8th Annual CSUF Geological Science Research Day

Department of Geological Sciences
California State University, Fullerton
Fullerton Arboretum
Wednesday, April 26, 2017

GEOLOGICAL SCIENCES
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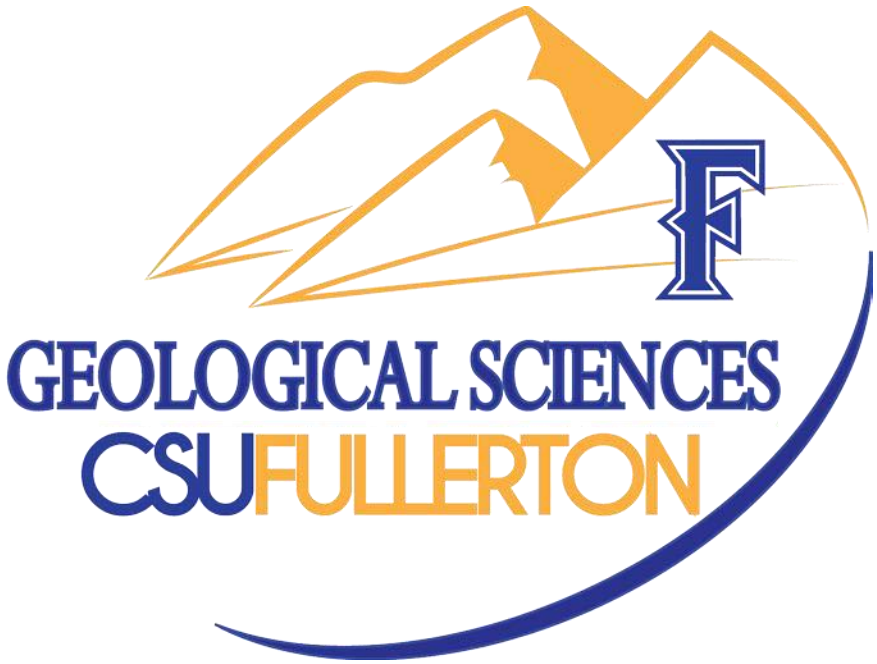
SOUTH COAST GEOLOGICAL SOCIETY
SCGS



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

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

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Abstract Volume Table of Contents

Undergraduate BA/BS Proposal Category

Reanalysis of late Miocene walruses from the Eastern Pacific based on new specimens from the Empire Formation of Oregon and their affinities to specimens from Orange County, California
Student: Shooka Shahbazi[2]
Faculty Advisor: Dr. James F. Parham

Earthquake Modeling and the Effects on California State University, Fullerton Campus Using Fema's Hazus Program
Student: Josh Vanderwal
Faculty Advisor: Dr. W. Richard Laton

Manageable Molecular Mineralogy: Developing a User-Friendly Interactive Mineralogy Game for Mobile Devices
Student: Leah Marie Wiitablake
Faculty Advisor: Dr. Natalie Bursztyn

On Campus Rock Garden as a Teaching Aid for Geoscience Students
Student: Anthony Mistretta
Faculty Advisor: Dr. Sinan Akciz

Undergraduate BA/BS Thesis Category

Recent Sedimentation along Intertidal Mudflats within an Urban Estuary
Student: Dulce Cortez[1,2]
Faculty Advisor: Dr. Joe Carlin

A Paleoecology of Late Pleistocene Oyster Beds, San Pedro, California
Student: Jolene Ditmar[1,2]
Faculty Advisor: Dr. Nicole Bonuso

Investigating Variations in Holocene Sedimentation along the Monterey Bay Continental Shelf
Student: Kevin Hunter[1]
Faculty Advisor: Dr. Joseph Carlin

What motivates questionable interactions between humans and protected lands that result in destructive behavior?
Student: Angelic Perez[1]
Faculty Adviser: Dr. Natalie Bursztyn

The Development and Study of Earth Science Lessons in Kindergarten Classrooms
Student: Annaimee Aguilar[2]
Faculty Advisor: Dr. Natalie Bursztyn

Analysis of 13 years of Data Collection: Water Pressure and Chemical Changes from Well CSF-1, Fullerton, CA
Student: Terrinda Alonzo[2]
Faculty Advisor: Dr. W. Richard Laton

Sulfur Isotopic Composition of Anhydrite in the Salt Stock and Cap Rock of Gulf Coast Salt Domes
Student: Kaelin Andelin
Faculty Advisor: Dr. Sean Loyd

Examining the Geochemical Relationships between the Twentynine Palms and Queen Mountain Plutons in Joshua Tree National Park
Student: Alexander Arita[2]
Faculty Advisor: Dr. Vali Memeti

Basalt Correlation in the Sylvania Mountains, California, by X-ray Fluorescence Spectroscopy (XRF)
Student: Shayna Avila
Faculty Advisor: Dr. Jeffrey R. Knott

Applying Laser-induced Breakdown Spectroscopy to Geologic Provenance Studies
Student: Eduardo Chavez
Faculty Advisor: Dr. Vali Memeti

Petrography and Geochemistry of Suspected Hunter Mountain Batholith Clasts, Death Valley
Student: Emma Griffie
Faculty Advisor: Dr. Jeffrey Knott

Investigating the Volcanic-Plutonic Connection Using Geochemistry in the Minarets Caldera, Eastern Central Sierra Nevada Mountain Range, California
Student: Evelyn Gutierrez
Faculty Advisor: Dr. Vali Memeti

Yosemite: Teaching the Impacts of Climate Change Through a Virtual Field Trip
Student: Joseph Gutierrez[2]
Faculty Advisor: Dr. Natalie Bursztyn

Playing in the Sand: The AR Sandbox as an Interactive Topographic Lesson
Student: Danielle Jackson
Faculty Advisor: Dr. Natalie Bursztyn

Basalt Correlations across the Fish Lake Valley Fault Zone, CA/NV Using X-Ray Fluorescence
Student: Eddie Jimenez[2]
Faculty Advisor: Dr. Jeffrey Knott

Geochemical Analysis of Ubehebe Hills and related basalts, Northern Death Valley
Student: Grant G. Kennis
Faculty Advisor: Dr. Jeffrey R. Knott

Identifying Paleoseismic Events along Newport Inglewood Fault Zone from Salt Marsh Stratigraphy
Student: Ryutaro Koga
Faculty Advisor: Dr. Joe Carlin

Geochemical and Petrographic Relations Between Mafic Intrusions in Post-Peach Spring Tuff Deposits in the Southern Black Mountains, Meadow Creek Basin, Near Oatman, Arizona
Student: Veronica Smith
Faculty Advisor: Dr. Diane Clemens-Knott

Are Southern California Salt Marshes Keeping Pace with Sea Level Rise? An Investigation of Salt Marsh Sedimentation in Upper Newport Bay, CA, USA
Student: Dane Anthony Van Orman
Faculty Advisor: Dr. Joseph Carlin

Examining an Oyster Reef Community from the Late Pleistocene Palos Verdes Sands, Knoll Hill, San Pedro, California
Student: Walicki, Julian
Faculty Advisor: Dr. Nicole Bonuso

Assessing Pleistocene Sediment from the San Pedro Formation for Oyster Species and Other Invertebrates to Piece Together the Paleoecology
Student: Maree Kutcher
Faculty Advisor: Dr. Nicole Bonuso

[1]BA Major
[2] Undergraduate Research Fund Funded Student

Graduate Proposal Category

Reconstructing the Paleoseismic History of the Newport-Inglewood Fault Zone Using Marsh Stratigraphy
Student: Michaela Adler
Faculty Advisor: Dr. Joseph Carlin

New fossil walrus skulls from the Los Angeles Basin shed light on major walrus radiations
Student: Jake Biewer
Faculty Advisor: Dr. James Parham

Southern California coastal wetland evolution: Using the geologic record to understand the shift from a late Holocene oyster reef to salt marsh
Student: Sarah Dickson
Faculty Advisors: Drs. Joe Carlin and Nicole Bonuso

The Age of the Vaqueros Formation in Laguna Canyon, Orange County, CA
Student: Jared Heuck
Faculty Advisor: Dr. James Parham

Biogenic vs Thermogenic: Determining Native Sulfur Formation Mechanisms in Gulf Coast Salt Domes Using Multiple Sulfur Isotopes
Student: John Hill
Faculty Advisor: Dr. Sean Loyd

A Geochemical Analysis of Productivity and Oxygenation Following the Permian-Triassic Extinction Event, Opal Creek, Alberta, Canada
Student: Anthony A. Macias
Faculty Advisor: Dr. Adam Woods

Thermal Infrared Remote Sensing for Water Temperature Assessment along the Santa Ana River using an Unmanned Aerial Vehicle (UAV) System
Student: Diana Carolina Chacon
Faculty Advisor: Dr. W. Richard Laton

Zoning in Feldspars as Tracers of the Extent of Magma Mixing and Magma Chamber Size in the Tuolumne Intrusive Complex, Yosemite National Park, CA
Student: Louis Oppenheim
Faculty Advisor: Dr. Vali Memeti

A Determination of the Timing and Consequences of the Late Ordovician Glaciation Using the Ely Springs Dolomite of East Central California
Student: Austin Poncelet
Faculty Advisor: Dr. Adam Woods

Graduate Thesis Category

Geochemistry of phosphatic-shales and associated authigenic minerals of the Miocene Monterey Formation: Implication for paragenetic evolution
Student: Tony Sandoval
Faculty Advisor: Dr. Sean Loyd

Carbonate Geochemistry of Marine Authigenic Carbonates and Host Sediments: Exploring Mineral Formation Pathways and Organic Preservation Potential in Modern Sediments
Student: Marissa Smirnoff
Faculty Advisor: Dr. Sean Loyd

From Sheets to Blobs: Implications of Multiple Kuna Crest Hornblende Populations for the Initial Construction of the Tuolumne Intrusive Complex, Sierra Nevada, CA
Student: Dustin Williams
Faculty Advisor: Dr. Vali Memeti

Research Category

Paper Models to the Rescue: New Exercises for Visualizing and Mapping Geological Structures in 3D
Student: Joseph Gutierrez[2]
Faculty Advisor: Dr. Sinan Akciz

Analysis of vegetation diversity, density and cover on maturing alluvial fan substrates
Adrian Escobar, Maureen Kelley, Andrew Roxas
Faculty Advisors: Dr. Darren Sandquist CSUF and Dr. Jennifer Garrison CSULA

Investigation of the Laguna Cell Beaches Using Lidar and Erosional Examination
Student: Taylor Kennedy
Faculty Advisor: Dr. W. Richard Laton

Subsurface Analysis of Orange County Water District's La Palma Groundwater Recharge Basin in Anaheim, California
Student: John Paul Masters
Faculty Advisor: Dr. W. Richard Laton

Building an Outdoor Garden for the College of Natural Sciences at CSUF
Student: Grant Kennis
Faculty Advisor: GEOL499L – Independent Research

First Record of Equus Occidentalis from Orange County, California, With Implications for the Late Pleistocene Distribution of Equus in the American Southwest
Students: Maree Kutcher and Eric Scott
Faculty Advisor: Cooper Center

Undergraduate BA/BS Proposal Category

Linking Marine and Terrestrial Processes to the Evolution of a Mid-shelf Mudbelt: An Investigation of the Salinas River Mudbelt, Central California, USA

Student: Jamie Hayward

Faculty Advisor: Dr. Joe Carlin

Earth's history is largely recorded within sedimentary rocks. Interpreting this history over any time scale requires the ability to link stratigraphy to the particular formative processes. The continental shelf in particular, is a dynamic setting where the stratigraphy is influenced by a combination of climate, marine, and terrestrial processes. As such, shelf stratigraphy is complex, but can preserve a valuable record at a much higher resolution than deep sea deposits. Therefore, shallow marine stratigraphy provides the key to understanding processes that operate on sub-millennial to sub-decadal time scales. In order to improve interpretations of shallow marine stratigraphic records however, it is critical to understand which processes influence shelf strata formation over relatively short geologic time scales. Mid-shelf mud deposits offer the ideal location to study strata formation. These features are common to continental shelves across a variety of climate and tectonic settings (high and low latitude shelves and along active and passive margins), and ultimately provide a significant contribution to the sediment budget of a continental margin during interglacial periods. This project will utilize the Salinas River Mudbelt (SRM), located along the central California continental shelf within Monterey Bay, to investigate modern changes in shelf strata, and directly link those changes to processes from historical observations. The SRM is an ideal location to study because it links active tectonics to a dynamic climate, driven by El Niño cycles, that modulate both marine processes (elevated energetic ocean conditions), and terrestrial (elevated fluvial discharge). Additional complexity stems from anthropogenic activities that can influence sedimentary responses such as changes in agricultural practices, dam construction, and nearshore sand mining. We hypothesize that there will be a shift in strata, reflected by changes in sediment accumulation rates, sediment texture, and sediment source that reflect the combination of natural climatic cycles and increases in anthropogenic disturbances. To test the hypothesis, we will collect 5-6 sediment cores, ~ 40 cm long, from the SRM. The cores will be subsampled at 1 cm intervals. To characterize the sediment texture, we will perform grain size analysis on each sample. Sediment provenance will be determined via X-ray diffraction and X-ray fluorescence. To determine sedimentation rates, samples will be analyzed for ^{210}Pb and ^{137}Cs activities. These analyses will increase our understanding of the processes influencing shelf strata formation; ultimately improving our ability to interpret the stratigraphic record across a variety of time scales.

