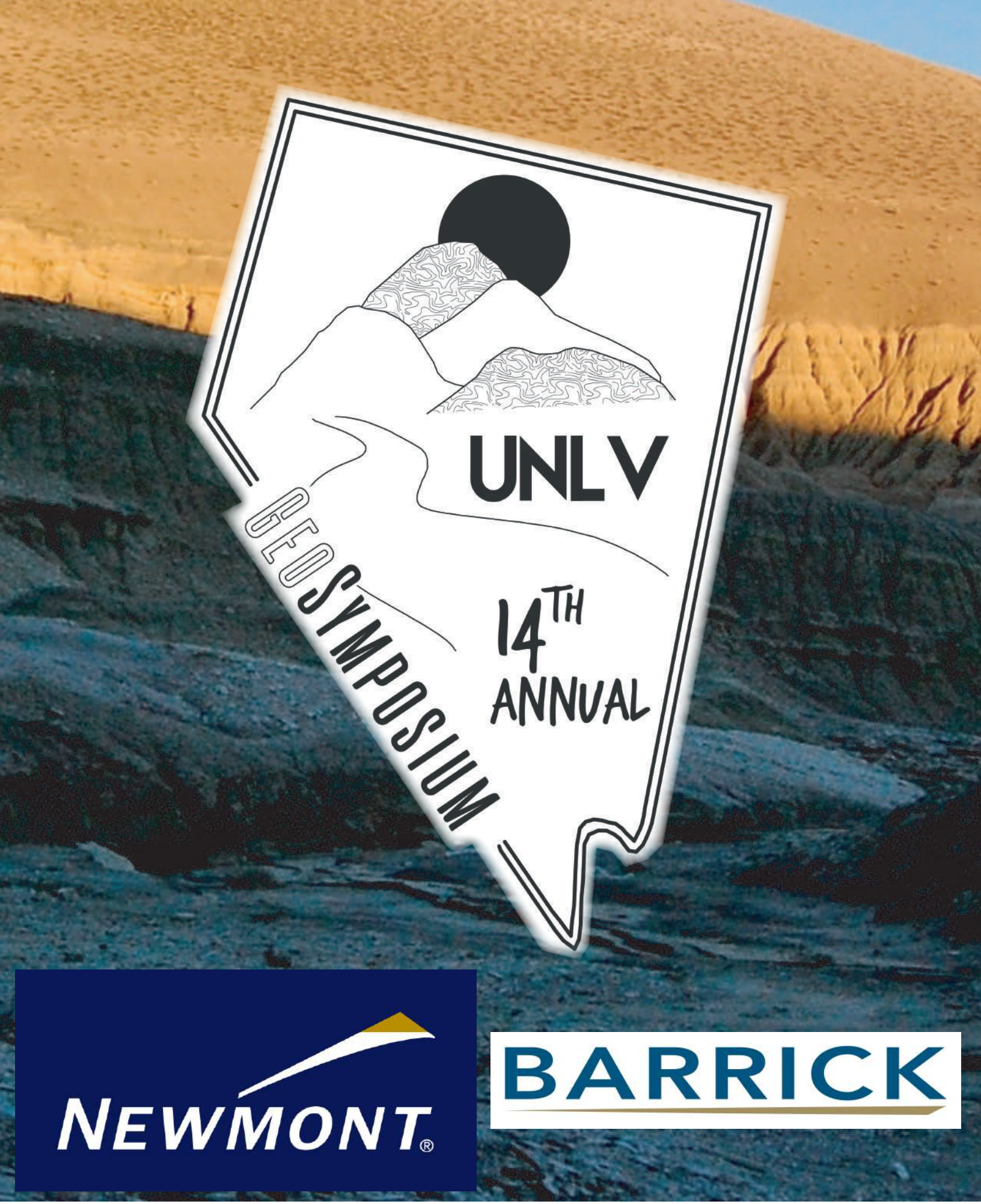

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The 14th annual GeoSymposium organizing committee would like to thank our sponsors, without whom this event would not be possible. GeoSymposium provides the opportunity for the next generation of geoscientists to practice their presentation skills in a friendly, yet professional environment. Our sponsors Barrick, Newmont, Jacobs, Kinross, Southern Nevada Water Authority, Nova Geotechnical & Inspection Services, and Nevada Water Resources Association as well as our numerous individual donors have made this event what it is today. This year's field trip will be present by the UNLV Society of Economic Geologists group and will consist of a tour of the open pit mine at the Mountain Pass carbonatite, led by the current operator, MP Minerals. We thank them for the time and effort to make the field trip a success.

The UNLV Geoscience Department would like to thank our keynote speaker Colby Pellegrino for providing inspiration for our student presenters and entertainment for all. While GeoSymposium is run by students, for students, our keynote speakers imbue success in geoscience careers—something we can all strive for. Likewise, the judges for this event have volunteered significant time and effort to push our student presenters to produce their best work by providing insightful reviews. On behalf of all geoscience students at UNLV, I would like to thank the Geoscience faculty advisors for guiding us through these early stages of our careers.

We would also like to thank those non-student volunteers for their invaluable time in making GeoSymposium a success. These people include the judges, SEB staff, and the UNLV Foundation staff. Particularly helpful to me were the Geoscience office staff—Maria Rojas and Elizabeth Smith, who were consistent sources of help, Alaina Cowley of the UNLV Foundation for answering my constant emails and for providing much needed advice, as well as the previous GeoSymposium coordinators Lauren Parry and Chris Defelice for providing structure where there was none.

Lastly, I would like to give a huge thanks to my organizing committee who were always eager and happy to help. GeoSymposium can be attributed to their ideas and hard work. GeoSymposium would not be possible without this volunteer army. If you see them today (names on the next page) let them know their work hasn't gone unnoticed and thank them!

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GeoSymposium Coordinator

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GeoSymposium Faculty Advisor
Matthew Lachniet

Abstracts and Programs
Chris DeFelice
Suzanne Mulligan
Kelsy Konkright
Lauren Parry

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Anabel Castro
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Judging
Chair: Natalie Renkes
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Debby Morales

Photography
Chair: Ngoc Luu
Paloma Marcos

Graphics
Chair: Lauren Parry

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Session I

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Graduate Poster Presentations (*by discipline*)

Session I

Schedule of Events

Friday, April 20

8:45 am - Opening Remarks
9:00 am - Morning Keynote address (Colby Pellegrino)
9:35 am - Oral Presentation Session I
- 9:35 am - Drew Barkoff
- 9:50 am - Emily Beard
- 10:05 am - Ngoc Luu
- 10:20 am - Chris DeFelice

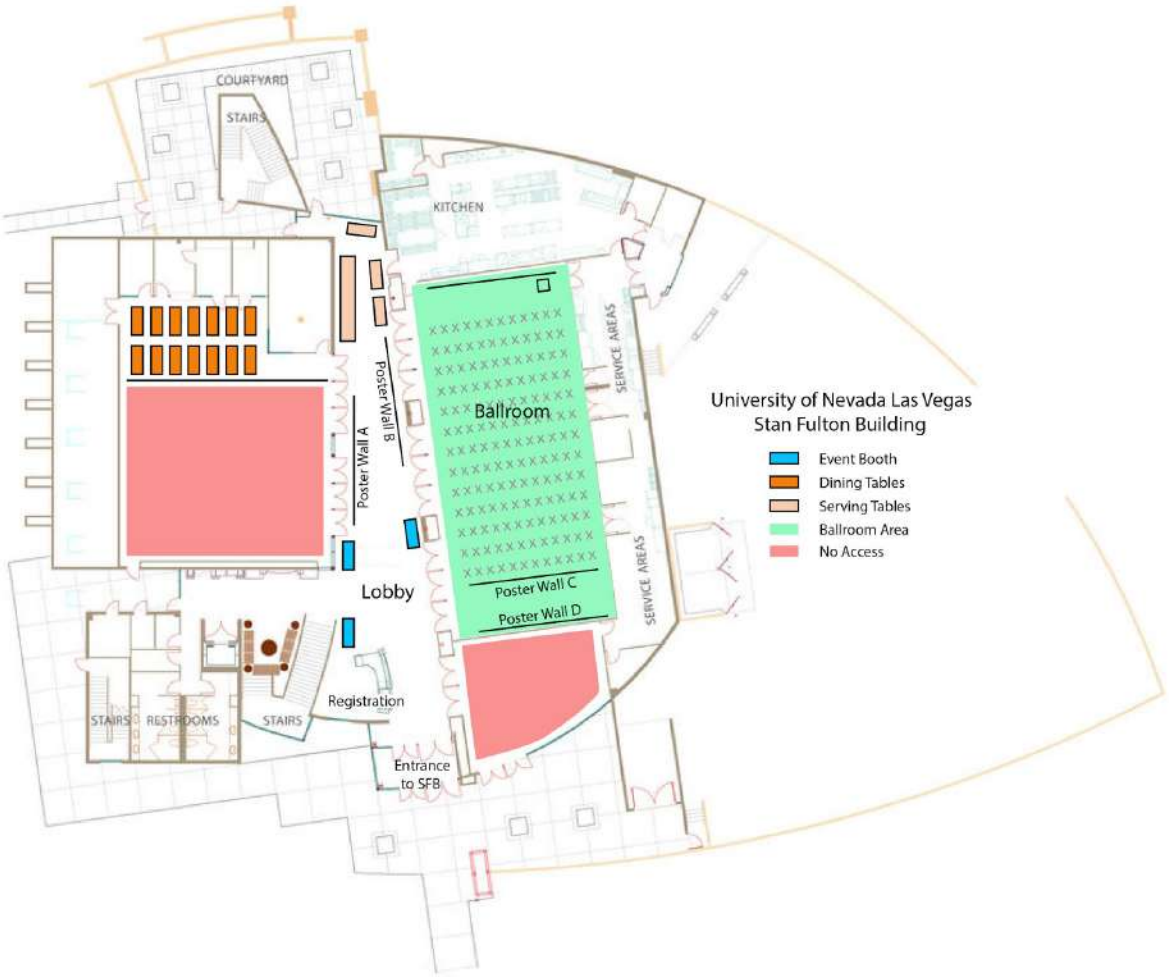
10:35 am - Poster Session I
12:30 pm - Lunch
1:30 pm - Oral Presentation Session II
- 1:30 pm - Lauren Parry
- 1:45 pm - Rebecca Humphrey
- 2:00 pm - Eli Turner
- 2:15 pm - Suzanne Mulligan

2:30 pm - Poster Session II
4:30 pm - Awards Ceremony
5:00 pm - Evening Reception & Silent Auction
6:00 pm - Silent Auction Closes
7:30 pm - Event Ends

Opening remarks, keynote addresses, oral presentation session, and the awards ceremony will be held in ballroom of the Stan Fulton Building.

Coffee and pastries, poster sessions, lunch, silent auction and the evening reception will be in the lobby of the Stan Fulton Building.

