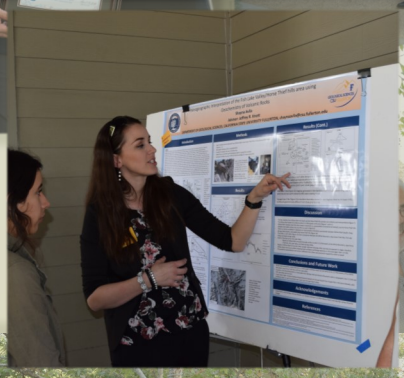
10th Annual CSUF Geological Science Research Day

Department of Geological Sciences
California State University, Fullerton
Fullerton Arboretum
Friday, April 12, 2019



This special event showcases the hard work of our student researchers and their faculty mentors. This event provides the opportunity for our students to "close-the-loop" regarding the communication-focused steps of the scientific method: students early in the research process present "proposal" posters, outlining the approach they intend to take in testing a hypothesis, while students nearing the end of their projects present their research and interpretations. To that end, we are particularly grateful to members of the South Coast Geological Society for volunteering to judge the posters, provide feedback to the undergraduate and graduate researchers, and recognize the top presentations with cash awards.

Thanks to everyone—cherished alumni, community college students, local geoscientists, families and friends—for spending the afternoon with the Department. We hope you enjoy good company and food in this beautiful setting. Most importantly, go talk to our students—challenge them, and help them grow as scientists!

GEOLOGICAL SCIENCES
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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.

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Undergraduate BA/BS Proposal Category

Developing a Yosemite National Park virtual field trip website for teachers to utilize in their high school classrooms

Student: Rebekah King

Faculty Advisor: Dr. Valbone Memeti

Virtual field trips are quickly becoming a new, integral part of geoscience education in the modern age. As an alternative to traditional field trips, virtual field trips can provide a cheap, effective, and engaging experience that is accessible for students, teachers, and informal audiences of all backgrounds, no matter the reason why they can't visit the field. I will be developing a free virtual field trip website for Yosemite National Park that is geared toward high school level students and that teachers, for example, can utilize in classrooms. Yosemite National Park is an exceptional location for a virtual field trip to educate about intrusive magmatic systems that were linked to volcanic eruptions in the past due to its excellent exposure of the Cretaceous, 95-85 Ma magma plumbing system called the Tuolumne Intrusive Complex (TIC). The TIC is a nested, normal zoned intrusive complex composed of three plutonic rock units that formed through incremental growth of multiple magmatic pulses that utilized the same magma pathway. Today, these rock units are represented by equigranular diorite and granodiorite to porphyritic granodiorite and granite compositions, the latter containing megacrystic, K-feldspar. Additionally, the TIC exposes a significant amount of magmatic structures at the outcrop scale including dikes, enclaves, schlieren tubes and troughs, and stoped blocks of the metamorphic host rock, etc. that inform about how magma systems operate at depth. I will be travelling to Yosemite National Park in the summer of 2019 to determine 10-20 locations to serve as stations for the website. This trip will involve gathering spatially referenced photos, videos, and other materials for application on my website. The website will include a Google Earth KMZ file map with the 10-20 stations labelled as points that the user may click on to be referred to that station. Each station will include images, videos, and text with a detailed description of the magmatic geologic features found at that location. For a greater educational purpose, interactive features such as questions and activities will be included at each station. The goal of this project is to not only educate the public on the geology at Yosemite National Park, but to excite and appeal to nonscientific audiences in a way that is accessible and requires critical thought, application, and understanding.

Trace Elemental Analysis of the Union Wash Formation following the Permian-Triassic Extinction: Determining Paleoenvironmental Conditions and their Relationship to Biotic Recovery

Student: Sunjay Jhaj

Faculty Advisory: Dr. Adam Woods

The boundary between the Permian and Triassic saw a mass extinction, with up to 96% of all marine species and 70% of terrestrial vertebrate species disappearing. Recovery of species across ecological zones was not homogenous; improvement directly correlates with the presence or absence of environmental stress. The Union Wash Formation of east-central California shows evidence for periods of recovery and stagnation that are associated with changes in sea level and thus changes in the environment during the Early Triassic. Numerous samples previously collected from the Darwin Locality of the Union Wash Formation will be prepared and examined using ICP-OES in order to better understand environmental conditions and their relationship to recovery following the mass extinction. Trace element data will help determine paleoredox and paleoproductivity during deposition and will also be used to examine lithologic and sedimentologic changes. Depleted levels of V, Mo, Cr, Co, and U are indicative of deposition under oxygenated conditions, while elevated quantities of the same elements can be used to determine anoxic or euxinic conditions. If anoxic or euxinic conditions correlate with enhanced productivity, as indicated by increased of levels of Ba, Cu, Ni, and Zn, then elevated primary productivity is the likely driver of anoxic conditions. In addition, lithologic changes will be determined by measuring Al, Si, Ca, Mg, Mn, Ti, and Zr; shifts in detrital elements (i.e., Al, Si, Ti and Zr) will also be used to examine shifting sediment sources. The results of this study will add to our understanding of the relationship between recovery and environmental conditions and will test the hypothesis of Woods et al. (2018) that much of the middle member of the Union Wash Formation was deposited under anoxic conditions.

Understanding the variability of organic carbon burial within a coastal wetland across time and space

Student: Sadie Kanneg

Faculty Advisor: Dr. Joseph Carlin

Atmospheric CO_2 levels are currently higher than they have been in millions of years, and the increases in concentration have been accelerating since the 1950s. These most recent increases are one of the major drivers of climate change over the past several decades and will have a significant impact on our climate in the future. Coastal ecosystems such as wetlands, marshes, and seagrasses, also known as blue-carbon systems, may be key to regulating future climate change. These ecosystems are particularly efficient at removing CO_2 from the atmosphere, putting it into plant biomass, and eventually burying it in the sediment. As sediment continues to accumulation in the marsh, the carbon-rich layers effectively get buried down deeper eventually sequestering the excess atmospheric CO_2 within the wetland soils. Therefore, these blue-carbon systems may be critical for regulating atmospheric CO_2 and import ecosystems to manage and restore, but questions remain, including: i) how does carbon-burial vary across wetland habitats and ii) how has carbon-burial changed over time with climate change and sea level rise. The purpose of this proposed project is to address these questions. To do this we will focus on a restored wetland in San Francisco Bay. We will collect sediment cores from three different wetland habitats: mudflat, cordgrass (low marsh), and pickleweed (high marsh). The cores will be analyzed to determine sediment mass accumulation rates, percent total organic matter, total carbon, and from this we will determine carbon-burial rates across the different habitats and through time. We hypothesize that cordgrass habitats will have the overall highest carbon-burial rates due to the combination of relatively high organic and inorganic sedimentation rates. Further, we hypothesize that carbon-burial rates will increase overtime as sea level rise increases accommodation space. From this project we hope to provide new insight into carbon-burial within wetlands that may inform future restoration and management activities.

Tephrochronology of the Modelo Formation in Ventura County, California

Student: Priscilla Martinez

Faculty Advisor: Dr. Jeffrey Knott

The Monterey Formation (Monterey) is a 19 Ma to 5 Ma, highly-siliceous sedimentary unit composed of sandstone, mudstone and diatomite that is found throughout California (Obradovich and Naesar, 1981). The Modelo Formation (Modelo), located in the central and eastern Santa Monica Mountains, is temporally and lithologically equivalent to the Monterey in many ways (Rumelhart and Ingersoll, 1993). The Monterey and the Modelo are important units because they are the source of much, if not all, of the petroleum in California (Garrison, 1981).

At the same time that the Monterey and Modelo were deposited offshore of California, over 30 eruptions of the Yellowstone Caldera occurred between 23 Ma and 5 Ma (Perkins et al., 1998). These volcanic tuffs are identified by tephrochronology as far south as the northern Mojave Desert (Perkins et al., 1998). A few tuffs from the Monterey are dated (Sarna-Wojcicki et al., 1984; Obradovich and Naesar, 1981), but the source of many tuffs is unknown and, although preliminarily identified by Andrei M. Sarna-Wojcicki, there are no published correlations of tuffs from the Modelo.

For my thesis, I propose to examine the Modelo section in Balcom Canyon where Sarna-Wojcicki found tuffs in 1985. The volcanic ash samples described by Sarna-Wojcicki bear a striking resemblance to the vitric tuffs that erupted from the Yellowstone Caldera as the Monterey formed. I will collect confirmatory samples for tephrochronology and compare the results to the U.S. Geological Survey database and published studies (e.g., Perkins et al., 1998) to identify the source and age of the tuffs. If these tuffs erupted from the Yellowstone Caldera system, then this will be the farthest known location from the source, which will increase the estimated size of the eruption, and provide a numerical age for the Modelo.

Environmental Stress as a Cause for Prolonged Recovery Following the Permian-Triassic Mass Extinction: A Geochemical Investigation of the Lower Triassic Union Wash Formation

Student: Brandon Moerer

Faculty Advisor: Dr. Adam Woods

Approximately 251.6 million years ago, the largest known mass extinction in Earth's history occurred. The Permian-Triassic (P-T) mass extinction wiped out nearly 90% of all species and was followed by an unusually prolonged recovery period. The purpose of this study is to determine what role environmental stresses played in this peculiar recovery and distinguish whether recovery trends were global or localized. The Union Wash Formation of East-Central California was deposited from the middle Early (Dienerian) to the early Middle Triassic (Anisian). The Union Wash Formation was deposited under conditions ranging from shallow to deep marine, with the majority of the unit deposited on the outer edge of the continental shelf. The upper Lower Triassic (Smithian – Spathian) middle member of the Union Wash Formation is the focus of this study and was deposited in quiet, moderately deep water. The middle member is comprised of mudstone and micritic limestone, and, along with the absence of macrofossils, only minor amounts of silt and sand, and a lack of sedimentary features, implies deposition in a deep, quiet, anoxic environment (Woods, 1998). In order to better understand what environmental conditions were present in the deep ocean during the Early Triassic and what environmental processes (e.g., upwelling, detrital input, etc.) were controlling those conditions, trace element analysis of samples from the middle member of the Union Wash Formation will be performed using the Perkin-Elmer 7500 DV ICP-OES located in the Geological Science Department at California State University, Fullerton. Variations in trace element content will offer insight into what specific environmental aspects that were important during deposition of the unit. If samples are enriched with Mo, V, and U, it can be assumed that the middle member was deposited under anoxic conditions. Elevated levels of Ba, Cu, Ni, and Zn would suggest that anoxic conditions were driven primarily by high primary productivity. However, depleted amounts of these elements would suggest that anoxic conditions were derived from ocean chemistry and found globally. Finally, variations in the amounts of Al, Si, Ca, Mg, Mn, Ti, and Zr will document lithologic variations and determine changes in provenance as well as whether nutrients were derived from runoff or upwelling.

Distribution of Surficial Slip Along the Eastern Santa Cruz Island Fault Based on Lidar Measurements

Student: Salena Padilla

Faculty Advisor: Dr. Sinan Akciz

The Santa Cruz Island Fault (SCIF) of Southern California is part of a system of left lateral strike-slip faults that extend from the Channel Islands to Pasadena for over 200 km. This system of faults, collectively named the Southern Transverse Ranges Fault (STRF) includes the following faults from west to east: Santa Rosa Island, Santa Cruz Island, Malibu Coast, Anacapa-Dune, Santa Monica, Hollywood, and Raymond faults. If the entire fault system were to rupture all together as a whole, similar to what the Landers earthquake did rupturing 5 different, but closely-spaced faults, then many urban areas in and around Los Angeles will be affected since a large portion of the system runs through these areas. So even though the STRF slips at a rate of about 1mm/yr, it is capable of causing a magnitude 7.5 earthquake. Despite this potentially catastrophic hazard, there is no information on whether each of the faults rupture individually or together during an earthquake. Therefore, documenting the past rupture history of the STRF is critical for evaluating its seismic hazard. Santa Cruz Island Fault (SCIF) is at an ideal location to investigate the rupture history of this fault system because it is the most well preserved of the faults and is away from urban settlements. Numerous offset drainages, scarps, and shutter ridges that demonstrate left-lateral offset form a sharp lineament visible in topographic maps and satellite imagery. The goal of this project is to measure offsets on tectonically displaced stream channels along the eastern 10 km section of the SCIF. Channel thalwegs and margins will be mapped and their displacements will be measured using ArcGIS. All offset measurements will be made on high-resolution bare earth digital elevation models (DEMs) derived from light detection and ranging (LIDAR) data. Since the distribution of displacement resulting from surface rupture during a large earthquake closely correlates to the magnitude of the earthquake, displacement measurements made along the SCIF will be utilized to infer a rupture pattern for the SCIF and the STRF system. Altogether this data will help us acknowledge the possibility of catastrophic damage that can be caused by a simultaneous rupture on the STRF system faults, just like the one that occurred during the Landers Earthquake in 1992.

Analysis of western Great Basin basalts in northern Owens Valley, California

Student: Matthew Pilker

Faculty Advisor: Dr. Jeffrey Knott

Studies show that the Mendocino Triple Junction between the Pacific, North America, and Juan de Fuca plates migrated north since the Miocene. At the beginning of the Pliocene, approximately 5 Ma, the Mendocino Triple Junction passed the latitude of northern Owens Valley. This changed the plate boundary conditions from a subduction zone to a transform boundary, altering the Ce, Y, Zr, and Ba concentration of rising basalt magmas. In addition, delamination of the Sierra Nevada batholith around 4 Ma produced high K_2O basalt magmas.

Basalts in northern Owens Valley have $^{40}Ar/^{39}Ar$ ages of approximately 3 Ma and 11 Ma, which precede and follow these tectonic events. Basalt flows in the White Mountains to the east are dated at 11.5 Ma. Existing research does not consider the relationship between the flows, assuming that they were formed by separate eruptions. This project makes three hypotheses. If the Sierra delamination raised K_2O in magma, then the 3 Ma basalts will have higher K_2O content. If the Ce, Y, Zr, and Ba concentrations change, then the 3 Ma basalts reflect plate boundary and magma pathway changes. Also, if the Owens Valley and White Mountain basalts are geochemically similar, then they represent the same flow or magmatic source.

To test these hypotheses, both 3 Ma and 11 Ma basalts in northern Owens Valley will be sampled and field observations will be made about the geologic nature of the outcrops. The samples will be powdered at California State University, Fullerton, before being prepared and analyzed for geochemistry by x-ray fluorescence at Pomona College.

Do offset stream channels in the Carrizo Plain, California, reliably record displacements of past earthquakes?

