School of Rock 2017

Diversifying the Next Generation Geoscience Mentor Community Through Training Aboard the *JOIDES/Resolution*

July 10-27, 2017

Initial Science Report

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Abstract

This year's School of Work was designed as a hybrid science/education workshop aimed at increasing the diversity of the geoscience mentor pool through training that also serves to position young scientists of diverse backgrounds to serve as sea-going scientists or co-Chief Scientists participating in IODP research. It also aimed to bolster the pipeline and build effective local networks through the pairing of high school teachers with these early career scientists. The workshop thus promoted synergy by increasing the diversity of (1) scientists who are positioned to contribute both to IODP science and geoscience more broadly, and (2) mentors who research shows stand a better chance of positively influencing the educational and/or career pathways of undergraduate students of color (Kendricks, et al., 2013; Summers and Hrabowski, 2006). Over time, direct scientific benefit will result, increasing diversity among the pool of young scientists who are broadly engaged in IODP science, allowing measurable impact on the trajectory of undergraduates in STEM fields through programs such as STEM Student Experiences Aboard Ships (STEMSEAS; Chang et al., 2014). This is a high priority for the NSF, UNOLS and other federally-funded programs.

Introduction

School of Rock 2017 was held July 10 - 27, 2017 during a 17-day transit on the JR from Subic Bay, Philippines to Townsville, Australia. The overarching goals of SOR 2017 were to:

- encourage early career scientists and secondary-level educators from communities that remain poorly represented in STEM fields, and particularly geosciences, to participate.
- showcase and educate about *JR*/IODP capabilities.
- increase the diversity of the talent pool that will apply to sail on IODP and related expeditions in the future.
- build a diverse mentoring pool for undergraduate STEM/geoscience students.
- create local partnerships to bolster the STEM/geoscience pipeline.

While the accrual of results will become apparent over time, we see School of Rock as a means of contributing toward shifting the demographic of IODP and more broadly geoscientists – a little bit at a time – through short but in-depth training using the charismatic, federally-funded vessel that is at the heart of the IODP. Based on our experiences, the *JR* and UNOLS vessels provide transformative experiences for nearly all trainees who sail on them. Taking advantage of available space during a long transit for the proposed workshop maximizes the use of NSF-funded programs and assets.

During the workshop, participants took part in numerous lectures, laboratory exercises, hands-on activities and discussions on a wide variety of science and education topics (See Appendix 1). Working in teams, they developed action plans to implement their new knowledge and connections in their own local communities (See Appendix 2). Throughout the workshop, participants and instructors worked together to adapt the agenda to the needs of the group and allow space for opportunities as they arose. This report provides an overview of what was studied and accomplished over the course of the transit.

Participants and affiliations
<u>Instructors</u>

Sharon Cooper (LDEO/USSSP IODP), education and outreach, informal science education, professional development. Ms. Cooper is the leader of Education and Outreach for the USSSP/IODP, a PI on the STEMSEAS Project, and is PI for the PopUp/DrillDown Project. She has participated in or helped to lead School of Rock since 2005 and has more than two decades of experience designing and implementing professional development, curriculum and informal science education projects.

Steven Hovan (Indiana University of Pennsylvania), sedimentology, paleoceanography. Dr. Hovan is a paleo-oceanographer and sedimentologist working primarily on climate change as recorded in Atlantic and Pacific sediment cores. He has served as a sedimentologist on five IODP expeditions, as a member of the IODP U.S. Science Advisory Committee (USAC) as a member of the Science Evaluation Panel (SEP), as a SOR instructor three times, and is currently a mentor and instructor for MSIREaCH.

R. Mark Leckie (University of Massachusetts Amherst), micropaleontology, isotope geochemistry, paleoclimatology. Dr. Leckie is a micropaleontologist and paleo-oceanographer working on topics of ocean-climate change spanning the Cretaceous and Cenozoic, including Oceanic Anoxic Events and other abrupt climate change events. He has sailed on one DSDP and five ODP legs, one as Co-Chief Scientist. He co-led the original School of Rock in 2005 and participated in the initial STEMSEAS project.

Jonathan C. Lewis (Indiana University of Pennsylvania), structural geology, active tectonics. Dr. Lewis is a structural geologist working primarily on active tectonic collisions in Taiwan and Costa Rica, and great earthquakes at the SW Japan convergent plate boundary. He sailed on IODP Expedition 315 as a structural geologist, served a 3-year term on the IODP USAC, served as instructor for SOR three times, is a PI on the STEMSEAS project, and is a member of the advisory committee for the PopUp/DrillDown Project.

Lisa White (UC Berkeley Museum of Paleontology [UCMP]), micropaleontology, education and outreach, and diversity mentoring. Dr. White is a veteran of several ODP cruises, has directed field-based geoscience programs for urban youth, and she is active in efforts to increase diversity in STEM. In her current position at the UCMP, Dr. White develops and disseminates learning materials on evolution, the nature and process of science, and global climate change.

Participants/Teams

Rachel Bernard, UT Austin

Colleen Henegan, KIPP Austin Collegiate High School

Thomas Cawthern, Salisbury University

David Hansen, Wicomico County Board of Education - Salisbury Middle School

Chloe Branciforte, Ventura College

Julia Domenech, Buena High School

Stephanie Milam-Edwards, Tempe High School

Marilyn Raming, Tempe Union High School District

Dori Read, Gates Middle School

Diane Thompson, Boston University

Kerrita Mayfield, Holyoke High School

Mark Leckie, University of Mass, Amherst

Kim Hatch, Long Beach City College

Matthew Campbell, University of Queensland

Suzy Urbaniak, Kent Street Senior High School, Perth Australia

Miguel Borges, Federal Institute of Education, Science and Technology of Paraíba, Brazil

Helenice Vital, Universidade Federal do Rio Grande do Norte – UFRN, Brazil

2. Core flow

One of the first concepts covered during School of Rock 2017 was "core flow." This term refers to the handling of core from when it reaches the rig floor after having been drilled, to when the core is preserved for archiving and future measurements. After seeing core flow through videos and in person, it is clear that incredible logistics and technical coordination is required to successfully process sediment cores. First, the core is transported from the rig floor and gently laid out on the catwalk by several scientists and technicians who must carry and support the 9.5-meter-long cylindrical core. Then, the core is cut into smaller sections, with technicians taking great care to label the tops and bottoms of each section, along with all pertinent information (expedition, hole, section, depth, etc.) Each of these core sections are subjected to a variety of analytical measurements. Interstitial water (IW) samples are taken first, then the multi-sensor track (MST) measured resistivity, P-wave velocity, magnetic susceptibility, and gamma rays at a sampling resolution of 1-5 cm resolution. Once the core is cut lengthwise into two identical halves, photos are taken and detailed descriptions made on the archive half; the other half is designated as the "working" half to be subsampled by scientists for additional studies.

Figure 1 - School of Rock participants take notes as they watch the technician explain the MST.

The most memorable aspect of this process – and what many of the educators will bring back to their students – is how many people are involved in this process and how busy they are. The technicians and scientists are involved with core flow on every core retrieved from the seafloor, sometimes with only 20 minutes between cores! These people work hard, and have to be careful in their attention to detail in order for this core to be in any way scientifically useful. It may be difficult to visualize the entire core-flow process, but several resources (particularly movies and infographics) illustrating this process are available from joidesresolution.org and IODP.org websites. These materials are an important introduction to any lesson plan that involves core data, as it shows the nature and teamwork of science, gives students an appreciation for the work involved, and demonstrates actual career possibilities in the geosciences.

3. Seafloor sediments

Marine seafloor sediment is composed of several types of materials, such as terrigenous, biogenic, authigenic, and volcanogenic grains. Two main types of sediments found in the oceans are terrigenous and biogenic, which differ mainly in composition and environment of formation.

Terrigenous sediments are brought from outside the marine environment (allochthonous) mainly by the rivers, glaciers and the wind, and have composition related to its source area. Near the continental source regions, along the margins are found mostly sand and clay particles and sedimentation rates are very fast. The deeper waters of the abyssal plains are often composed of red clays, sometimes mixed with authigenic minerals and biogenic siliceous sediment.

Deposition of biogenic sediments is related to conditions of productivity in surface waters, and preservation in the water column. The biogenic calcareous sediments are composed of plankton shells ($CaCO_3$) and generally accumulate in places with shallow bathymetry (above CCD), main types are nannofossils and foraminifera (Figure 1). Siliceous biogenic sediments are composed of plankton skeletal grains (biogenic SiO_2) and accumulate under areas of high productivity and are generally associated with upwelling conditions. Most common in marine environments are diatoms and radiolarians (Figure 1).

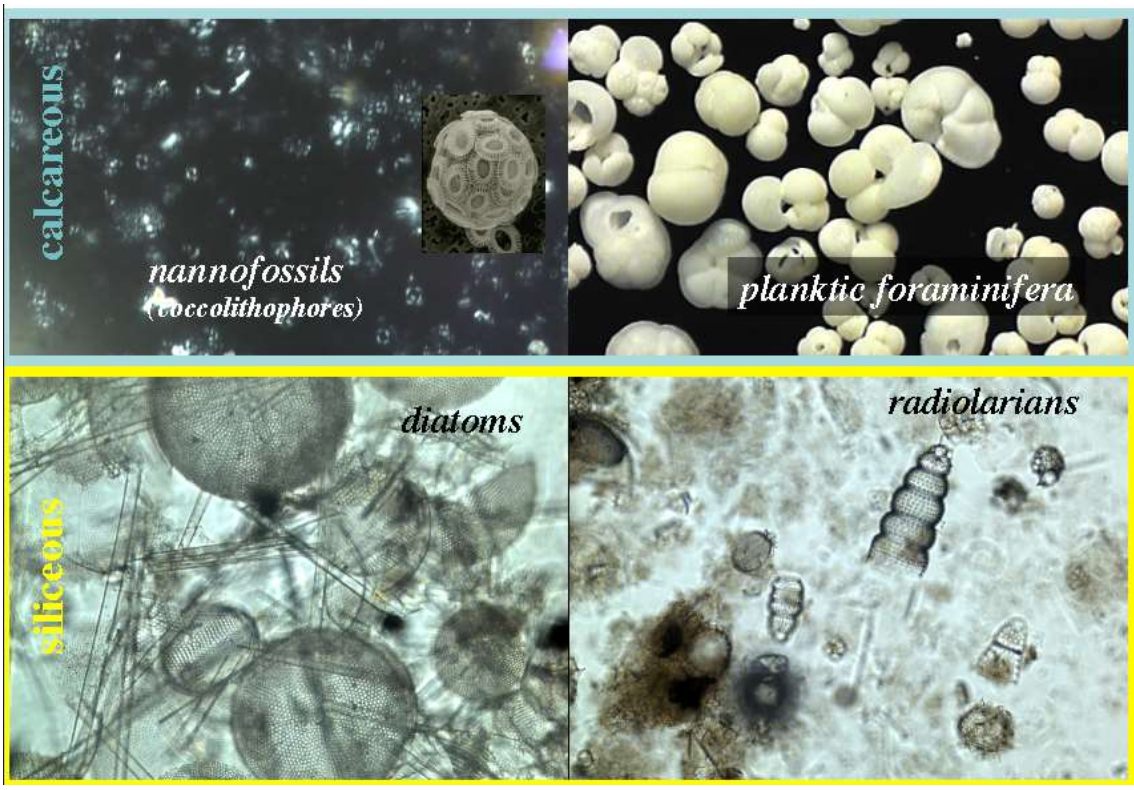

Figure 1: mean types of biogenic sediments in smear slide analysis.

Marine sediment cores are described by general observations of the different lithology. After that, representative samples of each lithology are selected for smear slide analysis. Smear slides are a way to describe the samples in more detail using a microscope (magnification). Following a lithology decision tree, we can classify the type of sediment. Core sections are further described based on color changes, percentage of microfossils, and size of mud and pebbles. In this way, scientists can construct maps illustrating the sedimentation trends on the ocean floor (Figure 2).

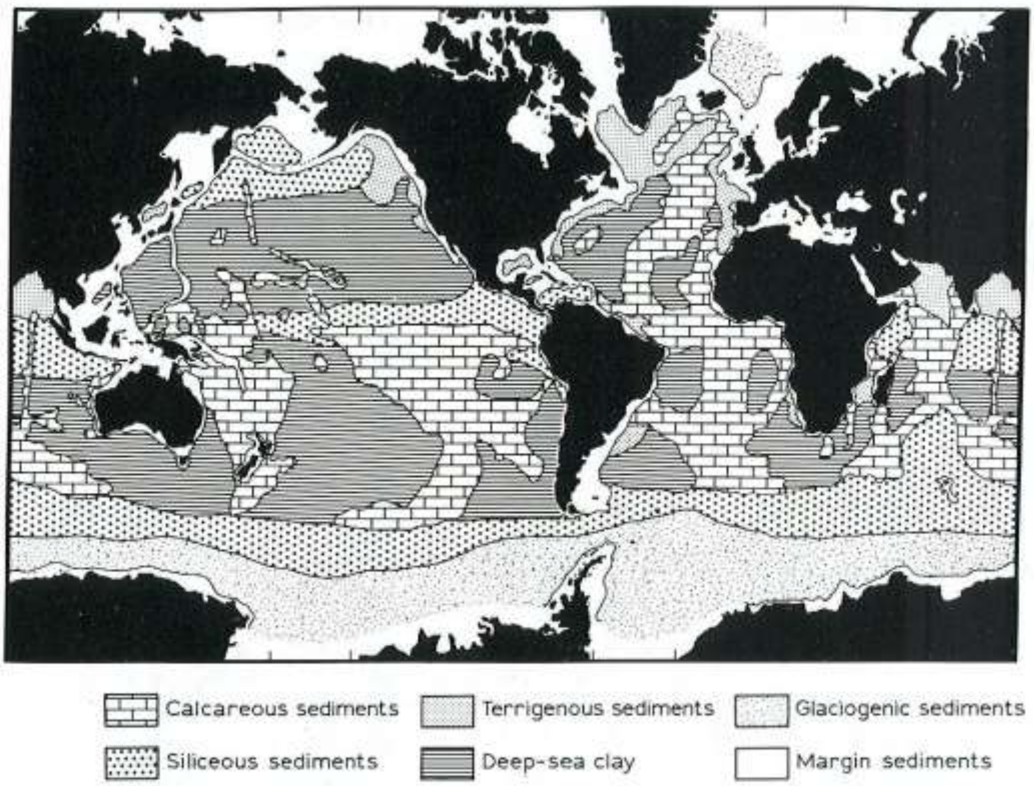

Figure 2: Map illustrating sedimentation trends of the ocean floor around the world.

4. Biostratigraphy

By studying biostratigraphy, we are better able to reconstruct past climate history. Depending on depth and location of sediments, it is possible to find a variety of microfossils, revealing much about the conditions on earth at a given point in time. Geoscientists can determine the age of deep-sea sediment cores and take into account factors that affect distribution, abundance or diversity of species, such as sea level rise and climate change. By considering first occurrence (FO) and last occurrence (LO) as timelines, or datums, and with zonal markers using biostratigraphic data, the evolution of a species is often evident.

Biostratigraphy concerns the study of fossil content (rather than lithology), and through the use of an established chronostratigraphic chart (Geologic Time Scale), geologic records, such as deep sea drill cores, can be calibrated. In addition, rates of geologic processes can be measured. Some species yield more information than others. Fossils with a short geologic range, with widespread dispersal, easily preserved and recognized are some of the most useful species biostratigraphically. Fossil species that span a long range of geological time are not as useful. For example, School of Rock students studied raw core data from the Shatsky Rise in the Northwest Pacific, from Hole 198-1208A. This revealed nannofossil datums from the Pleistocene and late Miocene period. Species such as discoasters were found to be extinct by the late Pliocene period. This authentic published deep-sea data effectively established the biostratigraphy of a cored sequence, and also aided in the calculation of sedimentation rates at specific sites. These data also revealed that it is the evolution and extinction of species that provides the FOs and LOs used by biostratigraphers and other geoscientists.

5. Paleomagnetism

Earth acts like a giant bar magnet (Fig. 5.1). This physical phenomenon is created as a result of the geodynamo set up by the dynamic behavior of the liquid outer core flowing around the solid inner core. Today, Earth's magnetic field exits near the geographic South Pole and enters near the geographic North Pole, though this has not always remained constant through time. Instead, at various times throughout the past, the magnetic poles have flipped polarity between modern (or normal polarity) and reversed polarity. These reversals are identified in the rock and sediment record by looking at the natural remanent magnetism preserved in a sample.

