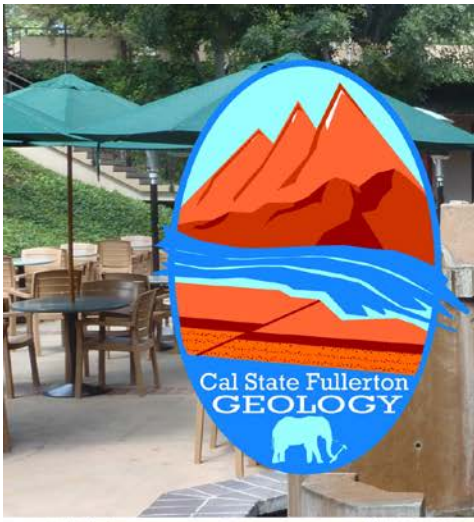


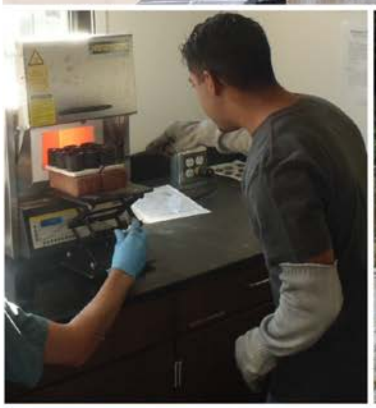
2012 Geology Research Day

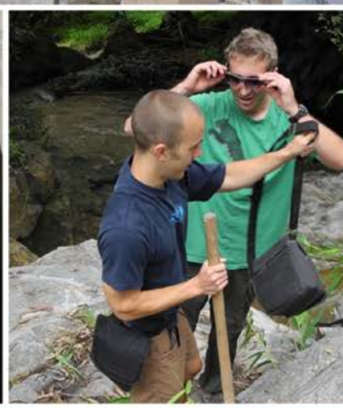
Abstract Volume

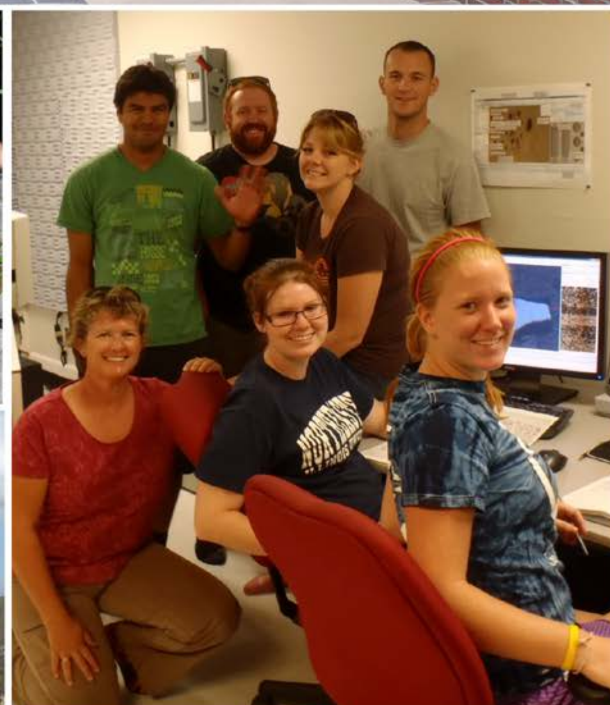
Department of Geological Sciences

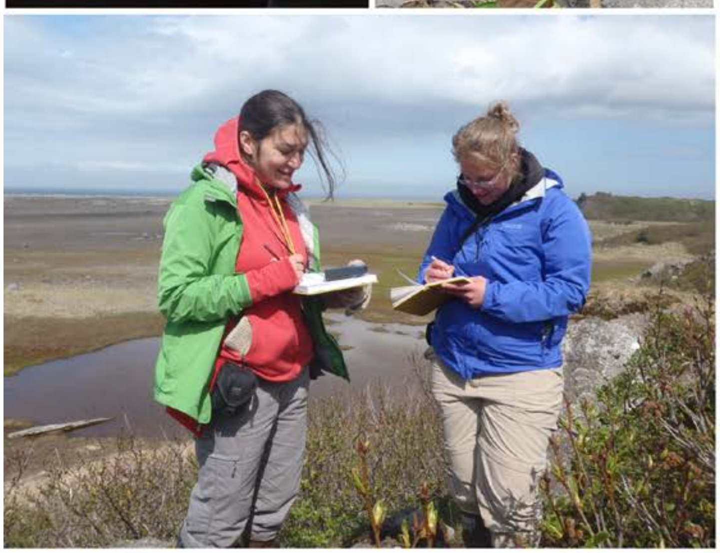
California State University, Fullerton

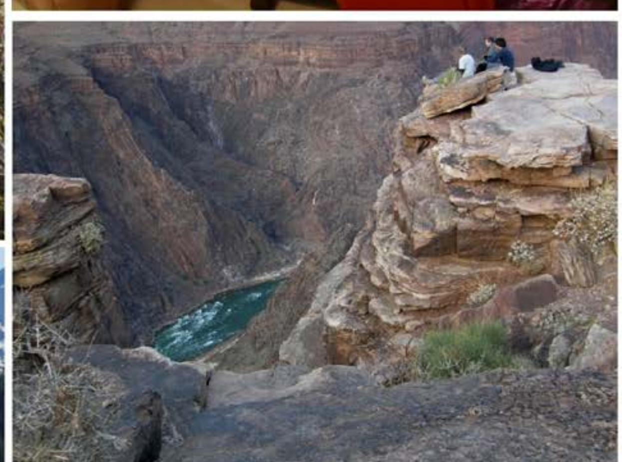
Titan Student Union - Garden Café , April 27 2012











The Department of Geological Sciences at California State University, Fullerton is an interdisciplinary education and research community whose members are active mentors and role-models. Our mission is to provide a student-centered educational and research experience that emphasizes critical thinking, communication, and scientific citizenship.

'Research Day' is an extension of this mission, where students are afforded the opportunity to share their research findings and scientific experiences with faculty, student peers, friends, family, and members of the professional geological community in an informal and supportive environment. Thank you for participating in this year's event!

3rd Annual Geology Research Day

California State University, Fullerton ~ Department of Geological Sciences

Titan Student Union Garden Café

April 27, 2012

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Applying apatite detrital fission-track thermochronology to evaluate exhumation in Southern Alaska

Chris Baker
Faculty Advisor: Professor Phillip Armstrong

The Alaska Range is believed to have begun uplift 5 Ma, but is inconclusive due to lack of data for this timing. A method to determine the exhumation rates is through detrital fission track analysis of sedimentary rocks that have well constrained ages of deposition. The Beluga and Sterling formations are well-dated sedimentary formations from the Kenai Peninsula of southern Alaska and are prime targets for fission track analysis; the Beluga and Sterling formations are primarily sandstone and siltstones, with some coal deposits. The principal hypothesis to be tested is that uplift of the Alaska Range began about 5 Ma. This hypothesis will be tested using detrital fission track thermochronology in apatite grains from the Beluga and Sterling formations. Two samples of immature, coarse-grained sandstone will be collected from each formation at various sites where the rocks have been well described and dated from previous studies. Fission tracks record a specific time of when they were at a temperature of ~110°C. The samples will be processed with a variety of techniques including crushing, the Wifely table, heavy liquid separation, and magnetic separation. Grains will be ground, polished, and etched to reveal internal tracks. After irradiation at the Oregon State reactor, tracks will be counted in 100 grains per sample to determine fission-track age distributions. Track counting will be completed at 1250 power on an automated stage system in the Fission-track Lab at CSUF. It is expected that fission-track ages will produce a peak at 5 Ma, indicating that there was one exhumation event in the source region. It is possible, however, that there were additional exhumation events or that other uplifted and exhumed regions (e.g., Chugach Mountains to the east) contributed to the apatite grain populations in the Sterling and Beluga Formations.

