Intellectual merit:
We propose to collect a suite of seismic data along the mid-Atlantic coast of East North America Margin (ENAM), in the context of a community-driven experiment with completely open data access, which can be used by the community to address a wide spectrum of GeoPRISMS and Earthscope science. Based on the results of a community straw poll, we propose an active-source and broadband, onshore and offshore seismic experiment that is focused on the East Coast margin around Cape Hatteras. The study area, encompasses the rifted margin, from unextended continental lithosphere onshore to mature oceanic lithosphere offshore, as well as along-strike changes in margin structure and two major fracture zones that are associated with significant offsets at the modern Mid-Atlantic Ridge. The study also covers several features representing the post-rift modification of the margin by slope instability and fluid flow.

The proposed experiment was designed to allow for multiscale imaging of crustal and mantle lithospheric structure and stacked geomorphologic features over a regionally extensive, shoreline-crossing footprint. It will provide an unprecedented geophysical data set to be used by the community to tackle the fundamental questions set forth in the GeoPRISMS and Earthscope science plans about the pre-, syn- and post-rift evolution of rifted continental margins and modification of continental lithosphere by deformation, magmatism and sedimentation. This experiment will augment the Earthscope Transportable Array with 40 broadband ocean bottom seismometers (OBS) offshore North Carolina and Virginia in a 400 x 500 km area. Embedded in this onshore/offshore passive seismic array, we propose to acquire seismic reflection and refraction data offshore with the R/V Marcus Langseth, and refraction data onshore with a land-explosion seismic experiment. This onshore/offshore acquisition plan will include two major active-source seismic lines in the rift direction from the Blue Ridge Terrane onto oceanic crust, an onshore strike line and three offshore strike lines to characterize along-strike variations, and unprecedented 3D imaging of the crust and mantle across the rifted margin using active-source recordings on the broadband array. Additional multichannel seismic (MCS) data acquisition in this region will enable characterization of crustal and sedimentary structure of the continent-ocean transition zone, as well as the structural setting and architecture of the Cape Fear Slide, Cape Lookout Slide, and Currituck Slide on the adjacent shelf and slope. If funded, we will continue to solicit community feedback to refine this experiment plan.

Broader Impacts:
All of the data acquired by this project will made available to the community immediately, which will enable the broadest possible benefit from these data and thus maximize the science and education derived from them. This multi-faceted seismic experiment also offers an immense opportunity for education of young scientists. We propose an integrated education effort during and after acquisition. The science and field parties for data acquisition will largely consist of young scientists, who will be chosen by application. Following the cruise, we propose to hold two short courses on multi-channel seismic reflection and wide-angle reflection/refraction data processing using the newly acquired data. Participants will also be chosen by application, and it is hoped that many of them will have also participated in data acquisition. In addition to providing educational opportunities, these short-courses will produce the basic active-source data sets -- processed reflection profiles and initial velocity models of the refraction profiles – that will be made available to the community immediately. Following the short-courses, we will hold a workshop to encourage close collaboration between the onshore and offshore, passive and active seismic research communities and to facilitate partnerships for post-cruise analysis. Our project will impact the general population by enabling unique public outreach opportunities and by addressing broad and important questions related to geohazards along the ENAM.
Introduction: History and Motivation of the ENAM Community Seismic Experiment

We propose a Community Seismic Experiment (CSE) within the Eastern North American Margin (ENAM) focus site of the GeoPRISMS Rift Initiation and Evolution (RIE) initiative. The science goals of GeoPRISMS in ENAM target processes that are linked across large spatial and temporal scales. True progress towards achieving these goals requires new observations that span these scales and that are co-located, so that the linkages and feedbacks between processes can be explored. Key GeoPRISMS science goals are to understand the roles of inheritance and magmatism on rifting and rupture, and also to understand how the products of rifting control margin evolution as expressed in surface processes and active tectonics today. Addressing these questions requires observations that extend across the Paleozoic Appalachian terranes and the continent/ocean transition onto ancient oceanic lithosphere, and throughout this expanse extend through the crust and down into the mantle. We propose to acquire such observations by taking advantage of the rare opportunity presented by the coincident focus of the GeoPRISMS and EarthScope programs on the U.S. Atlantic margin. We propose to extend the footprint of the EarthScope Transportable Array (TA) offshore ~400 km across mid-Atlantic margin and onto oceanic lithosphere, and to acquire an extensive onshore/offshore active-source seismic dataset within the footprint defined by the passive-seismic array.

The scale, scope and scientific potential of the data we propose to acquire are very large, and we believe that it only makes sense to undertake such an effort as a community experiment. The concept of a community experiment is new to GeoPRISMS, so it is important to explain our approach in this proposal. We outline a plan for a community experiment that is fully consistent with the model that was suggested in the GeoPRISMS Implementation Plan (IP) for both the RIE and SCD (Subduction Cycles and Deformation) initiatives, which reads:  

“The GeoPRISMS community, particularly in collaboration with the EarthScope community, have embraced the concept of acquiring some large geophysical datasets as community efforts when possible and sensible for a given project. Here we define community experiments as large field efforts planned and executed by the community rather than a small group of PI’s; data acquired from these programs would be made publicly available immediately. This approach would enable a much larger group of people to benefit quickly from the data, and the use of the data by a broader community will maximize their scientific impact. It would also facilitate the involvement and training of junior scientists and students.”

The inclusion of these words in the IP reflects substantial discussions at several workshops, but it does not prescribe community experiments for all or any of the GeoPRISMS focus sites. Instead, it invites us all to consider whether a community experiment makes sense within a given focus area.

The deliberations that led us to develop a community experiment for the ENAM focus site began at the joint GeoPRISMS/EarthScope ENAM implementation workshop held at Lehigh University in October 2011. Two things stood out in this context. First, a wide range of interests were represented by scientists from both communities, and there was broad consensus that an important avenue for discovery is the exploration of linkages between processes that span a large range of spatial scales, for example those between mantle processes and surface/shallow-subsurface processes. Second, the coincident arrival of the EarthScope Transportable Array (TA), GeoPRISMS efforts, and a planned USGS seismic study of the Extended Continental Shelf in the ENAM area, was unanimously viewed as an enormous opportunity that should be capitalized on to the greatest extent possible. At a well-attended working luncheon at the Fall 2011 AGU meeting organized by the GeoPRISMS office we started to discuss feasible scenarios for a CSE within ENAM. In the following months we received community input on the scope and design of the CSE via a GeoPRISMS-hosted website and e-mail outreach, which largely echoed the outcomes of the Lehigh workshop:

C-1
1) A CSE within ENAM should acquire data that can effectively address a spectrum of science questions, outlined in the RIE science plan and implementation plans, that are linking processes that span a range of spatial scales (10 m to 200 km).

2) The CSE should take the maximum possible advantage of the TA’s deployment on the U.S. East Coast.

3) The CSE should be structured so that growth and strengthening of the GeoPRISMS community is a natural outcome and such that interactions and synergies between the GeoPRISMS and EarthScope communities are maximized.

Satisfying these criteria requires a seismic experiment that is quite large in terms of spatial distribution, data volume and cost. With its potential to address the research interest of many scientists, it only makes sense to acquire such a large data set as part of a community experiment as defined in the GeoPRISMS IP. The work encompassed by the proposed community experiment includes data collection and reduction. We do not propose to analyze data beyond basic reduction, and we do not propose to test particular hypotheses or produce any scientific results. Scientific results based on these data will be products of independent, PI-driven efforts.

The proposed work also includes workshop and training activities designed to foster broad use and dissemination of these data and to develop a robust community of scientists working within ENAM. These activities include involving young scientists and students in land and marine fieldwork, two short courses following the field program on active-source seismic data processing, and workshops following the short courses to discuss science opportunities.

The value of the proposed experiment thus lies in its potential to address a broad range of RIE goals in a transformative way, to satisfy the observational needs of a broad spectrum of scientists working in ENAM, and to grow and strengthen the ENAM science community. We recognize that this is different from typical proposals, where merit is based on the value of likely scientific outcomes that are formulated and justified in the context of a hypothesis. Reviewing a community-experiment proposal is thus also different than for typical proposals, requiring reviewers to assess value in terms of potential for scientific merit and broader impacts.

A. ENAM CSE links to EarthScope and GeoPRISMS scientific goals

Based on a large amount of community discussion, feedback, and input, we propose an ambitious plan to collect a suite of seismic data across the Eastern North America Margin (ENAM) (Figure 1) in the context of a community-driven experiment with completely open data access. We propose an active-source and broadband, onshore and offshore seismic experiment that is focused on the structural changes in the East Coast margin around Cape Hatteras, where the Carolina Trough is bounded to the north by the Baltimore Canyon Trough. Farther offshore the Kane and Northern Fracture Zones form a significant offset in the modern Mid-Atlantic Ridge. To investigate whether deep structural variations in the Appalachian terranes affected the development of a major segment boundary in the Mid-Atlantic margin near Cape Hatteras, we propose to augment the EarthScope TA with 40 broadband ocean-bottom seismometers (OBSs) offshore North Carolina and Virginia in a 400 km by 500 km area. In this same region we plan for ship cruises with the R/V Marcus Langseth and the R/V Knorr to acquire multichannel seismic (MCS) and OBS refraction data, and a land-explosion seismic experiment to provide coverage from the landward side. With these tools we plan for two major active-source seismic lines in the rift direction from the Blue Ridge Terrane onto oceanic crust, and an onshore strike line and three offshore strike lines to characterize margin-parallel variations. Additional MCS data acquisition in this region will allow us to characterize the basement and sediments of the continent-ocean transition zone, as well as the structural setting of the Cape Fear Slide, Cape Lookout Slide, and Currituck Slide on the adjacent shelf. This data acquisition strategy will allow for multiscale seismic imaging over a regionally extensive,
shoreline-crossing footprint and will provide an unprecedented geophysical data set for addressing fundamental questions related to the continental breakup and post-rift evolution.

Figure 1: A map of the CSE design on the free-air gravity anomaly [Sandwell and Smith, 1997]. The positive ECMA and BSMA are marked in dark gray, while the negative BMA is marked in light gray. The legend shows where we plan seismic refraction and seismic reflection lines, OBS deployments, and land seismic shots. BB=Blacksburg, GB=Greensboro, NO=Norfolk, RI=Richmond, WS=Winston-Salem. Topography and bathymetry are contoured every 500 m. BMA=Brunswick Magnetic Anomaly, ECMA=East Coast Magnetic Anomaly, BSMA=Blake Spur Magnetic Anomaly, VR=Valley and Ridge, BR=Blue Ridge Terrane, CT=Carolina Terrane, BT=Brunswick Terrane, CFS=Cape Fear Slide, CLS=Cape Lookout Slide, CS=Currituck Slide. The inset shows the broadband CSE deployment (yellow circles) next to the TA (red triangles) on a larger scale.
The data set we propose to collect will be used to address an array of science questions related to the goals of the GeoPRISMS and EarthScope initiatives. Science questions related to the ENAM in general and to our geographical focus area in particular are detailed in the recent science and implementation plans for the GeoPRISMS RIE initiative and in the EarthScope Science Plan for 2010-2020. This proposal is structured strictly as a community data acquisition effort with no support requested for the analysis of the data set, and thus we do not detail all of the relevant science questions here. We emphasize, however, that our experiment plan is tied closely to the GeoPRISMS ENAM implementation plan and was designed so that the data set we will collect will be suitable for testing many of the hypotheses posed in the GeoPRISMS and EarthScope science plans.