Student: Julia Rosenblit

Faculty Advisor: Dr. Sinan Akciz

Seismic hazard determinations require reliable information regarding the rupture history of the active fault of interest, including the timing, magnitude, and recurrence intervals of past earthquakes that occurred along it. Offset stream channels are routinely used to determine slip rates and slip-per-earthquake measurements, which can be used to infer magnitudes for these past earthquakes. When earthquake chronology data are not available, offset channels can even be used to infer recurrence intervals. The underlying assumption for such interpretations is that the frequency of channel formation in an arid, semi-arid setting is higher than the recurrence of large surface rupturing earthquakes. This assumption implies that a fault will always have some spatially distributed stream channels of different ages that uniquely record the slip associated with each of the past earthquakes. However, it is not explicit what the recurrence interval threshold should be to determine if such an assumption is considered credible. Paleoseismic data from the Carrizo section of the San Andreas Fault (SAF) indicates recurrence intervals between surface-rupturing earthquakes ranging between 45 and 145 years. Did new channels in the Carrizo Plain form frequently enough to record individual earthquake slip? Such information is essential for the estimation of paleo-earthquake magnitudes and evaluation of conceptual models for earthquake recurrence. Previous research suggests 10-meter and 16-meter offsets in the Carrizo plain had been the result of one and two events respectively. A trenching investigation at the Bidart Fan site in the Carrizo Plain indicates that two earthquakes have displaced a channel by 10-meters and as many as six earthquakes displaced a channel by 16-meters. This study aims to determine the incision ages of these two channels by excavating across both of the channels and collecting charcoal and optically stimulated luminescence (OSL) samples from their corresponding channel fill units and also the incised fan deposits. These locally derived incision ages will be compared to the earthquake chronology data from the Bidart Fan site to determine if stream channel formation in the Carrizo Plain occurs more frequently than seismic events or not.

Distribution of Shear Along the Borrego Springs Shear Zone, Imperial County, California.

Student: Jeremy Torres

Faculty Advisor: Dr. Sinan Akciz

Ductile shear zones which generally develop in response to large displacements play a significant role in the deformation of the crust. Exhumed shear zones, though limited in number and exposure quality, provide unique exposures of materials that show how strain is partitioned at deep crustal levels. Montezuma Highway roadcut exposes a nearly complete cross section across the Borrego Springs Shear Zone (BSSZ), a ~5 km wide, west-vergent mylonitic thrust shear zone, located within the Eastern Peninsular Ranges batholith. While earlier investigations focused on macroscopic structural evidence for the thrusting evidence (Simpson, 1984), geometry and lateral variations of strain within the BSSZ remain undescribed. The focus of this research project, therefore, is to document whether evidence for shearing is continuous across the entire width of this ductile shear zone or is concentrated within narrow, discontinuous zones. I will do a geologic transect of the BSSZ along the Montezuma Highway at 1:1000 documenting the occurrence and distribution of nonfoliated, foliated (S-tectonite), lineated (L-tectonite), and foliated-and-lineated (LS-tectonite) rocks. Oriented hand samples from outcrops representing each of the structural sections will be collected. Thin sections from these samples will be photographed and structural textures will be described. Foliation and lineation measurements will supplement the macroscopic and microscopic characterization of the BSSZ. Based on preliminary field data, it is hypothesized that while the degree of mylonitization increases progressively to the east, strain remains localized as pockets of discontinuous undeformed sections exist throughout the width of the shear zone.

Malibu Wastewater the Significance of Public Wastewater Treatment Facilities

Student: Alley Williams

Faculty Advisor: Dr. W. Richard Laton

The area of study is the Civic Center Basin in the city of Malibu, California. Malibu was incorporated in 1991 and has 27 miles of scenic shoreline. Due to the city's beautiful and unique land and marine environment, the citizens of Malibu have restricted certain conveniences otherwise found in other cities. This helps preserve the natural landscape and protects the environment to prolong Malibu's native lifestyle. On-Site Wastewater Treatment Systems (OWTS) were implemented to reduce over-development and control local planning, ultimately avoiding a public sewage system. However, this has impacted the quality of the water in the shallow groundwater, Malibu lagoon, and nearby ocean. The purpose of this thesis study is to test the chemistry of the groundwater to determine if the pollution has improved or stayed consistent since the implementation of the Civic Center wastewater treatment facility. I expect to see results that support the change in chemistry of the groundwater in Malibu.

Undergraduate BA/BS Thesis Category

Geochemical and Rock-Eval Analysis of Marine Carbonate Minerals: Assessing organic carbon preservation and thermal maturity

Student: Yasmeen De La Cruz

Faculty Advisor: Dr. Sean J. Loyd

Concretions are diagenetic structures that form in sediments and sedimentary rocks as a result of mineral precipitation within open pore spaces. Carbonate concretions, the most common concretion mineralogy, result from the microbial degradation and oxidation of organic matter. It has been shown that authigenic carbonates can preferentially preserve organic matter once exposed in outcrop. Here, we explored organic matter preservation in "still-soft" marine sediments of the Gulf of California (GOCA), South African West Margin (SAWM), off the coast of Newfoundland and in the northernmost Atlantic (here referred to as Arctic). Host sediments and authigenic carbonates were analyzed for organic matter content (TOC_{CF}), carbonate carbon and organic carbon isotope composition ($\delta^{13}C_{carb}$ and $\delta^{13}C_{org}$, respectively), and Rock-Eval pyrolysis thermal maturity indices (GOCA and SAWM only). Arctic and Newfoundland exhibit $\delta^{13}C_{carb}$ values that decrease with depth ranging from −12 to −27‰ (VPDB) and +2 to ─19‰, respectively, indicative of respiration driven authigenesis. GOCA and SAWM show dominantly positive isotopic signatures ranging from +3.87 to +13.23‰ and −2 to +12.01‰ that increase with depth and likely reflect precipitation via methanogenesis. GOCA and SAWM thermal maturity analyses reveal negative correlations between oxygen indices (OI) and hydrogen indices (HI). In addition, HI increases (from 211 to 409 mg HC/gTOC) and OI decreases (from 88 to 51 mg CO_2/gTOC) with depth in both host and authigenic carbonate samples. These relationships imply that organic matter degradation via respiration occurs at shallow depths whereas more reducing degradation pathways (e.g., methanogenesis) dominate as depth increases and that these reactions can promote the precipitation of authigenic carbonates. However, the lack of TOC_{CF} enrichment within the authigenic carbonates compared to the host implies no preferential preservation mechanism in these sediments, in contrast to those previously explored in outcrop. In addition, $\delta^{13}C_{org}$ values exhibit no clear relationship with other chemical and spatial parameters, suggesting that negligible isotope fractionation accompanies degradation of organic matter. Ultimately, our results indicate that whereas marine authigenic carbonates precipitate via organic matter degradation, cementation does not act as a subsequent preservation mechanism.

Petrology of magmatic enclaves and mafic dikes in the Jack Main Canyon intrusive suite, central Sierra Nevada

Student: Alejandra Angulo

Faculty Advisor: Dr. Valbone Memeti

Mafic magmatic enclaves (MME) and mafic dikes (MD) represent one type of recharge magmas that might be sustaining plutons above the solidus at the emplacement level for 10s of kyrs to myrs. We use field observations, petrography, cathodoluminescence (CL), and X-Ray fluorescence whole-rock element analyses to study such magmas in the Jack Main Canyon intrusive suite (JMCIS) in the central Sierra Nevada. We 1) petrographically and chemically characterize MME magmas; 2) explore physical (crystal mixing) and chemical (melt mixing) exchange between recharge and host magmas; and 3) investigate whether MME and MD magmas are cogenetic.

The ~98-94.5 Ma JMCIS is a NW-migrating set of four plutons. It is composed of, from oldest to youngest and mafic to felsic, the Quartz Diorite of Mount Gibson (Kgi), the Granodiorite of Bearup Lake (Kbu), the Granodiorite of Lake Vernon (Klv), and the Boundary Lake Granite (Kbl). Field mapping reveals that MME are non-uniformly distributed throughout the JMCIS units; MME increase in abundance from the Kbl to the Kgi, Kbu, and Klv.

MME compositions vary between granodiorite, monzonite, monzodiorite, and gabbroic diorite. All MD and most MME follow the calc-alkaline host rock progression; however, many MME in the Klv are more alkaline. A/CNK increases in MME with younging host units; all MME are peraluminous in the Kbl, per- to metaluminous in the Klv, and metaluminous in the Kbu and Kgi. MME and MD are mineralogically similar, but texturally heterogeneous across the JMCIS, with grain sizes and textures ranging from fine to coarse-grained and equigranular to Plag and/or Hbl and Bt porphyritic. Their mineralogy includes Plag and Bt ± Hbl, ± Sphene ± Qtz ± Kspar in varying proportions. Hbl abundance typically increases in more mafic host magmas. Although MME with sharp margins are ubiquitous across the JMCIS, MME with lobate and diffuse margins are common. Net-veined MD occur in the Kgi, Kbu, and Klv, often frozen while clearly sourcing MME.

Our field/lithology observations, chemical data, and petrography/CL data suggest a) multiple MME/MD populations are present in the JMCIS, and b) physical and chemical mixing occurred between recharge and host magmas at the cm scale. We propose intermediate to mafic JMCIS recharge magmas originated from different sub-emplacement level sources and/or experienced varied degrees of local mixing with host magmas.

Using Holocene sediments from North Yolla Bolly Lake in the Northern Coast Range (CA) to investigate the California precipitation dipole

Student: Judith Avalos Avila

Faculty Advisor: Dr. Matthew Kirby

Where California receives its precipitation is as important, if not more, than how much precipitation it receives. Key to the "where and how much" issue is the position and strength of the California precipitation dipole (Dettinger et al., 1998; Wise, 2010). This dipole defines an approximate boundary of opposite precipitation signals – wetter north/drier south and vice versa. Based on a 500-yr tree ring study, the average position of the dipole sits at 40° N latitude (Wise, 2016). However, over 500 years, the dipole has varied between 35° and 44° N. To extend the dipole's record beyond 500 years, we are collecting lake sediment cores along a north-south coastal CA transect. Here, we present initial results from North Yolla Bolly Lake (40° N), located in the Northern Coast Range. Six sediment cores were collected in July 2018 from various water depths. Here, I focus on core NYBLRC18-6 from the modern littoral zone in 0.37 m of water. In general, the sediments consist of variegated brown-colored, organic-rich muds with occasional laminae. An age model was developed using Bacon v 2.2, based on six radiocarbon measurements on discrete organic materials and an assumed surface age of 2018 A.D. The total sediment history is approximately 10k cal yrs BP for core NYBLRC18-6. A variety of sediment analyses were determined including water content, dry bulk density, magnetic susceptibility, total organic matter, total carbonate, and grain size. Increases in percent sand is used to infer changes in the flux of terrigenous detritus during above average wet winters and/or discrete precipitation events. Changes in percent total organic matter and percent clay are used to infer long-term variations in lake level and lake trophic state. Results will be compared to Lower Bear Lake, a site that is south of the dipole, in order to understand the strength of the California precipitation dipole over the past 9170 years.

Petrography and Geochemistry of Enclaves across the Tuolumne Intrusive Complex, Sierra Nevada, CA

Student: Ryan Bremer

Faculty Advisor: Dr. Vali Memeti

The Tuolumne Intrusive Complex (TIC) is a 1,200 km^2 intrusion that is located in Yosemite National Park, CA. Across all plutonic units of the TIC, enclaves are abundant and representative of magmas that have mingled with intermediate to felsic magmatic host rocks. Examining mineral-scale compositional variations between enclaves and their host can provide clues into the origin of the mingling magmas as well as display the degree of interaction that occurs between them, which can ultimately provide insight into the evolution and petrogenesis of plutonic systems. Field observations made during transects across the four main TIC units show that enclave swarms are more prominent in the marginal units than central regions. Enclaves from the Cathedral Peak granodiorite/granite tend to occur less frequently in swarms and are smaller and less abundant overall. Enclaves from the Kuna Crest granodiorite, as well as the porphyritic and equigranular Half Dome unit, tend to be prominent in both monogenic and polygenic swarms. Most enclaves in all units are ellipsoidal with rounded edges but are occasionally observed deviating and splaying into the host rock in various shapes. Petrography reveals that all enclave samples collected have the commonality of containing biotite, plagioclase, and opaque minerals. Abundances of these minerals are highly variant among samples, especially biotite. Porphyritic mafic textures are most abundant among samples, though seldomly samples exhibit equigranular texture. Hornblende and chlorite are frequently found while quartz, potassium feldspar, and sphene are sparsely found. Preliminary x-ray-fluorescence results of enclave samples shows a variation of silica ranging from 46.6-57.3%. When comparing major oxides, samples plot within a few percentiles of each other, even among differing units, indicating that these enclaves may have come from a compositionally-similar source magma. Except for one anomalous, peraluminous sample, each enclave plots as metaluminous. Seven of the twelve samples plot in the monzodiorite field, while two plot as monzonite, one as monzo-gabbro, and two foid-bearing gabbros. The lack of foids found using petrographic analysis suggests that these two samples may represent cumulates which lost interstitial melt. Although the degree of host-enclave interaction at contacts varies drastically even among samples in the same units, overall, mineralogic and whole-rock geochemical data reveals there is some degree of compositional homogeneity among enclaves in the various rock units across the TIC.

Searching for the mechanism responsible for higher $\delta^{13}C_{org}$ in the Middle to Late Cambrian Bonanza King Formation

Student: Andres Bustos

Faculty Advisor: Dr. Sean Loyd

The transition from the Precambrian to the Phanerozoic is marked by the sudden appearance and radiation of metazoan life—an event often referred to as the Cambrian Explosion. The Precambrian-Cambrian boundary interval exhibits extreme carbon isotope variability that may be linked to ecosystem dynamics. In order to characterize shallow marine environments in the aftermath of the Cambrian Explosion, we conducted organic matter carbon isotope analyses ($\delta^{13}C_{org}$) of middle to late Cambrian aged carbonates of the Bonanza King Formation in western Nevada. Our $\delta^{13}C_{org}$ data range from −25.33 to −12.53‰ (VPDB) with an average value of −16.3‰. These values are generally higher than typical, open marine $\delta^{13}C_{org}$ values recorded in the Cambrian and other time periods (common average $\delta^{13}C_{org}$ value ~ −25‰). This data can be interpreted in one of three ways, 1) insufficient removal of carbonate during the pre-analysis acidification process, 2) post-depositional thermal alteration, and 3) accurate reconstruction of the depositional environment where $\delta^{13}C_{org}$ differs from typical open marine values. Our data suggests that the first interpretation is incorrect due to there being a negligible correlation between Total Organic Carbon content (TOC) and $\delta^{13}C_{org}$. Thermal alteration can also be ruled out by applying a simple Rayleigh Fractionation model, which allows us to determine the isotopic evolution of residual organic matter. A lack of correlation between reconstructed organic matter fraction and measured TOC contents implies that thermal alteration did not significantly impact $\delta^{13}C_{org}$ values. The third interpretation is that the data reflects the primary depositional environment. Interestingly, our data are quite similar to those of modern platform carbonates of Great Bahama Banks. Bahama Banks $\delta^{13}C_{org}$ values of ~ −17 to −12‰ have been attributed to a significant algal organic matter contribution to the sediments. We suggest that the Bonanza King may likewise represent a platform carbonate system that received a significant organic contribution from algae; additional organic chemical characterization would provide insight into this hypothesis. Ultimately our data provide insight into the nature of Earth's biosphere during the middle-late Cambrian.