Lava Flow Propagation Modeling at Mammoth Mountain with FLOWGO

Blair Davidson
Faculty Advisor: Professor Brandon Browne

In this study, basaltic lava flows in the western moat of Long Valley Caldera were analyzed in terms of whole-rock composition and mineralogy in order to predict hypothetical flow paths if there were to be a basaltic eruption from Mammoth Mountain in the future. Mammoth Lakes is a resort town located off of Highway 395 in Mono County, California. It currently has ~8000 permanent residents, not including the seasonal travelers. It is important that the town is aware of the current geologic hazards in the area to know how to react in the case of an eruption. In May of 1989, an earthquake swarm began that lasted until July of 1990. The characteristics of these earthquakes were different from normal tectonic earthquakes, in that they occurred in spasmodic bursts and were characterized by Hill and Prejean (2005) as being long-period in nature, which was interpreted to reflect an origin of magma intrusion at depths ranging from 15-25 km beneath the SW flank of Mammoth Mountain. Lethal concentrations of CO2 gas in the soil was first detected in the winter of 1990 by the US Geological Survey, followed by noticeable areas of tree kill. Most of these sites occur along or near normal faults on Mammoth Mountain, which allow a path for the gas to escape from the crust. This study uses six of these degassing sites as likely eruption sites of future eruptions. By using a kinematic thermo-rheological program, FLOWGO (after Harris and Rowland, 2001), we could hypothesize lava flow patterns from these vents. This program, assimilates channel flow patterns by pinpointing eruption sites on digital elevation maps. Parameters were changed based on composition and effusion rate at each site. A basaltic composition was run with effusion rates of 1 m^3/s, 10 m^3/s, and 100 m^3/s, and a dacitic composition at a rate of 10m^3/s. These flow models, however hypothetical, provide a better understanding of the threat to the town of Mammoth lakes in the case of an eruption. Key results are that with a low eruption rate of basaltic lava, flows tend to stay proximal to the vent and only travel at most 500m. As the eruption rate increases, flows begin to pool and travel at distances of up to ~6km.

Hill, D.P., Prejean, S. (2005) Magmatic unrest beneath Mammoth Mountain, California. Journal of Volcanology and Geothermal Research, 146(4), 257-283; Harris, A., Rowland, S.K. (2001) FLOWGO; a kinematic thermo-rheological model for lava flowing in a channel. Bulletin of Volcanology, 63(1), 20-44.

Constraining Exhumation in the Southern Alaska Syntax in the vicinity of Crows Pass, western Chugach Mountains, Alaska

Joseph Hawkins
Faculty Advisor: Professor Phillip Armstrong

The southern Alaska syntaxial region encompassing the Prince William Sound and western Chugach Mountains is characterized by very dynamic tectonic activity resulting from the subduction and possible underplating of the shallow dipping Yakutat microplate (YM). Exhumation in this region is thought to be occurring rapidly under the influence of the YM. However, the limits of this rapid exhumation are poorly constrained and further investigation is required to help fill out the data and provide a better understanding of the processes causing uplift. The principal hypothesis is that this region of rapid exhumation extends southwest across the northwest portion of the Kenai Peninsula. To test this hypothesis, low-temperature apatite (U-Th)/He ages will be determined from samples retrieved along the Crow Pass National Historic Trail in Chugach State Park. Approximately 5 to 10 samples of ~10kg each will be retrieved and processed using standard mineral separation techniques to obtain at least 5 appropriate apatite grains from each. Once appropriate samples have been selected, each will be placed in platinum tubes and sent to Cal Tech to retrieve (U-Th)/He ages, which will then be interpreted to help constrain the limits of rapid exhumation related to the subduction of the Yakutat Microplate. If the ages are relatively young (~3-5Ma), then we may be confident to say that the region of rapid exhumation does in fact extend south and west across the northwestern Kenai Peninsula. The proposed work should help constrain the dynamic effects of rock uplift above flat-slab subduction in Alaska and elsewhere.

Pyroclastic Stratigraphy of the ~680 yr BP Panum Crater “Dune” Deposit

Zachary Haygood
Faculty Advisor: Professor Brandon Browne

This study will investigate the pyroclastic “dune” deposits formed during the explosive eruption of Panum Crater ~680 yrs ago, located near the southern shoreline of Mono Lake in eastern California. Panum Crater is a volcano located along the northern tip of the mostly Holocene aged Mono Crater chain. The Mono Crater chain comprises approximately ~28 high silica rhyolite domes and coulees, which display eruption styles ranging from lava effusion to pyroclastic surge and flow generation to explosive craters. Methods employed by this study will include describing pyroclastic deposits in terms of thickness and internal stratigraphy along flow-parallel transects with increasing distance from vent and analyzing samples in terms of granulometry, componentry and ash particle morphology. Results will be used to determine the mechanics of the pyroclastic surge that formed the deposit. Specifically, granulometry will be encompassed using sorting, median grain size, and % fines to better evaluate the explosivity and style of eruption of Panum Crater. Componentry will be calculated by comparing the amount of juvenile material versus accidental material in the pyroclastic dune deposit itself. Ash morphology will be examined by using a scanning electron microscope, which will allow me to compare blocky vs. vesicular textures within the pyroclastic deposits. These methods of analysis will provide significant insight into whether Panum Crater’s eruption was triggered by either magmatic or phreatic processes, which is vital to the development of an accurate volcanic hazard assessment model for nearby populations. It is hypothesized that the ~680 yr Panum Crater dune deposits are the result of an eruption that was phreatomagmatic in nature. Cross-bedding, high % fines, high amount of accidental lithics, and blocky ash morphologies are expected to be found to support this hypothesis.

Pre-Eruption Storage Depths Recorded by Amphibole and Plagioclase in Magma Erupted During the 2006 Eruption of Augustine Volcano, Alaska

Laurel Morrow
Faculty Advisor: Professor Brandon Browne

This study will interpret pre-eruption storage depths of magma erupted in 2006 from Augustine Volcano by using volatile concentrations trapped by melt inclusions in plagioclase crystals and major element stoichiometry in amphibole crystals. Samples were collected in 2010 from Augustine Volcano, an andesitic-dacitic stratocone located in southwestern Cook Inlet of Alaska. Volatile concentrations of melt inclusions in plagioclase will be determined using the water-by-difference method via an electron microprobe. Major element concentrations of amphibole will also be acquired by electron microprobe and applied to the amphibole geobarometry model of Ridolfi et al. (2010). Results will be compared to data from volcano seismology and geodesy regarding pre-eruptive storage depth of erupted material. Amphiboles will be selected for analysis based on equilibrium textures and melt inclusions will be chosen for analysis based on having sealed rims, with no evidence of smearing or crystal breakage during transport to ensure accurate chemical signatures. My hypothesis for this study is that melt inclusions and amphibole crystals will record multiple depths of formation as opposed to a single depth based on the widespread evidence for magma mixing at Augustine Volcano.