B. Geological setting of the U.S. Mid-Atlantic margin

B-1. Amalgamation of terranes. The present-day morphology of the ENAM area was shaped over the course of two supercontinent cycles, including the formation and subsequent breakup of both Rodinia and Pangaea [Thomas, 2006]. During this time, several allochthonous terranes accreted onto the Laurentian margin [Bailey et al., 2004; Hibbard et al., 2007], creating a ‘lithospheric collage’ [Whitmeyer and Karlstrom, 2007] that was sutured together during several episodes of collision from the Mesoproterozoic through the late Paleozoic. There are several narrow, eastward-dipping terranes that span the region of interest from west to east, including the Blue Ridge Terrane, composed of Proterozoic and early Paleozoic rocks that formed on and in the Laurentian Margin, and the peri-Gondwanan Carolina Terrane, composed of Neoproterozoic sedimentary, metamorphic, and volcanic rocks [Hibbard et al., 2002]. It is unclear whether these terranes are placed on Laurentian lower crust beneath the coastal plain, or whether the accreted terranes represent the entire crustal section here. Land seismic reflection data gathered by the USGS in northern Virginia [Pratt et al., 1988] supports a thin-skin tectonic model. However, since the ancient Laurentian margin was segmented [Thomas, 2006], the geometry and the sutures probably exhibit some along-strike complexity as well.

B-2. Extension and magmatism on-land. Onshore and offshore rift basins associated with the breakup of Pangaea scar the lithosphere from Florida to the Grand Banks of Canada, producing the North American rift system [Manspeizer and Cousminer, 1988; Olsen, 1997]. Both buried and exposed basins tend to be bounded by reactivated Paleozoic thrust faults, suggesting that pre-existing lithospheric weaknesses play a strong role in rift basin development [Lindholm, 1978; Ratcliffe and Burton, 1985; Ratcliffe et al., 1986; Swanson, 1986]. The timing of rifting is largely constrained by the incidence of growth strata in the rift basins that suggests that rifting was underway throughout the margin by the late Triassic. The relatively long duration of rifting, which propagated from south to north along the US margin [Schlische, 2002], contrasts with the short duration (~1 million years around 200 Ma) of the Central Atlantic Magmatic Province (CAMP), which is expressed throughout the study region, both as intrusive dikes and as basalt flows in the synrift sections of some of the basins [Marzoli et al., 2011; Schlische et al., 2003]. The timing of CAMP may suggest that lithospheric tectonics largely controlled the emplacement of magmas [Hames et al., 2000].

B-3. Offshore magmatism. Rifting of the US East Coast margin also triggered volcanism offshore. The East Coast Magnetic Anomaly (ECMA) marks the approximate location of a wedge of volcanic and volcaniclastic rocks [Klitgord and Behrendt, 1979], seen in seismic sections as seaward dipping reflectors (SDRs), along the ocean-continent boundary [Tréhu et al., 1989] (Figure 1), and magmatic underplating at larger depth [Holbrook et al., 1994]. The large melt flux may imply that the mantle was relatively hot or fertile during extension [White and McKenzie, 1989], or that rifting induced small-scale convection [Holbrook and Kelemen, 1993; King and Anderson, 1998]. Though the SDRs are generally regarded as having formed during the rift-to-drift transition, it is uncertain whether their formation was coeval with CAMP [McHone, 2000; Schlische et al., 2003], as CAMP related basalt flows both overlie and underlie the SDRs.
along the margin. The timing of offshore volcanic with magnetic data is inadequate, as spreading likely commenced during the Jurassic quiet zone [Vogt, 1973]. In addition, erosion has likely removed the youngest synrift sediments in basins, and no wells have been drilled into the oldest postrift strata offshore [Withjack et al., 1998].

**B-4. Rift-to-drift transition, and formation of the early ocean lithosphere.** After the early opening of the Atlantic Ocean produced ECMA, a secondary event, perhaps a plate reorganization or a magmatic pulse, formed the prominent Blake Spur magnetic anomaly which led Vogt [1973] to suggest that it represents a sliver of crust that was left on the U.S. margin after an early spreading ridge jumped east, perhaps 22 Myr after ECMA formed. Alternatively, Labails et al. [2010] invoked a much larger spreading half-rate on the North American side to account for this asymmetry. It has also been suggested that some of the segmentation of the modern Mid-Atlantic Ridge, such as the Kane and Northern Fracture Zones (Figure 1) may be features inherited from the geometry of the adjacent continental margin [Behn and Lin, 2000]. This idea may be difficult to reconcile with a possible early reorganization of the spreading center [Vogt, 1973], but current timing and structural constraints on the early oceanic crust are not available to test it.

**B-5. Postrift margin tectonics.** The mid-Atlantic US margin has remained active after continental breakup, though the geological processes that drove post-rift deformation are largely unconstrained. For example, basin inversion took place along most of the margin, with N-S to NW-SE shortening directions, as exhibited by folding and basement involved reverse faulting [LeTourneau, 2003; Venkatakrishnan and Lutz, 1988]. Multiple postrift unconformities exist onshore and offshore, and very fast exhumation of the interior portion of the margin has been ongoing since the Miocene [Pazzaglia and Brandon, 1996]. Late Quaternary submarine landslides offshore the eastern US highlight a significant geohazard [ten Brink et al., 2009]. Salt tectonics [Dillon et al., 1982] and processes that mobilize gas hydrates [Hornbach et al., 2007] may have triggered tsunamogenic landslides south of Cape Hatteras, but these mechanisms are not likely responsible for landslides farther north [Twichell et al., 2009].

**C. Seismic experiment design**

**C-1. CSE Experiment plan.** To obtain good constraints on the structure of the sediments, crust and upper mantle, we propose to acquire both broadband seismic and active-source, short-period seismic data. Broadband seismic data are already going to be acquired on-land by the EarthScope TA. We propose to extend the broadband seismic coverage offshore in this critically important portion of the margin. We request ship time for a 14-day cruise with the R/V Knorr to deploy 40 broadband OBSs in 2014, and another 14-day cruise with the R/V Knorr in 2015 to recover these instruments. The constraints on mantle structure that the broadband seismic data offer can be matched with coverage of the crustal structure if we acquire land explosion seismic data, marine seismic reflection and refraction data with the R/V Marcus Langseth and short-period OBSs, and onshore-offshore recording. The active-source seismic data can be acquired in a single field season. While the broadband OBSs are in place, we request 47 days of ship time for the R/V Marcus Langseth to shoot seismic reflection and refraction lines and 32 days for the R/V Knorr to use 60 short-period OBSs for 137 drops on five offshore transects (Figure 1). We plan to extend the active-source marine footprint on land, and record the airgun shots with an array of 105 Reftek130 and 700 Reftek125. These instruments will also record 7 land-seismic explosions and will provide detailed information on the crustal structure across the coastal plain. Table 1 shows how we would use ship time for the R/V Marcus Langseth and R/V Knorr in this two-ship operation, in conjunction with onshore seismic recording of airgun shots and an explosion seismic refraction shoot. In the following sub-sections we explain the components of this experimental plan in more detail.

**C-2. Major transects.** We plan to acquire 6 major seismic profiles as part of the CSE active-source seismic program. The details of data acquisition are discussed in the next section; here
we here motivate the location of these transects. Lines 1 and 2 span in the approximate rift direction from the Blue Ridge across the Carolina terrane, the continental shelf, the ECMA and BSMA, onto what we think is normal oceanic crust. While Line 1 lies north of Cape Hatteras across the Baltimore Canyon Trough, Line 2 lies south of Cape Hatteras across the Carolina Trough. Differences in the deep structure of the Appalachian orogen along these two transects may be important for our understanding of the evolution of the rift. To study such along-strike variability in more detail, our experimental plan has four strike lines. Line 3 lies seaward of BSMA, where we may find differences in crustal structure across the landward extension of the Kane Fracture Zone. Strike Lines 4 and 5 lie on the seaward edge of the ECMA. Here we look for variability in the upper crustal structure, where SDRs have been imaged, or in the lower crust, where previous seismic refraction studies have found evidence for magmatic underplating. The offset between Line 4 and Line 5 follows a trend in the ECMA offshore Cape Hatteras. Line 6 is a strike line in the Carolina terrane that may capture a distinct lateral change in crustal structure that may coincide with the structural change in the rifted margin at Cape Hatteras.

**Table 1.** Schedule for seismic community experiment.

<table>
<thead>
<tr>
<th>R/V Knorr</th>
<th>R/V Marcus Langseth</th>
<th>On-land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leg 1 (Gaherty, Benoit, Long)</td>
<td>(Shillington, Hornbach, Becel)</td>
<td>Set up/survey/deploy Line 2 (1-3)</td>
</tr>
<tr>
<td>Deploy 40 BS OBSs (12 days)</td>
<td>Deploy 2 OBS (9-11) Recover insts/data, swap team (12-15)</td>
<td></td>
</tr>
<tr>
<td>Recover 2 and 3 OBS (3-6)</td>
<td>Recover 1 OBS (11-15) New team survey/deploy Line 1 (19-22)</td>
<td></td>
</tr>
<tr>
<td>Deploy 4 and 5 OBS (26-29)</td>
<td>Recover 1 OBS (26-29)</td>
<td>Recover insts, download data (26-29)</td>
</tr>
<tr>
<td>Line 2 OBS / MCS (d. 1-8)</td>
<td>Line 4 and 5 OBS (28-34)</td>
<td>Line 6: record airgun+land shots (38-40)</td>
</tr>
<tr>
<td>Line 4 and 5 OBS (d. 22-25)</td>
<td>Line 4 and 6 OBS (d. 28-32)</td>
<td>Pickup RT125s, RT130s, demob (40-45)</td>
</tr>
<tr>
<td>Additional M/Cs (d. 20-21)</td>
<td>Additional M/Cs (d. 33-47)</td>
<td>Recover 40 BS OBS (12 days) Recover 4 land broadband stations</td>
</tr>
</tbody>
</table>

**D. Seismic data**

**D-1. Refraction seismic data.** In recent studies of the crustal structure of margins, scientists have used a combination of land-seismic explosion refraction data, OBS seismic refraction data, and onshore recording of offshore air-gun shots. The spatial coverage of such a combined data set spans the coastline, so it is a good approach to study the deep structure of plate boundaries or passive continental margins. Such onshore and offshore seismic refraction data have also been acquired in the ENAM area. For example, the EDGE study on the US Mid-Atlantic margin [Holbrook et al., 1994] showed evidence for thick igneous crust with high seismic velocities (>7.0 km/s) in the vicinity and seaward of the ECMA (Figure 2).

