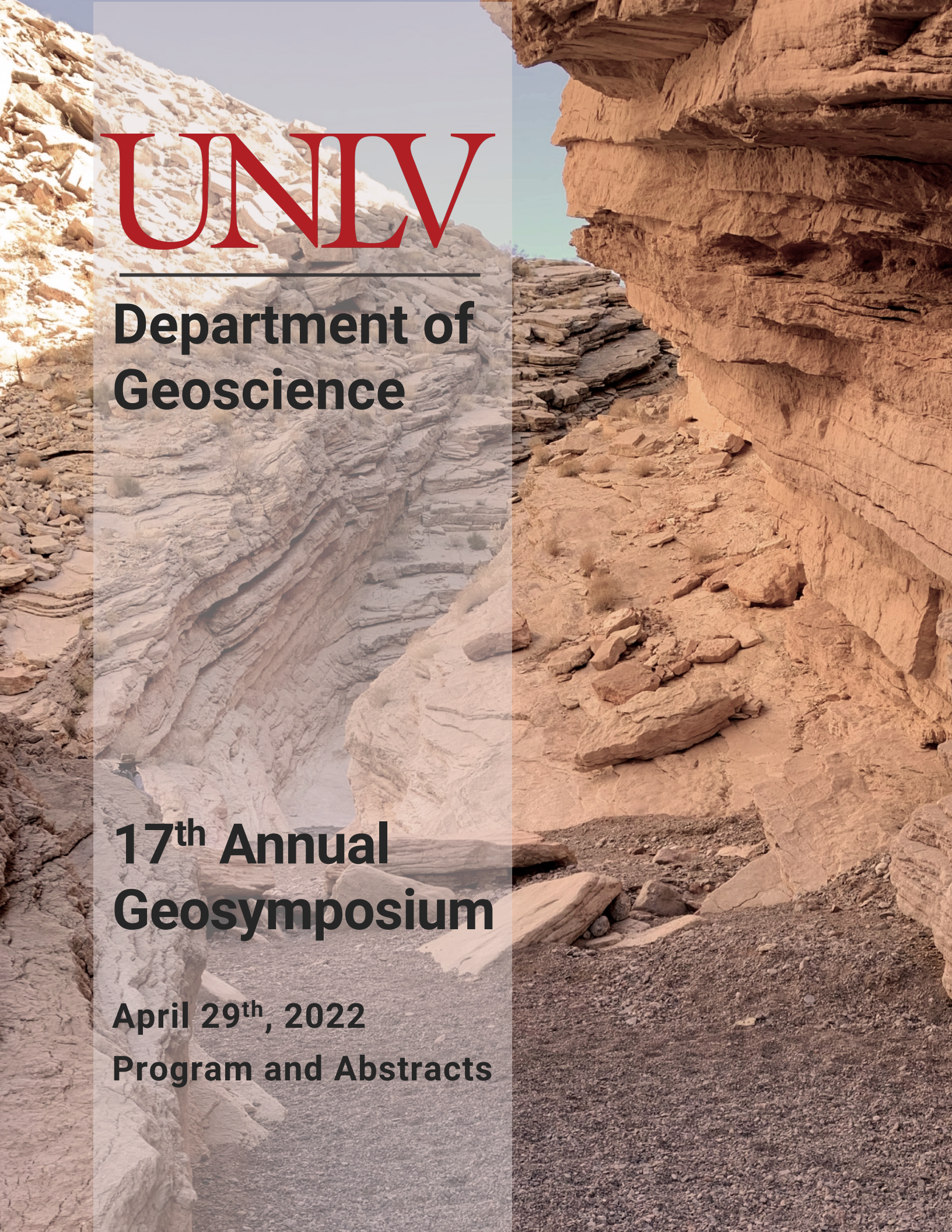

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17th Annual Geosymposium

April 29th, 2022

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Dear Geoscience community,

Welcome to the 17th annual UNLV GeoSymposium. After two years of meeting online, we are once again meeting in person to showcase the student research accomplishments within the Geoscience Department. GeoSymposium continues to provide both graduate and undergraduate students opportunities to present research to industry partners, alumni, community members, UNLV faculty, and colleagues. This year also marks the 50th anniversary of the Geoscience Department. Please join us for a special reception following the awards ceremony in celebration of this key milestone.

I wish to thank our sponsors for their support: Mission Support & Test Services (MSTS), Nevada Gold Mines by Barrick, Coeur Mining, Southern Nevada Water Authority (SNWA), Nevada Mining Association, KGHM Robinson Mine, MP Materials, SSR/Marigold Mine, i-80 Gold Corp, Kinross Gold Corporation, Stantec, Broadbent & Associates, Universal Engineering Sciences, Jacobs Technology, and Geological Society of Nevada. We are deeply appreciative of their commitment.

Furthermore, I am grateful to these companies for supporting our silent auction: REI at Boca Park, Desert Adventures, Meow Wolf at Area 15, the Springs Preserve, Sin City Yoga, Spiegelworld, and The Cosmopolitan of Las Vegas. Thank you to our many individual donors for their creativity and generosity.

My sincerest thanks go to Dr. Steve Rowland for leading the field trip to Anniversary Narrows. I would also like to extend my deepest gratitude to Cory Nelson, from the College of Science, who worked diligently to foster new and existing partnerships between the UNLV Geoscience Department and industry that made this meeting possible. I want to recognize Maria Rojas, Loren Harper, and the entire Geoscience Department office (including Frankie) for their monumental contributions to the logistical success of GeoSymposium. GeoSymposium continues to grow under their expertise.

Beyond question, I am indebted to our committee members for their extraordinary collaboration and teamwork. Exceptional efforts were provided by Audrey Warren in graphic design, Amanda Ostwald in building the program, and Suzie Lederer in fundraising. Congratulations to Genevieve Kidman for winning the t-shirt design competition with her artwork featuring the State of Nevada. Dr. Jeremy Koonce, the faculty advisor, was the pillar of our group. Finally, thank you to our volunteer judges, faculty, alumni, presenters, and attendees for participating in this year's event. Viva UNLV Geoscience!