Natural remnant magnetism within sediments and rocks is an extraordinarily insightful and rich dataset measured during scientific ocean drilling expeditions. Paleomagnetic records from seafloor sediments are measured aboard the *JOIDES Resolution* as either continuous measurement half core scans or subsamples of core from discrete intervals. Both half core scans and discrete subsamples of core are commonly analyzed using a cryogenic magnetometer (Fig. 5.2). Further analysis of subsamples may require the use of an alternating field magnetometer, or thermal or spinner demagnetization techniques, which are also available on board the ship.

There are three primary goals for acquiring paleomagnetic records of deep-sea sedimentary and rock samples. First, these records enable scientists to establish the downhole paleomagnetic stratigraphy for each site drilled. This is accomplished by comparing the trends in the duration and variation of the paleomagnetic signature from a core to the Geomagnetic Polarity Timescale (Fig. 5.3). By matching the "wiggles" of normal and reversed polarities in both records, geologists can determine the age of each core section brought to the surface. This is often done in collaboration with the micropaleontologists on board the ship, who provide a relative age of the sediment. The second useful piece of information is revealed from the demagnetization of minerals preserved within each core sample. Because different minerals preserve the Earth's remanent magnetic field at different strengths, it is possible to determine the exact mineralogy present within the core by incrementally demagnetizing the sample. Finally, in addition to recording a polarity, each magnetic mineral preserves a magnetic inclination (dip) that is correlative to its latitude at its time of formation. Consequently, sediments or rock samples preserve a paleolatitude at the time of deposition or crystallization. Mineral inclination is analogous to the angle at which metal filings make with the magnetic field established with the bar magnet in Fig. 5.1. In general, inclination increases with distance away from the equator. Thus, if the core is aligned properly during the coring process, then it is possible to use the inclination of the magnetic minerals within each sample to reconstruct the paleolatitude at the time of formation.

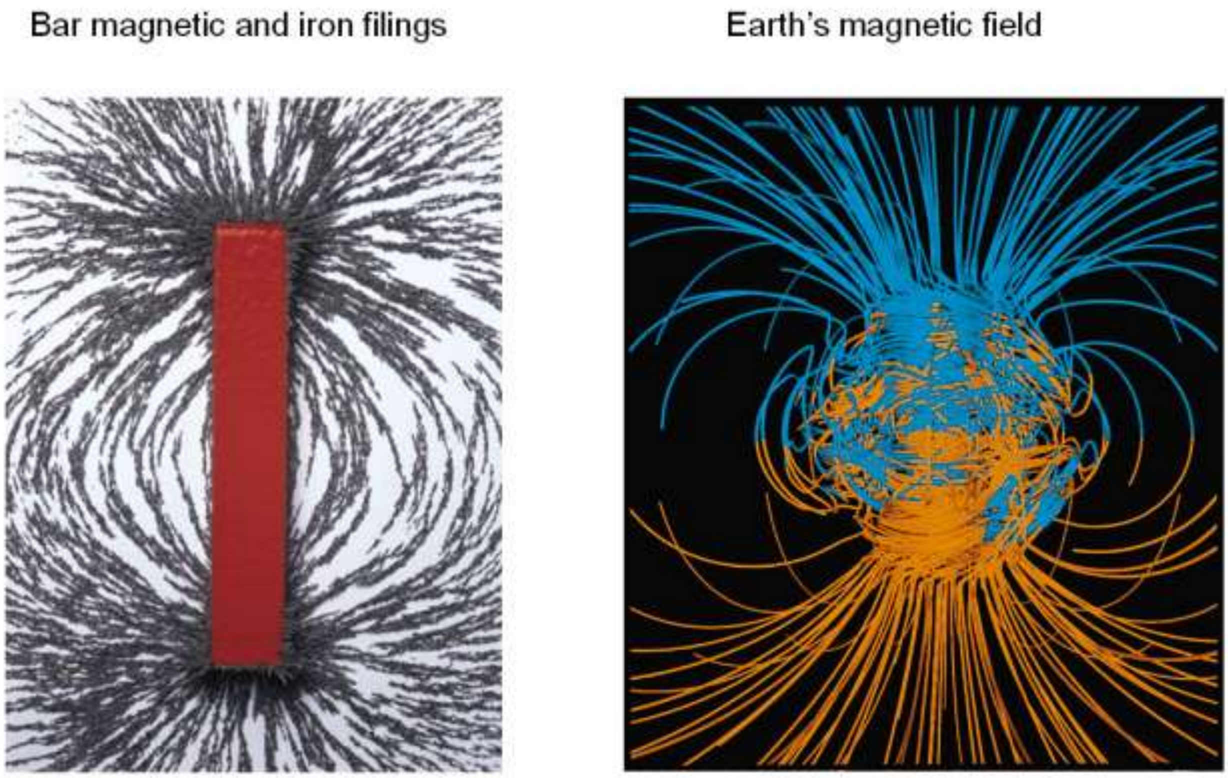

Figure 5.1: Analogue for Earth's magnetic field (left) modeled with a simple bar magnetic and iron filings. The inclination (dip) of the iron filings increases the closer the filings appear to either end of the magnet. Earth's magnetic field (right) behaves similar to the analogue – an imposed magnetic field causes magnetic minerals to align parallel with the magnetic field lines, but also with a declination correlative to the paleolatitude at the time of formation. Minerals will either be of normal or reversed polarity according to the magnetic pole orientation relative to today.
(http://hs.umt.edu/geosciences/faculty/sheriff/courses/439-applied-magnetics/images/bar%20magnetic%20and%20geomagnetic.jpg)

Figure 5.2: Cryogenic magnetometer aboard the *JOIDES Resolution*.
(https://iodp.tamu.edu/labs/ship/photos/pmag.jpg)

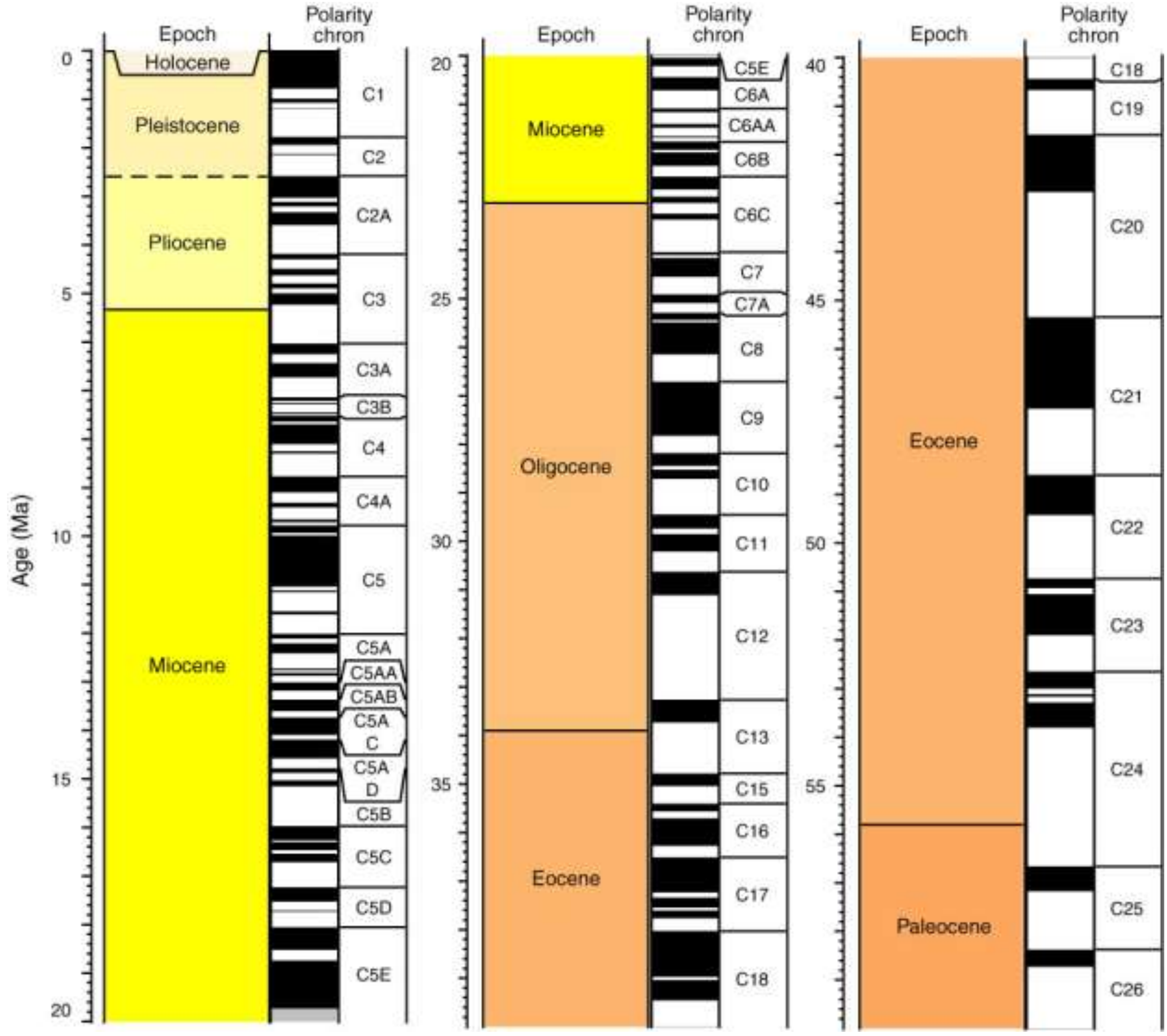

Figure 5.3: Example of the geomagnetic timescale, showing normal (black) and reverse polarity chrons. (http://publications.iodp.org/proceedings/318/102/images/02_F18.jpg)

6. Developing, Strengthening, and Sustaining Pathways to Promote Diversity in the Geosciences

Conversations about diversity were encouraged throughout the School of Rock expedition. In this section and in Table 6.1, we attempt to capture many of the goals and outcomes (or ideas) expressed by the educators when questions were posed about infusing greater equity and inclusion in curriculum, instruction, and in institutions. Because the cross section of SOR educators was so rich in terms of instructional levels taught, we break down by grade level aspirational strategies and methods to strengthen and achieve greater diversity.

This document was developed using the many informal conversations, mini-workshops and guided collaborations that were designed to foster deeper conversations about: the meaning of diversity as a set of practices; the contexts for diversity at our international educational sites; the importance of diversity in the (geo)sciences; and the roles of institutions in fostering (and benefitting from) diverse scientific learning and working communities. The beauty of this very intentional cross-country, cross-institutional, and cross-grade level collaboration is that we were able to both model and examine the meaning of diversity in a way that led to rich conversations. For example, in a jigsaw process, we worked for several hours to process large diversity concepts such as: inclusive leadership, curriculum, mentorship, recruiting, retention and classroom equity. We participated with such depth that several proposal ideas were generated, becoming Letters of Intent for national grant opportunities.

SOR educators felt strongly about the need for diverse perspectives in the geosciences to be interwoven throughout instruction The aim is not only to enrich the lives of all participants with examples relevant to their lives, but also assessment and evaluation of programs should be guided by individuals who look like or share things in common with participants. Attention should be paid to those guiding and those receiving instruction and we should often ask: “Who is in this room and how did they get there?”

To achieve diversity, one should involve community in every step of the process; recognize a community’s needs and, most importantly, diversity committees should be truly diverse and inclusive.

On a slightly different note, participants had an opportunity during the workshop to meet with a doctoral candidate and writer focused on the ways science processes are communicated with a wider audience. After completing a thorough packet prompting us about our writing’s: goals, audience, obstacles, outcomes and character, participants were able to present their works for editorial review and feedback. Wonderful works emerged such as: children’s stories, rich characterizations of Earth processes and accessible language that invited in all kinds of readers. Meaningfully, the structure was such that deeper understandings of the ways diversity as a process was integral to the geosciences, and much more than just a great idea owned by people who are marginalized. Several conference abstracts for upcoming AGU and GSA conferences developed.

Table 6.1

Level of Education	Instructors	Curriculum	Institutions and Structures	Actionable Outcomes
(Primary) **K-8** **(Secondary)** **9-12**	Teachers who look like the changing population. Readiness for NGSS standards in minority serving communities.	Rich field experience. Address geoscience issues. Impact marginal communities. Math, Chemistry, Physics, Geology preparation.	Support geoscience inquiry. Field trip permissions. Experiential informal opportunities. Hands on and project based learning. Experts in classroom. Storytelling and nature of science.	Increase in geoscience literacy. Visualize geoscience processes. Lifelong learners are created. STEAM readiness. Model building (NGSS).
Under-graduate	Intersectional experiences. Depth of tech/career support. Horizontal and vertical mentorship networks	Rich field experience. Inclusion of ALL peoples in geosciences.	Role models & mentoring Higher Ed emphasis on training faculty and funding K-12 and 12-16 networks. Incorporation of industries into instruction	Increase in geoscience literacy. Geoscience visualization. Preparation to participate in pathway courses like physics, math and chem.
Graduate	Supportive professors. Support means willingness to be on learning edge with students.	Acknowledge needs of diverse students. Flexibility and understanding of different learning styles and intelligences.	Industry participation. Graduate students as peers → into profession. Creating opportunities for industry skills practice.	Careers in STEAM. Create STEAM practitioners and curriculum.

Professional & Industry	Instructor preparation for hiring process/needs. Participation in industry conferences. Curriculum alignment.	Curriculum that creates networks and interrelationships of Math, Chemistry, Physics, Geology Readiness for geoscience participation.	Inquiry support. Industry creation. Ability to create work and instruction for K-16 persons. Providing funding for K-16 preparation.	Create STEAM practitioners. Growth in STEAM opportunities. Funding for geoscience research, innovation, and progress.

Table 1. The diversity work for each educational space is owned by stage of student development, their learning style, and the learning environment. It can be read in rows or columns.

7. Tectonics

How have continents shifted throughout time? Take for example the ancient supercontinent Rodinia, to the more recent Pangaea, to the future predicted Amerasia? The cause of this physical movement of continents is attributed to the Earth's lithospheric plates. The crust and uppermost mantle make up a brittle lithosphere that is broken up into various thin plates (Figure 7.1). The seven major plates are the Pacific, North American, South American, African, Eurasian, Indo-Australian, and Antarctic. The smaller plates include the Juan de Fuca, Nazca, Cocos, Caribbean, Fuji, Caroline, and Philippine.

Each of the aforementioned plates undergo movement and either converge, diverge, or transform (Figure 7.2). Subduction zones form at convergent plate boundaries where one plate sinks and subducts underneath the overriding plate. The denser plate is typically the one to do so. Diverging plate boundaries form rift valleys on continents and if these continue to grow, they evolve to become oceanic ridges where new lithosphere is created. Lastly, the transform boundaries are regions where plates are shearing past each other in opposite directions.

Lithospheric plates are solid and brittle and move across the asthenosphere that is a solid but relatively ductile part of the mantle. The majority of the mantle occurs below the asthenosphere, followed by the liquid outer core, and the solid inner core. The decay of elements found within the mantle and the primordial heat inherited from Earth's formation in the core, provide heat energy to produce convection currents within the mantle. This transference of energy is the mechanism that drives movement of the lithospheric plates (Figure 7.3).

How do we know these things? Earthquake body waves tell us quite a bit. Seismologists analyze the velocity of primary and secondary waves in order to determine the interior composition of the planet. Primary waves are able to travel through solids and liquids, and are the fastest seismic waves, while secondary waves are solely able to travel through solids. By analyzing the arrival times of both wave types scientists are able to discern the Earth's layered structure. It is critical to have an understanding of the mechanisms that drive the planet's interior because it invariably shapes the planet's surface structure which we reside in. These forces also control many natural hazards, such as volcanism, tsunamis, and seismicity.