Using U-Pb Dating to Determine the Maximum Depositional Ages and Provenance of the Cow Creek and Fairview Metasedimentary Pendants, southern Sierra Nevada Mountains

Student: Christian Concha

Faculty Advisor: Dr. Diane Clemens-Knott

Much of the pre-Mesozoic history of California is a mystery due to the effects of magmatic heat and tectonism related to emplacement of the Sierra Nevada volcanic arc, because metamorphic recrystallization destroyed much of the original fossil, mineral, and structural data. To overcome this obstacle, I measured the U-Pb ages of ~300 detrital zircons (DZ) separated from each of two clastic metasedimentary rocks. Detrital zircons are fairly resistant to erosion and recrystallization so can provide new information inaccessible through other means. Use of this new method enables us to better resolve the pre-Mesozoic history of the western margin of Laurentia.

The Cow Creek and Fairview metasedimentary pendants are located on the Great Western Divide of the southern Sierra Nevada mountain range. The Fairview sample (BFD-105) is an isoclinally folded, laminated biotite-quartz schist. The Cow Creek sample (BFD-107a) is a white quartzite associated with marble. Ross (1989) observed that rock sequences in these two pendants differed, so I hypothesized that the pendants might have differing provenance.

These samples have experienced significant lead-loss, likely due to hot water circulating within the long-lived volcanic arc. In order to identify the effects of lead loss, I first excluded only those grains having more than 70% discordance. Doing so enabled me to identify original age peaks. Then I applied a very restrictive 5% discordance filter, so only undisturbed grains were used in the statistics. BFD-107a contains major U-Pb age peaks at 1.46, 1.78, and 2.61 billion years (Ga), along with a small (n=5) 2.14 Ga peak. BFD-105 contains age peaks at 1.14, 1.42, 1.77, and 2.68 Ga, with a minor 2.25 (n=3) Ga peak. A significant difference is the absence of a 1.1 Ga population in BFD-107a.

Each sample's maximum depositional age (MDA) was determined by calculating the weighted average age of the youngest population of grains. The protolith of BFD-107a was deposited sometime after 1.46 Ga; in contrast, BFD-105 was deposited sometime after 1.14 Ga. Next, multi-dimensional scaling (MDS) compared the samples to likely sedimentary protoliths in the region surrounding the arc, revealing significant provenance differences between the two pendants. One explanation of the different MDA and provenance differences is that these unrelated rocks were juxtaposed along a pre-Mesozoic fault, evidence for which was destroyed by the Mesozoic arc. Future work will be conducted to relate these pendants with surrounding pendants, with the goal of expanding our understanding of California's pre-Mesozoic evolution.

Extending our View of a Shallow-Dipping Sierra Nevada Fault System South of Mount Whitney near Lone Pine, California

Student: Jackson Flanagan

Faculty Advisor: Dr. Phil Armstrong

The uplift of the Sierra Nevada Mountains has been debated for over 100 years, yet the orientation of the fault system that accommodates this uplift, the Sierra Nevada Frontal Fault System (SNFFS), is poorly constrained. Most kinematic models of uplift, extension, and slip rates for the Sierra Nevada Mountains assume 60° dipping range-front normal faults based on Andersonian fault mechanics. However, recent analysis of some sections of the SNFFS near Independence and Bishop suggest shallower dips of 25-35°. In this study, I use differential GPS to remap and survey sections of the SNFFS along 9 km of the range front near Lone Pine, south of Mount Whitney and the highest elevations of the Sierra Nevada Mountains. Survey results show that the 1.5 km long Carroll Creek section strikes N24W and dips 30°E, and the 2 km Diaz Creek section strikes N41W and dips 28°E. The Carroll Creek fault section was directly measured at a road cut exposure, producing a dip measurement of 30°E. A shallow dipping SNFFS significantly affects calculations of long-term extension and fault slip rates derived from fault profile and/or total basin to range crest vertical offset estimates. For example, fault profile derived extension rates increase by a factor of three to four using 30° dipping faults rather than assuming 60°.

Zircon Geochronology and Petrology of The Migrating Tarana Intrusive Complex, Bathurst Batholith, Australia

Student: C. Flores

Faculty Advisory: Dr. Vali Memeti

This study is examining both the temporal and compositional patterns of the migrated Tarana Intrusive Complex (TIC) located in the Carboniferous, ca. 30 myr active Bathurst batholith, eastern Australia. The ca. 420 km^2 TIC is composed of a series of 15 separately mapped bodies, starting with 3 main units in the western, asymmetrically nested Bathurst batholith, evolving to ca. 9 crescent-shaped units that are concave to the east and end in 3 nested units at the eastern end.

The TIC is composed of four crescent-shaped, repeating high alkali biotite granites that vary cyclically in texture from equigranular to porphyritic and discordantly intruded into N-S striking host rock units. The mineralogy in these variably magnetic, hornblende-bearing equigranular granitoids to more felsic porphyritic granites includes differing amounts of quartz, orthoclase (K-feldspar), plagioclase, and biotite and/or hornblende. All samples also contain the accessory minerals zircon, apatite and oxides as well as secondary minerals such as sericite from hydrothermal alteration.

New LA-ICP- MS U/Pb zircon geochronology confirms the field relationships indicating west-to-east migration: the westernmost sample yielded an age of 334.26± 0.97 Ma, a unit halfway between the two end units yielded an age of 333.95±0.77 Ma, and the easternmost unit yielded the youngest age of 327.49±0.72 Ma. The migration of the TIC thus occurred over ca. 6.8 myr.

Petrography and XRF element geochemistry still in progress on 8 samples from eight different units representing four compositionally repeating cycles examine this cyclic nature of the rock compositions and the causes of migration.

Orientation of the Sierra Nevada Frontal Fault System in the Vicinity of Whitney Portal Near Lone Pine, California

Student: Eric Fregoso

Faculty Advisor: Dr. Phil Armstrong

Uplift of the Sierra Nevada has been and continues to be a controversial topic. The Sierra Nevada Frontal Fault System (SNFFS) consists of a set of east-dipping, range-bounding normal faults in Owens Valley that control uplift of the Sierra. However, the orientation of the SNFFS is poorly constrained. Kinematic models of the Sierra Nevada are based on an assumption of steep 60° normal faults. Pleistocene to Holocene extension rates were calculated to be 0.2-0.3 mm/yr based on these parameters. However, recent studies evaluating orientations of the SNFFS in Owens Valley from Bishop to south of Lone Pine suggest shallower dips ranging from 21-36° E. A normal fault system dip of 30° would increase extension rates by a factor of three to four compared to 60°. In this study, I remapped, surveyed, and evaluated a 2 km section of the SNFFS east of Lone Pine near Whitney Portal by remapping and applying post-analytical techniques. The faults strands were mapped using standard GPS and differential GPS. The orientation of the fault section measured is N24W, 28° E. Shear fractures adjacent to the mapped fault section SNFFS have an average orientation of N21W, 33° E, which is very similar to the mapped fault strands. The similarity of the fault and shear fracture orientations suggest that the shear fractures formed during movement on the main fault system. The orientation of the SNFFS plays an important role in understanding kinematics of the Sierra Nevada as well as the general extensional processes of the Basin and Range Province.

The Implementation and Use of Next Generation Science Standards-Based Tactile Models in the K-12 Educational System

Student: Kate Gibson

Faculty Advisor: Dr. Joe Carlin

In recent years, there has been a lack of Earth and Space Science (ESS) education in the K-12 system, furthermore the vast majority science education classes have centered on passive learning through lecture and textbook assignments. Scientific lab classes are often taught with well laid out science experiments that give little room for deviation from the expected outcome. This ultimately leads to a deficient understanding of how science is conducted in the real world and a high failure rate of STEM fields at the college and university level. The problem has grasped the attention of the United States Government, who have called for an increase in the number of bachelor's degrees in STEM related fields (Freeman, et al. 2014). The Next Generation Science Standards (NGSS) intends to correct this shortfall of science education by encouraging active participation and collaboration in the classroom. Within these new standards, ESS is given the same amount of content as the typical core sciences of Chemistry, Biology, and Physics. The new standards have teachers and students working together to learn about the world around them and conducting more in-depth experiments. The development and usage of models to represent Earth's processes are another benefit of the NGSS which helps students become an active participant in the classroom. This project focuses on the construction of three Earth science models for use in the K-12 classroom: an ocean garbage patch model, a glacier model, and a sinkhole model. Models are an important way for students to connect to processes that are too large, too slow, or too far away for students to observe on their own. Therefore, this project also includes the design of NGSS-aligned lesson plans to accompany these models that aim to engage students in the scientific method; observation, testing, and proving a hypothesis. With the aid of NGSS-based lesson plans to accompany the models, teachers will be able to connect students to the processes occurring around the globe.

Expansion of the paleoseismic record at the Van Matre Ranch site within the Carrizo Section of the San Andreas Fault

Student: Joseph Grohman

Faculty Advisor: Dr. Sinan Akciz

There are hundreds of identified faults in California; about 200 are considered potentially hazardous based on their slip rates in recent geological time (the last 10,000 years). Paleoseismic data on the location, recurrence intervals, and magnitudes of past earthquakes along a fault are essential to creating probability models needed for estimating fault rupture hazard. The great Fort Tejon earthquake in 1857, with an estimated moment magnitude of 7.9, ruptured the south-central San Andreas Fault (SAF) for a length of about 350 km. There is considerable scientific and public interest to know whether a similar earthquake has a significant probability in the near future. While the SAF remains as one of the most studied active faults in the world, paleoseismic data that show evidence for enough earthquakes to be considered statistically significant (> 10) to characterize its past rupture history are few and far apart. Existing paleo-earthquake records of the Carrizo Plain in the southcentral San Andreas Fault only go back to the last six earthquakes and point to an average recurrence of ~90 years. While we hypothesize that this 700-year long record from the Carrizo section is representative of south-central SAF's long-term behavior, the calculated age mean recurrence intervals is less than the time since the Fort Tejon earthquake and all reported average intervals of prehistoric earthquakes along the SAF. The existence of this quiet outlier period supports the need of an expansion of the paleoseismic record, ideally to 2000 years, to determine if there are other long periods of inactivity in the fault's rupture history.

At the 2015 Van Matre Ranch excavation site, evidence for the last three earthquakes was observed, and 13 significant detrital charcoal samples from within Trench 1 were collected and dated. However, only three out of the 13 samples were within the fault zone, each extracted from within the second observed earthquake. Using Oxcal, modeled age ranges were applied to the observed penultimate event resulting in dates of 766-86 BC and 577-1045 AD. The bioturbated zones within this section indicate an absence of sectional continuity, and the lack of abundant charcoal samples within the fault zone results in widely varying dates, which are inconsistent with the existing record, meaning there exist gaps of time that would otherwise be measurable. This conclusion results in the need for further paleoseismic excavations and studies to be conducted within the Carrizo Section of the San Andreas Fault.

Evaluation of The Sierra Nevada Frontal Fault System Between Whitney Portal and Tuttle Creek Near Lone Pine, California

Student: Joseph Hernandez

Faculty Advisor: Dr. Phil Armstrong

The uplift history of the Sierra Nevada Mountains has been a topic of debate among geologists for over a hundred years. Some geologists argue the Sierra Nevada Mountains were uplifted in the last 10 Ma due to tectonic processes, whereas others argue uplift in the late Mesozoic and has since subsided in the last 10 Ma due to isostatic response. The Sierra Nevada Frontal Fault System (SNFFS) is a set of discontinuous normal faults that strike along the east side of the range in Owens Valley. All evaluations of Sierran uplift assume the SNFFS faults dip 60°, but recent work by other researchers suggest the SNFFS is a shallow-dipping normal fault that dips as low as 25°E in the Independence and Bishop areas farther north. The purpose of my research is to help constrain the orientation of the SNFFS between Whitney Portal Road and Tuttle Creek. In this analysis, I remapped sections of the SNFFS using differential GPS. The X-Y-Z GPS data points were input into plane-fitting software to determine the best-fit orientation of the fault. My results show a strike of N37W and a dip of 13°E near Whitney Portal Road and a strike of N34W and dip of 36°E near Tuttle Creek to the south. These data are consistent with fault orientation result in the Independence, Bishop, and Lone Pine areas, which all have dips ranging from 25°-35°E. Shear fracture data were collected in footwall bedrock adjacent to the fault near Whitney Portal Road; the fractures have an average orientation of N40W and dip of 35°E, which is consistent with the fault dip of 36°. My conclusion is that the SNFFS between Whitney Portal Road and Tuttle Creek is a shallow-dipping normal fault. Calculated uplift rates using the normally assumed 60° dip are 3-4 times higher than those calculated using the approximately 30° dip determined from this study along ~120 km of SNFFS (from south of Lone Pine to north of Bishop) . Thus, kinematic models of Sierra Nevada uplift need to be reevaluated using more shallow SNFFS dips.

Identifying anthropogenic modifications to a continental shelf sediment record

Student: Maddie Huscher

Faculty Advisor: Dr. Carlin

Anthropogenic modifications to coastal environments alter the supply of sediments and other material to the oceans, yet these alterations can vary across both extremes of the spectrum. Dams for example, can limit the supply of material, while deforestation increases supplies. Similarly changes in land use across the watershed can both increase and decrease sediment availability. Further, environmental response to anthropogenic modifications are also still modulated by the natural processes and changes that occur. To understand the impact humans have had on the environment, we contrast natural variability in the geologic past with the combined natural-anthropogenic responses of the modern era. This study utilized Monterey Bay to investigate these processes. Monterey Bay is an ideal study location as it is a sensitive oceanic region to climate and marine primary productivity changes. Additionally, the Salinas River is a small mountainous river that drains into Monterey Bay that responds to terrestrial processes such as drought, extreme storms, wildfires and anthropogenic modifications including deforestation, land use changes, and dam construction. For this study we focused on one sediment core from Monterey Bay that had an established chronology from radiocarbon dating over the past ~1,000 years, spanning two significant climatic periods the Medieval Climate Anomaly (MCA) and the Little Ice Age (LIA). We utilized X-Ray Fluorescence (XRF) to measure elemental concentrations downcore, focusing on iron (Fe) and titanium (Ti) as terrestrial source indicators, and calcium (Ca) and strontium (Sr) as marine source indicators. The results showed that over the past ~1,000 years, during dry periods deposits are enriched in terrestrial sediments, while during wet periods there are increases in the biologic components. We interpret this to reflect a coastal ocean that is nutrient-limited during dry periods, and increased runoff during the wet periods delivers nutrients stimulating primary productivity blooms. Interestingly, all four elements show decreases in concentrations in the 1950s, yet collectively the results suggest a system with increased marine productivity. As a result, these modern deposits are characteristically more aligned with LIA deposits although we are currently experiencing a warmer and drier climate more like the MCA. We interpret this discrepancy to be the result of dams that have reduced terrestrial sediment fluxes to ocean, thereby resulting in relative-enrichment in biologic sediment components. This study demonstrates the impact humans can have on coastal sedimentation, altering sediment characteristics beyond the predicted outcomes from natural processes.