MAP



Keynote Speaker

Colby Pellegrino

Colorado River Program Manager SNWA

Colby will be discussing the status of hydrologic conditions in the Colorado River Basin and what steps have been taken to protect the community against drought impacts, including the Drought Contingency Plan developed by the Colorado River Basin States.

Poster Session I (By Group)

Undergraduate Posters

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Lee, Nicole	GIS	103
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Newsom, Alex	GIS	105
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795 Posters Class

Author	Discipline	Poster Number
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Grove, Sarah	Paleontology	110
Reid, Andrew	Structural Geology	111
Turner, Eli	Structural Geology	112
Mifflin, James	Hydrology	113
Paulson, Gregg	Hydrology	114

Graduate Posters

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Kidman, Genevieve	Mineral Physics/Rock Deformation	116
Renkes, Natalie	Geology and Health	117
Shikrallah, Elizabeth	Archaeology/GIS	118
Traylor, Taryn	Experimental Rock Deformation	119
Zeidman, Ahdee	Water Treatment/GIS	120

Poster Session II (By Group)

Undergraduate Posters

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Clark, Drew	Paleontology	122
El Srouji, Esmeralda	Paleontology	123
Gelbart, Emily	GIS	124
Panduro-Allanson, Donovan	GIS	125
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795 Posters Class

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Graduate Posters

Author	Discipline	Poster Number
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McCaffrey, Dalton	Economic Geology	137
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UNDERSTANDING THE BEHAVIOR OF CRITICAL METALS IN HIGHLY EVOLVED MAGMATIC AND ASSOCIATED HYDROTHERMAL SYSTEMS; CASE STUDY OF THE BLAWN FORMATION, WAH WAH MOUNTAINS, UTAH

Drew W. Barkoff[1], and Simon M. Jowitt[1]
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Highly evolved topaz-bearing rhyolites represent prospective bulk-tonnage sources of critical elements such as the rare earth elements, Be, Li, and U. However, the igneous processes that generated these rhyolites and control the deportment and concentrations of these elements in these systems remain unclear. The Blawn Formation rhyolites of the Wah Wah Mountains of SW Utah form a series of domes and ash beds that are part of a larger suite of Cenozoic high-silica, topaz-bearing rhyolites within the western US. These rhyolites are typically A-type, related to extensional tectonic processes, and are characteristically enriched in F and other incompatible elements.

The Blawn Formation is divided into several separate flow units that intruded into Paleozoic to Oligocene sedimentary and volcanic units and was erupted from several vents at ~22-18 Ma. Both eruptive and intrusive units were thought to be sourced from the same parental magmatic system and thus have been mapped as a single unit. This study focuses on two of the Blawn Formation rhyolites, namely the Red Beryl (RBR) and the Tetons (TR) rhyolites. Although these two deposits are thought to be cogenetic, they have significant petrographic and geochemical differences in addition to the RBR having undergone a much higher degree of post-emplacement hydrothermal alteration. This presentation will focus on testing whether these deposits are indeed cogenetic or if they have differing petrogenetic histories and sources and will examine the effects of igneous and hydrothermal processes on the critical (and other) element concentrations within these different units. These new data will provide insights into the igneous and hydrothermal controls on the mobility of critical elements within highly evolved rhyolitic systems.

A COMPREHENSIVE AND CRITICAL ASSESSMENT OF GLOBAL GOLD RESERVES, RESOURCES, AND SUSTAINABILITY

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Gold is a resource that is desirable for its beauty and is necessary as a component in technologies ranging from communications satellites to dental fillings. The increase in the number of known uses of gold and its value as a tradeable commodity has led to a coincident increase in global gold demand and production by mining as well as recycling. However, the fact that mining is inherently unsustainable and primary gold resources are finite, suggests that this continued increase in gold production from primary sources cannot continue indefinitely. As such, understanding the world's available gold resources, both those currently being exploited and those that have potential for future exploitation, is a crucial step to understanding how much of this resource is available for human use and for determining best practices for economically and environmentally sustainable mining.

This study examines current gold resources and reserves, the nature of the mineral deposits that host them, and considers the future of global gold production using a database of >2,000 gold projects with associated resource and reserve data. 190,000 tAu are contained in global resources with an average grade of 0.40 g/t Au, these include total global ore reserves of >53,000 tAu. Preliminary analysis of these data indicate that global gold resources are dominated by gold-only deposits (>74,000 tAu out of a total of 190,000 tAu split among 1,400 gold only deposits). However, a significant proportion of these gold-only deposits are small, containing less Au than the average Cu-Au deposit within our database. Of the gold-only deposits, only some 20% of these resources are currently being exploited, with these mines containing only about 30% of the total global resource from gold-only deposits. Future work will focus on whether or not the remaining smaller and lower grade deposits will play a role in the future of mining.

ASSESSMENT OF THE SALT LOAD AT WALKER LAKE, NV

Ngoc C. Luu[1], Elisabeth M. Hausrath[1], Kip K. Allander[2], and Michael R. Rosen[2]

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A terminal lake that has undergone natural desiccation events in its geological past, Walker Lake is now subject to anthropogenic desiccation as agricultural diversions along the Walker River tributary have steadily reduced the water levels since the 1980s. This decline in Walker Lake's main water input has led to an increase in total dissolved solids (TDS) in the lake water, impacting the local ecosystem and reducing the survival rate of various key indicator species. To combat the detrimental effects of increasing TDS loads, Congress in 2009 enacted the Walker Basin Restoration Program (WBRP) in an effort to restore Walker Lake and protect it as a natural resource. Research efforts by private and governmental agencies, such as the United States Geological Survey (USGS), have worked on models that take into account the various water contributions to Walker Lake in order to estimate the required amount of water that needs to be secured in order to reduce TDS to WBRP goals. Visual observations by the USGS have noted evaporites forming along the shoreline, but no effort has yet been made to identify the types of salts that may have been deposited along the shoreline, or the potential impacts on lake water chemistry should these salts be redissolved in the lake. Preliminary X-ray diffraction analysis of lake sediments indicate the presence of phyllosilicates (e.g. muscovite and illite), halite, and monohydrocalcite. Our inverse evaporative PhreeqC models will use this information, along with lake water chemistry data, to interpret geochemical changes in Walker Lake with changes in water level.

AN ANCIENT, HIDDEN RESERVOIR IN THE HAWAIIAN MANTLE PLUME

Chris DeFelice[1], Soumen Mallick[2], Alberto Saal[2], Shichun Huang[1]
1-University of Nevada, Las Vegas
2-Brown University, Providence, RI
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The Hawaiian Islands are a volcanic ocean island chain that is thought to be the product of upwelling lower mantle material called a plume. Mantle plumes typically have enriched radiogenic isotope ratio values that have developed over Earth's history. A more isotopically depleted component has been observed in the Hawaiian plume and its origins are unclear. Two models have been proposed: entrained upper mantle material, or an intrinsic component to the plume. This depleted component is observed primarily in rejuvenated stage volcanism, 0.5-2 Ma after the end of active shield stage eruptions, and in submarine lavas that occur ~200 km both north and south of the islands. We investigate the radiogenic isotope ratios (Pb, Sr, Nd, Hf) and trace element compositions of 23 shield stage tholeiites with elevated CaO content at a given MgO content, called the 'high-CaO basalts'. We find that high-CaO basalts have the same radiogenic isotope compositions and similar trace element patterns as rejuvenated stage and flexural arch volcanism. Using trace element modeling, we show that high-CaO basalts trace element patterns can be reproduced by partially melting a rejuvenated stage source composition to a higher degree. We propose that the high-CaO basalts sample the same depleted source as rejuvenated stage lavas, but during the shield stage and must be intrinsic to the plume. This depleted component is present in the plume as 'plums' that provide heat to melt the enriched components with a lower solidus during shield stage volcanism. During arch and rejuvenated stage volcanism, the enriched component is absent, allowing the depleted component to melt. In the case of high-CaO basalts, they sampled the plume that had no enriched component present and was able to melt the depleted component to a higher degree due to higher temperatures at the center of the plume.

PALEOENVIRONMENTAL CHANGES ACROSS THE LATE CAMBRIAN STEPTOEAN POSITIVE CARBON ISOTOPE EXCURSION IN THE GREAT BASIN AREA

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The late Cambrian period (501–488 Ma) witnessed one of the most prominent Phanerozoic carbon isotope (δ13C) excursions known as the SPICE (Steptoean positive carbon isotope excursion). The SPICE has a magnitude of ≥+5‰ and has been interpreted as resulting from enhanced organic carbon burial. Because each mole of organic carbon burial would consume one mole of CO2 and leave one mole of O2 in the atmosphere and ocean (CO2 + H2O = CH2O↓ + O2↑), many researchers have speculated that the increase of oxygen resulting from the SPICE event may have been the major cause of the Great Ordovician Biodiversification Event (GOBE), during which marine biodiversity increased at all taxonomic levels. However, the detailed causal relationships between perturbations of the global carbon cycle, ocean redox change, and biotic innovations remain ambiguous and require spatially and temporally continuous record to evaluate.

The well-exposed late Cambrian strata in the southern Great Basin provides a great opportunity to evaluate the paleoenvironmental changes and their potential relationship with the biotic innovations surrounding the SPICE. The purpose of this research is to (1) establish a comprehensive stratigraphic framework for the carbonate-rich late Cambrian-early Ordovician strata from shallow platform to slope facies, using sequence and carbon isotope chemostratigraphy; (2) within the established stratigraphic framework, study the marine redox change across the SPICE in best preserved and most representative sections; and (3) evaluate the relationship between the carbon isotope excursion and ocean redox change. Preliminary rare earth element (REE) analyses across the SPICE in three sections show significant oceanic anoxia during the late Cambrian. In the shallow-marine sections including the House Range section in western Utah and the Shingle Pass section in Nevada, cerium (Ce) anomaly (Ce/Ce*) shows small changes before the positive δ13C shift (0.9–1). Ce/Ce* values increase to 1.0–1.1 at the peak of the δ13C excursion and return back to 0.9–1.0 at the falling limb of the δ13C excursion. In the slope section (Tybo Canyon, Nevada), Ce/Ce* values remain high (~1.0) through the majority of the section and slightly decrease after the δ13C peak. The overall high Ce/Ce* values and insignificant temporal change suggest low oxygen contents and/or stratified water column conditions in the late Cambrian ocean.

GE PROFILE OF TERMINAL PLEISTOCENE COLUMBIAN MAMMOTHS (*MAMMUTHUS COLUMBI*) FROM THE TULE SPRINGS FOSSIL BEDS OF NEVADA

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Late Pleistocene fossil assemblages are critical to evaluating the temporal and spatial paleoecological patterns preceding the end-Pleistocene megafaunal extinction in North America. The Gilcrease Cauldron Spring Paleontological Site (GCSPS) is located in Southern Nevada, approximately four kilometers west of Tule Springs Fossil Beds National Monument (TUSK). For this study, 58 Columbian mammoth (*Mammuthus columbi*) molariform teeth were selected from the GCSPS to determine the age of the animal at death in African elephant equivalent years for the purpose of constructing an age profile. Age profiles can be used to measure population health and selective versus non-selective mortality.

