Sumatra, and Aleutian Subduction zones (Tamara Jeppson) and analysis of seismic reflection data to elucidate the hydrogeologic role of faults in the downgoing plate on subduction processes through comparison of several subduction zones (Shuoshuo Han); a study aiming to integrate of laboratory, geophysical and geological data to characterize the Aleutian megathrust from trench to base of the seismogenic zone; a project aimed at developing a new GPS Velocity Field for the Alaska Peninsula from the Shumagin Gap to the northeast; a modeling study aimed at inversion of geodetic data to characterize slow slip and locking behavior in time and space at the Cascadia and Hikurangi margins; seafloor geodesy studies in Alaska and Cascadia; an analysis of seafloor geodetic and structural data to understand the environment of shallow slow slip along the Hikurangi margin; a project focused on understanding dehydration in the mantle wedge and the role of fluids in intermediate-depth seismicity and mantle wedge anisotropy in Cascadia and Alaska; and an upcoming field program that will integrate marine geophysical data and geodynamic modeling of subduction inititation at the Puysegur trench, New Zealand.

Allied Programs and Partner Organizations Updates

Terry Plank called in to give an update on the status of the SZ4D initiative (previously the SZO, or Subduction Zone Observatory initiative). The SZ4D Vision Document (*https://www.iris.edu/hq/files/workshops/2016/09/szo_16/sz4d.pdf*) was completed in May 2017 and presented to NSF. The organizing committee received input spanning OCE and EAR and was encouraged to continue to sharpen the focus on key science objectives and to move toward a more concrete implementation plan that might define the scope of a future program. Several presentations have been given at various international meetings since then (IAVCEI, GSA, AGU). The SZ4D Initiative aims at understanding the physical and chemical processes that underlie subduction zone hazards, with the goal of improving understanding of tsunamis, earthquakes, eruptions and landslides by capturing and modeling emergent phenomena and by collecting datasets in 4D (in real time and through geological time). Following an email to the GeoPRISMS Community (*http://geoprisms.org/listserv-01-15-18/*), many grassroots activities have been identified or are underway, including workshops (funded or proposed), community response, and experiment proposals.

Sarah Penniston-Dorland provided an update on the ExTerra initiative. ExTerra is a self-organized group of geoscientists, with the aim of investigating core themes in the GeoPRISMS science plan through the study of exhumed rocks. As part of this broader initiative, the "ExTerra Field Institute and Research Endeavor (E-FIRE)" proposal was submitted to NSF PIRE (Partnerships in International Research and Education) and was funded for 5 years starting in Fall 2016. E-FIRE guiding research questions are directly derived from white papers that the community developed during workshops and are linked to the key SCD questions in the GeoPRISMS Science Plan. The objective of the Field Institute is to investigate metamorphic rocks in the Western Alps that span from the shallow to deep reaches of the subduction zone. E-FIRE partners with ZIP (Zooming in between Plates), a European collaborative research and training project that aims to understand processes occurring along the plate interface of subduction zones. ZIP faculty and students led field excursions during a 2017 field institute in the western Alps. The samples and data from the effort are being shared among the group. The group will meet in summer 2018 to share research results, and conduct a second field institute in 2019. More info about ExTerra and E-FIRE can be found at: *http://geoprisms.org/exterra/*

Maggie Benoit (NSF-EAR) provided an update on EarthScope. NSF is currently planning internally and having conversations with the EarthScope community through the EarthScope National Office to plan synthesis and integration for the program over its final years. The activities of the EarthScope National Office are focused on capturing the program's legacy and facilitating synthesis and integration through small to medium sized workshops, as well as via a legacy website.

In addition, the GSOC received brief updates on a suite of major allied field projects at the New Zealand primary site, including the SHIRE project (funded by NSF-IES, with international partners in Japan and New Zealand), a 3-D seismic survey (funded by NSF, with international partners in Japan, the UK, and New Zealand), and multiple IODP drilling expeditions. The SHIRE project (Seismogenesis at Hikurangi Integrated Research Experiment) aims at understanding the mechanics governing fault slip behavior along the subduction thrust interface by combining large-scale seismic imaging, paleoseismology and geomorphology, and numerical modeling to investigate along-strike variations in megathrust locking and slip. This 4-year project is in its first year. The New Zealand 3D community seismic experiment focuses on acquisition of new high-resolution 3D seismic reflection data across the northern Hikurangi margin offshore of the North Island of New Zealand to understand slow slip events (SSE). The data will be open access. Two linked IODP expeditions (372 and 375) also focus on the Hikurangi subduction margin. These drilling expeditions aim to investigate slow slip events by collecting logging data and sampling material from the sedimentary section and oceanic basement of the subducting plate and from primary active thrusts in the outer accretionary wedge; and through installation of borehole observatories to monitor hydrologic, chemical, and physical processes during the SSE cycle.