In Figure 3 we show how explosion seismic, onshore-offshore recording and OBS refraction seismology together provide good coverage of the crustal and uppermost mantle structure along
Line 1. In the shallow water of the shelf we may not be able to shoot with the R/V Marcus Langseth, or deploy OBSs, but a ~50 km gap in the source and receiver arrays does not pose a problem, since the onshore-offshore data will undershoot the shelf, providing excellent coverage of the mid- to lower crust and upper mantle. By acquiring two major dip lines across the margin (lines 1 and 2) and several cross lines, we will develop a better understanding of the along-strike structural variations.

![Migrated depth section of EDGE Line 801](image)

**Figure 2.** Migrated depth section of EDGE Line 801 (center) [Lizarralde and Holbrook, 1997] showing crustal-scale features of interest across the continent/ocean transition and their relation to the ECMA (top) and velocity structure within the crust (bottom) [Holbrook et al., 1994]. The images show that ENAM crust thinned by ~50% over ~40 km and appears heavily intruded, based on diminished reflectivity and increased seismic velocity. New igneous crust formed immediately after rupture is very thick (~20 km) and has much higher seismic velocities than normal oceanic crust.

**D-1a. OBS refraction data** (van Avendonk/Dugan). The R/V Marcus Langseth will shoot all seismic refraction data on distance with a 150 m shot spacing, with the airguns towed at 9 m depth, and an approximate speed of 4.5 knots to limit previous shot noise. To make efficient use of the seismic vessel, we request time on the R/V Knorr to deploy 60 short-period OBSs from the US OBS Instrument Pool (OBSIP) on the five offshore transects. In the first deployment, we will place 38 OBSs on Line 2, and 22 OBSs on Line 3. After the R/V Marcus Langseth shoots Lines 2 and 3, we recover these OBSs for the next deployment. In the second deployment, we will drop 38 OBSs on Line 1. In the last deployment, we will place 22 OBSs on Line 4, and 17
OBSs on Line 5. The amount of time that we budget for OBS operations is consistent with the OBSIP guidelines.

D-1b. Onshore-offshore recording (Magnani/Lizarralde). The proposed CSE includes the deployment of a land seismometer array that will record the air-gun shooting along the three main profiles (Figure 1) and the land shots (see D-1c). This deployment is designed to ensure the coverage across the shoreline necessary to resolve the deep structure of the continent-ocean transition (see section A) and to provide an image of the crustal seismic velocity structure of the enigmatic Carolina Terrane. This coverage will enable investigations of questions pertaining to the role of the inherited structures in the evolution of the rift, the volume and distribution of the syn- and post-rift magmatism, and the postrift continental lithosphere modification and evolution.

The land deployment will consist of two components. 1) We will deploy 105 Reftek-130 (RT-130) seismographs sited 10 km apart along all mainland profiles. These instruments will record continuously throughout the offshore shooting of the main MCS/OBS profiles, including the land shots and some of the ancillary MCS profiles. The RT-130s will provide a gross 3D wide-angle velocity control of the passive margin, from the mature oceanic crust offshore, through the rifted continental crust, to the suture with the Blue Ridge accreted terrane. 2) We will deploy 700 Reftek-125 (“Texans”) seismographs spaced 500 m along individual ~350 km long profiles. These instruments will record airgun shots (preferably at the MCS shooting pace) and the land shots sited along the profile, and will be redeployed along each profile as we follow the R/V Marcus Langseth along the US east coast. The use of Texans rather than RT-130s for this component will speed up the redeployment and will enable a denser coverage along each profile, thanks to the larger pool of available instruments.

D-1c. Explosion seismic shots (Harder/Magnani/Lizarralde). In order to provide basic reverse coverage to the offshore airgun shots and to better constrain the velocity structure of the continental passive margin, we plan for a total of 7 large explosions (500-900 kg), 2 along each dip line (line 1, 2) and 3 along the strike line (line 6), with shot points positioned at the intersection of the lines to increase the coverage along the strike-line (line 6). We will record these shots both on the RT-130 array and on the more densely spaced array of RT-125 seismographs. Because the study area is one of the most populated in the ENAM region, we plan to shoot/record the land shots at night, to reduce cultural and wind noise and to improve data quality. Although these shots are too widely spaced to constrain upper crustal structures, we expect that PmP reflections recorded over offsets larger than 100 km will constrain crustal thicknesses up to ~40 km (Figure 3).

D-2. MCS with the R/V Marcus Langseth (Shillington/Hornbach/Becel). The CSE includes marine MCS data acquisition along the primary transects instrumented with OBS as well as an additional ~20 days (~4000 km) of MCS-only data acquisition along a series of ancillary lines. Considerations for siting lines in these two modes of MCS acquisition differ. Instrumented lines target crustal and lithospheric science questions, and their locations are coupled to the BBOBS array, which is in turn coupled to the onshore EarthScope TA. There is considerably more flexibility in the siting of the ancillary lines. The proposed MCS-only lines shown in Figure 1 are thus only representative of a possible set of ancillary lines, but we expect the layout to change prior to the experiment based on additional community input. An important consideration for siting the ancillary lines is the mix of deep-crustal lines, shot with an 8 km streamer and sampling at 2 ms, versus high-resolution lines using 3 km of streamer and sampling at 0.5 ms. There are numerous important targets for imaging spanning these scales.

D-2a. Crustal-scale MCS data enable the imaging of feature within the crust related to terrane accretion, extensional thinning, rift and breakup magmatism, segmentation, new igneous crust formation, and the full record of margin sedimentation. A number of features indicative of these processes can be seen in EDGE Line 801 (Figure 2), including bright, dipping lower-crustal
fabric possibly related to a suture [Sheridan et al., 1993], narrowing of the basement-to-Moho thickness indicating thinning, and seaward-dipping reflections thought to be related to voluminous subaerial volcanism at breakup. While this is a high quality MCS image, we expect even better images across the margin using R/V Marcus Langseth data, providing clearer images of early new-igneous/oceanic crust, possible sill intrusions into post rift sediments, and onlap of sediments onto the basement between ECMA and BSMA. In addition, strike lines will image basement offsets across incipient and mature fracture zones and also reveal along-strike patterns of early new-igneous crust extrusives that would be expected if effusive breakup magmatism was focused and/or segmented.

Figure 3. Example seismic velocity structure along proposed Line 1 (bottom), based on the EDGE seismic velocity model [Holbrook et al., 1994], and expected ray coverage in the proposed CSE (top). Crustal turning waves are shown in red, Moho (PmP) reflections are in black, and mantle refractions (Pn) in green.

**D-2b. High-resolution MCS imaging** with a shallow streamer is a critical first-step in addressing shallow, post-rift GeoPRISMS science objectives. Recording with 0.5 ms sampling can provide high-resolution (200-600 Hz) images to depths > 1 km below the seafloor in sedimentary basins [Holbrook, unpublished data] (Figure 4). Data of such quality would be a significant improvement over existing data, collected mostly before 1985 (see UTIG or LDEO data centers), and they are needed to evaluate the internal structures of sedimentary deposits and provide insights into depositional process, slope failure, fluid flow, or stratigraphic evolution [Sawyer et al., 2009; Wolinsky and Pratson, 2007]. Data of this quality and penetration are also needed to study the linkages between deep structure and shallow processes, which may help to understand the recurrence intervals of shallow events. Detailed images of stratigraphic architecture and (paleo)seafloor geometry can also provide constraints for numerical and
laboratory experiments on complex slope depositional and erosion processes [Pratson and Gouveia, 2002].

**Figure 4**: Seismic reflection data acquired in the Caribbean offshore Nicaragua with the R/V Marcus Langseth with the airguns towed at 6 m depth, and the streamer towed at 3 m depth (left) and 6 m depth (right).

**D-3. Broadband Seismic Deployment** (Gaherty/Long/Benoit) The broadband seismic experiment is designed to provide data critical for addressing ENAM science questions, with three goals in mind. First, it builds on EarthScope TA to enable broad, synoptic imaging of mantle lithosphere and underlying asthenosphere across the margin, from the ancient pre-rift terrains beneath the Appalachians to normal slow-spreading crust and lithosphere beneath the western Atlantic (Figure 2). Second, we will deploy a dense subarray that will enable targeted imaging of the crust and mantle across the presumed syn-rift volcanism implied by the ECMA, as well as several of the prominent along-axis segmentation features observed on the margin and the associated oceanic lithosphere. Finally, we have coordinated the deployment strategy to record the air-gun shots associated with the active-source reflection and refraction lines. This will provide critical three-dimensional imaging of crust and uppermost mantle velocities across the region at a resolution that is unattainable using broadband (passive) sources, but over an area that is much wider than that spanned by the short-period deployments. The deployment will consist of three components. Offshore, we will deploy 40 broadband OBS (BBOBS) obtained through the OBSIP program. All will be deployed in the depth range of 1000-5400 meters, allowing for the use of standard OBSIP instrumentation. Sixteen of these instruments will be deployed in a semi-regular “backbone” grid with nominal interstation spacing of ~100 km, spanning approximately 400x400 km. Twenty-four of the instruments will form a subarray centered on the ECMA, with 25x40 km instrument spacing (Figure 1). Onshore, the array will consist primarily of the EarthScope TA stations, which have a nominal station spacing of 70 km; there are approximately 30 sites within the footprint of the experiment. Under the proposed schedule, the TA will be in place for the entire duration of the offshore experiment. In order to close the gap between the most seaward TA stations and the deep-water BBOBS off the edge of the continental shelf, we will supplement the onshore deployment with four temporary stations.
deployed in special vaults on barrier islands (Figure 1). These instruments will combine OBS-like sensor cases buried in the lee side of the islands, with PASSCAL-style data loggers in extremely watertight containers.

**Figure 5:** Map of one year (2009) of teleseismic seismicity centered around the BB OBS array. Events of magnitude 5.8 and greater are shown; colors correspond to event depth (red = shallow, yellow = deep) and symbol sizes correspond to magnitude.

This combined amphibious array will provide an exceptional dataset for a full suite of broadband analyses. Anticipated seismic events are well distributed in both distance and azimuth, providing excellent coverage from surface waves, mantle body waves, and core phases (Figure 5). BBOBS datasets are often noisy, but generally produce very robust observations on the vertical component. In particular, Rayleigh waves from earthquakes and ambient-seismic noise enable imaging of shear-velocity structure in the crust and upper mantle with sufficient resolution to evaluate variations associated with terrain boundaries [Dalton et al., 2011], and possible magmatic modification [Gaherty and Dunn, 2007; Weeraratne et al., 2007]. Body-wave tomography [Wolfe et al., 2009] provides the means to evaluate relative rapid lateral transitions in structure both across and along the margin, in particular possible rapid changes in mantle velocities within the tight subarray associated with the ECMA and the western limits of the Kane and Northern fracture zones. If horizontal-component data quality is sufficiently high, receiver-function analyses provide constraints on crustal thickness and subcrustal reflectors associated with lithospheric heterogeneity and the LAB [Rychert et al., 2005]. Anisotropy estimates derived from Rayleigh-wave tomography and shear-wave splitting can be used to infer lithospheric provenance, extensional deformation, and patterns of sublithospheric flow; major unanswered questions remain about the origin of anisotropic structure beneath our study area [Long et al., 2010; Wagner et al., 2012].