Determining the age at death from fossil mammoth teeth is possible due to the unique pattern of dental eruption and wear in living and extinct proboscideans. A set of standard tooth measurement and identification standards for this analysis was compiled after extensive literature review. Re-calibrated radiocarbon dates of a subset of these teeth range from 14,336-20,567 Years BP, around the onset of deglaciation.

A hypothesis by Ripple and Van Valkenburgh (2010) proposes that top-down trophic control of Pleistocene megaherbivore populations was a precursor to extinction that may have been secondarily enabled by predation pressure from Clovis hunters. Data generated from this study support this hypothesis. Our results suggest that mammoth population sizes in the Las Vegas Valley during the Terminal Pleistocene were controlled from the top of the food pyramid down and were likely below carrying capacity. This trophic relationship may have made them vulnerable to extinction by an external catalyst, such as the introduction of Clovis hunters at the end of the Pleistocene, although climate change cannot be ruled out completely as a possible contributing factor. Results from this study and others are consistent with top-down trophic controls on proboscideans surrounding the Last Glacial Maximum that may have made them susceptible to extinction at the end of the Pleistocene.

TAXONOMY OF AN ORNITHOPOD DINOSAUR FROM THE WILLOW TANK FORMATION OF SOUTHEASTERN NEVADA

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In 2008, the partial skeleton of an unidentified ornithopod dinosaur was discovered from Valley of Fire State Park in southeastern Nevada. Ornithopods are a group of bipedal herbivorous dinosaurs that includes the iguanodons and hadrosaurs (duck-billed dinosaurs). They were abundant in western North America throughout the Cretaceous, and they rapidly diversified during the mid-Late Cretaceous. Extensive dinosaur assemblages, including many ornithopods, of mid-Late Cretaceous time have been discovered in Montana, Wyoming, and Utah. However, Nevada's dinosaur fossil record is more meager due to the lack of Cretaceous exposures. The Willow Tank Formation, where the specimen under study was found and continues to be collected, was radiometrically dated in previous studies between 98.68 to 98.56 Ma (Pape, 2011), early Late Cretaceous, temporally placing this dinosaur during the rise of hadrosaurs from their basal iguanodon ancestors. The objective of this study is to identify this ornithopod to species level and to evaluate its significance to ornithopod phylogeny. Techniques will include bone morphology, morphometric analysis, comparative anatomy, along with comparing this animal with those from regionally correlative formations. Researching their biogeographic histories and the paleoecology of the Willow Tank Formation will also be part of this study. Successful identification will help better understand the evolution, systematics, and distributions of ornithopod dinosaurs.

REGIONAL CORRELATIONS AND TIMING OF EXHUMATION ALONG THE PANAMINT THRUST FAULT, DEATH VALLEY, CA

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The correct correlation of the Panamint thrust (Pth) near Death Valley, CA, is a topic of debate between different investigators. The Pth is located within the Sevier-fold thrust belt, which was once continuous along strike, but has been partitioned into offset fragments by overprinting Cenozoic deformation. Correlating Sevier thrust faults between these fragments is an effective way to determine the cumulative slip along younger Cenozoic structures. Conflicting correlations of the Pth have resulted in variable estimates of Cenozoic offset, inhibiting the precision with which the magnitude and kinematics of regional Cenozoic deformation can be established.

I will determine the correct correlation of the Pth by comparing its timing of slip, peak metamorphic temperatures, and structural geometry to those of four potentially equivalent thrusts: (1) the Wheeler Pass thrust, (2) the Schwaub Peak thrust, (3) the Lemoigne thrust, and (4) an unnamed Mesozoic thrust reactivated by the Miocene Boundary Canyon detachment fault. To constrain the timing of slip on the Pth, I will obtain zircon (U-Th)/He thermochronology data from samples collected in a structural transect through the hanging wall. Peak metamorphic temperatures associated with Pth deformation will be determined via Raman spectroscopy of carbonaceous material of footwall and hanging wall samples. The geometries of fault-related folds, including a hanging wall anticline and recumbent footwall syncline outcropping in Tucki wash, have been determined by the collection of structural measurements. This new dataset for the Pth will be compared to similar datasets for each potential correlative structure as compiled from existing literature. Whereas previous Pth correlations have been inconclusive and exclusively supported by similarities in stratigraphy and structural geometry, this approach will provide a diagnostic fingerprint with which the Pth can be confidently correlated to coeval Sevier thrusts.

COMPARING RAMAN QUARTZ-IN-GARNET BAROMETRY WITH THERMODYNAMIC MODELING ACROSS A BARROVIAN METAMORPHIC TERRANE: THE FUNERAL MOUNTAINS METAMORPHIC CORE COMPLEX

Suzanne R. Mulligan[1], Suzanne Craddock-Affinati[2], Michael L. Wells[1], Thomas D. Hoisch[2], Christian Childs[1], Samuel Wright[2], Ashkan Salamat[1]
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As part of ongoing research to refine the application of Raman quartz-in-garnet barometry (QuiG) in metamorphic petrology, we compared pressures of metamorphism obtained using QuiG barometry and thermodynamic G-minimization modeling of mineral chemistries in rocks from the Funeral Mountains metamorphic core complex. Here, Barrovian rocks are exposed in the footwall of a Miocene detachment fault. Samples were collected from four locations across the continuous metamorphic field gradient. The lowest grade (upper greenschist facies) samples, from Indian Pass(IP), experienced garnet growth from 520-530°C. QuiG barometry yielded a quartz entrapment pressure of ~8.3kb, ~3 kb greater than the pressures of 4.5-5.2 kb obtained with P-T modeling. At Pyramid Peak(PP) (lower amphibolite facies), garnet grew from 543-553°C, with a QuiG pressure of ~8.8 kb, 3.2kb greater than the 5.0-5.6kb pressures obtained using G minimization modeling. At Chloride Cliff(CC) (middle amphibolite facies), garnet grew from 565-588°C, with a QuiG pressure of ~9.2 kb, 3 kb greater than the 5.0-6.2kb pressures obtained using G minimization modeling. In Monarch Canyon(MC) (upper amphibolite facies), the deepest structural level, QuiG barometry yielded a pressure of 10.6kb for a temperature of 670°C and 11.7kb for a temperature of 730°C, the range of possible temperatures here. Although the pressures obtained with QuiG barometry increase from 8.3 to 8.8, 9.2, and 11.7kb, with errors of ±0.25kb, consistent with the increasing grade across localities, the maximum wavenumber shifts of the Raman spectra are 1.351±0.12, 1.537±0.13, 1.538±0.12, and 1.176±0.12cm^{-1} from IP, PP, CC, and MC respectively, suggesting a temperature dependence on the pressures obtained using QuiG barometry in Barrovian settings, and reinforcing the need for accurate temperature estimates, especially in settings with intermediate and higher T/P ratios. Across this range, the pressures obtained using QuiG barometry exceed those obtained using thermodynamically based modeling by >3kb. We are investigating the reasons for this pressure disparity.

CHARLESTON BLUE BUTTERFLIES; HABITAT AND THREATS

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The endangered Mount Charleston Blue Butterfly (Aricia Shasta Charlestonensis), known to be endemic to the Spring Mountains in Southern Nevada, is at risk of further population decline and possible extinction. Natural fire regime cycles appear to clear overgrowth, allowing both their larval host plants and nectar sources to bloom easier. However, human development in the area has required attention for fire suppression; suffocating the plants. With the assistance of the vegetative and burn indexes from the Landsat program and spatial auto-correlation, our goal is to determine the most suitable location that fits the Charleston Blue's naturally occurring habitat without interference from human development.

LOIHI SEAMOUNT: THE ROSETTA STONE OF THE HAWAIIAN PLUME

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The Hawaiian-Emperor Chain is located within the Pacific Ocean and hypothesized to be a product of mantle plume activity. The Hawaiian volcanoes produced by the mantle plume have growth cycles that can be explained in 4 stages: pre-shield, shield, post-shield, and rejuvenated. Differences in geochemical signatures, temperature variations, changes in magma supply rates, degrees of partial melting and crystallization distinguish each volcanic stage. The pre-shield and post-shield stages of volcanism, dominated by alkalic lavas, experience lower degrees of partial melting while the active shield stage, dominated by tholeiitic lavas, showcases higher degrees of partial melting due to its proximity to the mantle plume's focus. Loihi Seamount is the youngest active volcano in the Hawaiian-Emperor Chain and located approximately 35 km from the Big Island of Hawai'i. Loihi is currently the only erupting volcano in its pre-shield stage. Pre-shield stage volcanism is under examined due to the volcanoes present on Earth, such as Mauna Kea and Kilauea, having surpassed this initial stage of volcanic growth. Due to its young age, submarine nature, and not being easily accessible, Loihi, as a whole, is under-studied as well. To further understand the geochemical components and the development and growth of this emergent volcano, we have analyzed 53 Loihi lava samples for their major and trace element compositions to better comprehend hot spot volcanism and its implications to the mantle plume hypothesis.

FOSSIL FUELED POWER PLANTS AND THE EFFECTS ON THE ENVIRONMENT AND HUMAN HEALTH

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Acid rain causes ecological, health, and structural damages. Scientists have discovered that the pollutants created by fossil fuel burning power plants, namely sulfur dioxide and nitrogen oxides, along with mercury and particulate matter, are a major cause of acid rain and pollution. Focusing on the states in the Great Lakes region, we are looking at datasets on the total mercury content in the Great Lakes, along with acidic rain and soil fertility in the region. We are examining these datasets and their relationship to coal burning power plants. While the aforementioned pollutants also enter the atmosphere from other sources, such as automobiles, this research suggests that there is a strong correlation between fossil fueled power plants and acid rain and contamination. The continued use of these power plants poses a great threat to environmental and human health.

KANE SPRINGS WASH, NV QUATERNARY FAULTS

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The Southern Nevada Seismic Belt traverses south-central Nevada, separates the northern and Central Basin and Range sub-provinces, and contains strike-slip earthquake focal mechanisms. The Quaternary Kane Springs Wash fault within this zone presents a potential earthquake hazard to the Las Vegas Valley. The Kane Springs Wash fault is ~120km N of Las Vegas, Nevada. The objective of this research is to analyze fault scarps in Quaternary alluvial fans and determine location of faults, fault interactions, number of deformation events, and past earthquake magnitudes. Methods for collecting data include using published data from the Geologic Map of the Delamar 3 SE Quadrangle, Lincoln County, Nevada, geologic mapping of the area at 1:12,000 scale, and use of the TopCon Total Station to collect fault scarp profiles. The new map data reveal a NE-striking left-lateral strike-slip fault with a left-step, releasing bend that forms a partial negative flower structure. Individual fault scarp heights average ~3m. Scarp heights that are interpreted to record multiple events of up to 4 faulting events on the larger scarps range from 6m to 31m high. Scarp height variations along strike show a minima near the releasing bend, which suggests that two fault segments linked near there. Total surface rupture length of these faults is ~8km. Calculations of earthquake magnitude based on published empirical relations with scarp height and surface rupture length suggest past earthquakes were M 6-8. Earthquakes of this magnitude have the potential to pose an earthquake hazard in the Las Vegas Valley. The location of the Kane Springs Wash fault and this documentation of the scarps along it suggest that it forms the southern boundary of the Southern Nevada Seismic Belt, and may serve as an accommodation zone for different rates and loci of extension in the Northern and Southern Basin and Range.