Clast Provenance and Detrital Zircon Dating of Pliocene Fluvial Conglomerate: Implications for Paleohydrology of Crooked Creek and Deep Springs Valley, California

Student: Lindsey M. Langer

Faculty Advisor: Dr. Jeffrey R. Knott

The paleohydrology of the western Great Basin has long been of interest to geologists and biologists interested in reconstructing dispersal pathways for various biota. Past studies briefly describe a fluvial conglomerate, with an interbedded 3.1 Ma tuff, that crops out on the 270-m-high ridge separating Deep Springs Valley from Eureka Valley. Additional inspection reveals that the fluvial conglomerate contains boulder-to gravel-sized clasts in a sandy matrix interbedded with cross-bedded coarse sandstone. Dominant clast types are sandstone, limestone, quartz monzonite, granite, and basalt. U-Th/Pb dates of 273 detrital zircons separated from the sandstone matrix are dominantly Jurassic (183.6–167.6 Ma), with an average zircon age of 175.33±0.38 Ma that correlates with local plutons. Lesser Triassic and Cretaceous zircon are also present. Six Proterozoic grains are likely derived from Paleozoic metasedimentary sources as they yield U-Th/Pb ages with known North American provenance: ca. 1.1, 1.4, and 1.8 Ga. Zircon ages and clast types can be used to identify the likely drainage basin from which the conglomerate was sourced. Basalt is not found in Wyman Creek drainage, eliminating that drainage. The drainage network of modern Crooked Creek, however, is underlain by Jurassic granodiorite, basalt and Paleozoic sedimentary rocks making it the likely source of the conglomerate. Based on the electron-microprobe analysis of volcanic glass the 3.1 Ma tuff layer can be correlated to the tuff of Mesquite Flats based on a similarity coefficient. Although similar to Long Valley, the source of the tuff of Mesquite Flats is unknown. I infer that (a) the conglomerate provenance is to the north-northwest in the White Mountains across Deep Springs Valley, and that (b) post-3.1 Ma uplift along the Deep Springs fault cut off the northwest-to-southeast river flowing in modern Crooked Creek and formed Deep Springs Valley.

Transport in Southern Monterey Bay

Student: Esther Lee

Faculty Adviser: Dr. Joe Carlin

Sediment delivery to the coast is important because it replaces sand that is lost from beaches due to waves and currents. Sediment supplied to the coast however, is susceptible to natural variability from climate shifts, and human modifications such as dams and sand mining directly from rivers or the coast. The result of these activities is often a reduction in the sediment input to the coast that can accelerate coastal erosion. Knowing exactly where the sediments are coming from and how they are distributed along the coastline can be useful in determining where and why potential shoreline loss is occurring or where certain areas may be vulnerable in the future. For this study, we focused on the coastline and coastal watersheds of southern Monterey Bay, one of the fastest eroding coastlines in California, to assess coastal sediment provenance and transport pathways. A total of 38 different surface sand samples were collected from the Salinas River, the beaches and dunes near the Salinas River mouth and throughout southern Monterey Bay, and the rocky headland beaches of the Monterey Peninsula. For each sample, the mineralogical composition of quartz, feldspar, and lithics were determined via microscopy. The results showed that quartz dominated most samples, with the rocky headland samples slightly enriched in feldspars and fluvial samples from the Salinas River enriched in lithics. From these results we see that there are clearly 2 source end members with the rocky headlands and the river. The beaches in southern Monterey Bay are a mix of both of these end members while the beaches proximal to the Salinas River mouth are primarily sourced from the river. Interestingly, the dunes throughout the area have a mineralogy more closely aligned with the river, even for those in southern Monterey Bay suggesting these may be relict features from a time when the river provided more sediment to the region. This study demonstrates the how categorizing coastal sediments based on their mineralogical components can be a useful tool in investigating coastal changes.

Investigating Coastal Sediment Provenance and Transport Pathways in Northern Monterey Bay, California

Student: Andrew Lindquist

Faculty Advisor: Dr. Joseph Carlin

The delivery of sediment to the coast is crucial because it provides material to beaches and other coastal areas that protect against storm events and sea level rise. Human activities such as dam construction and land use changes have caused a significant reduction in sediment supply to the coast and thus an increase in coastal erosion. As sea level rises, erosion is expected to increase, therefore, it is imperative that we understand coastal sediment sources and transport in order to better manage this valuable resource. Monterey Bay, California is one area in particular where there is an immediate need to assess coastal sediment source and transport processes. In this project, we determined the sediment source areas for coastal sediment in northern Monterey Bay to provide a better understanding of sediment transport in the region. We analyzed a total of 13 sand samples that included 10 beach samples from along the open coast north of the bay, Santa Cruz area beaches, and beaches proximal to the Pajaro River mouth within the central part of the bay. We also analyzed 3 sediment samples to serve as fluvial end member sources from the San Lorenzo and Pajaro rivers. All samples were analyzed using Quartz, Feldspar, and Lithics (QFL) analysis to identify mineralogical components for each sample in order to compare the beach samples to their potential source areas. Our results indicated that quartz is the most abundant mineral in all of the samples, consistently ranging from 57% to 62%. Feldspars and lithics exhibited greater variability, ranging from 12-41% and 9-24%, respectively. The results showed noticeable variability between the north coast beach samples, suggesting that each beach is supplied by individual small creeks in the area. For the Santa Cruz beaches, the samples closely corresponded to the San Lorenzo River samples, indicating it is the dominant source. Further, the beach sample near the Pajaro River mouth also closely aligned with the San Lorenzo River samples rather than the Pajaro River. This suggests that many of the beaches in the bay may be supplied by the San Lorenzo River, with Pajaro River sediment likely only dominating beaches directly adjacent to mouth and downdrift. These findings demonstrate that regional sediment delivery does not always correspond to the largest river systems, providing us with an improved understanding of sediment transport for northern Monterey Bay that may help manage sediment resources in the future.

Distribution of Surficial Slip Along the Santa Cruz Island Fault Based on Lidar Measurements

Student: Radwan Muthala

Faculty Advisor: Dr. Sinan Akciz

San Andreas Fault is the fastest moving (36 mm/yr) active fault in southern California that is capable of producing a moment magnitude (Mw) 8 earthquake. However, a much slower (1 mm/yr) and quieter (recurrence intervals 2000-5000 yrs) fault system extends for over 200 km from the Channel Islands to Pasadena. This left-laterally slipping fault system consisting of seven short (15-90 km) but closely spaced (separated by less than 2 km) faults are capable of causing a major earthquake of Mw 7.5 that ruptures right through downtown LA. Based on minimal chronological data from different sections of the fault system which indicate recurrence intervals that are around 5000 years, we hypothesize that the fault system generally ruptures as a whole during large, but infrequent earthquakes that produce offsets that average 3-5 m.

Santa Cruz Island Fault (SCIF) is at an ideal location to investigate the rupture history of the fault system as most of the other sections are either underwater or in heavily urbanized areas (e.g., Anacapa-Dume, Santa Monica, and Raymond faults). The goal of this project was to measure offsets on tectonically displaced stream channels along the western 10 km section of the SCIF utilizing recently acquired high-resolution (0.5 m/pixel) digital topographic data; accompanied by USGS Quaternary faults database to identify offset locations that would help in estimating slip-per-event for the past several surface ruptures. Thalwegs and channel margins of displaced channels were traced and projected on to the fault trace, and displacement for each feature was made using ArcGIS. The smallest magnitude offsets each channel has preserved evidence for was the focus of this project. A total of 37 channels with evident displacements along the fault were measured. Since the distribution of displacement resulting from surface rupture during a large earthquake closely correlates to the magnitude of the earthquake, our analysis suggests that the most recent earthquake along the SCIF produced at a minimum on average, 3 m slip, which correlates to a ~100 km surface rupture during a magnitude 7.2 earthquake. While this displacement data suggests a possible cascading earthquake style for the most recent earthquake, documentation of displacements associated with previous earthquakes is needed to test the validity of the wall-to-wall rupture of this fault zone.

Paleoecological Reconstruction of Marine Invertebrate Communities post end-Permian Mass Extinction Event Within the Central Nevada Region

Student: Melonie Nguyen

Faculty Advisor: Dr. Nicole Bonuso

Solid understanding of how environmental changes affects ancient ecosystems can help predict biodiversity stability and change within current and future ecosystems. This research aims to assign predictive power to present and future ecosystem recovery trends by analyzing ancient marine invertebrate communities after the end-Permian mass extinction event. We present a collaborative effort, between myself, Connor Prentiss, and Jesus Sancen, that strives to reconstruct paleoecological communities by focusing on invertebrate abundance and diversity data from the Central Nevada region. Specifically, I focus on the Lower Member and Fossil Hill Member of the Favret Formation within Favret Canyon, Nevada. This specific section is the youngest section within the study - the Middle Anisian stage of the Middle Triassic. The other section, studied by Connor Prentiss and Jesus Sancen, focuses on material from Bloody Canyon, Nevada. Sancen focused upon the stratigraphic range from the Middle Member of the Prida Formation, placed within the Lower Anisian stage of the Middle Triassic. Prentiss focused upon the Lower Member of the Prida Formation, set within the Spathian stage of the Early Triassic.

At each locality, we identified at least 100 specimens to the genus level. We measured each stratigraphic section and noted lithologies and sedimentary structures to interpret the depositional environment and relative sea level changes. Ultimately, we compared the depositional environments and systems tracts amongst three stratigraphic intervals. Our hypothesis states that taxa data from the same depositional environment and the same relative sea level cycle should have similar abundance, diversity, and ecological trends. If taxonomic patterns differ, we assume they differ due to evolutionary changes as opposed to environmental change. Based on our data, we interpret the overall depositional environment to be a mixed siliciclastic-carbonate ramp environment. Within that ramp environment, the data suggests that my samples were deposited within an open marine environment during a transgressive systems tract, Sancen's samples deposited within an open marine environment during a highland systems tract, and Prentiss' samples deposited in an intertidal environment during a transgressive systems tract. The results showcase a variable display of taxa found within each locality, with little ecological and taxonomic similarity between the stratigraphic intervals. Depositional environment and systems tracts were not held constant throughout this study, constraining the conclusion of the taxonomic changes within the stratigraphic intervals to be either evolutionary or due to environmental change. Future studies should hold depositional environments constant to track evolutionary change.

Reconstructing the Paleoecology of Marine Invertebrate Communities during the Early to Middle Triassic in Central Nevada

Student: Connor Prentiss

Faculty Advisor: Dr. Nicole Bonuso

After the end-Permian mass extinction, an ocean transgression occurred globally. While ocean transgressions are well studied, and taxonomic patterns are well studied, studies focusing on the combination of the two events are limited. Studying taxonomic change within reference to sea level change helps differentiate whether taxa change because environments shift or due to evolutionary change. Studying how previous rising sea levels affect biodiversity can help us better understand how modern rising seas may affect biodiversity. My thesis work is part of a collaborative effort to produce abundance and taxonomic data from Central Nevada. Specifically, I focused on data collected from a single stratigraphic interval within the Lower Member, Prida Formation of Bloody Canyon, NV. This interval is within the Upper Spathian, Early Triassic. Jesus collected data from the Lower Anisian, and Mel collected from the Middle Anisian. At each locality, we measured and described lithology, bedding, and sedimentary structures. Sedimentological data were used to interpret the depositional environment, specific sedimentary facies, and depositional sequences. At each fossiliferous bed, we identified fossils to the genus level and counted at least 100 specimens when possible. Within my fossiliferous bed, the data indicate an ecosystem dominated by stationary semi-infaunal suspension feeding bivalves like O*xytoma*. Deposition of the lower member of the Prida formation interval occurred within an overall sea level rise, particularly within a transgressive system track (TST). Overall, this member consists of a fining upward sequence beginning with a sandstone lithology containing rip-up clasts and ripple marks, suggesting a shallow intertidal environment, that transitions to siltstone and then limestone. This transition marks the very top of the TST: the maximum flooding surface. Bedding increases stratigraphically from centimeter scale to meter scale, which cohobates a TST sequence. Jesus's data suggest an open shelf, below storm wave base, in a highstand systems tract (HST) due to the presence of active mobile nektonic carnivores (ammonites) and evidence of upward shallowing. Mel's data provide evidence of an open shelf, below storm wave base, in a TST due to being rich in bivalves and a shallowing upward sequence followed by a deepening upward sequence. ANOSIM data analysis shows that the taxa collected from the three sections are not statistically similar. This is likely due to each sample being from different depositional environments. However, with more data, we can begin to evaluate whether these changes across the sections are due to evolutionary changes or due to environmental changes.

Conditions and Persistence of Mcdonald Well, Bird Spring, And North Bird Spring in The Mojave Desert, San Bernardino County, California

Student: Eddie Reyes

Faculty Advisor: Dr. Jeffrey R. Knott

Desert springs are often the sole sources of water and biodiversity across large areas of arid land. Their importance cannot be overlooked in conservation efforts and water resource management because they provide research opportunities for studying evolution and adaptation. Discharge, temperature, salinity, conductivity, and pH were measured at three Mojave Desert springs: McDonald Well, Bird Spring, and North Bird Spring from March 2018 to March 2019. There were 33 days of recorded rainfall in 2018-19 with a total of 165 mm (6.48 inches) of rain. McDonald Well is a regional spring with discharge ranging from 0.74 to 1.0 L/min during the year. Discharge decreased or remained the same immediately after rain; however, discharge increased throughout the rainy season (Nov-Mar). The lower discharge immediately following rain events signifies a lag time between precipitation and discharge. Higher salinity (660 ppm average) and conductivity (1327 μS average) compared to the other springs indicate water-rock interaction and a long recharge path. Bird Spring is the least persistent of the three springs. Discharge, as 0.0080 L/min drips, occurred only in March 2018. Salinity (279 ppm) and conductivity (550 μS) measurements were fresher than McDonald Well, implying less rock-water interaction and a shorter recharge path. Discharge from North Bird Spring (informal name) occurred four times during the year. Discharge as fracture seepage and dripping from the tuff cliff face occurred immediately after rain events over 12.5 mm (0.5”). Drip rates were 0.0062 and 0.032 L/min. The low salinity (162 ppm average), conductivity (323 μS average) and short lag time support low rock-water interaction and a short recharge path. All of these springs are disturbed by human activity. Because of the intermittent and low discharge at Bird Spring and North Bird Spring restoring the springs to their natural state by the removal of man-made diversions would not harm the environment; biota cannot utilize the springs much in the spring’s current state regardless. Removal of McDonald Well’s diversion would not be harmful because its steady discharge makes it likely that the spring will reestablish itself.