Finally, GSOC member Danny Brothers summarized several USGS research activities that are strongly aligned with the GeoPRISMS science plan. These include major efforts focused on geophysical data acquisition along the US Atlantic margin, the Queen Charlotte Fairweather Fault System, and upcoming efforts at the Cascadia subduction zone, with three cruises planned for 2018.

Plans for Upcoming Meetings

GeoPRISMS will be at the 2018 AGU Fall Meeting in Washington, DC with a Townhall on Monday evening and planned Mini-Workshops for Sunday, Dec. 9. A call for Mini-Workshop proposals has been sent out to the Community; the GSOC will select the successful mini-workshop proposals in late summer. The GSOC also discussed planning for the upcoming Integration & Synthesis TEI scheduled for February of 2019 (see p. 47 of this issue). A primary objective of this major workshop will be to integrate ongoing work and results across themes and between primary sites, with the goal of identifying advances on the cross cutting science themes in the Science Plan, defining emerging questions, and positioning the community for new initiatives while also shaping the program's legacy over its final years. As details for this major workshop materialize, announcements will go out via the listserv and the application portal will open on the GeoPRISMS website, so please stay tuned.

Call for GeoPRISMS Mini-Workshop Proposals at AGU 2018

Application Deadline: July 1st, 2018




We are pleased to announce that this year we will again be able to host a few Mini-Workshops at the 2018 AGU Fall Meeting (December 10-14). A Mini-Workshop is a research meeting that is held on the Sunday prior to the meeting. Examples of Mini-Workshops held in association with recent and upcoming national and international meetings can be found at:
http://geoprisms.org/meetings/mini-workshops/

Mini-Workshops offer excellent opportunities to jump-start science discussions, as well as to coordinate implementation for future GeoPRISMS studies, both for primary sites and thematic studies. We encourage you to consider such an undertaking. The GeoPRISMS Office provides logistical support, a meeting room, and refreshments. We do not cover any travel costs or per diem to the organizers or participants. GeoPRISMS Mini-Workshops will be open to all interested parties and will be advertised via the GeoPRISMS mailing list, newsletter, and website.

If you would like to host a GeoPRISMS-related Mini-Workshop in association with the 2018 AGU Fall Meeting, we invite you to submit your proposal to the GeoPRISMS Office at info@geoprisms.org. The proposals will be reviewed and ranked by the GeoPRISMS Steering and Oversight Committee (GSOC). The number of Mini-Workshops is limited but we expect to be able to host two to three events.

The deadline for upcoming Mini-Workshop proposals is July 1, 2018. The proposal guidelines are described on the GeoPRISMS website at:
http://geoprisms.org/meetings/mini-workshops/

We encourage you to contact the GeoPRISMS Office with questions or for advice prior to submitting.

We look forward to hearing your ideas.

Questions should be directed to the GeoPRISMS Office:
info@geoprisms.org

More information at:
http://geoprisms.org/meetings/mini-workshops/

Volunteer

GeoPRISMS Student Prize at the AGU Fall Meeting

Are you willing to help us judge student presentations at the AGU Fall Meeting?

Contact us at info@geoprisms.org

GeoPRISMS

The GeoPRISMS Office will again organize a best student presentation award at the AGU Fall Meeting. The competition is open to all students who work on GeoPRISMS- or MARGINS-related research.

Students will compete for a best poster and a best talk award. Both awards carry a $500 cash prize. Awardees and runners up will be featured on the website and in the Spring newsletter.

The competition is always very popular. You can help!

We hope that if you attend the AGU Fall Meeting this year that you will be able to help us evaluate the student award. We generally ask judges for their assessment of three or four presentations.

Thank you for your help with this important effort

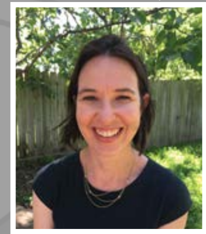
Distinguished Lectureship Program

2018 - 2019

The GeoPRISMS Office is pleased to announce the annual Distinguished Lectureship Program for academic year 2018-2019 with an outstanding speakers list. Distinguished scientists involved with GeoPRISMS science and planning are available to visit US colleges and universities to present technical talks and public lectures on subjects related to GeoPRISMS science.

Apply before July 1 to host a Speaker!

Any US college or university wishing to invite a GeoPRISMS speaker may apply via the GeoPRISMS website before July 1, 2018. 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 PhD programs. Institutions may request a technical and/or public lecture. The GeoPRISMS Office will cover airfare for the speaker's travel and will coordinate travel and off-site logistics. Host institutions are responsible for local expenses for the duration of the visit.