POST-FIRE SLOPE STABILITY AND HARRIS PEAK TRAIL

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The 2013 Carpenter One Fire burned 28,000 acres of forest in the Spring Mountains affecting Harris and Griffith Peaks, south of Charleston Peak. Soil degradation and loss of vegetation has decreased stability in some areas, increasing washout frequency and causing the closure of recreation areas.

The fire destroyed the historic Harris Peak Trail (HPT), built by the Civilian Conservation Corps, connecting Harris Springs Road to Griffith Peak and the popular South Loop Trail route to the summit of Charleston Peak. An effort is underway to rebuild and reopen HPT to the public.

This study analyzes slope conditions along HPT using ArcGIS, primary and secondary datasets from non-profit and governmental sources, and remote sensing data to determine areas of concern and locations where the original route should be modified.

HIGH-PRESSURE MINERAL PHASES OF OLIVINE (Mg_2SiO_4) FORMED BY PRE-COMPRESSION FOLLOWED BY LASER-DRIVEN HYPERVELOCITY SHOCK IMPACT VS. DYNAMIC SHOCK IMPACT WITH SINGLE STAGE SHOCK GUN.

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The high pressure polymorphs of olivine provide important constraints on shock pressure (P) [5], temperature (T), and shock duration [1,6,7] for impacts in chondrite parent bodies and Mars. Duration of shock may be constrained through growth of a high-pressure polymorph where the actual kinetic boundaries may deviate from the phase boundaries. Since impact conditions are dynamic, the kinetics of transformation and growth is key. Previous studies on synthesizing the high-pressure polymorphs ringwoodite and wadsleyite (γ- and β-Mg_2SiO_4, rsp.) in shock-experiments have either been from dynamically generated melts [1] or have failed [4]. Here, we examine the possibility of solid-solid transformation of San Carlos olivine into high-pressure polymorphs at very short shock duration but at pressures twice to thrice the thermodynamic boundaries with pre compression in a Diamond Anvil Cell with in-situ hypervelocity shock. In order to keep temperatures low enough for solid-solid transformation, we used an approach where statically precompressed samples are subjected to shock compression. In addition a reverberative gun shock experiment was conducted also.

In a 400 ps shock compression to 36 GPa, 700-1000 K we observed the reversible transformation of olivine to spinelloid phases (ref: Finkelstein et al.). At compression to 48 GPa, 1000-1300 K a temperature-quenched Mg-Si-spinelloid has formed. This observation is first evidence for recoverable solid-solid transformation of olivine into a high-pressure polymorph in a shock experiment In a single stage shock gun in the Department of Geoscience's Shockwave Lab, new samples of San Carlos olivine were exposed to 20 GPa peak pressure after three reverberations. Recovered material of recrystallized olivine was examined by micro-XRD at GSECARS and we found indications for ~2-3vol% of spinelloid in the recovered material. With peak temperatures ≤2500 K at 20 GPa, we obtain a kinetic diagram of olivine-to-spinelloid transformations that is relevant for interpreting the occurrence of high-pressure polymorphs of olivine in shock-metamorphic environments. (This work was performed under the auspices of the U. S. Department of Energy by Lawrence Livermore National Security, LLC under contract DE-AC52-07NA27344). Synchrotron X-ray diffraction data were collected at beamline 13-IDD (GSECARS) at the Advanced Photon Source, Argonne National Laboratory).

LINKING SEISMIC ANISOTROPY AND SURFACE GEOLOGY IN CENTRAL COLORADO

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Exposed igneous and metamorphic rocks contain faults, folds, and ductile fabrics that result from lithospheric deformation, but characterizing the geometry of these structures in the subsurface has remained elusive. The ability to image these subsurface structures has implications for estimating seismic hazards and understanding crustal dynamics. Analysis of crustal seismic anisotropy from passive receiver function data is a promising technique, but the successful use of receiver function data is dependent upon resolving the scale difference between km-size seismic waves and the sub-mm scale microstructures that influence seismic wave propagation. Here, we use a scaling approach that combines regional geologic map data and a worldwide compilation of crustal rock elastic tensors to compare data and scaling results with receiver function and surface wave analyses. We use the 1:100,000 Denver West quadrangle in Central Colorado as a first test of this methodology. Using a simplified lithologic map and applying best-fit elastic tensors from the compilation to surface foliation orientations, we homogenize the seismic properties across the study area. Results show 2.4% Vp anisotropy with NE-SW striking slow plane and NE plunging fast axis. We compare the modelled anisotropy with receiver function data from two stations in the area and with published regional surface wave anisotropy. Expectedly, lithologies with the strongest anisotropy control the homogenized regional anisotropy. However, averaging within the dominant lithology changes the symmetry of anisotropy, affecting interpretation of seismic results. Further analyses will be aimed at determining what fabric orientations dominantly influence anisotropy and the relationship between fabric orientations and anisotropy as a function of depth. The scaling between microstructures and seismic wavelengths allows the methodology to be applied to structurally complex crust wherever seismic and regional structural geologic data exist, with the goal of characterizing the crust from regional to continental scales.

SPATIAL ANALYSES OF FIRE HISTORY IN WILDLAND-URBAN INTERFACE: BUTTE COUNTY, CA

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Fires play an essential role in shaping the Earth's surface and developing environmental and biotic communities. However, as urban development continues to expand towards wildfire prone ecosystems in the state of California, fires have become a common threat to its population, properties, and resources. Butte County, CA is an area of interest for evaluating wildfire activity and impacts because of the recent county wildfire, which caused $16.5 billion in total losses, burned more than 150,000 acres of land, and led to 85 casualties within the past year. This study discusses the ethicality of urban development within these fire hazard zones in Butte County through spatial analyses of wildfire likelihood and severity over the last decade, and potential urban damage. Integration of geodatabases provided by federal and state agencies and utilization of GIS tools, including spatial distribution ellipses and mean centers, indicate a general northern trend in annual fire history data and a significant overlap between high fire hazard severity zones (HFHSZ) and wildland-urban interface. Ultimately, our results suggest that wildfires are projected to move towards larger populated cities within Butte County. Therefore, if urban development continues to overlap with wildfire prone environments, mitigation efforts should be produced to reduce human and financial consequences.

ENVIRONMENTAL IMPACT OF THE ATHABASCA OIL SANDS OF ALBERTA, CANADA

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The Athabasca Oil Sands (AOS) of Alberta, Canada is a significant bitumen resource that houses contaminants such as polycyclic aromatic compounds and priority pollutants which can lead to reproductive and birth defects as well as cancer. The acknowledgment of these contaminants is important because of the proximity of the AOS to wildlife, and the natural environment. By studying the AOS contaminate coverage and its proximity to dangered life and resources, knowledge of the sites risk can be accessed. The result of this study indicated that AOS directly poses a high risk to above ground water resources within 50km north of the AOS site, and indirectly puts indigenous people at risk of disease by contaminating their water supply. Local wildlife is at a lower risk as only migratory bird paths overlap with the at-risk area while deer and bear roaming areas did not overlap. The conclusion of this study is important as the contamination of the AOS is shown to pose an environmental health risk that should be addressed.

ANNOUNCING A DISCOVERY OF DINOSAUR TRACKWAYS IN THE JURASSIC SANDSTONE OF SOUTHERN NEVADA

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The goal of this presentation is to publish the discovery of previously unknown Jurassic trace fossils in the Aztec sandstone deposits of the Valley of Fire State Park in Southern Nevada. While hiking for a geology project, student Jennifer Lange found three toed dinosaur trackways of multiple animals of different sizes and weights traveling in the same general direction. Based on the size and shape of the footprints, these dinosaurs are believed to be those of Grallators. Being that the footprints are all on the same surface could indicate that they were emplaced at the same time, which could in-turn be evidence for gregarious behavior. Perhaps, if gregarious, could the variety of animal sizes indicate a family unit? Maybe a hunting troop? We intend to use precision measurements of the foot prints, stride lengths, and pace, which we will use to calculate and publish hip height, animal size, and speed of travel. We hope this and other information will help further the studies of the Jurassic environment in Southern Nevada and the biota it supported.

EXCAVATION AND PREPARATION OF A COLUMBIAN MAMMOTH FROM AMARGOSA VALLEY, NEVADA

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In the spring of 2018, we excavated a partial skeleton of a Columbian Mammoth from Amargosa Valley, Nevada under permit from the Bureau of Land Management. Three plaster field jackets were constructed and transported to the Richard A. Ditton Learning Lab at the Las Vegas Natural History Museum. There, we have been preparing the largest of the three plaster field jackets, which contains both partial tusks and a cranial bones of this mammoth. Fossil preparation is necessary for this project to assess which skeletal elements are present, as well as the ensure the long-term conservation of these specimens. Procedures used for this process include removing sediment using hand tools and pneumatic tools, as well as the use of Paraloid consolidents. Sediment was also collected within the field jacket and screen-washed for microfossils. The mammoth bones are in varying states of preservation, with a lot of portions being fairly soft and fragmented. Moving forward with this project, we hope to prepare the second largest field jacket containing postcranial elements, conduct a taphonomic analysis of the Fairbanks Spring Mammoth, and understand what environment the mammal may have lived and died in.

EVALUATING THE IMPACTS AND FIRE HAZARDS OF INVASIVE GRASS SPECIES IN THE LAS VEGAS VALLEY

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According to the Early Detection and Mapping System for Nevada, 95 invasive grass or grass like species have been detected in the Mojave Desert. As the density of invasive grass species increases, the potential fire hazard for the Las Vegas Valley and the Eastern Mojave Desert grows. This not only serves as a threat to native species that thrive in this arid environment, but increases fire hazards across the valley as well. The invasive grasses are thriving in areas that were once populated by native Mojave plant species and limiting their regrowth after fires causing a dramatic shift in the ecosystem overall. By analyzing the fire hazards and the locations of city boundaries in relation to invasive grass species, we can detect fire hazards across the valley. We can also look at the correlation of invasive aquatic species and how they affect this transition that is occurring across the valley. This serves to benefit the safety of citizens and analyze the impact these invasive grasses have on our environment overall. Further steps can be taken following our analyzations to promote native species recovery and the elimination of invasive grass species in our local areas such as Lake Mead and Red Rock.