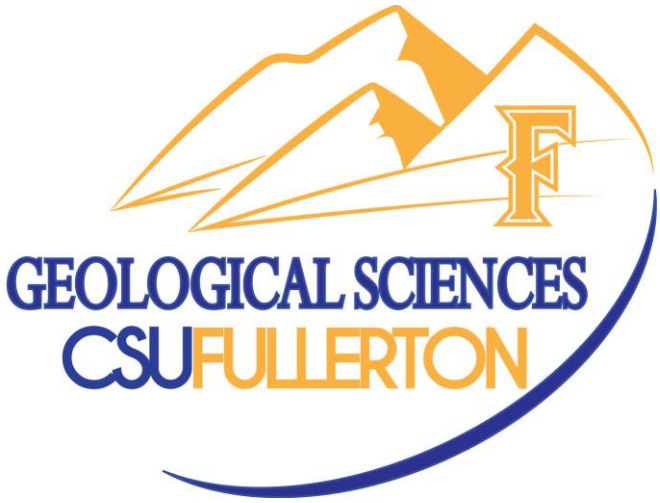
Tracking Invertebrate Taxonomy and Environmental Patterns After the End-Permian Mass Extinction Within the Humboldt Range, Nevada

Student: Jesus Sancen

Faculty Advisor: Dr. Nicole Bonuso

The fossil record can be used to understand community ecological and evolutionary responses to environmental change. Our research goal is to examine the restructuring of marine invertebrate communities after the end-Permian mass extinction. Detailed investigation of how communities evolve after mass extinction provides unique insight into general community assemblage rules. Understanding how past marine ecosystems assemble, and remain stable over millions of years, can help provide predictive power concerning the future of modern marine communities. Paleoecological data from Central Nevada is limited. My thesis work is part of a collaborative effort to produce abundance and taxonomic data from this region. Specifically, I focused on data collected from a stratigraphic interval within the Middle Member, Prida Formation of Bloody Canyon, NV. This interval is within the Lower Anisian, Middle Triassic. Connor collected data from the Lower Member of the Prida Formation in Bloody Canyon, NV, within the Spathian, Early Triassic; and Melonie collected from the Fossil Hill Member of the Favret Formation in Favret Canyon, NV, within Middle Anisian, Middle Triassic. At each locality, we measured and described lithology, bedding, and sedimentary structures. We used sedimentological data to interpret depositional environment, sedimentary facies, and depositional sequences. At each fossiliferous bed, we identified fossils to the genius level and counted at least 100 specimens when possible. The data indicates that the stratigraphy, abundance, diversity, and ecologies of fossils in the region change over time. Within my interval, ammonites dominate the limestone beds. The limestone coarsens up from a mudstone, within the first three meters, to a wackestone, in the last six meters. The most dominant ammonite genus within the interval is *Eutomoceras,* an active mobile nektonic carnivore. Followed by the bivalve *Sphaera,* a facultively mobile deep infaunal chemsybiotic organism. Deposition occurred in an open shelf facies within a highstand system tract. The data and interpretations I obtained differ from Connor's and Melonie's data and interpretations. Connor's data is representative of an intertidal zone facies in a transgressive systems tract and Melonie's data represents the same facies, an open shelf, but in a transgressive system tract. This information can be used to determine if the organisms changed due to evolution and/or environmental changes, however our work is just the beginning and more research must be conducted to come to any conclusions.

Masters MS Proposal Category



Comparing Natural Silica Sand and Glass Bead Filter Packs Used in Production Well Design and Construction

Student: Terrinda Alonzo

Faculty Advisor: Dr. W. Richard Laton

The building blocks of a water well are hole, pipe, screen and filter pack. If any of these are not sized correctly for the purpose and geology, then you are asking for problems. Water wells are key to most of the world's potable water supply. Poor filter pack in wells leads to poor hydraulic conductivity which results in more time and money spent pumping. Gravel pack is the main material used in wells to reduce sand pumping, however, the use of filter pack materials is changing as glass beads are now being used in water production wells more commonly. Natural high silica filter packs tend to be poorly sorted and less spherical compared to glass beads. The sphericity and uniform nature of glass beads create a filter pack that is hydraulically more efficient. Filtration capabilities of the natural, high-silica filter pack and the glass bead filter packs will be compared by evaluating the following: permeability, porosity, size, shape, and density to help better understand how to design a filter pack that is hydraulically efficient and provides good filtration to prevent sand pumping.

Exploring the Potential for Progressive Marine Authigenic Carbonate Formation with Depth

Student: Mauricio Avila Jr

Faculty Advisor: Dr. Sean Loyd

Authigenic carbonates precipitate within pore spaces of sediments and sedimentary rocks primarily via reactions involving the degradation of organic matter. The degradation of organic matter in sediments occurs through microbial reaction of oxygen, nitrate, sulfate, and metal oxides that can produce bicarbonate and dissolved metals as byproducts. These reactions are depth-distributed within organo-diagenetic horizons that promote the formation of carbonate minerals with specific geochemical signatures. This precipitation can create a rigid framework that allows retention of original porosity that is filled with later stage cements, providing an opportunity for cement production from multiple organo-diagenetic reactions with depth. We therefore hypothesize that authigenic carbonate precipitation occurs progressively with depth and from multiple reaction pathways. To test this hypothesis we will collect carbonate carbon isotope ($\delta^{13}C_{carb}$) and trace metal content data (Mn, Fe, Ba, and Sr) from multiple concretion-bearing marine sediment sites recovered from International Ocean Discovery Program (IODP) expeditions. Samples were obtained from the Newfoundland margin, the South Africa western margin, the Arctic, and the Gulf of California. Whereas sediments at all sites contain high organic matter contents, these sites differ with respect to sedimentation rate, lithology, depth, and age. Collection of data from these diverse sites will help constrain authigenic carbonate formation environments and indicate if progressive formation with depth is a widespread process.

Investigating the Seismic History of Santa Cruz Island from Surficial Slip Distribution Using LiDAR and Field Measurements

Student: John F Eggers

Faculty Advisor: Dr. Sinan Akciz

The Santa Cruz Island Fault (SCIF) is located within the Northern Channel Islands as part of a series of closely spaced left-lateral strike-slip faults, here named the Southern Transverse Ranges Fault System (STRFS). The Santa Rosa Island, Santa Cruz Island, Anacapa-Dume, Malibu Coast, Santa Monica, Hollywood, and Raymond Faults comprise a seven-fault system with 1 to 5 kilometers of separation between sections. While none of the sections are capable of producing a large magnitude earthquake on their own due to their short lengths (<100 km), the rupture pattern of the 1992 Landers earthquake, which involved several discontinuous but closely-spaced faults, suggest that the STRFS is capable of causing a major earthquake of Mw 7.5 that may rupture right through Downtown LA. Evidence for such a large magnitude earthquake must be preserved in the geomorphological record as ~5 m of left-lateral slip. SCIF is at an ideal location to investigate the rupture history of the fault system as most of the other sections are either underwater or in heavily urbanized areas. Numerous offset drainages, scarps, and shutter ridges that demonstrate left-lateral offset form a sharp lineament visible in topographic maps, satellite imagery, and newly acquired high resolution digital topographic maps produced from lidar point-cloud data. The goal of this project is to (1) confirm and update the Quaternary Faults linework on Santa Cruz Island, and (2) measure offsets on tectonically displaced stream channels using a MATLAB-code that automatically makes restorable offset measurements utilizing lidar data. Field confirmation of the fault line work and the offset measurements will also be conducted using a differential GPS unit. Since the distribution of displacement resulting from surface rupture during a large earthquake closely correlates to the magnitude of the earthquake, displacement measurements made along the SCIF will be utilized to infer a possible earthquake rupture pattern for the SCIF and the STRF system.

Testing the Efficacy of 3D-Printed Geologic Block Models as Tools for Fostering Spatial Visualization Abilities

Student: Joseph Gutierrez

Faculty Advisors: Dr. Sinan Akçiz and Dr. Natalie Bursztyn

Spatial visualization is crucial to success in the geosciences, especially in courses such as sedimentology and stratigraphy, structural geology, and field techniques. Sedimentary and tectonic processes tend to form geometrically predictable features, and students capable of imagining those geometries can visualize basic structural patterns given surface clues. Students with the spatial visualization abilities necessary to succeed in these courses are more likely to continue in the geosciences, while those that are lacking in their spatial visualization abilities struggle, resulting in an overwhelming proportion of students who migrate away from the geosciences. This issue stems from the fact that students are often unprepared for spatially-intensive coursework in the geosciences due to a lack of spatial training in K-12 and undergraduate education. Previous studies have demonstrated that spatial visualization abilities are malleable skills that can be trained efficiently and inexpensively, yet widespread spatial training - especially in the geosciences - is uncommon. With this project, we propose the use of 3D-printed geologic block models as tools for fostering spatial visualization abilities. Recent advances in 3D-printing technologies are making 3D-printing more accessible to educators, and the digital component of 3D-printing allows material designs to be shared with educators around the world. Through pretest-posttest experimental design, we intend to test the efficacy of our 3D-printed models as instructional tools designed to foster spatial visualization skills. Spatial visualization and demographic background surveys will be used to collect data from introductory geology laboratory students who complete a geologic structures lab as part of their coursework. The data collected through these instruments will be used to answer the following research questions - (i) Does teaching geologic structures with the assistance of 3D-printed block models impact students' spatial visualization abilities? (ii) Do student demographics such as gender, ethnicity, and STEM pursuit have statistically significant impacts on the acquisition/development of spatial visualization abilities? We hypothesize that the block models used to teach geologic structures at CSU Fullerton will have some positive impact on students' spatial visualization abilities, and that historically underrepresented and underserved students will receive the greatest benefits from the models, putting them on a more level playing field with their peers who have likely had more opportunity to develop their spatial skills. Should these hypotheses be supported by the data collected during this study, we have reason to believe that the block models developed for this study may have educational merit beyond the context of an introductory geology lab.

Holocene Paleohydrological Reconstruction Using Lake Sediments from North Yolla Bolly Lake, Mendocino National Forest, California

Student: Alex Woodward

Faculty Advisor: Dr. Matthew Kirby

This study seeks to create a reconstruction of Holocene hydrologic variability of the Northern Coast Range of California using sediment cores collected from North Yolla Bolly Lake (Tehama County California). North Yolla Bolly Lake is a permanent natural lake in the Northern Coast Range of California. At 41° N latitude the lake is located at the average latitude of the California (CA) precipitation dipole, which characterizes the spatial variability of El Nino-Southern Oscillation (ENSO) derived precipitation (Wise, 2010). As a result, North Yolla Bolly Lake is well-situated for examining changes in the average position and strength of the CA precipitation dipole through the Holocene. In order to develop a record of Holocene hydrologic variability, a multi proxy methodology is proposed. The proposed methods include: magnetic susceptibility, organic and carbonate content, grain size, carbon-nitrogen ratios, and X-ray fluorescence. Age control for these sediment cores will be based on of AMS ^{14}C dates taken from macroscopic organic material such as conifer needles and seeds. The results determined from this study will be compared to other hydrologic reconstructions throughout the western coast of North America, both to the north and south of CA precipitation dipole, such as Lake Elsinore, Lower Bear Lake, Silver Lake, Tulare Lake, Barley Lake, and Sanger Lake. At the conclusion of this research, potential climate forcings responsible for observed hydrologic changes will be proposed, such as Milankovitch forcings, ocean-atmosphere interactions, meridional overturning circulation.

Using Aquifer Pump Test data to Modeling Well Interference from OCWD Injection wells in Centennial Regional Park, Santa Ana, CA and to Compare Well Efficiency of Wells Constructed with Glass Beads v. Gravel Pack

Student: Andrea Arevalo

Faculty Advisor: Dr. Richard Laton

The Orange County Groundwater basin is experiencing declining groundwater levels. High volumes of well production have stressed local groundwater levels heavily so below Santa Ana, California calling for the construction of a series of injection wells at Centennial Regional Park as part of the Mid-Basin Injection (MBI) Project using Groundwater Replenishment System (GWRS) waters to replenish drinking water supply directly where it is needed. The MBI injection wells are supplemental to recharge ponds, those purposefully placed in the forebay area, and have the capacity to inject up to 12 million gallons day in target areas found within confined aquifers that would otherwise take weeks to months to reach. The amount of volume of water that can be injected into the aquifer is called well efficiency and is highly dependent on an aquifer's and filter pack's hydraulic conductivity, or how freely water moves through it. Aquifer pump test data from these wells will be used to 1) model different injection rate scenarios using a groundwater model to measure magnitudes of well interference between MBI injection wells during injection conditions as a preliminary study for potential flood hazards at the surface 2) analyze well efficiency of the MBI wells constructed with a filter pack consisting of glass beads, a more expensive product, to the MBI wells constructed with a natural gravel pack to determine how significant the differences are, if any. In addition, data collected from wells constructed with glass beads from a project in Malibu will also be analyzed.

Masters MS Thesis Category

Thermal Infrared Remote Sensing for Water Temperature Assessment Along the Santa Ana River Using an Unmanned Aerial Vehicle (Uav) System

Student: Diana Chacon

Faculty Advisor: Dr. W. Richard Laton

Water temperature is a critical regional indicator of water quality in rivers and streams. For this reason, stream temperature monitoring is required to protect endangered or threatened wildlife, such as the Santa Ana sucker (*Catostomus santaanae)*. In-stream data loggers provide continuous discrete data, yet they lack spatial data which is needed to model temperature distribution in rivers at a larger scale. The aim of this study is to identify favorable areas for the spawning of the Santa Ana sucker by mapping the radiant water temperature (*T*r) spatially and identify areas with coarser substrates and riparian vegetation in an approximate 1-kilometer (km) (0.6-mile (mi)) reach of the Santa Ana River. Unmanned aerial vehicles (UAVs) were used to collect high resolution imagery (Aerial photography, Thermal Infrared (TIR), and multispectral imagery) at high spatial resolution suitable for narrower rivers and streams during two seasons, Fall 2017 and Spring 2018. In addition, temperature loggers were installed to correct the TIR imagery and to understand diurnal temperature variations within the study area. Results indicate that TIR anomalies are associated with upwelling groundwater, and that favorable areas for spawning are found in tributary streams (Anza Drain and Sunnyslope channel). These tributary streams have native riparian vegetation that provides cover and shelter and upwelling groundwater with lessen temperature variations compared to the Santa Ana River.

Recycling of magmatic K-feldspar megacrysts as evidence for large interconnected magma mush bodies, Tuolumne Intrusive Complex, CA

Student: Melissa Chambers

Faculty Advisor: Dr. Vali Memeti

The size and connectivity of magma mush bodies at the emplacement level is debated, but important to determine as it relates to the size of volcanic eruptions. I hypothesize that megacrystic K-feldspars from the porphyritic Half Dome (pHD) unit of the Tuolumne Intrusive Complex (TIC) were magmatically formed and recycled into the Cathedral Peak (CP) unit where they continued growth into their megacrystic size and recorded ages and geochemical characteristics of both units. This suggests that pHD and CP magmas were interconnected at one point during construction and capable of feeding large volcanic eruptions.