JAIME BARNES
UT Austin

ANNE BECEL
LDEO, Columbia U

CYNTHIA EBINGER
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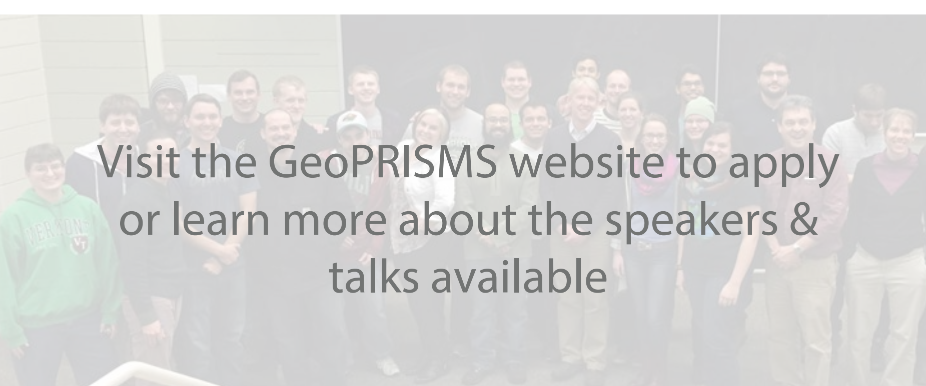
UC Riverside

GeoPRISMS is on YouTube! Subscribe and watch lectures given by the GeoPRISMS Distinguished Lecturers in the past years.

*Questions?
Email info@geoprisms.org
For more information, visit the GeoPRISMS Website at:
http://geoprisms.org/education/distinguished-lectureship-program/*



Visit the GeoPRISMS website to apply or learn more about the speakers & talks available

GeoPRISMS at AGU Fall Meeting - Mini-Workshop Reports

December 11-15, 2017 AGU Fall Meeting, New Orleans, LA

GeoPRISMS provides the opportunity for groups of researchers to meet and discuss GeoPRISMS Science or planning activities at the AGU Fall Meeting. Here are the reports from the Mini-Workshops organized at the 2017 AGU Fall Meeting.

ENAM science advances: progress and outlook

Conveners: Zachary Eilon (UC Santa Barbara) and Colton Lynner (University of Arizona)

The *Eastern North American Margin (ENAM) science advances: progress and outlook* mini-workshop was held on Sunday morning immediately preceding the 2017 AGU Fall Conference. This workshop was designed to provide an opportunity for community presentation and discussion of new and future work on the Eastern North American Margin. The timing of the workshop, approximately two years following the conclusion of the ENAM Community Seismic Experiment (CSE), was ideal for showcasing mature research projects that span the entirety of the margin, from the Appalachian Mountains to the offshore region. The workshop featured products of the amphibious broadband seismic and multi-channel seismic (MCS) data as well as the integration of EarthScope Transportable Array with the ENAM-CSE.

This workshop had 34 participants in total, including twenty early-career scientists (graduate students and post-docs). In order to promote the integration of multiple scientific perspectives and sub-disciplines that encompass the ENAM, the mini-workshop was organized thematically by geographic region. Sessions were divided between the Appalachian Mountains and the Onshore Margin, the Offshore Margin, and Margin-Wide Synthesis, ordered sequentially for a geographic and thematic progression. The format of the workshop was split approximately evenly between keynote presentations, pop-up talks and discussion time. Keynote speakers were asked to give an overview of the active research topics and outstanding questions in each region. Pop-up talks were selected from graduate-students and early career researchers who applied to speak at the mini-workshop. This format allowed fifteen separate presenters to highlight their recent research products, while also building in opportunities for participants to talk through consistencies and incongruences between cutting-edge results.

Participants and conveners at the pre-AGU GeoPRISMS mini-workshop discussing new and future research initiatives on the Eastern North American Margin, one of the GeoPRISMS Focus Sites.

Photos by A. Férot

Appalachians and Onshore Margin

Lara Wagner (Carnegie) provided a thorough tectonic and literature background for ENAM research; she emphasized that for a "passive" margin, ENAM looks surprisingly active, with ongoing seismicity, Eocene volcanics near Harrisonburg, and steep relief. Patrick Duff (U South Carolina) used magnetic and gravity modeling along with legacy seismic datasets to argue for ~370 km of shortening during Appalachian orogenies. He showed that lower-crustal variability was not necessarily needed in order to account for the gravity signal. Lindsay Worthington (U. New Mexico) showed new results from the on-land component of the ENAM-CSE active source experiment. Her results show a surprisingly simple lower-crustal structure beneath the onshore portion of the margin, with elevated supra-Moho velocities perhaps indicating crustal underplating related to the initial formation of the ENAM on one of the two lines. Rachel Marzen's (LDEO) work on the SUGAR lines (South Georgia Basin) crosses Mesozoic rift basins and multiple potential suture zones between accreted terranes. They observed high Vp and Vs within the Inner Piedmont and Carolina accreted terranes that are underlain by a low velocity zone at ~5 km depth. Cong Li's (UMass, Amherst) P-s receiver function study (presented in his absence by Xiaotao Yang) indicates good correlation between Bouger gravity and Moho topography in New England, suggesting that Mesozoic terrane boundaries still control today's Moho gradients with significant offsets in Moho topography associated with the northern Appalachians. Ben Murphy (U. Oregon) presented magnetotelluric (MT) evidence for a deep, electrically-resistive body beneath the piedmont, spanning the region from Georgia to Virginia and extending from just east of the mountain belt to the coastline.