Sincerely,

Deborah Morales

Deborah C. Morales
GeoSymposium Coordinator, 2022

Committee Members

Debbie Morales
Audrey Warren
Maria Rojas
Loren Harper
Suzie Lederer
Sierra Ramsey
Amanda Ostwald

Subcommittee Members

AnnMarie Jones
Danny Panduro
Giuseppe Lucia
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Chin Chai Huan
MacKenzie Mitchell
Susie Hertfelder
Photographers: Max Arnault and Kristi Sexton

Geosymposium Advisor: Dr. Jeremy Koonce
Website: Dr. Arya Udry

SCHEDULE OF EVENTS

Friday, April 29th

Science and Engineering Building (SEB)*

7:30 am	Sign-in
8:30 am	Opening Remarks
8:45 am	Keynote address
9:30 am	Oral Presentation Session I
11:00 am	Poster Presentation Session I
12:00 pm	Lunch (served through 2:00 pm)
1:00 pm	Career Day activities begin
2:00 pm	Oral Presentation Session I
3:30 pm	Break
3:45 pm	Poster Presentation Session II
4:45 pm	Break

Richard Tam Alumni Center (TAC)*

5:00 pm	Awards Ceremony
5:30 pm	Reception and Silent Auction

Saturday, April 30th

Field trip to Anniversary Narrows:

Depart from Lilly Fong Geoscience (LFG)* Building at **8:00 am**

*Interactive Campus map is available at unlv.edu/maps/campus
Or, open your smartphone camera app and take a picture of this code:

CAREER DAY SCHEDULE

Sponsored by Nevada Gold Mines by Barrick

This year, Career Day event activities are held throughout Geosymposium.
During this event, industry representatives will give short presentations about their organization. Students will then be encouraged to sign up for 15-minute informational interviews with industry representatives. The schedule of events is as follows:

Friday, April 29th

Science and Engineering Building (SEB)

1:00 pm – 2:00 pm	Industry presentations
2:00 pm – 2:15 pm	Interview Sign-ups
2:15 pm – 4:45 pm	Student Interviews

SILENT AUCTION INFORMATION

This year, the silent auction items will be available for viewing in person during the reception at the Richard Tam Alumni Center. Bidding will only be accepted online at the following link:

https://e.givesmart.com/events/qNe/

Alternatively, you may use your smartphone camera app to take an image of the following code to access the link:

FIELD TRIP DESCRIPTION

This year's Geosymposium field trip will be to Anniversary Narrows in the Muddy Mountains Wilderness, adjacent to Lake Mead National Recreation Area, led by Professor Emeritus Steve Rowland. The trip will involve a leisurely hike of approximately three miles, round trip, in Callville Wash. Lunch will be provided to those who registered. Bring water, comfortable walking shoes, and sun protection. We will return to UNLV by mid-afternoon. Features to be examined and discussed along the way include the following:

1. Stratigraphy of the Miocene Horse Spring Formation,
2. Borate mining history of the Anniversary Mine,
3. Paleo-liquefaction sedimentary structures in the Horse Spring Formation, including a truly spectacular injection dike that records the occurrence of a high-magnitude Miocene earthquake,
4. Hiking through a long, wonderful slot canyon.

ABSTRACTS: TABLE OF CONTENTS

KEYNOTE SPEAKERS

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AFTERNOON SESSION, IN ORDER OF PRESENTATION

POSTER PRESENTATIONS

MORNING SESSION: GRADUATE STUDENT POSTERS

MORNING SESSION: UNDERGRADUATE POSTERS

AFTERNOON SESSION: GRADUATE STUDENT POSTERS

AFTERNOON SESSION: UNDERGRADUATE STUDENT POSTERS

KEYNOTE SPEAKER BIOGRAPHIES

PETER J. JAUCH, P.E.

Peter currently serves as the Director of Engineering for the Southern Nevada Water Authority and Las Vegas Valley Water District in Las Vegas, Nevada. During his 25 years with the Authority and District, Peter has been involved in the planning, design and construction of over $1.7 billion in water infrastructure. Peter is a graduate of the University of Arizona and a licensed professional engineer in Arizona and Nevada. Peter is passionately curious about people and processes, and also enjoys making new memories with family and friends.

ADRIANA VENTIMIGLIA, P.E.

Adriana Ventimiglia, a Senior Program Engineer with the Southern Nevada Water Authority, has more than 20 years of professional civil engineering experience in engineering design, construction management, project permitting, and inter-agency coordination for municipal and private entities. Adriana is currently leading the SNWA's engineering program for the Horizon Lateral, a large-diameter transmission pipeline that will increase service reliability to the southern portion of the Las Vegas Valley. As a graduate of the University of Nevada, Las Vegas, Adriana holds a degree in Civil Engineering and maintains her accreditation as a professional engineer. In her spare time, Adriana enjoys camping and visiting national parks with her husband and their two teenage sons.

