GULEED ALI
Date Orals Passed: 4/13
Advisory Committee: Hemming, Christie-Blick, Broecker

My dissertation work is focused on constraining a Last Glacial Maximum and deglacial record of hydroclimate change from the Mono Basin, California. The emphasis of my work is on sedimentary and stratigraphic observations that I use to interpret lake level fluctuations—a proxy for changes in the basin's precipitation minus evaporation balance. I hope that this, along with a chronology based on uranium series and radiocarbon data, can yield an accurate and precise record, which can be used by climate modelers to understand the dynamics of this period's climate change. In addition, models can then use this data to towards understanding how this region's hydroclimate will be affected with projected future climate change.

RAFAEL ALMEIDA
Date Orals Passed: 4/09
Advisory Committee: Christie-Blick, Anders, Hemming

I am looking at patterns of crustal extension in Southern Nevada. By re-evaluating the constraints on amounts of extension in the Lake Mead Domain of the Basin and Range, I will try and determine the validity of the proposed mechanisms for crustal extension in the region. Given that this region has been pivotal for the development of ideas regarding crustal extension, this re-evaluation is important for extensional processes in general.

USAMA ANBER
Date Orals Passed: 4/13
Advisory Committee: Sobel, Polvani, Shaw

Idealized models for tropical climate

Extensive cloud resolving model simulations with idealized settings are conducted in order to understand important parameters controlling the climate of topical regions interacting with the global atmosphere. This interaction is accomplished through parameterization of the large-scale circulation.

Among these parameters, we investigate the effect of the environmental vertical wind shear of atmospheric convection when the radiative cooling is prescribed and when it is interactive. Convective organization, mean precipitation, and its variability are strong functions of the vertical shear.

We also examine the vertically integrated moist static budget for surface fluxes of moisture and sensible heat versus radiative cooling rate. Convection responses differently for two different initial conditions of moistures. Moreover, the range of multiple equilibria is very wide when starting with zero moisture as initial condition.
CLAIRE BENDERSKY  
*Date Orals Passed: 4/12*  
*Advisory Committee:* Plank, Kelemen, Gaherty

**Destruction of the Continental Lithosphere in the Southwestern United States**

The lithosphere is the strong lid at the surface of the earth that sits on the less viscous asthenosphere. It is the crust and uppermost mantle that behaves coherently with the crust. The Earth efficiently recycles oceanic lithosphere within ~200Ma, yet cratons and their lithosphere persist for over a billion years. Why and how cratons deform is unclear. Current thought cratonic lithosphere persistence is divided into two incompatible ideas: it is either strong or buoyant. Geochemically a buoyant lithosphere is warm and depleted (experienced significant melting and melt removal); a strong mantle is dry, cold, and undepleted.

Geophysical studies indirectly observe the lithosphere-asthenosphere boundary. It can be seen seismically as a low velocity zone under a high-velocity seismic lid. Geochemical studies directly observe the mantle. Basalts, brought to the surface by volcanoes, are mantle melts. My research combines these methods to sharpen our view of lithosphere-asthenosphere boundary behavior and gives insight to processes acting on it.

Today the eastern and western margins of the Basin and Range, in the Southwestern United States, are undergoing active lithospheric deformation. The boundaries of the Basin and Range are bands of extension, faulting, and active volcanism. My research uses basalts from the young volcanism to determine pressure, temperature and volatile conditions of the mantle. These results are combined with recent images of today’s mantle, from EarthScope’s USAArray, to provide a clear picture of the processes acting to deform the lithosphere.

SOPHIA BRUMER  
*Date Orals Passed: 4/13*  
*Advisory Committee:* Zappa, Gordon, Sobel

My research focuses on air-sea interaction. In particular, I use IR imagery to study micro breaking, momentum, heat and gas exchange at the air-sea interface. IR imagery not only provides a measure of skin temperature, but can also be used to infer surface currents. Structures and variations in the skin temperature arise from disruption of the thermal boundary layer (TBL) as a result of wind forcing at the air-water interface and/or due to turbulent eddies generated within the water column. The TBL makes up top few micro meters of the water column and the key intermediate between the ocean and atmosphere, which plays a crucial role in heat and gas exchanges. My studies aim to infer subsurface and bulk water column characteristics such as turbulent kinetic energy dissipation, and water depth from non-intrusive surface measurements of the thermal boundary layer. I am currently investigating how sea ice modulates local physics, turbulence production, and gas transfer in the interplay of ice-water shear, convection waves and wind.

CHEN CHEN  
*Date Orals Passed: 4/11*  
*Advisory Committee:* Cane, Ting, D. Chen

**Integrated evolution of the atmosphere-ocean coupled modes**

El Niño and the Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and Atlantic Multidecadal Oscillation (AMO) are a few significant modes of climate variation from interannual to multidecadal time scales identified from sea surface temperature (SST). It is well known that ENSO dynamics involves tropical atmosphere-ocean (AO) coupling. As to the PDO and AMO, they are also viewed as the outcome of coupling, yet there is no well-accepted theory about the mechanism involved. Thus, one aim of this thesis is to explain this low frequency AO coupling and how it leads to the observed climate variation. Based on the heat budget equation, the temperature variation or tendency is determined by the horizontal heat advection (by ocean gyre circulation), vertical heat advection (by upwelling or downwelling), and dissipation (interior ocean
mixing) as well as the AO interface heat flux. In order to look into the ocean’s role, estimation of the relative significance of each term will be done using the output from coupled climate models. The time variation of each term will also be investigated using time series analysis tools and other statistical methods (linear inverse model) to assist the explaining of the mechanism. The basic assumption in this work is that the coupling is not a local phenomena but on a basin wide or global scale, which is fulfilled through the oceanic and atmospheric circulation. By studying this topic, we attempt to understand the fundamental question of how heat is transported through AO coupling within the climate system. Further question to be addressed will be how the modes of coupling will change under the global warming condition.

JIANYE CHEN
Date Orals Passed: 4/12
Advisory Committee: Norell, Meng, Flynn

Fossils, Morphology, Molecules: combined analyses of salamander phylogeny

Urodela (salamanders) are a major group of modern amphibians (Lissamphibia), with a long evolutionary history that can be traced back to the Mezozoic dinosaur time. Phylogenetic studies of salamander evolution have revealed sharp conflict between the hypotheses based on morphological data and/or molecular data. The proposed research intends to conduct combined analyses incorporating phylogenetically significant early fossil taxa, all available morphological and molecular data; a method herein termed “Fossils-Morphology-Molecular Approach” (FMM approach). Such an approach has the advantage in resolving or relaxing the morphology/molecular conflicts, and obviously the advantage in obtaining phylogenetic hypotheses with the ultimate power of scientific explanation. Fossil discoveries from the Middle Jurassic to Early Cretaceous beds in northern China have provided the key material for understanding the origins and early evolution of modern salamander clades. The fossil material found includes the earliest known fossil record of two major salamander clades (Cryptobranchioidea and Salamandroidea), and the basal taxa of several modern salamander clades. These fossils, together with other Mesozoic fossils worldwide, not only increase the taxon sampling for the phylogenetic analysis to be conducted, but also represent new combinations of anatomical characters, many of which are ancestral to salamander evolution. Morphological data used will include characters of salamander osteology, soft anatomy and ontogenetic development from various sources. Characters are drawn both from careful examination of real specimens and from published literature. Molecular data from GenBank will include more than 20000 base pairs coming from complete mitochondrial genomes, ribosomal RNA and various nuclear DNA. These data will be analyzed both separately and combined. Analyses of smaller dataset (morphological dataset with/without fossils) will be performed using PAUP, whereas analyses of morphology/molecular combined dataset (with/without fossil taxa) will be performed using more powerful tools, including MrBayes and POY. Phylogenetic results of parsimony analysis will be compared with that of Maximum Likelihood and Bayesian analysis. Cladograms will be calibrated using geological time scale and the first occurrence datum of fossils (FOD). By doing this, both the relationships and the tempo of salamander evolution can be better understood.