Figures

Figure 7.1

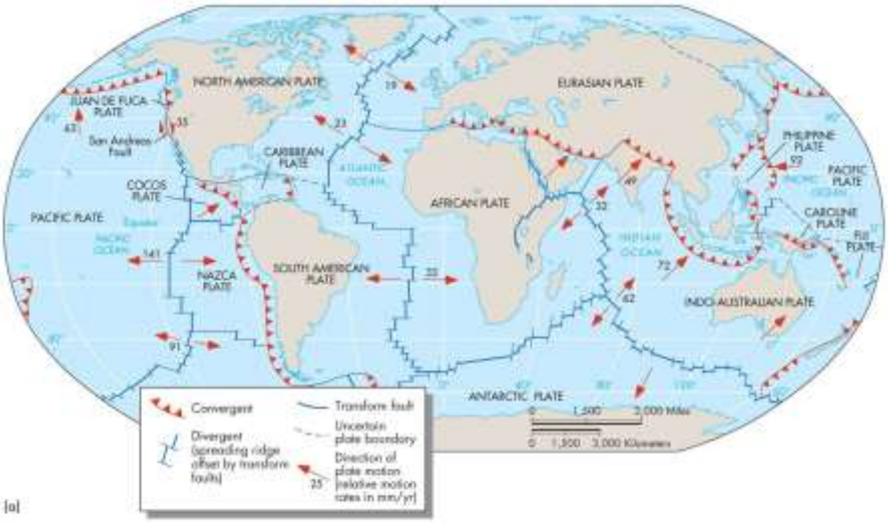

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Figure 7.2

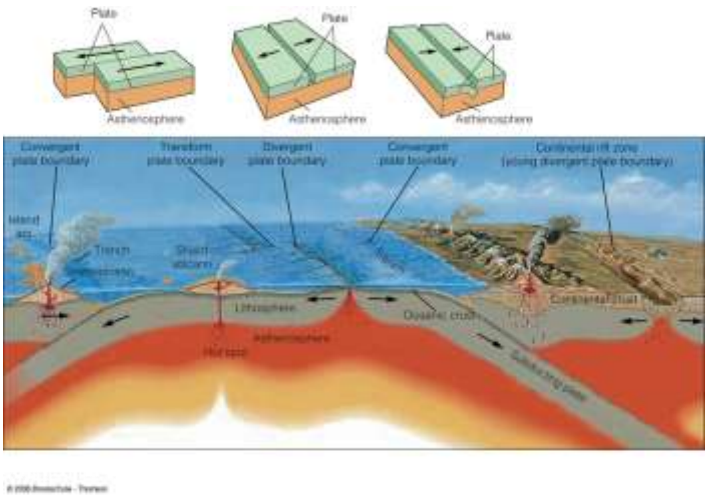
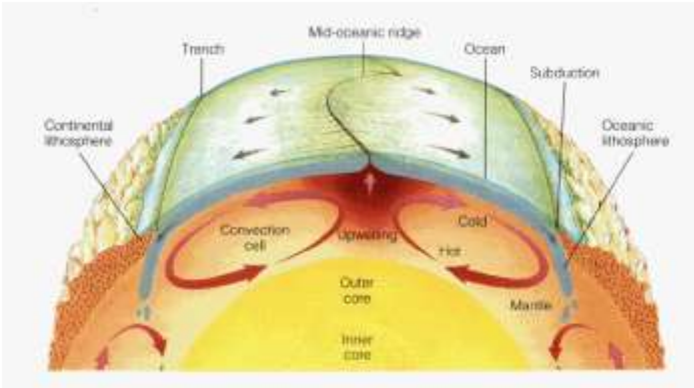


Figure 7.3



Resources

Website: www2.sunysuffolk.edu/hornj/ESC102_PlateTectonicsMapLinks.htm
Oceanexplorer.noaa.gov/facts/plate-boundaries.html
http://serc.carleton.edu/NAGTWorkshops/deepearth/visualizations

Who cares about subduction zones?

When tectonic plates converge, enormous geological forces are unleashed. Such forces result in the formation of earthquakes, active volcanism and mountain building events. One very important tectonic process that results in such forces occurs beneath the ocean, a process known as 'subduction'. Subduction occurs when an oceanic plate converges with a continental plate at convergent plate boundaries, resulting in the oceanic plate being pushed underneath the edge of the continental plate (Figure 7.4). Some examples of subduction zones in the world today include the 'Pacific Ring of Fire', which constitutes a nearly continuous series of oceanic trenches, volcanic arcs and areas of high stress, which can result in earthquakes (Figure 7.5).

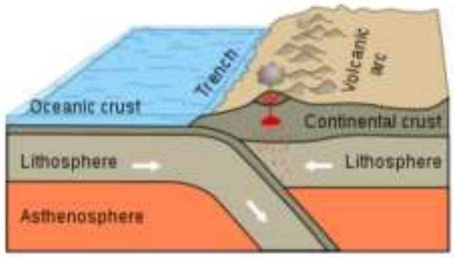


Figure 7.4: Schematic model of a subduction zone at a convergent plate margin.

Understanding the geological activity and processes that occur at subduction zones is enormously beneficial to all mankind. Powerful earthquakes and violent, unpredictable volcanic eruptions cause great destruction and death near convergent boundaries. Underwater earth movements and explosions can trigger enormous sea waves, called tsunamis, which travel across entire oceans to crash upon the distant shores. The ability to monitor and predicted earthquake and volcanic activity along convergent margin zones enriches our understanding of subduction zone, and leads to better methods of predicting and minimizing the dangers they pose. Major economic resources (e.g. gold, silver, copper, lead) are mainly derived from subduction processes that occurred throughout Earth's geological history, thus a better understanding of subduction processes and associated mechanisms today can aid in the discovery of new resources that might exist along these areas.

Figure 7.5: Tectonic plates and subduction zones, highlighting the location of

Thinking in 3D: What is a fault?

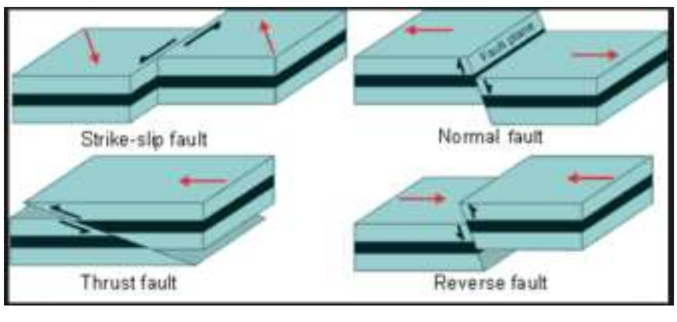
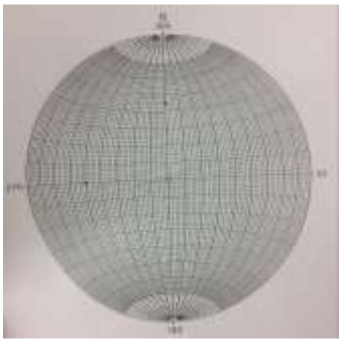


Figure 7.6: The main types of faults.

A *fault* is a break in the rocks that make up the Earth's crust, along which rocks on either side have moved past each other. The formation of faults in the Earth's crust are associated/form with the boundaries between tectonic plates (e.g. convergent margins, divergent margins). The main types of faults include normal faults, reverse faults and strike-slip faults (Figure 7.6). Normal faults are usually associated with extensional forces (tensile forces), resulting in a block of rock moving down relative to the rock on the other side of the fault. Reverse fault form when rocks are pushed together (compression), causing a block of rock to be pushed up relative to the rock on the other side of the fault. The third type of fault is called a transform (strike-slip) fault. The movement along a transform (strike-slip) fault is horizontal, with a block of rock on one side of the fault moving in one direction and the block on the other side of the fault moving in the opposite direction.

During School of Rock, we were able to learn how IODP geoscientists investigate faulting within core samples from the ocean floor. In order to reconstruct the geometry of fault planes from the ocean floor, geoscientists have to be able to measure planes from the core and plot them on a stereonet plot (Figure 7.7). A stereonet is a common, and very powerful tool geoscientists use to visualize three-dimensional structures in a two dimensional space. Once the fault planes are calculated, geoscientists will consult a paleomagnetist on board the IODP vessel to correctly orient the core based on its paleomagnetic signature, and thus determine the precise orientation of fault structure present. Such information provides insight into the stress direction causing faulting, as well as the intensity or strain present in the area being investigated.



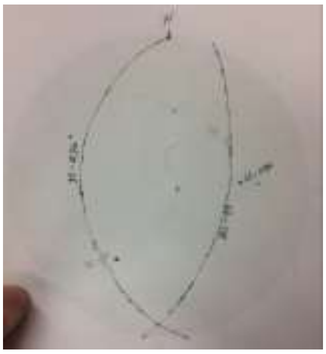


Figure 7.7: Example of a stereonet (left) and two measured fault planes from an IODP core in the core reference frame.

8. Oxygen Isotopes

Much of what we know about the evolution of the climate system throughout the Cenozoic comes from the marine stable isotope record of benthic foraminifera. The ratio of the stable isotopes of oxygen ($^{18}O/^{16}O$) and carbon ($^{13}C/^{12}C$) relative to the standard mean value, known as $\delta^{18}O$ and $\delta^{13}C$, respectively, recorded in the shells of marine micro-biota have provided a wealth of information about past temperatures, ice cover, salinity, productivity and sea level. These isotopes hold the key to past climate due to differences in their chemical and physical properties as a function of mass. These differences cause them to be treated differently as oxygen and carbon are moved throughout the global hydrologic and carbon cycles. Much like the way we parse "easy" and "difficult" tasks, the lighter isotopes take less energy to move around the climate system. For example, water vapor is depleted in $\delta^{18}O$ during evaporation, and organic matter is depleted in $\delta^{13}C$ during photosynthesis (as organisms preferentially utilize ^{12}C). As a result, seawater becomes enriched in $\delta^{18}O$ during cold periods when ^{16}O is locked in polar ice caps, and enriched in $\delta^{13}C$ during periods when ^{12}C burial is high (as a result of increased productivity and/or sea level). Marine organisms inadvertently incorporate the isotopic composition of the seawater when they create their shell material from $CaCO_3$, providing a record of seawater isotopic composition (and thus climate) through time. In the case of $\delta^{18}O$, organisms also preferentially incorporate ^{16}O as climate warms, providing additional information about past ocean temperatures.

During School of Rock, we used this marine isotope record to investigate climate change across the Cenozoic Era. We focused specifically on three large isotope excursions in the marine record: the Paleocene-Eocene Thermal Maximum, Eocene-Oligocene, and Cretaceous-Paleogene (K-Pg). These rapid climatic changes provide opportunities to put current climate changes in context of past climate and teach our students about potential tipping points/threshold responses in the earth system. Even the during most rapid excursion observed in the Cenozoic isotope record, the PETM, the rate of climate change was an order of magnitude slower than the rates of change occurring today! Marine isotope records therefore provide powerful teaching tools for our classrooms about interactions and feedbacks among components of the climate system.

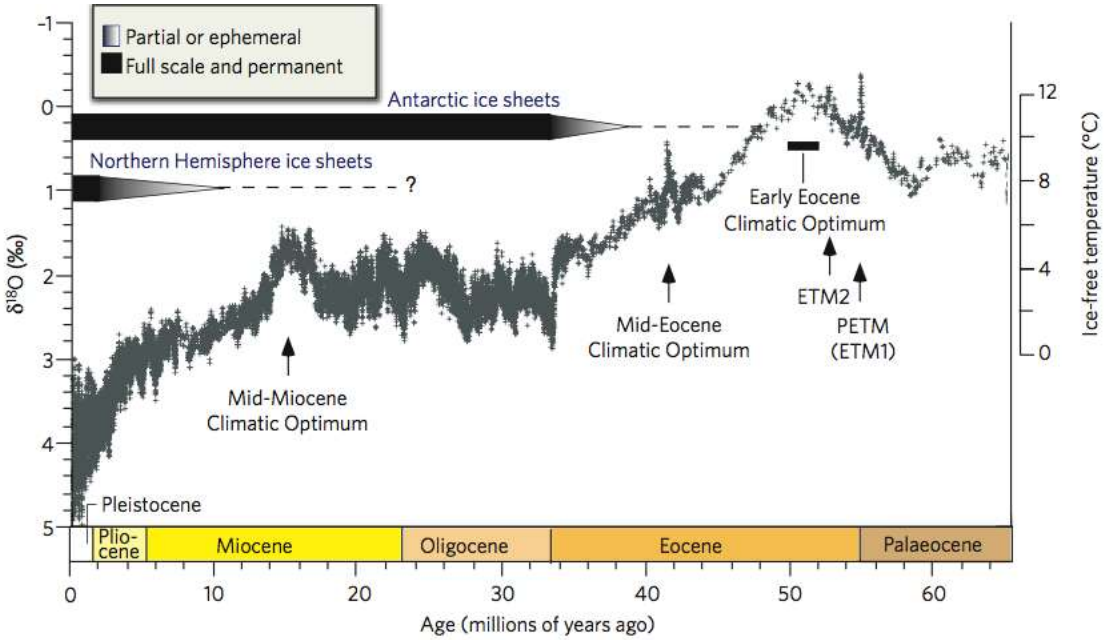


Figure 1: Record of climate variability across the Cenozoic Era, as recorded in the stable oxygen ($\delta^{18}O$) and carbon ($\delta^{13}C$) isotope ratio of deep-sea foraminifera. Higher $\delta^{18}O$ values in benthic foraminifera indicate cooler temperatures and/or increased ice cover, while higher $\delta^{13}C$ values indicate increased carbon burial due to increased productivity and/or raised sea level. Figure from Zachos et al. (2008).

The transit also provided an opportunity to collect seawater samples to add to the sparse network of existing modern oxygen isotope data. Despite the importance of oxygen isotopes for understanding past climate variability, we have limited observations of the oxygen isotopic composition of seawater across our modern ocean basins. Such data are key understanding spatial patterns in seawater $\delta^{18}O$ (in response to changes in precipitation, evaporation and current patterns) and separating the relative contribution of temperature and seawater $\delta^{18}O$ to the $\delta^{18}O$ recorded in marine carbonates. These data are particularly critical in the western tropical Pacific Ocean, as the region is characterized by strong climate variability across space and time. Capitalizing on the unique opportunity to transit through this dynamic region, we collected seawater samples and weather data three times daily. These samples will be used to analyze the oxygen isotopic composition ($\delta^{18}O$) of seawater and its relationship to local salinity. This work will fill in key gaps in our existing $\delta^{18}O$ dataset and help improve the interpretation of $\delta^{18}O$ from marine carbonates.

Figure 2: Collecting seawater samples and local weather data (sea-surface temperature, air temperature, relative humidity and salinity) three times daily during transit between Subic Bay and Townsville, Australia. $\delta^{18}O$ and salinity measurements from these samples will be used to help understand hydroclimate patterns across this dynamic region. Ultimately, such measurements can help tease apart the relative role of $\delta^{18}O$ (hydroclimate) and temperature on $\delta^{18}O$ of marine carbonates and improve paleoclimate reconstructions from these archives. Photo by Mark Leckie

9. K/Pg and PETM boundaries

K/Pg Boundary

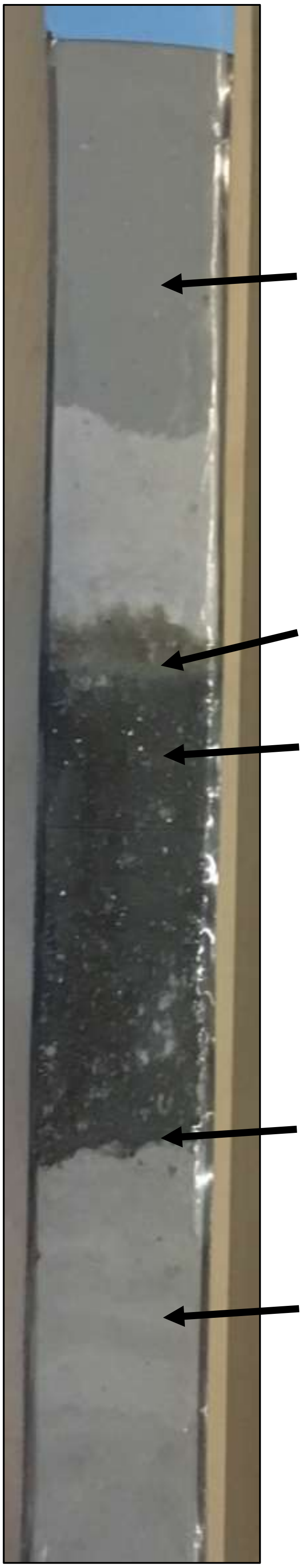
The Cretaceous – Paleogene (K/Pg) boundary signifies the end of the Mesozoic Era and the beginning of the Cenozoic Era and represents one of the five major mass extinctions in Earth's history resulting in the extinction of approximately 70 percent of species.

Students are often familiar with the K/Pg boundary (more commonly known as the K/T extinction) and are quick to point out that "the dinosaurs go extinct, due to an asteroid impact." What students don't always understand is that while there is significant geologic evidence of a bolide impact at the K/Pg boundary, including presence of iridium, shocked quartz, tektites, tsunami deposits, etc., there are also a number of other events that proceed the extinction. These precursor events including the eruption of a large igneous province (LIP), in what is now India, known as the Deccan Traps; and changing climate likely set the stage for such a catastrophic mass extinction event. The large bolide impact most likely represents the "kill mechanism," that killed off more than just the dinosaurs, including swimming and flying reptiles and many species of foraminifera. This extinction event permitted mammals to diversify during the Cenozoic -- filling many of the niches occupied by reptiles during the Mesozoic.

Research on this boundary has been ongoing for decades and, while there is consensus among scientists that the bolide was the "kill mechanism," there will always be new data, interpretations, and conclusions that continue to develop and evolve the hypothesis.