THE 17th ANNUAL UNLV GEOSYMPOSIUM
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THE ANTLER OROGENY RECORDED IN ZIRCON U-PB GEOCHRONOLOGY, SOUTHERN NEVADA

James T. Duncan[1*], Tomas N. Capaldi[2], Michael L. Wells[3], Margo L. Odlum[4], Chris DeFelice[5]
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The Antler orogeny was a Devonian-Mississippian (~325-375 Ma) mountain building event that occurred along the western Laurentian margin, which trends NNE-SSW from southeastern Idaho to southeastern California. The initiation of the Antler orogeny occurred during the emplacement of the Roberts Mountain Allochthon (RMA) that thrust Cambrian-Devonian deep water marine siliciclastic rocks 100 km eastward onto the western Laurentian margin. The RMA thrusting caused a flexure response in the continental crust and resulted in the formation of the adjacent Antler Foreland basin. The significance of the Antler orogeny led to decades of research but a consensus on both the origin of the RMA and driving tectonic forces has yet to be made. End-member models for the potential source of the RMA includes local derivation from southwestern Laurentia, versus far traveled exotic source that involves peri-Gondwana or Northern Laurentia derivations. Additionally, proposed mechanisms for RMA emplacement are also debated, with end-member models including eastward subduction driving the closure of a back-arc basin, or high angle westward subduction that emplace the RMA as an accretionary prism with or without a terminal arc collision. To test these models, we sampled upper Paleozoic sedimentary rocks along a transect spanning SE-SW Nevada. Samples were chosen based on spatial relationships covering major provinces associated with the Antler orogeny such as the cratonal region, distal and proximal Antler foreland basin, hinterland sources within the fold and thrust belt, and the Antler overlap sequence. We will compare the Paleozoic basin sample age distributions against a suite of new modern river sand samples that drain numerous Precambrian basement and lower Paleozoic sedimentary sources that potentially eroded into the Antler Foreland basin. Samples taken across the RMA-Antler foreland basin system were separated for zircon U-Pb geochronology and will be used to better constrain one of the proposed accretion and origin models.

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TRACKING THE NEOGENE TECTONIC EVOLUTION OF THE ACTIVE ANDEAN THRUST FRONT USING THE FORELAND BASIN RECORD AND DETRITAL GEO-/THERMOCHRONOLOGY, WESTERN ARGENTINA

Zoey Plonka[1], Tomas Capaldi[1], Margaret Odlum[1], Patricia Alvarado[2], Gustavo Ortiz[2]
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2- CONICET and Universidad Nacional de San Juan (CIGEOBIO), San Juan, Argentina
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The Neogene Bermejo Basin of west-central Argentina is a classic example of a seismically active broken foreland basin system associated with present day flat slab subduction tectonics. The region is comprised of a thin-skinned fold-thrust belt in the Central Precordillera and basement-involved uplifts of the Sierras Pampeanas that partition the once continuous foreland basin. The kinematic relationship between the Sierras Pampeanas, the Central Precordillera, and the enigmatic west-vergent Eastern Precordillera thrust front remains debated. End member tectonic models for Eastern Precordillera deformation include: (1) thin-skinned deformation at 8-6 Ma associated with the Central Precordillera fold-thrust belt to the west, and (2) thick-skinned deformation at <5 Ma linked to Sierras Pampeanas deformation to the east. Our study seeks to constrain the along-strike Neogene tectonics of the Eastern Precordillera by integrating new structural, stratigraphic, detrital zircon U-Pb geochronology and sediment provenance, and detrital apatite (U-Th/He) thermochronology datasets from the Bermejo Basin. New data from two ~1.7 km thick Neogene stratigraphic sections in southern Bermejo Basin constrain deposition between ~12-5 Ma with dominant fluvial-lacustrine deposits that transition into fluvial/alluvial fan facies tracking the eastward migration of Andean deformation and transition from foredeep to wedge-top depositional systems. Provenance data reveal an up-section unroofing sequence of the Central Precordillera demonstrated by greater input of Paleozoic sedimentary sources. When we compare new data with published data from northern Bermejo Basin, we observe (1) a north-south decrease in stratigraphic thicknesses from >5 to <2 km, and (2) along strike increase in exhumation ages from 2-5 Ma in the north to 6-8 Ma in the south. Our results suggest the southern segment of the Eastern Precordillera is kinematically linked to thin-skinned thrust structures in the Central Precordillera, whereas to the north structures appear to be linked to the thick-skinned Sierras Pampeanas, demonstrating complex along-strike variability of thrust-front evolution.

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AGE AND GENESIS OF W–MO–CU MINERALIZATION, GOLD HILL, UTAH

Nathan J. Carey[1], Simon Jowitt[1], and Stephanie E. Mills[2]
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Utah's Gold Hill mining district hosts a Jurassic felsic pluton emplaced into a Mississippian–Pennsylvanian carbonate-dominated sedimentary sequence that is spatially associated with numerous polymetallic (potentially skarn-type) mineral deposits. The timing of mineralization in this district has not previously been constrained, resulting in uncertainty on the relationship between mineralization and pluton emplacement. This study presents new geochronological data for understudied W–Mo–Cu mineralization associated with a Jurassic pluton and outlines key relationships between the geological setting, magma composition, and paleo-fluid evolution of these polymetallic systems.

Six molybdenite samples dated using the Re-Os technique yielded five ages between 156.8 ± 2.2 and 154.4 ± 2.2 Ma that are consistent with existing unpublished zircon U-Pb ages for the proximal pluton (156.1 ± 1.8 Ma). This suggests that the pluton was likely the controlling factor in the generation of the molybdenite and associated mineralization in this area, indicating these are most likely skarn systems. However, an older age of 165.6 ± 2.4 Ma for the sixth low-Re sample provides evidence of multiple pulses of molybdenite mineralization, potentially indicating an earlier non-skarn molybdenite phase of mineralization or that some skarns are associated with a hitherto unidentified earlier phase of intrusion. This study also presents in-depth petrographic analyses from several mines in the district which outline key paragenetic relationships (cross-cutting and overprinting) and mineral assemblages that constrain the timing of alteration and mineralization. These include (1) early actinolite, apatite, diopside, and scheelite(?) skarn alteration, (2) a main molybdenite, chalcopyrite, bornite, pyrite, magnetite, hematite, and calcite phase of mineralization, and (3) post-skarn supergene malachite, azurite, chrysocolla, chalcocite, calcite, and limonite alteration. Future SEM imaging and EPMA will provide further insights into the genesis of W–Mo–Cu mineralization in the Gold Hill district as well as future exploration targeting in similar terranes.