Ridolfi, F., Renzulloi, A., Puerini, M., (2010) Stability and chemical equilibrium of amphibole in calc-alkaline magmas: an overview, new thermobarometric formulations and application to subduction-related volcanoes. Contributions to Mineralogy and Petrology, v 160, p. 45-66

Petrology of ~90ka Rhyolite Deposited During Mammoth Mountain's (Only?) Plinian Eruption, Sierra Nevada

Zackary Newman
Faculty Advisor: Professor Brandon Browne

Mammoth Mountain is a stratovolcano located in eastern California that was constructed over the past 111ka largely by effusive eruptions of dacite and trachydacite lava flows and domes with textures indicative of mingling between basalt and dacite. Geologic mapping coupled with geochronological studies indicate that more than 50% of the Mammoth Mountain edifice formed between 67-57ka (Ring, 2000). One exception to this period of relatively quiescent volcanic eruption styles exists, however, in the form of a voluminous rhyolite pumice fall deposit exposed on Mammoth Mountain's east flank. This deposit formed as a result of a violent and highly explosive volcanic eruption approximately 90,000 years ago. What is the significance of this unusually explosive episode in Mammoth's past? The goals of this study are to learn more about the rhyolite's (1) mineralogy and composition, (2) pre-eruptive storage conditions in terms of pressure and temperature, and (3) eruption dynamics responsible for such a violent eruption. Addressing these issues will allow me to evaluate the hypothesis that before Mammoth Mountain's 67-57ka 'flare-up' the magma chamber fueling eruptions rarely experienced magma mingling and thus afforded a longer time period for magmas to crystallize and exsolve volatiles, possibly resulting in a second boiling event, creating a highly explosive Plinian style eruption. Sampling of the pumice, every 90cm representing the whole eruption sequence, was conducted summer 2011. After sampling, the median grain size of each sample was determined through wet sieving and plotted on a median grain size versus stratigraphic height graph. This plot indicates a maximum mass flux during the eruption at about 175cm up in the deposit, and a second, but lower maximum at about 360cm. this second maximum is just below the upper limit of the deposit, indicating the end of the eruption. Preliminary and ongoing Scanning Electron Microscope work has shown elongate pores in the pumice as well as a larger amount of ash filled spaces in the uppermost samples. The next step in addressing the hypothesis is analyzing thin sections of the rhyolite that were made fall 2011 to characterize: the mineralogy and textures, as well as in electron microprobe analysis, which will be used in the analysis of minerals such as quartz, plagioclase sanidine, biotite, magnetite, and ilmenite to infer storage depth and temperatures; and the glass, which will be useful for regional tephrochronology studies aimed at correlating different tephras in the Sierra Nevada's. Density measurements of pumice fragments from the samples will be performed to determine the magma fragmentation process as the eruption progressed.

Application of the (U-Th)/He Thermochronology in the Chiang Mai Basin to Reconstruct the Deformational History in the Western Ranges of Chiang Mai, Thailand

Adam Piestrzeniewicz
Faculty Advisor: Professor Brady Rhodes

The Western Ranges, located in northwestern Thailand, are the result of deformation influenced by the extrusion of present-day Indochina due to the collision of the Indian Plate into the Eurasian Plate along the border of India and Tibet. The rocks that make up the Western Ranges are a suite of metamorphic rocks referred to as the Western Ranges Metamorphic Complex (WRMC). Two major faults bind the region but there is controversy regarding their relationship with uplift and consequent erosion of the WRMC. The WRMC is characterized by a core of metamorphic and igneous rocks overlain by Paleozoic metasedimentary rocks, separated by an older, low-angle normal fault. A younger (Early Tertiary) normal fault forms a boundary fault to the Chiang Mai Basin. Controversy surrounds the dynamics of these faults and their relationship to the uplift of the WRMC and it is unclear which fault accounts for most of the normal slip observed in the WRMC. The Mae Rim Formation (MRF), located at the eastern base of the WRMC and within the Tertiary Chiang Mai Basin, contains conglomerate and sandstone composed of clasts exhumed from the metasedimentary formation of the WRMC. (U-Th)/He thermochronometry of apatite grains picked from the MRF can help place constraints on the tectonics responsible for the uplift and consequent erosion of the WRMC. I hypothesize that most of the normal slip occurred on the older, low-angle normal fault and that slip shifted to the younger boundary fault during the later stages of extension. This hypothesis would be supported by MRF (U-Th)/He dates that are much older than those of the high-grade metamorphic rocks (existing zircon fission-track and (U-Th)/He to be calculated by B. Scheppmann). The results of this study will help determine the timing and style of faulting and uplift in the Western Ranges area and ultimately aid in reconstructing the deformational history of Indochina as a result of larger scale tectonics in the Himalayan collision.

Reconstructing Late Holocene lake level using littoral cores from Zaca Lake, California

Lilian Rubi
Faculty Advisor: Professor Matthew Kirby

The primary objective of this study is to use sediment data from two littoral cores to reconstruct late Holocene lake level change. Sediment cores will be extracted from Zaca Lake, located approximately 70 km northwest of Santa Barbara, California. The secondary objective of this study is to cross-reference the littoral core lake level reconstruction with a profundal core to evaluate the lake level record acquired from two different sedimentary environments. The working hypothesis is that the Little Ice Age was wet and with high lake levels, compared to the previous Medieval Warm Period where lake levels were lower. Documenting the variability of lake level allows us to anticipate future changes in the hydrological variability of a region. This is especially important in Southern California, which is prone to severe drought and faces a perennial water supply crisis due to its rapidly growing population. Zaca Lake is one of the few natural lakes found in southern California with depositional conditions worthy enough to make it a candidate for paleoclimatic research. Several sedimentological analyses will be done to complete this reconstruction such as magnetic susceptibility, LOI 550 °C and 950°C, photographing and describing the cores, grain size, and microfossil counts. Discrete terrestrial organic materials will be sampled and used for 14C dating and age control.

Rate and Timing of Exhumation in the Copper River Corridor, Western Chugach Mountains, Southern Alaska

Matan Salmon
Faculty Advisor: Professor Phillip Armstrong

The Western Chugach Mountains and the surrounding areas in southern Alaska are located in a position of dynamic tectonic activity. Here, the Yakutat microplate shallowly subducts under the North American plate causing the Chugach Mountains to be rapidly exhumed in some places. There is a lack of data at the critical site that links the southern collision zone and the western Chugach Mountains and Prince William Sound regions. The aim of this research will be to evaluate the exhumation within this critical site – the Copper River Corridor (CRC). The hypothesis to be tested is that (1) the rocks of the CRC are being exhumed rapidly as part of the overall collision from the southeast and (2) that major faults cut the CRC differentially uplift and exhume the rocks. This hypothesis will be tested by evaluating uranium-thorium dating ((U-Th)/He) ages from samples collected along the CRC. Ten samples will be collected along the CRC, with concentrated sample density adjacent to topographic expressions of faults. Samples will be processed to extract apatite crystals at CSUF. Four to five grains from each sample will be selected for (U-Th)/He analysis at Caltech. The proposed research will address four possible outcomes: Outcome 1: All or most of the ages are relatively old (>10 Ma) with no major variability across the transect. This would suggest that the area is not subjected to the rapid exhumation as originally hypothesized. Outcome 2: All or most of the ages are relatively young (<5 Ma) with no major variability across the transect. Outcome 3: The samples vary slightly in age across the CRC. Significance of minor variations can be evaluated using local thermochronology ages from other research in the area. Locations of continuing bands of rapid exhumation cutting across the CRC can be located and evaluated. Outcome 4: Large ages variations in adjacently located samples. This could represent possible recent faulting in the area, with a significant dip-slip component. The results of this study will place valuable constraints on mechanisms of rock uplift across the broad region of deformation related to Yakutat flat-slab subduction.

Trace Element Analysis and Productivity Rates of the Permian-Triassic Extinction from Ute, Nevada

Shawn Sullivan
Faculty Advisor: Professor Adam Woods

The end of the Permian event (~252 My) was marked by an extinction that proved greater than any mass extinction of the past 600 million years. The Permian-Triassic mass extinction had an estimated loss of 85 percent of marine genera 70 percent of terrestrial genera. Understanding environmental conditions and the timing of the reestablishment of primary productivity after a mass extinction such as the Permian – Triassic crisis is key to understanding the recovery of many organisms. 25 samples were taken from the Spathian (uppermost Lower Triassic) Virgin Limestone (Moenkopi Formation), from Ute, Nevada for geochemical analysis. The Virgin Limestone at Ute is comprised of interbedded red and green shales and limestone beds (primarily packstones and grainstones) that are fossiliferous (primarily bivalves, gastropods and phylloid algae), often oolitic, and commonly contain so-called anachronistic facies (i.e., fabrics and features that are more common prior to the Ordovician). The limestone units were previously examined in detail (Woods, in revision), and the purpose of this study was to determine the relationship of the interbedded shales with the limestone units. Shale samples were analyzed using a Perkin-Elmer 7300 DV ICP-OES to determine specific trace elements contents in parts per million (ppm) that can be used to better understand environmental conditions, primary productivity, and sedimentology during deposition. Vanadium, molybdenum, cobolt, chromium, and manganese values indicate that oxygen levels within the shale beds range from dysoxic to anoxic, while barium, copper, nickel, phosphorus, and zinc values suggest that the anoxic waters were associated with high productivity. Clay content relates to the aluminum, titanium, and zirconium. Aluminum values are high (48631.6), titanium values are low (734.932), and zirconium values are low (20.7196). Magnesium values are typically low (18084.8) while calcium values are high (71611.6) indicating that the shales are rich in calcite as opposed to dolomite. As mentioned above, the dysoxic and anoxic shales are interbedded with fossiliferous limestones that often contain anachronistic facies. Anachronistic facies are often associated with the inorganic or microbial precipitation of calcium carbonate, which has been attributed to the upwelling of anoxic, alkaline deep waters and the results of this study support this hypothesis by demonstrating the close juxtaposition of anoxic waters and anachronistic facies with each other.