Chemical abrasion-isotope dilution-thermal ionization mass spectrometry-trace element analyses (CA-ID-TIMS-TEA) U-Pb geochronology of zircons from the core, rim and surrounding host rock of one CP K-feldspar megacryst as well as core-to-rim trace element analyses of K-feldspars from the TIC were completed to resolve 1) the origin of megacrystic K-feldspars, 2) the cause of the megacrystic size, 3) the presence or absence of recycling between units, and 4) the size and interconnectivity of magma bodies at the emplacement level to infer potential volcanic eruption size.

Results include: 1) Most pHD K-feldspars are abundant in mafic mineral inclusions and this same feature is seen in the cores of some CP megacrysts; 2) the megacryst rim is ~0.5 m.y. younger than the core; 3) core zircon ages correspond to pHD whole rock ages while the rim and host ages overlap with CP whole rock ages; 4) core and rim zircon trace elements show similar traces, but contrast with the host zircon traces; 5) megacryst trace elements show characteristic pHD values in some of the cores of CP megacrysts.

The age difference between core and rim zircons suggests a magmatic origin rather than a metasomatic origin for the K-feldspar megacrysts. The ages, size, mineral inclusion density, and the geochemically characteristic pHD cores in CP megacrysts suggests pHD K-feldspars were magmatically recycled into the CP where they experienced extended growth to their megacrystic size. The similar zircon trace elements recorded mixing of pHD and CP magmas during the formation of an interconnected magma mush. The zircon trace element evidence and recycling of K-feldspars across gradational contacts suggests an interconnected magma chamber existed. The construction of large magma bodies rather than incremental emplacement of smaller dikes suggests magmatic systems like the TIC could have fed large volcanic eruptions.

Late Holocene Rupture History of the South-Central San Andreas Fault at Van Matre Ranch site, Carrizo Plain, California

Student: Nick Inserra

Faculty Advisor: Dr. Sinan Akciz

Characterizing long-term rupture patterns for active faults is integral to understanding fault dynamics and evaluating seismic hazard. Even for the south-central San Andreas Fault (SAF), sites with well-constrained past earthquakes evidence are few and geographically widely spaced. Recent paleoseismic data from Bidart Fan and Frazier Mountain sites, in the Carrizo Plain and Big Bend sections of the SAF, suggest frequent but variable magnitude earthquakes occurring every ~88 ± 41 yr. According to chronological data obtained from these sites and correlations with the sites further to the south, only twice in the last 800 yr has the fault produced a M_w 7.8-like event, including the most recent 1857 Fort Tejon earthquake. Rupture lengths, and therefore the magnitudes, of the other documented earthquakes remain unconstrained. The new paleoseismic trenches at the Van Matre Ranch (VMR) site, located in between the Bidart and Frazier Mountain sites, were opened to confirm the Bidart-Frazier Mountain event correlations, and put an additional constraint on the timing of the Carrizo-only events. Two connected fault-perpendicular trenches were excavated across a linear fault scarp from the active portion of the SAF. The trenches revealed 5 earthquake evidences, contained within 4 distinct stratigraphic packages. These lithological packages are separated by >0.5 m thick bioturbated intervals. Time lost in these zones corresponds to hundreds or thousands of years. Evidences of the 1857 and penultimate earthquakes are preserved within the uppermost package. We used a combination of 10 radiocarbon and 5 OSL ages to define the chronology of the depositional phases and surface ruptures at VMR. Oxcal modeled ages of the earthquakes are: Event A (1857 A.D.), Event B (1681 – 1796 A.D.), Event C (1223 – 1447 A.D.), and Event D and E (both occurring between 7570 – 713 B.C.). Our new chronological data for the penultimate earthquake (1681 – 1796 A.D.) provides a tighter constraint than the data from the Bidart Fan site (1631-1823 A.D.). This new data also falls within the age constraints of the penultimate event to the south at Frazier Mt. (1733 – 1854 A.D.). Assuming these evidences are from a single continuous rupture, the extent of the penultimate event was as much as 200 km, and is constrained to 1733 – 1796 A.D. Given 37 mm/yr slip rate for the SAF in the ~100 yr between the penultimate and 1857 earthquakes, this time interval should produce ~4 m of slip for 1857 in the Carrizo.

Early Triassic Paleoceanography Along Western North America: An Analysis of The Middle Member of The Union Wash Formation, East-Central California

Student: Rostislav Kovtun

Faculty Advisor: Dr. Adam Woods

Biotic recovery following the Permian-Triassic mass extinction was hampered by environmental stresses present in Early Triassic environments. Deep water anoxia in the global ocean is speculated to be a major contributor to delayed recovery rates of marine fauna following the extinction, as oxygen-poor deep waters periodically transgressed onto continental shelves, and added to other difficulties affecting shallow water settings, including hypercapnic stresses and elevated sea surface temperatures that were potentially lethal. The middle member of the Union Wash Formation of eastern-central California provides a means to reconstruct environmental conditions present in Early Triassic deep water settings along the western margin of North America and test the hypothesis of Woods (1998) that the unit was deposited under anoxic conditions. The middle member of the Union Wash Formation was examined at the Darwin Hills, CA locality in order to determine the nature and extent of anoxia off the coast of western North America during the Early Triassic (Olenekian) recovery interval. Interpretations of field observations, thin sections and ichnofabric indices suggest much of the middle member being deposited under anoxic conditions, based on extensive laminated units and a complete lack of benthic fossils. Thin section analysis reveals the presence of calcispheres and radiolarians, which, along with ammonoid macrofossils observed in outcrop and hand sample, denotes a pelagic fauna that lived above the seafloor. Furthermore, needle-like crystal pseudomorphs, interpreted to be former aragonite crystals, are common within gray, cm-scale layers of micritic limestone that are interbedded with laminated tan dolomite, and are hypothesized to have precipitated within the soupy sediment as the result of the unusual carbonate chemistry of the oceans at the time. Trace element analysis of massive limestone units points to the mud's original composition being aragonite (high Sr values), precipitation being rapid due to low detrital input (based on low values of Al_2O_3, SiO_2, TiO_2 and Zr), and bottom waters being anoxic (Mo, U, V enrichment factors > 1). Additional geochemical data of laminated limestone and calcareous siltstone couplets suggest consistent low-oxygen bottom-water conditions not driven by fluxes in primary productivity (enriched Cu, Ni and Zn values). Overall, this study hopes to better constrain the environmental conditions present along the western coast of North America during the Early Triassic and determine the degree to which paleoenvironmental stresses affect recovery from extinction events.

Late Glacial to early Holocene paleolimnology inferred from Barley Lake sediments (Northern Coastal Ranges, California)

Student: Jenifer Leidelmeijer

Faculty Advisor: Dr. Matthew Kirby

A multi-proxy study on a sediment core from Barley Lake provides insight to past variations in lake-level and changes in lake productivity during the late Glacial to early Holocene. Here, we focus on the interval between 12,850 – 8,130 calendar years BP. Barley Lake is a small (presently shallow) lake located in Mendocino County, California. Formed by a landslide, the lake is characterized by a small, steep-sided drainage basin and an ephemeral outlet. Located near the current position of the western United States precipitation dipole (~40° latitude) (Dettinger et al., 1998; Wise, 2010; Wise, 2016), Barley Lake represents an important location for recording changes in the dipole's position and strength over time. A combination of physical and chemical analyses, including magnetic susceptibility, total organic matter, total carbonate, total organic carbon, bulk $\delta^{13}C_{(bulk\ organic\ C)}$, and grain size are used to infer past limnological conditions. Age control is constrained by twelve radiocarbon dates on discrete organic materials between the depths 474 cm and 746 cm. An age model was constructed using Bacon version 2.2 (Blaauw and Christen, 2011). The data reveals two distinct lake states: 1) an oligotrophic, deep lake during the late Glacial (12,850 – 11,500 cal yrs BP), and 2) a eutrophic, shallow lake during the early Holocene (11,500-8,130 cal yrs BP). The former encapsulates the Younger Dryas (YD) chronozone, suggesting wet conditions in the Northern Coast Range during the Younger Dryas. At the same time, lakes in the Pacific southwestern United States such as Lake Elsinore (Kirby et al., 2013) and Silver Lake (Kirby et al., 2015) indicate dry and/or variably dry/wet conditions. Here we demonstrate robust evidence for a persistent north-south precipitation dipole in the western United States during the YD and early Holocene based on an assemblage of regional paleoclimate records. A closer look at the early Holocene lake record shows a long-term transgression between 11,500 – 8,130 cal yrs BP, with a notable change in lake status ca. 10,200 cal yrs BP. Our late Glacial to early Holocene interpretation is compared to a variety of climatic forcings to explain the reasons for inferred paleolimnological changes at Barley Lake.

Piecing together the magmatic history of the migrating Jack Main Canyon intrusive suite in Yosemite National Park by integrating mapping, geochronology, and geochemistry

Student: Cullen Scheland

Faculty Advisor: Dr. Valbone Memeti

The Cretaceous (125-85 Ma) Sierra Nevada magmatic arc migrated eastward and underwent spatiotemporal magmatic focusing (ca 105-85 Ma) in the central Sierra Nevada. A series of migrating nested bodies, mapped as the Jack Main Canyon intrusive suite (JMCIS), was emplaced on the west edge of the focusing zone with a northwesterly migration direction opposite to arc migration and focusing. We use 1:10,000-scale mapping, whole-rock element data, and LA-ICPMS U-Pb zircon ages to characterize its map pattern, structure, age and petrology and examine its antithetical migration and internal magmatic processes.

The JMCIS includes four units and six facies that young and largely increase in SiO_2 from the SE to the NW: (1,2) Mount Gibson quartz diorite fine (Kgif) and coarse-grained facies (Kgic); (3) Bearup Lake equigranular granodiorite (Kbu); (4) Lake Vernon porphyritic granodiorite (Klv); (5,6) Boundary Lake transitional granodiorite (Kblt) and granite (Kbl). Mapping has revealed gradational contacts in the centers and outward-dipping sharp contacts at the peripheries of units and has added hundreds of structural measurements of four foliation types. The latter include discordant and concordant margin-parallel foliations, NW-SE and ~E-W striking regional foliations, and foliations defining outcrop-scale magmatic structures. Geochronology data suggest that the JMCIS was crystallizing zircon between ~98 Ma and 93.5 Ma (± ~1-2 Ma) with overlapping ages spanning up to 5 my in single samples. Element geochemistry results define an evolving calc-alkaline series with an SiO_2 range of ~56-73 wt. %. Units record decreasing compatible major element contents with increasing silica and have compositional major and trace element arrays overlapping with preceding and subsequent units.

We propose that the map pattern, geochemical trends, and temporal relationships can be reconciled by the past presence of a migrating locus of intrusion. Discordant fabrics reflect strains of originally ellipsoidal intrusions truncated by subsequent ones. Such truncation would result in older zircon and major solid phases (±melt) being transferred into younger units, yielding ages spanning both units and compositions averaging the old and new units. Migration of the JMCIS intrusive locus over ~10 km took ~3.5 myr. Early migration (Kgif to Kbu) was followed by increased nesting (Klv to Kbl), potentially reflecting an initial failure to sustain a magma conduit followed by success.

Investigating the DICE (Drumian Carbon Isotope Excursion) in Cambrian aged Bonanza King Formation carbonates in the Western Great Basin.

Student: Bayne Westrick-Snapp

Faculty Advisor: Dr. Sean Loyd

The Drumian Carbon Isotope Excursion (DICE) is a –2 to –3‰ magnitude negative carbon isotope excursion that occurred around 506.5 Ma and has been observed in the central and eastern Great Basin, Scandinavia, and China. This excursion is associated with transgression and the appearance of agnostid trilobites in the sites explored in past studies. We collected 120 samples from north of Shoshone California and the Bare Mountains south of Beatty Nevada of the westernmost Great Basin to investigate spatial variation in DICE-related excursions. Inorganic carbon, organic carbon, and pyrite sulfur isotope analyses are ongoing and will be used to reconstruct the chemical characteristics of the depositional environment. Preliminary carbonate carbon isotope compositions in the Bonanza King range from –2.20 to +1.34‰ (VPDB) and capture the DICE at both localities. The organic carbon isotope data collected so far averages around –16.3‰. The organic and inorganic carbon isotope data do not correlate, similar to relationships observed in modern day carbonate platforms of the Bahama Banks. These similarities suggest that the Bonanza King may likewise represent a shallow platform carbonate deposit. The consistency of the carbonate carbon isotope data both between our study sites and with the broader record suggest a regional and perhaps global driver of the DICE. Through a simple mass balance model, we calculate an ~8-12% decrease in the fraction of carbon leaving the ocean as organic matter during the DICE, depending on the locality. This rapid fluctuation in organic matter burial implies a significant shift in the redox environment during the DICE. Pyrite abundance and sulfur isotope data will be collected and contribute to the larger picture of Drumian ocean redox chemistry, particularly during the dynamic DICE event. Additional modeling will be used to explore the nature of the carbon and sulfur cycling indicated by the produced isotope records, including combined quantification of the magnitude of organic carbon and pyrite sulfur burial. Regardless of the outcome, this study will help us better characterize the important interval in Earth history that directly follows the Cambrian Explosion.

Student Research Category

Petrology of Composite Mantle Xenoliths from Dish Hill, Mojave Desert, California: Implications for Mantle Heterogeneity and Metasomatism

Student: Caitlin Bates

Faculty Advisor: Dr. E. Erik Bender

Nineteen samples of mantle xenoliths were collected to better understand the nature of the uppermost mantle beneath the central Mojave Desert of California. Samples were collected from within host rocks that included both basaltic lava flows and cored bombs from two Quaternary volcanic centers at Dish Hill (Siberia Crater) near Ludlow, California and the Cima Volcanic Field near Baker, California. The distinctive macroscopic feature of the Dish Hill xenoliths is their coarse grain size with average grain sizes of 0.5-1.5 mm in collected samples. The variety, compositional changes, and possible sources of the core materials were analyzed. Xenoliths are highly variable in nature, consisting mainly of lherzolite, with subequal amounts of olivine and both ortho- and clinopyroxene with subordinate spinel. Other minor amounts of upper lithospheric xenoliths consist of fused granite fragments. Lesser quantities of both olivine and spinel xenocrysts are the found throughout the area. The generally accepted hypothesis is that these dominant lithologies, such as the lherzolites, are accidental inclusions derived from a surprisingly heterogeneous upper mantle. The variable mineralogy and geochemistry of these xenoliths appears to largely reflect differences due to metasomatism. Further petrologic and geochemical studies of both the xenoliths and the host rocks will reveal the specific nature of these xenoliths and provide constraints on the composition and nature of the upper mantle in the region.