THE 17th ANNUAL UNLV GEOSYMPOSIUM
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EMBEDDED CRITICAL MATERIAL FLOW: THE CASE OF NIOBIUM, THE UNITED STATES, AND CHINA

Dalton M. McCaffrey[1,2], Nedal T. Nassar[2], Simon M. Jowitt[1], Abraham J. Padilla[2], Laurence R. Bird[2]
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Critical mineral commodity assessments (i.e., commodities with a wide array of applications in low- or zero-CO_2 emissions, energy-efficient, and strategic technologies but associated with a high potential for a limited supply limitation or risk) consistently rank Nb above other critical mineral commodities. This reflects its important suage within steels implemented in automobiles, high-rise buildings, and other modern infrastructure coupled with the limited geographical distribution of raw material Nb production. However, there is limited research available on embedded Nb flows (i.e., Nb contained within more widely traded, finished goods such as automobiles) even though such analyses can highlight bottlenecks in the Nb supply chain. This study, focused on embedded flows within the steel industry, provides the first dynamic (2000–2020) Nb flow analysis for two primary Nb-consuming countries: the United States and China.

This study indicates that the United States is import dependent on Nb throughout all stages of the Nb flow cycle, including both raw material (primary) and embedded (manufactured steel products) forms, whereas China is only import dependent on primary Nb. Additionally, yearly consumption of Nb is ~73% higher and ~70% lower for the United States and China, respectively, when including both embedded and primary Nb flows compared to etimates only considering primary Nb. This demonstrates that although both countries are Nb import dependent, their reliances are different, meaning a supply chain disruption would have different impacts on both countries. This is because the United States consumes Nb whereas China re-exports most Nv in manufactured forms, suggesting its dependence on Nb for economic growth and health (i.e., economic dependence). Lastly, this research demonstrates that excluding embedded flows results in missing the key information necessary for criticality ratings and reducing exposure to supply chain restrictions.

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PETROGENESIS AND HYDROTHERMAL ALTERATION OF AN EVOLVED RHYOLITE, THE BLAWN FORMATION, SOUTHERN WAH WAH MOUNTAINS, UTAH

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The Red Beryl (RBR) and Tetons units of the Blawn Fm. are two A-type rhyolites within the Wah Wah Mountains of Utah with different igneous evolution and alteration histories. The RBR is subdivided into two units, RBR Early and RBR Late, based on eruption timing and notable differences in concentrations of select trace elements. These rhyolites were derived from mantle- or lower crustal-derived basalts that underwent high degree fractional crystallization with little to no crustal contamination. The RBR Late unit is strongly depleted in several incompatible elements compared to the other undepleted rhyolites in the Blawn Fm. These incompatible elements were removed by the crystallization of fluorite, cerianite, monazite, and xenotime from the evolving melt. This indicates that extensive differentiation prior to eruption can generate rhyolites that are depleted in incompatible elements, some of which are classified as critical for current technology and the energy transition.

Some critical element-bearing mineral phases within the Blawn Fm. are anhedral, porous, and present in the groundmass or in pores within the rhyolite, whereas others are euhedral and typically present as inclusions within phenocrysts. These variations in crystal texture and mineral associations indicate different primary igneous and secondary hydrothermal mineral assemblages. Alteration indices as a proxy for hydrothermal alteration indicate that alteration and secondary mineralization did not affect trace element concentrations (REE, Nb, Ta, Y, etc.) of the rocks, neither upgrading nor degrading them beyond the concentrations established during igneous processes. This study indicates that although concentrations of elements of interest, such as the REE, Nb, Ta, Y, and others, may not increase during the alteration of A-type rhyolites, this alteration may significantly increase the economic potential of these units by increasing leachability and processability of the altered units.

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REDUCING AND INTERPRETING DATA FROM ICP-MS USING THE STANDARD ADDTION METHOD

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Inductively coupled mass spectrometry (ICP-MS) is a commonly used type of mass spectrometry used to analyze and identify elements or isotopes. By determining the mass-to-charge ratio of ionized analytes and separating them into detectors, a resulting ion signature can be reported as counts per second. This signature is known as the instrumental signal. Here we present the methodology of reducing and interpreting data from the ICP-MS signal. Using the standard addition method of data reduction, we determined the concentrations of U-238 and Th-232 in two pyrite samples. A standard solution was prepared from known U ppm and Th ppm standards and diluted to a 10 ppb concentration. The samples were seperated into separate aliquots and spiked with the standard solution to determine the concentrations of U and Th in the pyrite samples. By plotting the instrumental signal on the y-axis and spiked concentrations on the x-axis, we can extrapolate sample concentrations using a linear regression model. Final concentrations were corrected by using U and Th as internal standards, thereby decreasing the uncertainty of the measurement.

THE 17th ANNUAL UNLV GEOSYMPOSIUM
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THE ROLE OF ASSIMILATION AND FRACTIONAL CRYSTALLIZATION IN THE DIVERSIFICATION OF THE MARS CRUST

Amanda Ostwald[1], and Arya Udry[1]
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The crust of Mars is primarily comprised of basalt, but also contains localized compositional diversity including felsic (>55 wt.% SiO_2) rocks such as those analyzed by the *Curiosity* rover at Gale crater. In absence of crustal recycling, martian felsic rocks may have formed by intraplate magmatic processes, such as fractional crystallization (the progressive removal of minerals as they form). However, studies find that large and possibly unrealistic degrees of solid fractionation are required to generate felsic rocks in Mars-relevant fractional crystallization models. Assimilation and fractional crystallization (AFC) is a process wherein minerals are removed from magma as it cools, but the surrounding crust (wallrock) is simultaneously heated until it partially melts. The crustal partial melt, when added to the cooling magma, causes further evolution. In this study, we conduct AFC modeling using the Magma Chamber Simulator with Mars-relevant magma compositions and conditions. We find that AFC replicates observed martian felsic materials within error of the ChemCam instrument onboard the *Curiosity* rover. Normative mineralogy for the best fit models is comparable to *Curiosity* felsic targets as well. AFC provides good fits to observed felsic targets at lower degrees of crystallinity than fractional crystallization models alone. The primary control on AFC is the initial temperature of the wallrock, as hotter wallrock will melt more readily. Thus, AFC and its potential associated crustal diversification would be more relevant on early Mars when the crust was hotter, near to volcanic centers where the temperature is elevated, or at depth. These findings match observations of felsic martian materials, which are concentrated in ancient (~3 Ga) crust. Compositional diversity on other terrestrial planetary crusts, such as those of Venus or Mercury, may also have resulted from AFC.