Primary Productivity and Paleoxygenation following the End-Permian Mass Extinction based on Trace Element Analysis of a Drill Core from the Peace River Basin, Alberta, Canada

Elizabeth Agredano
Faculty Advisor: Professor Adam Woods

The recovery of primary producers following the End-Permian mass extinction (~252 Ma) is a misunderstood and inadequately studied niche of extinction recovery analysis. Although primary productivity recovery is the foundation for ecological re-equilibration, most studies have instead focused on elucidating the recovery of flora and fauna. Thus, it is essential to quantify trends in the recovery of primary producers in order better understand the way in which life rebounds after such a crisis. To that end, this study utilized trace element variation in samples from varying depths of a core extracted from the Lower Triassic (Griesbachian) Montney formation of the Peace River Basin (PRB), located within the greater Dawson Creek Graben sedimentary complex (DCGC) in modern day Alberta. Forty- five ~25mg samples from core 16-8-86/20W6 were examined for trace element concentrations using ICP OES (Perkin Elmer 7300 DV). Total organic carbon (TOC) contents of the samples were previously obtained using the Loss on Ignition method. Preliminary results demonstrate low concentrations of Ba, Cu, Ni, and Zn, which are indicative of low productivity levels, while high concentrations of Mo and V suggest anoxic, and possibly euxinic depositional conditions. Low levels of primary productivity indicate that the reduced benthic oxygenation levels characteristic of the samples are the result of a deep ocean water mass impinging onto the continental shelves, rather than a product of high levels of primary productivity. Trace element analysis of samples from additional cores and outcrops will provide a clearer picture of temporal and regional trends in primary productivity, as well as an understanding of the environmental conditions that lead to recovery from the mass extinction. Quantifying the recovery of primary producers following what is generally considered Earth's most devastating crisis will offer a better understanding of the way in which life recovers from substantial perturbations, thus providing insight into the Earth system as a whole.

Investigation of the Sheep Creek Fans Origins from the Wrightwood Watershed, San Bernardino County, CA

Erik M. Cadaret
Faculty Advisors: Professor W. Richard Laton and Professor John Foster

The Sheep Creek Fan is located in southern California between the townships of Wrightwood to the south and El Mirage to the north. In this study, the relationship between the Wrightwood watershed and the Sheep Creek fan were analyzed with ArcGIS. The areas of the Wrightwood watershed and the Sheep Creek Fan were within one order of magnitude agreement. The volumes of the Wrightwood watershed and the Sheep Creek Fans present subsurface sediments were found to be within the same order of magnitude agreement. The agreement between both the area and volume of the watershed and the fan indicate a strong relationship of origin and deposition.

Hydrogeologic Investigation of the Sheep Creek Fans Regional Aquifer, San Bernardino County, CA

Erik M. Cadaret
Faculty Advisors: Professor W. Richard Laton and Professor John Foster

The Sheep Creek Fan is located in southern California between the townships of Wrightwood to the south and El Mirage to the north. In this study, the hydrogeology of the Sheep Creek Fan was modeled in 3D with Rockworks15 and the sand vs. clay ratio from surface to water was assessed to determine what areas dictated by the Mojave Water Agency 1.5mi buffer zone from the California aqueduct are favorable for artificial recharge. The 3D model along with the sand vs. clay ratios indicated that the southern middle portion of the recharge zone within a 1.5mi buffer region of the California aqueduct is suitable for artificial recharge.

Tectonic Analyses Using Geomorphic Parameters of the Black Mountains in Death Valley, California

Thomas Feistel
Faculty Advisor: Professor Jeffrey Knott

The Black Mountains make up the eastern border of southern Death Valley in the Mojave Desert, California (Figure1). The mountains are bounded by three fault zones, the strike slip Furnace Creek fault zone (FCFZ), the strike slip Southern Death Valley fault zone (SDVFZ), and the normal Death Valley fault zone (DVFZ) (Figure1). Previously, work was done by hand by Denny (1965), Knott (1998), Bull and McFadden (1977) in the Black Mountains using the geomorphic indices of basin area vs. fan area, mountain front sinuosity, and stream concavity index, to evaluate the tectonic geomorphology of the mountain range. This project will utilize the previously unavailable Geographic Information Systems (GIS) to evaluate the aforementioned geomorphic indices and compare these new findings to the previous findings of Denny (1965), Knott (1998), Bull and McFadden (1977). Each parameter being re-evaluated will be more closely examined than previously. Mountain front sinuosity will be taken over five different segments as defined by Knott (1998), instead of the two values of the 80 kilometer mountain range that Bull and McFadden measured. Similarly, 16 basins and fans will be evaluated to find basin area vs. fan area, which is four more than were evaluated than Denny in 1965. The same 16 basins will be used to measure stream concavity index which are the same basins that Knott (1998) previously used to find stream concavity index. Since this work has been done before, this project will either affirm the previous work that was completed by hand, in a more reputable way using GIS, or differ from them. If the results differ then a revision to the previous conception of tectonism of the Black Mountains will be necessary. This revision would give geologists a more accurate understanding of the current tectonics of the Black Mountains.

Last Glacial Maximum Paleoclimate Reconstruction Using Sediments from Lake Elsinore, California

Christine Hiner
Faculty Advisor: Professor Matthew Kirby

Lake Elsinore is one of the few natural, permanent lakes located within the coastal southwestern United States. This study presents a section of a new sediment core (LEDC10-1) taken from the deepest portion of Lake Elsinore in 2010. The new record represents the first high-resolution terrestrial record spanning the mid-Last Glacial Maximum (LGM) and its termination in the coastal southwestern United States, approximately 17,650 to

24,550 cy BP. The age model for LEDC10-1 was constructed from sixteen AMS 14C dates, of which most were discrete organic matter. To characterize the LGM, a series of sedimentological analyses were used including magnetic susceptibility, loss on ignition (550° C and 950° C), and grain size analysis to infer the past climate within the lake and its drainage basin. The results of this study indicate the LGM terrestrial climate within the coastal southwestern United States was characterized by large hydrologic variability. Particularly, three millennial scale hydrologic cycles spanned the studied interval. A hemispheric comparison to the Greenland paleoclimate record shows no consistent relationships. Regionally, a comparison of the Elsinore record to the Santa Barbara Basin Pinus record shows a moderately clear relationship between run-off events (i.e. higher percent of sand) in the coastal southwest and Pinus events (cold and/or wet) as recorded in the Santa Barbara Basin record.