SEVERITY OF FOOD DESERTS IN NORTH LAS VEGAS

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Lack of access to nutritious food has been a prevailing issue in the US despite being a developed nation. Without access to a grocery store, families are highly limited with their food choices and often turn to convenient establishments such as fast food and gas stations, which don't provide many nutritional options for meals. In this study, we use geospatial tools and census-tract data to analyze the correlation between low-income areas and accessibility to grocery stores in a defined perimeter of the North Las Vegas Valley. North Las Vegas is a region of the Las Vegas Valley that has a high density of low-income, low vehicle access, and high scores of Area Deprivation Index (ADI). The Area Deprivation Index uses information such as income, education, housing quality, and more from the Census Tract to determine which neighborhoods are the most disadvantaged in the US (University of Wisconsin School of Medicine and Public Health, 2018). Our group will use concentric buffers originating from grocery stores to determine which low-income areas have the greatest inaccessibility to affordable fresh food retailers. The study will increase our understanding of food deserts in North Las Vegas and which areas in North Las Vegas are affected the greatest. Defining the communities that face the most severe restriction to grocery stores will help determine which areas need the most aid to receive nutritious food options.

SAPONITE SYNTHESIS AND DISSOLUTION WITH IMPLICATIONS FOR THE AQUEOUS HISTORY OF MARS

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The detection of smectites by CheMin X-Ray Diffraction analysis aboard the Mars Science Laboratory (MSL) Curiosity rover suggests an early aqueous history with implications for past habitable environments. Surface orbital detections of these iron-bearing clay minerals have been interpreted to be ferric (Fe^{3+}-bearing), which are produced under oxic conditions, and contrasts with evidence of reducing conditions during the Noachian epoch. Previous research suggests that these clay minerals were first deposited in ferrous (Fe^{2+}-bearing) form under reducing conditions and later altered to ferric phases because of long-term exposure, chemical weathering, and oxidation from the atmosphere. However, due to the lack of available Mars samples for direct experimentation and the susceptibility of ferrous smectites to oxidation, this process is not well-studied. To understand potential past aqueous alteration of these martian saponites, we are conducting a series of dissolution experiments of terrestrial and synthesized analogues to yield dissolution rates at activities of water, $a H_2O$, equal to 1.00 (0.01 M NaCl) at 25°C. Sourced from Griffith Park, California, the natural saponite is the closest match to the Mars smectites that have been detected by Curiosity. XRD and spectroscopic data from our natural saponite dissolution experiments are used as a reference for our synthesized samples of ferroan and ferric saponite. Ultimately, our results will help us better understand the evolution of Mars minerals and interpret the past aqueous environment on Mars with important implications for potential habitability.

SPATIAL DATA SHOWS NATIVE PLANTS WITHIN A SOLAR FACILITY IN PAHRUMP, NEVADA BENEFIT FROM DISTURBANCE

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Clean energy in the desert southwest continues to expand and solar facilities are popping up to harvest the abundant sunshine. These facilities help with increasing energy demands, however the effects on desert wildlife remains relatively unknown. The field site is located at the Valley Electric solar facility in Pahrump that didn't level the soil, in other words left natural washes. The environmentally friendly facility also didn't remove all the native plants before they installed an 80-acre solar plant with solar panels. The dominant native plants *Larrea tridentata* (Creosote) and *Ambrosia dumosa* (Bursage) exhibit interesting characteristics inside the facility compared to outside the fenced in panels. We measured leaf xylem water potential, canopy temperature, and chlorophyll index to identify the plants stress inside the facility compared to plants outside the fence and a control site 800 m away. The stress level of each plant was joined with spatial data to indicate a relationship between location and health of the plant in GIS. The results demonstrate that solar panels create an environment benefitting plants. We hypothesize the shade from the panels actually reduces the stress of the plants inside the facility. Perhaps Valley Electric can set a precedent for future solar facilities to include native plants and not grade the land.

FIRST TRIASSIC VERTEBRATE TRACKS FROM THE STATE OF NEVADA

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Trace fossils are important proxies for biodiversity, paleoenvironmental interpretation, biogeography, and animal behavior. Terrestrial Mesozoic trace fossils are known from the state of Nevada from the Jurassic Aztec Sandstone and the Cretaceous Baseline Sandstone. As yet there have been no known animal traces of Triassic age from the state. In this study we present the first known terrestrial Triassic trace fossils from the state. These fossils were discovered by the author (AP) and later confirmed (by RH & JB) in Lake Mead National Conservation Area. The traces are most likely from exposures stratigraphically high in the Moenkopi Formation or rather stratigraphically low in the Chinle Formation. Part of this proposed study will refine this stratigraphic occurrence.

The traces are found along bedding planes in epirelief. The host sediment is a dark brown, very fine sand to siltstone with 3-D ripples. Traces are shallow in relief with at least one track maker being quadradactyl. The shallow claw impressions are reminiscent of swimming tracks from Triassic units in neighboring southwest Utah

To properly interpret these fossils we propose to revisit the fossil site, permit pending, and measure a detailed stratigraphic section through the area to identify which formation is the host and stratigraphically where within that unit the fossils are coming from. More detailed sedimentological data will be collected to better understand how the fossils came to be preserved and in what sort of depositional environment. Photogrammetry will be used to digitally model the tracks in three dimensions. The models can reveal details of the fossils not apparent to the naked eye. From there the track maker will be hypothesized, the depositional environment will be interpreted, and the age of the tracks will be deduced. These will ultimately be Nevada's oldest known terrestrial trace fossils.

WATER ON EARLY MARS: TERRESTRIAL SOILS AS ANALOGUES FOR WEATHERING PROCESSES IN GALE CRATER

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Since landing on Mars in 2012, the Curiosity rover has provided a detailed analysis of Gale Crater sediments, identifying significant accumulations of x-ray amorphous materials as well as iron- and magnesium-rich clay minerals. The x-ray amorphous component is most commonly modelled as basaltic or rhyolitic glasses, suggesting the presence of primary materials. However, identification of volatiles within the calculated chemical makeup of the x-ray amorphous component instead indicates the presence of secondary weathering products. Characterizing the x-ray amorphous component can help provide constraints on the duration and nature of water-rock interactions within Gale Crater. To gain an improved understanding of the nature of the Gale Crater x-ray amorphous component, as well as the weathering pathways that could have formed the iron-rich clay minerals, we are investigating the development of weathering products within ultramafic soils possessing similar chemical signatures to sediments located at Gale Crater. We have collected samples from a variety of locations with different climatic types including the Klamath Mountains of northern California; the Tablelands of Newfoundland, Canada; and Pickhandle Gulch, Nevada. Preliminary results confirm soils from these locations are iron- and magnesium-rich and relatively aluminum poor. Sampled soils have been determined to possess significant accumulations of x-ray amorphous materials within the clay particle size fraction and possess a large suite of iron- and magnesium-rich clay minerals. Preliminary results also demonstrate the presence of both ferric and ferrous iron within the clay particle size fraction. Concurrent with a low organic carbon content, these results confirm the utility of these soils as relevant sites for studying Martian weathering processes. As such, we propose a more detailed investigation of the x-ray amorphous and clay mineral content to determine the structure and composition of these materials and the role precipitation and temperature play in weathering in ultramafic soils.

DANCING ON THE DUNES: AN ICHNOLOGICAL EXAMINATION OF THE AZTEC SANDSTONE AND THE JURASSIC PALEOECOLOGY OF THE SOUTHERN NEVADA REGION

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In recent years, multiple fossil trackways have been reported across the Southern Nevada Region within the eolian dune deposits of the Jurassic Aztec Sandstone. These wind-blown sand-dune deposits are the southern- and western-most exposures of an ancient erg, active in the Early- to Middle-Jurassic, around 200-170 million years ago. The fossiliferous Nugget and Navajo Sandstones, exposed throughout much of the American West, composed the majority of this large sand sea. Despite being the leading-edge of one continuous erg system, the Aztec Sandstone had previously been deemed unproductive in prior paleontological studies.

Sedimentological and ichnological features of interest occur in Red Rock Canyon National Conservation Area (RRCNCA), Valley of Fire State Park (VFSP) and Gold Butte National Monument (GBNM). Three-dimensional photogrammetric reconstruction of suitable trackways and their host rock will be analyzed to evaluate the possibility that the Aztec Sandstone records multiple pluvial intervals at the time of erg deposition. By examining these reconstructions and field-collected data we can identify the behavior of the fauna present, as well as their relationship with the dynamic environment of this ancient sand sea.

We suspect that monsoonal conditions along the western margin of Pangea promoted pluvial intervals that provided the necessary paleoecological conditions to support the diverse life that is being documented in these ancient dunefields. We have also recently discovered two structures that are tentatively being interpreted as preserved proto-mammal burrows in VFSP. These structures are similar to burrows described in the Navajo Sandstone and were found near a potentially spring-fed lenticular carbonate lens. These features in VFSP reinforce the existence of pluvial intervals during the Early- to Middle-Jurassic Period. Multiple previously-reported track sites and this first report of potential burrows in the Aztec Sandstone suggests that well-documented pluvial-supported ecosystems in the Navajo and Nugget Sandstones were also present in the Aztec dunefields.

CRETACEOUS SEVIER THRUST FAULTS AND NEOGENE LEFT-LATERAL DEFORMATION: STRUCTURES AND TECTONISM IN KANE SPRINGS WASH, NEVADA

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In the western US, Basin and Range province (BRP) extension overprints the Sevier fold-thrust belt (SFTB) and both of which are poorly understood locally. The SFTB developed as the Farallon plate subducted beneath North American from Jurassic-Eocene time. From Cretaceous-Eocene(?) time, an externally-drained highland – the Nevadaplano – formed in the internally deformed Sevier hinterland. North of Las Vegas, a zone dominated by BRP sinistral strike-slip and normal faults overprint the SFTB. This zone is the boundary between the Northern (NBR) and Central (CBR) Basin and Range subprovinces, and coincides with several left-lateral faults or zones including the Kane Springs Wash (KSW) fault. These superposed deformation events provide the opportunity to use each to study the other.

The KSW fault lies between the Delamar and the Meadow Valley mountains, to the NW and SE respectively, and has offset estimates ranging from 4-8 km when measured from the KSW caldera wall. The Sevier-related Delamar (DT) and Meadow (MVT) Valley thrusts have an apparent offset that is greater than offset measured from the KSW caldera. Because these thrusts are often unconsidered in SFTB reconstructions, determining their structural relationship can lead to improvements in calculations of both total SFTB shortening and BRP extension. Cretaceous-Eocene sedimentary (EKs) rocks are exposed on both sides of the KSW fault, and can help us delineate the boundary of the southern Nevadaplano.

Preliminary map data will be used to test the following hypotheses. (1) The DT and MVT are the same fault belonging to one of three regionally important thrust systems. (2) The EKs strata are equivalent across the KSW fault and are deposited from drainage from the southern Nevadaplano, or are synorogenic deposits. (3) The KSW fault is a transfer fault accommodating extension across the NBR-CBR boundary zone, and, the apparent offset of the Sevier-related thrusts is the same.