Investigation and Monitoring the Spread of Water Contaminates Using an Open Source Database in the Orange County Area

Student: Adam Meadows

Faculty Advisor: Dr. W. Richard Laton

Orange County relies on a combination of the Santa Ana River, recycled water, and precipitation as the main sources for water. Northern Orange County is a heavily industrialized urban area there is cause for concern about contaminates reaching public water supply wells and risk of spread of contaminates through the subsurface to groundwater pumps. Contaminants such as Toluene, Perchlorate, Nitrate, Benzene, Trichloroethylene, and Perchloroethylene will be the focus of this study. In order to understand the threat that these contaminates impose on local sources of water supplies in Orange County, this study will be limited to the Fullerton-Placentia-Anaheim area. Using pre-existing data from open source well databases from Geotracker, Orange County Water District (OCWD) well data, and Geographical Information Systems (GIS) modeling software, several three-dimensional models will be produced to map the rate and spread of contaminates within the subsurface of the study area. I hypothesize that this data can firstly be used to accurately track the movement of groundwater, and secondly that this open source data can be then modeled into a three dimensional map showing the rate of spread of contaminates through the subsurface. Furthermore, this thesis will track the groundwater movement around the OCWD recharge facilities to identify possible spreading paths of contaminate plumes. This project will help us understand how ground water moves through Orange County through the subsurface and identify direct risks to our drinking supply as well as the source of these risks.

Investigating the causes of compositional variation in the Half Dome granodiorite unit of the Tuolumne Intrusive Complex, Yosemite National Park, California: Big or small magma chambers?

Student: John Ayers

Faculty Advisor: Dr. Vali Memeti

The understanding of the behavior of magmas in deep magma reservoirs (plutons) and their sizes and what controls their compositional variations provides knowledge on causes of different volumes and styles of volcanic eruptions, and improve the ability to predict future events. The subject of this study is to use field mapping and geochemical analyses on the compositional variation of the Half Dome unit in the Tuolumne Intrusive complex in Yosemite National Park, California, to shed light on these questions.

The Tuolumne Intrusive Complex is a 1,100 km^2 Cretaceous age granitoid intrusion that is composed of three main units and situated along the eastern crest of the Sierra Nevada Mountains. Coleman et al. (2012) suggested that the formation of the Half Dome Granodiorite unit in the western lobe (and by inference the entire Tuolumne Intrusive complex) occurred through a stacked series of km scale repeating magmatic 'cycles' (i.e. sills or laccoliths). These moderately outward dipping sheet-like bodies display a sharp eastern contact of more mafic composition granodiorite that gradationally becomes more felsic towards the west due to local fractional crystallization. This stacked sill-model contrasts with previous models of large magma mush bodies (e.g. Memeti et al., 2014; Paterson et al., 2016), which suggest that pulses of magma amalgamate to form large magma chambers whose compositional variation is derived from magma chamber processes, such as wide-scale fractionation and mixing of magmas. Research in Lyell Canyon of Yosemite National Park will test the Coleman et al. (2012) and Memeti et al. (2014) models at the eastern Half Dome granodiorite lobe where compositional variations are observed similar to what is seen on the west side. Field mapping will determine the orientation and contact relationships as well as the mineralogy of the compositional variation in the Half Dome unit. XRF whole rock geochemical analysis on samples gathered from the field locations will be conducted to determine the magmatic process and the length scale of the process that is responsible for the changes in composition. Both field and lab data will be used to determine if the magma mush developed sheet-like as suggested by Coleman et al. (2012) and never formed large magma chambers, or if the size of interconnected magma mush is rather irregular and can be traced across the whole unit, arguing for a big magma reservoir.

Ground source heat pump potential characterization for California State University Fullerton

Student: Adrian Escobar

Faculty Advisor: Dr. W. Richard Laton

Anthropogenic climate change is an intensively studied area of science that has resulted in the consensus that mankind is affecting the climate by emitting large amounts of greenhouse gasses. Actions by government agencies have been taking place over the last few decades and have become the topic of many political discussions over the last few years. Emission reducing strategies are being taken by everyone from individuals to large institutions. Of the many strategies, ground source heat pumps (GSHP) are likely one of the least known methods for reducing emissions. The technology has been implemented on large scales across the United States and in several European countries over the last decades proving its capacity to reduce emissions and cost. California State University Fullerton (CSUF) is an institution that has several projects to increase sustainability on campus along with many groups providing information for students and the surrounding community, making it a good candidate for this research. With several types of GSHP systems a review of literature and industry standards along with an analysis of the geology beneath CSUF will determine which GSHP system is appropriate for the university. Multiple employment scenarios will be analyzed for buildings and/or combinations of buildings around the campus that seek to maximize sustainability and cost benefits. The research will conclude with a report on these findings to the University's Center for Sustainability for consideration.

Figure 1, CSUF campus map with highest load buildings marked

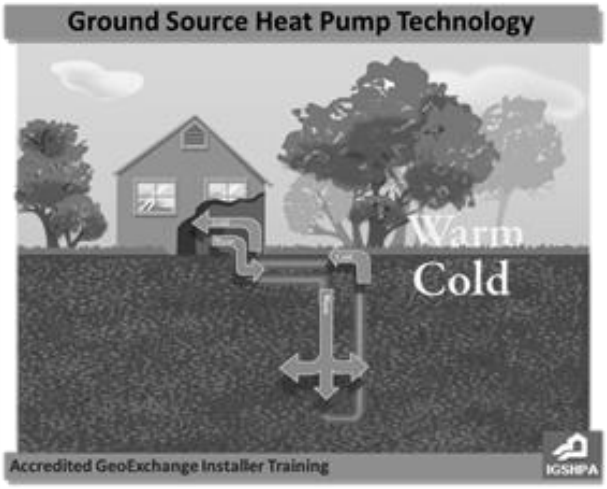

Figure 2, Basic Ground Source Heat Pump configuration

Geochemical and Petrographic Analysis of Salt Dome Associated Calcite Phases in Gulf Coast Cap Rocks: Implications for Carbon Sources and Paragenetic Evolution

Student: Connor Frederickson

Faculty Advisor: Dr. Sean Loyd

Salt dome associated calcites of the Gulf of Mexico region exhibit multiple phases with varying physical properties. These phases are thought to form through microbially mediated chemical reactions that involve hydrocarbons, which locally accumulate around salt domes. This study seeks to identify the carbon sources for cap rock calcites from six locations in the Gulf of Mexico: Boling Dome, Damon Mound, Hockley Dome, Davis Hill Dome, Winnfield Dome and Main Pass Dome. Samples of multiple calcite phases from each dome will be subjected to carbon isotope analysis. Comparison among measured calcite carbon isotope and known Gulf Coast hydrocarbon (e.g., methane and petroleum) isotope compositions will provide insight into the carbon source(s) for each calcite phase. Petrographic analysis will be used to characterize spatial relationships among phases and determine the relative order of precipitation (i.e., paragenetic evolution). These two sets of data, geochemical and crystallographic, allow for the development of a more complete description of the evolution of salt dome associated calcites, with an emphasis on temporal variability in carbon sources. We hypothesize that individual calcite phases precipitate from distinct sources of carbon, as indicated by unique $\delta^{13}C_{carb}$ values. Research findings will provide insight into salt dome related hydrocarbon degradation and microbially mediated mineralization.

Investigating volcanic and plutonic connections in the Iron Mountain Pendant, Sierra National Forest, CA

Student: Sabrina Green

Faculty Advisor: Dr. Valbone Memeti

Volcanic eruptions and associated secondary hazards pose a threat to society on a daily basis, yet the causes of eruption and what occurs in the magma chamber before and during an eruption is poorly understood. Volcanoes are connected to deeper plutonic systems of a vertically extensive magma plumbing; both volcanic and plutonic rocks record magmatic histories that help unravel the magma processes at depth. The focus research area is the Iron Mountain pendant in the Sierra Nevada batholith, located northeast of Oakhurst, CA, which exposes both Cretaceous volcanic and plutonic rocks of what we hypothesize to be coeval in age and thus part of the same plumbing system. The purpose of this research is to ascertain the rocks are contemporary and to understand the chemical connection between the volcanic and plutonic rocks in order to help predict volcanic eruptions in the future.

The goals are to firstly determine the age of the volcanic and plutonic rock units in the area to make sure the rocks all formed contemporarily and therefore could have belonged to the same magma plumbing. If this can be established, the geochemical analyses of volcanic and plutonic rocks will test if the rocks are compositionally equivalent or complementary to one another. If these different units are complementary in composition, we will conclude that fractional crystallization of the magma chamber took place. If they are equivalent, then we can deduce that part of a homogeneous magma chamber was evacuated.

To determine the age of the volcanic and plutonic rocks, zircon separations will be obtained from the rock samples and used for U-Pb zircon geochronology using the LA-ICPMS technique at the University of Arizona Laserchron lab. Using a polarizing light microscope, minerals present in the different rocks will be determined by studying thin sections to investigate if the mineralogy between volcanic and plutonic rocks is similar or different. Disequilibrium mineral textures will point to magma mixing before the eruption. Lastly, to also test this hypothesis through geochemical compositions, one inch homogeneous glass beads will be made from powders of the rock samples and analyzed with the XRF machine at Pomona College, which will determine major oxides and trace elements present in both rock types. Petrography and whole rock geochemistry will help determine whether the system is equivalent or complementary in composition and test if magmas were fractionated or mixed in the magma chamber before the volcanic rocks erupted.

Modeling Groundwater Contamination Using an EMriver Process Simulator

Student: Michelle Manzano

Faculty Advisor: Dr. Natalie Bursztyn

Groundwater is a resource that is important to all living things. It is an integral part of the hydrologic cycle, which is a complex system that is difficult to understand using a physical or computer model alone. Simple physical models such as the EMriver table and vertical aquifer models, which focus on few variables, can be used to help our understanding of water systems. The variables that can be manipulated on the EMriver table are flow rate and table slope; on the aquifer model, only flow rate can be controlled. These two physical models can be used to learn about the movement of contaminants in groundwater. Contamination is a variable that must be tracked in groundwater in order to maintain federal or state water quality standards and foster life.

In this project an EMriver table and aquifer model will be used to model the movement of groundwater contamination by changing inputs, such as flow rate and well type. The aquifer model will show the vertical movement of contaminants through four dye injection wells that represent wastewater wells. The EMriver table will also contain four wells that are used as wastewater wells. The wells will be set up similarly to the aquifer model. The time and distance the contaminants travel will be measured for both models to quantify any change as inputs are adjusted. The objective of this project is to provide a physical model system that can be used for groundwater contamination teaching demonstrations and as a visual learning tool for students.

Interpreting Recent Stratigraphic Changes for the Northern Monterey Bay Continental Shelf

Student: Victoria Severin

Faculty Advisor: Dr. Joe Carlin

Continental shelves are dynamic environments that are influenced by marine, terrestrial, and climatic process. As such, shelf environments can be important recorders of global change, however there is a lack of understanding about how strata form in continental shelf mud deposits over short time scales. The goal of this project is to improve our understanding of signal preservation within shelf stratigraphy over relatively short time scales. To address this problem we will investigate the Monterey Bay shelf located in central California. Monterey Bay is an ideal study area because it is dominated by variable, but high sediment loads from small mountainous rivers, impacted by high-energy wave events from the North Pacific Ocean, and lies at the northern extent of the influence of El Niño. These factors contribute to a surplus of sediment accumulation along the mid-shelf mud belt. This accumulation of mud cannot be accounted for by fluvial sediment supply alone, highlighting the lack of understanding for this system. Moreover, preliminary data suggests that modern sedimentation has changed over recent decades. This project seeks to answer the following question: Is the limited preliminary data showing changes in sedimentation since the 1960s uniform across the northern bay, and what is driving these changes? We hypothesize that the sedimentation changes are uniform throughout, and that these changes are primarily climate driven. To test this hypothesis, this summer we plan to collect plan to collect five to six short (~ 50 cm) cores along the mid-shelf of Northern Monterey Bay to capture ~100-150 year sedimentation record. The core will be subsampled in 1 cm intervals for short-lived radionuclides (^{210}Pb and ^{137}Cs) to determine sedimentation rates, and sedimentological characteristics. Lead-210 is a naturally occurring isotope with ~22 year half-life. It forms in the atmosphere and seawater, adsorbing onto sediment particles as they sink through the water column. Cesium-137 is an anthropogenic isotope that was introduced to the environment in the 1950s from nuclear weapons testing. It provides an independent chronometer to ^{210}Pb by establishing two time horizons at 1953 and 1963. The sedimentological characteristics we will analyze include: sediment texture (grain size analysis), and sediment provenance through mineralogical characterization (x-ray diffraction and/or x-ray fluorescence). By understanding the drivers behind strata formation on these short time scales, we aim to improve our stratigraphic interpretations throughout geologic time.

Reanalysis of late Miocene walruses from the Eastern Pacific based on new specimens from the Empire Formation of Oregon and their affinities to specimens from Orange County, California

Student: Shooka Shahbazi

Faculty Advisor: Dr. James F. Parham

Walruses are represented by a single living species (*Odobenus rosmarus*) that is restricted to the Arctic, but from the Miocene to the Pliocene a diversity of fossil odobenids (20 species) are known throughout the North Pacific. Ongoing studies separates walrus lineage into two radiations, the early Miocene and late Miocene, based on the description and analysis of a complete walrus (OCPC 11141, AKA "Waldo") from Orange County, California housed at the Cooper Center. My thesis will focus on two walrus skulls collected from the late Miocene Empire Formation of Oregon that share a striking similarity to the Orange County walrus. The goal of my research will be to: 1) create scientific descriptions of the Oregon specimens, 2) perform a phylogenetic analysis to determine the evolutionary relationship of the Oregon specimens to the Orange County specimen (e.g., are they the same species?), 3) develop a new evolutionary tree to reflect these relationships. This study will provide a deeper understanding of the evolutionary history and biogeography of walruses through time.