**D-4. The justification for a unified, multi-scale CSE** follows from the connections between science targets across scales, and from the scientific synergies gained by conducting nested experiments at the same time and place. The tectonic, magmatic and sedimentary processes of lithospheric rupture and postrift evolution of ENAM are manifest throughout the lithosphere. For example, synrift magmatism has a demonstrably dramatic expression in the crust, where legacy refraction data reveal thick mafic magmatic underplating. Voluminous magmatism almost certainly has a correspondingly distinct, complementary expression preserved in the underlying lithospheric mantle. To fully capture the magmatic processes associated with continental breakup, data are needed that provide an integrated portrait of crustal and mantle lithosphere. Deformation and magmatism during rifting also modify the strength the lithosphere, and its response to stress. The ENAM margin is stressed by a number of forces, including plate-tectonic forces, glacial unloading, sedimentary and sealevel loading, and thermal contraction. The margin’s response to these stresses is also manifest throughout the lithosphere, from deep deformation, intraplate crustal earthquakes, and the stability of sediments deposited at or near critical stability along the margin’s shelf edge and slope. Acquiring this suite of spatially collocated, multi-resolutional data at the same time will also provide exciting possibilities for crossover between components, creating a data set that is
more than the sum of its parts. Recording air-gun shots on the BBOBS array will yield unprecedented 3D ray coverage of the crust and upper mantle at the continent-ocean boundary. Another practical advantage of coincident experiments includes the practicality of using the R/V Marcus Langseth to achieve a variety of goals while it is offshore ENAM. The likely availability of Langseth in the Atlantic Ocean dovetails nicely with the scheduled TA deployment; the ship is tentatively scheduled to return to the Pacific after 2014.

The key intangible benefit of a coincident, co-located multi-scale experiment is the increased likelihood that a spectrum of earth scientists, who otherwise may not work together, will interact closely throughout the entire time span of the RIE initiative in ENAM, beginning with data acquisition, followed closely by post-cruise data-reduction workshops, and then hopefully in the submission of joint proposals for data analysis and targeted science.

**D-5. Additional community input** will continue to refine details of the CSE acquisition plan. If this proposal is funded, a number of scientists will likely be motivated to suggest improvements to the experiment design. We will actively seek this input by broadly advertising the current experiment design (via AGU posters, etc.) and any evolutions in that design.

**E. Education and outreach strategy for the ENAM CSE**

One of the primary motivations for proposing a community experiment with open access is to create data products that will benefit as large a community as possible. A related objective is to provide young scientists with the training necessary to take advantage of state-of-the-art seismic data that will be collected during this program. To this end, we propose a comprehensive education component that will provide training in seismic data acquisition, processing, and analysis to graduate students and junior scientists during and after the onshore/offshore field effort.

During fieldwork: Berths will be available for ~12 students/young scientists on the R/V Marcus Langseth, ~6 on the OBS vessel, and ~40 to assist in the onshore deployment of a passive seismic array and acquisition of onshore active source data. Students will be deeply involved in all aspects of the data acquisition effort, including watching-standing, instrument deployment, quality control and initial data processing. All co-PI’s have experience in involving undergraduate and graduate students in geophysical data acquisition. Travel costs for students/young scientists to participate in the planned fieldwork are included in our budget. We will widely advertise opportunities to participate in data acquisition and select students/young scientists through an application process.

After fieldwork: We will hold two intensive short courses on data analysis that will also be open to any graduate student/junior scientist by application. Our budget also includes support for their travel and subsistence expenses to participate. One workshop will cover MCS reflection processing, and will be held at LDEO and taught by Shillington, Magnani and Bécel. The second workshop will cover wide-angle seismic refraction modeling and will be held at UTIG and taught by Van Avendonk and Christeson. We anticipate ~15 students/young scientists in each course. Each short course will be ~2 weeks long and will cover the basic principles and practical aspects of data processing/analysis and will strongly focus on hands-on analysis of the data acquired. Both UTIG and LDEO have computer labs, software licenses, and other facilities needed to host these courses, and Van Avendonk, Christeson, Shillington, Magnani and Bécel have experience teaching such courses (see CV’s).

These classes will not only serve as a training opportunity for graduate students/junior scientists, they will also provide a means to process all of the active source data to the extent that they can be utilized by a larger community. By the end of the MCS course, the students will have produced initial time-migrated sections of all of the newly acquired profiles. Likewise, the wide-angle course will yield velocity models for each of the wide-angle reflection/refraction profiles using first-arrival tomography. These data products will then be made available to the
community immediately via the Marine Seismic Data Center website and will be widely announced through listservs and websites (e.g., GeoPRISMS, IRIS, EarthScope).

F. Broader Impacts
The work proposed here will provide a host of broader impacts to the GeoPRISMS and EarthScope scientific communities (particularly to early-career researchers) and to the general public. First, the fully open access model under which we propose to collect data will enable a large section of the community to immediately benefit from a large and comprehensive geophysical data set. This is particularly important given the model under which GeoPRISMS science planning has progressed. There has been broad community participation in a series of workshops and meetings over the past two years to craft a scientific vision for GeoPRISMS, produce a detailed science plan, select “discovery corridors” in which resources will be focused, and design implementation plans for individual areas. The collection of an open access geophysical data set will facilitate the continuing participation of many members of the community in the analysis and synthesis of the new data, which is a natural next step in achieving the GeoPRISMS science goals.

A second major broader impact of this project is the integrated education and community outreach opportunities that we propose to carry out (see section E). When recruiting scientists for these opportunities through an open application process, we will make a concerted effort to reach a very broad population. This will include, for example, students at smaller institutions who may not regularly participate in large field projects and scientists working at primarily undergraduate institutions. The design of our experiment, which takes advantage of a stated goal of GeoPRISMS to be able to “cross the shoreline,” will also enable closer collaboration between the onshore and offshore communities. We will recruit scientists who have mainly worked onshore and have little experience with seagoing data acquisition to sail on the cruises as part of the shipboard science parties. Conversely, the onshore part of the active source data collection will involve a large number of participants, including undergraduates and (ideally) researchers from the marine geophysics community. Strengthening the ties between the offshore and onshore communities—and the training opportunities available through our project for scientists who are unfamiliar with seagoing data collection—is vital to achieving the science goals of GeoPRISMS.

Third, our project will impact the general population by enabling unique public outreach opportunities and by addressing broad and important questions related to geohazards along the ENAM. The potential for geohazards along the eastern US coast was dramatically highlighted by the magnitude 5.8 Mineral, Virginia earthquake in August 2011, which was felt by millions of people along the heavily populated eastern seaboard. Additionally, increasing coastal populations will potentially be adversely affected by geohazards offshore, where submarine landslides are potentially tsunamigenic, and increased stresses on coastal aquifers can result in brine encroachment and freshwater contamination. Our experiment will enable studies that will help to define current locations of increased submarine landslide risk, understand landslide recurrences, and delineate the distribution of coastal aquifers. Additionally, structural studies of the data we will collect will help to provide a broad geophysical context for earthquake hazards in our study region. Public education and outreach associated with this project will be complemented by working with organizations such as the USGS and the EarthScope/GeoPRISMS E&O offices.

G. Leveraging/add-on opportunities
The design of the community seismic experiment provides an extraordinary opportunity for additional PI-driven proposals to leverage the data sets that will be provided through our efforts. There are numerous opportunities for scientific advancement regarding active processes in shallow sediments. Detailed seismic constraints on the shallow (<2 km) subsurface obtained as
part of the CSE will allow predictions of porosity changes \cite{Bangs_1999} and sediment strength \cite{Tobin_2009} for slope stability studies \cite{Locat_2009}. To further improve our understanding of sediment and fluid storage and transport processes \cite{Cohen_2010} along the ENAM, natural complementary science add-ons include acquisition of chirp seismic data, side-scan sonar, and jumbo piston cores. Chirp and sonar data can provide fine-scale details on active venting and potential locations of insipient failure \cite{Hill_2004}. Water column sampling would constrain composition and origin of venting fluids \cite{Newman_2008}. Cores would provide definite information on pore fluid geochemistry/fluid source \cite{Newman_2008}, geotechnical properties for stability/hazard studies \cite{Locat_2009, Stigall_2010} and age control for assessing depositional history and recurrence interval for landslides and hazards \cite{ten_Brink_2009}. Seismic velocity and attribute analysis can help constrain models for active fluid flow systems, gas hydrate dynamics, fluid overpressure, and tsunami potential studies \cite{Dugan_2000, Hornbach_2007}.

The broadband OBS component of this project provides a natural complement to the onshore TA component of USArray; together, this framework provides a backbone for additional Flexible Array (FA)-style deployments that would focus on smaller-scale science targets onshore. The active source components (both onshore and offshore) provide an opportunity for additional piggyback experiments that would result in detailed images of crustal structure over a regionally extensive cross-section of the passive margin, as well as detailed studies of smaller-scale targets.

In order to widely publicize these opportunities to leverage the data set we propose to collect to the scientific community, our plans for data collection (including maps of our experiment design, timelines, etc.) have been distributed via bulkmail lists and posted to the GeoPRISMS and EarthScope web pages. We will continue to encourage members of these communities to take advantage of opportunities to propose additional PI-driven experiments that would be synergistic with the community experiment.

H. Prior NSF Support

M. Benoit: DUE-0942518; $166,946; 9/15/09-8/31/12; \textit{Bringing seismology’s Grand Challenges to the undergraduate classroom}. This is a collaborative project between TCNJ and the IRIS Consortium E&O program that will create innovative undergraduate course materials based on current research findings associated with the \textit{Seismological Grand Challenges in Understanding Earth’s Dynamic Systems} document. The curricular materials designed by this program will be pilot tested at several institutions and disseminated through professional development workshops for undergraduate faculty, online through the IRIS, SERC, and other websites, and at special sessions held at national meetings.

B. Dugan: OCE-0824368; $156,816; 09/01/08-08/31/12; \textit{Collaborative Research: Stratigraphic Controls on Freshwater Beneath the Continental Shelf}. We completed a high-resolution seismic survey (~1150 km) of the continental shelf offshore Martha’s Vineyard, USA. We image stratigraphic and erosional patterns that we interpret as evidence that Pleistocene ice sheets extended up to 80 km offshore on the continental shelf \cite{Siegel_2012, Siegel_2011, Siegel_2009}. The data provide constraints for modeling linkages between onshore and offshore hydrogeology. All data have been submitted to the Marine Geoscience Data System. This work contributed to the training of three graduate students.

J. Gaherty: EAR-0708445; $605,000; 07/07-6/13 (NCE); \textit{Collaborative Research: How Is Rifting Exhuming the Youngest HP/UHP Rocks on Earth?} As part of a Continental Dynamics project, we operated a 39 station onshore-offshore broadband array to image crustal and upper mantle structure beneath the rapidly extending D’Entrecasteaux Islands region in eastern Papua New Guinea. Thirty-one PASSCAL stations were deployed onshore for 18 months, while 8 OBS were placed on the seafloor for one year. Gaherty lead the OBS operations, and was a co-investigator for the onshore operations. All stations operated successful, and the complete
dataset was recovered in summer of 2011 and has been fully archived at the IRIS DMC. Analyses are ongoing, with presentations at the Fall 2011 AGU and the 2012 IRIS Workshop.