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LABORATORY GROWN HYDROTHERMAL VENT CHIMNEYS AS ANALOGS TO THE STRÝTAN HYDROTHERMAL FIELD SITE IN ICELAND AND THE ERIDANIA BASIN ON MARS

N.A. Carman[1], L.M. Barge[2], E.M. Hausrath[1], A. Celestian[3], J. Chavez[4], D.E. LaRowe[5], R. Price[6]
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Submarine hydrothermal vents are ubiquitous features where seawater percolates through the crust, heats up, interacts with rocks and emerges at the ocean floor as hydrothermal fluid. These hydrothermal systems can provide information on origin of life on Earth and past alkaline hydrothermal conditions that could have supported biological processes on early Mars. This study focuses on the Strýtan Hydrothermal Field (SHF) in Iceland, which is basalt-hosted, anoxic, alkaline environment that forms massive hydrothermal saponite. The SHF site is analogous to that of the Eridania basin on Mars where massive saponite and other Fe/Mg-clays have been proposed to form under a deep sea volcanic-sedimentary setting driven by hydrothermal activity. The project's purpose is to simulate the growth of hydrothermal chimneys under similar conditions as the Eridania basin on Mars; in particular, to determine how the Fe/Mg ratio of the seawater and hydrothermal fluids influences the chimney mineralogy under anoxic conditions and aging at high temperature to form clay minerals.

Laboratory experiments were conducted to simulate hydrothermal conditions analogous to the Eridania basin on Mars, with a Si-containing hydrothermal fluid interacting with Mg^{2+}-rich (for the SHF) and variable Fe^{2+} seawater (for Eridania). Chimneys grown in 50/50 Fe/Mg experiments were analyzed by Raman spectroscopy, µXRF, and XRD before and after they were aged in Teflon lined Parr-vessels at 158°C for 48 hrs. Raman shifts 184cm^{-1}, 359cm^{-1}, and 680cm^{-1} correlated with a Mg-montmorillonite. Mineral assemblages from XRD such as halite, gypsum, talc, montmorillonite, and a possible amorphous Fe phase could be analogous to the Eridania basin. The chemical composition of our chimneys observed by µXRF varied and may be due to its porous interior resulting in a chemical gradient. Future work will continue to examine other Fe/Mg ratios, geochemical modeling of the lab simulated chimney's chemistry and evaluating trapped organic matter within the chimneys.

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INCIPIENT ALTERATION OF OLIVINE INDICATES THE UTILITY OF OLIVINE IN DETERMINING PAST WATER-ROCK INTERACTION ON MARS

Feldman AD[1], Hausrath EM[1], Rampe EB[2], Burnley P[1], Morris RV[2]
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Olivine has been proposed as a mineral indicator for the duration of water-rock interaction on Mars. However, evaluating olivine alteration requires interpretation of a complex combination of environmental factors including fluid pH, aqueous alteration duration, and temperature. Here we examine the effects of environment and composition on dissolution of natural olivine and emplaced polycrystalline forsterite and fayalite disks within ultramafic soils chemically similar to many Martian sediments, developing under mediterranean, subarctic, and desert climates. Forsterite disks were cut from a pre-existing column of 97% forsterite and 3% co-existing enstatite prepared by hot pressing at 1400℃ and 100 MPa. Fayalite disks were prepared by sintering synthetic fayalite powder within a Griggs apparatus at 24 MPa and 950°C for a period of 8 hours and contain ~2% co-existing quartz. Previous X-ray diffraction results indicate that natural olivine persists in our ultramafic soils to ~12-15 ka under the mediterranean climate but >20 ka under the subarctic climate. Forsterite and fayalite disks emplaced for 365 days were examined by SEM, x-ray photoelectron spectroscopy, and visual and near infrared spectroscopy for dissolution feature formation, cation leaching, and the development of secondary precipitates. Forsterite dissolution correlated well with environmental conditions; formation of lining and pitting features was accompanied by leaching of Mg in the wetter soils while we observed minimal surface alteration under the desert climate. The warm and wet mediterranean conditions correlated with the greatest alteration, with more limited but observable alteration of forsterite disks emplaced in the subarctic climate soils. In contrast, fayalite surfaces exhibited greater alteration than forsterite in the subarctic and desert soils but exhibited limited surface alteration in the mediterranean climate soils. Variations in olivine weathering on Mars determined by rover analyses and following sample return may thus yield important information about environmental conditions and the duration of water-rock interaction.

THE 17th ANNUAL UNLV GEOSYMPOSIUM
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THE POTENTIAL OF USING URANIUM CONCENTRATION AS THE REDOX PROXY; URANIUM CONCENTRATION CHANGE ACROSS THE STEPTOEAN CARBON ISOTOPE EXCURSION (SPICE) IN THE SOUTHERN GREAT BASIN.