Earthquake Modeling and the Effects on California State University, Fullerton Campus Using Fema's Hazus Program

Student: Josh Vanderwal

Faculty Advisor: Dr. W. Richard Laton

The purpose of this thesis is to look at the surrounding faults near California State University, Fullerton campus and the impact that it can have on the campus buildings. The way to understand the impact is to first understand the structures that are on campus and their construction. The construction of the buildings and seismic retrofitting of the buildings will be determined by communicating with facilities operations and building records for the campus. This data will then be put into FEMA's Hazard US, or HAZUS program. This program is used to determine the effects of natural disasters and can run multiple parameters at once. To better understand the implications a flood scenario will also be run. The integration of the data will project the events that will unfold after the rupturing of the different faults that are within proximity of the campus like the Puente Hills fault system, Whittier Fault and the Newport-Inglewood Fault to some degree. The focus of the data will be on the library and McCarthy Hall, which are the buildings that are hypothesized to be at most risk. The results of the simulation will then be used to determine the safety level of the structures on campus. This is being undertaking due to the 2014 5.1 magnitude fault that occurred in La Habra near the Puente Hills system that devastated part of the California State University, Fullerton library and leave it still in a condition of repair. The overall safety of staff and students on the campus is why simulations like these are run with the appropriate data.

Manageable Molecular Mineralogy: Developing a User-Friendly Interactive Mineralogy Game for Mobile Devices

Student: Leah Marie Wiitablake

Faculty Advisor: Dr. Natalie Bursztyn

In this digital age, pedagogy falls short with methods of teaching mineralogy being stuck in the past. This project addresses the problem documented in the chemistry community and anecdotal in the geology community: students cannot visualize crystal structure. In the geoscience community, there are papers published on students having difficulty with the visualization of structural geology and ways to solve this problem. However, with respect to molecular mineralogy, the struggle students have with the material has not been documented. Nonetheless, anecdotally, there is teacher dissatisfaction with the poor retention of material from mineralogy classes.

Research has found that information relayed through images is retained better than information relayed through text. In fact, three-dimensional (3D) models and visuals have been shown to be the most effective methods for teaching and have results of greatest student retention of material. Due to the great leap in technology in the last decade, reports on the use and effectiveness of virtual reality and games in education has taken off.

Here we describe the design of an interactive game to teach crystal structure to undergraduates. Game-like elements engage the user, while touch-manipulated 3D models allow students to play with the structure of a mineral at the molecular level. Starting from an outcrop and zooming into minerals, then to individual atoms, students will be able to build different silicate minerals by rearranging silicon tetrahedra to see how different structures affect the outward appearance of the crystal. We believe this game will improve student learning of minerals and their structure and will help bridge the technology gap between the outdated ball and stick models and today's digital native undergraduates. By using up-to-date technology we can combine text, audio, video, and user-manipulated 3D models to better help students understand the molecular world with a game for mobile smart devices.

On Campus Rock Garden as a Teaching Aid for Geoscience Students

Student: Anthony Mistretta

Faculty Advisor: Dr. Sinan Akciz

The lack of readily available hands on learning environments for geoscience students could be a hinder to their ability to apply skills from the classroom to actual field work. A rock garden with a geologic emphasis constructed on campus would allow students and professors access to a valuable resource that can aid in bridging the gap between the classroom and the field. The rock garden's theme is based around the rock cycle, and will be organized to show how rocks go through changes and recycle within the three rock groups (Igneous, Sedimentary, and Metamorphic). The boulders that make up the garden will be arranged in an oval with the path leading one through the cycle with signs posted explaining the processes rocks experience along the cycle. This will aid Geo-101 students by allowing them to see and feel many concepts and structures learnt in class such as: the differences in types of rocks, igneous/sedimentary/metamorphic textures, volcanic vs. plutonic, and mineral identification. Geo-380 (Geologic Field Techniques) and Geo-360 (Structural Geology) would use the shale/slate to practice strikes and dips on a real rock surface. The inclusion of rocks with sedimentary structures and fossiliferous rocks to the garden would be easily utilized by Geo-321(Sedimentology and Stratigraphy), Geo-333 (Oceanography) and Geo-322 (Paleontology). Students would be able to practice note taking, compass usage, and drawing sketches on campus with unlimited access so they can be a lot more efficient in the field, where they have a limited time frame to comprehend subjects. The addition of a rock garden to the campus would be beneficial to not just geoscience students of the campus but can also be used by community college students as a field trip location, and addition of benches will make it nice place to socialize and take a break.

Undergraduate BA/BS Thesis Category

Recent Sedimentation along Intertidal Mudflats within an Urban Estuary

Student: Dulce Cortez

Faculty Advisor: Dr. Joe Carlin

In southern California, many of the historic estuarine habitats have been lost as a result of urbanization. Those that remain are often bound by development that prevents these habitats from migrating landward with relative sea level rise (RSLR). In these systems therefore, it is critical that habitats maintain elevation relative to RSLR. In order to maintain elevation, sediment accumulation will be a critical process. This project investigated recent sedimentation along mudflats in Upper Newport Bay, an estuary located in Orange County, CA, in order to better understand seasonal sediment deposition, and long-term sediment accumulation. The goal of this project was to assess the bay's vulnerability to future RSLR. To accomplish this goal, we collected sediment cores from three mudflats located throughout the bay in both June and October of 2016. Sediment samples were analyzed for grain size, total organic matter, and short-lived radioisotopes (^{7}Be, ^{210}Pb, and ^{137}Cs). The results showed the deepest penetration (~7 cm) of ^{7}Be in June was observed at the primary channel site. In October at this site however, ^{7}Be was only detected at the surface, and with overall lower activities. At the mid-estuary site, ^{7}Be penetration was comparable between seasons, although overall activities were lower. This ^{7}Be data suggest centimeter-scale deposition over the 2015-2016 winter and spring in the upper and middle reaches of the bay, but in summer 2016 these sites experienced no-deposition. At the upper bay site not only was it non-depositional, the data suggests that this site experienced up to 6 cm of erosion. These results demonstrate that deposition only occurred during the winter (wet-season), and where winter deposition was the highest, those deposits were nearly completely reworked and redistributed during the summer (dry-season). In spite of this seasonal deposition/erosion cycles in the upper reaches of the bay, long-term accumulation rates ranged from ~3 mm/yr to > 5 mm/yr. These rates are greater than recent estimates of relative RSLR for Newport Bay. Additionally, the results from the upper bay site also clearly show a cyclical trend in sediment accumulation, with short periods of higher than average accumulation every couple of years. Preliminary interpretations of these periods suggest that climate, e.g. El Niño, may be driving these pulses of sedimentation through time. From this project we conclude that sedimentation throughout the estuary is dynamic on short time scales, but over time appears to be out-pacing relative RSLR.

A Paleoecology of Late Pleistocene Oyster Beds, San Pedro, California

Student: Jolene Ditmar

Faculty Advisor: Dr. Nicole Bonuso

Oyster diversity steadily declined from four species in the Cenozoic to two oyster species in the Pleistocene. Currently only one native species remains: *Ostrea lurida*. Biologists attribute the decline of oyster beds to industrialization and urbanization of southern California. Restoration efforts continue within southern California but researchers lack the deep-time perspective of oyster bed community history. Here we examine an oyster paleocommunity to better understand pre-human oyster habitats by documenting fossil content from the Late Pleistocene Palos Verdes Sands on Knoll Hill, San Pedro, California and comparing that to oyster data documented by Kelly Vreeland (2014). Two samples have been wet sieved, sorted and all usable fossils are identified to the species level and counted. Length and width measurements of all oyster fossils are recorded. *Ostrea lurida* accounts for 11.6 % of all taxa recovered from my sample. It is the most abundant taxa present, with 86.5 individual specimens. Oyster specimens from the other sample only account for 6.7% of the total taxa determined. Average oyster sizes from both samples are less than one millimeter in difference. The addition of the Late Pleistocene San Pedro locality oyster sizes disproves the hypothesis that oyster size decreases through the Quaternary. However, oyster diversity data from the Late Pleistocene San Pedro locality supports the hypothesis that oyster diversity decreases post-Miocene.

Vreeland, K. K., 2014, A paleoecological reconstruction of oysters from Orange County, California: Understanding the past to help restore the future [M.S.: CALIFORNIA STATE UNIVERSITY, FULLERTON, 140 p.]

Investigating Variations in Holocene Sedimentation along the Monterey Bay Continental Shelf

Student: Kevin Hunter

Faculty Advisor: Dr. Joseph Carlin

Sedimentation on the continental shelf reflects the link between earth processes that occur in the ocean and on land. Today, climate change, and associated sea level rise is approaching levels comparable to the early and mid-Holocene, and understanding the changes that have occurred during the past may help to prepare for the future changes. This project investigated sedimentation along the Monterey Bay continental shelf throughout the late Holocene utilizing a 370 cm long core that was collected from a mid-shelf location just north of the Monterey Canyon, proximal to mouth of the Pajaro River. The sedimentary fabric of the core was analyzed from CT imagery, while variations in wet bulk density, and sediment texture were also investigated. High-resolution bulk density was determined from a multi-sensor core logger that was used to convert CT-derived density data. Sediment texture was determined from grain size analysis using laser diffraction. Each grain size sample was pre-treated to remove organic matter, carbonates, and biogenic silica prior to analysis. From these results we identified 4 sedimentary packages. The lowermost package spans from the base of the core to a depth of 180 cm, and is characterized by relatively high bulk density (~1.97 g/cm^3), is dominantly silty sand, and lacks definitive sedimentary structures. The overlying package from 179 cm to 85 cm is comprised of distinct alternating layers of silty clay and sandy silt, with generally low bulk density (~1.76 g/cm^3). Above this package (84 cm – 45 cm) is another high density (~1.91 g/cm^3), dominantly silty sand unit that lacks sedimentary structures. The upper core 45 cm of the core is characterized by alternating layers of high (~1.90 g/cm^3) and low (~1.60 g/cm^3) densities that are dominantly sandy silt and silty sand, respectively. The lowermost unit represents a shallow marine facies deposited > 11 kya when sea level was lower. The upper contact of this unit was formed as sea level rose quickly as a result of Meltwater Pulse 1B. Above this unit, the alternating layers likely reflect climate variations, with the low-density, silty clay layer (~ 60 cm) corresponding to the Medieval Climate Anomaly. The overlying coarse layer may correspond to the Little Ice Age. The top of the core represents modern warming, and a return to increased climate variability. This study reveals how continental shelf sedimentation records changes in sea level and climate, similar variability as is expected due to future climate change.

What motivates questionable interactions between humans and protected lands that result in destructive behavior?

Student: Angelic Perez

Faculty Adviser: Dr. Natalie Bursztyn

In the last two years there have been numerous news headlines about questionable interactions between humans and protected public lands. Examples of these interactions include: destroying geological structures, vandalizing iconic park landmarks and interfering with wild species. Though park visitation is encouraged, many visitors damage natural structures and behave illegally during their visits. Previous research conducted on this topic suggest that visitors recreate within these parks with little regard for maintaining the act of preservation until the damage done begins to affect their personal experience. This project aims to better understand the motivation behind visitors' illegal and destructive actions by utilizing social science research methods and a foundation of policy and ethics. Data from the public was collected via a survey designed to examine both knowledge of rules and personal opinions about behavior within protected public lands. The survey was administered to students enrolled in classes that relate to National Parks, and online via social media including Facebook and Instagram. Data from 158 participants was analyzed using summary statistics to try and answer the question: What are the true motivations and influences behind the destructive actions against protected natural lands? Results from true/false questions showed a wide range in participants' understanding of legal/illegal actions in public lands with 50-90% accuracy on this part of the survey. 70-73% of participants identified as extremely unlikely to perform an illegal action on protected public lands. Unfortunately, it is certain that social desirability bias has convoluted these data. Remaining data on participant opinions regarding case studies have been analyzed to interpret public opinion and the influence it contributes to destructive behavior representation. The data show that the majority of survey participants wanted a harsher sentence or agreed with the outcomes of fines or punishments for perpetrators in the case studies.

The Development and Study of Earth Science Lessons in Kindergarten Classrooms

Student: Annaimee Aguilar

Faculty Advisor: Dr. Natalie Bursztyn

Kindergarten classrooms are filled with curriculum that allows the children to develop social and motor skills, but falls short on teaching them scientific curriculum that will benefit them in the long run. Earth science courses are not taught until middle school, which allows the students from kindergarten to sixth grade to develop misconceptions about this scientific concept.

This project includes Kindergarten Earth science lessons that have been developed to fit the Next Generation Science Standards in order to allow students at an early age to grasp these concepts without developing misconceptions. Along with these lessons, teacher and student assessments were created to better understand their perception of the lessons. Each lesson will be tested every week and will correspond with the previous one. After every assessment has been completed, each lesson will be revised to fit the notes and comments done in these assessments. This is done to develop Earth science lessons that can be taught and understood in any kindergarten classroom.