**S. Harder:** EAR-0843835; $580,790; 5/09-4/12; **Collaborative Research: Formation of basement-involved foreland arches: An integrated Earthscope experiment.** The project aims to understand how the formation of contractional basement-involved foreland arches is linked to plate tectonic processes. It includes structural geology, passive earthquake monitoring, and an explosion land seismology experiment consisting of 24 shots along two profiles. Data analysis is currently underway. Thanks to new technical innovations in shot hole engineering at UTEP the drilling and blasting portion of the experiment was $\sim$100,000 under budget. The new cost-effective drilling and explosive technologies are reflected in the budget for this new proposal.

**M.J. Hornbach:** OCE-0648879; $405,264; 05/01/07-04/30/10; **Ultra high resolution 3D seismic surveying of active Hydrate Ridge vents to complement proposed IODP CORKing.** This study generated high-resolution 3D seismic images of an active methane vent. We used these data to developed 3D and 4D fluid-flow/heat-flow models that can be applied globally to other methane vent systems [Bangs et al., 2011; Hornbach et al., 2012]. The study supported a graduate student, and brought 3 undergraduates and a woman minority student from Fort Valley State University into the field.

**M.D. Long:** EAR-0911286; $141,109; 10/1/09-9/30/12; **Collaborative research: A global examination of the subduction zone flow field from seismic anisotropy.** The goal of this work is to combine geodynamical modeling with seismological observations of anisotropy to understand the pattern of mantle flow in subduction systems and implications for subduction geodynamics. The project has supported one M.Sc. thesis (J. Hanna, M.S. 2011), part of a Ph.D. dissertation (K. Paczkowski, Ph.D. 2012), and a senior thesis (D. Petkevich, B.S. 2012) at Yale. Publications from this grant include Wirth and Long [2010], Long and Becker [2010], Silver and Long [2011], Foley and Long [2011], Druken et al. [2011], Hanna and Long [2012], Wirth and Long [2012].

**M.B. Magnani:** EAR-0607783; $40,102; 07/01/06-06/30/08; **Collaborative research: Crust-Mantle Interactions at an Oblique Arc-Continent Collision Zone: The SE Caribbean Plate Boundary (BOLIVAR), UofM.** The goal of this work was the study of the evolution of the Caribbean-South American plate boundary. About 6000 km of marine reflection data, 4 600-km-long onshore-offshore wide-angle profiles, marine and land broadband data were acquired as part of the project. Results were published in more than 15 papers (8 co-authored by Magnani). The project resulted in 2 M.Sc. theses at the UofM and several dissertations at collaborative institutions (Rice U., UTIG, Indiana U.).

**D.J. Shillington:** OCE-0926614; $713,878; 1/1/10-12/31/12; **Megathrust seismic hazards by reflection mapping.** The goal of this program is to use active-source seismic data to characterize along-strike and downdip variations in the properties and behavior of the megathrust in a section of the Alaska subduction zone that appears to exhibit variations in seismic coupling and earthquake history. In Summer 2011 we acquired reflection and refraction data aboard the R/V Marcus Langseth. This project is supporting parts of two PhD theses (Li, LDEO and Kuehn, Dalhousie) and one undergraduate thesis (Wessbecher, B.S., 2012). We also took five undergraduate students to sea as a part of a course taught at Columbia, 'Seagoing experience in Earth Science'. We have presented initial results at international meetings (Nedimović et al., 2011; Shillington et al., 2011, Bécel et al., 2012) and in public outreach presentations at LDEO.

**H.J.A. Van Avendonk:** OCE-040556; $363,314; **D. Lizarralde:** OCE-0405608; $408,185; /15/04-11/15/08; **Collaborative Research: Seismic measurements of magma flux, arc composition, and lower-plate serpentinization in the Central American Subduction Factory.** The goal of this project was to characterize the Central American arc crustal structure and the subducting Cocos Plate to understand the fluid and mass fluxes, and petrogenesis. In 2005 we gathered land seismic refraction data along two transects in Costa Rica, and in 2008 we gathered marine seismic reflection and refraction data with the R/V Marcus Langseth. This project supported a M.Sc. student at UT (Sood, 2007), and two published papers [Van Avendonk et al., 2011; Van Avendonk et al., 2010].
References


REFERENCE


D-3


Siegel, J., B. Dugan, D. Lizarralde, M. Person, N. Miller, and W. DeFoor (2011), Geophysical evidence and implications of an Early Pleistocene glaciation offshore Massachusetts, USA, GSA annual meeting, Minneapolis, MN.


Swanson, M. T. (1986), Preexisting fault control for Mesozoic basin formation in eastern North America, Geology, 14, 419-422.


REFERENCES


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(a) Professional preparation
Undergraduate: Utrecht University, The Netherlands Geophysics B.Sc. 1993
Graduate: University of California, San Diego Earth Sciences Ph.D. 1998

(b) Appointments
2008-current Research Scientist, University of Texas at Austin, Institute for Geophysics
2002-2008 Research Associate, University of Texas at Austin, Institute for Geophysics

(c) Publications
(1) Five most relevant publications

(2) Five other publications

(d) Synergistic activities
2011/2012 NSF GeoPRISMS Distinguished Lecturer
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2010/11 Co-convener NSF GeoPRISMS SCD workshop (Jan. 2011, Austin TX)
(e) Collaborators & Other Affiliations

(1) Non-UT collaborators:
L. Brown, Cornell University; Jeffrey Freymueller, Univ. Alaska at Fairbanks, W.S. Holbrook, Univ. Wyoming; P. Kelemen, Columbia University; D. Lizarralde, Woods Hole Oceanographic Institution; K. Louden, Dalhousie University, Halifax; D. Okaya, Univ. Southern California; J. Orcutt, SIO; G. Pavlis, University of Indiana; T. Pavlis, Univ. Texas El Paso; D. Shillington, Columbia University; B. Tucholke, Woods Hole Oceanographic Institution; F. Wu, SUNY Binghamton.

(2) Graduate (PhD) advisors: John Orcutt and Alistair Harding (both at Scripps Institution of Oceanography, UCSD).

(3) Postdoctoral sponsor: W. Steven Holbrook (Univ. of Wyoming).

(4) Graduate students: Advised: Sanjay Sood (MSc) 2004-2007, Drew Eddy (PhD) 2010-present, Mark Duncan (MSc) 2011-present. Graduate student committees: Chaoshun Hu (PhD 2008, UT-Austin), Lindsay Worthington (PhD 2010, UT-Austin), W. Ryan Lester (PhD, UT-Austin), Max Garnier (MSc in 2012, Univ. Wyoming), Dan Eakin (PhD, UT-Austin), Ana Svartman (PhD, UT-Austin).


Field experience

1994 (June): A marine tilt/passive seismic experiment at the Juan de Fuca Ridge on board the R/V Wecoma. (Nov.-Dec.): A seismic refraction study of the Australian-Antarctic Discordance Zone on board the R/V Roger Melville

1996 (Mar.-May): An investigation of the Austral Islands using multichannel seismics, bathymetry mapping and dredging, on board the R/V Maurice Ewing

1997 (Sept.-Oct.): A 3-D seismic refraction and reflection experiment on the northern East Pacific Rise (ARAD) on board the R/V Maurice Ewing

2000 (July-Aug.): A seismic refraction and reflection study of the Newfoundland basin (SCREECH) on board the R/V Maurice Ewing. (Sept.-Oct.): A 3-D seismic reflection study at the Blake Ridge on board the R/V Maurice Ewing

2001 (May-June): Recovery of 16 broadband instruments in northwest Wyoming

2004 (June-July): Fieldwork in preparation of explosion seismic refraction study in Costa Rica


2006 (July-Aug.): Co-chief scientist during marine geophysical survey of the Chukchi Borderlands and Mendeleev Ridge on board USCGC Healy


2009 (May-June): Ocean-bottom seismometer deployment and recovery for TAIGER study of the geodynamics of arc-continent collision in Taiwan.

2010 (Sept.-Dec.): Chief scientist, OBS seismic refraction study in the Gulf of Mexico on board the R/V Iron Cat.
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Undergraduate: Texas A&M University, Geophysics, B.S. 1988  
Graduate: Massachusetts Institute of Technology/Woods Hole Oceanographic Institution, Geophysics, Ph.D. 1994

Postdoctoral: University of Texas Institute for Geophysics, Marine Seismology, 1/94 – 8/95

(b) Appointments
Senior Research Scientist, University of Texas Institute for Geophysics (9/10 – present)  
Research Scientist, University of Texas Institute for Geophysics (9/01 – 8/10)  
Research Associate, University of Texas Institute for Geophysics (9/95 – 8/01)

(c) Publications
(i) Most Relevant Publications:


(ii) Other Significant Publications:


**(d) Synergistic Activities (recent)**
Journal of Geophysical Research – Solid Earth, Associate Editor, 2009 – present
U.S. Advisory Committee for Scientific Ocean Drilling (USAC), Oct 2011 - present
Ocean Bottom Seismometer Instrument Pool (OBSIP) Oversight Committee, 2006-2012
Consortium for Ocean Leadership 2010 Distinguished Lecturer
IRIS Internship Selection Committee, 2009-2010

**(c) Collaborators & Other Affiliations**
Collaborators (non-UT, last 48 months):
  - Penny Barton, University of Cambridge
  - Richard Grieve, University of Western Ontario
  - Jeff Karson, University of Syracuse
  - Paul Mann, University of Houston
  - Joanna Morgan, Imperial College
  - Gary Pavlis, Indiana University
  - Terry Pavlis, University of Texas, El Paso
  - Jaime Urrutia, UNAM
  - Mike Warner, Imperial College

Graduate Advisor: G. Michael Purdy, Lamont-Doherty Earth Observatory
Postdoctoral Sponsor: Jan Garmany, independent consultant
Thesis Committees:
  - Trevor Aitken, Masters Degree, UT, Spring 2005 (co-supervisor)
  - David Gorney, Masters Degree, UT, Spring 2005 (Committee Member)
  - Matthew McDonald, Masters Degree, UT, Fall 2006 (Committee Member)
  - Margaret Kroehler, Masters Degree, UT, Fall 2007 (co-supervisor)
  - Robert Reece, PhD, UT, current (Committee Member)
  - Yi Tao, PhD, UT, current (Committee Member)
  - Drew Eddy, PhD, UT, current (Committee Member)
  - Mark Duncan, Masters Degree, UT, current (co-supervisor)

**Field Experience:**
I was chief scientist or co-chief scientist on 5 recent cruises: a 2003 R/V *Maurice Ewing* cruise to acquire seismic data in the Hess Deep region, a 2004 R/V *Seward Johnson II* 2-ship cruise with the R/V *Maurice Ewing* to acquire seismic data in the SE Caribbean, a 2004 R/V *Maurice Ewing* cruise to acquire seismic data near the Blanco Fracture Zone, a 2008 R/V *Marcus Langseth* cruise to acquire seismic data offshore Alaska, and a 2010 R/V *Iron Cat* cruise to acquire regional wide-angle profiles in the Gulf of Mexico.
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Professional Preparation:

2000  B.S. (*summa cum laude*) Geology, Rensselaer Polytechnic Institute (RPI), Troy, NY
2006  Ph.D. Geophysics, Massachusetts Institute of Technology (MIT), Cambridge, MA
2006-2008  Postdoctoral associate/fellow, Department of Terrestrial Magnetism (DTM), Carnegie Institution of Washington, Washington, DC

Appointments:

2009-  Assistant Professor, Department of Geology and Geophysics, Yale University
2009-  Visiting Investigator, DTM, Carnegie Institution of Washington

Publications:

(*denotes graduate advisee; **denotes undergraduate advisee)

Most relevant to the current proposal


Additional recent publications


Synergistic Activities:

MG&G), Czech Science Foundation, National Environment Research Council (UK), National Research Council (Romania), Netherlands Organization for Scientific Research, French National Research Agency; Panelist, National Science Foundation, EAR-Geophysics, 2010.