Chin Chai Huan[1], Ganqing Jiang[1], Shichun Huang[1], Jonathan Baker[1]
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Uranium (U) is a redox-sensitive element. In oxic water columns, U occurs as soluble U(VI) and under anoxic conditions, U would reduce to less soluble U(IV) and sink with organic/mineral particulates into sediments. In ancient oceans if anoxic seafloor expands, U would sink faster, resulting in U depletion in seawater. Abrupt drops of U concentration across the major anoxic events in geological history suggest that U concentration in carbonate rocks potentially recorded the redox landscape of ancient oceans. To test if U concentration in carbonate rocks recorded the redox conditions of late Cambrian carbonate platform, I have analyzed the U concentration across the SPICE in three sections of the southern Great Basin. The U/Th ratios (here Th is used as discriminators for siliciclastic influence) in all three sections of different depositional environments are very low (< 2.0) during the SPICE, but they show an increase to ≥ 4–6 after the SPICE. The low U/Th values suggest that during the SPICE, expansion of anoxic seafloor may have led to depletion of U in seawater. The increase of U/Th values after the SPICE may imply the growth of the oceanic U reservoirs in response to ocean oxygenation.

Compilation of the U concentration data of carbonate rocks through time shows that U concentrations in carbonates display secular trends similar to those of the black shales and iron-rich rocks. The secular variations of carbonate U concentration also match those of the Ce anomaly, sulfur isotopes, Zn/Fe ratio, U isotopes (δ238U), and I/(Ca+Mg) ratio. The consistent secular pattern of multiple redox proxies implies that the U concentrations of carbonates, after careful diagenetic screening, could be a valuable proxy for documenting the redox change in ancient carbonate platforms.

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ADAPTING A TEACHING ACTIVITY INVOLVING COLUMBIAN MAMMOTH (*MAMMUTHUS COLUMBI*) MOLARS TO THE DIGITAL REALM USING STRUCTURE-FROM-MOTION PHOTOGRAMMETRY

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The use of 3D scanning is experiencing increased widespread use for fossil documentation, preservation, and research. For fossil replication, the use of 3D scanning provides advantages over more traditional methods of replication, which involve creating casts from molds taken of the original fossil; such methods can damage the original fossil material. Through 3D scanning, the resulting 3D models can be disseminated digitally by displaying them on a web-based digital platform, such as Sketchfab, or by producing replicas of the original material through the use of 3D printing.

A previously developed teaching activity involves students examining resin casts of locally collected fossil molars of Columbian mammoth (*Mammuthus columbi*). This teaching activity not only teaches students about the local fossil record, it helps them develop skills in measuring, graphing, data collection, and hypothesis testing. It involves the students making inferences about the age distribution of mammoths that had once inhabited Las Vegas Valley. To facilitate this activity, resin casts were created from latex molds taken of fossil molars. However this methodology had some negative impacts on the original fossil material.

Here, we present a digital adaptation of this activity through the use of close-range Structure-from-Motion (SfM) photogrammetry. The use of SfM photogrammetry provides advantages over other 3D scanning technologies, including cost-effectiveness and the production of photorealistic 3D models. The resulting models will be uploaded to the Sketchfab account of the Las Vegas Natural History Museum and made publicly available for viewing and download. This adaptation will also demonstrate that the use of 3D scanning technologies should be a preferred method for use in future projects similar to this one.

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FOSSIL PRESERVATION IN THE LAS VEGAS FORMATION: TAPHONOMIC MODES AND DEPOSITIONAL ENVIRONMENTS

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The Las Vegas Formation (LVF) is a middle Pleistocene to early Holocene sequence of groundwater discharge (GWD) deposits that represent ancient spring ecosystems that occupied the much of the Las Vegas Valley between ~573 ka and 8.2 ka. Fluctuations in climate led to repeated expansion and desiccation of these ecosystems, and evidence for various groundwater-fed hydrologic regimes including marshes, wet meadows, spring pools, and spring-fed streams are contained within the LVF sediments. The LVF preserves a diverse vertebrate fauna, designated as the Tule Springs Local fauna (TSLF), which dates to ~100 ka to 12.5 ka, and is composed of a variety of taxa including mammals, birds, reptiles, amphibians, and fish. The primary goals of this project are to: (1) Characterize the taphonomic modes of preservation of the large mammal taxa of the TSLF; (2) Examine the relationship between facies and taphonomic modification; and (3) determine if vertebrate fossil preservation in the LVF is primarily controlled by depositional setting or by stratigraphic member/age of deposition. Large mammals (>5 kg body size) were included in this analysis; small mammals and non-mammalian vertebrates are affected differently by taphonomic filters than large mammals, and were not considered for this study. The most abundant large mammal taxa in the TSLF are Mammuthus sp., Camelops sp., Equus sp., and Bison sp.; carnivore fossils are rare but include Smilodon fatalis and Canis dirus. A total of 28,842 bone fragments from museum collections were analyzed, yielding a total number of identified specimens (NISP) of 717. We are currently examining and describing surface modification, fragmentation, and weathering of specimens to interpret the taphonomic history of vertebrate remains from the LVF. The results of this study will clarify relationships between fossil preservation, depositional environment, and hydrologic regime in the upper Las Vegas Wash during the Late Pleistocene epoch and provide context for the preservation of vertebrate remains in GWD deposits elsewhere in the Mojave Desert.

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GENERATING POWER WITH LESS LAND – ASSESSMENT ON SOLAR PLANT EFFICIENCY AND THE REAPPROPRIATION OF ENDANGERED SPECIES LAND USE

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In the periphery of the Las Vegas Valley, recent infrastructure developments for renewably sourced energy have caused concerns for those interested in the preservation of open natural habitat. The Ivanpah Solar Facility and Nevada Solar One power plants represent two different renewable energy technologies with potentially different area to power generation statistics. This project assesses the impacts of the two power facilities on the habitat of the endangered Mohave Desert Tortoise. If future plants are to be built, one might consider the most concentrated power-to-land energy system to be ideal in effort to reduce the underlying environmental impact inherent in the development of spatially extensive infrastructure.