Much of the discussion for this session focused on the discrepant tomographic and MT results beneath the coastal plain. Whereas tomographic images clearly delineate a thin piedmont seismic lithosphere, the MT data indicates almost the exact opposite, with thick resistors outboard of the orogen. There was also significant discussion regarding the differences between lower crustal active source lines.

We concluded this section with the questions: 1) Is there such a thing as a type locale for a magmatic (or really any type) of passive margin? 2) What is the necessary scale of an experiment to capture all of the complexities and variability of a passive margin? 3) What does the lithosphere-asthenosphere boundary look like across the ENAM?

Offshore Margin

Anne Bécel (LDEO) presented high quality MCS and wide-angle refraction results spanning the entire continental margin. Among the notable features were a continuously map-able Moho, erosional unconformities demarcating rift-related sedimentation, well-captured seaward-dipping reflectors (SDRs) and thick ocean-continent transitional crust in the region of the East Coast Magnetic Anomaly (ECMA). Brandon Shuck (UT Austin) presented OBS results that were in strong agreement with Anne's findings. He used petrological modelling to argue that thickened Blake Spur Magnetic Anomaly (BSMA) crust implies Tp ~ 1450˚C, positing that heterogeneity in source mantle fertility could explain along-strike crustal thickness variations. John Green (TAMU) presented refined magnetic anomaly correlations throughout the offshore ENAM and assigned updated ages and chron numbers to M0-M25 and eight pre-M25 anomalies, identifying five correlated magnetic anomalies between the East Coast Magnetic Anomaly (ECMA) and the BSMA. His results suggest that, if the BSMA source is oceanic crust, the BSMA may have formed ~168.5 Ma and represent the initiation of oceanic crust formation. Joshua Davis (LDEO) presented his modelling of ECMA SDR emplacement, seeking to explain the paradoxical observations that this feature is a single positive magnetic anomaly. James Gibson (LDEO) expanded deep water allostratigraphy observations to show that bottom-current erosion rates vary along the margin.

Discussions focused primarily on the location of initiation of oceanic crustal formation and on the best ways to assimilate offshore results with onshore data.

Margin Overview

Roger Buck (LDEO) gave an expansive overview of the large outstanding geodynamic questions in the context of rifts: Are plumes important for rift initiation? What role does pre-existing structure play? Roger discussed the rarity of a rift directly abutting a large orogenic province such as the Appalachians, and discussed implications of this juxtaposition. Xiaotao Yang (UMass, Amherst) showed results of his full-waveform ambient noise Vs tomography in the Adirondacks, where accreted terranes inboard of the Appalachian orogen are co-located with a Bouger gravity high. He showed localized low VS in the upper mantle in this region; when modeled, the associated density structure explains the high topography, perhaps related to edge-driven convection. Erin Cunningham (U. Maryland) presented S-p and P-s receiver function common conversion point maps that reveal crustal thickening beneath the eastern Tennessee seismic zone.

The conclusion of the Margin Overview session served as both a discussion of the overall structures and processes associated with the ENAM and of mature passive margin formation worldwide. As one of the GeoPRISMS primary sites, inferences made at ENAM should be applied more broadly to advance our understanding of rifting processes. This lead to significant discussion as to whether such applications are justified, given the variability and discordant results observed along the margin. Even the most basic questions, such as: What is the Moho topography? What is the LAB structure? Where did rifting begin? Is there magmatic underplating beneath the margin? seem to have answers that strongly depend on the specific seismic lines, imaging techniques, and geophysical observables being used.

The ENAM is more complex and recently active than was previously appreciated and there may be no such a thing as a 'type-locale' for a passive margin. The ENAM community has more discovery and discussion lying ahead as we reconcile diverse observations and begin to unravel the controls on the variable nature of the margin.

Early-Career Scientists/Faculty: Introduction to GeoPRISMS/MARGINS data resources, mini-Lessons, and effective broader impacts

Conveners: Andrew Goodwillie (Lamont-IEDA), Julia Morgan (Rice University)

Early-career members of the GeoPRISMS community including graduate students, post-docs and recently-appointed faculty often seek help in three areas: in generating ideas for successful broader impacts, in finding reliable sources of material for their class exercises, and in locating effective data tools relevant for their research and teaching. This workshop aimed to provide guidance and pointers on these topics, and aimed to show how the GeoPRISMS-hosted MARGINS mini-lessons could be used as a vehicle to explore each aspect.

Following an introduction by GeoPRISMS Office chair Demian Saffer, this half-day workshop proceeded with demonstrations from the NSF-funded IRIS, UNAVCO and IEDA data facilities of data tools and resources that are relevant for GeoPRISMS.