- Member, IRIS EarthScope USArray Advisory Committee and EarthScope Electromagnetic Working Group, (2009-present); IRIS Board of Directors Nominating Committee (2010); IRIS summer internship selection committee (2012).
- Education and outreach: public lecturer on the March 2011 Tohoku, Japan earthquake and tsunami, Yale; volunteer, Yale Girls’ Science Investigation session on “The Geophysical World”; several invited talks at elementary schools, Girl Scout troops, Yale Peabody Museum, and Institute for Science Instruction and Study, Southern CT State University; school science fair judge, Rindge & Latin High School and New Haven Public Schools.

**Current and Recent Collaborators:**
Geoff Abers (Lamont), Susan Beck (Arizona), Thorsten Becker (USC), Margaret Benoit (TCNJ), Richard Carlson (Carnegie), Martin Chapman (Virginia Tech), Kelsey Druken (Carnegie), Karen Fischer (Brown), Matthew Fouch (Carnegie), Haiying Gao (URI), Timothy Grove (MIT), Eugene Humphreys (Oregon), Christopher Kincaid (URI), Eric Kirby (Penn State), Scott King (Virginia Tech), Sergei Lebedev (Dublin Institute for Advanced Studies), Einat Lev (Lamont), Laurent Montesi (Maryland), Nicholas Schmerr (NASA), Christy Till (USGS), Lara Wagner (UNC), Doug Wiens (Washington U).

**Graduate and Postdoctoral Advisors:**
Rob van der Hilst (MIT) – Ph.D. advisor
David James (DTM, Carnegie) – Postdoctoral co-advisor
Paul Silver (DTM, Carnegie) – Postdoctoral co-advisor (deceased)

**Student and Postdoctoral Supervision:**

- **Postdoctoral:** Dr. Xiaobo He (2010-), Yale

**Field Experience:**

- 2010- Co-PI, Peru Lithosphere and Slab Experiment (PULSE) deployment, Peru
- 2009-2010 Co-PI, Test Experiment for Eastern North America (TEENA) deployment, eastern USA
- 2007-2009 High Lava Plains broadband seismology deployment, Oregon/Idaho, USA
- 2001 Groundwater survey (resistivity, induced polarization, seismics), Curacao
- 2001 Geophysical and geochemical survey of Harrison’s Cave, Barbados
- 2000 GPS survey, Oregon/Washington, USA
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Professional Preparation
University of Minnesota  Geological Engineering  B.GeoE., 1997
The Pennsylvania State University  Geosciences  Ph.D., 2003
US Geological Survey  Coastal & Marine Geology  Post-Doc, 4/03-12/04

Appointments
2005-present  Assistant Professor of Earth Science, Rice University
2004-2005  Adjunct Assistant Professor of Earth Science, Rice University
2003-2004  USGS Mendenhall Post-Doctoral Fellow, USGS-Woods Hole

Publications: Most Related [*student co-author]


Publications: Other Significant [*student co-author]


*Hustoft, S., Dugan, B., Mienert, J., 2009, Effects of rapid sedimentation on developing the Nyegga pockmark-field; Constraints from hydrological modeling and 3-D seismic

**Synergistic Activities**
(1) Consortium for Ocean Leadership Distinguished Lecturer (2012-2013)
(2) Member of IODP Environmental Protection and Safety Panel (2010-present) and IODP Scientific Technology Panel (2007-2010)
(3) Geoﬂuids Editorial Board Member (2007-present)

**Recent Collaborators**
Nathan L. Bangs (University of Texas Institute for Geophysics)
Gaurav Bhatnagar (Shell)
Gerald Dickens (Rice University)
Rob L. Evans (Woods Hole Oceanographic Institution)
Peter B. Flemings (University of Texas at Austin)
John T. Germaine (Massachusetts Institute of Technology)
George Hirasaki (Rice University)
William C. Hockaday (Baylor University)
Daniel Lizarralde (Woods Hole Oceanographic Institution)
Mark Person (New Mexico Tech)
Carolyn Ruppel (US Geological Survey)
Carlos Santamarina (Georgia Institute of Technology)
Derek E. Sawyer (ExxonMobil)
Julia Schneider Reece (University of Texas at Austin)
Thomas C. Sheahan (Northeastern University)
Kyle M. Straub (University of Minnesota)
William Waite (US Geological Survey)

**Graduate Thesis Advisor**
Peter B. Flemings (The Pennsylvania State University)

**Post-Doctoral Advisor**
Deborah Hutchinson (US Geological Survey)

**Graduate Students**
Hugh Daigle (Ph.D., 2011)
L. Ashley Hubbard (M.S., 2008)
Zuolin Liu (Ph.D., expected 2015)
Walter O’Hayer (M.S., 2009)
Jacob E. Siegel (Ph.D. candidate)
Justin Stigall (M.S., 2010)
Xin Zhao (Ph.D., expected 2015)
BIOGRAPHICAL SKETCH: MAGNANI M. BEATRICE

Center for Earthquake Research and Information (CERI)
University of Memphis
Memphis, TN 38152-6509
Tel: (901) 678-4830
Fax: (901) 678-4734
mmagnani@memphis.edu

EDUCATION
2000  Universita’ degli Studi di Perugia, Perugia, Italy, Ph.D. Earth Sciences.
1994  Universita’ degli Studi di Perugia, Perugia, Italy, MS Geology.

PROFESSIONAL POSITIONS
Research Associate Professor, University of Memphis, 2010 - present
Research Assistant Professor, University of Memphis, 2006-2010.
Research Associate, Rice University 2005-2006.
Post-Doctoral Fellow, Rice University, 2000-2005.

FIVE PUBLICATIONS FROM THE LAST 5 YEARS
(relevant to this proposal)
South American plate boundary at 65W: results from wide-angle seismic data, J.
Magnani, M. B., C. A. Zelt, A. Levander, and M. Schmitz, 2009, Crustal Structure of the
South America-Caribbean Plate Boundary at 67°W from controlled-source seismic
Clark S. A., A. Levander, M. B. Magnani, C. A. Zelt, 2008, Negligible convergence and
lithospheric tearing along the Caribbean–South American plate boundary at 64°W,
Clark, S. A., C. A. Zelt, M. B. Magnani, and A. Levander, 2008, Characterizing the
Caribbean-South American plate boundary at 64°W using wide-angle seismic data, J.
Clark, S. A., M. Sobiesiak, C. A. Zelt, M. B. Magnani, M. S. Miller, M. J. Bezada, and A.
Levander, 2008, Identification and tectonic implications of a tear in the South
American plate at the southern end of the Lesser Antilles, Geochem. Geophys.

OTHER SIGNIFICANT PUBLICATIONS
boundary: a long-lived assembly structure in the lithosphere of southwestern North
Levander A., Zelt C.A. and Magnani M.B., 2005, Crust and upper mantle velocity
structure of the Southern Rocky Mountains from the Jemez Lineament to the
Cheyenne belt, in The Rocky Mountain Region – An Evolving Lithosphere: Tectonics,
Geochemistry and Geophysics: American Geophysical Union Geophysical
Monograph 154, 293-308.

SYNERGISTIC ACTIVITIES
2011 IRIS/SSA Distinguished Lecturer
Member of the IRIS-PASSCAL Standing Committee (2008-2011)
Member of the AGU Tectonophysics Program Committee (2011-present)
Co-Chair of 2011 SSA National Meeting Program Committee
IRIS Undergraduate Internship student mentor/advisor (2010, 2011)

COLLABORATORS WITHIN PAST 48 MONTHS
Heather DeShon (SMU), Samantha Hansen (University of Alabama), Steve Harder (UTEP), Charles Langston (CERI, Univ. of Memphis), Kirk McIntosh (Univ. Texas, Institute of Geophysics),), Kate Miller (TAMU), Buddy Schweig (US Geological Survey), William Stephenson (US Geological Survey), Suzan van der Lee (Northwestern University), Brian Waldron (Univ. of Memphis), Robert Williams (US Geological Survey), Lindsay Worthington (UNM).

GRADUATE AND POST-GRADUATE ADVISORS
Graduate advisor(s): G.P. Pialli (Universita’ degli Studi di Perugia, Italy) (deceased),
Larry Brown (Cornell University);
Post-doc advisor: A. Levander (Rice Univ.)

GRADUATE STUDENTS

FIELDWORK LEADERSHIP EXPERIENCE
Chief PI – High resolution P-wave seismic reflection data acquisition, Marion, AR. September, 2010.
Chief PI - High resolution P-wave seismic reflection data acquisition, Memphis, TN. April 2006, July 2006.
Post-Doc - High resolution P- and S-wave seismic reflection and GPR data acquisition, Ogden, Utah, USA. September 2005.
Post-Doc - High resolution 3D seismic reflection and refraction data acquisition, Ogden, Utah, USA. July-August 2000.
MATTHEW J. HORNBACH  
Southern Methodist University  
Huffington Department of Earth Sciences  
PO Box 750395, Dallas, Texas, 75275-0395  
Phone: 512-636-5030  
Email: mhornbach@smu.edu

EDUCATION
A.B. Hamilton College, 1998, Physics
Ph.D. University of Wyoming, January, 2005, Geophysics

GRADUATE ADVISOR: Steve Holbrook
POSTDOCTORAL ADVISOR: Harm Van Avendonk

PROFESSIONAL POSITIONS
- 2011-Present  Associate Professor, Dept. of Earth Sciences, SMU, Dallas, TX
- 2011-Present  Adjunct Research Fellow, Institute for Geophysics, University of Texas, Austin
- 2006-2011  Research Associate, Institute for Geophysics, University of Texas, Austin
- 2009-2011  Lecturer, Jackson School of Geosciences, University of Texas, Austin
- 2005-2006  Post-Doctoral Fellow, Institute for Geophysics, University of Texas, Austin
- 2003  Geophysics Intern, Conoco, Midland, TX
- 1999-2004  Graduate Research Assistant, Department of Geology and Geophysics, The University of Wyoming, Laramie, Wyoming