Age and provenance of the oldest sediments in the Peninsular Range forearc basin, Orange Co., CA

Natalie Hollis
Faculty Advisor: Professor Diane Clemens-Knott

Late Cretaceous sedimentary rocks exposed along the western flank of the Santa Ana Mountains record deposition in one of the many forearc basins that formed along the western North American margin during the Mesozoic. This study investigates the extent to which new forearc basins are filled with purely arc-derived sediments versus sediments transported by either longshore drift or arc-traversing fluvial systems. The results of this study will contribute to an investigation of the provenance of the forearc deposits associated with the Peninsular Ranges batholith (PRB), with the ultimate goal of expanding our understanding of sediment delivery and forearc basin development. Detrital zircons (dz) were separated from samples collected from two locations within the Cleveland National Forest: (1) along Silverado Canyon, from the Baker Canyon Conglomerate member of the Ladd Formation; (2) within Williams Canyon, from the Shultz Ranch and Pleasant Sandstones members of the Williams Formation. These formations were sampled because they represent the oldest shallow-marine-to-fluvial sediments associated with the PRB. An LA-ICP-MS at the University of Arizona's Laserchron Laboratory was used to measure the U-Pb isotopic composition of 100 individual zircon crystals from each of three samples. Statistical analyses of the dz populations provide maximum constraints on the depositional ages of these units. Two of the three dz depositional ages correspond well with their respective stratigraphic ages; however, dz from the middle sample provides a maximum depositional age that is approximately 20 Ma older than the accepted stratigraphic age (Cooper, 1982). This discordance indicates either an absence of pyroclastic volcanism or minimal uplift and erosion. Discordance between the dz age constraint and the stratigraphic age is not present in the stratigraphically youngest sample. Statistical analysis also provides information about sedimentary provenance; the two older samples are purely arc derived, while the youngest sample contains a significant population of exotic zircons. Possible origin of these exotic zircons include ≈83 Ma plutons from the eastern PRB and ≈75 Ma plutons exposed by Laramide thrusting in western Arizona. Recently published detrital zircon analysis of the Baker Canyon Conglomerate in Silverado Canyon produced significantly different results (Jacobsen et al., 2011). This puzzling discrepancy motivated a follow-up investigation into the lateral continuity of detrital zircon ages within depositional units. In March 2012, three samples of the Williams and Ladd Formations were collected along San Juan Creek, approximately 23 km southeast of the initial sampling sites. Separation and analysis of these samples is underway.

Palaeocurrents and Provenance of the Mae Rim Formation, Chiang Mai Basin, Northern Thailand

Dalin Nguyen
Faculty Advisor: Professor Brady Rhodes

The Mae Rim Formation (MRF) consists of fluvial sandstone and conglomerate that was shed off the rising Western Ranges Metamorphic Complex (WRMC) and its tectonic cover of low- grade metamorphic rocks of the Shan Thai terrane. Previous published data on the palaeogeography of the MRF, including palaeocurrent and provenance data, have been limited because of poor exposures and heavy weathering. In this project, I proposed to collect palaeocurrent and provenance data from the new and numerous road cuts on the campus of Chiang Mai Rajabhat University, Northern Thailand. Knowing if the MRF newly exposed in the Rajabhat road cuts consists of clasts from the Shan Thai terrane, or rocks from the WRMC constrains the timing of deposition compared to exhumation of the Western Ranges. To better understand the palaeogeography of the Rajabhat MRF, we also need to know the depositional flow direction. I hypothesized that the Rajabhat MRF would contain clasts exclusively from the Shai Thai terrane, and the palaeocurrent will have flowed from NE to SE off the rising Western Ranges. To test this hypothesis, I: 1) described the MRF exposed in these road cuts and measured its orientation, and the orientation of any cross- cutting faults; 2) measured the orientation of imbricate cobbles in MRF conglomerate for palaeocurrent analysis; 3) counted at least 100 clasts at each study site in the MRF to determine the distribution of lithologies represented; 4) determined palaeocurrent directions by plotting rose diagrams of clast orientations on OSXStereonet; 5) determined the provenance by plotting pie charts of clast compositions, and matching them to lithologies exposed in the Western Ranges. The results of this study helped confirm the palaeogeographic setting and timing of the deposition of the MRF relative to the WRMC's exhumation.

Fault Scarp Morphology Along the Northern Eureka Valley Fault zone, Eureka Valley, Eastern California, U.S.A.

Ernest Nunez
Faculty Advisor: Professor Jeffrey Knott

Eureka Valley, CA, in northwestern Death Valley National Park, is one of a series of valleys formed by oblique extension within the Eastern California shear zone and Walker Lane belt. In Eureka Valley, extension is accommodated by the normal-oblique, north-south trending Eureka Valley fault zone (EVFZ) that bounds the valley's east side at the foot of the Last Chance Range. A Mw 6.1 earthquake on May 17, 1993 is attributed to a northeast-southwest-trending trace of EVFZ located in the west-central portion of the valley. The earthquake produced ground deformation best detected by remote sensing with only minor ground cracks observed after the earthquake. The minor ground rupture is in stark contrast to the prominent fault scarps found along valley-bounding fault on the east side. Here I present measured fault scarp profiles offsetting Quaternary alluvial-fan deposits along the northern trace of the EVFZ at the foot of the Last Chance Range. Fault scarp height and slope angle indicate that the northern EVFZ produced a ~Mw 6.7 earthquake with 0.7 m of normal displacement and 3.2 m of right-lateral offset. The parallel trend of these scarps to the aftershock pattern of 1993 event suggests that a cross-valley fault is developing in Eureka Valley. The development of a cross-valley fault is consistent with clay models and field observations of a basin in the late extension phase.

Analysis of Trace Element Variations of Sedimentary Rock Samples from the Western Canada Sedimentary Basin following The Permian-Triassic Mass Extinction

Julie Ortiz
Faculty Advisor: Professor Adam Woods

The Permian – Triassic mass extinction was the largest mass extinction in Earth history, and left behind a devastated planet. In order to gain a better understanding of the causes and consequences of the Permian-Triassic mass extinction, trace element values related to oceanic oxygen levels, primary productivity, and lithology were measured from sedimentary rock samples collected from the Western Canada Sedimentary Basin of western Alberta and eastern British Columbia. Thirty-six samples were collected from a drill core from the Pedegree-Ring Border-Kahntah River area of northeastern British Columbia (C-74-E/94-H-16) that penetrated Griesbachian-aged rocks of the Lower Triassic Montney Formation. Approximately 25 milligrams of powered sample were combined with aqua regia, placed in a microwave digester (Anton Paar Multiwave 3000) and heated to 160^{0} C with a ramp time of 10 minutes and a 20 minute hold time. Digested samples were then analyzed for trace element contents using a Perkin Elmer Optima 7300DV ICP-OES. Overall, the results suggest low levels of oxygen during deposition of all of the samples, with V, Co and Mohigher in shale units than the sandstone units, suggesting the shales were deposited under lower levels of oxygenation. The sandstones units were likely deposited in shallower or higher energy environments, and as a result were better oxygenated. Cu, Ni, and Zn values are typically <5 ppm, suggesting that productivity was not particularly high within the study section. These results support hypotheses that suggest shallow water environments were better oxygenated due to stirring by ocean currents and waves while deeper water environments were more anoxic (e.g., Beatty et al., 2008). Relatively low productivity in the study area suggest that low oxygenation was the result of large scale oceanic conditions, as opposed to productivity-driven anoxia, and support hypotheses that suggest that anoxic waters were widespread in Late Permian and Early Triassic oceans (e.g., Wignall and Twitchett, 2002). Examination of ancient mass extinctions is important because a 6thmajor mass extinction is currently underway. Gaining a better understanding of mass extinctions, therefore, allows us to further our understanding of the modern mass extinction.