WING YIN CHU
Date Orals Passed: 3/13
Advisory Committee: Bell, Buck, Nettles

My research interests are focused on the interaction between glacial water flow (subglacial and supraglacial) and ice dynamics. Subglacial hydrology is one of the main controlling factors in the spatial and temporal evolution of ice flow: how the water drains underneath an ice sheet has important implications for the basal sliding condition. However, subglacial water drainage is dynamic in space and time and varies in a complicated manner coupled to surface hydrology. Despite recent conceptual advances, relatively little is known about how the surface hydrology interacts with the subglacial drainage system and how it affects effective pressure and ice flow. Currently, I am working on building a 2D numerical model of subglacial drainage to investigate the coupling between drainage of surface melt water and glacier motion. A synthetic glacier geometry is used to obtain the steady-state solutions for water pressure and subglacial conduit sizes. The water pressure solution is applied to a sliding law to calculate ice flow speed. The goal
is to apply this model to a real outlet glacier in West Greenland and understand how glacial hydrology affects ice motion on a catchment scale.

**SLOAN COATS**  
*Date Orals Passed: 4/13*  
*Advisory Committee: Smerdon, Seager, Miller*

My research focuses on model-data comparisons of low-frequency hydroclimate dynamics using the CMIP5 and PMIP3 model archives. Specifically, I use the paleoclimate record as a model target for both specific hydroclimate features (e.g. megadroughts in the Southwest of North America) and more generally hydroclimate variability on multidecadal-to-centennial timescales in the PMIP3 model runs.

**ELLEN CRAPSTER-PREGONT**  
*Date Orals Passed: 4/13*  
*Advisory Committee: Ebel, Walker, Plank*

Chemical and Textural Variations of Ca-and Al-rich Inclusions in Carbonaceous Ornans-like Chondrites

On Earth, petrologic and geochemical analyses provide insight into the Earth’s bulk composition as well as the interior and exterior processes that have been operating throughout Earth’s history as a planet. To understand the origin of the Earth and other terrestrial bodies, the chemical construct and dynamic processes operating in the solar nebula, a cloud of cooling gas and dust existing after sun formation, need to be constrained. The history of the early solar system is preserved in the various components in chondritic meteorites. Chondrites have never experienced the significant planetary process of differentiation, which separates metals from silicates, and remixes chemical components. Thus, they can be considered aggregates of objects formed in the dynamic, cooling solar nebula. Ca- and Al-rich inclusions (CAI) are some of the highest temperature solids formed and preserved in chondrites. The chemistry and texture of the CAIs directly reflect the conditions and processes in the CAI forming regions of the nebula. While many previous studies have chosen to focus on a few objects in detail, my study aims to examine many CAIs to better understand chemical, mineralogical, and textural variations and correlations.

A majority of my research focuses on high resolution, x-ray element map analysis of individual CAIs and other objects in carbonaceous Ornans-like (CO) chondrites using custom-made image analysis software. But, to obtain a more complete understanding of complementarity, or the concept that bulk CO chondrite has a solar composition while individual components do not, I am analyzing the rare-earth element (REE) patterns in individual components. Determining the relationship between object mineralogy, texture, and REE pattern will yield insight into the occurrences of various components and their relative proportions that must combine to maintain solar composition within the bulk chondrite. This broad survey of CAIs and other objects in CO chondrites will help constrain astrophysical models, refine the order in which minerals condense from the solar nebula, and further improve the formation criterion necessary to produce the observed variation. Altogether, the results of this study will contribute to our understanding of our solar system as solids began to form and the journey these solids took before becoming asteroids or planets.

**MEGHAN CROWLEY**  
*Date Orals Passed: 9/10*  
*Advisory Committee: Plank, Kelemen, Spiegelman*

Constraints from volatiles on magma ascent and eruption dynamics
CATHLEEN DOHERTY
Date Orals Passed: 4/12
Advisory Committee: Class, Goldstein, Hemming

Constraining the dynamic response of subcontinental lithospheric mantle to rifting using Re-Os model ages in the Western Ross Sea, Antarctica

In order to understand the dynamic response of the subcontinental lithospheric mantle (SCLM) during rifting, it is important to be able to distinguish the geochemical signatures of SCLM vs. asthenosphere. Recent work demonstrates that unradiogenic Os isotope ratios can indicate old depletion events in the convecting upper mantle, and allow us to make these distinctions. Thus, if SCLM can be traced across a rifting margin, then its fate during rifting can be established. The Western Ross Sea of Antarctica provides favorable conditions to test the dynamic response of SCLM to rifting. The West Antarctic Rift System (WARS) is a region of active extension that separates West Antarctica from the East Antarctic craton, and is characterized by a multi-stage tectonic history. Furthermore, widespread Cenozoic volcanism in the Ross Sea Area that post-dates major episodes of rifting has supplied mantle xenoliths with a range of compositions that sample the lithospheric mantle across the rifted margin.

My current research involves using a suite of analytical techniques to investigate the geochemical and dynamic evolution of the SCLM beneath the WARS. The first chapter of my thesis involves using the Re-Os isotope system to constrain ages of melt depletion and subsequent stabilization of the SCLM. By combining melt depletion ages and with pressure-temperature conditions (i.e. depth constraint), we can begin to uncover the structure of the SCLM subsequent to rifting. The next step in this study is to use Sr-Nd-Hf-He isotope systems and trace elements to investigate the role of the SCLM in the formation of regional volcanics, look for evidence of metasomatic re-enrichment after melt depletion, and determine the possibility of mantle plume activity. From this, I hope to gain a better understanding of the mantle’s role in continent formation, and how it records geochemical differentiation events in a tectonically complex region.

ZACHARY EILON
Date Orals Passed: 3/13
Advisory Committee: Abers, Gaherty, Buck

My research has focussed on the Woodlark Rift in southeastern Papua New Guinea. This is one of the youngest and most rapidly extending continental rifts in the world, and is an intriguing locality for investigating how continents break apart. Within the most highly-extended continent lie the D’Entrecasteaux Islands (DIs), comprising metamorphic core complexes that contain the world’s youngest ultra-high pressure coesite eclogite, which appears to have been exhumed at rates of ~20 mm/yr. I have applied a variety of seismological techniques to investigate this region, using data from a temporary array that ran from 2010-2011, and was installed by members of the LDEO seismology dept..