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ASSESSING THE POTENTIAL FOR MAGMATIC SULFIDES WITHIN THE SOUTHWESTERN LAURENTIA LARGE IGNEOUS PROVINCE

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The Southwestern Laurentia large igneous province (SWLLIP) consists of a range of diabase dikes, sills, and sheets emplaced between 1094 and 1080 Ma in the southwestern United States and northern Mexico. These intrusions were emplaced into shallow sedimentary units, granites, and gneissic basement units. This study focuses on determining the petrogenesis, sulfur saturation, and magmatic sulfide potential of this LIP. This includes an assessment of crustal contamination, an essential process in generating magmatic Ni-Cu-platinum group element (PGE) sulfides.

An initial examination of the limited data available from previous research provides evidence of fluctuations in Cu and Co concentrations and preliminary evidence of crustal contamination, suggesting that these units may be prospective for magmatic sulfide mineralization. However, this will need to be investigated further during this study. Samples have been collected from known diabase intrusions in California and New Mexico, with a further sampling of Arizona localities to take place in late Spring 2022. These samples will be used for thin section petrography as well as whole-rock geochemical analysis by solution inductively coupled plasma atomic emission spectroscopy (ICP-AES) for major elements, inductively coupled plasma mass spectrometry (ICP-MS) for trace elements, and Ni-telluride assay with an ICP-MS finish for precious metals such as Pt, Pd, and Au.

The interpretation of the resulting data study will further our understanding of this complex magmatic event, outline the magmatic sulfide potential of the LIP, and enable the testing of models for the formation of this LIP and any possible relationship to contemporaneous and magmatic sulfide-associated with the Midcontinental Rift (MCR) magmatic event. This study will also place this LIP into the tectonic and global LIP record context to understand whether the diabase intrusions of the SWLLIP are prospective for future mineral exploration for magmatic sulfide mineralization and other LIP-related mineralizing systems.

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ON THE ORIGIN OF THE GEOLOGIST SEAMOUNTS: PRELIMINARY MODELS AND FUTURE DIRECTIONS

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The Pacific Basin encompasses hundreds of seamounts and guyots, most of which have unknown geodynamic origins. These seamounts provide vital constraints on mantle source reservoirs, past tectonic events, and paleo-plate motion vectors. The Geologist Seamounts (alternatively named South Hawaiian Seamounts), located at 18° 40′ N, 157° 40′ W, are a group of nine seamounts arranged in a NE/SW facing V-shape. The morphological structure of these seamounts ranges from guyots, radial seamounts, and volcanic ridges. Previous work has suggested a late Cretaceous age for seamount construction through plagioclase 40Ar/39Ar total fusion experiments. The previous models were based on older, limited age determinations and lack geochemical constraints. Here we seek to test previous models and propose new models through the acquisition of high-resolution age determinations and whole rock geochemistry. This study incorporates newly acquired multibeam bathymetry, submersible dive footage, and basalt samples from the NOAA Ocean Exploration Expedition EX1504L3. Here we focus on five samples from McCall, Ellis and Swordfish Seamounts that are primarily alkalic subtrachytic-trachytic plagioclase basalts. Plagioclase separates have been generated for $^{40}Ar/^{39}Ar$ age determinations and whole rock slabs are being prepared for major and trace element concentration analysis. Using the proposed analyses, this study aims to test three possible models for the formation of the Geologist Seamounts: (1) mantle plume source, (2) asthenosphere shear-driven volcanism, (3) intraplate extensional volcanism. The mantle plume model requires an age progression oriented along paleo plate motion and trace element ratios representative of primitive and/or recycled mantle components. Asthenosphere shear volcanism and extensional volcanism would have similar chemistry, but the extensional model would produce contemporaneous ages along the width of the seamount province while the shear model would predict an age progression correlated to the local mid-ocean ridge spreading rate.

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CHARACTERIZATION OF THE KINGMAN REEF AND PALMYRA ATOLL UNITS OF THE PACIFIC REMOTE ISLAND MARINE NATIONAL MONUMENT: A JOURNEY ON THE *E/V NAUTILUS*

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The ocean basins are home to a large variety of active and extinct volcanic structures such as seamounts, ridges, guyots, and rises. However, due to their inaccessibility, most marine volcanoes are underexplored compared to their subaerial counterparts. Here we focus on 53,175 km^2 of U.S. seafloor territory within and surrounding the Kingman Reef and Palmyra Atoll Units of the Pacific Remote Island Marine National Monument (PRIMNM) that contains numerous seamounts, guyots, and ridges. These poorly explored features have a debated geodynamic origin ranging from multiple hotspots to largescale plate extensional events. Volcanic structures in and around the PRIMNM were explored on three separate remote operated submersible (ROV) expeditions by NOAA and Ocean Exploration Trust (OET). Here we discuss recent discoveries from OET's NA137 *E/V Nautilus* expedition which took place in March 2022. Eight total ROV dives were conducted, six within PRIMNM and two within the US economic exclusive zone as well as high resolution multibeam mapping of 8277 km^2 of seafloor and the collection of 36 rock samples.

Future onshore research following the 2022 expedition will consist of bathymetric mapping, ROV video analysis, petrologic descriptions, $^{40}Ar/^{39}Ar$ age determinations, and geochemical analyses. This combination of geo-morphological, chronological, and chemical analyses will allow for a thorough testing of previously proposed mechanisms for the formation of these enigmatic features.