Analysis of 13 years of Data Collection: Water Pressure and Chemical Changes from Well CSF-1, Fullerton, CA

Student: Terrinda Alonzo

Faculty Advisor: Dr. W. Richard Laton

To better understand the hydrogeology surrounding CSF-1, a deep multiport monitoring well located in the northwest corner of California State University, Fullerton (CSUF) was installed in 2003. Since the installation of the well, Orange County Water District (OCWD) has been collecting both water pressure and water chemistry either seasonally or annually. In order to understand the groundwater conditions under CSUF, it was proposed that a detailed review of the past 13 years' worth of data collected from well CSF-1 be reviewed. Patterns in the assembled data composed correlations that can be traced to a potential source of recharge. The graphed datasets of the chemicals Nitrate and Perchlorate showed a correlation to this recharge water but at lower than expected depths. There are abnormally high concentrations in aquifers 2 and 5 with lower but still significant levels in aquifers 3, 4, and 6. The key finding is that even though the lower aquifers showed abnormally high amounts of these chemicals, they showed low to no traces of the tracer chemicals in the upper unconfined aquifer. Based upon this finding, it was determined that the tracer chemicals Nitrate and Perchlorate do not originate from local runoff or recharge. But rather that the recharge of the lower aquifers originates further away, most likely the OCWD recharge area east of the town of Placentia by the Santa Ana River and import of water from the Colorado River.

Sulfur Isotopic Composition of Anhydrite in the Salt Stock and Cap Rock of Gulf Coast Salt Domes

Student: Kaelin Andelin

Faculty Advisor: Dr. Sean Loyd

A salt dome is a column of salt that has protruded upward into overlying strata due to downward pressure of overlying sedimentary units and the lateral pressure of tectonic movement. Salt, unlike other sediment, has the ability to change its shape and flow when placed under enough pressure. These salt domes are composed mainly of salt and other evaporite minerals, including minor amounts of anhydrite and gypsum. Salt domes of the Gulf Coast are sourced from the Jurassic Louann Formation, an extensive evaporite unit that formed during the early stages of development of the North Atlantic Ocean. Minor anhydrite contents (determined from a sequential dissolution, precipitation procedure) range from 0.633-3.56 wt%, similar to previously reported quantities (0.694-3.950 wt %). Sulfur isotope data from this minor anhydrite will provide insight into sulfur cycling. Sulfur isotope values that differ from the Jurassic seawater value of ~ +15‰ (VCDT) can be explained by microbial reactions such as sulfate reduction and sulfide oxidation, both of which are thought to occur in conjunction with salt domes. Sulfur cycling in salt dome environments is often coupled to hydrocarbon degradation, thus impacting resource potential. In addition to significance in the petroleum industry, salt domes are mined as an economically significant source of salt and are popular sites for underground storage of hazardous waste.

Examining the Geochemical Relationships between the Twentynine Palms and Queen Mountain Plutons in Joshua Tree National Park

Student: Alexander Arita

Faculty Advisor: Dr. Vali Memeti

Figure 1: Sharp contact between the TPP (lower) and QMP (Upper)

Plutonic studies increasingly show that plutons spend a lot of their hypersolidus time as magma mush. Over time, they may build vertical magma mush pathways in arcs and interact at various degrees with other magmas. How extensive these magma mushes are, which magma processes dominate and if and how much interplutonic interaction between different plutons takes place at the emplacement level is not well understood.

A place where these questions can be investigated is in the northern part of Joshua Tree National Park, California, which contains outcrops of a Triassic arc magma plumbing system consistent of two contemporaneous plutons: the ca. 235 Ma Twentynine Palms pluton (TPP) and the Queen Mountain pluton (QMP). The TPP is a megacrystic quartz monzonite composed of 1-20 cm blocky K-feldspar phenocrysts in a medium grained, equigranular matrix of largely plagioclase, hornblende, and minor quartz, biotite and accessories. The size and abundance of the K-feldspar varies substantially between different pluton domains. The QMP is a medium grained granodiorite with plagioclase, K-feldspar, quartz, biotite, hornblende and accessories. In addition, both plutons contain small pendants and blocks (TPP) and smaller, cm-dm pieces and biotite clots (QMP) of Pinto gneiss, the host rock into which the magmas intruded. Together, the plutons form a roughly bull's-eye shape map pattern with the megacrystic TPP forming the outer rim and the QMP the interior of the complex. The contact between the two plutons is steep and sharp to gradational where exposed and dikes of the QMP intruded the TPP. The QMP contains sparse Alkali-feldspar phenocrysts up to 4 cm large, which resemble the phenocrysts in the TPP. Both plutons exhibit local solid-state deformation with the strongest fabric along the TPP margin.

Given these field relationships and concurrent crystallization of both plutons, we are investigating through petrography and element and isotope geochemistry the hypothesis that the two units may be related to one parent magma and are potentially representing a fractionate (QMP) and cumulate (TPP) pair. Geochemical modeling suggests that fractionation of up to 30% of an assemblage composed of 65 wt.% K-feldspar, 20 wt.% Amphibole and 15 wt.% Plagioclase can reproduce QMP compositions from TPP magma, supporting our fractionate (QMP) and cumulate (TPP) hypothesis. This would propose that we may be looking at a cross section of a horizontally and vertically extensive magma mush zone that underwent extensive open system differentiation and efficient crystal-melt separation.

Basalt Correlation in the Sylvania Mountains, California, by X-ray Fluorescence Spectroscopy (XRF)

Student: Shayna Avila

Faculty Advisor: Dr. Jeffrey R. Knott

I collected four rock samples from Willow Wash in Fish Lake Valley, California, and two rock samples from Horse Thief hills, California. I analyzed these samples with X-Ray Fluorescence (XRF) and obtained the geochemical signature for all six samples. The Willow Wash samples are classified as basalt (47-52% SiO_2). The Horse Thief hills samples are classified as andesite-trachyandesite (56-60% SiO_2). The four samples from Willow Wash are dated at 11.5 Ma (by others) and using Zr/Ba and Ce/Y ratios I correlated these basalts with others in the White Mountains, atop Horse Thief hills, Fish Lake Valley, and Deep Springs Valley. This correlation shows that the 11.5 Ma basalt flowed over 40 km and predates the formation of Fish Lake Valley. The 6.2 Ma andesitic rocks are unique in this area. These andesitic rocks are interbedded with sedimentary rocks and thus represent a remnant Miocene basin now uplifted and exposed on the south side of the Horse Thief hills. These data constrain the formation of Fish Lake Valley and the Fish Lake Valley Fault zone to after 11.5 Ma.

Applying Laser-induced Breakdown Spectroscopy to Geologic Provenance Studies

Student: Eduardo Chavez

Faculty Advisor: Dr. Vali Memeti

Memeti et al. (2010) investigated the provenance of metasedimentary pendant units in the Sierra Nevada and passive margin strata by collecting U-Pb detrital zircon ages to make inferences about the Mojave-Snow Lake fault. While stratigraphy and age dating provided strong age correlations, it is not clear from where exactly at the passive margin the strata came from. Although provenance studies are typically conducted using U-Pb detrital zircon geochronology, this study is a good example for that the method can be time consuming and expensive, and the results still inconclusive.

Thirteen heavy mineral separates from Memeti et al. (2010)'s study underwent geochemical analysis using laser-induced breakdown spectroscopy (LIBS) to discern between passive margin strata at different locations. LIBS provides a detailed elemental signature of heavy minerals (McMillan et al., 2014) in (meta)sediments and is capable of distinguishing between different heavy mineral populations that are characteristic for each rock unit. The spectral lines produced by LIBS can be analyzed using emitted light wavelengths and relative light intensity to determine the element populations that are present to determine which mineral was ablated or to identify elemental variations within the same mineral type.

Two approaches were used for this study: (1) minerals from heavy mineral separate fractions were ablated blindly without mineral ID, and (2) specific minerals were ablated with the knowledge of type of mineral (apatite, sphene, and zircon). Geochemical results between spots were then compared and interpreted. One way to interpret the large amount of data collected by LIBS is to do principal component analysis (PCA). PCA compares data sets in multiple dimensions in order to observe correlations within data (McMillan et al., 2014). In PCA plots, points that plot closer together are interpreted to be of similar chemistry; points that are further apart are of dissimilar chemistries.

The plots produced by the first approach yielded insufficient clustering and result. Variability of mineral types within the heavy mineral separates may have obscured the score plots with high amounts of noise. The second approach yielded score plots with stronger clustering; implying that provenance using characterized minerals is more efficient than blindly ablating heavy mineral separates. Thus far, LIBS has shown to be capable of distinguishing between different mineral populations within heavy mineral separates; however, further investigation will be needed in order to optimize LIBS as a geologic provenance tool.

Petrography and Geochemistry of Suspected Hunter Mountain Batholith Clasts, Death Valley

Student: Emma Griffie

Faculty Advisor: Dr. Jeffrey Knott

The fluvial conglomerates of the Miocene (13.4 Ma) Eagle Mountain Formation, located at Eagle Mountain and the Resting Spring Range, eastern California, include monzogabbro clasts from the Jurassic Hunter Mountain (HM) batholith in the Cottonwood Mountains over 100 km to the northwest. Reconstruction of Basin and Range extension hinges on, in part, as to whether these conglomerates were tectonically transported or were a 100-km-long fluvial system. If HM clasts were found elsewhere, then reconstruction would be improved. This study investigated three locations in Death Valley (Salt Creek, East Coleman Hills and Gower Gulch) where HM clasts were anecdotally reported. Samples of "granitoid" clasts were collected from each location, examined macroscopically and then analyzed by x-ray fluorescence. Additionally, these clasts are present in three other Formations, all of which have different age constrains (Artist Drive (14-6 Ma), Furnace Creek (6-5 Ma), and Funeral (5-3 Ma)). Geochemical analysis was used to determine if these clasts are sourced from Hunter Mountain. If these clasts are related, then these formations can be used in conjunction with depositional environment to contribute to palinspastic reconstruction of pre-Cenozoic extension in Death Valley. Mass spectrometer analysis was performed on samples taken from Cottonwood Fan (control), Gower Gulch, Salt Creek, and Coleman Hills. Results indicated that these rocks are related with low variability.

Investigating the Volcanic-Plutonic Connection Using Geochemistry in the Minarets Caldera, Eastern Central Sierra Nevada Mountain Range, California

Student: Evelyn Gutierrez

Faculty Advisor: Dr. Vali Memeti

Understanding how magma plumbing systems operate at different levels of the crust helps better understand volcanic eruptions and ultimately allow their prediction. Investigating how exactly volcanic materials and deeper magma chambers (preserved as plutons) are geochemically linked can provide insights into the magma processes that produce the compositional variations observed at different levels of the magma plumbing and their vertical interconnectivity. Vertical cross sections of contemporaneous volcanic and plutonic rocks, however, are rare.

One such location is the Minarets caldera in the eastern central Sierra Nevada Mountains, where both the surficial, volcanic and the deeper, plutonic parts are exposed. The rock record in the Minarets caldera shows a well-preserved intracaldera ignimbrite, an intercalated caldera-collapse breccia, and a granitic to granodioritic intrusion known as the Shellenbarger Lake pluton located at the center of the volcanic complex. The volcanic and plutonic rocks have been determined to be contemporaneous at ca. 100 Ma (Tomek et al., 2015). Fiske and Tobisch (1994) hypothesized that the Shellenbarger Lake pluton might represent the magma source for the volcanic deposits. If true and the Minarets caldera represents an upper crustal magma plumbing system, we can test the following hypothesis: Are the volcanic and plutonic rocks of the exact same composition or are they complementary to one another? The former will imply that the volcanics are partial extractions of a homogeneous magma chamber, whereas the latter will imply that the erupted materials may have fractionated from the magma reservoir and the pluton represents the restitic crystal-rich magma.

To test this hypothesis, volcanic and plutonic samples from the Minarets caldera were analyzed for petrography and XRF major and minor trace elements. The XRF results were further used for geochemical modeling to test a fractionation model. Preliminary results indicate that the volcanic rocks include both equivalent and complementary compositions to the pluton. Major oxide and trace element data of complementary rocks indicate that plagioclase was likely fractionated, which is variably abundant as a phenocryst in the plutonic rocks. Some volcanic units plot with or near plutonic compositions, indicating equivalent compositions.

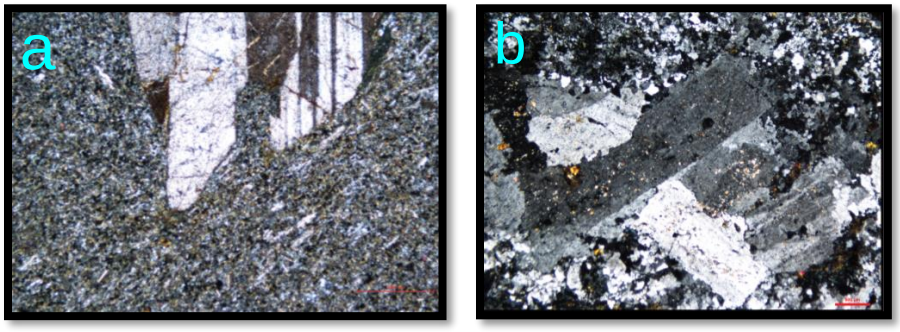

Figure 1 (a) Volcanic sample of a plagioclase phenocryst in a plagioclase rich matrix (b) plutonic sample with plagioclase twin on plagioclase and quartz + albite rich matrix

Yosemite: Teaching the Impacts of Climate Change Through a Virtual Field Trip

Student: Joseph Gutierrez

Faculty Advisor: Dr. Natalie Bursztyn

The benefit of field trips is undeniable— however, growing class sizes and high costs make the logistics of organizing a traditional, on-location field trip challenging. This gives rise to the concept of a virtual field trip (VFT) which can provide a field trip proxy. The current generations of students entering college are digital natives and connected 24/7 allowing them to easily navigate a VFT. These students also tend to have short attention spans making it that much more important to incorporate field trips into the curriculum to keep students engaged. While not a complete replacement for an actual field trip, VTFs can offer an interactive alternative to a traditional lecture. Importantly, successful VTFs have proven to be comparable to real life field trips in educating students.