My analysis of shear-wave splitting, using mantle-traversing teleseisms, shows strong anisotropy beneath the DIs, which I have attributed to crystallographic fabric in the shallow mantle caused by the rate and extent of continental rifting. I have related anisotropy and shear strain in the shallow convecting mantle to predict shear-wave splitting times that are very close to the splitting times I observe, bolstering our hypothesis that the anisotropy arises from mantle fabric, in turn related to rifting. My findings constrain the way in which mantle flow transitions as a rift matures from a small-scale extensional regime to a large-scale divergent boundary.

At present, I am conducting body-wave tomography in the same region, using teleseismic P- and S- wave arrivals. I hope to make use of our understanding of pervasive mantle fabric to measure anisotropic seismic velocity heterogeneities. This project should yield a detailed understanding of the kinematics and history of this rift, and the relationship between the DIs and the more developed rift to their east.
ELEANOR FERGUSON  
*Date Orals Passed: 4/13*  
*Advisory Committee: Steckler, Anders, Christie-Blick*

I am investigating the very young, active, crustal-scale Shillong compound anticline in northeast India. The structure displays segments: western, within continental India; central, along a bend in the former passive margin; and eastern, overridden by the west-verging Burma accretion system. This provides an ideal natural laboratory for studying transient topography, the evolution of a continental collision, tectonics in transition and the intersection of major structures. I have been mapping the structure and my results challenge the currently accepted model that has the Shillong Massif uplifting between a pair of steeply dipping reverse faults unrelated to the Himalayan system of crustal-scale thrusts. I am using catchment-wide denudation rates determined from cosmogenic radionuclides (10Be) in the modern rivers draining the steep southern limb of the central anticline to provide constraints for a iterative uplift/erosion model. Unconformities observed on the hangingwall of the Dauki Fault are also providing new constraints on the relative timing of uplift and the interaction between the Shillong anticline and the Burma foldbelt.

ANNA FOSTER  
*Date Orals Passed: 4/10*  
*Advisory Committee: Ekstrom, Nettles, Gaherty*

Observations and models of surface-wave propagation across the western United States

The composition and structure of the interior of the Earth are inaccessible to physical observation, and instead must be investigated remotely. My research approaches this using teleseismic surface waves that have been recorded on the USArray Transportable Array. Using a new two-station method, the inter-station phase is measured and inverted for a phase-velocity model at discrete periods. These models are improved using corrections based on the change in observed arrival angle of energy at a station compared with the arrival angle predicted for straight-ray travel along the great-circle path. The arrival-angle estimates are made using a mini-array method similar to beamforming, and constitute a useful data set in their own right. The second part of my thesis involves characterizing these variations as they are tracked across the array, and determining the type of velocity structure required to cause them. The final part of my thesis will investigate another wave-propagation effect that influences both phase measurements and arrival-angle estimates. Overtones are known to make measurements on fundamental-mode surface waves difficult at certain periods. I plan to investigate these effects on local phase-velocity measurements, improving our understanding of overtones and detailing criteria for removing data contaminated by overtone interference.

SHUOSHUO HAN  
*Date Orals Passed: 3/11*  
*Advisory Committee: Carbotte, Mutter, Buck*

Investigations of Hydrothermal Alteration of Oceanic Crust on Mid-Ocean Ridge Flanks from Seismic Observation and Numerical Modeling

Oceanic crust constitutes 70% of the surface of the solid earth. It is generated at mid-ocean ridge crests, physically modified by hydrothermal alteration, mineralization, and sedimentation as it ages and moves away from the ridge, and eventually consumed at subduction zones. Hydrothermal activity within the oceanic crust plays an important role in the global heat transfer and geochemical exchange between lithosphere and oceans, and plays a primary role in the seafloor and subseafloor biological activity. My thesis focuses on the alteration of oceanic crust by hydrothermal activity at mid-ocean ridge flanks and consists the following parts:

1. Integrated seismic study on the crustal structure above a prominent off-axis magma lens (OAML) around 9°39′N, East Pacific Rise. I use 3D seismic reflection imaging and 2D streamer tomography on downward continued shot gathers to constrain the structure of the recently discovered 9°39′N OAML and the overlying upper crust, in order to understand OAML’s potential
contribution as heat sources for localized high-temperature hydrothermal circulation on the ridge flanks.

2. Numerical modeling of the off-axis sill intrusion at mid-ocean ridge. I will model the off-axis sill intrusion process and the thermal structure with the presence of off-axis magma bodies to better understand their influence on the hydrothermal flow pattern at ridge flanks.

3. Seismic study on upper crustal evolution from Juan de Fuca Ridge to Cascadia Subduction Zone. I will analyze the active source seismic data recorded by both multichannel streamers and ocean bottom seismometers along two 300-450 km long profiles to constrain the evolution of upper oceanic crustal structure due to hydrothermal alteration. The overall goal of this project is to study how the oceanic crust becomes hydrated with age and to estimate the water content in the oceanic crust when Juan de Fuca Plate subducts beneath North America Plate, which has important implication of the earthquake and volcanic activities at Cascadia Subduction Zone.

ALISON HARTMAN

Date Orals Passed: 4/10
Advisory Committee: Goldstein, Anderson, Hemming

Neodymium Isotopes in the Atlantic Ocean

Neodymium (Nd) isotopes are an important water mass tracer in the Atlantic ocean. Records of the bottom water Nd isotopic composition have been preserved in an array of substrates within deep sea sediment cores and can be used to investigate how the Nd signal has changed throughout time. By determining the Nd signal in regions of water mass mixing, we can investigate paleoceanographic questions. For this project, we seek to determine changes in the deep water Nd isotope composition in the South Atlantic. This region is the most southern extent of North Atlantic Deep water, which is often used to monitor changes in meridional overturning circulation during glacial to interglacial transitions. Nd isotopes measured from modern day seawater samples in the North Atlantic can be interpreted in ways other than water mass mixing. Dust, hydrothermal vents and boundary exchange are potential sources of Nd to the ocean. We will seek to understand how these inputs affect the isotope composition and Nd concentration.

L. GENE HENRY

Date Orals Passed: 4/12
Advisory Committee: McManus, Hemming, Anderson

Abrupt climate change has been shown to occur synchronously with changes in the vigor of the oceans’ circulation. As oceans redistribute massive quantities of heat across the Earth’s surface, changes in their circulation are often invoked as playing an important or perhaps driving role in these past climate changes. Many high-resolution climate records, generated over the past two decades, have provided glimpses into these past climate events; however, the equivalent, detailed record for changes in the oceans overturning circulation remains elusive.

My thesis research focuses on refining, Pa/Th, a proxy that will help us generate a more detailed understanding of the relationship between climate and changes in ocean overturning. Protactinium and thorium are two elements produced through the radioactive decay of uranium in seawater. As the concentration of uranium is well known and relatively homogenous in the ocean, the disparate chemical properties of these two elements help us to understand the strength of the oceans’ circulation regime, elucidating the role of the oceans in global climate change.