School of Rock provided educators with resources to better explain the science behind Earth's climate change events, including the K/Pg boundary. These resources include the replica core of the K/Pg boundary (Figure 9.1). Additional resources will be an invaluable resource to demonstrate to students what events occurred before, at, and after the K/Pg boundary.

Cretaceous/Paleogene Replica Core
IOPD 171B-1049A-17X-2



After the Impact: Sediment is laminated and slightly bioturbated. Only tiny, less ornate foraminifera microfossils are found in this layer; a few new species have evolved.

Fireball Layer: This layer is stained orange due to oxidization of the upper part of the spherule layer. Contains dust and ash fallout from the asteroid

Tektite Layer: Ejecta, including tektites – glassy spherules condensed from the hot vapor cloud produced by the asteroid impact – are found in this layer of the core. Debris thrown into the atmosphere by the impact rained down on the Earth for days or even months after the event. The impact and ensuing global climatic change devastated life. In the ocean, 95% of the free-floating foraminifera died out. Sediment size grades from coarser to finer particles from the bottom to top of this layer.

Moment of Impact: The irregular surface is the K/Pg (Cretaceous-Paleogene) Boundary.

Before the Impact: The sequence immediately below the K/Pg unconformity displays microfauna and slump. This layer contains microfossils of the large and ornate foraminifera that flourished in the oceans during the time of the dinosaurs.

Figure 9.1. Cretaceous-Paleogene (K/Pg) boundary replica core. From IODP 171B-1049A-17X-2

PETM Boundary

Approximately 55 million years ago, between the Paleocene and Eocene epochs, an abrupt warming event, known as the Paleocene-Eocene Thermal Maximum (PETM), occurred. There is evidence of a large global event at this boundary affecting environments from pole to pole including $\delta^{18}O$, and Carbon-13 isotope excursions (Figure 9.2).

The evidence suggests warming in both the shallow and deep ocean and a rise in the carbonate compensation depth (CCD). This event coincides with benthic foraminifera extinction (BEE) and migration of species (marine and terrestrial) to higher latitudes. This boundary is well represented in marine sediment cores as a sharp contact with a gradual recovery (Figure 9.3).

The global event includes rapid warming (6°C/10,000 years; 0.6°C/1000 years) lasting approximately 100,000 years. Compared with the rate of climate change today (0.6°C/100 years), students may begin to understand how much greater today's rate of climate change is compared to the Paleocene-Eocene event.

The current hypothesis is that the PETM likely resulted from a massive influx of carbon into the ocean. Previous research had suggested the release of methane hydrates trapped in the seafloor as a likely carbon source. However, new research suggests that methane released from large permafrost reserves in the continental polar regions is a more likely source of this carbon.

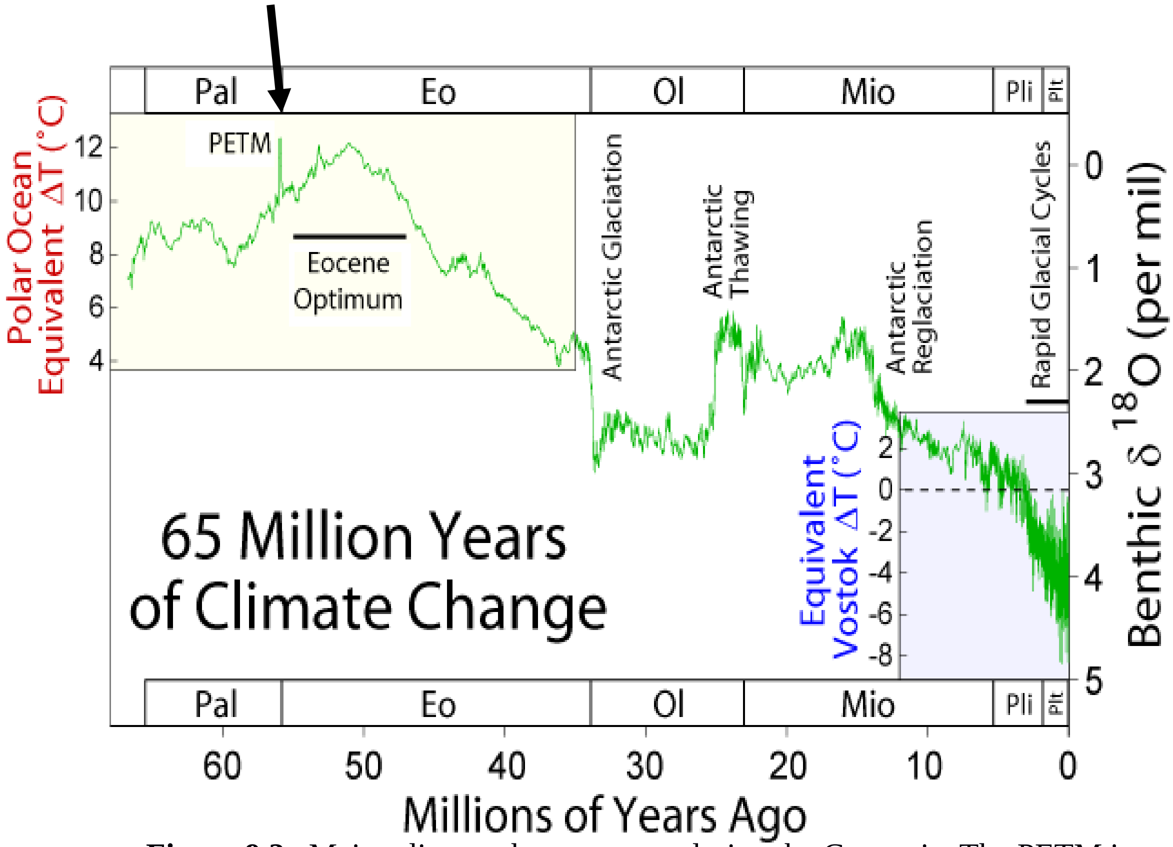


Figure 9.2. Major climate change events during the Cenozoic. The PETM is highlighted at the arrow. $\delta^{18}O$ is plotted as the green line, with an excursion represented at the PETM boundary. Note the relationship with temperature change in the Polar Ocean.

Paleocene – Eocene Thermal Maximum (PETM) Replica Core
Walvis Ridge ODP Leg 208

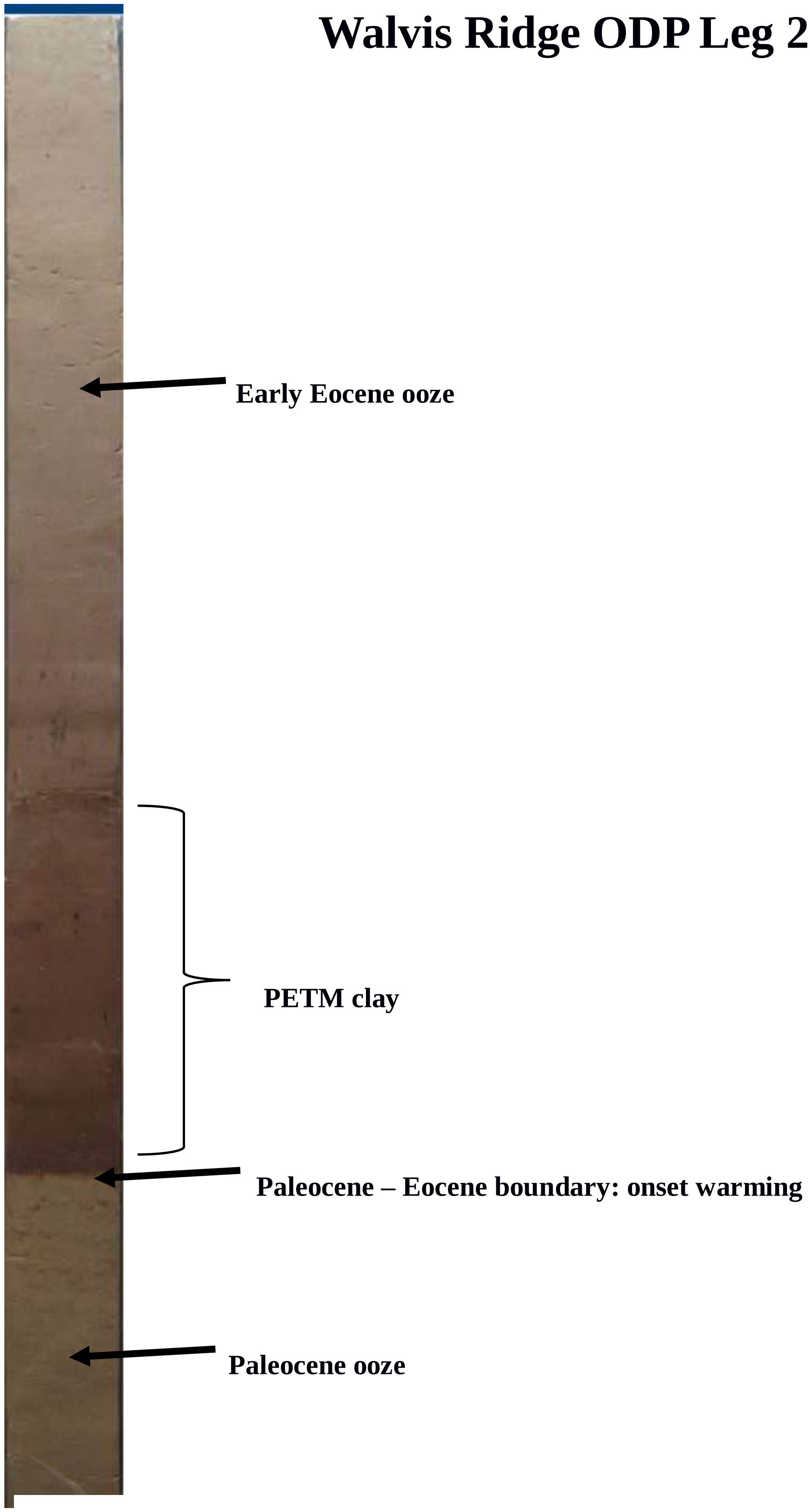


Figure 9.3. Paleocene-Eocene Thermal Maximum (PETM) replica core. From Walvis Ridge ODP Leg 208.

10. E/O Boundary

Not as visually spectacular as the PETM, the **Eocene/Oligocene boundary (Oi1 event)** is just as remarkable. The Oi1 event is when the Earth commenced its pathway along a cooling trend. Not since the Permian had the Earth's surface been characterized by ice. About 21 million years after the PETM, at ~34 Mya, ice sheets began to grow in Antarctica. The world at that point transitioned from a dominantly greenhouse to an icehouse environment; a transition defined by an interplay of major planetary and environmental conditions; an icehouse environment that to this day has transitioned between glacial and interglacial periods. This boundary marks the geological transition between the Paleogene to the Neogene.

Figure 1: Colleen, Matthew & Marilyn with Cenozoic Core from Site 1218 A. PETM core in the foreground, Oi 1 core in the background. Note the color gradation.

Understanding this significant climatic shift, was undertaken in 3 phases:

1. Lithological core examination
2. Smear slide microfossil identification
3. Research paper examination

Leg 199 core from the Pacific Western American Equatorial Expedition was utilized for this task. Scientists chose this drilling site because of its rich biological activity. Geologically, such sites served to produce significant biogenic sediment which could then be studied in detail, to examine the climatic changes which occurred across this Cenozoic boundary. Core from Site 1218 A was examined.

Lithologically, the boundary is transitional, but distinguishable. At depth, the sediment is a tan brown color which lightens and assumes a mottled texture, progressing up hole. The mottling, an indication of bioturbation transitions into a dark cream coloration which then gives way to a bright white zone towards the top of the hole. Aside from the color gradation, not other structural or physical feature was observed.

The color transition zones were selected for smear sampling. Samples were taken from the lower tan brown layer, the mottled zones and the upper white zone. In summary, distinctive microfaunal assemblages correlated with the color zonations.

1. Lower brown tan layer comprised siliceous ooze represented by radiolarians, diatoms and silica flagellates; good variety and some ‘dust’.

2. Within the mottled transition zone, there were diatoms, sponge spicules and calcereous nannos.

3. The white layer above the transition zone is comprised of calcereous nannofossils.

The lower siliceous brown layer developed when the CCD must have been shallow within the water column. According to the drilling depth, this must have been around ~3500m. The presence of nannos in the transition zone indicates that there must have a sudden drop of the CCD to ~

+4500 to account for their existence. The calcereous, white color ooze of the upper layers indicates the dominance and stability of the CCD at greater ocean depths for this younger period. The transition zone is acknowledged as the transition between the Eocene & Oligocene; a major climatic shift.

Synopsis' of research papers provided additional tectonic, chemical, stable isotope and sea level evidence to confirm the Oi 1 boundary, as visualized from lithological and microfossil analysis and interpretation. Key evidence includes:

1. Analysis of deep sea cores indicate the opening of the Southern Ocean and Drake Passage; final break-up of Gondwanaland. Terrestrial facies transition to shallow and then deep water marine environments. Isolating Antarctica as a stand alone, southern continent positioned on the South Pole.
2. South Atlantic deep waters changed from warm water nannos to cool water nannos.
3. Sea level falls recorded in core off New Jersey and Tanzania
4. +ve 18O shift by ~2 0/00, indicating a cooling environment; a consistent measurement for all sites.
5. +ve 13C shift by ~+2 0/00, indicates that more CO2 was consumed by autotrophs and the development of more calcium carbonate flux
6. Orbital parameters of low tilt and eccentricity accomodate cooling; Antarctica cooled within one orbit.

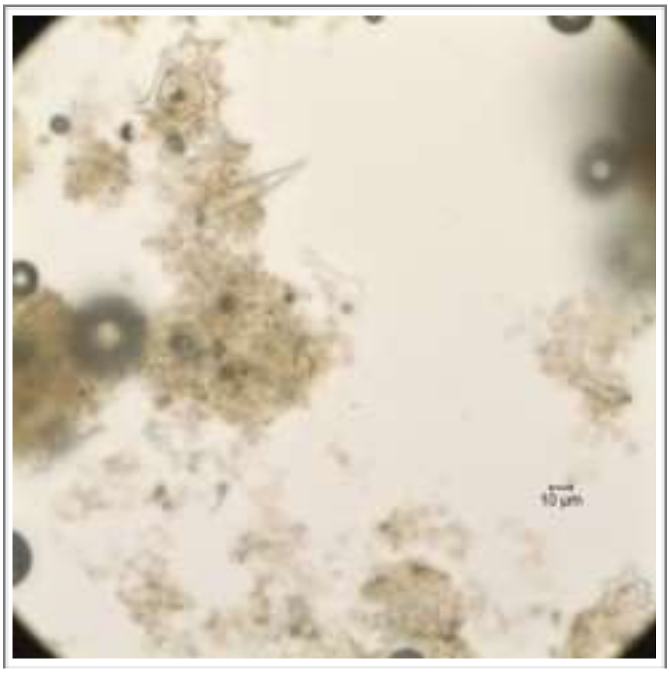
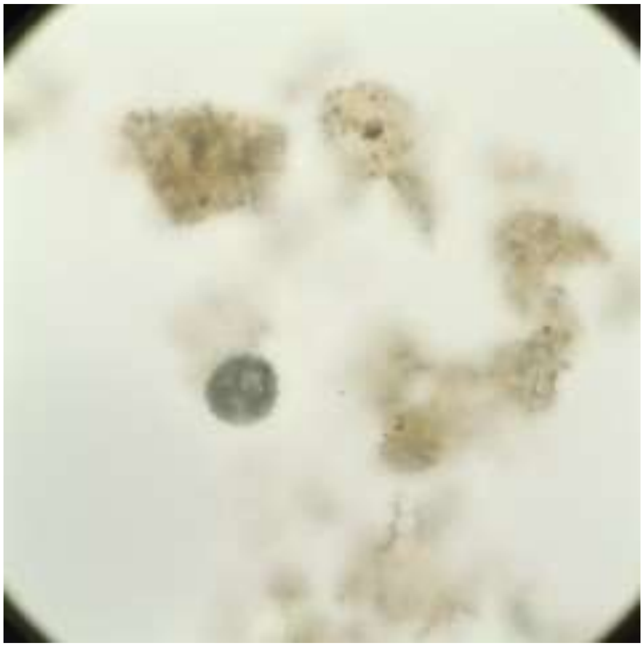


Figure 10.2: Smear slide of 1218 A within the dark tan section, below the transition. Note the siliceous microfossils.