Our VFT takes place within Yosemite National Park and showcases the rich geologic history and iconic geomorphology of the park describing the effects of climate change via a roadside geology style field trip app. The app is targeted towards 101 level geology students as well as the general public who visit the National Parks. The story is told through three chapters with various stops in Yosemite Valley (e.g. Yosemite Falls, Mirror Lake), along Tioga Road (e.g. Olmstead Point, Fairview Dome) and additional stops on the outer roads (e.g. Hetch Hetchy, Glacier Point). As the user reaches a stop in the chapter, the app will use GPS to trigger a narration explaining the processes that formed the geology of the area. The user can pull over to the side of the road and the app will offer pictures, figures and overlays to further explain the geologic processes and effects of climate change. In the classroom, the app can be used as a standalone interactive VFT without GPS triggers. We believe that an easily accessible VFT can teach and inspire a new generation of students entering college as well as educate the general public about climate change and the rich geologic history of Yosemite National Park.

Playing in the Sand: The AR Sandbox as an Interactive Topographic Lesson

Student: Danielle Jackson

Faculty Advisor: Dr. Natalie Bursztyn

The daily use of technology has become the norm in modern society. The simplicity of cellular phones and GPS navigation systems in our digital age has resulted in a new challenge for educators teaching topographic maps. Visualizing landforms from a 2-dimensional map and understanding the basic concept of contour intervals has become increasingly troublesome for many students new to the geosciences. Research has shown that undergraduate students have significant difficulties understanding how to interpret information presented on topographic maps. In the last several years, as virtual reality (VR) and augmented reality (AR) technologies have become more accessible to classrooms, researchers are seeing an improvement in student learning through their use. AR used in various STEM fields has improved teacher and student collaboration, and has been especially useful in facilitating the learning of three dimensional forms.

In the last couple of years, AR sandboxes have been popping up across the nation in museums, universities, and schools. This project will assess the educational effectiveness of the AR sandbox by directly comparing it with a traditional topographic map lesson. Based on the educational successes of AR, and the growing popularity of the AR sandbox, we suggest that this cutting edge tool will result in improved student understanding of topographic maps and can easily be integrated with already existing geology 101 labs. We are adapting an introductory paper topographic map lab from a geology 101 class to include the AR sandbox while maintaining the same questions and exercises. After students complete the traditional paper and AR-adapted labs, we will qualitatively assess student perception of the experiences. Students typically look at a paper map and have trouble visualizing the landforms; therefore for them to be able to view and manipulate the map in three dimensions (by playing in the sand) is interactive, engaging and exciting.

Basalt Correlations Across the Fish Lake Valley Fault Zone, CA/NV Using X-Ray Fluorescence

Student: Eddie Jimenez

Faculty Advisor: Dr. Jeffrey Knott

In this study, basalt outcrops across the Fish Lake Valley fault zone (FLVFZ), Fish Lake Valley, California and Nevada, were collected and analyzed for chemical composition. These basalts are found as isolated outcrops with no the volcanic source presumably in the White Mountains. Four samples (three presumed basalt and one rhyolite) were collected. The first (EJ-1) is from a basalt flow with a 4.8 Ma K/Ar age. EJ-2 and EJ-3 are a rhyolite and an 11.5 Ma (whole rock $^{40}Ar/^{39}Ar$) basalt, respectively, from west of the FLVFZ. The last sample (EJ-4) is a basalt deposited on a monzonite east of the FLVFZ. All samples were powdered at CSUF and analyzed at Pomona College by x-ray fluorescence (XRF) for geochemical signatures. Analysis shows that the rocks are: trachy-basalt (EJ-1; 51% SiO2), rhyolite (EJ-2; 77% SiO2), basalt (EJ-3 and EJ-4; 47-51% SiO2). When classifying using Zr/Ba and Ce/Y ratio EJ-3 and EJ-4 plot as asthenosphere dominated (< 5 m.a.). EJ-1 plotted as lithosphere dominated (>5 m.a.) and can be differentiated from the 11.5 m.a. flow because its composition and age (4.8 m.a.). EJ-3 & 4 are assumed to be outcrops of the northern margin of the same 11.5 Ma basalt flow on either side of the FLVFZ. If true, the northern margin of the flow is offset roughly 11 km, which yields a slip rate of ~1mm/yr over the last 11.5 Ma. If, however, the FLVFZ did not begin until 4 Ma when the Willow Wash basin began, the slip rate is ~2.5 mm/yr. These slip rates are comparable with the Pleistocene slip rate of 1-5mm/yr. At the very least, these data show that the 11.5 Ma basalt flow was erupted prior to the formation of Fish Lake Valley and uplift of western margin of the Silver Peak Range. Comparison with other basalt outcrops in the White Mountains, Inyo Range, and Last Chance Range show that the basalt flow covered an area 20 km wide (N to S) and 16 m long (W to E).

Geochemical Analysis of Ubehebe Hills and related basalts, Northern Death Valley

Student: Grant G. Kennis

Faculty Advisor: Dr. Jeffrey R. Knott

An olivine-bearing basalt flow in the Death Valley Wash (37.05175°N, 117.45295°W) underlies the 3.3 Ma Mesquite Spring tuff. Determining the source of the Death Valley Wash (DVW) basalt will help elucidate Death Valley Late Miocene-Pliocene paleogeography and stratigraphy. Based on its stratigraphic position, the basalt flow was previously correlated with the 3.7±0.2 Ma basalt of Ubehebe Hills found 10 km to the south; however, there are three other olivine-bearing basalt flows older than 3.3 Ma closer to the DVW. A 4.2±0.3 Ma olivine-basalt is found 5 km to the west on the eastern slope of the Last Chance Range. Two basalt flows in the Grapevine Mountains with dates of 7.5±0.3 Ma and 7.4±0.4 Ma are found 8 km southeast and 8 km north, respectively. Major and trace element ratios (Zr/Ba vs Ce/Y) measured by X-ray fluorescence (XRF) confirm the DVW basalt is distal equivalent of the 3.7 Ma basalt of Ubehebe Hills. The 7.4-7.5 Ma basalt in the Grapevine Mountains have a different asthenosphere-dominated magma source. The geochemistry of the 4.2 Ma basalt that erupted from the Saline Range to the west, prior to uplift of the Last Chance Range, is distinguishable from the DVW basalt. The basalt of Ubehebe Hills flowed south to north in a narrow, north-south trending sedimentary basin. The eruptive source for the Ubehebe basalts could be either locally in Death Valley or possibly from the Saline Range to the west. Another Saline Range basalt with a K/Ar date of 3.17±0.12 Ma that crosses the Last Chance Range near the basalt of Ubehebe Hills is a target for future research.

Identifying Paleoseismic Events along Newport Inglewood Fault Zone from Salt Marsh Stratigraphy

Student: Ryutaro Koga

Faculty Advisor: Dr. Joe Carlin

Southern California is home to more than 20 million people. In addition to the large population, Southern California is also home to numerous faults capable of producing damaging earthquakes. Many of these faults remain under-studied, such as the Newport-Inglewood Fault Zone (NIFZ) that extends through highly urbanized areas of Southern California including Culver City, Long Beach, and Newport Beach. The most recent rupture associated with this fault was a magnitude 6.4 earthquake in 1933, but little is known about other past events over the recent geologic past. One reason for this lack of knowledge is that the urban location of the fault that makes it particularly hazardous also makes it difficult to study. Recent studies however, have shown that wetlands located along the fault may offer key stratigraphic insight into better understanding the seismic history of this fault. The goal of this study was to improve our understanding of the late Holocene seismic history of the NIFZ. To accomplish this, we utilized the coastal sediment record within the Seal Beach Wetlands (SBW) to identify past earthquake events. The salt marshes in the SBW are an ideal sedimentary environment to preserve evidence of past earthquake events as recent studies have shown that the SBW can experience co-seismic subsidence during earthquake events. Building upon this work, we focused on a new core collected in 2016 from a previously unstudied region of the SBW. High-resolution sample analysis from this core included magnetic susceptibility, percent total organic matter, and percent total carbonate. From these results, we characterized the sediment into one of three facies: marsh, mudflat, or subtidal. Typical marsh progradation would follow a sequence of subtidal to mudflat to marsh; and we used variations from this sequence that were indicative of elevation decreases to identify potential earthquake events. In this core we identified 3 potential earthquake events. The lowermost event was at 275 cm, where a subtidal environment abruptly decreased in elevation to a mudflat environment. The second event was at 214 cm where a mudflat environment was overlain by a subtidal environment, and then at 130 cm where a subtidal environment abruptly changed to a mudflat environment. This study has provided the initial insights into potential stratigraphic contacts that may reflect a paleoseismic event. Future work will be focused on improving the confidences of these interpretations through additional analyses, and determining the ages of each event.

Geochemical and Petrographic Relations Between Mafic Intrusions in Post-Peach Spring Tuff Deposits in the Southern Black Mountains, Meadow Creek Basin, Near Oatman, Arizona

Student: Veronica Smith

Faculty Advisor: Dr. Diane Clemens-Knott

Mafic rocks intrude and overlie the rhyolite- and trachyte- dominated Miocene volcanic stratigraphy of the Meadow Creek basin in the Southern Black Mountains, AZ. The Meadow Creek sequence postdates formation of the nearby Silver Creek Caldera, the source of the 18.8 Ma Peach Spring Tuff (PST) supereruption (Ferguson, et all, 2012). Mafic magmas that intruded this volcanic center and formed capping lavas can provide insights into the evolution of magmatism as the silicic system that fed the supereruption waned.

Three large, NNW-striking aphanitic dikes that cut the younger lavas and tuffs are compositionally and texturally similar trachyandesites with sparse phenocrysts of plagioclase and cpx and a plag-dominated groundmass (SiO2 avg = 55-57 wt%, Fe2O3 (t) avg = ~7%, MgO avg = ~3%, K2O avg = ~ 3%, Sr avg = ~ 700 ppm, Ba avg = ~1123ppm, Zr avg = ~ 300ppm, Rb avg = ~60 ppm[by XRF]). Another parallel dike and a lopolith are diabase-textured (olivine and laths of plag with interstitial cpx; traces of apatite, Fe-Ti oxide, and interstitial amphibole) and more mafic (SiO2 avg = 49-51%, Fe2O3(t) avg = 11%, MgO avg = 5-8%, K2O avg = 0.3-0.7%, Sr avg = 350-530ppm, Ba avg = 320-430ppm, Zr avg =110-135ppm, Rb avg = 20-30ppm). Capping lava has similar elemental composition. MELTS modeling indicates that these mafic magmas were emplaced at ~1200° C. The diabases and lava define a clear tholeiitic Fe-enrichment trend on an AFM ternary. The more silicic dikes are clearly distinct from the diabases and cluster tightly near the calc-alkaline:tholeiitic boundary.

The diabase intrusions are likely part of a system that fed the ~14-16 Ma capping lavas of the region, which have been interpreted to have been late- to post extensional (Thorson, 1971; Faulds et al., 2001; Varga et al 2004). Proximity and orientation of the trachyandesite dikes suggests that they are part of the same intrusive episode, but their distinct characteristics indicate that they not closely related petrogenetically.

Mafic to intermediate volcanics that predate the PST in the southern Black Mountains form a continuous calc-alkaline compositional trend (Flansburg et al 2014), while younger capping lavas are uniformly basalt (Spencer et al 2007) and form an identical tholeiitic trend to mafic rocks in Meadow Creek basin. This compositional shift corresponds to evolution in tectonic setting from early synextensional to late or post-extensional.