Abrupt shifts in the Atlantic’s circulation regime have been inferred from carbon isotopes within benthic foraminifera, geostrophic gradient shifts captured in oxygen isotope data from benthic foraminifera, and the change in burial rate of 231Pa/230Th in bulk sediment. Drift deposits are often selected for 231Pa/230Th paleoceanographic reconstructions because the sedimentation rates far exceed those of the mean ocean average, thus allowing for resolution of transient climate events not preserved in other seafloor sediment cores. The fine sediment (<20um) that makes up the majority by mass of these deposits is chiefly carried from non-proximal localities. Previous work suggests that the fine fraction of the sediment carries a disproportionately high
concentration of authigenic thorium, 230Th, and extra-terrestrial helium, 3He, two nuclides frequently employed as constant-flux proxies in the aid of climate reconstructions from sediments.

GE JIN
Date Orals Passed: 3/11
Advisory Committee: Gaherty, Abers, Buck

I’m interested in details that how the teleseismic surface wave propagation responses to the Earth’s structure. The accurate characterization of seismic surface wavefields across an array of stations provides constraints on crustal and mantle shear velocities and anisotropic fabric directly beneath the array. We have developed a new multi-channel cross-correlation procedure that allows us to track phase and amplitude differences between nearby stations with high precision. These relative phase and amplitude measurements can then be used to reconstruct a smooth phase and amplitude surface across the array. Via the Helmholtz equation, the gradient of the phase surface, appropriately corrected for amplitude variations, provides the dynamic phase velocity of the wavefield, which is dependent both on earth structure and non-plane wave propagation anomalies. Since each event provides an independent dynamic phase velocity map, by comparing the maps as a function of source-receiver azimuth, we can distinguish the velocity anomalies that are related to Earth structure with the ones that are caused by propagation anomalies.

COLIN KELLEY
Date Orals Passed: 4/11
Advisory Committee: Ting, Seager, Kushnir

Identifying the relative contributions of natural variability and anthropogenic forcing to Mediterranean precipitation change at multidecadal timescales

"In order to better predict future Mediterranean precipitation change it is necessary to understand not only the mechanisms that combine to bring about decades of dry or wet conditions, but also to what degree each mechanism may be influenced by natural multidecadal variability relative to any human-induced response to increasing greenhouse gases.

Climate models predict a steady decrease in 21st Century precipitation over most of southern Europe, the eastern Mediterranean and the north African coast as a result of higher atmospheric concentrations of greenhouse gases. This expected drying has important societal ramifications.

Research indicates that multidecadal precipitation change during the 20th Century was dominated by natural variability but that toward the end of the century the anthropogenic response began to emerge and is particularly evident in the Eastern Mediterranean where the low frequency natural variability is less pronounced. If this anthropogenic signal continues to increase, as the models predict, then its influence will become stronger relative to the natural variability."

JIYAO LI
Date Orals Passed: 5/13
Advisory Committee: Shillington, Abers, Webb

Current seismic behavior and variation of seismic reflectivity signature for megathrust in the Alaska/Aleutian Subduction zone

Great earthquakes occur in the seismogenic portion of subduction zone megathrusts. Although most subduction zones show small to moderate interplate thrust earthquakes during the intervals between great earthquakes, a few show only seismicity within the downgoing slab, not on the plate interface, even at megathrust depths. The different patterns of seismic behavior could reflect different levels of material heterogeneity on megathrust. Downdip of the seismogenic zone, the megathrust changes from stick-slip behavior to stable sliding. Competing models suggest that the transition is controlled by temperature or the intersection of the megathrust with the
serpentinitized forearc mantle wedge. In some subduction zones, changes in behavior appear to be accompanied by changes in seismic reflection signature.

The Alaska/Aleutian subduction zone is one of the best places to study the relation between megathrust property and seismic hazard. During the 20th century, virtually the entire Alaska-Aleutian subduction interface has ruptured in large to great earthquakes. The 1964 Mw 9.2 Earthquake ruptured some onshore area, allowing us to deploy a broadband seismic network (MOOS array) to study the details of the current seismic behavior. Further west, the rupture zone of 1938 Mw 8.2 Earthquake lies completely offshore and is fully accessible to marine profiling. The megathrust of the Alaska/Aleutian subduction zone also exhibits large variations from locking to freely sliding along strike from recent GPS study.

My thesis focuses on the seismic behavior and reflectivity of the megathrust in the Alaska/Aleutian subduction zone and consists of:

1. A detailed study of seismicity recorded by the MOOS array. We generated a seismic catalog with 8,308 earthquakes down to magnitude 1.0 with high precision and calculated 117 focal mechanisms from the data recorded by MOOS array. Most microearthquakes are showing normal faulting mechanisms, and the direction of the T axes generally follows the dipping direction of the slab, indicating that they lie inside the subducting slab under down-dip extension or result from plate bending. Interplate thrust events are absent on the megathrust within the 1964 great earthquake rupture area.

2. Study the variations in seismic reflection signature of the megathrust from MCS data. We trace the reflections of the plate interface from the trench to place 140km landward on the dip profile across the rupture zone of the 1938 Mw 8.2 earthquake. Large variations in the reflection response are observed with depth. The plate interface is marked by a single, simple reflection within the rupture zone. Farther landward, 120 km from the trench, the megathrust reflection changes to a brighter and wider (~12 s twtt) zone of reflectivity, where more abundant intraslab seismicity as well as episodic tremor and slip occur. The change in the megathrust reflection response appears to occur where it intersects a shallower band of reflectivity, which we tentatively interpret as the continental Moho.

ALEXANDER S. LLOYD

Date Orals Passed: 5/11
Advisory Committee: Plank, Kelemen, Buck

Magma Ascent Rates during the 1974 eruption of Volcán de Fuego: Insights from Volatile Loss

Assessing the rate at which basaltic magma degasses and ascends during an explosive volcanic eruption is a complex task. The rheologic properties of basaltic magma and the poorly understood nature of conduit and magma chamber processes during explosive eruptions create a unique challenge to which traditional ascent chronometers cannot be applied.

For my thesis, we are exploring three novel techniques to assess the decompression/ascent rates during the 1974 eruption of Volcán de Fuego. When a volatile-rich magma ascends through the crust, dissolved H2O and CO2 begin to exsolve into a gas phase. This process of exsolution creates a state of disequilibrium between the melt and the phenocryst. We think it is possible to estimate timescales by assessing the degree of reequilibration that occurs in volatile concentrations between the external melt and the phase in question. Chapter 1 will focus on evaluating the possibility of H2O reequilibration of melt inclusions during ascent; chapter 2 will utilize new analytical capabilities and established techniques to measure and interpret multi-element diffusion patterns in melt embayments; and chapter 3 will determine whether zoning patterns in nominally anhydrous minerals are related to crystal growth or represent another signature of diffusive reequilibration during ascent.
MIRIAM MARLIER  
*Date Orals Passed: 4/11*  
*Advisory Committee: DeFries, Griffin, Shindell*  

Global Public Health Hotspots from Exposure to Biomass Burning Emissions  

Fire is one of the most significant instruments of land use change, releasing gases and aerosols that interact with the climate system, degrade surface air quality, and jeopardize public health. Emissions from burning are the second leading source of atmospheric carbon behind fossil fuel emissions. For my dissertation, I will combine satellite-derived fire estimates from the Global Fire Emissions Database with atmospheric models to estimate the added burden of fires on public health. The study will consist of the following components:  

1. Identify locations most susceptible to transported fire emissions in Southeast Asia. This region has extremely large interannual variability in fire activity due to El Niño-induced droughts and anthropogenic drivers of land use change.  
2. Determine how the temporal resolution of fire emissions influences common applications of global atmospheric models in the tropics, including atmospheric composition, air quality, and climate.  
3. Develop a method to create future fire emissions inventories based on projected land use change for Indonesia. These inventories can be used with atmospheric modeling to assess the potential health impact of different economic scenarios for development in this region.  