A Test of Lossless Image Compression and its Utility in Recognizing Biogenicity in Sedimentary Rocks

Student: Kyle Campbell

Lossless Image Compression Testing (LICT) is an experimental method initially tested and developed by Corsetti and Storrie-Lombardi (2004) in order to determine the biogenicity of putative stromatolites. The goal of this study is to stress test the LICT method of Corsetti and Storrie-Lombardi (2004) by removing as many variables as identified in their paper and check for data that reflects distinct changes in the compression rate (Compression Rate = Compressed Image Size/Initial Image Size) based on the object captured in the image. Some of the variables that have been accounted for are Distance, and Color differences in images. The test was initially purely digital, using a stock image of a sliced apple, and testing various deformations to the apple that resulted in changes in image sizes. The results were promising, as each deformation produced varying compression rates. But these simulated conditions are not feasible in a true Martian environment (Corsetti and Storrie-Lombardi, 2004). The testing progressed to compressing images of stromatolites, landscapes, and scale items (such as pennies and pens). All images were taken at various distances and photographic settings, and each photo was run through a compression algorithm that included grey-scaling the images to remove color as a variable (allowing only complexity of image and distance to vary). These results were more mixed; however, we are able to differentiate long range photographs from images that were taken from a closer range without ever seeing the image. This demonstrates distance (as a positive correlation with image complexity) affects results and therefore needs to be fully accounted for. Our final test will consist of analysis of hundreds of photos of biotic and abiotic features within rock formations. Concretions were selected as an additional test subject, along with three confirmed biogenic stromatolites, and a number of igneous, sedimentary and metamorphic rocks with no biotic implications as control groups. This large set of data will aim to either prove or disprove the utility of the LICT method by Corsetti and Storrie-Lombardi (2004).

Diagnosing Abiotic and Biotic Presence Testing Efficacy and Efficiency in a Martian environment

Student: Kyle Campbell

NASA currently has 3 functioning rovers on the surface of Mars. With the recent loss of Opportunity, calls for more missions designed to find microbial life have begun to build. Finding life on another planet is anything but a simple task, as there is no rulebook on what life beyond Earth might be. Will it be Carbon-based? Silicon-based? A rare isotope of Neodymium? For now, researchers are making the assumption that life on other worlds will function chemically similar to that of Earth- using Carbon as a starting point.

The current approach to finding Martian life is answering the query: “How do we find Earth life?”

I have identified, for the purposes of the California State University Titan Rover Program as part of the University Rover Challenge (URC) a total of eight methods that can be reasonably utilized to detect life. For each method, I analyzed the various implications, such as cost, time usage, and weight requirements, to complete the test for biotic presence. Any of these tests that ran afoul of the guidelines provided by the URC were deemed inefficient or untenable in a realistic Martian environment using an actual rover designed by NASA.

After deliberating, researching, and testing where possible (see XRF Scanner summary), I have determined that the most effective as per cost, weight, and time efficiency is testing for the presence of Catalase in Hydrogen Peroxide (H_2O_2). Catalase is a very common component in living organism cell structures but is entirely absent (to the best of scientific knowledge) in abiotic settings, making it a good candidate for standardizing Carbon-based life detection. The byproducts for this reaction are pure water and oxygen gas, which makes it favorable for preventing contamination of the Martian soils. Additionally, and most importantly in the competition setting, the reaction is easy to recognize by distinct effervescence and quick to react.

While it is certain that superior tests exist, some of which are discussed in my research, practicality must be given full attention in a task that is results driven. Given the fewest points of failure, ease of implementation and interpretation, I posit that Hydrogen Peroxide should be considered the standard for Carbon-based life detection testing.

The Nature of Textural and Compositional Variability in the Lake Vernon Granodiorite in Western Yosemite National Park, CA.

Students: Jamie Hayward and Cullen Scheland

Faculty Advisor: Dr. Valbone Memeti

Granodioritic Sierran plutons are often characterized by within-unit, local to regional textural and compositional (modal) variability, too subtle for separation into mapping units. These within-unit changes might be due to differences in cooling histories, magma mixing, internal fractionation, and crystal accumulation. This study uses cathodoluminescence (CL), petrography, and whole rock XRF element analysis on 7 samples from across the 97-95 Ma Lake Vernon Granodiorite (Klv), Jack Main Canyon intrusive suite, western Yosemite National Park, CA, to determine the nature of this variability.

Three plagioclase populations were identified. In order of abundance they are: (1) grains (150-3000 μm) that exhibit oscillatory and patchy zoning in both crossed-polarized light (XPL) and CL, 95% of grains have albitic overgrowth; (2) grains (150-2000 μm) that have no zoning (XPL and CL); and (3) grains (350-3000 μm) with oscillatory zoning characterized by thicker rims and inclusions of hornblende and opaque minerals (XPL). All samples display cumulate textures of populations 1 and 2 over 5-25% of the thin section area. K-feldspar crystallized interstitially adjacent to the plagioclase cumulates in 4 of 7 samples; the other 3 have K-feldspar grown in interstitial pockets throughout the thin section. The samples with the highest degree of plagioclase accumulation (15-25%) are located at the NE gradational contact with the older Kbu unit. The samples with the highest abundance of population 2 are found at the gradational contacts with the Kbu (NE), and a younger Kbl unit (SW). Population 3 has no spatial preference. Element results display negative correlation with increasing silica in MgO and CaO (strong), and Sr (weak) from the eastern margin to the western interior.

Our results suggest that 3 petrographically distinct plagioclase populations likely originated in an earlier Klv magma or adjacent older units and concluded their magmatic histories together in the Klv. Cumulate textures suggest that melt migrated at least locally. More abundant plagioclase accumulation at Klv boundaries with the older Kbu suggests boundary effects led to greater interstitial melt loss. Elemental trends coupled with CL and petrography observation suggest the Klv experienced crystal fractionation over 6 wt% of silica. These findings suggest Klv variability was caused by changing conditions throughout crystallization and/or magma mixing, and accumulation/crystal fractionation. The presence of 3 populations in all samples across the Klv in addition to marginal accumulation of plagioclase suggests that the Klv was melt interconnected across the pluton.

Evidence for a Sustained Late Holocene Dry Period in the Coast Range of California (Barley Lake, CA)

Student: Adam D. Rueckert

Faculty Advisor: Dr. Matthew Kirby

Barley Lake (39°35'N), is a lake in northern California selected because of its position relative to the average position of the CA precipitation dipole (40°N). The purpose of this study is to describe an event in the late Holocene of apparent hydrologic significance and define the lake's relation to the precipitation dipole at this time. To do so, three primary sediment cores were taken and analyzed for age, magnetic susceptibility, water %, dry bulk density, % total organic matter, % total carbonate, % non-carbonate inorganic matter and grain size distribution. Primary focus is placed on an event of significantly decreased % total organic matter in the late Holocene which occurred simultaneously with decreased water % and % clay and increased dry bulk density, and % non-carbonate inorganic matter. This is interpreted as the lake transitioning from a shallow eutrophic lake to a deeper oligotrophic lake. Separating this transition is a nearly 2000-year sediment hiatus, interpreted to reflect a sustained period of aridity in the North Coast Range of CA. A latitudinal CA lake-based, hydrologic reconstructions suggests that Barley Lake, at the time of the shift, remained south of the precipitation dipole. Continued analysis of further segments of the Barley Lake cores could yield important information regarding the position and intensity of the precipitation dipole across time.

Physical Model Use in High Education

Student: Chelsea Lee Strohm

Faculty Advisor: Dr. Richard Laton

One of the most challenging components in teaching and understanding earth science is the visualization of earth processes. Particularly, the processes that are within the Earth's crust and invisible to the human eye. This is often compensated by utilizing drawings and teaching in a very detailed manner. However, when attempting to explain what occurs below the Earth's surface, in terms of the movement of water and contaminants, drawings and detailed pictures in books do not show the process in its entireness. This pivotal moment is where a lull in learning occurs for our students. In an effort to bridge this learning gap further we have implemented the use of Physical Models. Just one of these hands-on models allows for multiple labs to be created. Each of these labs creates a more solidified learning atmosphere of each subject of interest. The hands-on physical model allows the educator to recreate various scenarios of environments that show how contaminants and water can spread or how they infiltrate between different layers of soil. These physical models allow each student to learn in their own way. If the student is a hands-on learner, they can physically partake in the lab and watch the cause and effect of their actions on the physical model. If the learner does best with visuals, they can simply watch the other students complete the tasks with the model. And if the student does better with audio then they can listen to the conversations that take place while the lab is being completed. Allowing physical models into the classroom prepares the educator and students alike for a well-rounded learning session full of detail and accuracy.

GEOLOGY STUDENT AWARDS/SCHOLARSHIPS April 2019

Research Day Presentations - April 12, 3:00 pm - Fullerton Arboretum

Outstanding Graduate Student in Geology — ***Cullen Scheland***
Awarded to a Geology graduate student who demonstrates excellent performance in classes and in their research as evidenced by, but not limited to, publications, presentations, collegiality, and/or leadership in the department. Award: $250 plus engraved glass

Outstanding Graduate Teaching Associate in Geology — ***Joseph Gutierrez***
Awarded to Geology graduate student teaching associate (TA) who demonstrates outstanding performance based on, but not limited to, Student Opinion Question-naires, in-class visitations by faculty, teaching, collegiality, and/or mentoring other TAs. Award: $250 plus engraved glass

Outstanding Major Award – B.S. in Geology — ***Judith Avila-Avalos***
Awarded to an upper-division Bachelor of Science Geology major who demonstrates high quality performance in classes, their undergraduate research project, and some type of service to the department, University or community. Award: $250 plus engraved glass

Outstanding Major Award – B.A. in Earth Science — ***Rebekah King***
Awarded to an upper-division Bachelor of Arts in Earth Science major who demonstrates high quality performance in classes and some type of service to the department, University or community. Award: $250 plus engraved glass

Outstanding Academic Achievement Awards– B.S. in Geology — ***Jamie Hayward***
Awarded to a junior or senior major with an exceptional CSUF GPA. The number of units completed in Geology and the related fields will be factored into the decision. Award: $250

Outstanding Academic Achievement Awards– B.A. in Earth Science — ***Kate Gibson***
Awarded to a junior or senior major with an exceptional CSUF GPA. The number of units completed in Geology and the related fields will be factored into the decision. Award: $250

John D. Cooper Field Camp Award — ***Josh Vanderwal***
Annual award to a declared Geological Sciences Major with outstanding performance in GEOL 481A-Geology Field Camp. Selected by field camp instructor with approval of all full-time geology faculty. Award: backpack embroidered with Cooper Award/year

Department of Geological Sciences Alumni Field Camp Scholarship — ***Eddie Reyes***
Open to declared Geology and Earth Science majors that will be enrolled in GEOL 481A – Field Camp, in the upcoming summer. Awarded to a student who shows financial need, outstanding academic achievement (2.5 GPA or better for the previous academic year), and quality of written statements. This scholarship is given through the generosity the alumni and friends of the Department of Geological Sciences. Recipient to be selected by faculty of the Department of Geological Sciences. Amount: Varies (up to $550)

NSM Banquet Presentations - April 15 - 5:30 pm - TSU Conference Center (by invitation)

Candice L. Jones Outstanding Service Award — ***Melonie Nguyen***
Given to the student who has made a significant contribution to the mission, operation and/or well being of the Department community. Examples of service include, but are not limited to, taking a leadership role in Geology Club activities; serving as a TA, tutor, or volunteer in GEOL classes; selflessly assisting others in meeting their educational, research or outreach objectives. Efforts above and beyond any employment or course credit obligations are given greater weight, and a positive attitude is required. Award: $250 each

Prem K. Saint Hydrology Award — ***Diana Chacon***
Award for Geological Sciences or Environmental Studies (with Environmental Sciences emphasis) major with a GPA of 3.0 or better for the previous academic year. Recipient must show an outstanding academic performance in course work and/or research in Hydrology, Hydrogeology or Water Quality. Award based on the recommendation of the geology full-time faculty. Award: $200 and a copy of "Cadillac Desert"

John D. Cooper Field Camp Scholarship — ***Alejandra Angulo***
Awarded to a student who shows financial need, outstanding academic achievement (2.5 GPA or better for the previous academic year), and capacity to excel at field camp. Recipient to be selected by faculty of the Department of Geological Sciences. Award: $550

David L. Willoughby Scholarship — ***Lindsey Langer & Radwan Muthala***
Given in memory of the late David Willoughby, an alumnus of the department. His family established the award in recognition of David's passion for sedimentary geology and paleontology. This scholarship is open to undergraduate students who are studying geology or paleontology, or who are participating in course-related fieldwork. Minimum GPA of 2.5 or higher in Geological Sciences at the time the scholarship is awarded. Recipient to be selected by faculty. Award: $550 each

Dr. Margaret Skillman Woyski Scholarship — ***Christian Concha***
Open to declared geology major with 2.5 GPA or better for the previous academic year. Awarded in odd years to a student who shows financial need and outstanding academic achievement. Service to the department or the university is also required, i.e., involvement in the geology club, tutoring or participation in faculty directed research. The award will be made on the recommendation of the entire full-time faculty of the department. Award: $550

Marilyn A. Brown Award — ***Ross Kovtun***
Awarded to a graduate student conducting research in the general areas of paleontology or stratigraphy, and having an expressed or demonstrated interest in teaching or educational outreach. Award: $200

Searchers Gem and Mineral Society Award — ***Madison Huscher***
Established by The Searchers Gem and Mineral Society and awarded to an undergraduate or graduate student who has demonstrated an interest in mineralogy, petrology or science education, with 2.5 or better GPA during the previous academic year, and the recommendation of the faculty. Award: $1000

GEOLOGY STUDENT AWARDS/SCHOLARSHIPS
April 2019

Presented at Research Day – Friday, April 12 – Fullerton Arboretum – 3-7 PM

Outstanding Major Award – B.S. in Geology
Awarded to an upper-division Bachelor of Science Geology major who demonstrates high quality performance in classes, their undergraduate research project, and some type of service to the department, University or community. ***Award: $250 plus engraved glass***

Recipient: Judith Avila-Avalos
Bio: *Judith Avila-Avalos is an undergraduate in the Department of Geological Sciences. As a student, Judith is truly exceptional. She is in the Honor's Program, a CSUF McNair Scholar, and a LSAMP student. She is curious, energetic, hard-working, and always positive. Next year, she will begin her PhD at University of Minnesota. Her future is truly boundless.*

Outstanding Major Award – B.A. in Earth Science
Awarded to an upper-division Bachelor of Arts in Earth Science major who demonstrates high quality performance in classes and some type of service to the department, University or community. ***Award: $250 plus engraved glass***

Recipient: Rebekah King
Bio: *Rebekah is awarded the outstanding BA major award for her exemplary performance in classwork and efforts as university geology tutor. She is working on an honors project with Dr. Memeti and Dr. Zeedyk in CHAD producing a website for High School students to educate them about the geology of Yosemite National Park as an alternative to going into the field.*

Outstanding Academic Achievement Awards– B.S. in Geology
Awarded to a junior or senior major with an exceptional CSUF GPA. The number of units completed in Geology and the related fields will be factored into the decision. ***Award: $250***

Recipient: Jamie Hayward
Bio: *Jamie represents the pinnacle of student achievement, having received near-perfect grades in Geology and non-major courses. She has also completed two research projects with very disparate topics including the exploration of sedimentation in Monterey Bay and quantification of melt loss during Sierran volcanic eruptions and has presented her findings at national scientific meetings. Congratulations Jamie!*

Outstanding Academic Achievement Awards– B.A. in Earth Science
Awarded to a junior or senior major with an exceptional CSUF GPA. The number of units completed in Geology and the related fields will be factored into the decision. ***Award: $250***

Recipient: Kathryn Gibson
Bio: *Kate Gibson is an undergraduate Earth Science major, with a consistent record of academic excellence. She is working on an undergraduate thesis with former faculty member Dr. Bursztyn and Dr. Carlin and has recently presented this work at the annual GSA meeting. After graduation, Kate will enter the Teacher Credential program as she works on becoming an Earth Science teacher.*

John D. Cooper Field Camp Award
Annual award to a declared Geological Sciences Major with outstanding performance in GEOL 481A-Geology Field Camp. Selected by field camp instructor with approval of all full-time geology faculty.
Award: backpack embroidered with Cooper Award/year

Recipient: Josh Vanderwal

Bio: Josh Vanderwal completed his undergraduate geology degree in 2018. His undergraduate thesis with Dr. Laton was an assessment of the seismic risks related to McCarthy Hall on the CSUF campus. Josh is currently a staff geologist with Southern California Geotechnical, Inc. in Yorba Linda, California.