PREVIOUS RESEARCH EXPERIENCE
- BEG Subcontract for 3D seismic imaging development for DOE funded CO2 sequestration (2011-2012)
- SEG-GWB: Kingston Harbour Geohazard Study (2010-2012)
- NSF-OCE: 3D/4D Hydrate Ridge Seismic Study (2008-2011)
- Dutch Antilles Pension Fund: Slide Hazard Study (2007-2009)
- GX Technology: 2D seismic Industry collaboration (2005)
- NOAA: 2D/3D chirp imaging of methane seeps (2003) R/V Atlantis

FIVE PUBLICATIONS MOST RELEVANT TO THIS PROPOSAL:


FIVE ADDITIONAL PUBLICATIONS:

COMMUNITY SERVICE
Panel Member/Reviewer for the following Programs:
Scientific Steering and Evaluation Panel (SSEP,PEP) for Integrated Ocean Drilling Program (IODP), 2009-Current
National Academy of Science review panel member for the National Resource Council Research Associate Program, 2007-Current
NSF/USDA Microbial Interactions and Processes Proposals
NSF ODP Site Survey Proposals
NSF Margins Proposals
NSF MG&G Proposals

RECENT COLLABORATORS:
N.L. Bangs (UTIG), C. Berndt (GEOMAR), S. Bunz (Tromso), C. Breitkreuz (Freiberg), R. Briggs (USGS), F. Colwell (OSU), P. Flemings (UTIG), C. Frohlich (UTIG), S. Gulick (UTIG), L. Lavier (UTIG), M. Manga (UC-Berkeley), P. Mann (U. Houston), C. McHugh (CUNY-Queens), T. Meckel (BEG), J. Pohlmann (USGS), C. Rupple (USGS), L. Seeber (LDEO), M. Steckler (LDEO), P. Talling (NOCS), D. Valentine (UCSB)

STUDENTS ADVISED:
Ben Phrampus (currently a second year Ph.D. student at SMU)
Morgan Kennedy (currently a 1st year masters student at SMU)
Margaret H. Benoit  
Associate Professor of Physics  
The College of New Jersey  
2000 Pennington Ave  
Ewing, NJ 08628  

CURRICULUM VITAE  
phone: 609-771-2237  
fax: 609-637-5109  
email: benoit@tcnj.edu

Education

The College of New Jersey  
Physics  
B.Sc. 1999

Pennsylvania State University  
Geosciences  
Ph.D. 2005

Massachusetts Institute of Technology  
Seismology  
postdoc 2005-2007

Professional Experience

2012-Present  
Associate Professor of Physics, The College of New Jersey

2007-2012  
Assistant Professor of Physics, The College of New Jersey

2009-Present  
Adjunct Assistant Graduate Professor of Geology, Rutgers University

Relevant Publications


Field Projects

TEENA – Test Experiment for Eastern North America - 2009-2010
TAMSeis - TransAntarctic Mountain Seismic Experiment - Winter 2001, 2002
Ethiopia Kenya Broadband Experiment - Winter 2000
BEAAR – Broadband Experiment Across the Alaska Range - Summer 1998
Synergistic Activities

Member – GeoPRISMS Steering and Oversight Committee, 2012-present
Member – Amphibious Array Steering Committee, 2012-present
Member – MARGINS/GeoPRISMS Education Advisory Committee, 2010-present
Member – IRIS Education and Outreach Program standing committee, 2009-2012
Member – IRIS Early Career Investigators working group, 2011-present

Recent Collaborators (other than above)

Rick Bennett (U. Arizona)
Michael Brudzinski (Miami U. of Ohio)
Michael Carr (Rutgers University)
Cindy Ebinger (U. Rochester)
John Hole (Virginia Tech)
Michael Hubenthal (IRIS)
Eric Kirby (Penn State)
John Taber (IRIS)
Steve Roecker (RPI)
Michael Wysession (Wash. U)

Thesis and Postdoctoral Sponsor

Andrew Nyblade, Penn State
Nafi Toksöz, Earth Resources Laboratory, MIT

Graduate Committees

Alix Nikulin, Rutgers, 2011
STEVEN HARDER
Dept. of Geological Sciences
University of Texas at El Paso
El Paso, Texas 79968-0555
(915) 747-5501 e-mail: harder@utep.edu

Professional Education
  New Mexico State University, B.S., Geological Engineering, 1976; B.S., Surveying, 1996
  University of Wyoming, M.S., Geology, 1985
  University of Texas at El Paso, D.Sc., Geophysics, 1986
  University of Texas at El Paso, Post-Doctoral, Geophysics, 1986-1987

Appointments
  1/12-present  Research Professor at University of Texas at El Paso
  9/96-present  Director of the J.W. Miller Geophysical Laboratory, University of Texas at El Paso.
  6/94-12/11  Research Specialist at the University of Texas at El Paso
  1/88-6/94  Visiting Assistant Professor at Texas A&M University.

Related Papers


Other Papers


Synergistic Activities – Non-PI Experimental Collaborations

Tangshan 3-D imaging project, China, 2010, Technology transfer for large seismic shots, support during shooting, and software transfer and support.
KCRT experiment, Korean Peninsula, 2008, Experimental support and software transfer and support.
Red River Fault experiment, Vietnam, 2008, Technology transfer for large seismic shots, shooting support, experimental support, and software transfer and support.
TICO/CAVA experiment, Costa Rica, 2005, Engineering support for large seismic shots, shooting support, and software transfer and support.
Dead Sea experiment, Jordan, 2004, Technology transfer for large seismic shots, shooting and experimental support.

Collaborators

Megan Anderson, Colorado College; Rick Carlson, Carnegie Institute, Washington; Bob Duncan, Oregon State Univ.; Eric Erslev, Univ. of Wyoming; Matt Fouch, Carnegie Institute, Washington; Tim Grove, MIT; Anita Grunder, Oregon State Univ.; Bill Hart, Miami Univ., Ohio; Steve Holbrook, Univ. of Wyoming; John Hole, Virginia Tech; David James, Carnegie Institute, Washington; Chris Kincaid, Univ. of Rhode Island; Randy Keller, Univ. of Oklahoma; Simon Klemperer, Stanford Univ.; Jim Knapp, Univ. of South Carolina; Dan Lizarralde, WHOI; Peter Maguire, Leicester Univ., UK; Kate Miller, Texas A&M Univ.; Steve Park, Univ. of California, Riverside; Steve Roecker, Rensselaer Polytechnic Institute; Christine Siddoway, Colorado College; Anne Sheehan, Univ. of Colorado; Cathy Snelson, UNLV; George Spence, Univ. of Victoria, BC; Uri ten Brink, USGS Woods Hole; Hans Thybo, Univ. of Copenhagen, Denmark; Harm van Avendonk, Univ. of Texas Austin

Graduate and Post-doctoral Advisors

Scott Smithson, University of Wyoming
G. Randy Keller, University of Oklahoma

Graduate Advisees

Tiffany A. Ohnstad
Said A. Al Zahrani
Steven J. Mauri
Bernnadus S. Sudarmo
Christopher J. Peoples
Susan M. Marshall
Ali Yildizel
Ali A. Zaidi
Michael G. Riehle
BIOGRAPHICAL SKETCH

DANIEL LIZARRALDE
Woods Hole Oceanographic Institution
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Mail Stop 22
Fax: 508 289-2187
Woods Hole, MA  02543
E-mail: danl@whoi.edu

A. PROFESSIONAL PREPARATION
Virginia Polytechnical and State University
Geophysics,  B. Sc.  1985
Texas A&M University
Geophysics,  M. Sc.  1990
MIT/WHOI Joint Program in Oceanography
Geology and Geophysics,  Ph. D.  1997
Danish Lithosphere Center

B. APPOINTMENTS
Woods Hole Oceanographic Institution
Associate Scientist  8/05-present
Georgia Institute of Technology
Assistant Professor  1/99-2/06

C. PUBLICATIONS
(i) 5 most relevant to this proposal
Sutherland, F. H., G. M. Kent, A. J. Harding, P. J. Umhoefer, N. W. Driscoll, D. Lizarralde, J. M.
Fletcher, G. J. Axen, W. S. Holbrook, A. González-Fernández, and P. Lonsdale, Mid-
Miocene to early Pliocene Oblique Extension in the southern Gulf of California, Geosphere,

Lizarralde, D., S.A. Soule, J.S. Seewald, and G. Proskurowski, Carbon release by off-axis
magmatism in a young, sedimented spreading centre, Nature Geosciences, 4,
doi:10.1038/NGEO1006, 2010.

Holbrook, G. M. Kent, P. Paramo, F. Sutherland, and P. J. Umhoefer, Variation in styles of

Lizarralde, D., and W.S. Holbrook, U.S. mid-Atlantic margin structure and early thermal

Lizarralde, D., W. S. Holbrook, and J. Oh, Crustal structure across the Brunswick magnetic
anomaly, offshore Georgia, from coincident ocean-bottom and multichannel seismic data, J.
(i) 5 Other publications


D. Five Synergistic Activities

- MARGINS Distinguished Lecturer 2006/07, 2007/08
- Associate editor, G-Cubed 2006 – 2010
- MG&G Datasystems Advisory Committee 2006 –
- OBSIP Oversight Committee 2001 – 2005

E. Collaborators and Affiliations

- G. Axen (New Mexico Tech)
- B. Dugan (Rice U.)
- J. B. Gaherty (LDEO)
- A. Harding (Scripps)
- G. Hirth (Brown U.)
- D. Hutchinson (USGS Woods Hole)
- P. Kelemen (Columbia/LDEO)
- G. M. Kent (Scripps)
- M. Person (New Mexico Tech)
- D. J. Shillington (LDEO)
- P. Umhoefer (N. Ariz. U)
- H. van Avendonk (UTIG)
- A. Wilson (U. South Carolina)

**Graduate Advisor:** W. Steven Holbrook, WHOI (now at Univ. of Wyoming)

**Postdoctoral Advisor:** Hans Christian Larsen, Danish Lithosphere Center
Biographical Sketch: Donna J. Shillington
Lamont-Doherty Earth Observatory
Columbia University
61 Route 9W, P.O. Box 1000
Palisades, NY 10964
E-mail: djs@ldeo.columbia.edu Tel: +1 845 365 8818

Professional Preparation:
Undergraduate: University of Georgia, Journalism, 1998, A.B.J. Magna Cum Laude with high honors
Undergraduate: University of Georgia, Geology, 1998, B.S., Magna Cum Laude with high honors
Graduate: University of Wyoming, Geophysics, 2004, PhD

Appointments:
Lamont Assistant Research Professor Lamont-Doherty Earth Observatory July 2010 – present
Doherty Associate Research Scientist Lamont-Doherty Earth Observatory Nov. 2007 – June 2010
Lecturer in Geophysics National Oceanography Centre, Southampton Jan. 2007 – Nov. 2007

Five publications most closely related to proposal:

Five other significant publications:
Synergistic Activities:

1. **Outreach presentations**: LDEO Spring Public Lecture Series speaker (Spring 2011); Columbia University Earth Institute ‘State of the Planet’ blog author (http://blogs.ei.columbia.edu/author/donna-shillington/), Distinguished Lecturer – MARGINS-NSF (Fall 2008 - Spring 2010)

2. **Service on national committees**: GeoPRISMS steering committee member (Oct 2010-present), USArray Advisory Committee (Jan 2011-present)