IVAN MIHAJLOV  
*Date Orals Passed: 4/10*  
*Advisory Committee: Stute, Schlosser, van Geen, Bostick*  

The vulnerability of low-arsenic aquifers in Bangladesh: a multi-scale geochemical and hydrologic approach  

Chronic, low-dose arsenic poisoning of tens of millions of Bangladeshis is caused by drinking contaminated shallow groundwater. Deeper, often Pleistocene-age, aquifers in Bangladesh are mostly low in arsenic and currently represent one of the major mitigation options. However, this resource is threatened by increasing exploitation, which can lower the pressure at depth and induce a downward flow of shallow groundwater rich in organic carbon and arsenic. The goal of my research is to study how the potential plume of arsenic would move through the deeper aquifer. The question is approached from both the chemical and physical aspects of arsenic and water migration. I study the sorption of arsenic onto aquifer's sediments by batch, column, and field experiments, ranging in scale from micrometers to a village field site. The extent, reversibility and rapidity of sorption are important factors in slowing down the transport of arsenic. In parallel, my study also aims to answer local hydrologic questions about the aquifers through studies with pumping tests and groundwater tracers such as bromide, 14C, 3H, or stable isotopes. Specifically, of interest is the amount of dispersion in the deeper aquifer, its degree of hydraulic connectivity with the contaminated zones, and whether there are signs of younger, shallow groundwater intrusion. On a regional scale, we would like to know what the age and recharge rates of groundwater are at depth, thus allowing the estimates of groundwater flowlines and their changes with shifting deep groundwater usage.
Global Mantle Tomography using free oscillations, body waves, surface waves and long-period waveforms

Given a description of the Earth in terms of density, elastic moduli (velocity and anisotropy) and intrinsic attenuation (i.e. an “Earth model”), we can mathematically compute the vibrations from an earthquake in terms of (i) free oscillations (standing waves or normal modes) or (ii) body and (iii) surface waves propagating through the Earth, and predict the (iv) displacement with time (full waveforms) at a seismometer location. In this work, we focus on understanding the Earth’s interior using seismic tomography, which is an “inverse problem” of finding the Earth model whose theoretical predictions match these observations. Our algorithm represents the first attempt at using all four types of data [i--iv] that span a very wide band of frequencies (~ 0.3 to 50 mHz) and evenly constrain the Earth model at all depths in the mantle, which may provide additional insights into the physical and chemical state of the Earth’s interior.

Seismic anisotropy, or the dependence of wave speeds on the propagation direction or polarization of the waves, is a result of the deformation mechanisms in the Earth. The inclusion of long-period normal mode splitting data is important for detecting anisotropy because they are sensitive to the transition zone and the lower mantle and because their sensitivity to mantle anisotropy has not been exploited. Recent studies using mode-splitting data have suggested the presence of a high-density and low-velocity anomaly in the lower mantle and interpreted this anticorrelation as a chemical contribution to the lateral heterogeneity. We attempt to put stronger constraints on the density structure using a broad spectrum of data types while including new mode observations from recent large Earthquakes. Most seismic imaging studies either look at the variations in wave speed resulting from the elastic properties of the mantle or at the variations of shear attenuation resulting from its anelasticity. A robust interpretation in terms of temperature, composition, water or partial melt requires a jointly constrained model and we therefore attempt to also find a self-consistent model of the shear—wave velocity and attenuation in the Earth’s mantle.

The controlling mechanism of Sea Surface Temperature at intraseasonal timescales in Indonesian seas

The Sea Surface Temperature (SST) variability is governed mainly by sea-air or surface heat fluxes, subsurface processes including Ekman pumping, intense tidal mixing, and lateral advection. My study particularly focuses on describing the SST characteristics at intraseasonal timescales (20-90 days) over the Indonesian Seas by considering plausible governing processes such as atmospheric and oceanic motions and their corresponding to the sea-air interaction. The Indonesian seas are influenced by many oceanic and atmospheric forcing across different timescales, which consist of tides, Indo-Australian monsoon, El Niño-Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD), and the Indonesian Throughflow. They are located at the pathway of prominent tropical atmosphere phenomena such as the Madden-Julian Oscillation (MJO), which is identified as convective and subsidence cells along the equator that propagate eastward from the Indian to Pacific Ocean. All oceanic and atmospheric forcing determines the variability of intra-seasonal SST in Indonesia seas. This study is very useful for a better weather prediction in the region.
AMELIA PAUKERT
Date Orals Passed: 4/11
Advisory Committee: Stute, Matter, Kelemen

Carbonation of mantle peridotite in the Samail Ophiolite, Oman: implications for permanent CO2 capture and storage.

CO2 capture and storage (CCS) will be crucial as we seek to mitigate global climate change due to anthropogenic CO2 emissions while still meeting the global energy demand. One method of CCS is in situ CO2 mineralization, which converts atmospheric CO2 to carbonate minerals within mafic and ultramafic geologic formations. This method promises to be a safe and permanent mechanism for storing CO2, but is still in the nascent stage and requires further investigation before it can be considered for implementation. My work involves using a natural analog to help understand the factors controlling in situ CO2 mineralization within mantle peridotites and examine the feasibility of enhancing mineralization.

The peridotite aquifer within the Samail Ophiolite is a site of exceptionally well-developed, naturally occurring in situ CO2 mineralization and offers insight into the water-rock interactions occurring during CO2 mineralization in mantle peridotite. For my dissertation, I am characterizing the chemistry and hydrology of the peridotite aquifer system and creating a 3-D reactive transport model to delineate the processes governing mineralization in the subsurface. The model will incorporate reaction kinetics and local hydrology in order to track the evolution of factors such as porosity, permeability, reactive surface area, and aqueous chemistry over time. I will use the model first to help identify the limiting factors for natural CO2 mineralization in the peridotite of the Samail Ophiolite, and then to evaluate the efficacy of mechanisms for enhancing CO2 mineralization rates, such as increased temperature and CO2 injection.

RUI PEI
Date Orals Passed: 4/11
Advisory Committee: Norell, Flynn, Meng

Troodontid fossils from East Asia and the coelurosaurian evolution

Troodontidae is a group of feathered dinosaurs living in the age of Jurassic and Cretaceous. It is one of the dinosaur groups that are closely avian-related. The evolution of troodontid dinosaurs has significant meanings on the origin of flight and the transition from non-avian dinosaurs to birds. In my dissertation, three new troodontid taxa from China and Mongolia are carefully examined for the first time. The specimens are examined by both traditional and modern (high resolution CT scan) methods. Anatomical information will be used to generate a better resolution of the long-debated coelurosaurian phylogeny. High resolution CT data will also be utilized to reconstruct the endocasts of several troodontid taxa to give insights of the brain evolution during the dinosaur-bird transition. Finite element analysis will be employed to reveal the stresses on dinosaur skull in order to reflect the life-style while the dinosaurs were alive.