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Are Southern California Salt Marshes Keeping Pace with Sea Level Rise? An Investigation of Salt Marsh Sedimentation in Upper Newport Bay, CA, USA

Student: Dane Anthony Van Orman

Faculty Advisor: Dr. Joseph Carlin

Salt marshes are one of Earth's most valuable ecosystems. These environments however, are threatened by sea level rise due to climate change, and human activities. In southern California in particular, urbanization has altered sediment fluxes to the marsh, and prevent marsh habitats from migrating landward with relative sea level rise (RSRL). In this study, we sought to assess salt marsh vulnerability in Upper Newport Bay (UNB) to RSLR. To accomplish this we collected sediment cores from throughout UNB to characterize the sediment (grain size analysis and total organic matter from Loss-On-Ignition), and measure decadal sediment accumulation rates (^{210}Pb and ^{137}Cs geochronology). The results showed Salt Marsh 1 (SM1), in the upper reaches of the bay, was dominantly muddy, with a ~10 cm sandy-gravel layer mid-core. The accumulation rate at this site was 3.1 mm/yr. Salt Marsh 2 (SM2), proximal to the San Diego Creek mouth, was consistently muddy throughout, with an accumulation rate of 8.0 mm/yr. Salt Marsh 3 (SM3), in the lower reaches near the bay mouth, was a mix of mud and sand with an accumulation rate of 3.4 mm/yr. Therefore, sedimentation rates were highest at SM2, reflecting the proximity to the primary sediment source. Removed from this input, rates at SM1 and SM3 were relatively similar. At each site however, there were three different types of accumulation: 1) consistently rapid accumulation (SM2), 2) slow sedimentation punctuated by event deposition (SM1), and 3) rapid sedimentation punctuated by erosion (SM3). For all three accumulation types, the net accumulation rate exceeded RSLR (~2.2 mm/yr), but only Type 1 demonstrates low vulnerability. For Type 2, if not for a significant event deposit associated by extreme flooding in 1969, this location may not have kept pace with RSRL. While for Type 3, relatively rapid accumulation has been buffered by periods of erosion/non-deposition due to channel migration. The net effects of these accumulation types are that for Types 2 and 3, where accumulation is more or less keeping pace with RSRL, and then we would expect that habitats are building vertically in place. For Type 1 locations, we would expect habitats to prograde seaward given these accumulation conditions, resulting in an apparent local drop in RSRL for these areas. This study suggests that UNB salt marshes have been keeping pace with RSRL, but depositional variability increases with increased distance from San Diego Creek, therefore increasing habitat vulnerability to future changes.

Examining an Oyster Reef Community from the Late Pleistocene Palos Verdes Sands, Knoll Hill, San Pedro, California

Student: Walicki, Julian

Faculty Advisor: Dr. Nicole Bonuso

We examined samples of oysters from the Late Pleistocene Palos Verdes Sands rock formation, Knoll Hill, San Pedro, California. We did this to document pre-human oyster communities. Knowing what pre-human oyster communities looked like before humans disrupted their environments can better help biologists restore damaged oyster beds back to what they used to be. The first method we used was wet sieving. We wet sieved because we needed to get all the oysters and other fossils out of the sand so we could examine them. Next we sorted them. We sorted the fossils because we needed to see which fossils were gastropods or bivalves and which specimens were identifiable. To identify the fossils, we used books and compared our specimens to other curated collections from the Knoll Hill location. We identified all fossils to the species level. Then we counted all the fossils for each species. We looked up the ecology of each genus using the Paleobiology Database (www.paleobiodb.org). The three abundant species are *Ostrea conchaplila* (12%), *Callinax (olivella) biplicata* (11%), and *Glossaulax reclusiana* (9%). In terms of ecology, active mobile epifaunal carnivores dominate (27%) followed by slow moving low-level epifaunal carnivores (19%), and facultatively mobile infaunal suspension feeders (18%).

Assessing Pleistocene Sediment from the San Pedro Formation for Oyster Species and Other Invertebrates to Piece Together the Paleoecology

Student: Maree Kutcher

Faculty Advisor: Dr. Nicole Bonuso

Oysters are an important part of coastal water ecology in Southern California. Throughout the last million years, during the Pleistocene Epoch, the ecology of Southern California has changed drastically; the advance of civilization and the urban development of Southern California has contributed to the decline of various oyster species as well as other mollusks and gastropods. Currently only one species of oyster, *Ostrea lurida,* inhabits the coastal waters of Southern California.

The present study reviewed the past record of invertebrate species from the Palos Verdes Sands of the San Pedro Formation. Fossiliferous sediment from the San Pedro Formation, from Knoll Hill in San Pedro, California, was examined for invertebrate fossil remains. Fossils were sorted into taxonomic order and species, and then counted to assess relative abundance. Results show an abundance of oyster species during the late Pleistocene; four different unidentifiable species of oysters were documented. Determining which species are represented will require more in-depth analysis.

In terms of relative abundance, the most well-represented species was *Macoma nausta*, a form closely related to *Ostrea.* Overall the most abundant class is Bivalvia and the second most abundant is Gastropoda. The most abundant type of ecology is facultatively mobile infaunal suspension feeders. The data was collected from the sediment pertaining to Maree Kutcher and not to the other students working with the same type of sediment.

This study suggests that *Ostrea* may not have shown similar abundance to that of other bivalves and gastropods, and southern California coastal communities today do not differ much from those of the late Pleistocene. Further research will explore this possibility, helping researchers at California State University, Fullerton in the Biological Sciences department to restore the species diversity that was misplaced during human and urban development in southern California. Restoring Southern California oyster beds will improve the local shallow marine ecosystems by the oysters filtering the waters, reducing the abundance of carbon, increasing landscape diversity, and stabilizing intertidal and benthic habitats.

Masters MS Proposal Category

GEOLOGICAL SCIENCES
CSUFULLERTON

Reconstructing the Paleoseismic History of the Newport-Inglewood Fault Zone Using Marsh Stratigraphy

Student: Michaela Adler

Faculty Advisor: Dr. Joseph Carlin

With more than 20 million people living in southern California, this tectonically active location may be the most vulnerable region to seismic hazards in the United States. Although this region contains numerous active faults, one that maybe particularly impactful is the Newport Inglewood Fault Zone (NIFZ). The NIFZ bisects densely urbanized areas in the Los Angeles Basin, and recently it has been suggested that the NIFZ extends down the coast, linking up with the Rose Canyon Fault in the San Diego region. Therefore, this combined system may represent a seismic hazard throughout much of the southern California region. Due to its urban location, NIFZ had remained largely understudied until recently. The Seal Beach Wetlands (SBW), which straddle the NIFZ, have emerged as key location to study the NIFZ. Recent work in wetlands suggests that subsidence occurs during large magnitude earthquakes, but this work focused on only section of the SBW, and could not provide a quantitative subsidence estimate.. Additionally, a second study recently demonstrated that foraminifera could be used to determine past elevations in the wetlands. Therefore, this proposed project aims to build upon this previous work to better understand the extent of coseismic subsidence in the SBW, both laterally and vertically through addressing the following questions: 1) is coseismic subsidence consistent throughout the SBW, and 2) how much do the wetlands subside during these events? We hypothesize that abrupt sedimentary contacts will be contemporaneous throughout the SBW, adding support for the interpretation that these contacts form during large earthquakes. Further, we hypothesize that the observed stratigraphic changes will require at least 0.5 m of subsidence. Preliminary data show similar stratigraphy in cores from the unstudied sections of the SBW, suggesting lateral continuity. During this project, we will analyze 5 new cores collected from the SBW, and preform new analyses on previously collected cores. The analysis plan will consist of first; characterizing the sediment to identify potential subsidence-induced contacts by measuring magnetic susceptibility, grain size distributions, percent organic matter, and percent carbonate in the cores. Second, dating these potential contacts using radiocarbon geochronology to connect contemporaneous events across the wetlands. Finally, identifying the foraminifera present across the event contacts to apply a transfer model to quantify vertical subsidence. Ultimately this study will provide a better understanding of the frequency of these large magnitude earthquakes that will be beneficial for assessing seismic hazards in the region.

New fossil walrus skulls from the Los Angeles Basin shed light on major walrus radiations

Student: Jake Biewer

Faculty Advisor: Dr. James Parham

Today, walruses are represented by a single species, *Odobenus rosmarus*, which is confined to the Arctic. However, millions of years ago, walruses were more diverse (20 species in the Miocene) and widespread throughout the Pacific. Ongoing phylogenetic studies identify two major radiations of walruses, one in the early Miocene and one in the late Miocene, but with a gap in data from the middle Miocene. This study will describe 11 new fossil walrus skulls from the Los Angeles Basin in order to provide more information on the timing of walrus diversification events, filling in the "middle Miocene gap," as well as tie these events to climatic changes occurring in the Miocene. Most of these specimens are housed at the John D. Cooper Archaeological and Paleontological Center (OCPC) and Natural History Museum of Los Angeles County (LACM). The 11 skulls represent 3-4 new species from a time when walruses were thought to have low diversity. Furthermore, the amount of material from the LA Basin provides a rare opportunity to make comparisons among males, females, and juveniles from the same formation. For my thesis I will: 1) provide scientific descriptions of new fossil walrus material, 2) perform a phylogenetic analysis to develop a new evolutionary tree for fossil walruses that includes insights from the new material, and 3) reassess the fossil record of walruses through time. This work will allow me to develop the most accurate picture of walrus evolution through time. I can then compare the timing of walrus radiations and extinctions to those of other taxa as well as oceanographic patterns and global climate change.

Southern California coastal wetland evolution: Using the geologic record to understand the shift from a late Holocene oyster reef to salt marsh

Student: Sarah Dickson

Faculty Advisors: Drs. Joe Carlin and Nicole Bonuso

Ostrea lurida, commonly known as the Olympic oyster, is the only oyster species native to the US Pacific coast. Although this species was once common throughout Southern California, the past 200 years have seen a serious decline in abundance as the result of anthropogenic influences. Evidence of past oyster communities has also been observed in the geologic record of modern salt marshes. This indicates that these environments once supported oyster communities, but naturally lost favorable habitats in the transition to salt marshes. Therefore, in order to improve management and restoration of this fishery, we must better understand the natural drivers that may adversely affect oysters in the region.

The goal of this study is to answer two questions: (1) Does this shell layer represent a past oyster reef? (2) Does the shell layer indicate a significant shift in the evolution of the lagoon? We hypothesize that (1) the shell layer represents a past oyster reef community, and (2) the layer marks the boundary of an environmental change marking the initiation of the marsh, and the decline of suitable oyster habitat. These hypotheses are supported by preliminary data which show (1) that the mollusks present correspond with those expected in an oyster community, and (2) that the shell layer is the contact of an abrupt change from a sandy unit below to a muddy sequence.

Six cores will be extracted from Los Penasquitos Lagoon and analyzed to (1) assess the ecology of the shells, (2) characterize the sediment, and (3) establish an age-depth relationship. The ecology will be assessed through shell identification and taphonomic analysis, which will indicate whether the shells are *in situ* or a reworked lag deposit. The sediment will be characterized by grain size distribution and percent organic matter, both of which will be used as paleoenvironmental indicators. Finally, radiocarbon dating will be used to constrain the age of the shell hash layer by dating indicative shells, and other material throughout. This will provide a better sense of when any environmental transitions occurred, and how the shell layer fits into that timeline. Ultimately, this study will provide insight to the natural environmental factors that may have contributed to the historical decline in *Ostrea lurida*. The results of this study will aid future restorative efforts, and allow them to be more successful in reestablishing oyster communities throughout the west coast.

The Age of the Vaqueros Formation in Laguna Canyon, Orange County, CA

Student: Jared Heuck

Faculty Advisor: Dr. James Parham

The precise ages of most fossil-bearing rock units in Orange County are poorly constrained, which presents challenges to placing the rich fossil record of the region into a comparative context. The Vaqueros Formation at Laguna Canyon in Irvine is one such poorly constrained unit that is important because of its unusual marine mammal fauna. In particular, some specimens from Laguna Canyon belong to a group of archaic mysticete (baleen-bearing) whales that still have teeth. These so-called "toothed-baleen whales" are found around the margins of the North Pacific Ocean, but are thought to go extinct by the end of the Oligocene. Previous authors have claimed that the Laguna Canyon site is Miocene, but without providing much substantiating evidence. The goal of my thesis is to use multiple methods for dating the Laguna Canyon to develop a precise age for its fauna. Methods for this study include: 1) a correlation of marine invertebrates to other known occurrences; 2) an isotopic analysis on invertebrate material; 3) a reevaluation of relevant North American Land Mammal Assemblages and how these fauna relate to Orange County; 4) structural examination of the site with emphasis on relationships with surrounding formations. These studies should provide a reliable age for the Laguna Canyon site and its important whale fossils. A refined age will allow me to make more accurate comparisons with other Oligo-Miocene whale faunas and ultimately provide the most precise temporal and biogeographic context for the origin of baleen whales.

Biogenic vs Thermogenic: Determining Native Sulfur Formation Mechanisms in Gulf Coast Salt Domes Using Multiple Sulfur Isotopes

Student: John Hill

Faculty Advisor: Dr. Sean Loyd

Cap rocks of Boling and Main Pass Gulf Coast salt domes contain anomalously large elemental sulfur concentrations. Isotopic and petrographic data indicate complex histories of calcite paragenesis for both domes. Whereas paragenetic complexity is in part due to the open nature of these hydrodynamic systems, a comprehensive understanding of sulfur sources and concentration mechanisms is lacking. Large ranges in sulfur isotope compositions ($\delta^{34}S$) among oxidized and reduced sulfur-bearing phases has led some to infer that microbial sulfate reduction and/or repeated influx of sulfide-rich formation waters occurred during cap rock formation. Ultimately, traditional sulfur isotope analyses alone cannot distinguish among local microbial or exogenous sulfur sources. Recently, multiple sulfur isotope (^{32}S, ^{33}S, ^{34}S) analyses reveal small, but measurable differences in mass-dependent behavior between microbial and abiogenic sulfur cycling. We propose to apply multiple-sulfur-isotope analyses to native sulfur from Boling and Main Pass cap rocks to distinguish between the proposed sulfur sources. Similarities or deviations from the so-called terrestrial mass-dependent relationship ($\delta^{33}S = 0.515\delta^{34}S$) can indicate which pathways were responsible for native sulfur precipitation. Pathway determination will provide insight into Gulf Coast cap rock development and potentially highlight the conditions that led to anomalous sulfur enrichment in Boling and Main Pass Domes.