Interpretation

In summary, +ve 18O was a 2 step process, and the +ve 13C demonstrated how the radiolarian ooze gave way to nannofossil ooze. Both excursions were fast shifts (with oxygen being a 2 step process). This isotope signature correlates with the color revealed in the sediment core. The shifts were happening globally in deep water in the tropics and at the poles, firstly in the poles as indicated by the level of the CCD. Core data indicates that the CCD was shallow and transitioned to a deep CCD by a 1500m drop. When the CCD drops, this is indicative of less corrosive waters down deep allowing for a greater flux of carbonate into the shallower regions. A shift to deeper CCD levels is indicative of higher flux of carbonate ooze derived from an increase in erosion rates off continental land masses. Sea level drops (as indicated by increased ice volume correlated with observed ice rafted sediments in core) combined with continental collision and the production of mountain fold belts such as the Himalayas and the Andes both account for increase erosion rates. This is known as Basin Flux Fractionation and is verified by 87Sr values which show that from 40 mya, 87Sr is increasing, becoming more positive. The increase rate of erosion is proportional to increased weathering from carbonic acid, stripping CO_2 from the atmosphere further facilitating a cooling trend. This long-term trend geologically is known as the Carbon-Silicate Thermostat.

Cooler waters, a decrease in global sea surface temperatures and decrease in sea levels are accounted for by an increase in ice volume and in this case was represented by the development of the Antarctic Ice Sheet. The final break-up of Gondwana, isolated Antartica and set up the very cold Circumpolar Current which further corroborates the cooling trend as evidenced by the increase of nannos as a result of the depressed CCD.

11. Geohazards

Geohazards, such as earthquakes, volcanic eruptions, landslides, and volcanic collapse, are of immediate societal concern. In an oceanic setting (Fig. 11.1 below), all are capable of generating tsunamis that threaten coastal zones at distances of many thousands of kilometers.

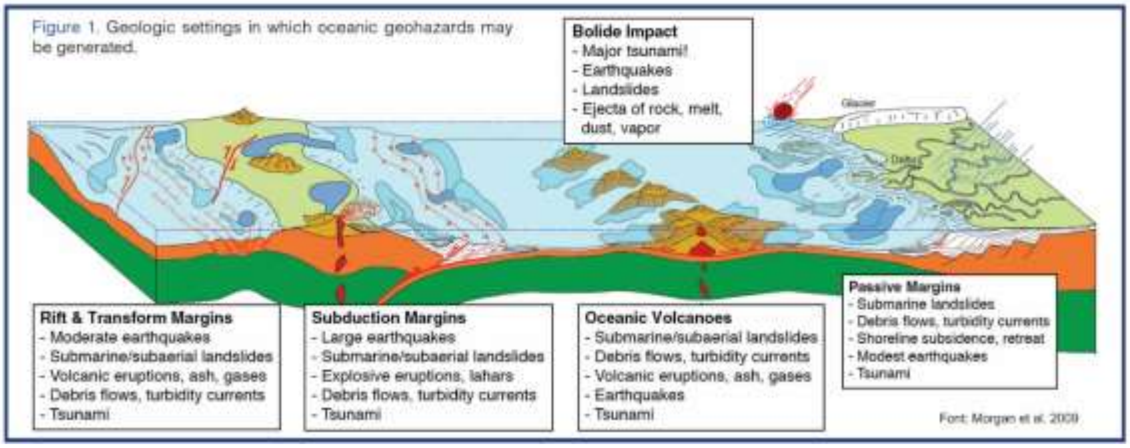


Figure 1. Geologic settings in which oceanic geohazards may be generated.

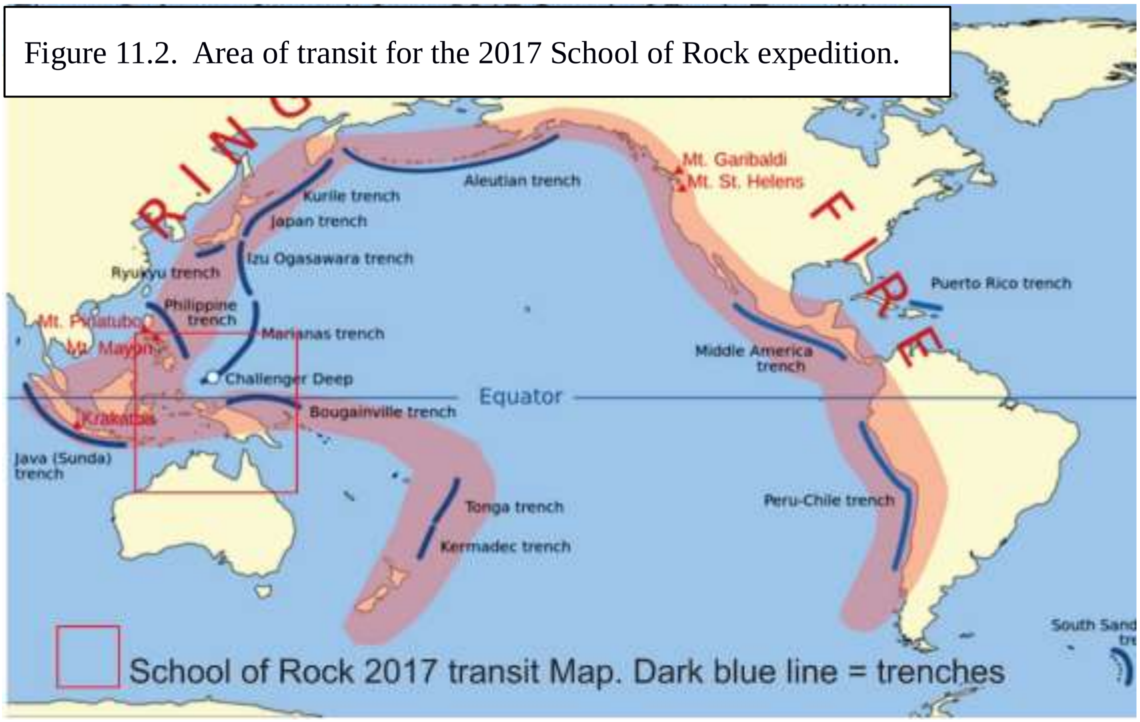
Great subduction zone earthquakes account for over 90% of global seismic energy released, and represent the greatest natural hazard to life and property for major coastal population centers. Submarine landslides and catastrophic volcanic flank collapse (and associated tsunami) also pose significant risks to coastal populations and to seafloor infrastructure.

At the other end of the scale, the geologic record suggests that less common, large-volume volcanic collapses and extraterrestrial meteorite and comet impacts in ocean basins have the potential to initiate tsunami of extraordinary power that can threaten huge sections of coastlines with growing populations. These events also disperse enormous volumes of ash, steam, and ejecta into the atmosphere, with short- and long-term consequences, including climate change.

The 2017 School of Rock on board the *JOIDES Resolution* occurred while transiting from Subic Bay, Philippines to Townsville, Australia. This Expedition crossed 3 trenches (Philippine, Mariana and Bougainville), passing the NE-E coast from Philippine and the N-NE coast from Papua-New Guinea to a geohazards high risk, in contrast with Australia, which sits in the middle of a tectonic plate, some distance from the nearest subduction zones (Fig. 11.2).

Fluids are essential to many of these processes, influencing the locations, magnitudes, and timing of seismic events; the focused transfer of mass and energy within and across the seafloor; the development, accumulation, and movement of carbon; and the establishment and maintenance of a vast subseafloor biosphere.

Figure 11.2. Area of transit for the 2017 School of Rock expedition.



All of these processes, which have operated throughout the Earth's history, are instrumental in shaping the Earth system today. However, they are characteristically difficult to predict. Understanding what mechanisms control the occurrence of destructive earthquakes, landslides, and tsunamis are important for characterizing associated hazards.

References:

IODP Science Plan for 2013-2023

Morgan J. et al. 2009. Addressing Geohazards through Ocean Drilling. Science Reports. Science Drilling, No. 7. P. 15-30. Doi: 10.2204/iodp.sd.7.01.2009

12. **Milankovitch Orbital Cycles:**

The Earth's climate controls can be thought of as an elaborate analog stereo receiver with big and small control knobs that affect Earth's climate. Long-term climate changes of tens to hundreds of millions of years are influenced most by the big control knob CO2. We can turn this control knob and warm or cool the planet by adding or subtracting CO2 respectively. The effects of plate tectonics and the evolution and extinction of life on Earth are two examples of processes that can turn the big control knob one way or another. Once the big knob is turned feedbacks and tipping points in the system begin. Short-term climate changes of centuries to hundreds of thousands of years are a consequence of turns of the smaller control knobs. Examples include; volcanic emissions, ocean current changes, surface albedo, sun spots, human forcing, and the Milankovitch Orbital Cycles.

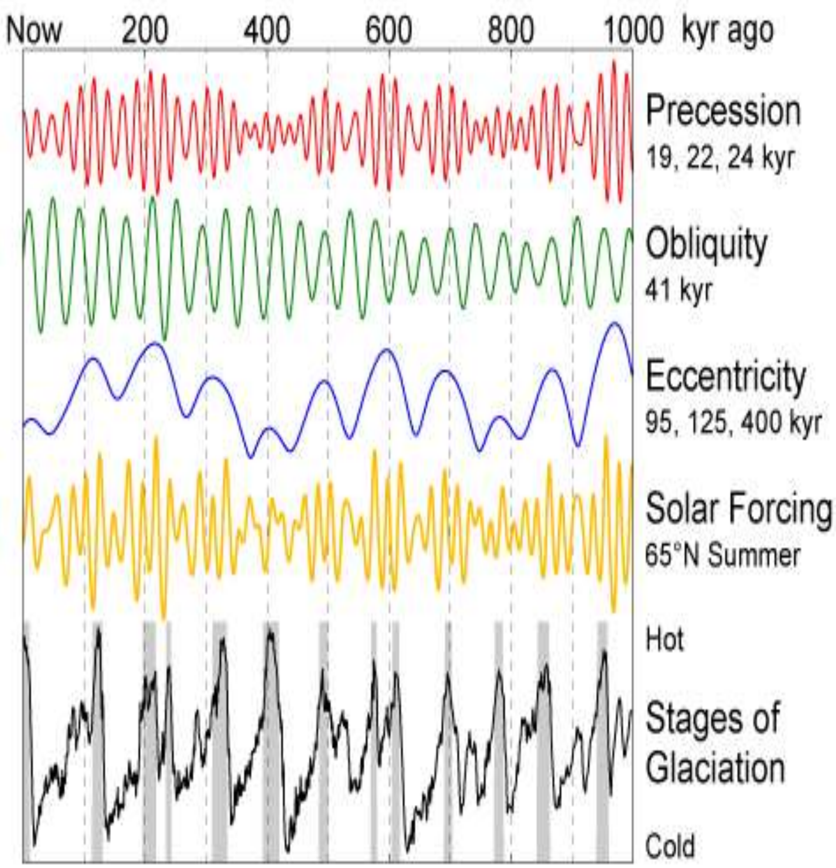


Figure 12.1. Milankovitch Orbital Cycles; http://www.azimuthproject.org/azimuth/show/Milankovitch+cycle accessed 7/23/17

For example, changes to the big knob can set the stage for a planetary ice age but it's the smaller Milankovitch Orbital Cycle knob that explains the advance and retreat of glaciers <u>during</u> an ice age. This climate changing "small knob" was identified by Milutin Milankovitch, who was a 1920's geophysicist and astronomer. He evaluated three aspects of Earth’s movements that can act as one of the feedback triggers that could cool or warm the Earth during shorter term climate cycles. These three Earth cyclic motions are: Orbital Shape (eccentricity) a 100,000 year cycle of a circular orbit to an elliptical orbit around the sun, Tilt of Earth’s Axis (obliquity) a 41,000 year cycle that varies Earth’s tilt by 2 degrees, and Wobble of Earth’s Axis (precession) a 23,000 year cycle. These cycles plot out like independent waves of varying amplitude and frequency but occasionally they conspire with the big knob turns to change Earth’s short-term climate when their cyclic waves meet at nodal points. (See Fig 1.) While the big knob CO2 is the main driver of long term Greenhouse Earth and Ice-house Earth conditions it’s the turns of all the small knobs that explain short-term climate variations.

13. Global climate change

Throughout our academic journey on School of Rock, we studied many causes of climate change throughout Earth's history. We learned about catastrophic mass extinctions caused by climate change related to specific, warming or cooling events like in the K-Pg Extinction, the Paleocene-Eocene Thermal Maximum and the Eocene-Oligocene Glaciation (Fig. 13.1). These lessons, in addition to lessons on topics like thermohaline circulation in the ocean and the impact of wind currents on the creation of subtropical gyres, prepared us for our final lesson on global climate change. Modern anthropogenic climate change differs from the historical warming and cooling periods throughout Earth's history because it is driven by human activities.

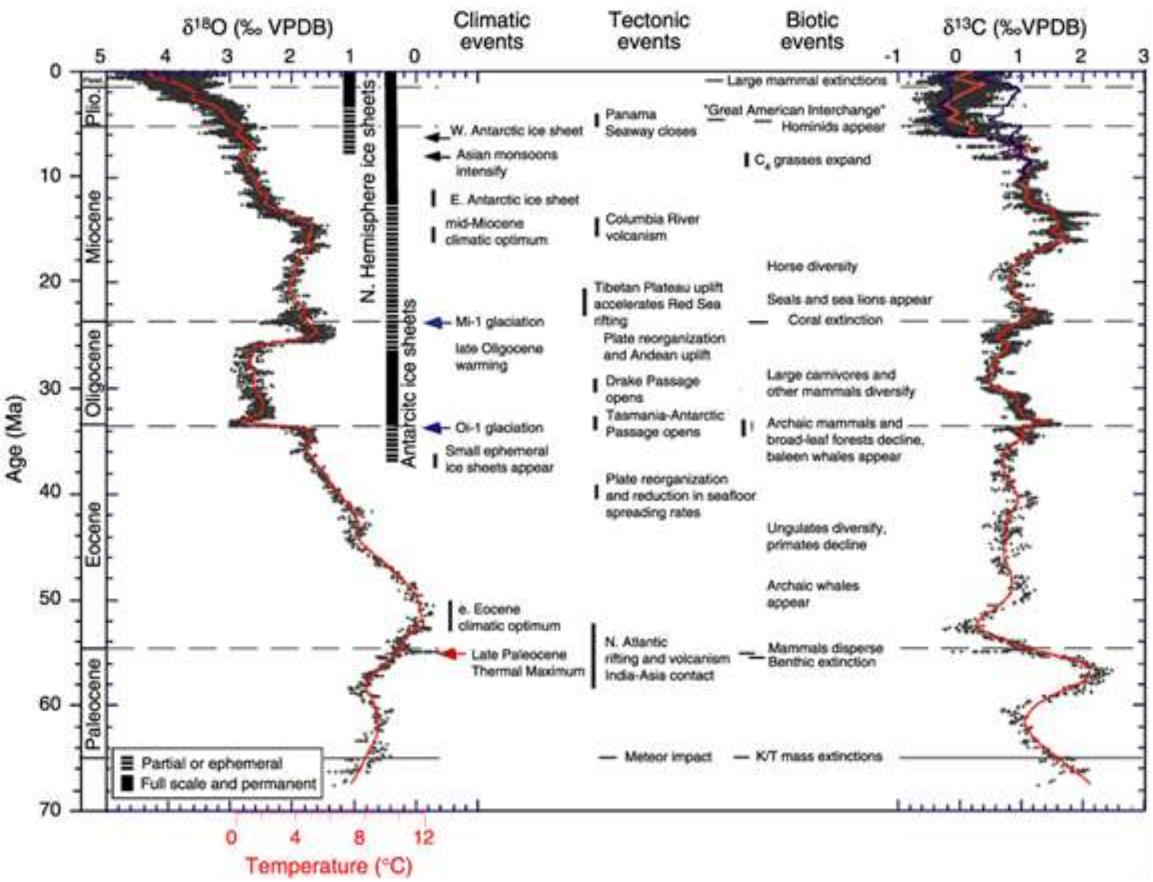


Figure 13.1. Proxy records of climate.

This climate change has been driven by the consumption of fossil fuels for industry, energy, and transportation. When fossil fuels are burned, greenhouse gases like carbon dioxide and methane are released into the troposphere. These gases increase the amount of re-emitted infrared radiation on Earth. The additional IR radiation trapped in the atmosphere causes global temperatures to rise. These rising temperatures trigger a series of positive feedback loops, which in turn increase the rate of warming. For example, increased atmospheric temperatures at the poles cause sea ice to melt, thereby reducing the albedo. This loss in reflectivity will increase the amount of heat absorbed by the oceans. This increased IR radiation causes temperatures to rise, and more sea ice to melt, which continues the cycle. Increased temperatures will also cause glacial ice trapped on land to melt, increasing the amount of cold, fresh water in the oceans, which will dramatically raise sea levels. Historically, melting sea ice has impacted the salinity, oxygen, productivity, and nutrient levels of Earth's oceans. These abiotic changes in ocean chemistry can cause losses in aquatic biodiversity, stemming from a loss in both planktonic and benthic microscopic organisms that form the base of aquatic food chains.