MEG REITZ
Date Orals Passed: 10/10
Advisory Committee: Steckler, Schaefer, Christie-Blick

The structural evolution of the Calabrian forearc: a multidisciplinary approach to investigating subduction-rollback in a confined oceanic basin, Southern Italy.

My PhD thesis is focused on the deformation of the Calabrian forearc, located in Southern Italy. In this active subduction zone, there has been 1 km of uplift in the last million years with no discernible cause. I have been mapping the structure of the exposed forearc basin to understand the long term (12My) evolution of the forearc basin. These results have been compared to deformation occurring since the Pleistocene to provide a new hypothesis for the rapid uplift. In addition, I am using catchment-wide denudation rates determined from cosmogenic radionuclides (10Be) in the river systems of the forearc to provide constraints on the spatial and temporal variations in the Pleistocene forearc uplift. These results are among the first erosion rates
accurately measured from an active tectonic region and provide insight into further understanding the mechanism of Pleistocene uplift.

CASSAUNDRA MEYERS ROSE
Date Orals Passed: 11/12
Advisory Committee: deMenocal, Polissar, Hemming

My dissertation research focuses on reconstructing the hydrological and vegetation history of North Africa over the last 23 Myr, utilizing new organic biomarker stable isotope techniques in conjunction with more traditional paleoceanographic and paleoclimatic proxies to shed light on the aridification histories of northern and eastern Africa. As the marine sediment record is longer and more continuous than those present in Africa, I utilize these sediments to extract terrestrial leaf wax compounds, which are blown by the wind and carried by rivers from land into surrounding marine basins. Terrestrial leaf wax organic hydrocarbon compounds carry a unique identifying signature and are resilient on geologic timescales. Recent developments in mass spectrometry have allowed hydrogen isotopes to be measured in addition to existing carbon isotope techniques, allowing for the hydrogen isotope signal of water utilized by the original plants to be recorded in their leaf waxes. This allows a unique opportunity to reconstruct the isotopic composition of rainfall in Africa through time, which is primarily controlled by rainfall intensity, i.e. the “amount effect”. To date I have examined the eastern Mediterranean record of leaf wax δD and δ13C in two similar eccentricity cycles on either side of the rise of East African C4 grasslands. I have expanded my studies to the last 23 Myr of NW African hydrological and vegetation history, to specifically explore the initial aridification of the western Sahara region. I will also be investigating the organic carbon rich sapropel record of the eastern Mediterranean over the last 4.5 Myr by measuring leaf wax isotopes in each sapropel interval, approximately deposited every 20 kyr in response to intensified African monsoon rainfall and runoff. This will allow me to better place my initial studies in a long-term context, as well as investigating possible secular changes in the strength of African monsoon rainfall since the initiation of Northern Hemisphere glaciation and its contribution to North African aridity.

LISA STREIT
Date Orals Passed: 4/10
Advisory Committee: Kelemen, Matter, Walker

Carbonation of peridotite in the Oman Ophiolite

When exposed to water and CO2 at earth's surface, tectonically mantle peridotite reacts rapidly to form solid carbonate minerals, such as magnesite, dolomite, and calcite, as well as secondary silicate minerals like serpentine, quartz, or talc. In the Oman Ophiolite, these reactions are manifested (1) in active, on-going low-temperature systems involving meteoric water, which result in serpentinization, carbonate vein formation, and travertine precipitation at alkaline springs, and (2) in older, higher-temperature systems, which resulted in completely carbonated peridotite, known as listwanite. These natural processes of hydrothermal alteration and weathering could potentially be accelerated to provide a permanent storage solution for the disposal of CO2 via the in situ formation of solid carbonate minerals in peridotite. My research focuses on constraining the conditions under which natural carbonation has occurred in the Oman ophiolite, with the goal of understanding what factors and feedbacks control efficient carbonation of peridotite. This work includes field studies, petrologic observations, geochemical modeling, stable isotope thermometry.
JING SUN
Date Orals Passed: 3/12
Advisory Committee: Bostick, Chillrud, Schlosser

Arsenic and Iron Speciations and Transformations in Contaminated Soils under Differing Treatment Strategies.

Arsenic is a widespread contaminant in groundwater around the world, and is highly detrimental to humans and many other organisms. Arsenic is also the second most common contaminant of concern at U.S. EPA National Priority List. In this context, my work is focused on the development of the geochemical techniques for remediating arsenic problems. The fate of arsenic contamination is often linked to iron. But their interaction is not simple in that it involves a complex network of biological and chemical (abiotic) redox processes, solid-solution phase equilibria, and both thermodynamic and kinetic controls. Therefore, I want to investigate laboratory microcosms using arsenic-bearing aquifer sediments and groundwater and also conduct field scale research, to understand the efficacy of different amendments at retarding arsenic mobility, and elucidate changes in solid-phase iron and arsenic speciation. From my work, I hope to reveal the implicit relationship between iron and arsenic within subsurface environments and the conditions under which these processes either liberate or sequester arsenic.

SHANNAN SWEET
Date Orals Passed: 3/13
Advisory Committee: Griffin, Boelman, Rowden

Increasing deciduous shrub cover in the Alaskan arctic tundra: impacts on vegetation structure, phenology, function, and spectral fingerprints

Increasing temperatures in arctic regions are causing earlier spring snowmelt, leading to earlier plant emergence and a lengthened growing season. Warming is also leading to a shift from graminoid to shrub dominated tundra, increasing winter snow depth and delaying spring snowmelt as taller stature shrubs trap more snow. I am investigating potential causes, cues, and consequences of altered plant phenology due to changes in vegetation functional groups and structure.

My current research compares early season foliar phenology of deciduous shrub species between naturally occurring graminoid dominated communities and taller stature deciduous shrub dominated communities on the North Slope of Alaska. To better understand what variables impact the timing of bud break and leaf expansion in deciduous shrubs of varying statures, I measure variables such as snow depth and duration, leaf size, and leaf nitrogen content. I found that larger stature shrubs had deeper snowpack, later snowmelt dates, and delayed bud break and leaf expansion. However, foliar phenology of larger deciduous shrubs eventually caught up to that of smaller shrubs in graminoid dominated tundra, indicating a shorter period of leaf development. Leaf bud and leaf nutrient analyses suggest that this convergence in the timing of later leaf developmental stages, despite later snowmelt dates in shrub dominated communities, is potentially enabled by greater nitrogen availability in shrub dominated tundra.