Analysis of the Sierra Nevada Frontal Fault orientation in the vicinity of Lone Pine and Independence, California

Greg Shagam
Faculty Advisor: Professor Phillip Armstrong

The western side of the Owens Valley is bound by the east-dipping normal fault system called the Sierra Nevada Frontal Fault Zone (SNFFZ). Published calculations of long-term horizontal extension across Owens Valley and the rest of the western Basin and Range generally assume a relatively steep fault dip of 60 degrees. Recent studies conducted by Phillips and Majkowski (2011) along the northern SNFFZ north of Bishop show that this boundary is better represented by lower angle normal faults with dips of 26 to 52 degrees east-facing faults. To test the hypothesis that faults farther south in Owens Valley might also dip more shallowly than the assumed 60 degrees, I used differential GPS and hand-held GPS devices to conduct a field study of three strands of the SNFFZ west of the towns of Independence and Lone Pine, California. GPS locations and elevations were taken approximately every 5-10 meters along the surface exposure of the faults for up to 2 km distance in order to capture maximum elevation variation along the fault traces. The faults were mapped on 1:24,000 USGS topographic maps and on Google Earth images and fault orientations were determined from 3-point analysis. The Independence Creek segment of the SNFFZ crosses Independence Creek with a strike of 340 degrees. Farther south, the Shepherd Creek segment is partitioned into two surficial faults. The eastern Shepherd Creek stand strikes 316 degrees and the western strand strikes 321 degrees. Data collected from the hand-held GPS will be compared to the differential GPS to determine the accuracy of the hand-held device for these types of fault studies conducted in the future. Structural analysis of the GPS data indicates that the normal faults at Independence and Shepherd Creeks dip shallowly, ranging from 29 to 44 degrees to the east. Because of this low-angle dip geometry, long-term horizontal extension rates calculated from 60 degree dips need to be re-evaluated. Extension rates could be underestimated by up to a factor of four.

Pebble Counts from the Pliocene Furnace Creek Formation, Death Valley, California

Coral Shaw
Faculty Advisor: Professor Jeffrey Knott

The upper Furnace Creek Formation crops out in the modern Furnace Creek basin between the Funeral Mountains to the north, composed mainly of Paleozoic sedimentary rocks, and the Black Mountains to the south, composed mainly of Tertiary volcanic and sedimentary rocks. The source of sediments in the 4.18-~3.22 Ma upper Furnace Creek Formation is not clearly understood because previous studies did not have the benefit of geochronology. I counted clasts in a measured section of the upper Furnace Creek Formation to determine clast provenance. Understanding the clast provenance is important because it may give insight into the uplift of the surrounding mountains. I counted clasts at three locations in the Furnace Creek Formation in the Zabriske Wash in Death Valley, California, which is closer to the Black Mountains. I found an accessible surface and divided the clasts located there into Sedimentary Clasts, Volcanic Clasts and Granitoid Clasts, but also noted the specific types of clasts in those three groups. I counted at least 100 assorted-size clasts at each location and recorded the rock type. There is a change in the percentage of volcanic clasts from 57-58% in the Lower Furnace Creek Formation to 80% volcanic in the overlying Funeral Formation. I interpret this to suggest a period of uplift of the volcanic terrain of the Black Mountains.

A Geochemical Analysis of Biotic Recovery following the Permian-Triassic Mass Extinction within the Peace River Basin, Central Western Canada Sedimentary Basin

Robert Sia
Faculty Advisor: Professor Adam Woods

The most severe biotic catastrophe in Earth's history, known as the Permian-Triassic mass extinction, occurred approximately 251 Ma and caused about 52% of marine invertebrate families and 96% of marine species to be lost (Erwin, 1993; Raup, 1979). Previous studies have attempted to determine the relative rate of the biotic recovery period following this mass extinction event but have had conflicting results, ranging from a quick recovery to a slower, dampened recovery (Wang et al., 1994; Beauchamp and Baud, 2002; Racki, 1999; Trappe, 1994). This paper focuses on the well preserved, Early Triassic Montney Formation that consists of black shale deposits within the Peace River Basin, Western Canada Sedimentary Basin. A chemostratigraphic analysis of primary productivity, paleoxygenation, and lithology was accomplished using trace elemental data collected from 47 samples from an 1,818 centimeter long drill core from the Pedigree – Ring Border – Kahntah River area of northwestern Alberta. Approximately 25 mg of sample was digested in aqua regia by heating the sample to 160°C over 10 minutes and holding at 160°C for 20 minutes. Trace metal contents were then measured on a Perkin-Elmer Optima 7300DV ICP-OES. Productivity indicators are as follows: P_2O_5, 0.02-0.2%; barium, 500-690 ppm; nickel, 50-100 ppm; copper, 200-600 ppm; zinc, 500-1000 ppm; and total organic carbon, 3.5%. Paleoxygenation indicators are as follows: cobalt, 5-20 ppm; MnO, 0.01-0.1%; molybdenum, 4-15 ppm; vanadium, 50-150 ppm; V/(V+Ni), 0.98-0.99 (indicative of euxinic conditions; Rimmer, 2004). Lithologic indicators suggest that the samples are clay-poor (Al_2O_3, 1-4%), dolomite-rich (CaO, 1-20%; MgO, 0.4-2%), poor in heavy minerals (TiO_2, < 0.01%; zircon, 1-6 ppm), and rich in pyrite (Fe_2O_3, 1-2.5%). These results indicate anoxic and euxinic conditions with high productivity throughout deposition in a relatively deep continental shelf environment. Overall, these results support previous studies that propose widespread anoxia in the global oceans during the post-extinction period (e.g., Isozaki, 1997), and high amounts of primary productivity following the extinction that likely drove paleoxygenation towards euxinia (Algeo and Twitchett, 2010). Of particular interest is comparison of this study to those by Ortiz and Woods and Agredano and Woods from the same basin, but from cores deposited in shallower depositional environments that demonstrate both higher degrees of oxygenation and low levels of primary productivity.

A Detrital Zircon Study of the Age and Provenance of the Gravelly Flat Formation, Great Valley Group, and Metasedimentary Rocks of the SCICON and Slate Mountain Pendants

Joshua P. Sobolew, Hector Fernandez, Isaac Shirley
Faculty Advisor: Professor Diane Clemens-Knott

Early Cretaceous fluvial sediments in the western Sierra Nevada mountains provide the basis for reconstructing sediment transport from the Mesozoic arc westward into the Great Valley forearc basin. Specifically, detrital zircon U-Pb dates are used to test the hypothesis that Early Cretaceous rivers delivered sediment to the Great Valley forearc basin at modern-day 36°N latitude. First, zircons were separated from three samples of the Early Cretaceous(?) Gravelly Flat formation--the stratigraphically lowest sediments of the Great Valley Group in the San Joaquin basin--in order to determine whether the 140 Ma fluvial sediments of the Goldstein Peak formation and forearc sediments of the Gravelly Flat Formation are indeed coeval. Second, zircons were separated from three metasedimentary samples from the SCICON and Slate Mountain pendants in order to address the provenance of pre-Mesozoic zircons in the Gravelly Flat Formation. Third, comparisons of the Gravelly Flat to the Goldstein Peak formation assessed the degree of statistical similarity between the coeval fluvial and forearc sediments. Important results include demonstration that the metamorphosed fluvial sediments are, in fact, coeval with the oldest forearc sediments, and that the zircon "cargo" of the Goldstein Peak rivers was fairly similar to that of the forearc sediments. Moreover, 60% of the zircons in the lowest, Early Cretaceous sample from the Gravelly Flat Formation could have been derived from the arc's Paleozoic-Precambrian metamorphic framework. Lastly, Late Cretaceous samples of the Gravelly Flat Formation were fairly similar to the Stoney Point Formation, the lowermost member of the Great Valley Group in the Sacramento Valley. This statistical similarity suggests that by ≈100 Ma, the Great Valley forearc basin was one unified, well mixed depositional system. A surprising outcome was the correlation of pendants to rocks cropping out in northern California-Nevada, providing new constraints to the Mesozoic tectonic history of North America.