ALONG-STRIKE CORRELATIONS OF THE PANAMINT THRUST FAULT, DEATH VALLEY, CA

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Despite decades of study, the magnitude and kinematics of Cenozoic deformation in western North America persist as controversial topics. Mesozoic structures of the Sevier fold-thrust belt, which were incised into offset fragments by Cenozoic faults, can be correlated to determine the cumulative slip along these younger structures. The correct correlation of the Panamint thrust (Pth), a Sevier structure near Death Valley, CA, is a topic of debate. This has resulted in variable estimates of Cenozoic offset, inhibiting the precision with which the magnitude and kinematics of regional Cenozoic deformation can be established.

I will determine the correct correlation of the Pth by comparing its timing of slip, peak metamorphic temperatures, and structural geometry to those of four potentially equivalent thrusts: (1) the Wheeler Pass thrust, (2) the Schwaub Peak thrust, (3) the Lemoigne thrust, and (4) an unnamed Mesozoic thrust reactivated by the Miocene Boundary Canyon detachment fault. To constrain the timing of slip on the Pth, I will obtain zircon (U-Th)/He thermochronology data from samples collected in a structural transect through the hanging wall. Peak metamorphic temperatures associated with Pth deformation will be determined via Raman spectroscopy of carbonaceous material of footwall and hanging wall samples. The geometries of fault-related folds, including a hanging wall anticline and recumbent footwall syncline outcropping in Tucki wash, have been determined by the collection of structural measurements. This new dataset for the Pth will be compared to similar datasets for each potential correlative structure as compiled from existing literature. Whereas previous Pth correlations have been inconclusive and exclusively supported by similarities in stratigraphy and structural geometry, this approach will provide a diagnostic fingerprint with which the Pth can be confidently correlated to coeval Sevier thrusts.

FLOODING IN LAS VEGAS VALLEY: COMPARATIVE ANALYSIS OF NATURAL AND MAN-MADE DRAINAGE PATTERNS

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The American Southwest is a region characterized by extreme weather and rapid, sprawling urban growth. Reports of flooding in Clark County, Nevada date back over 100 years. Las Vegas is recognized consistently as one of the fastest growing urban areas while at the same time as having struggled to address its vulnerability to extreme flood events and localized flash flooding. Urban expansion, fueled by economic growth, has resulted in more people and infrastructure at risk from flooding each year. As Las Vegas continues to expand, natural desert drainages (washes) are being overprinted by impervious man-made surfaces. Consequently, heavy rainfall events create excessive runoff resulting in portions of the Vegas Valley becoming inundated due to inadequate storm water drainage. This study will utilize geospatial analysis of natural drainage patterns compared to man-made drainage patterns. The goal is to identify areas of recurring inundation in Northwest Vegas (Providence and Skye Canyon) associated with disagreement between these natural regional drainages and neighborhood scale man-made drainages. It is expected that the most problematic flood areas will occur where the man-made drainage is not in line with the natural drainage pattern. A series of maps will be produced in ArcGIS in order to represent the overlap and orientation between natural and man-made drainages. The intent is to match areas of drainage disagreement to records of historical inundation in order to provide insight into the pervasive flooding. A comprehensive understanding of the interplay between natural and man-made drainage in the Las Vegas valley will aid city planners in their ability to protect lives and property from flooding hazards.

MICROPLASTIC POLLUTION: ADDRESSING THE PROBLEMS OF SAMPLING AND PROCESSING A CONTAMINANTS OF EMERGING CONCERN

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Microplastic (MP) pollution is a contaminant of emerging concern that has been found in biota, water, soils and air pollution across the globe. MP are defined as a piece of petroleum polymer <5mm in size. Currently there are no standardized methodologies for sampling and processing MP's. Without tried and true methods, any study that wants to investigate MP pollution needs to critically examine the techniques it will employ to make the study as scientifically sound as possible. This poster outlines the methods that will be used to study water and sediment samples in Lake Mead.

Plastic materials are an integral part of daily life, therefore contamination of MP samples are a major concern. Natural fiber clothing will be worn to prevent MP fiber contamination, and plastic material will be used only when no other material is available as a substitute. Biofouling can hinder density separation and identification of MPs. Removal of the organic material will be done with wet peroxide oxidation reaction.

A density separation apparatus is used to remove the MPs from sediment, and it has 4 major components; sediment chamber, tower, collection chamber, and the separation fluid. The sediment chamber collects and stirs the sample, using a low rpm motor to minimize the break up of the MPs. The tower is a borosilicate glass tube with a conical metal cap. The tower allows the MPs to separate and float to the top, where they are funneled into the removable collection chamber. A saturated $ZnCl_2$ solution provides the high density separation fluid needed for the MP to float. This solution will be filter between samples allowing it to be recycled throughout the study. MP free sediment will be dosed with a known mass of MP, then processed to determine the recovery rate of the apparatus.

DIFFERENTIATING CENOZOIC EXTENSION FROM MID TO LATE CRETACEOUS EXTENSION IN THE PANAMINT MOUNTAINS, CA.

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Synconvergent mid to late Cretaceous extension within the retroarc of the North American Cordillera often displays similar kinematics to that of Neogene Basin and Range extension, thus making it difficult to differentiate between the two. The Panamint Range in Death Valley, California has experienced several deformational events and the earliest extensional fabric, as developed at the Tucki Mountain metamorphic core complex, is thought to be no older than Miocene (Hodges et al., 1987). This interpretation is supported by the fact that the orientation of the extensional fabric does not match the overall E-W shortening direction during Farallon plate convergence and that the fabric occurs in the footwall of Neogene detachment faults. However, stretching lineations and kinematic indicators associated with this extensional event have dominantly top-NNW kinematics, which are incompatible with the regional WNW Death Valley Neogene extensional direction as indicated by: (1) a westward dip of detachment faults, (2) an eastward tilt of hanging-wall fault blocks, and (3) a WNW orientation for major Miocene transfer faults. Alternatively, the top-NNW extensional fabric recognized in the Panamint Mountains could represent mid to late Cretaceous synconvergent extension. This hypothesis will be tested through a series of critical field observations coupled with geochronological techniques. Elucidating the timing of the earliest extensional event at Tucki Mountain will aid in understanding if some component of extension/unroofing occurred during plate convergence, which would have implications on both slip estimates of Neogene detachment faults and models for synconvergent extension, perhaps associated with Laramide flat-slab tectonics.

HOW TREES REVEAL PAST CLIMATE: SUMMER STREAMFLOW RECONSTRUCTION FOR THE FRASER RIVER BASIN, B.C., CANADA

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Reconstruction of past summer streamflow in the Fraser River Basin in British Columbia, Canada, is of great interest as the area is the seventh largest watershed in North America. Droughts similar to those that occurred during the last decade threaten local salmon populations and through this the food and economic sovereignty of over eighty First Nations as well as the western Canadian economy. A better understanding of natural water variability and availability, especially worst-case scenarios of droughts and floods, is important for water management agencies as well as different economic sectors as instrumental records of streamflow are relatively short. To obtain longer records tree-ring information is used as a source of past hydroclimate information. Tree-ring reconstructions of streamflow have the potential to provide information covering several centuries back in time and in the past have been used in various settings for major watersheds in the US.

Sample collection will take place in the summer of 2019 after the analysis of preliminary samples that were collected in the fall of 2018. From these samples tree-ring chronologies will be developed through wood anatomical analysis, statistical detrending and autoregressive modelling, and manual as well as statistical crossdating. Reconstructions will be developed through correlation and regression analysis, and paleoclimate model calibration and validation techniques. This can be used to gauge how severe recent abnormal streamflow has been, enable comparisons to future climate change models and identify areas where changes in water availability are likely to occur. Results from this project will be made available through the NOAA World Data for Palaeontology for water managers, stakeholders or other interested parties to access.

DEGRADATION OF ANTIBIOTICS IN AQUEOUS PHASE USING ZERO-VALENT IRON NANOPARTICLES (NZVI) IMMOBILIZED IN SBA-15

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The estimated annual consumption of antibiotics worldwide is between 100,000 and 200,000 tons and with the removal efficiency of secondary treatments ranging between 5% - 87%. With no standards, set by the EPA for drinking water quality within treated wastewater effluent the presence of antibiotics in treated wastewater effluent has led to the pursuit of alternative or additional treatment processes to deal with the threat of antibiotic accumulation and possible antibiotic resistance. These additional processes, in the case of Las Vegas the use of Ozonation, create an Advanced Oxidation Process (AOP) that produces hydroxyl (˙OH) radicals. These (˙OH) radicals break apart particles like antibiotics that are not broken down or settled out during conventional biological water treatment. Dispersal of Zero-Valent Iron nanoparticles (nZVI) in water produces oxygen-based free radicals (e.g., hydroxyl radicals), that oxidase organic compounds in water. However, initially dispersed nZVI has a tendency to agglomerate, which substantially reduces efficiency. Fixation of nZVI, onto a non-reactive porous media (e.g., mesoporous silicate-based materials) such as SBA-15 has become the preferred supporting material to improve the performance of the nZVI by inhibiting agglomeration. The potential reactivity and degradation of four different antibiotics (cloxacillin, amoxicillin, tetracycline, and sulfamethoxazole) and exposed to nZVI/SBA-15 at three different concentrations will be measured and recorded with a Modified Kirby-Bauer test, a measurement of biological activity using our own infusion wafers and antibiotic solutions also known as an antibiogram, and High-Powered Liquid Chromatography (HPLC).

SEARCHING FOR TRAPPED FLUID INCLUSIONS IN TANZANIAN LITHOSPHERIC MANTLE OLIVINE

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Understanding the composition of the Earth's mantle is essential to understanding the formation of the Earth as a whole, as well as magmas that have been and are currently being created. This study is focused on locating and investigating the nature of fluid inclusions in 3 samples of Tanzanian lithospheric mantle olivine using Raman spectroscopy. This study is intended to supplement existing infrared spectroscopy (IR) data that has already been collected on these samples elsewhere and should prove useful due to the complementary capabilities of the two methods, which are sensitive to different types of bonds. The spectrometer used for this study utilises a Krypton-Argon gas laser, set specifically for this study at the wavelength λ=488 nm. The study is focused on looking specifically for fluids, such as OH or CH_4, that would have been sealed within the crystal lattice of the samples during crystal formation while still in the mantle. Fluid inclusions are important for comprehending abundance of volatiles in the mantle. Volatiles are either dissolved in partial melts in the mantle or are part of fluids interacting with mantle rock. Fluids have influence on relative abundances of incompatible elements, melting temperature, and viscosity. Furthermore, widespread fluid inclusions in minerals that are not part of the regular crystalline structures of those minerals can represent considerable reservoirs of certain elements.