I am also using remote sensing technology to track canopy development and am looking for spectral signatures that correlate with environmental variables (such as active later depth, soil temperature, and soil moisture) important to plant phenology, functional group, and vegetation structure. In addition, because the timing of leaf developmental stages is important from a canopy carbon gain perspective, I also plan to examine canopy phenology from a carbon gain perspective. By measuring chlorophyll fluorescence, I hope to determine if plants are photosynthetically active at early stages of leaf development, or if photosynthesis does not become significant until the stage at which larger stature shrubs catch-up to smaller stature shrubs.
JOHN TEMPLETON
Date Orals Passed: 4/12
Advisory Committee: Anders, Hemming, Bruckner

Sediment provenance and tectonics of the Hornelen basin, Western Norway

The structural geology and tectonics of constructing an orogeny are better understood than those of orogenic collapse and crustal extension. The Caledonian orogeny has been well-studied in terms of thrust and nappe tectonics, but in the last few years, study has focused on the late-stage orogenic collapse that exhumed deeply subducted metamorphic rocks from at least 100 km depths. Ultra-high pressure metamorphic terranes are observed in orogenies around the world, but little is known about the structures that bring these rocks to the surface, or the tectonic conditions under which this may happen. This study will add to our understanding of these globally-significant processes through a case study in Western Norway.

Hornelen basin is a mid-Devonian alluvial-fluvial basin that formed during the late stages of the Caledonian orogeny, in the hanging wall of a major crustal-scale ductile detachment zone called the Nordfjord-Sogn Detachment (NSD). The NSD juxtaposes upper crustal (greenschist facies) hanging wall rocks, including the Devonian sandstones and underlying metamorphic rocks, with coesite-bearing eclogites, from the lower crust, in the footwall. The ultra-high pressure (UHP) eclogites equilibrated at depths > 100 km, and the metamorphic gap across the NSD represents 60 km of crustal excision. The timing of the rise of the UHP terrane to near-surface conditions corresponds closely with the timing of the basin fill, roughly 382 Ma. This temporal correspondence, along with several independent lines of stratigraphic evidence, have led to the interpretation that Hornelen basin is a tectonically controlled supradetachment basin which is the brittle faulting expression of movement on the mid- to lower-crustal NSD.

The goal of my project is to test the supradetachment model using the abundance of geochronological data available from Western Norway and sediment provenance studies of the sandstones in the basin. Initial approach will be to use U/Pb zircon dating with LA-ICPMS. These results will be supplemented with other geochemical provenance tools such as trace element analyses on zircon, Ar/Ar dating of detrital mica, and U/Pb dating of titanite and monazite.

KAORI TSUKUI
Date Orals Passed: 4/10
Advisory Committee: Flynn, Hemming, Meng

High precision U-Pb and Ar-Ar geochronology of tuffs from the early to middle Eocene: implications for calibration of the Geomagnetic Polarity Time Scale and understanding the Bridgerian/Uintan land mammal turnover.

The Geomagnetic Polarity Time Scale (GPTS) plays an integral role in interpreting geological records ranging from biological evolution, climate change to sea floor spreading, making the precision of its calibration a matter of fundamental importance to our understanding of Earth history. Currently, pre-Neogene part of the GPTS is calibrated via interpolation between a set of discrete calibration points, but according to this method, calibration of intervening magnetic chron is highly sensitive to the number and accuracy of the tie points used. However, a more precise and stable timescale is needed in order to resolve geological and paleoclimatological records that are being recovered at an increasingly fine temporal resolution and also to correlate the record of mammalian faunal turnover between continents and against climatic data. To this end, I provide chronostratigraphic including magnetostratigraphy of the Bridger Formation and U-Pb and 40Ar/39Ar geochronology from a series of tuffs from the Greater Green River Basin. These tuff beds are ideal as they have a potential to be used for U-Pb zircon and Ar-Ar sanidine geochronology, paleomagnetic polarity determination and are often found interbedded with fossiliferous beds. A new calibration model that integrates all of the high precision radioisotopic, paleomagnetic polarity and paleontological data will enhance our ability to understand the dynamic interrelationships between the mammalian evolution as preserved in the Greater Green River Basin and the climate that reached the Cenozoic peak around this time.
MARC VANKEUREN  
*Date Orals Passed: 3/12*  
*Advisory Committee:* Christie-Blick Anders, Olsen  

New insights on the styles of extension in southeastern Idaho  

A long-standing problem in the Cordillera of southeastern Idaho and northern Utah is the presence of enigmatic faults oriented at a low angle to bedding, that place younger rocks over older. Recent research has suggested that these faults have originated and slipped at a low inclination and accommodated large amounts of extension in the region. My research is aimed at re-evaluating the geometries and constraints on these faults and on the amounts of extension in southeastern Idaho. I will try and determine the validity of two competing hypotheses of extension in the region: 1) that low-angle normal faults accommodated >15 km of extension in the region along a single detachment, 2) that faulting initiated at moderate to high-angles and subsequently rotated to the present geometries resulting in a lesser amount of total extension. Given that the amount of extension and styles of faulting in the Basin and Range has been an issue of contention, this re-evaluation is important for extensional process in general.

STEPHEN VEITCH  
*Date Orals Passed: 3/12*  
*Advisory Committee:* Nettles, Abers, Gaherty  

Glacial Earthquakes in Greenland  

I am interested in a specific type of anomalous earthquake associated with glacier calving at numerous large marine-terminating glaciers in Greenland. Glacial earthquakes produce globally observable surface waves that can be analyzed in order to provide information on the geometry and dynamics of their source glaciers. As these events may be analyzed in near-real time, they potentially represent an important means of monitoring large glaciers in Greenland for changes in their dynamic behaviour.

I am attempting to connect information on the seismic source of these events with physical changes in the source glaciers in order to increase the amount of information that may be derived from recordings of glacial earthquakes. To date this includes studies of glacier grounding states, front-position, and calving-front orientation.

MICHAEL WOLOVICK  
*Date Orals Passed: 3/12*  
*Advisory Committee:* Buck, Bell, Martinson  

Basal Water and Sliding Dynamics of Continental Ice Sheets

YINGZHE WU  
*Date Orals Passed: 4/13*  
*Advisory Committee:* Goldstein, Pena, B. Anderson  

Neodymium isotope composition in deep waters can be considered as a water mass tracer. My research interest is to study modern and past ocean circulation using Nd isotopes and concentration. It consists of the following components:

1. The major deep water masses North Atlantic Deep Water (NADW) and North Pacific Deep Water (NPDW) have εNd of ~ -13.5 and ~ -4, respectively. Based on known Nd source, the modeled εNd values for NADW are consistent with observations. But NPDW estimate (~-11) is much lower than observation (~-4). This indicates the need for a source with εNd higher than -4. Seawater samples from the North Pacific Ocean (INOPEX cruise, 2009) were collected for Nd concentration and isotope composition analyses to understand the potential source of the high εNd in the NPDW and how this signal is added to the seawater.
2. The modern Southern Ocean has significant input from NADW, which is reflected in Nd isotope compositions of the Southern Ocean, and when the Atlantic meridional ocean circulation weakens, so will the North Atlantic signal. Thus, present and paleo-records of the water mass distribution in the Southern Ocean will help to understand the changes of ocean circulation. Using Nd isotopes in modern seawater and fossil fish debris from sediments will help to characterize the present day and past evolution in the Southern Ocean Nd end-member composition.