John Taber, IRIS director of education and public outreach, presented IRIS data tools including Seismic Monitor (http://ds.iris.edu/seismon/) which displays near real-time earthquake information, the Earthquake Teachable Moments slide packets (https://www.iris.edu/hq/retm/), IRIS Ground Motion Visualization GMV animations (http://ds.iris.edu/ds/products/gmv/), the IRIS 3-D Earthquake Browser (http://ds.iris.edu/ieb/), a seismic wave propagation visualization tool (http://ds.iris.edu/seismon/swaves/), and the jAmaSeis realtime seismic data display (https://www.iris.edu/hq/inclass/software-web-app/jamaseis).

UNAVCO's Shelley Olds described the Short Courses for advancing technical expertise which cover topics including GPS and InSAR data processing, and Terrestrial Laser Scanning (https://www.unavco.org/education/professional-development/short-courses/2018/2018.html). The GETSI peer-reviewed teaching modules were shown (https://serc.carleton.edu/getsi/index.html). Her presentation also provided a demonstration of the GPS Velocity Viewer web interface (https://www.unavco.org/software/visualization/GPS-Velocity-Viewer/GPS-Velocity-Viewer.html).

Andrew Goodwillie from the IEDA facility demonstrated the NSF Data Management Plan Tool (Data Search using EarthChem (http://www.earthchem.org/portal) and MGDS (http://www.marine-geo.org/tools/new_search/search_map.php), and the GeoMapApp data discovery and visualization tool (http://www.geomapapp.org/).

Former GeoPRISMS Office chair and lead PI on the MARGINS mini-lessons project Juli Morgan introduced the rationale behind the mini-lesson modules (http://geoprisms.org/education/mini-lessons/). They were designed to integrate in undergraduate geoscience curricula the critical new MARGINS observations and insights of fundamental geological processes along continental margins. Covering all four MARGINS scientific initiatives (SubFac, SEIZE, RCL, S2S), the MARGINS mini-lessons present a comprehensive and balanced suite of learning modules that highlights key results of the MARGINS program, as well as some early results of the GeoPRISMS SCD and of RIE initiatives. The mini-lessons enable data-rich learning opportunities for upper-level undergraduate students and provide a valuable resource to educators interested in continental margins research. Juli Morgan discussed the Rift Basin Morphology module as an example of bringing RCL science into the classroom. Eliza Richardson and Jeff Marshall summarized SEIZE initiative mini-lesson modules covering Slow-Slip Events. Bob Stern and Jeff Ryan described SubFac modules that tackle active tectonics and geochemical studies at the Marianas and Central America subduction systems.

The final part of the workshop was a round-table discussion of strategies to improve the impact and effectiveness of proposed Broader Impacts, with a focus on the generation of community accessible mini-lessons and data sets.

More than thirty participants from a range of fields registered for the event. The conveners thank GeoPRISMS for arranging this mini-workshop at the Fall AGU meeting.

Demonstrations from the NSF-funded IRIS, UNAVCO and IEDA data facilities of data tools and resources relevant for the GeoPRISMS Community.

Amphibious community experiments in Alaska and related opportunities

Conveners: Geoff Abers (Cornell University), Aubreya Adams (Colgate University), Emily Roland (University of Washington), Susan Schwartz (UC Santa Cruz), Spahr Webb (LDEO, Columbia University), Lindsay Worthington (University of New Mexico)

73 scientists met in New Orleans in advance of the AGU Fall Meeting to discuss the current status and plans for the Alaska Amphibious Community Seismic Experiment (AACSE). Attendees encompassed a broad spectrum of marine and onshore science backgrounds including representatives from GeoPRISMS, NSF, IRIS, the Alaska Volcano Observatory, and academic institutions across the US and abroad. Graduate students and early career scientists were particularly well represented in the audience. After a brief introduction from GeoPRISMS Chair Demian Saffer and workshop co-Chair Aubreya Adams, AACSE lead-PI Geoff Abers reviewed previous work in the Alaskan subduction zone and highlights of the preceding community amphibious array, the Cascadia Initiative.

Workshop co-Chair Emily Roland provided a history of the AACSE and plans for execution of the project. Data collection will commence in 2018 with onshore deployments in May and June, and offshore deployment in two cruise legs. Leg 1 (co-chiefs Spahr Webb and Lindsay Worthington) will sail from May 9-29 and Leg 2 (co-chiefs Anne Sheehan and Doug Wiens) will sail from July 11-25. The array footprint extends along strike from Kodiak Island to the Shumagin Islands, and from the onshore backarc to the outer rise 250 km past the trench. A total of 75 ocean-bottom seismometers will be deployed, including twenty in shallow water with trawl-resistant design. Thirty broadband sensors will be deployed onshore to complement the ongoing EarthScope Transportable Array. In 2019 a high-density nodal array will be deployed along the 50 km road system on Kodiak. All data will become open through the IRIS Data Management Center immediately upon recovery and pre-processing. Roland also highlighted opportunities for community engagement, including the opening of the Apply-to-Sail program to scientists from all career stages. By the January 2018 deadline, a total of 47 graduate students, postdocs, faculty, and geoscience professionals applied for twelve available berths. Applications will reopen in late 2018 for the 2019 recovery cruises, one of which will be reserved for undergraduate participants.