THE PARENTAL MAGMA COMPOSITIONS OF THE NAKHLITE MARTIAN METEORITES AS DETERMINED BY MELT INCLUSION ANALYSIS

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The nakhlite meteorites originate from a single location on Mars, and the 22 unpaired samples represent the largest suite of igneous rocks from another planet. As such, nakhlites preserve the most detail of all martian meteorites as to the composition of their parental magmas (the liquid from which they crystallized) and their sources, which can help better constrain the composition of the martian interior. However, only three nakhlites (Nakhla, Governador Valadares, and Miller Range [MIL] 03346) have established parental melt compositions. We are conducting a study on the melt inclusions (pockets of trapped parental melt) present in a comprehensive suite of nakhlites to constrain their parental melt compositions, relationships between them, and possible metasomatic, hydrothermal, or crustal influences therein.

We present here initial findings on the parental melt compositions of four nakhlites: Governador Valadares, MIL 090030, MIL 090032, and a new find; Northwest Africa 10645. We measured elemental compositions of the different minerals and glasses present in the melt inclusions in each sample using electron microprobe analysis. We then corrected the trapped liquid compositions for the effects of re-equilibration with the host mineral, which typically results in a net Fe-loss in the inclusion.

We find that there is significant variation in the trapped liquids hosted by olivine and pyroxene (the two primary cumulus phases present in nakhlites). Pyroxene is possibly a late-stage phase that encloses a more evolved melt composition than earlier olivine, resulting in a relative K enrichment. Olivine-hosted inclusions in the four nakhlites reveal distinct compositional evolution that may originate from a single source composition. Significant differences between olivine- and pyroxene-hosted inclusions may result from fractional crystallization (the removal of primitive solid phases), or from the presence of xenocrystic olivine from a distinct parental magma. In light of these findings, a larger study encompassing more samples is warranted.

POTENTIAL PILOT COMMUNITIES FOR INTEGRATED WATER RESOURCES MANAGEMENT IN THE VOLTA RIVER BASIN

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Water is and will always be a limiting factor on the social and economic development of mankind, impelling societies to optimize the management of this valuable resource. Integrated Water Resources Management (IWRM) has innovated the management of this natural resource by encouraging transboundary coordination through regional-level planning with collaboration at the local level. The PAGEV initiative is an exemplary IWRM plan in which Burkina Faso, Ghana, Togo, Mali, Benin and Côte d'Ivoire have worked together to implement the sustainable management of the Volta River basin from transboundary to local levels. The purpose of this study is to identify potential pilot communities for future local projects in the country of Togo. Using spatial analysis, this study analyzed poverty and population density, and located small village communities as potential project sites similar to the successful pilot community projects in Burkina Faso and Ghana. This study identifies viable pilot communities for future projects in Togo. Further studies are needed to survey these actual places for in-person assessment.

MEASURING STRESS STATES IN QUARTZ USING RAMAN SPECTROSCOPY

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The stress conditions leading to rock deformation are influential in how a rock will ultimately deform, which in turn is important to understanding Earth's geologic processes. However, the internal distribution of stress in an elastically anisotropic rock under load which leads to rock deformation is not well understood. Knowledge of the stress state of rock can lead to a fuller understanding of many geological topics such as fracture patterns in rocks, rheology in the mantle, orogenic events, and rock metamorphism. Through Hooke's law, it is possible to quantify the overall stress state of individual points on a polycrystalline material through the elastic strain response of crystal lattices placed under a load. Observing stress is possible through Raman spectroscopy which can measure load dependent elastic strain changes in a crystal lattice by looking at a change in peak position between a non-loaded and loaded material's spectrum. For these purposes, I am currently investigating single crystal and polycrystalline quartz for its ability to withstand large loads without plastic deformation. Uniaxial break tests for yield strength, polishing, and Raman techniques must be mastered to resolve the small Raman stress shift seen in single crystal samples. Current data, focusing on the quartz emission line 206 cm-1 show inconsistent stress shifts. As current work progresses in polishing techniques, I hypothesize that a shift greater than system and sample error will be able to be achieved, allowing for future mapping of polycrystalline samples which can then be analyzed for stress patterns. The creation of stress maps within natural polycrystalline material will lay a foundation for using stress states to understand how rocks deform in specific patterns. Mapping stress states can lead to a large-scale understanding of how stress is distributed in a natural polycrystalline material which can lead to a basis for understanding larger-scale Earth systems.

MORPHOLOGY OF RECRYSTALLIZED VS NEOCRYSTALLIZED FIBROUS AMPHIBOLE: IMPLICATIONS FOR POTENTIAL HEALTH RISK

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The presence of naturally-occurring asbestos (NOA) has gained a great deal of attention from scientists, health and regulatory agencies, and citizens living in impacted areas. It is commonly believed that fibrous amphibole asbestos can only form through neocrystallization. In southern Nevada, NOA occurs as a result of hydrothermal alteration of granitic rock producing fibrous amphibole asbestos both as cross-cutting neocrystallized veins and via recrystallization of original magmatic hornblende crystals. This study will measure the maximum length and average width of both recrystallized and neocrystallized fibers to see if the morphologies are similar. The morphology of asbestos fibers is an important characteristic that strongly affects toxicity: longer and thinner fibers are believed to be significantly more toxic than shorter and wider fibers. Samples were collected from corresponding units in McCullough Range, NV. Neocrystallized and recrystallized fibers were identified using a petrographic microscope and extracted from polished thin sections using a 0.015” diameter motorized drill. Samples were then analyzed using the scanning electron microscope (SEM) and field emission scanning electron microscope (FESEM) with energy dispersive x-ray analysis (EDS). Amphibole mineralogy will be accurately identified using wavelength dispersive spectroscopy (WDS) and electron probe microanalysis (EPMA) on polished thin sections. We hypothesize that there will be no significant difference in the aspect ratios, average width, and maximum length of neocrystallized and recrystallized fibers having similar mineralogy and chemistry. If so, then both formation processes can produce fibers that are likely similar in toxicity. Because hydrothermal alteration and recrystallization of primary minerals is a very common geologic process, this finding may significantly increase the number and distribution of rocks and soils that contain NOA. Therefore, many more people than we currently recognize may be unknowingly exposed to hazardous fibrous amphibole fibers.

BUILDING A FLOOR OF "TRASH:" ANALYZING URBAN DECREASE THROUGH ARTIFACT DISTRIBUTION AT DHIBAN, JORDAN

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Archaeology is a destructive science that depletes the archaeological record through continuous sampling of an incredibly limited supply. Archaeological sites are also threatened by modern urban growth and environmental changes, and so efforts need to be made by archaeologists to preserve sites for future economic, academic, or other purposes. An increased understanding of both how an archaeological site can indicate urban growth trends and the cultural implications of potential building uses would help archaeologists better analyze previously excavated sites, and decrease the need for future destructive excavation. Tell Dhiban in Jordan is an ideal archaeological site to research urban growth trends because it has been continuously occupied for about 6,000 years. It also experienced multiple periods of rapid growth and decrease, providing an ample sample to draw urban growth data from. Therefore, one of Dhiban's rapid desettlement shifts in the Late Byzantine period - around the seventh century AD - was selected to analyze the artifact distribution through ArcGIS. Inverse Distance Weighted (IDW) interpolation on two primary locations at the site provides the individual distributions of ceramics, lithics, botanical remains, human/faunal remains, glass, metals, and chaff tempered clay. The IDW outputs, when compared together, show a tentative map of potential area uses of Tell Dhiban, assuming clusters of botanical and faunal ecofacts might represent cooking/food preparation areas, clusters of lithics and ceramics might represent work areas, etc.

COMBINING STEADY STATE DEFORMATION AND ULTRASONICS: A STUDY ON THE ELASTICITY OF POLYCRYSTALLINE OLIVINE

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It is well known that elasticity is a key physical property in the determination of the structure and composition of the Earth and provides critical information for the interpretation of seismic data. This study investigates the stress-induced variation in elastic wave velocities known as the acoustoelastic effect, in San Carlos olivine; which has not been previously investigated. The newly developed experimental ultrasonic acoustic system, the DIASCoPE, is incorporated into the D-DIA multi-anvil apparatus to obtain compressional and shear elastic wave velocities. To integrate the DIASCoPE, a hybrid sample assembly is required that includes aspects of an ultrasonics experiment and a deformation experiment. Using this cell, a suite of low strain experiments was conducted on polycrystalline San Carlos olivine. The sample was isostatically hot-pressed at 1100°C and 300 Mpa, cored to produce a right cylinder and polished to ¼ µm to produce parallel ends. The sample is in series with a fully dense sintered alumina piston in the center of the assembly, and an alumina buffer rod is placed below the sample. The sample was deformed at 2.5, 3.7, and 4.6 GPa at a strain rate of ~$5x10^{-6}$/sec at 450, 650, and 850°C. Preliminary analysis of the data indicates that compressional and shear wave velocities change in response to loading in different ways with the compressional wave velocities changing proportionally to compressive stress in the elastic regime and the shear wave velocities showing less linear dependence with the stress state. In addition, once the sample reaches its yield point, the linearity between the relative wave velocity variation and the macroscopic stress changes.

SPATIAL ANALYSIS OF THE RELATIONSHIP OF ANTIBIOTICS BETWEEN PUBLIC PARKS AND STORMWATER DRAINAGE NETWORKS

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Estimated annual consumption of antibiotics worldwide falls between 100,000 and 200,000 tons and possibly the same amount if not more for pet use, thus there can no longer be ignorance of accumulation in treated wastewater effluent and waterways. The regulations put in place to try and minimize the impact is through the EPA's Clean Water Act, first implemented in 1972, face a lack of information regarding how much antibiotic waste is entering the waterways treated wastewater effluent and stormwater runoff. In Clark County, NV, the difference between runoff vs. infiltration in urban public land is large and both processes bypass the treatment plants heading straight into the groundwater or Lake Mead National Recreation Area, otherwise known as our drinking water. This contributes to a large percentage of the water entering Lake Mead being non-treated stormwater mixing with the treated effluent that also hold trace amounts of antibiotics making it difficult to know the concentration of antibiotics being removed from the treatment plants vs. the concentrations entering the Lake from stormwater runoff. The focus of this project is to do a spatial analysis consisting of locating hotspots of urban public land with high pet populations (e.g., dog parks and public parks) nearest to stormwater drainage networks, as antibiotic sampling locations. The identification the major drainage networks in these areas can help provide the most probable locations for antibiotic sampling to give an approximate concentration of antibiotics entering the waterways bypassing the wastewater treatment plants using multiple different GIS methods for analysis. The anticipated result will be a map with the most probable sampling point locations that can be implemented in future research.