ANASTASIA YANCHILINA
Date Orals Passed: 4/12
Advisory Committee: McManus, Ryan, deMenocal

The Late Pleistocene Evolution of the Black Sea

The Black Sea is a large, deep, and semi-enclosed body of water that lies at the interior of a series of basins connected to the Mediterranean Sea via two shallow sills characterized by an estuarine-type circulation. This hydrologic setting changed in the past. Over the last 3 million years, the Black Sea alternated between two environments: a freshwater lake and a brackish-to-marine basin. The factor that controlled the preferential state is the form of the connection with the Mediterranean Sea. The entry of salt water is limited by the height of the global sea level relative to the threshold depth of the sill in the Bosphorus portal. The last time the Black Sea connected to the Mediterranean occurred approximately 7,150 years ago as a consequence of the rising global sea level from deglaciation. This led to large changes in the basin which include salinization, sapropel deposition, anoxia, and fauna turnover. This event is clearly seen in both shelf and slope cores.

Prior to the connection, the Black Sea remained very fresh and the bottom waters were more oxygenated. Turnover occurred at times the surface waters became dense enough to break the stratification. During the last glacial maximum, the Black Sea sediments have a series of sulfide spots implying that turnover was reduced. These spots disappeared when a series of meltwater pulses appear in the cores, which have a distinct brownish color and record hyper-thermals. Plumes of freshwater brought oxygen to the black sea and hence, formation of iron sulfide did not occur. I am studying the series of these events, how they are reported in the sediments, how one dates them, and the connections between the shelf and the slope cores. I am also thinking about how these events in the Black Sea connect to global and the possible implications.

WENCHANG YANG
Date Orals Passed: 4/09
Advisory Committee: Seager, Cane, Ting

Monsoon dynamics in a Simple Numerical Model

Monsoons play an important role in the atmospheric circulation and the global hydrological cycle and influence lives of billions of people in the world. Therefore, it is both theoretically and practically crucial to understand their dynamics. We first diagnose the global monsoon circulation dynamics in July and January based on reanalysis data and obtain the dynamical balances of the global monsoon circulation. Then, based on the diagnostics, we use a simple tropical beta-plane model to simulate the circulation and precipitation fields and compare the results with the observations from the reanalysis. After simulating the monsoons in the mature stages, we will investigate the monsoon seasonal cycle in our simple model and see if the simple model is able to capture the major features of monsoon seasonal cycle, e.g. the feature of abrupt onset. Finally, we will use the surface thermal conditions projected by the CMIP5 models to drive the circulation in our model and examine the response of the monsoons to the greenhouse gas induced warming climate. Through this way, we hope to get a first order and dynamically clean estimate on how the monsoons will respond to climate change.
HONGYU YI  
*Date Orals Passed:* 11/10  
*Advisory Committee:* Norell, Flynn, Meng

My dissertation is on the origin of snakes based on brain structures. My study applies modern techniques (3-D reconstruction using HRCT scan) to a common animal group (snakes and lizards), in order to tackle a question long under debate: which group of lizards are the closest to snakes? Internal structures of the braincase (e.g., inner-ear structure) provide numerous information on reptile evolution, but remain rarely studied for squamates (snakes and lizards) because traditional techniques are time consuming and destructive (especially for fossils). High Resolution Computed Tomography (HRCT) scanning is non-destructive and enables 3-D reconstruction of braincase endocasts. I provide the largest data set on braincase endocasts of squamates (living and fossil species) and aim to reveal from which group of lizards snakes evolved their specialized brains that are adapted to their distinct lifestyles.

NATALIA ZAKHAROVA  
*Date Orals Passed:* 4/10  
*Advisory Committee:* Goldberg, Martinson, Menke

Carbon Sequestration in Unconventional Reservoirs: Petrophysical, geomechanical and geochemical considerations

In the face of the challenges presented by the acceleration of global warming, carbon capture and storage (CCS) may provide a vital option to reduce the emissions of anthropogenic greenhouse gases and to mitigate climate change. To operate on a global scale, however, CCS would require thousands of geologic repositories that could accommodate a few billion tons of carbon dioxide (CO2) per year. In order to reach such capacity, various types of geologic reservoirs should be considered, including unconventional reservoirs such as volcanic rocks, fractured formations and moderate permeability aquifers. My research focuses on understanding of petrophysical, geomechanical and geochemical properties of such reservoirs using borehole geophysical methods collected in a variety of geologic settings, e.g. extrusive continental flood basalt (Columbia River Plateau), igneous intrusion (the Palisades Sill) and fractured aquifers in the Newark Rift Basin, and oceanic floor basalt (IODP Hole 1256D).

Borehole geophysics provides a set of effective techniques for formation characterization at an intermediate scale, filling the gap between large-scale surface surveys and core-scale analysis. In my research I utilize advanced borehole logging methods, such as borehole imaging, full wave sonic, and spectral geochemical logging, to improve base-line characterization techniques and explore their potential for CO2 sequestration monitoring. Among primary objectives are estimating formation porosity and permeability, and assessing caprock integrity under injection conditions; characterizing fracture distribution and their hydraulic properties; evaluating in-situ stress regime, formation geomechanical properties, and induced seismicity risks; understanding formation anisotropy; and detecting in-situ geochemical and mineral changes. Overall, my research contributes to better understanding of structural and petrophysical properties of unconventional reservoirs, and improves geophysical characterization techniques for igneous rocks and fractured formations.

YANG ZHA  
*Date Orals Passed:* 3/12  
*Advisory Committee:* Nettles, Webb, Buck

Constraining seismic structure beneath oceanic spreading centers through ocean bottom geophysical techniques

Over 70 percent of the earth’s surface is created at oceanic spreading centers. My thesis research is focused on imaging the seismic structure at oceanic spreading centers using seismic surface wave and seafloor geodetic measurements to help better understand the geodynamics of the spreading process. It consists several components:
1. Using 3D seafloor compliance modeling to constrain shear wave velocity structure and melt distribution in the lower crust at East Pacific Rise 9-10 N. Seafloor compliance is the seafloor deformation under the loading of long period ocean waves. It is mainly sensitive to crustal shear velocities. We numerically calculate the seafloor compliance, and compare the modeling results with data collected at East Pacific Rise 9-10 N to constrain the shear velocity structure in the lower crust, which will indicate the melt distribution under the spreading center.

2. Ambient noise tomography of Ocean Bottom Seismograph data to image upper mantle velocity structure at Eastern Lau Spreading Center (ELSC). The Eastern Lau Spreading Center is a 400-km-long back-arc spreading center close to the Tonga subduction trench in the southwestern Pacific. We analyze ambient seismic noise data collected from a large OBS array during a 13-months deployment over the ELSC. Phase velocities of seismic surface waves are recovered from inter-station signal coherences, and then inverted for shear velocities. We seeks to better understand the transition process between rifting and mid-ocean-ridge-style passive spreading over the length of the ELSC.

3. Developing a new technique for obtaining ocean bottom seismometer orientations. Accurately orienting OBS horizontal components to record shear waves has been a challenge for the marine seismology community. Some of the main difficulties of current earthquake-based methods include low signal to noise ratios and small number of usable events. We propose a novel method which uses ambient noise correlation to estimate the instrument orientations, increasing the amount of available data as well as the data quality.