Following the introduction by members of the AACSE PI team, scientists from across the community gave updates on related studies and highlighted opportunities to leverage the AACSE. Jeff Freymueller (AVO) gave insights into monitoring of volcanic activity and volcano seismology along the entire subduction area and updates on upgrades to the AVO monitoring network. Shanshan Li (UAF) reviewed recent geodesy studies and investigations of locked and creeping sections of the subduction interface.

Members of the broader community then presented a series of lightning talks, highlighting related projects in Alaska and other regions of subduction. Carl Tape (UAF) gave updates following the demobilization of the SALMON network, providing insights into the unique challenges of field work in this region and into designing bear-resistant stations. Kerry Key (LDEO) showed preliminary results from a joint ocean-bottom magnetotelluric data and onshore seismic from Okmok Volcano in the eastern Aleutian Islands. Terry Plank (LDEO) reviewed recent geochemical studies of magma ascent and volatiles in Aleutian volcanoes. Dave Chadwell (SCRIPPS) discussed the use of seafloor geodesy to study locking and creeping patches of the subduction interface. Harold Tobin (U. of Wisconsin) presented SZ4D, focusing on the status of that initiative, and how insights from the AACSE could inform subduction zone science across the globe.

Community discussion after the talks focused on encouraging feedback for improvement of the implementation plan and reinforcing the ongoing charge of how we use the AACSE to better understand subduction zones on a global scale. Steps toward this goal include a focus on instrumenting seismic gaps in order to span critical boundaries in seismic behavior, as well as linking new observations to numerical, theoretical, and conceptual models. Other measurements such as heat flow, sea-floor pressure measurements, and magnetotelluric surveys will be key in addressing these aims and could motivate complementary experiments. Attendees noted the need to have a response plan in place in the case of a large volcanic eruption or earthquake during the deployment.

More than seventy participants attended the pre-AGU mini-workshop in the evening to discuss the status and plans for the Alaska Amphibious Community Seismic Experiment.

Photos by A. Férot

GeoPRISMS Student Prize for Outstanding Presentations

2017 AGU Fall Meeting, New Orleans, LA

Congratulations to the winners of the GeoPRISMS 2017 AGU Student Prize! As in previous years, the judges were greatly impressed by the quality of the entrants 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. Thank you to all the entrants and judges for making this contest possible and worthwhile.

Poster Presentation Winner

Elenora van Rijsingen | U. Roma Tre, U. of Montpellier

How does subduction interface roughness infuence megathrust earthquakes? Insights from natural data and analogue models

Coauthors: S. Lallemand, M. Peyret, F. Corbi, F. Funiciello, D. Arcay, A. Heuret

From the Judges: "Elenora has a thorough understanding of the methodology and handled questions and discussions quite effectively";"presentation covered an important topic of great interest to GeoPRISMS and the research used a clever blend of observation and analogue modeling. The student was enthusiastic and engaged very effectively with the audience. She handled questions very well and made her case with confidence";"This was one of the best posters I saw at the meeting"

From the Student: "I am very grateful and honored to receive this GeoPRISMS award! Sharing and discussing my research in an international and interdisciplinary community is already a pleasure, but being acknowledged like this makes it even better. The efforts from the GeoPRISMS community to support and acknowledge student research are great, and I hope there will be many more young researchers who can benefit from this in the future"

Oral Presentation Winner

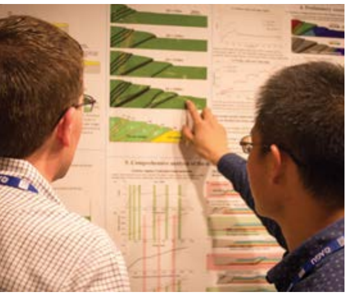
Natalie Accardo | LDEO, Columbia University

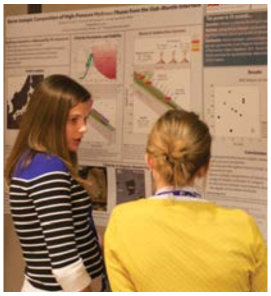
The growth and interaction of large border faults in the Malawi Rift from 3D seismic refraction imaging

Coauthors: D.J. Shillington, J.B. Gaherty, C.A. Scholz, C.J. Ebinger, A.A. Nyblade, P.R.N. Chindandali, G. Kamihanda, T. McCartney, D. Wood, R. Wambura Ferdinand