Graduate Proposal Category

Multi-isotopic analysis of magmatic zircon from gabbroids across the Sierra Nevada: Addressing tectonic models with geochemistry

Michelle Gevedon
Faculty Advisor: Professor Diane Clemens-Knott

The Mesozoic Sierra Nevada batholith (SNB) was intruded across multiple crustal slices and exotic lithospheric mantle slivers assembled during Late Paleozoic truncation and modification of the North American continental margin (Saleeby, 2011). Multiple lines of evidence support this tectonic model, such as gravity data indicating major crustal boundaries (Oliver & Robbins, 1982), and a well-established west-to-east variation in whole rock (WR) isotopic data (Kistler,1990). Most interpretations attribute arc-transverse arc geochemical variations to the assimilation of multiple crustal slices of assorted thicknesses and compositions. Recent tectonic models however, imply that variations also existed in the Mesozoic mantle source region, and likely contributed to geochemical variations in the arc. Paired analysis of δ18O and εHf (O-Hf) in zircon is a relatively new geochemical technique, previously useful in determining sources and contamination histories of crustal granitoids (Lackey, in press; Lackey et al., 2008). Similarly, O-Hf analysis of zircons from gabbroids may reveal information regarding the compositions of mantle source regions from which melts were derived. Past O-Hf studies have focused on granitoids due to the high likelihood of finding abundant zircon; in contrast, many gabbroids contain little or no zircon, adding an element of risk to O-Hf studies targeting mafic rocks. Using zircon that I've successfully separated from gabbroids from the western SNB, I will test the hypothesis that zircons from gabbroids yield significant information to identify geochemical variations within a mantle wedge that was tectonically amalgamated. Furthermore, εHf analysis from granitoids in the study area will be used as a comparison to test the hypothesis that εHf signatures of gabbroids will have higher maximum values and tighter data spreads than higher silica rocks. An unusual abundance of gabbroic rock occurring in two ring dike complexes near the Stokes Mountain region of the SNB foothills present an ideal opportunity to test these hypotheses. Sample collection will reflect the area's structural and geographic diversity. For comparison, additional samples will be collected from the eastern SNB where the mantle source region is suspected to be homogenous. Previously collected gabbro WR isotopic data indicate small-scale variations in the mantle source region that seemingly correlate with plutonic and postulated tectonic boundaries (Clemens-Knott & Saleeby, 1999). Preliminary εHf research on zircon from study area granitoids document spatial variations that mimic those illustrated by WR data. WR trace element patterns from study gabbroids are consistent with a depleted mantle source as expected according to tectonic models.

Reconstructing Orange County's Oyster History: Understanding the Past to Help Restore the Future

Kelly Kathe
Faculty Advisor: Professor Nicole Bonuso

Current restoration projects, lead by Dr. Danielle Zacherl from CSU Fullerton, aim to reestablish the only native oyster, the Olympia oyster, Ostrea lurida back into its southern California habitat. Fished to near-extinction in the 1930s, then further damaged by sulfite pollution from paper mills, Ostrea lurida's species habitat once stretched beyond the southern California coast to Baja, Mexico. The modern history of oysters has been well documented by biologists, however the paleontological history dating back millions of years is less well known and many questions remain unanswered such as: Was Ostrea lurida always the only native oyster or did multiple oyster species live here? What other organisms thrived as a result of the oysters' reefal hard ground? How did the thickness of oyster beds vary through geological time? Did ocean environments play a role in community structure through time and if so, how? The goal of this research is to examine the last 70 million years of oyster history within the southern California region to help answer these questions. This study will incorporate both field methods as well as analysis of specimens housed at the John D. Cooper Center. This analysis is imperative to reconstructing the history of oysters in Orange County, California. By looking into the past, we are able to get a better understanding of how the diversity and abundance changed over time. This project is important for the current and future restoration of oyster communities along the southern California coast.

Western Ranges of Thailand: A Response to the Himalayan Collision

Megan Murphy
Faculty Advisors: Professor Brady Rhodes and Professor Phillip Armstrong

The Western Ranges of Thailand (WRT) are an ideal location for understanding the deformation of Earth's crust because of their location adjacent to the Himalayan collision (Fig. 1a). The Himalayas experience yearly vertical elevation gain as well as lateral motion resulting in the crustal extrusion of most of Indochina. The WRT are underlain by a core of metamorphic and igneous rocks. To the east are a series of Cenozoic basins, the Chiang Mai Basin (CMB) being the largest (Fig. 1b). Knowledge of the extensional deformation resulting in the opening of the basins and uplift and exhumation of the adjacent WRT is critical to understanding the response to the Tertiary Himalayan orogeny. Controversy and lack of data surround two major faults within the WRT; two opposing hypotheses have been proposed to determine the relationship between exhumation of the metamorphic core and opening of the CMB. The first hypothesis states that slip on the older fault, fault I, resulted in the exhumation of middle crustal metamorphic and plutonic rocks. The second hypothesis suggests that the older fault represents older compressional deformation, and slip on the younger fault, Fault II, caused the uplift and exhumation. One method for hypotheses testing is to determine the exhumation history of the metasedimentary rocks (Ms). If Ms shares a similar exhumational history to the metamorphic core (Gn) then the second hypothesis would be favored: that is, Fault I may be related to compression and Fault II is responsible for extension and exhumation. Should Ms exhibit an older exhumation history than the core rocks, hypothesis one would be favored because the younger fault, Fault II, could not have caused most of the exhumation of the metamorphic core (Gn). For age determination, apatite fission track and (U-Th)/He analyses will be used to determine timing, rate and amount of uplift of both units. 20-25 samples will be collected along transects that include areas over, under and between the faults. Detrital samples will be taken from the CMB in order to determine the source terrain, depositional age, and deformation and uplift history of the basin. Understanding the faults' timing and relationship to the ductile deformation, and eventual exhumation of the metamorphic core of the WRT will allow a more confident correlation with events in the Himalayans. These data will constrain the ages and magnitude of slip, constraints necessary to understand the extrusion process in this part of the Himalayan orogen.

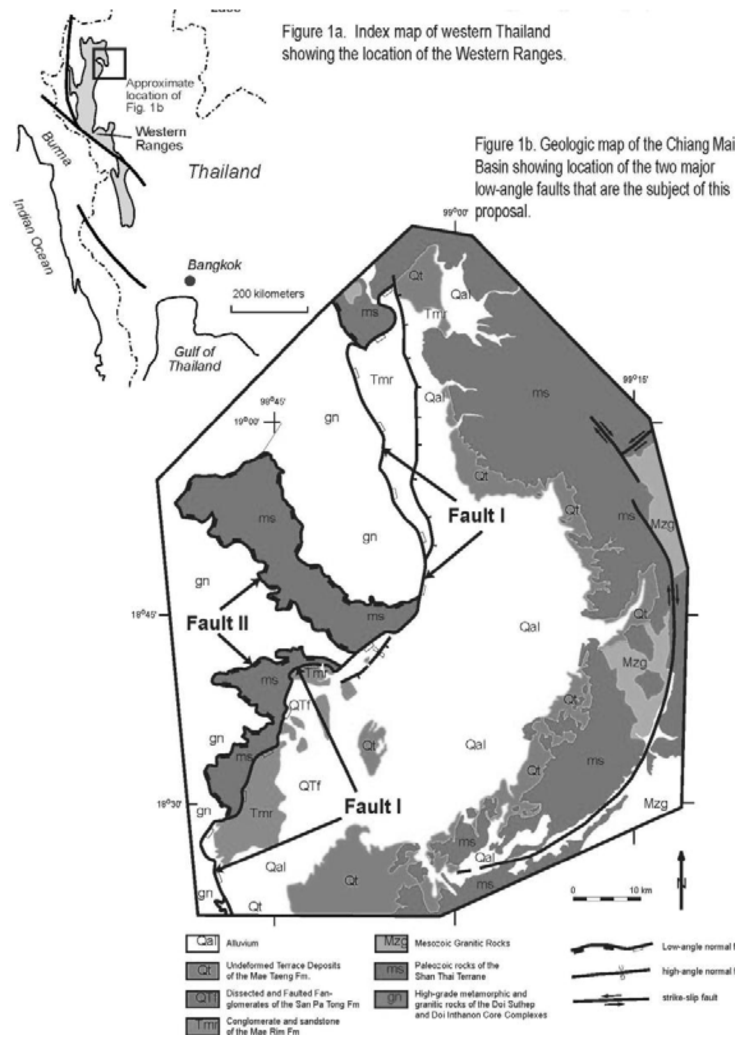

Figure 1a. Index map of western Thailand showing the location of the Western Ranges.