One of the main barriers preventing K-12 students from fully understanding the process of climate change stems from a lack of understanding of how historical climate change data are collected. During our School of Rock lessons on climate change, we learned many of the specific ways in which scientists collect this historical data. One such technique for collecting historical climate data is taking ice cores from Antarctica. These ice cores reveal accurate temperature and carbon dioxide concentrations dating back 400,000 years. The increase in carbon dioxide in an ice core section, for example, directly correlates with a decrease in the delta Oxygen 18 levels in the same ice core samples, which indicates a rise in global temperatures. If an ice core section contains evidence of a decrease in carbon dioxide levels, that same section will also have an increase in the delta Oxygen 18 levels, which indicates a drop in global temperature. These historical trends are extremely relevant when analyzing present-day averages of carbon dioxide in our atmosphere. In June 2017, the Mauna Loa Observatory recorded 402 parts per million of atmospheric carbon dioxide. Carbon dioxide levels most likely have not been this high since the PETM, which was caused by massive global warming and the melting of both ice caps. This melting caused the sea level to rise drastically, averaging around twenty-five meters. Now that School of Rock educators have learned the processes behind ancient climate calculations, and calculated temperature changes due to shifts in carbon dioxide and delta oxygen 18 levels themselves, they will be much more equipped to teach their students about climate change data collection with confidence.

The topic of anthropogenic climate change is also hotly disputed in political arenas, and as a result, many people come into conversations about climate change with misconceptions and assumptions. The prevalence of these misunderstandings among the general public reaffirms the importance for developing strong, rigorous, engaging lesson plans to explain this topic to students. During School of Rock, we explored the connections between various climate change topics through an activity recently designed for the Understanding Global Change website for the University of California, Berkley. In this activity, participants were given a set of terms that can be classified as either causes or effects of global climate change. Participants worked with a partner to place the terms into one of those two categories, and they engaged in debate and evidence-based reasoning in the process. After sorting the terms, the instructor asked the participants to share out patterns that they could see in the cards. As a class, we debated whether these terms were causes or effects of global climate change, and we were unable to agree about the placement of many of the terms. This debate reminded us that all of these interactions in the biosphere, atmosphere, lithosphere, and hydrosphere influence each other in a complicated, interconnected web. The lesson concluded with a demonstration of a large poster that laid out these complex relationships in an easy-to-read flow chart.

14. Oceanography 101

Over the duration of the expedition, instructors provided mini-lessons on oceanography. Covering the basics and diving into more in-depth concepts further enforced the process of ocean floor drilling. The first mini-lesson consisted of discussions on the thermocline, pycnocline, soar angle, and radiation. This was followed by winds, weather and wind-driven circulation. Finally, we covered the bottom, deep and intermediate water masses of the Atlantic and Pacific Oceans.

The implementation of this course connected the factors of oceanography to the work being conducted on the *JOIDES Resolution* as well as the path the ship took from Subic Bay, Philippines to Townsville, Australia and the features we would encounter. Tracking ocean currents, prevailing winds and the global oceanic conveyor belt provides insight to scientists into the makeup of the Earth's upper layers and how the land masses have evolved over millions of years. By backtracking the isotopic composition of a sediment layer, scientists are able to piece together the puzzle of how Earth has changed and permits opportunities to study possibilities of Earth's future.

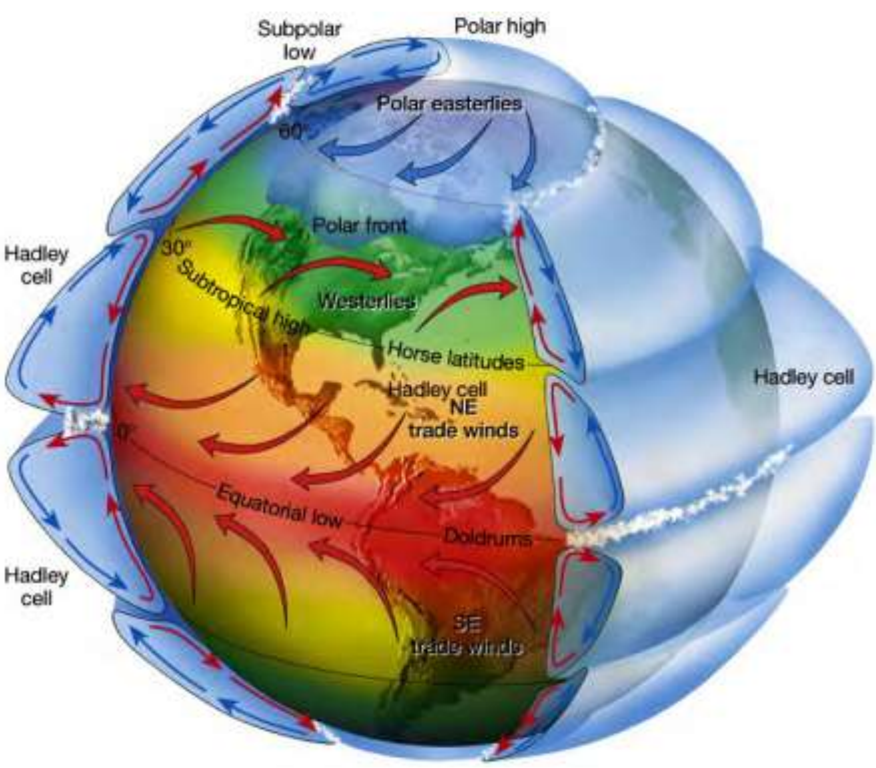


Figure 14.2 Figure depicting the direction of the prevailing winds and resulting cells around the Earth. http://www.ux1.eiu.edu/~jpstimac/1400/FIG07_006.jpg

Conclusions

School of Rock 2017 was a synergistic collaboration on multiple levels. The model of a blended group (graduate students, professors, K-12 educators and scientists) was successful in promoting the following:

1) *Understanding current obstacles in promoting diversity in STEAM fields and how to facilitate changes.*
   Though the lessons, dialog and frank discussions during this transit, participants were able develop strategies and action plans to promote diversity within their respective spheres of influence, many working together to develop proposals to champion diversity in education.

2) *Deeper knowledge in geosciences (specifically oceanography, climatology, sedimentology, micropaleontology, structural geology, meteorology and plate tectonics).*
   Through the SOR instructors, participants were able to delve into geoscience content that will enable participants to bring authentic science into their classrooms on multiple levels. Not only are participants more prepared to engage students in scientific inquiry but they now possess greater knowledge and motivation to promote scientific literacy in their respective communities.

3) *Increased overall knowledge of the nature and process of science.*
   Participants were engaged in activities that were designed to not only model the process of science through STEAM, but they were allowed to conduct that process for themselves, utilizing the skills and knowledge obtained while aboard the *JOIDES Resolution.* On this transit, participants were immersed in the process of science, analyzing mountains of raw data that have come from a succession of different ocean drilling expeditions.

School of Rock unequivocally promotes the *JOIDES Resolution*, the International Ocean Discovery Program, the importance of the geoscience data obtained expedition after expedition, and the people (scientists, technicians, and support staff) who devote their time to making scientific discovery possible. In addition, by connecting educators and graduate students through this program, the path to diversify and connect future generations with geoscience has become more focused and achievable.

The participants wish to extend a thank-you to all for the opportunity to grow in a way that could not be done elsewhere.

Appendix 1: Full Agenda

School of Rock 2017

Expanding the Geoscience Pipeline by Connecting Educators with Early Career IODP Scientists

July 9-27 2017

On board the JOIDES Resolution on transit between Subic Bay Philippines and Townsville, Australia

SCIENCE LAB INVESTIGATION SCOPE AND SEQUENCE

DAILY Activities

- Every day: journaling, blogging, social media updates, "words of the day"
- Ship-to-shore events can be scheduled throughout
- Ship tours and operations as appropriate

Day 1: July 9

13:00 Captain and safety talks

Ship tours

16:00 Ice-breaker

Day 2: July 10 Monday

07:30 Why are we here? Background on IODP and the program

Open Space session: What do you want to gain from this workshop?

LUNCH

Introduction to coring

Introduction to observations and questions: gallery walk

Oceanography 101

Day 3: July 11 Tuesday

AM Introduction to coring and core flow

Lunch

PM: Core flow continued

Ship operations – sail away!

Evening Reflection activity-Introduction to How Science Works?

Day 4: July 12 Wednesday

AM: Overview of IODP Education Resources/GeoMap Ap

Seafloor sediments Introduction - Steve and Mark

Lunch

PM: Seafloor sediments continued

Evening: Reflection and more smear slides

Day 5: July 13 Thursday

Seafloor sediments continued

Smear slides

Evening: Zenon Mateo and learning about the Philippines

Day 6: July 14 Friday

Biostratigraphy – Lisa and Mark

(sampling scoops and glass vials)

Evening: Oceanography 101 (Coriolos effect and wind-driven circulation) - Mark

Day 7: July 15 Saturday

AM	Paleomagnetism
PM	Paleomag con’t

7:00 Inclusive environments and diversity: what works?

Day 8: July 16 Sunday

AM:

Brainstorming on collaborative projects and planning in teams an Sharing ideas across teams

Mentoring and best practices discussion

Day 9: July 17 Monday

AM Earth Structure

LUNCH

PM Plate Interaction

Evening Science Café

Day 10: July 18 Tuesday

AM Plate Motion and What is a Fault?

09:30 ship tour/work in teams on projects

LUNCH

PM Diversity next phase

15:30 ship tours/work on team projects

Evening Oceanography 101

Day 11: July 19 Wednesday

AM Who Cares About Subduction Zones?

Permeability, Stress, fault geometry, kinematics and focal mechanisms

PM Oxygen Isotopes

Evening: Ops Superintendent Kevin Griger

Day 12: July 20 Thursday

K/Pg Boundary and PETM

Evening: Group discussion: Inspiring students and the general public; storytelling in science mini-workshop

Day 13: July 21 Friday

Finish PETM

Core lab track work and Pore-water extraction and geochemistry demos (chemistry lab, in groups)

4:00 Diversity session

Evening: Science café: Share your research lightning talks Part I

Day 14: July 22 Saturday

EO Boundary, and including How to access IODP data

Geochemistry demos and lab tour

Team project planning time

Evening: Research lightning talks Part 2

Day 15: July 23 Sunday

AM Revisit Ocean Space topics

Logging Faults in Core (in groups)

PM Hands-on Plotting Faults in 3D (optional)

Team project planning time and report-writing/microscope time

4:00 pm Oceanography 101

Day 16: July 24 Monday

AM Mentoring presentation

How to apply for IODP expeditions/programs

Understanding Global Change website

Climate Change/Hazards/Impacts Synthesis

LUNCH

PM 13:00 Sarah storytelling Zoom

Report-writing/microscope time

Day 17: July 25 Tuesday

Project planning time and report-writing

Initial reports due

Out of Lab

Day 18 July 26 Wednesday

Individualized project time

Teams complete their project plans

Presentations and synergies (challenges, plans, needs, etc.)/Raffle

Evaluations

Graduation

July 27

Disembark

School of Rock 2017

Team Action Plan

Team members:

Colleen Henegan and Rachel Bernard

Schools/Institution:

KIPP Collegiate and University of Texas at Austin

Location:

Austin, TX

Audiences:

Austin area middle and high school students

Individual ideas:

n/a

Project Partnership Ideas:

With minor, inexpensive alteration, a standard high school classroom microscope can be easily and temporarily transformed into an instrument capable of viewing rocks in plane and cross-polarized light. We developed a lesson plan for a high school AP Environmental Science class which covers three required topics through the use of these microscopes: (1) the rock cycle; (2) intrusive vs. extrusive igneous rocks; and (3) porosity vs. permeability in sedimentary rocks. While developed for use in an AP Environmental Science class, the lesson plan could be modified for any high school or middle school course that covers the rock cycle or polarization of light, and addresses several standards including the Next Generation Science Standards (NGSS) and the Texas Essential Knowledge and Skills (TEKS).

Due to the inaccessibility of rock thin sections to most K-12 teachers, we plan to construct five classroom kits that can be loaned out to be used in conjunction with the lesson plan. The only material needed but not provided is a basic, classroom microscope. These kits will be advertised to other middle and high school teachers (science and physics) at KIPP Collegiate, as well as other teachers in the Scientist-in-Residence program at UT Austin.

How project plans will address and increase participation in the geosciences by underrepresented groups

This lesson plan aims to inspire middle and high school students to get excited about rocks, and learn a common tool of professional geologists. Another goal is to show teachers one way that microscopes can be incorporated into lessons outside of biological sciences. This project will specifically target schools serving majority underrepresented groups, and will reach out to teachers at these schools in the Austin-area. At KIPP Collegiate in particular, 97% of the students are Hispanic/Latino.

Education standards this will help me meet (if applicable):

- AP Environmental Science exam: various topics that fall under Earth Systems and Resources (10–15%)
- Texas Essential Knowledge and Skills (TEKS):

- §112.18. *Sixth grade Science*
  - Knowledge & Skill Statement - 6.10: The student understands the structure of Earth, the rock cycle, and plate tectonics.
- §112.36. *High School Earth and Space Science (ESS)*
  - Knowledge & Skill Statement - ESS.1: The student conducts laboratory and field investigations, for at least 40% of instructional time, using safe, environmentally appropriate, and ethical practices.
  - Knowledge & Skill Statement - ESS.12: The student knows that Earth contains energy, water, mineral, and rock resources and that use of these resources impacts Earth's subsystems.
  - Knowledge & Skill Statement - ESS.11: The student knows that the geosphere continuously changes over a range of time scales involving dynamic and complex interactions among Earth's subsystems.
- §112.66. *Advanced Placement (AP) Environmental Science* (One Credit).
  - Content requirements for Advanced Placement (AP) Environmental Science are prescribed in the College Board Publication Advanced Placement Course Description: Environmental Science, published by The College Board.

- Next Generation Science Standards (NGSS)
  - *Middle School, grades 6-8*
    - MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
  - *High School, grades 9-12*
    - HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Other potential partners:

Donorschoose.org, Scientist-in-Residence (SciRes) program at UT Austin through the Environmental Science Institute (ESI).

Assistance I may need from USSSP (e.g., contacts, resources, prior activities, funding):

Perhaps getting the word out if we decide to loan out our kits beyond the Austin area (and money for shipping?).

Proposed Timeframe:

- Spring 2017: Submit lesson plan manuscript to *The Science Teacher*. DONE
- July: Raise money for rock cycle classroom learning kits on Donorschoose.org
- August: Receive donated rocks, boxes, and polarized filters
- By end of August: Send out rock pieces for thin sections to be made (Rachel). Lesson plan complete (Colleen).
- By end of September: Have one complete kit
- October: Use kit and lesson plan with Colleen's class. See what works and tweak if necessary. Publish finalized lesson plan on personal website.
- November: Give other teachers at KIPP (middle school science and high school physics) the kit to use. Get feedback.
- By the end of November: all 5 kits complete and available for loaning out. Advertise to UT Austin SciRes K-12 teachers and offer to demonstrate the lab at one of the professional development days.

School of Rock 2017

Team Action Plan

Team members:

- *Stephanie Milam-Edwards*
- *Marilyn Raming*

Schools/Institution:

- *Tempe High School (Steph)*
- *Mountain Pointe High School (Marilyn)*

Location:

Both schools are part of the Tempe Union High School District serving students in Tempe and Phoenix, Arizona. We hope to also partner with Mesa Community College, located in Mesa, Arizona which may involve a variety of students in the geoscience program from across Arizona.

Audiences:

- *THS / MPHS 11th -12th grade high school students enrolled in Earth Science*
- *TUHSD Faculty members and specifically colleagues teaching Earth Science*
- *Tempe-El District teachers and students (K-8th)*
- *Pre-K children*
- *Community*
- *Mesa Community College / Arizona State University*

Individual ideas:

We work very well as partners and will be partnering to integrate these lessons into the established scope and sequence of the Tempe Union High School District Earth/Space science course.

We would like to set up each classroom as if students are joining an expedition to teach each other about the benthic, pelagic, chemical makeup and circulation of the world's oceans, time scale, structure and plate tectonics, etc.

> *For example, in order to learn about the benthic profile of the ocean, students would be set in teams, given the scientific focus of the leg, and data collected. Students would work to determine the overall bathymetry of the seafloor in sections and come together to present their findings, hopefully developing a profile of the seafloor (continental shelf, slope, rise, mid-ocean ridges, abyssal plains, etc.) and coming to consensus. After which, they join another expedition, switching roles and focus to another set of learning objectives.*

Project Partnership Ideas:

Immediate

- THS / MPHS Earth Science students
  We will be integrating lessons from the SOR (modified as needed) as well as other pieces, where appropriate, from the Deep-Sea Learning Program and <u>*Reconstructing Earth's Climate History*</u> *throughout our curriculum. The plan is as follows:*

  1st quarter – Oceanography 101, Sedimentology lessons

  2nd quarter – Geologic Time-scale and evidence of extinction events

  3rd quarter – Structure of Earth, Plate Tectonic and Seismic lessons

  4th quarter – Meteor Impacts (revisiting the K/Pg boundary)

- ASTA (Arizona Science Teachers Association)
  We are contacting the ASTA to ask about either speaking at one of their break-out sessions or setting up a table to promote the School of Rock, the IODP, and other opportunities associated with them at the upcoming convention in Mesa in October.