From the Judges: "This was an *OUTSTANDING* talk. […] clearly introduced the tectonic area and why the region of study was important, explaining in detail the newly collected dataset and method of analyses, and exploring the key results and conclusions";"This presentation was a perfect combination of thoughtful design and prepared delivery, and it was the best talk I saw at the entire meeting";"really interesting and well-delivered talk"

From the Student: "I am very grateful to receive this great recognition by the GeoPRISMS program. I have always appreciated the fantastic opportunities for collaboration and research made possible by the GeoPRISMS organization. I look forward to participating in many GeoPRISMS opportunities in the future"





PARTICIPATE

GeoPRISMS is offering two $500 prizes for Outstanding Student Poster and Oral Presentations on GeoPRISMS-related science at the AGU Fall Meeting to highlight the important role of student research in accomplishing GeoPRISMS-related science goals, and encourage cross-disciplinary input. The contest is open to any student whose research is related to the objectives of GeoPRISMS. More information will become available closer to AGU on the GeoPRISMS website, stay tuned!

James Biemiller | UTIG, Austin

The influence of tectonic inheritance on crustal extension style following failed subduction of continental crust: Applications to metamorphic core complexes in Papua New Guinea

Coauthors: S. Ellis, T. Little, M. Mizera, L Wallace, L. Lavier

From the Judges: "James gave an excellent oral presentation at AGU. He had well designed slides, gave a compelling motivation, spoke clearly and connected with his audience";"He presented exciting results with relevance to the GeoPRISMS community"

From the Student: "I am grateful and honored to receive this recognition from GeoPRISMS. I look forward to future participation in this important community organization"

Jessie Bersson | Whitman College

Explosive to effusive transition in intermediate volcanism: An analysis of changing magma system conditions in Dominica

Coauthors: L.E. Waters, H.M. Frey, K.P. Nicolaysen, M.R.F. Manon

From the Judges: "Jessie has an impressive knowledge of her field and an awareness of the implications of her work for the volcanic hazard faced by residents of the capital city of Dominica [..] This was an excellent undergraduate contribution";"Jessie was an engaging speaker who presented her poster clearly. She did an impressive job answering questions and showed a depth of knowledge about her subject that was impressive for an undergraduate"

From the Student: "I am deeply honored to be recognized by the GeoPRISMS community, a program that so importantly promotes interdisciplinary discussion and supports student research. I look forward to future collaboration and conversation with this dynamic community"

Aude Lavayssière | University of Southampton

Imaging rifting at the lithospheric scale in the northern East African Rift using S-to-P receiver functions

Coauthors: C. Rychert, D. Keir, N. Harmon, , J. Hammond, M. Kendall, S. Leroy, C. Doubre

From the Judges: "Aude gave an excellent presentation, which generated a lot of interest";"spoke clearly and concisely. Great execution. Slides were well designed and to the point. Excellent job answering questions"

From the Student: "I am grateful and pleasantly surprised by this award. It is a great honor to have my work recognized by the GeoPRISMS community. I look forward for more exciting research and meetings!"

Brandon Shuck | UTIG, Austin

Constraints on mantle dynamics during Jurassic rifting in the ENAM area from seismic and petrological modeling of the oldest oceanic crust

Coauthors: H. Van Avendonk

From the Judges: "Brandon's presentation was extremely well done.[…] He was cognizant of work being done in the same field area, as well as in different GeoPRISMS focus sites, which I think demonstrates a very mature sense of awareness. Very enthusiastic, interesting project, and excellent presentation." ; "Knowledgable and engaging presentation of the results. […] Brandon sought out ways to combine multi-disciplinary constraints, consistent with the GeoPRISMS scientific goals"

From the Student: "I am ecstatic to have my research recognized by the GeoPRISMS community! I really appreciate the opportunity to contribute to a thriving group of talented scientists, and I look forward to ongoing involvement in the future"

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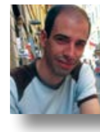
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GeoPRISMS TEI 2019
Synthesis & Integration

February 27 to March 1, 2019 | Menger Hotel, San Antonio, TX

www.geoprisms.org/tei-2019

The 2019 GeoPRISMS Theoretical and Experimental Institute (TEI) will represent an opportunity for our community to synthesize results from the Rift Initiation and Evolution Initiative (RIE) and the Subduction Cycles & Deformation Initiative (SCD). During this meeting we will evaluate what has been accomplished so far in all GeoPRISMS themes and primary sites, and what gaps still need to be filled in the last years of the decadal program. We will also try to identify emerging new opportunities and to develop new research directions for our community after the end of the GeoPRISMS Program. The three-day meeting will be preceded by an Early-Career Investigator symposium on Tuesday February 26.