A Geochemical Analysis of Productivity and Oxygenation Following the Permian-Triassic Extinction Event, Opal Creek, Alberta, Canada

Student: Anthony A. Macias

Faculty Advisor: Dr. Adam Woods

The Permian-Triassic Extinction event occurred about 251 million year ago, and is acknowledged as the largest loss of biodiversity in the geologic record, resulting in the decimation of roughly 90% of marine and terrestrial species at the time. Recovery was not coeval after the extinction; instead, recovery is thought to have been strongly influenced by regional or local environmental conditions. To understand how organisms rebounded following such a devastating crisis, it is necessary to examine the reestablishment of primary productivity and its relationship to environmental conditions, specifically oxygenation levels, during this period as a whole. Located within the southern section of the Canadian Rockies, the Opal Creek section is a stratigraphically continuous section of Late Permian to Early Triassic deep-water sediments deposited along the northwestern continental margin of Pangea. The Opal Creek section is an approximately 330m thick unit composed of three distinct formations assigned to the Johnston Canyon, Ranger Canyon, and Sulphur Mountain formation. To better understand the relationship between recovery and environmental conditions related to the extinction, productivity and marine oxygenation levels will be reconstructed by analyzing trace elements of samples previously collected from Opal Creek. Trace element analysis allows for reconstruction of productivity levels through the collection of Ba, Cu, Ni and Zn data, while Mo and V are used to reconstruct marine oxygenation (Tribovillard et al., 2006.) In addition, Total organic matter content (%TOM) will be determined using the Loss on Ignition procedure described by Dean (1974). Developing a better understanding of how environmental conditions plays a role in recovery after catastrophic events such as the Permian-Triassic mass extinction are important, because it can help us better understand the effects of climate change on Earth's current biota and determine when and how life will recover from Earth's modern mass extinction.

Thermal Infrared Remote Sensing for Water Temperature Assessment along the Santa Ana River using an Unmanned Aerial Vehicle (UAV) System

Student: Diana Carolina Chacon

Faculty Advisor: Dr. W. Richard Laton

Water temperature is a critical regional indicator of water quality in rivers and streams that it is influenced by surface water, groundwater, canopy cover, solar radiation, and discharge from wastewater plants along the Santa Ana River. To identify areas that don't meet water quality standards and protect endangered or threatened wildlife, such as the Santa Ana sucker (*Catostomus santaanae)*, stream temperature monitoring is required by the Clean Water Act of 1977), (Section 303d). (Beschta et al. 1987; SWRCB, 2015). The conventional methods (in-stream data loggers) provide continuous discrete data, yet they lack of spatial data which is needed to model temperature distribution in rivers at a larger scale. Airborne remote sensing, using unmanned aerial vehicles (UAVs), can provide images at high temporal and spatial resolutions suitable for narrower rivers and streams. Moreover, the data acquisition has a much-reduced cost and flexibility (easily deployable) compared to conventional sources of remote sensing. I proposed that by using UAV high resolution imagery and TIR remote sensing technology, I'll be able to identify thermal variations in the stream by mapping the radiant water temperature (*T*r) spatially and identify areas with coarser substrates and riparian vegetation on an approximate 3-mile reach of the Santa Ana River. To do this, a series of low altitude flights will be performed to generate a 3D point cloud, Digital Elevation Models (DEMs), a digital orthomosaic, and Digital Surface Model (DSM) during summer and winter (when the maximum temperature contrast of groundwater/surface water is expected). Pix4mapper will be used to process the data collected, and the resulting models will be exported to ArcMap for geospatial analysis. The results may have important implications regarding identification of favorable areas for spawning of the Santa Ana sucker, who prefers coarse substrates (gravels, rubbles, and boulders), native riparian vegetation that provides cover and shelter, and colder flowing water that are only maintained in some areas by the upwelling of cooler groundwater, tributary flows, or shade from overhanging vegetation (FWS, 2009; USFWS, 2000).

Zoning in Feldspars as Tracers of the Extent of Magma Mixing and Magma Chamber Size in the Tuolumne Intrusive Complex, Yosemite National Park, CA

Student: Louis Oppenheim

Faculty Advisor: Dr. Vali Memeti

While there is general agreement in the granite community that intrusive bodies are emplaced incrementally in the crust over prolonged time scales, it is unclear how interconnected these magma increments (batches) get and if they ever amalgamate to form large magma mush bodies or reservoirs, which has significant implications for how eruptible such magmas are and the nature and size of volcanic eruptions at the surface.

This study focuses on characterizing alkali feldspar and plagioclase populations from the Half Dome and Cathedral Peak granodiorites from the south-eastern section of the Tuolumne Intrusive Complex (TIC), Yosemite National Park. The goal is to investigate whether it is possible to determine if magmas were mixed at the emplacement level, especially at the interface between the two units. If this was the case, the nature of the hybridization at the pluton contacts might provide information on the extent of the interconnected magma mush and its crystallinity.
Cathodoluminescence and polarized light microscopy will be used on thin sections from different parts of the transect to first characterize the morphology of the zoning patterns within both types of feldspars and work to identify multiple mineral populations for analysis. Preselected mineral populations will then be analyzed with an electron microprobe and LA-ICP-MS for distribution and concentrations of slow-diffusing trace elements, such as barium and strontium. The following hypotheses will be tested through this approach: 1) Feldspar populations are mixed across the interface between Half Dome and Cathedral Peak units; 2) if mixing is only observed as unidirectional from the older Half Dome granodiorite into the Cathedral Peak Granodiorite, then the older unit might have been a majority crystallized when the younger Cathedral Peak was emplaced, supporting TIC emplacement as a series of small batches that didn't form magma chambers across units. If mixing is mutual across the pluton interface and feldspars were mutually recycled forming a hybrid of both units, the suggestion would be that the older unit was still mushy when the younger one was emplaced, which supports the TIC forming an extensive magma mush body.

A Determination of the Timing and Consequences of the Late Ordovician Glaciation Using the Ely Springs Dolomite of East Central California

Student: Austin Poncelet

Faculty Advisor: Dr. Adam Woods

The Late Ordovician is characterized by an anomalous glacial episode that caused profound changes in global oceanic circulation. Although the Late Ordovician glaciation is well recognized from sedimentological observations, the timing/extent of glaciation is poorly understood, with two competing hypotheses: 1) Glaciation during the Late-Ordovician was short-lived (<1 my) and occurred during the Hirnantian (e.g., Brenchly et. al., 1994); and, 2) Glaciation during the Late Ordovician was long-lived (lasting ~10-35 my) and began during the Sandbian (e.g. Saltzman and Young, 2005). The goal of this study is to constrain the duration of the Late Ordovician glaciation, while providing paleoceanographic data about the northwest margin of Laurentia during this time. The Late Ordovician-Early Silurian Ely Springs Dolomite, deposited as part of a homoclinal carbonate ramp along the northwestern margin of Laurentia, may help determine the nature and timing of observed glaciation. Two inner to outer carbonate ramp settings will be examined in south-central California, including the Nopah Range and Hard Scramble Nose. Evidence of prolonged glaciation during the Late Ordovician is expected to show pronounced sequence boundaries and cool-water carbonate grain associations related to the upwelling of cool waters (James, 1997) during enhanced thermohaline circulation (Wilde, 1991). Evidence of a short lived glaciation is expected to show smaller scale sea level fluctuations prior to the Hirnantian, along with cool-water carbonate assemblages limited to the uppermost Ordovician. Analysis of the Ely Springs Dolomite will shed light on the nature of the Late Ordovician glaciation and its effects on a carbonate ramp far from the locus of glaciation.

Masters MS Thesis Category

Geochemistry of phosphatic-shales and associated authigenic minerals of the Miocene Monterey Formation: Implication for paragenetic evolution

Student: Tony Sandoval

Faculty Advisor: Dr. Sean Loyd

The Monterey Formation is a petroleum source and reservoir rock in California that was deposited in several basins during the tectonically-active Middle Miocene. The middle member of the Monterey Formation contains intervals of phosphatic-shales that are rhythmically cemented by dolomite as layers and concretions. Diagenetic-minerals can form as the result of organic matter remineralization, facilitated by microbes utilizing oxygen, nitrate, iron (III), sulfate and fermentation products as electron acceptors. Precipitation of phosphate and carbonate minerals tends to occur in suboxic-anoxic sediments, generally experiencing sulfate reduction, where degradation of organic matter yields alkalinity, sulfide and phosphate ions.

Here, we present sulfur and carbon geochemical data to better characterize the conditions that led to the precipitation of phosphorous-rich minerals (e.g., carbonate-fluorapatite (CFA)) and dolomite that occur in close stratigraphic proximity. These data include concentration of CFA-associated sulfate, carbonate associated sulfate (CAS) and the respective $\delta^{34}S$ values. The concentration of inorganic/organic carbon and associated $\delta^{13}C$ values have been determined for CFA, dolomite and the host-shale, to further characterize the diagenetic environment of precipitation. These data indicate that authigenesis occurred in pore waters influenced by multiple microbial reactions, including respiration and methanogenesis reactions, and ultimately highlight the complexity of the Monterey diagenetic environment.

Carbonate Geochemistry of Marine Authigenic Carbonates and Host Sediments: Exploring Mineral Formation Pathways and Organic Preservation Potential in Modern Sediments

Student: Marissa Smirnoff

Faculty Advisor: Dr. Sean Loyd

Ancient authigenic dolomites (e.g., concretions) have been long studied in order to determine formation conditions and provide insight into shallow diagenetic environments. The formation of these dolomites is commonly attributed to the anaerobic microbial degradation of organic matter (a process that can increase the local pore water alkalinity), based on carbon isotope as well as other geochemical data. Authigenic dolomites also occur in modern, "still soft" sediments rich in organic matter, however a comprehensive carbon isotopic characterization of these precipitates has yet to be conducted. Ultimately, organic matter degradation produced carbonates can be distinguished from primary carbonates (i.e., marine-produced carbonate) by expression of non-seawater $\delta^{13}C$ values (~0‰ in the modern ocean). Data show a wide range of $\delta^{13}C$ values (about -11 to +12‰) that significantly differ from modern seawater. $\delta^{13}C_{inorg}$ values generally increase with depth consistent with exposure to deeper diagenetic zones. Positive values that typify dolomites of the Gulf of California and the southwestern African margin indicate mineral precipitation in the zone of methanogenesis. Dolomites of the Peru margin and Cariaco Basin yield negative values that may represent a variety of respiratory-type organic matter degradation mechanisms. Total insoluble organic carbon ($TOC_{insoluble}$) values range from ~0.5 wt% to ~9 wt%, total inorganic carbon (TIC) values range from ~1 wt% to ~12 wt%. Values for $TOC_{insoluble}$ generally decrease with depth, suggesting progressive degradation with burial. Unlike previous work on outcrop concretions, these dolomites do not express a significant correlation between TIC and $TOC_{insoluble}$. This suggests that authigenic carbonates (i.e., these dolomites and concretions) only protect organic matter during outcrop weathering.

From Sheets to Blobs: Implications of Multiple Kuna Crest Hornblende Populations for the Initial Construction of the Tuolumne Intrusive Complex, Sierra Nevada, CA

Student: Dustin Williams

Faculty Advisor: Dr. Vali Memeti

Understanding the emplacement and evolution of large and long-lived plutons in the middle crust is essential in comprehending igneous crustal growth, how arcs operate and are physically and compositionally connected to the source and volcano. One challenge is that the plutonic rock record seldom preserves the initial stages of pluton growth, which is often overprinted by subsequent magmatism. The initial stages of growth, however, may give us clues on the size and compositions of the first intruding magma batches and if or when they coalesce to form interconnected magma mush bodies.

Early stages of pluton growth are preserved in the 95-93 Kuna Crest margin located in the southeast lobe of the 95-85 Ma, 1,100 km^2, normal zoned Tuolumne Intrusive complex (TIC) in the central Sierra Nevada batholith. The Kuna Crest is composed of cm- to m-scale sheets at the margins to ≤ km-scale, irregular bodies toward the interior of the lobe. Compositions range from fine- to medium-grained granodiorite, medium- to coarse-grained tonalite, diorite, and gabbro with knife sharp to gradational contacts. Petrographic analysis revealed that color index ranges from 10% to 32%, and magmatic hornblendes vary in size from 1-4 mm, shape from euhedral to subhedral, and pleochroic color from blue-green to olive-green. These variabilities suggest various mineral populations with different growth histories present within single samples.

Previous Sr and Nd isotopes data from the compositionally diverse Kuna Crest sub-units show all magmas originated from a homogenous and rather primitive source. To determine the significance of the observed intra-unit mineralogical and geochemical variation observed in the field and through petrography, we conducted whole rock and mineral-scale geochemical analysis. Irrespective of the location, size, and shape of Kuna Crest hornblendes, they classify as magnesiohornblende unless they have undergone sub-solidus alteration to actinolite. These hornblendes display crystalizing temperatures ranging from 730-830 °C. Differing trace element trends indicate that varying hornblende populations grew in chemically diverse magmas or underwent various degrees of magmatic differentiation at the emplacement level. This study concludes that incremental pluton growth was initially sheet-like and heterogeneous, but subsequently magma pulses coalesced to form extended magma mush bodies.