- Tempe Public Library/Mountain Pointe Pre-school
  We will be donating a "hard" copy of the children's book written about the JOIDES Resolution and its science focus. Both libraries have regularly scheduled preschool story times and we hope to schedule at least one with that book, hoping to perhaps read and share a little of the science and our experience aboard the JR.

Short Term

- Tempe Union High School District Earth Science Curriculum Cadre
We will be sharing the knowledge gained here with our colleagues from our sister schools within the district at the earliest possible opportunity. By sharing lessons we are hoping to grow this to a longer-term project. Our hope is to be able to present some standard-aligned lessons modified from what we've learned here (or from previous School of Rock alumni) and if given the opportunity, perhaps deliver them in the classroom.

Longer term

- Broadmor Elementary / Tempe Academy for International Studies
We are hoping to grow this into a longer-term project, but in the short term hoping to engage elementary school teachers about possible STEAM lessons that focus on the exploration of Earth and the JR's role in this exploration. Our hope is to be able to present some standard-aligned lessons modified from what we've learned here (or from previous School of Rock alumni) and if given the opportunity, perhaps deliver them in the classroom and scheduling Ship to Shore events.

  By engaging students and teachers, we hope to promote the entry of more geoscience related science projects at the annual science fair especially at the 4th and 5th grade where science interest drops off significantly and re-ignite interest within the geosciences.

- College/Career Day (Fall 2017)
We hope to grow the already established college recruitment day into a showcase of the geoscience programs and career opportunities. This will be done by inviting people from the geoscience fields to participate in the college day and promote their career path and the route taken.

- Geeks Night Out (March, 2018)
Tempe Public Library hosts this community event showcasing STEAM education at various levels (K-12, college/university, government and business levels). It is a unique event and draws hundreds of people across the Phoenix metropolitan area. We hope to request the IODP display board and information (if available) for this event. If not, we will use anything we developed for college day and/or an ASTA table display.

How project plans will address and increase participation in the geosciences by underrepresented groups?

Tempe High School serves a diverse group of students. Minority enrollment is 89% of the student body (student body is mostly Hispanic and African American). The majority of students fall into low-mid socio economic categories. Tempe High is a Title I school where the majority of students are on free or reduced lunch programs. There is 48/52 ratio of males to females in a school of 1550.

Mountain Pointe High School also serves a diverse group of students. Minority enrollment is 61% of the student body (student body is mostly Caucasian followed by Hispanic and African American). The majority of students fall into the mid-high socio economic categories. There is nearly a 50/50 ratio of females to males of a school of 2865.

The level of instruction and subsequent knowledge obtained from this experience help us to better connect the process of science with these diverse groups of students. We hope to connect students to geoscience through STEAM driven lessons (pun intended). We believe that by showing that science is accessible to these students, they will seriously consider the geosciences as a possible major.

Education standards will help us meet:

- *AZCCRS Strands 1, 2, 3 and 6*
- *Common Core Literacy Standards for Reading, Writing, and Science*

Other potential partners:

- Mesa Community College / Ventura College / Buena High School
  Through the collaboration with our SOR colleagues, we have found an avenue to approach Mesa Community College about a possible future partnership, hoping to write a GEOPATH proposal which benefits all involved.

- ASU (Arizona State University)
  Through our connections with the School of Sustainability, we hope to similarly develop a partnership with the School of Geoscience, inviting graduate and undergrad students to come to the high school to promote their program interests at our respective college days and scheduling field trips to visit their facilities.

Assistance I may need from USSSP (e.g., contacts, resources, prior activities, funding):

- *Resources and materials (either loaned or given to disseminate at planned events.*

- *Contacts with Education Officers and other positions on the JR. We would like to include Ship to Shore events to include other positions aboard the JR (like engineering, mechanics, and culinary arts) for the CTE (Career & Technical Education) classes we have on our campuses.*

Proposed Timeframe:

Forever until the end of time… we hope to shift our curriculum over this upcoming school year and establish partnerships with aforementioned colleges / universities within the next year. We believe once we establish these types of partnerships they will be sustainable, will adapt as they unfold to include more students, and ultimately have a cumulative impact moving forward.

Other ideas:

We suspect more ideas will come as partnerships grow and our plan is put into action. This plan will evolve as needed to meet the students we serve.

Team Members:

R. Mark Leckie & Kerrita K. Mayfield

Schools/Institutions:

UMASS Amherst & Holyoke High School

Location:

Holyoke, MA; Amherst, MA; Plum Island, MA; possible New York

Audiences (demographics, be specific):

Holyoke High School 9th graders up to ~120 possible if project is successful. All generated from membership in an extracurricular after school science club. If we generate buzz we hope to use this interaction as a classroom incentive.

HHS is: 70% Latinx, 40% of the HoH are women, 96% FRL, 30% are ELL students

Latinx – ungendered designation of Spanish heritage persons in the American dispora

HoH – Head of Household

FRL – a marker denoting family income below the Federal poverty line

ELL – English Language Learner who may be fluent/literate in a language other than English

Individual ideas:

KKM creating activities and networks that connect highs school students to geoscience opportunities in their home region.

RML uses field trips as opportunities to build geoscience wonderment that we hope leads to increased (geo)science participation.

Immediate Plans:

1. Cultivate working relationships between high school science students (club members) & RML –who will provide field trips and co-create some aspects of the science club curriculum.
2. To introduce an outside -> in approach to high school science instruction.

Short Term Plans:

1. Possible reorganization of science club (KKM).
2. Introducing RML to high school students as ally, resource and advocate – establishing a longer term relationship.
3. Planning first of 2 field trips. In the Fall, the first to the dinosaur tracks and wave pattern fossils on the Connecticut Riverfront – then see fossil collection at Amherst College. Holyoke is part of the Holyoke Range. Students will complete own projects to fund their part of the trip.

Longer Term Plans:

Actions:

1. Plan second field trip to Plum Island, Mass (Spring) to talk about hydrogeological implications of climate change as evidenced by changing shorelines, changing industries and beach impacts.
2. Possible pair up with Dori Read's students.
3. Establish working K-16 relationships with UMASS by creating and completing group activities.
4. RML will *Zoom* in from his South Pole expedition.

Outcomes: At the end of last school year students requested two things this plan addresses: They wanted more participants and they wanted field trips. I think this collaboration will provide both.

1. Increased student participation in science club activities.
2. Improved awareness of science activities and pathways that are accessible to my students/community.
3. More town<->gown interaction and sharing of resources.

How project plans will address and increase participation in the geosciences by underrepresented groups.

I've already explicated the statistical data of who my learners are. But they are so so much more. On the end of the year survey they said they were good at: *Visualization. Following directions. Making things.* They also said that they were surprised by: *How much fun they had. They they made things. And that they had access to so much different stuff.* My students are ready for more and deeper engagements with their world via the skills and dispositions of scientific inquiry.

Education standards this will help me meet (if applicable): NGSS – Next Generation Science Standards.

1. NGSS has a standard about the creation and use of models to underscore science concepts. While NGSS stresses that: ***models should always be used to help explain and show the relationships with a real-world phenomenon, not simply define a concept,*** it is much much harder to discern the difference between a defining demonstration and a replication of an interlocking real world event. I

hope that in this collaboration RML and I model the ways science is conducted, and the skills that undergird inquiry.

2. NGSS has 4 categories. Two of which is richly covered by science club: Physical Science & Life Science, the third which will be enriched by working with RML: Earth and Space Processes and a fourth that is covered in other experiences: Engineering and Technological Applications of Science.

Assistance I may need from USSSP (e.g. contacts, resources, prior activities, funding):

Yay funding opportunities! But I would love to personally lever this opportunities into the creation of a series of nationwide, funded, curriculum driven, and standards-based (geo)science opportunities that address the inequity of science resources in underserved communities. Resources= social and political access to structures of institutional power (where, who, and how?), familiarity with the tools of science, and extracurricular opportunities to explore their world. We are simply recreating the hierarchies of power if we keep funding models of interaction that are based in higher ed science leadership and not other forms of partnership. Okay. Hops off soapbox and hope you don't hate me…

Proposed Timeframe:

Starts immediately in the fall.

Other potential partners:

NE aquarium

Boston University

School Districts throughout the state of Massachusetts who can collaborate with the many august higher education institutions there.

Assessment:

Pre and post surveys that ask questions like:

1. Student readiness for science
2. Student perception of science ability
3. Student belief in role of science in talking about the(ir) worlds.

Extensions to this collaboration (Other ideas):

a. GEOPATHS IMPACT (Improving pathways into geosciences through institutional collaborations and transfer) proposal for multi-year training opportunity (*3 year proposals*). ***Letter of intent: Aug 18. Full proposal deadline: October 10.***

b. *Goals:*

i. Convey the importance of Geosciences in an urban environment.
ii. Get urban students and underepresented communities in urban environments into Geosciences
iii. Develop teacher training opportunies
iv. Develop a recursive mentorship training program (K-5, 6-8, 9-12 & undergraduates)
v. Develop joint field trips across institutions, such as:
    1. Plum Island
    2. Beach/ coastal processes (Scituate?)
    3. Dinosaur track site in the failed rift system
    4. Upstate New York to collect Devonian fossils
vi. Develop social justice/diversity education programs across institutions

c. Budget:

i. Cost of CORI (fingerprinting/background checks needed for the partnership)
ii. Cost of field trips
iii. Conference presentation(s)
iv. Publication costs

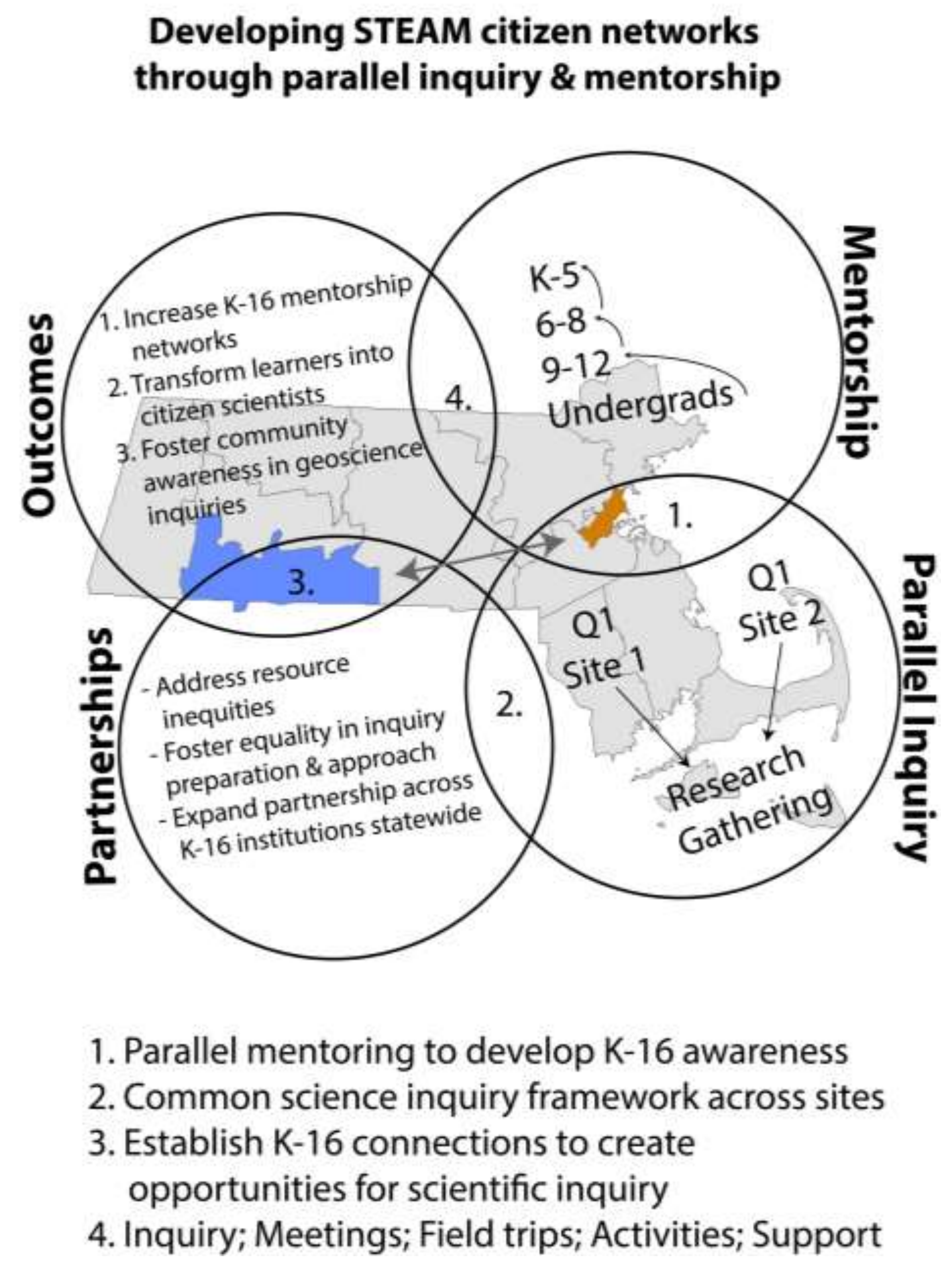


Figure 1: Concept map for GEOPATHS IMPACT proposal: "Developing STEAM citizen networks through parallel inquiry & mentorship"

School of Rock 2017

Team Action Plan

Team members:

Kim Hatch

Dr. Lisa White (mentor)

Schools/Institution:

LBCC - Long Beach City College

Location:

Long Beach, CA

Audiences:

Long Beach City College LBCC student population and the City of Long Beach community.

Demographics:

LBCC 2016; 56% Hispanic, 14% White, 13% African Amer., 13% Asian, 3.5% multi-racial, 0.5% unreported

In addition, LBCC student population is primarily 1st generation college students

City of Long Beach 2010; 41% Hispanic, 29% White, 13% African Amer., 13% Asian, 4% multi-racial

Individual ideas:

For the SOR program – I want to increase the diversity of geoscience majors and communicate the societal relevance of marine sediments to the LBCC college student population and to the broader Long Beach community. I plan create a **Marine Geoscience "pop-up"** display for community outreach at college and community events.

Action Items:

- produce geoscientist career handout (from BLS.gov Bureau of Labor Statistics)
- pathway to college major in geosciences classes;
    - Associate Degree Transfer Geology (LBCC)
    - BS/BA typical transfer courses to UC or CSU for geosciences
- microscopes with microfossil slides for public viewing, to be attended by LBCC students
- display video showing activities on the JR
- get funding for purchase of simulated sediment cores PETM, KT Impact Extinction
- free standing color poster of sediment core(s)
- or print sediment core poster on fabric to lay-out on table
- free standing poster(s) of microfossils in Spanish and English
- careers at sea handout (from Deep Earth Academy Activity book)
- hand-outs and small giveaways from IODP
- create "coloring book" worksheets of microfossils for small kids (example: color the JOIDES activity)
- make "papercraft" model of JOIDES and have pre-printed copies for kids to make at home
- 3-D printed microfossils
- Make simulated paleomagnetic cores from "pool noodles"
- the display should be powered by LBCC portable "DC Solar Power station

Project Partnership Ideas:

Immediate

IODP

Short Term

LBCC

Longer term

CSULB or local high school

How project plans will address and increase participation in the geosciences by underrepresented groups:

The demographics of our college and the public outreach events in the city of Long Beach would be audiences of diverse ethnicities, social, and economic backgrounds. We will have LBCC students armed with geoscience career data and educational pathways information about the geoscience major at our “pop-up”. Having student role models from our college will reflect the larger ethnic make-up of our city and they will be better at engaging the public of all ages.

Education standards this will help me meet (if applicable):

NA

Other potential partners:

We could outreach to Cal State Long Beach geology department to get their students to help manage the “pop-up.” Need to find out if they have an outreach coordinator.

Assistance I may need from USSSP (e.g., contacts, resources, prior activities, funding):

Lisa White is my contact mentor with SOR team and will be monitoring my progress on the “pop-up”

Proposed Timeframe:

Fall 2017 will be gathering tabling materials from IODP and developing materials from scratch. Will have pop-up done by Spring 2018.