Department of Geological Sciences Alumni Field Camp Scholarship

Open to declared Geology and Earth Science majors that will be enrolled in GEOL 481A – Field Camp, in the upcoming summer. Awarded to a student who shows financial need, outstanding academic achievement (2.5 GPA or better for the previous academic year), and quality of written statements. This scholarship is given through the generosity the alumni and friends of the Department of Geological Sciences. Recipient to be selected by faculty of the Department of Geological Sciences. ***Amount:*** **$550**

Recipient: Eddie Reyes

Bio: *Eddie Reyes is an undergraduate geology major. He is completing an undergraduate thesis with Dr. Knott on Discharge and Drought Recovery of Three Springs in Harper Valley, Mojave Desert, California. He is in the geology club and plans to attend graduate school in the fall.*

Outstanding Graduate Student Award in Geology

Awarded to a Geology graduate student who demonstrates excellent performance in classes and in their research as evidenced by, but not limited to, publications, presentations, collegiality, and/or leadership in the department. ***Award: $250 plus engraved glass***

Recipient: Cullen Scheland

Bio: *Cullen investigates the migration of volcanic roots in Yosemite National Park with Dr. Memeti. He has received two research grants, presented his results at several conferences, and is preparing two manuscripts for publication. He is an excellent TA, mentor and role model for our undergraduate majors. Cullen received the NSM SCAR award and is headed to USC for PhD research.*

Outstanding Graduate Teaching Associate in Geology

Awarded to Geology graduate student teaching associate (TA) who demonstrates outstanding performance based on, but not limited to, Student Opinion Questionnaires, in-class visitations by faculty, teaching, collegiality, and/or mentoring other TAs. ***Award: $250 plus engraved glass***

Recipient: Joseph Gutierrez

Bio: *Joseph Gutierrez is finishing his first year of his masters of science in the Geological Sciences. He works with Drs. Sinan Akciz and Natalie Bursztyn on assessing the efficacy of 3D-printed geologic block models as tools for fostering spatial visualization abilities. He is pursuing his graduate degree to become a college educator, specifically teaching Earth science.*

GEOLOGY STUDENT AWARDS/SCHOLARSHIPS
April 2019

Presented at the Awards at NSM Banquet – Monday, April 12

Marilyn A. Brown Award

Awarded to a graduate student conducting research in the general areas of paleontology or stratigraphy, and having an expressed or demonstrated interest in teaching or educational outreach. **Award: $200**

Recipient: ***Ross Kovtun***

Bio: *Ross Kovtun is a graduate student in the Woods lab examining Lower Triassic sedimentary rocks from east-central California in order to reconstruct oceanic conditions following the Permian-Triassic mass extinction and determine the role of environmental amelioration in biotic recovery from mass extinctions. Ross plans on attending Rice University in the Fall to start a Ph.D. program in Planetary Geology.*

Searchers Gem and Mineral Society Award

Established by The Searchers Gem and Mineral Society and awarded to an undergraduate or graduate student who has demonstrated an interest in mineralogy, petrology or science education, with 2.5 or better GPA during the previous academic year, and the recommendation of the faculty. ***Award: $1000***

Recipient: ***Madison Huscher***

Bio*:* *Madison Huscher is an Earth Sciences major who will graduate in 3 years. Maddison is completing an undergraduate thesis on Monterey Bay continental shelf sediment deposits with Dr. Carlin. Maddison applied to the Master of Arts in Teaching at the American Museum of Natural History in order to become a high school geoscience teacher.*

Candice L. Jones Outstanding Service Award

Given to the student who has made a significant contribution to the mission, operation and/or well-being of the Department community. Examples of service include, but are not limited to, taking a leadership role in Geology Club activities; serving as a TA, tutor, or volunteer in GEOL classes; selflessly assisting others in meeting their educational, research or outreach objectives. Efforts above and beyond any employment or course credit obligations are given greater weight, and a positive attitude is required. ***Award: $250 each***

Recipient: ***Melonie Nguyen***

Bio*: Melonie Nguyen is an undergraduate geology major. She is completing an undergraduate thesis with Dr. Bonuso on Recovery of Middle Triassic Fossils after the end- Permian mass extinction. She is the geology club representative to the Interclub Council and plans to continue her paleoecological studies by pursuing an academic career.*

Prem K. Saint Hydrology Award

Award for Geological Sciences or Environmental Studies (with Environmental Sciences emphasis) major with a GPA of 3.0 or better for the previous academic year. Recipient must show an outstanding academic performance in course work and/or research in Hydrology, Hydrogeology or Water Quality. Award based on the recommendation of the geology full-time faculty. ***Award: $200 and a copy of "Cadillac Desert"***

Recipient: Diana Chacon

Bio: *Diana Chacon's work on the Santa Ana River will have a profound effect on the Santa Ana Sucker and water resources in general. Her master's thesis titled; "Thermal Infrared Remote Sensing for Water Temperature Assessment Along the Santa Ana River Using an Unmanned Aerial Vehicle (Uav) System", will allow for a more detailed and spatially sensitive measurements of surface water.*

John D. Cooper Field Camp Scholarship

Awarded to a student who shows financial need, outstanding academic achievement (2.5 GPA or better for the previous academic year), and capacity to excel at field camp. Recipient to be selected by faculty of the Department of Geological Sciences. ***Award: $550***

Recipient: Ajejandra Angulo

Bio: *Aly will us the Cooper scholarship to attend field camp in California this summer. Aly is a first generation college student with a 4.0 Geology GPA who loves and excels in field geology. She is completing her field/geochemistry thesis project in Yosemite National Park with Dr. Memeti. She also keeps busy as an SI leader, volunteer tutor and lab manager.*

David L. Willoughby Scholarship

Given in memory of the late David Willoughby, an alumnus of the department. His family established the award in recognition of David's passion for sedimentary geology and paleontology. This scholarship is open to undergraduate students who are studying geology or paleontology, or who are participating in course-related fieldwork. Minimum GPA of 2.5 or higher in Geological Sciences at the time the scholarship is awarded. Recipient to be selected by faculty. ***Award: $550 each***

Recipient: Lindsey Langer

Bio: *Lindsey Langer is an undergraduate geology major. She is completing an undergraduate thesis with Dr. Knott on Provenance, Detrital Zircon Age and Tephrochronology of Pliocene Conglomerate, Eastern Deep Springs Valley, California. She is a member of the geology club, Starbucks manager and plans to work in consulting, then attend graduate school.*

Recipient: Radwan Muthala

Bio: *Radwan Muthala is a Bachelor of Science major in the Department of Geological Sciences. He is interested in surface deformation associated with large earthquakes. His Senior Thesis with Dr. Sinan Akciz is on determining magnitudes of earthquakes that ruptured the Santa Cruz Island Fault. He is an active member of the Geology Club.*

Dr. Margaret Skillman Woyski Scholarship

Open to declared geology major with 2.5 GPA or better for the previous academic year. Awarded in odd years to a student who shows financial need and outstanding academic achievement. Service to the department or the university is also required, i.e., involvement in the geology club, tutoring or participation in faculty directed research. The award will be made on the recommendation of the entire full-time faculty of the department.
Award: $550

Recipient: Christian Concha

Bio: *Geology major Christian Concha completed his thesis with Dr. Clemens-Knott on detrital zircon dating of Paleozoic-Proterozoic metasedimentary pendants in the Sierra Nevada batholith. He is a member of the geology club and plans on attending graduate school in the fall.*

Department of Geological Sciences
2019 Alumni of the Year
Janis Hernandez

About Janis

Janis Hernandez obtained her B.S. in Geology from California State University, Fullerton in 1995 during which time she served two years as the President of the Geology Club. Janis completed a senior thesis entitled "Aquifer analysis of the Cucamonga Groundwater Basin" with Dr. John Foster. During the first nine years after graduation, Janis worked as a staff geologist, as a project geologist, and as a client relations manager for geotechnical consulting firms in southern California.

Hired by the California Geological Survey in 1991, Janis was recently promoted to Senior Engineering Geologist (Supervisor} for the California Geological Survey (CGS). In this capacity, she manages the Southern California Regional Office. Her certifications include Registered Professional Geologist #7237 and Certified Engineering Geologist #2260.

Janis's professional experience includes, geologic mapping, fault and landslide investigations, groundwater well construction management, and geophysical studies. Her work at the California Geological Survey has encompassed several programs including: Seismic Hazards Zonation, Earthquake Fault Zone mapping, geologic mapping in the Lancaster, Victorville, and Borrego Valley 100k map areas for STATEMAP, and Seismic Hazards Review for the Division of the State Architect. She has performed surface-rupture mapping for post-earthquake events (El Mayor Cucapah earthquake, 2010, and Parkfield earthquake, 2004), and has performed debris flow inundation mapping for post-fire events in Santa Barbara County (Montecito, 2018). She has also collaborated with geophysicists from the U.S. Geological Survey in performing guided wave seismic studies on the Santa Monica, Raymond, and Hollywood Faults. One of her long-term projects includes new geologic mapping within the Peninsular Ranges Batholith in northern San Diego County, where she is mapping detailed Cretaceous and Jurassic plutons and pre-batholitic metamorphic rocks in collaboration with retired USGS geologist, Victoria Todd. Janis is also performing detailed mapping along the Elsinore Fault Zone in this area, which will update the regulatory Earthquake Fault Zone maps. In many areas in San Diego County, Native American Tribal lands are crossed by the Elsinore Fault, and in addition to being given permission to map on the reservations, Janis met with the Tribal Chairmen of these areas to explain location of the fault traces, so the tribal members can be aware of the surface rupture hazard as they plan structures for their communities.

Janis participates in mentorship/outreach activities at the Geological Society of America meetings, and California Science Teacher events. She was a panelist for an NSM Career Week and is currently working to involve current CSUF students in paid mapping experiences with the CGS. Janis is a role model for young women aiming for careers in field-based geosciences.

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Your generosity helps our students succeed!

There is no greater influence than the generous donations the Department of Geological Sciences receives each year from our Alumni, Students, Faculty, Staff, and Friends. We want to thank each of our donors listed below for their amazing gift. Without these contributions, the Department of Geological Sciences would not be able to fund the many scholarships presented to our students at the Annual Awards banquet in April and throughout the year.

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Michael J. Cruikshank `06
Kathleen Davis
Environmental Engineering & Contracting, Inc.
Thomas B. Feistel `12
Everett Ferguson '92
Otto F. Figueroa '03 & Andrea Figueroa '05
Susan A. Fisher `03
Candace J. Foster `93
Dr. John H. Foster
Anna L. Garcia `95 & '10
General Conference of Seventh-Day-Adventists
GMU Geotechnical, Inc.
William Y. Goodman `83 - NMG Geotechnical, Inc.
Groundwater Resources Association of California
Dwight R. Haggard `77
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Leslie R. Hargrove
Sean Hunt '06
Thomas C. Kartrude '76 & Beth S. Kartrude
Taylor Wilson Kennedy, I '13
Brian A. Killeen `96
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Dr. Kari A. Knutson-Miller
Earth Forensics, Inc.
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Mary C. Lacey
Carlos M. Landaverde '08
Anthony Lizzi '07
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Valbone Memeti
Laurie K. Morgan '88
Anay Palafox `14
J. Michael Palin '81
Eric S. Patschull `07
Rene A. Perez `02
Daniel J. Philo `14
Brian P. Pitts `79
Kay L. Pitts `77
Dr. Brady Rhodes
Joe Roe '01
Dr. Prem K. Saint
Dr. Sanjay K. Saint
Cullen Scheland '19
Searcher's Gem & Mineral Society
Suzanna L. Schatzlein '14
Susan C. (Titus) Smith '08
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Everett Stuck '75
Nancy E. Stuck '75
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Scott R. Traub `97
Steven L. Turner '05
Michelle L. Vitale `12 - YourCause, LLC
Kristen M. Waters
Katherine F. Whitlow `05
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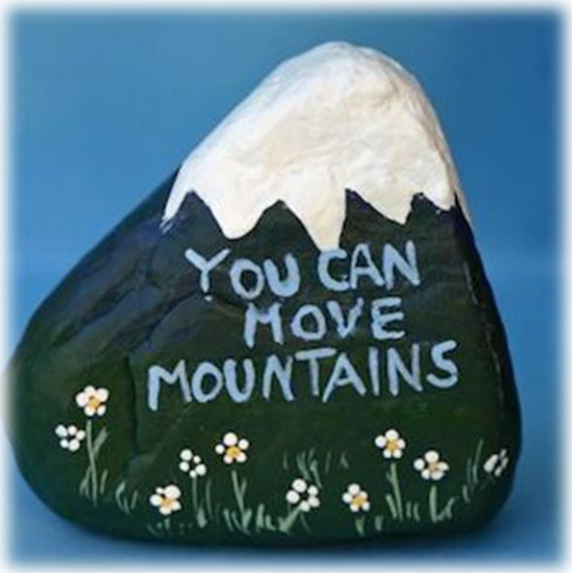
Steve Williams '06
William B Woyski
Jeri J. Young '98
Lynn Yost & Barney Yost '96
Janet R. Zeko '88 & Mark T. Zeko `87

Thanks to all of our Geoscience Students, Faculty, Staff, and Alumni for another successful year!



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and Wood Rodgers
for their support of CSUF students,

and to

the Department Staff and Dr. Richard Laton for making Research Day such a special event!

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