POST-WILDFIRE HYDROLOGIC RESPONSE: EROSION AND DEBRIS FLOWS FOLLOWING THE BRIAN HEAD FIRE

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In June-July of 2017, the Brian Head Fire (BHF) burned approximately 71,000 acres of mountainous terrain in Southwestern Utah. Intense wildfires, such as the BHF, have a prolonged impact on the hydrologic response of the affected watersheds. Extreme heat generates hydrophobic soil layers that reduce infiltration capacity; and the destruction of plant canopy increases the amount of rainfall that reaches the ground; the combined effect is intensified overland flow. Removal of groundcover and shallow root systems lowers resistance to erosion. As a result, even modest rainfall on fire-damaged soils can produce hazardous debris flows. Improving our understanding of where debris flows occur, the materials involved, and the associated erosional processes require that we better understand how hydrologic pathways (channels, rills, and gullies) are impacted by wildfire. This study will utilize repeat high-resolution terrestrial laser scanning (LiDAR) surveys to compare morphometric change in a steep headwater basin that burned in the BHF to a similar, unburned basin. Rain and stream gauges in these respective basins will be used to track hydrologic response to individual rainfall events. LiDAR data will be used to select target areas for field mapping of new, or altered hydrologic pathways (channels, rills, and gullies) that have the potential to form new debris flows. These areas of interest will be tested to evaluate the persistence of soil hydrophobicity. Tracking the development of new hydrologic pathways (channels, rills, and gullies) will allow us to identify hazardous areas susceptible to debris flows and excessive erosion. A better understanding of these at-risk areas and the factors contributing to debris flows will aid hazard management for areas impacted by large wildfires such as the BHF.

SPATIAL ANALYSIS OF FAUNAL MATERIAL AT A MIMBRES ARCHAEOLOGICAL SITE

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GENERATING AN $^{87}SR/^{86}SR$ ISOSCAPE FOR CLARK COUNTY, NV

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Strontium has increasingly become part of the standard isotopic toolkit for understanding the migratory movements of humans and animals across a range of disciplines including archaeology, forensics, ecology, and paleoecology. An important step in the use of strontium, usually measured as the ratio of ^{87}Sr to ^{86}Sr, is to create an isoscape, that models changes in $^{87}Sr/^{86}Sr$ ratio values across a landscape. While measurements of strontium have been conducted in a limited number of lithologies across Clark County, Nevada, a regional isoscape of $^{87}Sr/^{86}Sr$ ratio values across the county has never been created.

In this exercise, I generated a preliminary isoscape of $^{87}Sr/^{86}Sr$ values across Clark County using previously reported values of different lithologies from across the county. Values were compiled into ArcGIS and the isoscape was generated using an Inverse Distance Weighted (IDW) algorithm. The data set used to generate this isoscape under-represents the lithologies and sediments found in Clark County. Particularly lacking is data for Quaternary-aged basin-fill sediments distributed throughout the county. Such data can be gathered by sampling sources of bioavailable strontium such as plants, range-limited animals, soils, and surface waters. Future refinement of this isoscape will provide a valuable tool for reconstructing the movements of humans and animals in southern Nevada.

GEOCHEMICAL DISTRIBUTION AND PETROGENESIS OF CRITICAL METAL PEGMATITES FROM THE NORTH VIRGIN MOUNTAINS PEGMATITE FIELD, NEVADA – ARIZONA

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The critical metals (e.g., Li, Be, B, Cs) are vital to modern and evolving green technology, and are deemed critical because of their irreplaceability, important end uses, and heavy supply restrictions due to social, political, and technological barriers. However, there is a lack of understanding in deposit formation processes. Granitic pegmatites are known for their ability to concentrate many of the critical metals into distinct phases and potentially minable forms. These pegmatites, like other critical metal deposit types, are poorly understood in terms of the processes invoking deposit formation and enrichment in critical metals.

The North Virgin Mountains on the border of Nevada and Arizona hosts an understudied pegmatite field with known critical metal enrichments. Both "barren" pegmatites lacking critical metal enrichment and critical metal pegmatites containing either beryl or chrysoberyl and variable amounts of Nb-Ta mineralization, form geochemically and mineralogically distinct trends within this field. This bimodal occurrence is not uncommon in critical metal bearing pegmatite fields, with barren pegmatites occurring nearer to a parental pluton or source and critical metal pegmatites being more distal. However, the relationship between the North Virgin Mountains pegmatites and the controls on their distribution pattern remain poorly understood. In addition, the source of these pegmatites, whether derived from a granitic pluton or low-degree anatectic origin, is unknown for this area. Understanding the critical metal distribution and source, combined with the pegmatite field zonation model, can be used to explore for potentially more evolved or enriched critical metal bearing pegmatites in the North Virgin Mountains.

This study presents new whole-rock geochemical data for the North Virgin Mountains pegmatites and uses this data to outline their petrogenesis and the links between these pegmatites and potential sources.

X-RAY COMPUTED TOMOGRAPHY (XCT) SCANNING OF AUBRITE METEORITES AT NASA'S JOHNSON SPACE CENTER

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The aubrites are a unique group of differentiated meteorites that formed on parent bodies with oxygen fugacities (fO_2) ~2 to ~6 log units below the iron-wüstite buffer. At these highly reduced conditions, elements deviate from the geochemical behavior exhibited at terrestrial fO_2, and may form FeO-poor silicates, Si-rich metals, and exotic sulfides. Geochemical examinations of aubrites, such as mineral major-element compositions, bulk-rock compositions, O isotopes, and crystallization ages, are crucial to understand their formation and evolution at extreme fO_2 conditions. While previous studies have described the petrology and 2D modal abundances of aubrites, this work provides the first 3D view of aubritic mineralogies, which are compared to the available 2D data. In this study, we calculate the first bulk partition coefficient data among silicate, sulfide, and metal phases within aubrites. Constraints of 3D modal abundances will increase the accuracy of these bulk partition calculations; therefore, 3D scans of aubrite samples are imperative.

The Astromaterials Acquisition and Curation Office at the NASA Johnson Space Center (JSC) hosts a micro X-ray computed tomography (micro-XT) laboratory used to non-destructively analyze astromaterials, such as meteorites. XCT scanners have many scientific uses, such as measuring 3D modal abundances, calculating porosity, and identifying internal structures. We identify clasts containing sulfide phases and calculate the 3D modal mineralogy of the Cumberland Falls, Mount Egerton, Norton County, Peña Blanca Spring, and Shallowater aubrite meteorites. Scans of the Mount Egerton aubrite have produced surprising results upon 3D reconstruction: the sample contains vesicles and fractures with a preferred orientation along long axes. This may give insight into temperature and pressure conditions on the aubrite parent body, which had been subjected to pyroclastic volcanism.

After the awards ceremony, a silent auction along with light refreshments will be served in the lobby.

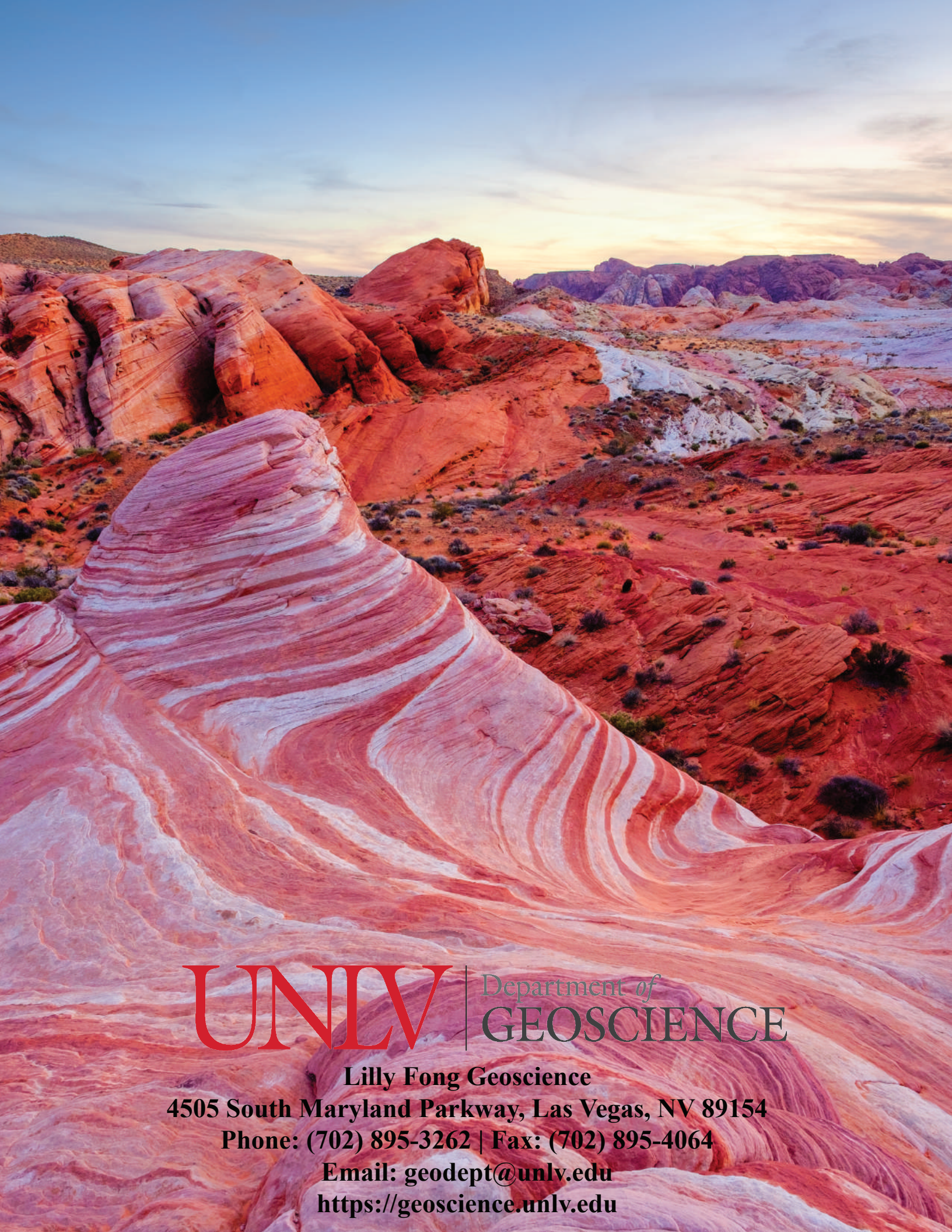
Field Trip
Saturday, April 27th, 2019

Mountain Pass Carbonatites

This year's GeoSymposium field trip, hosted by the UNLV SEG Student Chapter, will feature a tour of the open pit mine at the Mountain Pass carbonatite given by mine staff of the current operator, MP Minerals. Carbonatites are igneous rocks containing more than 50% carbonate minerals and can host economic grades of rare earth elements (REEs), uranium, thorium, yttrium, and zinc. The Mountain Pass carbonatite contains 8-12% REE oxides, mostly hosted in bastnäsite, and has been mined on and off since the 1950s. Participants will be required to wear long pants and close-toed shoes, along with high-visibility vests provided by the department and hard hats provided on-site.

Please meet in front of Lily Fong Geoscience (LFG) AT 7:30 am.

Thanks to Andrew Rigney for the back photo cover.



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