Other ideas

NA

School of Rock 2017

Team Action Plan

Team members:

David Hansen, Tom Cawthern, Matthew Campbell

Schools/Institution:

Salisbury Middle School, Salisbury University, University of Queensland

Location:

Salisbury, Maryland, USA; Brisbane, Australia

Audiences:

Middle School
- 8th grade physical sciences/chemistry
- Faculty/staff
- K-12 outreach

University
- Undergraduates (freshmen – seniors)
- Faculty/staff

Individual ideas:

Salisbury Middle School

1. Weather/climate – thermohaline circulation lab: fish tank with waters of different temperatures and salinities; add food coloring to the different “masses” and allow them to circulate.

University of Queensland

1. Seminar events/workshops

2. Guest speakers to give seminars/talks about their trips and experiences with IODP and their research.
3. Promoting IODP trips and opportunities for students to participate.

Salisbury University

1. Partner with the Chesapeake Bay Foundation to leverage existing ship time and field equipment to collect water column samples and grab/core samples of tidal creeks entering the Chesapeake Bay as well as the Bay itself.
2. Provide an option day-long field trip for students enrolled in Introduction to Physical Geology around the seacoast region toward the end of the semester to highlight and point out features that were discussed throughout the course. The rationale for this is multi-pronged. First, many students often comment on course evaluations how they'd like to have field experience. Second, this would reinforce topics discussed in class. Third, this might help lead to retention of majors, but more importantly, this might lead to an increase in the number of majors through engagement of undeclared/undecideds, or it might lead to an increase in the number of minors. The field trip could focus not only on geologic aspects (we have no structure or rocks!), but also the intersection of physical geology and human geography, potentially drawing in those underrepresented students from more rural communities and urban centers by *showing* them exactly how geology affects their daily life – and how it did throughout their lives' and they never even knew it!

Collaborative Plans

1. Both Salisbury University and Salisbury Middle School will mutually benefit from collaborating on the collection of field data. In particular, Salisbury University students will collect vibracore samples of the Atlantic margin, near Assateague Island State Park, Assateague Island National Seashore, and Ocean City, Maryland. Core location will be selected based on consultation with David Hansen's Middle School class. Cores can be split at either the middle school or university; core halves will reside at both localities for description and subsampling. Sieves, limited picking and petrographic microscopes, slides and cover slips, a UV lamp, and UV reactive epoxy can be provided by Salisbury University for students at the middle school to utilize for analysis. One particular are of focus might be overwash sands from tempestites (storm deposits), or perhaps a study of trash accumulation along the beach through trench/core sampling.

   Salisbury University will benefit from this collaboration because it will allow undergraduate students to mentor high school students on techniques. The potential also exists for Salisbury students to help the middle school students analyze their data and prepare them in a scientific poster to display in their school hallway for all to see. Since Salisbury University students will also be using their half of the core for the exact same purpose, students at both institutions should be able to engage in meaningful and enriching discussion as collaborators.

2. Rather than a collaborative plan, this idea for a lab is one that both Salisbury University students and Salisbury Middle School students could benefit from with certain tweaks. The lab will be structured such that a suite of microfossils pictures will be provided to students with their species/genus, age range, and perhaps information regarding bathymetric range, water temperature or any other pertinent ecological information. A hypothetical core will be provided to students. Within sections of each core, “smear slides” will be provided to the students. These smear slides will consist of real enlarged smear slide photos with selected combinations of the microfossils from the pictures provided. Students will have the use the microfossil assemblage within the hypothetical smear slides from each core interval to determine how the core age varied downhole. Next, they will have to determine how species diversity varied downhole. Using this data, students will then be able to investigate how things like water temperature, salinity, etc. might have varied with time.

Project Partnership Ideas:

Immediate

1. Incorporate new lab activities into classes (utilize the Leckie et al. textbook in my Geological Oceanography textbook)
2. Work with partner institutions
3. Contact local public library to establish a contact and line of communication for public outreach
4. Contact community organizers for our local 3rd Friday’s town event to begin planning “pop-up” events

University of Queensland

1. Immediate contacts include people met in the School of Rock program, in particular, Suzy.

- IODP contacts with ANZAC. E.g. Neville Exon
- QUT educator office

Short Term

1. Update lecture content with new literature examples; have students get more hands on with the lecture content by evaluating primary literature datasets in small/large groups in class.

2. Modify existing labs to make them more engaging.

University of Queensland

1. Connecting with other geoscience communities/societies in the Brisbane area – getting their input and ideas to help promote the work of IODP.

Longer term

1. Partner with the Salisbury Zoological Park and community leaders to create an interactive geological landscape within the zoo premises that teaches kids about rock formations from their home state of Maryland (i.e., age, formation, depositional environment, fossils, etc.). Bring in select representative boulders from different parts of the state that kids can climb on and place around the zoo with placards displaying this information, allowing them to make connections to their home state and expand their appreciation for time, space, climate, and faunal change.

How project plans will address and increase participation in the geosciences by underrepresented groups

1. Provide college students the opportunity to mentor middle school students.
2. Provide middle school students with the opportunity to perform original research on a real sediment core using real scientific equipment and instruments.
3. Expose students to a selection of career choices by introducing them to National Park Service and Maryland State Park employees, and marine scientists from the Chesapeake Bay Foundation.
4. Pop-up events and educational outreach opportunities with the library will provide opportunities to engage with under-represented groups.

University of Queensland

1. In terms of addressing diversity in Australia, the immediate and short term action plans will hopefully allow young, geoscientists in their undergraduate years to learn and be exposed to the work being done by IODP. Especially, since the JOIDES Resolution will be situated in the Southwest Pacific region, it provides a unique opportunity for Australian students to join such expeditions and get hands on experience with IODP.

Education standards this will help me meet (if applicable):

University of Queensland

1. **1.** One option could be to take a pre-survey of interest in the IODP geosciences, and then take a survey after to compare if interest has risen or drop since the start/end of seminars and workshops.

Other potential partners:

1. University of Maryland Eastern Shore (UMES)
2. IODP
3. Australian Institute of Geoscientists (AIG)
4. - Geological Society of Australia (GSA)

Assistance I may need from USSSP (e.g., contacts, resources, prior activities, funding):

1. Core examples/samples/materials (travel core)
2. Laboratory activities used during School of Rock
3. Registration fees for 3rd Friday
4. Contacts, resources and advice would be the main assistance needed for this project plan (Matt)

Proposed Timeframe:

1. Some proposed items are easier to begin within the first year; others, like the pop-ups and 3rd Fridays will take some time to gain traction.
2. 6 – 12 months to establish and build relationship/communication with relevant people from IODP in Australia, as well as other geological communities (Matt)

Other ideas

1. The Salisbury, MD community would respond favorable/positively to the new JOIDES Resolution traveling expedition. Once the exhibit is fully operational, David and I would be very interested in helping to bring this to our home town.

School of Rock 2017

Team Action Plan

1. **Team members/ /Location**
   - Helenice Vital/Natal, Brazil
   - Miguel Borges/Natal, Brazil

2. **Schools/Institution:**
   - Federal University of Rio Grande do Norte (UFRN)
   - Federal Institute of Paraíba (IFPB)

3. **Location**
   - Natal-RN, Brazil
   - Picuí-PB, Brazil

4. **Audience**
   - **Middle School**: ~100 students/year
   - **High School** (technical in Geology): ~100 students/year
   - **Undergraduate:** ~60 students/year
   - **Graduated** (Msc./Phd.): ~30 students/year

5. **Individual Goals**
   - Replicate along the Brazilian margin the lessons learned in SOR, using Brazilian ships or ships financed by the Brazilian Government (or others financial sources), to create a Brazilian IODP Summer School. This Brazilian summer school aims the preparation of scientists and students at different levels, and would support the Brazilian site surveys of IODP proposals, recommended by the SEP, with Brazilian participation.
   - Increase the diversity of the talent pool that will apply to sail on IODP, and related expeditions in the future, especially when we take in account the expected increase of proposals to the Atlantic South Ocean.
   - Local partnerships to establish a better connection and cooperation

between the university, and, high- and middle schools as well.

6. **Ideas**

   Immediate

   Disseminate and expand the knowledge of the deep sea to the Brazilians in the different levels of education by:
   - Promote IODP program showing how are done research aboard JOIDES Resolution on Brazilian science conferences (Ex.: Northeastern Symposium of Geology 2017, 2º IODP-CAPES Brazilian Meeting, CIENTEC 2017 - UFRN Fair of Science & Technology); IFPB Fair of Science)
   - Develop an extension project to promote marine sciences and IODP program in different public schools of the States of Rio Grande do Norte and Paraíba
   - Work activities from SOR 2017 in classroom to make evident the importance of core data to geoscience

   Short Term

   Apply for funding to create the Brazilian SOR (CAPES, CNPq, MCTi, …)
   - Short-courses for middle and high school teachers transferring SOR ideas about mentoring and adviser to improve diversity
   - Improve Brazilian students and scientists applications for IODP Cruises

   Longer Term
   - Encourage Brazilian ocean researchers to submit new proposals for IODP
   - Execute Brazilian School of Rock (Shore and/or in ship)

7. **How project plans will specifically address diversity in the geosciences**
   - Attracting woman, black people and low-income by divulgation of IODP in public school

8. **Other Potential Partners**
   - Federal Institute of Rio Grande do Norte (IFRN)
   - CAPES/IODP

9. **Evaluation Strategies**

   - Number of school visited
   - Number of students attended
   - Number of Brazilian students and researchers selected or applied for IODP leg

- Number of short-curses
- Number of Brazilian SOR

10. Assistance I may need from USSSP and SOR team or other

- Contacts
- Instructors
- Materials
- Funding

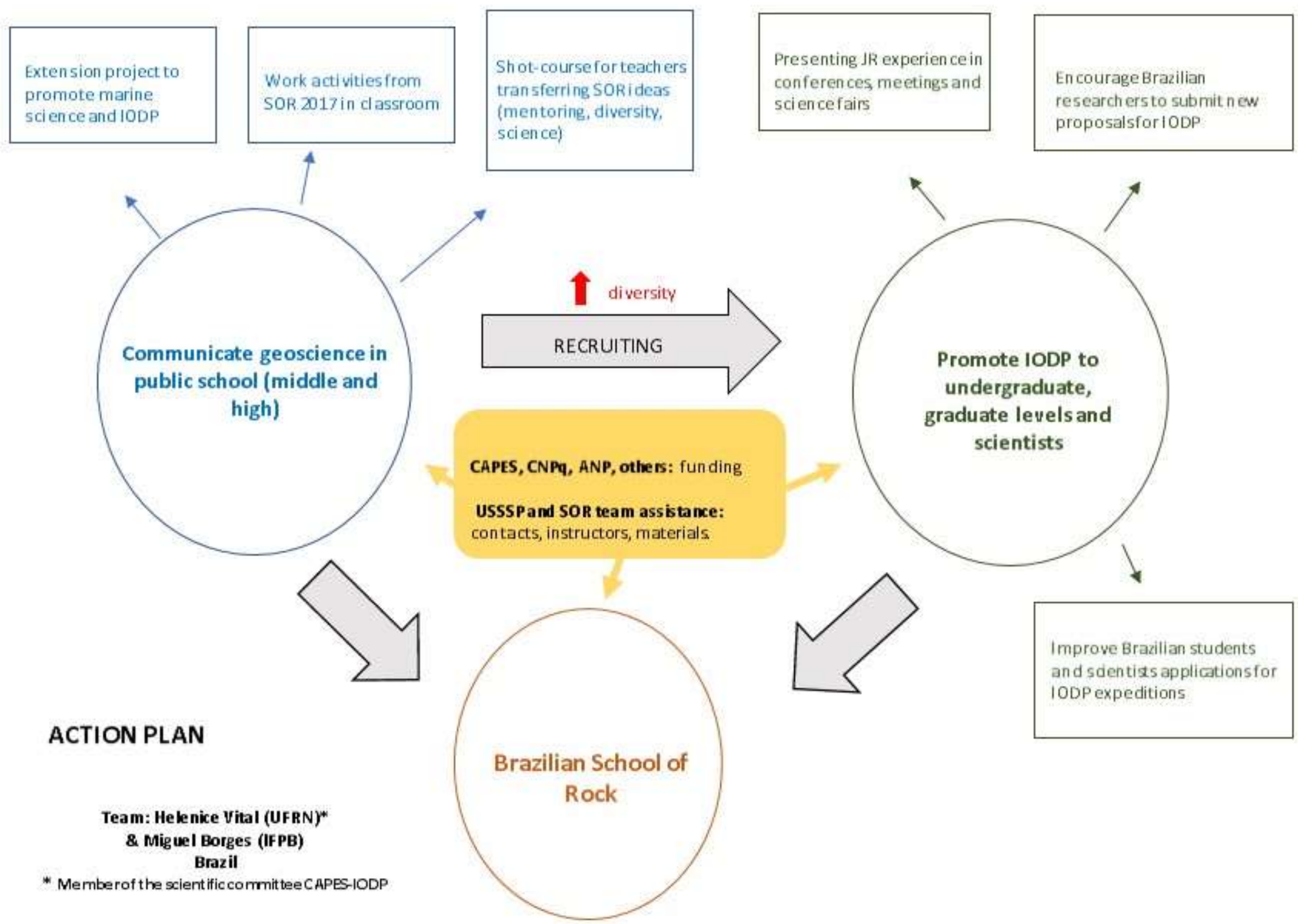
11. Proposed Timeframe

Activity / Year	2017	2018	2019	2020
Talks for Middle- and High School students	X	X	X	X
Short-courses for Middle- and High School teachers		X	X	X
IODP presentations in Sciences Fair	X#	X	X	X
Presentations in Congress, symposium, conferences	X*	X**	X	X
Funding application for Brazilian SOR	X	X	X	X
Brazilian SOR execution		X	X	X

CIENTEC 2017 - UFRN CIENTEC 2017 - UFRN Fair of Science & Technologize to be held in Natal in October 2017 (Confirmed for 2017). CIENTEC occurs annually. Necessary to apply each year to have the stand.

* Northeastern Symposium of Geology, to be held in Joao Pessoa in November 2017, 2o. CAPES-IODP Brazilian Meeting and Brazilian Meeting of Marine Geophysics & Geology to be held together in Itajai (SC) in November 2017.

** GeoSciEd VIII conference to be held in Campinas in July 2018, Brazilian Geological Congress to be held in Rio de Janeiro 2018.



ACTION PLAN

Team: Helenice Vital (UFRN)*
& Miguel Borges (IFPB)
Brazil

* Member of the scientific committee CAPES-IODP

School of Rock Action Plan

Location: Ventura, California

Partnership:

- *Julia Domenech* - Buena High School - Earth and Space Science course (9-12 grade)
- *Chloe Branciforte* - Ventura College - Geology courses (Physical Geology, Historical Geology, Geology of the National Parks, Geologic Disasters)

Additional people

- Lab tech at VC
- Additional faculty at both BHS and VC
- SOR Mentors – IODP
- Coast Geologic Society and other local gem and mineral clubs

Audience:

- Students (9^{th} – 12^{th} grade and community college students)
- Colleagues and fellow faculty
- Ventura County Community

Ideas:

- Provide a collaborative opportunity between Ventura College and Buena High School.
    - Majority of non-university bound Buena HS students continue their education at VC.
- Integrate/increase paleoclimate data into new or existing Geoscience and Earth Science courses.
    - Use lessons and activities provided by SOR throughout coursework.
        - Understanding climate change activity (from UC Berkeley)
        - Utilize new research, data, and information in lesson plans, lectures, activities, etc.
    - Alignment with Next Generation Science Standards (NGSS) Earth Science standards at HS level.
- Expand geologic, paleoceanographic, and/or paleoclimatic research opportunities for high school and community college students through student centered and project based learning.
    - Help to increase diversity in the geosciences (SDAIE and HSI).
        - Pop-up science at the VC Swap Meet (Ship Trip)
        - Mentorship between geology majors and BHS science students

        - Fostering STEAM literacy (HS, VC, and within the local community)
        - Coordinate with Earth Science Week, National Park Week, and other significant science or art celebrations.
- Deliverable regarding collaboration with a geoscience education publication (i.e. AGU, NAGT, GSA, etc.)
    - Pop-up science?
    - Measurable advancement in STEM literacy?
    - Demonstrate diversity increase?

Assessment:
- Long term project
- Education standards:
    - BHS – NGSS
    - VS – Program and Course Student Learning Outcomes

Approximate Timeline:
- Implement collaboration between VC and Buena HS (2017-2018 academic year)
- Students utilize data available through IODP to complete research projects and activities.
- Throughout the fall and spring, information is disseminated to students, colleagues, and community.

Resources needed from IODP
- Replica cores
- Core data – available through website
- 3-D microfossil files
- Funding
    - Attend AGU, GSA, etc.
    - Identification of funding for materials and additional opportunities.