Student Research Category

Paper Models to the Rescue: New Exercises for Visualizing and Mapping Geological Structures in 3D

Student: Joseph Gutierrez

Faculty Advisor: Dr. Sinan Akciz

Students are generally expected to develop knowledge about geological features and processes through visualizing 2D drawings and photos. This is not very intuitive to many at first because they were never given an opportunity or a reason to develop 3D visualization skills. There are a few geological 3D visualization models that many universities around the world use as educational resources. However, many of them do not expect students to do anything besides interpret what is already drawn on the faces of block diagrams. Computer apps are only semi-interactive: they teach students by showing how a particular structure or a contact relationship should look like; similar to providing a problem set and its key at the same time. The only other interactive block model exercise, the dry-erase cube, requires the use of custom made dry-erase cubes and offers limited constructive feedback opportunities to the students. For this project, we have created printable paper models and related questions that will enable students to practice visualizing and exploring multi-dimensional geological datasets. Our models are printed on an ordinary printer paper or card stock. The models can be cut out and folded over 2”x2” wood block if a more rigid, stable work surface is desired. The models and the accompanying questions are designed to help students in their ability to recognize basic structures on a map and in cross section, interpret geologic history and interpolate geologic maps from cross sections and vice versa. Students can also use the exercises to practice with inking contacts, coloring geologic units and creating legends. In addition to the four questions we present here as examples, new questions on different fold and fault types are currently being developed. Once complete, these block diagram models will be used in structural geology (GEOL 360) and field techniques (GEOL 380) classes at CSUF and will be shared with other faculty teaching similar classes at other universities. We are currently trying to find inexpensive and non-customized ways to incorporate topography into these models.

Analysis of vegetation diversity, density and cover on maturing alluvial fan substrates

Adrian Escobar, Maureen Kelley, Andrew Roxas

Faculty Advisors: Dr. Darren Sandquist CSUF and Dr. Jennifer Garrison CSULA

A comparative analysis of vegetation on maturing alluvial fan substrates was performed using cover, density and diversity characteristics of perennial shrubs. Development of desert varnish and pavement on lobes of the Springer and Zzyzx alluvial fans near the Desert Studies Center (Zzyzx, California) were used as indicators of relative substrate age. Based on previous studies we hypothesized that intermediate-aged lobes would possess higher plant cover and density than older and younger lobes because intermediate substrates are less active than younger channels and more permeable than significantly varnished older lobes. We also hypothesized that there would be greater plant diversity at the distal end of the fan, regardless of substrate age, due to higher water input and retention, and greater nutrient availability. Our results showed that plant density was highest on the intermediate-aged lobes (0.21 plants/m^2), plant cover was highest on youngest lobe (6.5%), and plant diversity was higher at distal portions of the fan (0.12 plants/m^2). While the results show a trend in support of our initial hypotheses, larger sample sizes are needed for greater confidence in these finding and to better understand alluvial fan vegetation development within the Mojave.

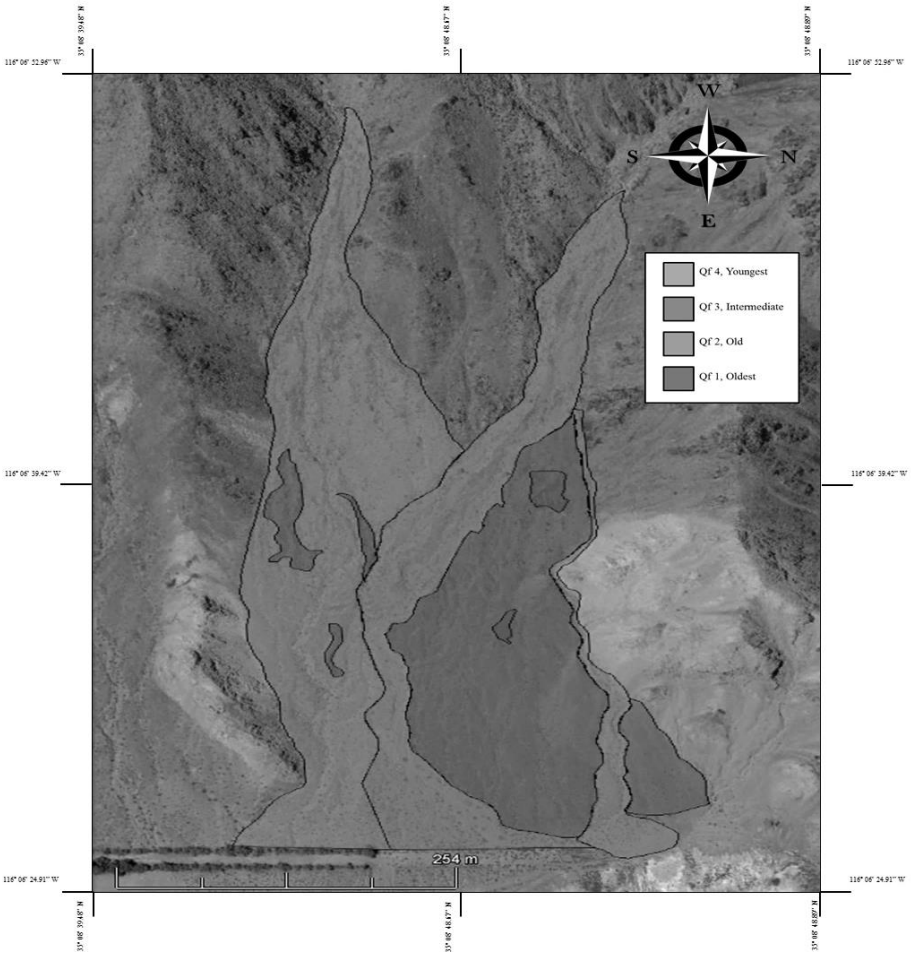

Figure 2, Zzyzx Spring Fan complex outside of Zzyzx California

Investigation of the Laguna Cell Beaches Using Lidar and Erosional Examination

Student: Taylor Kennedy

Faculty Advisor: Dr. W. Richard Laton

Beaches, in general, are made from river and cliff deposits. As the tides change day to day and season to season the waves will either erode or deposit sand. When storms move over the coast it will cause high amounts of erosion and deposition to the beach and surrounding areas. Higher amounts of erosion reduce cliffs and remove beach deposits. Strengths of geologic units can reduce erosion for a time and the floodwaters can bring more sediment to beaches. Other institutions such as dams and Gabion cages further reduce erosion and deposition. Cities will also import material from other areas to deposit on their beaches. With so many different sources coming and going the elevation of these areas can get complicated. Using topographic analysis of Light Detection and Ranging (LIDAR) we can shows the change in elevation over the years. The change in elevation will relate to the erosion, which in turn will relate to the rate of deposition of the beaches. This will make the system less complicated. In order to witness these changes in topography a visible medium is necessary. Using ESRI's geographic information system ARCmap and LIDAR data by Scripps Research Institute and the National Oceanic and Atmospheric Administration, a mapping system is created that show this change in elevation.

Subsurface Analysis of Orange County Water District's La Palma Groundwater Recharge Basin in Anaheim, California

Student: John Paul Masters

Faculty Advisor: Dr. W. Richard Laton

Orange County Water District's Groundwater Replenishment System (GWRS) is crucial in helping southern California become non-dependent upon outside water sources. The GWRS program utilizes several recharge basins to replenish the underlying aquifers. The newest basin constructed for this program is La Palma basin. To better understand the subsurface conditions of the La Palma recharge basin in Anaheim, California, an evaluation of collected data was used to create 3-Dimensional models. Boring and well logs taken within and around the site were used to create a well log data base which was used with RockWare Software to create the models. These models will be used to help Orange County Water District's hydrogeologists and recharge operators to gain a better understanding of the subsurface.

Building an Outdoor Garden for the College of Natural Sciences at CSUF

Student: Grant Kennis

Faculty Advisor: GEOL499L – Independent Research

Cal State Fullerton's landscape is changing to make it more water wise, which creates a unique opportunity to propose a geoscience rock garden that is designed to supplement our undergraduate classes, and be an outreach exhibit attracting members of the university community. The locality for this rock garden would be the 90x10m lot southwest of Dan Black Hall found on the south end of campus. The purpose of this independent study is to provide a schematic landscaping design of a rock garden to the College of Natural Sciences at CSUF that provides an outdoor learning experience for various geology courses including, Physical Geology, Earth History, Field Methods, Mineralogy, Structural Geology, and Sedimentology. I designed my project to display boulders that have formed in settings that are similar to the main geologic regions that form continental North America and its surrounding oceans. These regions from West to East are: Hawaiian Islands, Pacific Ocean, California Coast, the Sierra Nevada, Basin and Range province, the Rocky Mountains, the Mississippi Valley, North American craton, Appalachia, and the Atlantic Ocean. Each section of the rock garden would allow students to recognize different rock types in a setting outside the classroom, make their own interpretations on the various tectonic environments based on the rock samples serving as diplomats for the various geographic localities. This garden provides a unique opportunity to travel across North America without physically leaving California State University, Fullerton.

First Record of Equus Occidentalis from Orange County, California, With Implications for the Late Pleistocene Distribution of Equus in the American Southwest

Students: Maree Kutcher and Eric Scott

Faculty Advisor: Cooper Center

Horses (genus Equus) are common in Pleistocene faunas throughout North America. Despite this abundance, the number of species occurring remains unresolved. Molecular data from fossils has been employed to suggest no more than two species, one stout-limbed and the other stilt-legged, while morphology-based paleontological investigations propose multiple species.

In the late Pleistocene, two morphospecies of large stout-limbed horses have been documented from the American southwest: Equus occidentalis from California, west of the Sierra Nevadas and south-southwest of the Transverse Ranges, and Equus scotti from the central Mojave Desert. These species are readily distinguished dentally; E. scotti possesses lower incisor infundibula, while E. occidentalis lacks them. The presence of two large, stout-limbed equine morphs in the southwest, with no evident geographic overlap, suggests (in combination with fossils of small horses) that multiple horse species inhabited the region during the late Pleistocene. However, fully diagnostic remains of E. occidentalis and/or E. scotti are known from only five localities in the region. Assessing whether the hypothesized distribution of these two large horse morphs is real, or instead is an artifact of the dearth of diagnostic material, therefore requires additional fossils.

To test this hypothesis, we examined a previously undescribed late Pleistocene horse from San Juan Capistrano, Orange County, California. Remains include a skull, mandible, articulated right hind leg, and other postcrania recovered from nonmarine terrace deposits that also yielded remains of Bison, an index taxon for the late Pleistocene. Metric data confirm that this is a large species of horse; the metapodials are stout rather than slender, while the lower incisors lack infundibula. These characters demonstrate clear affinity with Equus occidentalis. Based upon size and morphology, this is the first confirmed record of E. occidentalis from Orange County.
The presence of Equus occidentalis in this region accords well with the hypothesized distribution of late Pleistocene large stout-limbed Equus in the American southwest. Our results indicate that multiple horse species inhabited North America during the late Pleistocene.

Department of Geological Sciences
2017 Alumni of the Year
James A. Harrell, Ph.D.

About Jim

Professor James Harrell is a member of the first class to graduate from the CSUF Department of Geological Sciences in 1971. HE was one of four in that first graduating class. Dr. Harrell graduated cum laude with a BA in Earth Science (the only degree awarded at that time) with a minor in archeology. He also completed two years of study abroad at the University of Uppsala in Sweden as part of his BA degree. Dr. Harrell went on to earn a M.S. in geology at the University of Oklahoma (1976) and a Ph.D. in geology at the University of Cincinnati in 1983. Professor Harrell has been a faculty member at the University of Toledo since 1979 and in 2009, after 30 years of teaching at Toledo, retired as a Professor Emeritus.

Dr. Harrell's research focus is on the geoarchelogy of Egypt where he is a leader in that field. He has published 96 scholarly papers in archeological geology and 24 articles in sedimentology, geostatistics, and paleoclimate. He has taught a variety of classes at University of Toledo, authored a lab manual, and supervised 17 M.S. theses along with being honored for outstanding faculty research in 1995, and the Distinguished Doermann Lectureship in 1999. He was the 2002 AAPG National Distinguished lecturer.

Dr. Harrell has had a long and distinguished career that began at CSUF at the same time as the Department. He is recognized as a prolific and outstanding educator both at his institution, within his profession, and by professional organizations and an excellent representative of the CSUF Department of Geological Sciences.

GEOLOGY STUDENT AWARDS/SCHOLARSHIPS April 2017

AWARDS

Outstanding Graduate Student Award in Geology — ***Dustin Williams***
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 — ***Kalie Duccini***
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 framed award certificate

Outstanding Major Award – B.S. in Geology — ***Eduardo Chavez***
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 — ***Jolene Ditmar & Olivia Hinton***
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 — ***Conner Fredrickson***
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 — ***Stephanie Swanson & 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

Candice L. Jones Outstanding Service Award — ***Terrinda Alonzo***
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 — ***Christine Pham & Michelle Manzano***
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 — ***Joseph Gutierrez***
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

John D. Cooper Field Camp Award — ***Amanda Shellhorn***
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

Marilyn A. Brown Award — ***Angela Aranda***
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

SCHOLARSHIPS

David L. Willoughby Scholarship — ***Shayna Avila***
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: $400 each

Dr. Margaret Skillman Woyski Scholarship — ***Adrian Escobar***
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: $300

Department of Geological Sciences Alumni Field Camp Scholarship — ***Veronica Smith***
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)

Thanks to All of Our Geology Students, Faculty and Staff for another successful year within the Geology Family!

A Special thanks to the South Coast Geological Society for the support and Dr. W. Richard Laton for all his hard work in making Research Day possible!

Thank You

GEOLOGICAL SCIENCES
CSUFULLERTON

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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