Key objectives that the workshop will try to achieve:

- Set the stage for legacy of GeoPRISMS, develop concrete ideas for legacy products or activities in the coming 2-3 years. This should include both science and Education and Outreach.
- Identify the outstanding process-based questions and cross-cutting themes that engage both RIE and SCD communities. These burning science questions can help guide the integration of science results from GeoPRISMS, and it can lead to future proposals and funding opportunities.
- The Early Career Investigator (ECI) symposium will foster cross-disciplinary collaborations among young scientists.
- The synthesis workshop will help position our science community for future years. We can evaluate the role that large research infrastructure will play, how science goals of the GeoPRISMS program can be met in other initiatives such as a SZ4D, and the importance of continued NSF support for cross-disciplinary and cross-shoreline research.

More information will be soon available on the GeoPRISMS website, stay tuned!

http://geoprisms.org/tei-2019/

Team of GeoPRISMS Synthesis and Integration TEI:

Katie Kelley (University of Rhode Island)
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Early Career Investigator symposium leaders:

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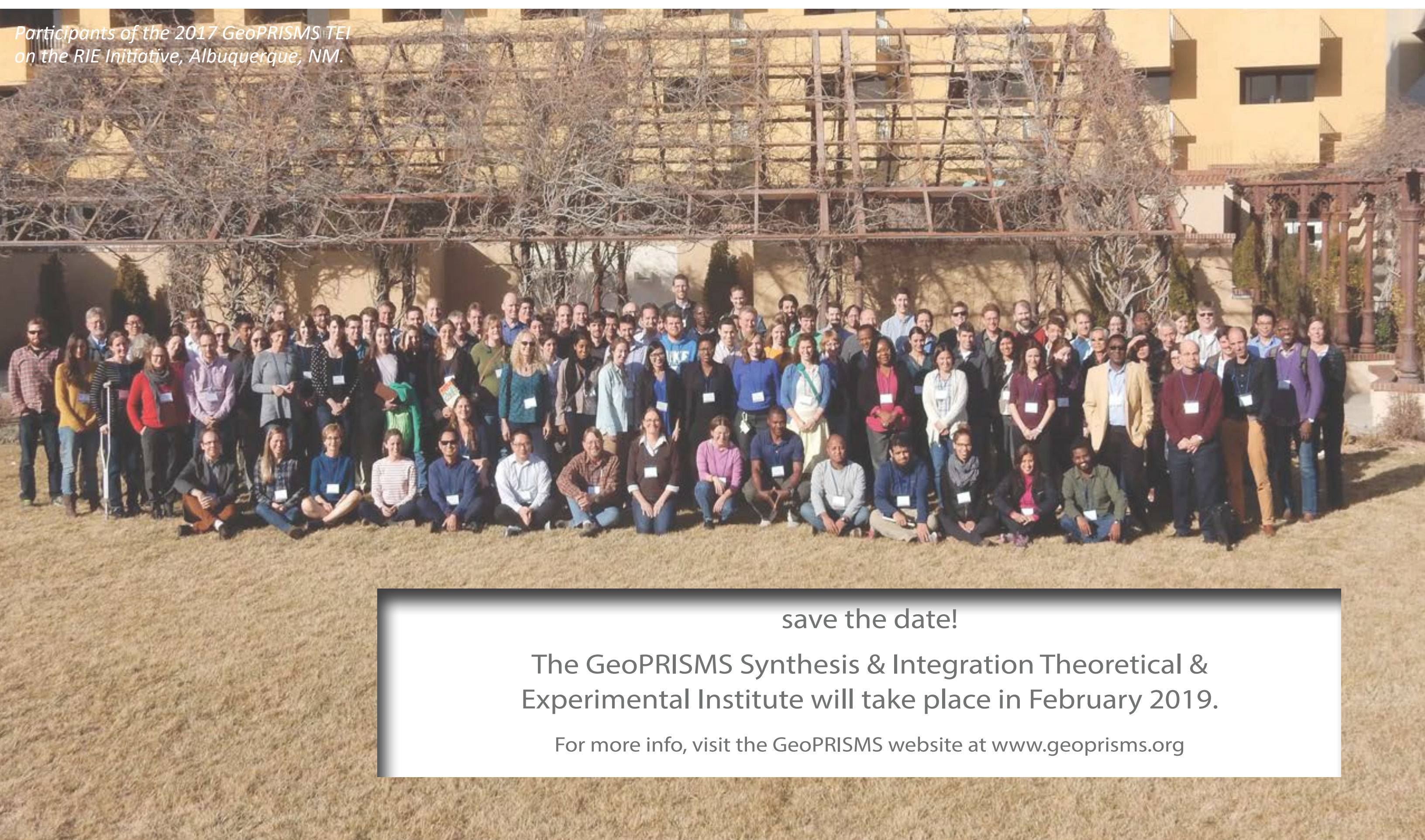

Participants of the 2017 GeoPRISMS TEI on the RIE Initiative, Albuquerque, NM.

save the date!

The GeoPRISMS Synthesis & Integration Theoretical & Experimental Institute will take place in February 2019.

For more info, visit the GeoPRISMS website at www.geoprisms.org