3. **Community workshop leadership**: GeoPRISMS SCD implementation workshop (co-convener, September 2011); GeoPRISMS-Earthscope ENAM mini-workshop (co-convener, May 2011); GeoPRISMS RIE implementation workshop (co-convener, November 2010), R/V Langeth workshop (steering committee, March 2010); MARGINS Planning Meeting (science plan writing committee, Feb. 2010)


5. **AGU Fall Meeting program committee member for Tectonophysics Section** (2009-2010)

Field experience:

- **Jan. 2010, May 2010**: Deployment/recovery of small seismic network for aftershock survey, Malawi
- **July 2008, June 2010**: High-resolution multi-channel seismic study of recent tectono-sedimentary history of Sea of Marmara. Shipboard Scientist, R/V K. Piri Reis
- **Jan. – Feb. 2008**: ROV and microbathymetry study of exposed oceanic lower crust in Hess Deep, JC021 Geophysics Team Leader, RRS James Cook
- **Nov. 2006**: Commercial shallow OBS study of P- and S-wave velocity structure of sediments in North Celtic Sea basin. Shipboard Scientist, M/V Sea Surveyor
- **Feb. – March 2005**: Onshore-offshore wide-angle seismic study of deep structure of the eastern Black Sea. Shipboard Scientist, R/V Iskatel. Also assisted in onshore seismometer deployment
- **July – Sept. 2003**: Drilling expedition to Newfoundland magma-poor rifted margin (ODP Leg 210) Logging Scientist, R/V JOIDES Resolution

**Collaborators and Co-editors (papers or proposals in last 48 months, not including LDEO):**
Mark Behn (WHOI), Milene Cormier (U. Miss); Cindy Ebinger (U. Rochester), Steve Harder (UTEP); Katie Keranen (U. Oklahoma); Dan Lizaralde (WHOI), Mladen Nedimovic (Dalhousie), Andy Nyblade (Penn State), Gwenn Péron-Pinvidic (NGU, Trondheim, Norway), Matthew Pritchard (Cornell), Dale Sawyer (Rice); Chris Scholz (Syracuse Univ, NY), Chris Sorlien (UCSB), Brian Tucholke (WHOI), Harm Van Avendonk (UTIG, Austin, TX)

**Graduate Advisor:** W.S. Holbrook (U. Wyoming)

**Postdoctoral Sponsors:** T.A. Minshull (NOCS), R.A. Edwards (NOCS), N.White (Cambridge)

**Students and Teaching:**

**Previous:** Peter Brown, Research Advisor, MRes., National Oceanography Centre, Southampton, UK, 2007; Phyllis Thangaraj, undergraduate intern, Lamont-Doherty Earth Observatory, summer 2009; Helen Janiszewski, undergraduate intern, Lamont-Doherty Earth Observatory, summer 2010

**Current:** Jiyao Li, PhD committee (fall 2010- present); James Gibson, co-advisor (fall 2012-present)

**Recent Teaching:** “Seagoing experience in earth science” (Columbia University, with Tolstoy); “Marine Seismology” (to scientists from the India Geological Survey, with Carton)
Biographical Sketch: Anne Bécel
Lamont-Doherty Earth Observatory
Columbia University
61 Route 9W, P.O. Box 1000
Palisades, NY 10964
E-mail: annebcl@ldeo.columbia.edu  Tel: +1 (845) 365-8648

Professional Preparation:
Undergraduate  B.Sc. in Geophysics, University of Rennes 1, France, with honors  2001
Graduate  Institut de Physique du Globe de Paris” (IPGP), PhD  2006
  Scholarship from the French Ministry of National Education
Postdoctoral  Institute of Earth Science ‘Jaume Almera’-CSIC, Barcelona, Spain  2007-
  Institut de Physique du Globe de Paris” (IPGP)  2010

Appointments:
Associate Research Scientist  Lamont Doherty Earth Observatory  Sept 2011- present
Post-doctoral position  Institut de Physique du Globe de Paris (IPGP)  June 2009-Aug 2010

Five publications most closely related to proposal:
M. Laigle, A. Bécel, H. Kopp, A. Hirn, J.-F. Lebrun, and D. Klaeschen, Along-arc segmentation and interaction of subducting ridges with the Lesser Antilles Subduction forearc crust revealed by MCS imaging. Tectonophysics. (Special Issue), accepted.

Five other significant publications:
A.Bécel, J. Diaz, M. Laigle, A. Hirn, and the “Thales Was Right” working group, Subduction zone seismic signals: A case study of the conditions of observation on a submerged fore-arc with Ocean-Bottom Seismometers in the Lesser Antilles, Tectonophysics. (Special Issue), accepted.
Hergert, T., Heidbach, O., Bécel, A. and M. Laigle (2011) Geomechanical model of the Marmara Sea region: Quantifying the 3D contemporary kinematics, Geophys. J. Int., 185 (2), 1-17,

E-3

1249814
doi:10.1111/j.1365-246X.2011.04991.x

M. Evain; A. Galve; P. Charvis; M. Laigle; H. Kopp; A. Bécel; W. Weinzierl; A. Hirn; E. R Flueh; J. Gallart; the Lesser Antilles Thales scientific party, Structure of the Lesser Antilles subduction forearc and backstop from 3D seismic refraction tomography, *Tectonophys.* (Special Issue), in Press, doi:10.1016/j.tecto.2011.09.021


Synergistic Activities:

**Community workshop participation:** Geological Society of America Penrose conference. Deformation, Fluid Flow, and Mass Transfer in the Forearc of Convergent Margins, Italy March, 2012 (presenter); IODP Marmara Trans Workshop, Istanbul, Turkey, June 2011 (invited); work presented at Orfeus Workshop in Lisbon (Portugal), May 2011; NERIES-ESONET OBS-Marine Seismology workshop at IPG Paris, France, February 2010:

**Seminars:** LDEO - SGT/MMG seminar; February 2012; Seminar at Dalhousie University; February 2012, invited by Malden Nedimovic; Collège de France-CEREGE seminar, June 2010 invited by Pierre Henry; GeoAzur seminar, January 2009, invited by Philippe Charvis

**Field experience**

**Alaska**
June to Aug. 2011
ALEUT survey

**Greece**
April and Sept. 2009
“ULYSSE” survey, part of the « THALES WAS RIGHT » European project.

**Fiji-Tonga**
Jan. 2008
OBS recovery and deployment on board of the R/V Aegaeo

**Lesser Antilles Arc**
Jan. to Feb. 2007
Two-month marine multi method-seismic experiment: acquisition and processing of seismic data on board of R/V Maria S. Merian and N/O Atalante. SISMANTILLES II survey in the frame of Thales was right EU project

One week of land seismometers deployment on the Guadeloupe Island.

**Greece**
July 2006
Deployment of land seismometers on the Peloponnese Peninsula.

**Chili**
Jan. to Feb. 2005
Participation in a 5 weeks marine crustal-scale refraction seismic experiment, TIPTEQ « From the Incoming Plate to mega Thrust Earthquakes » on board of R/V Sonne, Ifm-GEOMAR, Kiel, Germany.

**Collaborators and Co-editors (papers or proposals in last 48 months, not including LDEO):** Philippe Charvis (GeoAzur, France), Jordi Diaz (CSIC-ICTJA-Barcelona, Spain), Ernst Flueh (Ifm-Geomar, Germany), Josep Gallart (CSIC-ICTJA-Barcelona, Spain), Oliver Heidbach (GFZ, Postdam), Pierre Henry (College de France, Aix-en-Provence, France), Alfred Hirn (IPGP, France), Heidrun Kopp (Ifm-Geomar, Germany), Mireille Laigle (GeoAzur, France), Jean-Paul Montagner (IPGP, France), Mladen Nedimovic (Dalhousie Univ, Halifax, Canada).

**Graduate Advisor:** Alfred Hirn and Mireille Laigle (IPG Paris, France)

**Postdoctoral Sponsors:** Josep Gallart and Jordi Diaz (ICTJA-CSIC, Barcelona, Spain), Alfred Hirn (IPGP, France)

**Students and Teaching:**

Teaching:
2005-2006: Seismic imaging with the Seismic Unix software to Master students and training period in applied geophysics to Master students (IPGP)

2004: Multichannel Seismic Reflection data processing with the Seismic Unix software to Master students (IPGP)
JAMES B. GAHERTY

Lamont Research Professor
Lamont-Doherty Earth Observatory
61 Rt. 9W
Palisades, NY 10964
ph. (845) 365-8450
fax. (845) 365-8150
e-mail: Gaherty@ldeo.columbia.edu

A. PROFESSIONAL PREPARATION

Brown University
Sc.B., Geology-Physics/Math 1986

University of Michigan
M.S., Geology 1990

Massachusetts Institute of Technology
Ph.D., Geophysics 1995

Massachusetts Institute of Technology
Post Doctoral Associate, Geophysics 6/95-12/97

Co-chief or Chief Scientist, 6 OBS Deployment and/or Recovery Cruises 2001-2011

B. APPOINTMENTS

Lamont-Doherty Earth Observatory of Columbia University
Lamont Research Professor 3/12-present

Lamont-Doherty Earth Observatory of Columbia University
Lamont Associate Research Professor 7/10-2/12

Lamont-Doherty Earth Observatory of Columbia University
Doherty Research Scientist 7/06-6/09

Lamont-Doherty Earth Observatory of Columbia University
Doherty Associate Research Scientist 9/03-6/06

Georgia Institute of Technology
Assistant Professor 1/98-8/03

C. PUBLICATIONS

(i) 5 most relevant to this proposal


(ii) 5 other publications


**D. SYNERGISTIC ACTIVITIES**

Associate Editor, *G-cubed* 5/03-present

Incorporated Research Institutions in Seismology:
- Vice-Chair, Board of Directors 1/09-12/11
- Board of Directors 1/07-1/09
- Standing Committee, Global Seismic Network 1/01-1/04

**E. COLLABORATORS AND OTHER AFFILIATIONS**

(i) Collaborators (non-LDEO)
- S. Baldwin (Syracuse)
- J. Collins (WHOI)
- C. Dalton (Boston U.)
- C. Ebinger (Rochester)
- R. Evans (WHOI)
- P. Fitzgerald (Syracuse)
- B. Hacker (UCSB)
- G. Hirth (Brown)
- D. Lizarralde (WHOI)
- P. Mann (Texas)
- M. Roy (UNM)
- C. Scholz (Syracuse)
- E. Garnero (Arizona State)

(ii) Graduate and Post-Doctoral Advisors
- Ph.D. and Post-Doc: Thomas H. Jordan
- M.S.: Thorne Lay

(iii) Student Advisees
- Post-Doc: C. Dalton, P. Chen, C. Wilson
- Graduate: Claire Bendarsky, Zach Eilon, Anna Foster, Charles George, Prasoon Gupta, Ge Jin, Sangmyung Kim, Raj Moulik, Kori Newman, Yongcheol Park, Ashley Shuler, Danielle Sumy, Steve Veitch
- Undergraduate: Nina Carriero, Jessica Demoise, Alex Hutko, Katie Kirsch, Amanda Markee, Steve Scharf