Figure 1b. Geologic map of the Chiang Mai Basin showing location of the two major low-angle faults that are the subject of this proposal.

Kings Sequence and Calaveras Complex Rocks of the Southern Lake Kaweah Roof Pendant, Tulare County, California

Christopher T. Buchen
Faculty Advisor: Professor Diane Clemens-Knott

Strongly deformed metasedimentary rocks of Paleozoic and Mesozoic age are found in the numerous roof pendants of the central and southwestern Sierra Nevada and, further north, in the Western Metamorphic Belt. Age, paleoenvironmental conditions, and geographic location at the time of deposition for these rocks provide essential input for reconstructions of the complex series of tectonic events that have produced the forearc basement and metamorphic framework for the Cretaceous Sierra Nevada arc. A 350 m dam spillway excavated through the southern end of the Lake Kaweah roof pendant, supplemented with nearby road cuts and natural outcrops, provides data regarding these three factors. Detrital zircon data provides a maximum depositional age constraint of ~165 Ma for rocks interpreted as Kings Sequence turbidites. The metaturbidites overlie metamorphosed ribbon chert and argillite beds (chert-argillite) interpreted as Calaveras Complex deep marine deposits. The latter also contains marble lenses similar to those in nearby pendants that have generally been interpreted as olistoliths, in part because chert-argillites devoid of carbonates are thought to form below the carbon compensation depth. The marble lenses found at this site are surrounded by calc-silicate rocks, and several calc-silicate layers of 5 to 15 m in thickness are found within the metachert unit. Well exposed contacts of these calc-silicate beds with the chert-argillite units display possible inconsistencies with an olistostrome interpretation. If the carbonates now found within the chert-argillite units were all originally deposited as sediment upon a marine basin floor, variations in environmental conditions such as a fluctuating carbon compensation depth may be represented at this location. Such changes could perhaps be produced, for example, by shifts in prevailing oceanic currents, seafloor uplift and subsidence, or a combination of these factors. Results of detrital zircon statistical analysis, petrological analysis, and field relations will be presented to help support the interpretations.

Rock Uplift above the Subduction Megathrust at Montague Island, Prince William Sound, Alaska

Kelly Ferguson
Faculty Advisor: Professor Phillip Armstrong

Flat-slab subduction of the Yakutat microplate has had a profound effect on southern Alaskan geology for the last 30-35 Ma. The Yakutat allochthonous terrane is subducting very shallowly (~6°) beneath the North American Plate at a rate of approximately 46 mm/yr to the northwest. Deformation from this subduction extends as far inland as ~800 km and has resulted in syntaxial bends throughout the region. Numerous studies have focused on exhumational patterns across these major fault zones using low-temperature thermochronology in the Alaska Range, Chugach Mountains, and St. Elias Mountains. Some of these studies have detected loci of rapid exhumation, particularly in the St. Elias and Chugach Mountains, which may be the result of lithologic 'backstops' to accretionary forcing. However, many questions still remain about how strain is partitioned to the southwest of the Yakutat collision zone in the Prince William Sound and, in particular, on Montague and Hinchinbrook Islands. These islands are part of the overriding North American Plate closest to the Alaskan

convergent boundary, where permanent deformation due to flat-slab geometry is least well-known and where there is possibly a large degree of coupling/underplating between the subducting Yakutat microplate and overriding North American Plate. This area is also thought to be most susceptible to 'seismogenically' intense events, or elastic failure capable of generating large (>MW 9.2) earthquakes like the 1964 Alaskan earthquake. Montague Island is of particular interest because it lies in between two areas of rapid rock uplift focused in the western Chugach Mountains and St. Elias Mountains. Montague Island itself is narrow, elongate, steep, and contains numerous thrust faults. As much as 7 m of vertical offset and 8 m of horizontal offset occurred along some of these faults, demonstrating the potential for strain accommodation above the collision zone. In addition to this geomorphic evidence, we present further constraints on deformational patterns along Montague Island using low-temperature thermochronology. Two cooling ages of 1.3 and 4.4 Ma for the Apatite helium and apatite fission-track systems, respectively, show that convergent accretionary strain is being accommodated by recent and rapid uplift on Montague Island. These age constraints are evidence that Montague Island marks a narrow zone of intense deformation in the overriding North American Plate above the shallowly-subducting Yakutat microplate. Future thermochron cooling ages will also help to constrain the timing of arrival of the thickened Yakutat terrane, how strain has been partitioned thereafter, and the lateral extend of this zone of deformation.

A Comparative Study of the 370 YR B.P. West Island and 1883 C.E. Burr Point Pyroclastic Deposits, Augustine Volcano, Alaska

Carolyn Rath
Faculty Advisor: Professor Brandon Browne

Augustine Volcano, Alaska is the most active volcano in the eastern Aleutian Islands, with 7 violent eruptions over the past 200 years and at least 12 catastrophic debris-avalanche deposits over the past ~2,000 years. The frequency and destructive nature of these eruptions combined with the proximity of Augustine Volcano to commercial ports and populated areas represents a significant hazard to the Cook Inlet region of Alaska. The focus of this study examines the emplacement of pyroclastic density currents by comparing the stratigraphic, granulometric, and petrographic characteristics of pyroclastic deposits emplaced in the 1883 Burr Point eruption and those emplaced ~370 14C yr B.P. West Island eruption. Data from this study combines grain size and componentry analysis of pyroclastic deposits with density and textural analysis of juvenile clasts contained in the pyroclastic deposits. Stratigraphic and granulometric data suggest differences in the manner in which these two pyroclastic density currents traveled and groundmass textures are interpreted as recording differences in how the two magmas ascended and erupted, whereas juvenile Burr Point clasts block and ash flow deposits, vesicular and glassy juvenile West Island clasts bear some resemblance to clasts derived from so-called "blast-generated" pyroclastic density current deposits at Mt. St. Helens in 1980.

A New 9000-Year Record of Centennial-to-Multi Centennial Scale Pluvial Events From Lower Bear Lake Sediments (San Bernardino Mtns., Coastal Southwestern North America)

Jose Rivera (Zimmerman, Starratt, Patterson, Hiner, Monarrez collaborators)
Faculty Advisor: Professor Matthew Kirby

Lower Bear Lake is located in the San Bernardino Mountains of coastal southwestern North America (CSWNA). This lake is the natural, pre-dam lake where present day Big Bear Reservoir is located. A single drive, 4.8 m-long sediment core was extracted from Lower Bear Lake in 2005. We present a 9000 calendar years before present (cal yr BP) paleohydrologic reconstruction. This new multi-proxy record (LOI 550°C, 950°C; C:N ratios, microfossils counts, grain size) is well-dated (22 AMS 14C dates on discrete organic material) and is characterized by variable sedimentology. Our results indicate two major features: 1) a long-term Holocene drying trend as observed elsewhere in CSWNA with an abrupt shift from wetter to drier conditions about 6200; and, 2) nine centennial-to-multi-centennial pluvial events over the past 9000 cal yr BP superimposed on the long term drying trend. Of these nine inferred pluvial intervals, five are considered major based on their combined proxy interpretations: 9300?-8250, 7000-6400, 3350-3000, 850-700, and 500-??? cal yr BP. To assess our results in terms of broader, regional paleoclimate records, we compare the timing of the major pluvial intervals at Lower Bear Lake to those identified previously at Lake Elsinore and Tulare Lake. This comparison reveals a similar timing between the three sites and the major pluvials. This temporally and spatially coherent signal indicates that a similar climate forcing acted to increase regional wetness at various times during the past 9000 cal yr BP. As a working hypothesis, we contend that small changes in the dominant patterns of Pacific SSTs modulated atmospheric circulation, thus favoring periods of enhanced atmospheric river storm activity across CSWNA.

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