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DEVELOPING APATITE PETROCHRONOLOGY TO DATE DEFORMATION AND METASOMATIC PROCESSES OCCURRING ALONG THE SUBDUCTION PLATE INTERFACE IN THE CATALINA SCHIST

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The subduction plate interface is a site of fluid transfer, intense metamorphism, and metasomatism. These processes are difficult to reconstruct through space and time given the lack of well constrained in-situ chronometers that occur in exhumed blueschist to greenschist facies subduction complex rocks. Apatite is a common accessory mineral in blueschist and greenschist facies rocks of pelitic, basaltic, and ultramafic origin that may be capable of recording metamorphic and deformational processes at these P-T conditions. Santa Catalina Island/Pimu, Southern California, is host to a suite of metamorphic rocks, termed the Catalina Schist, that formed in an Early Cretaceous subduction zone beneath Western North America. The Catalina schist is comprised of a lawsonite-blueschist facies unit, an intermediate unit that includes rocks from epidote blueschist to albite epidote amphibolite facies, and an amphibolite facies unit that contains mafic amphibolite and ultramafic mélange. Peak metamorphic conditions are estimated to be 300°C and 9 kbar for blueschist, 450°C and 8 kbar for greenschist, and 600°C and 10 kbar for the amphibolite and mélange units. The closure temperature for the U-Pb system in apatite is ~450-550°C, making it the ideal thermochronometer for understanding chemical and mechanical processes along the plate interface recorded in the Catalina Schist. A combination of in-situ analyses, including LA-ICP-MS U-Pb and geochemical analysis integrated with microstructural observations, will be used to test the viability of apatite U-Pb petrochronology as a tool for directly dating deformation and metasomatism at relatively cool blueschist to greenschist facies subduction zone conditions.

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CHARACTERIZATION OF BEDROCK FAULT SCARPS AND HEMATITE FAULT MIRRORS IN THE NORTHERN COLORADO RIVER EXTENSIONAL CORRIDOR NEAR LAKE MEAD, NV

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Fault mirrors are highly reflective, thin (typically <1 mm thick) slip surfaces in exhumed fault zones that provide a record of thermal, chemical, and rheological changes to fault materials during deformation and slip. This study investigates a series of hematite coated fault mirrors along bedrock fault scarps in Miocene volcanic rocks near Lake Mead, Nevada. The studied faults are located at the intersection of the NE-SW trending strike slip faults of the Lake Mead fault system and N-S striking extensional faults of the Northern Colorado River Extensional Corridor (CREC). The studied fault scarps are typically m^2, locally mirrored, and generally NE striking and near vertical. Two sets of slickenlines indicating both strike-slip and oblique slip are preserved on the surface, providing evidence these faults were reactivated multiple times. Initial field and SEM observations on the samples support that these discrete faults have accommodated multiple episodes of slip since the Miocene. A variety of hematite particle textures, sizes, and deformed grains have been observed through SEM analysis of the fault mirror volume. At the slip surface, hematite is characterized by sub-rounded nanoparticles (0.1-1 μm diameter) and broken hematite plates. Along with the varying grain size and morphologies, there is an apparent gradient in size distribution with smaller particles at the surface. Grain morphology observations of scaly and cataclasite fabrics near fault surfaces with specular hematite plates towards contact with host rock (away from the fault surface) and a lack of recrystallized or annealing textures may indicate slow seismic to aseismic slip rates. Future microstrucutral and microtextural characterization and hematite (U-Th)/He thermochronology will inform on fault slip behavior and timing of hematite mineralization along these fault surfaces. Ultimately, this information will inform on the spatial and temporal relationships between extension, magmatism, hematite mineralization, and fault slip in the Northern CREC.

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A GEOSPATIAL ANALYSIS OF LAND DEGRADATION WITHIN THE SAN JOAQUIN VALLEY, CALIFORNIA

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Soil salinization presents a major threat to soil fertility and can lead to land degradation and eventual desertification. Irrigation of farmland is one of the primary causes of increased soil salinization. The San Joaquin Valley in central California is where majority of the state's agricultural industry exists. Since the late 19th century, land subsidence has been observed in the valley resulting from over pumping of groundwater to meet the demands of farmers. Understanding the effects of current irrigation practices and how they contribute to the increased rate of soil salinization is crucial to better manage our croplands before they become rendered useless for food production.

With ArcGIS, I will illustrate the extent of land degradation in the San Joaquin Valley. Data utilized will include soil salinization measurements, vertical land displacement, and land use data. Several GIS tools will be employed in data analysis including operating spatial queries, clipping, the use of buffer zones, and overlay techniques. An index will be created to determine the areas within the valley at greatest risk of land degradation.

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UTILITY-SCALE SOLAR PV IN NEVADA: A DEMONSTRATION MAP OF SOLAR RESOURCES, INFRASTRUCTURE, AND DEVELOPABLE LAND MANAGED BY THE BUREAU OF LAND MANAGEMENT

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Due to an abundant solar resource, Nevada has significant solar photovoltaic development potential. This map illustrates Nevada's current solar assets and future potential by identifying areas auspicious for solar development. To this end, the map combines global horizontal irradiance (GHI) data from the National Renewable Energy Laboratory (in kWh/m^2/year) with solar PV plant and infrastructure data from the Energy Information Administration. The GHI data is four-kilometer resolution with respect to longitude and latitude. Additionally, developable land owned by the United States Bureau of Land Management is shown that either has current solar projects on-site or has been identified as having significant solar resource development potential. High-voltage transmission lines are mapped, and a basic spatial analysis shows that nearly all solar PV plants are located within 1 mile of high-voltage transmission lines.

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INVESTIGATING CONTROLS ON VARIABILITY OF DISSOLVED URANIUM AT HORN CREEK, GRAND CANYON, ARIZONA

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The Grand Canyon is a site of great geologic, cultural, ecological, and economic significance. It serves as a homeland for Native American people such as the Havasupai and Hualapai, attracts millions of visitors annually, provides habitat for twelve endemic plant species, and contains some of the highest-grade uranium ore deposits in the United States. The relationship between groundwater contamination and uranium mining remains inconclusive, although the highest observed dissolved uranium concentrations in the region are observed at springs in the Horn Creek drainage, situated directly below an old uranium mine, Orphan Mine.

Through previous studies, a high variability of uranium concentrations has been observed over relatively short periods of time at sampling sites in the Horn Creek drainage. Although meteorological events have been hypothesized to be a primary control for this variation, no study has been conducted to fortify this hypothesis. This study's objective is to test this hypothesis, in conjunction with three other hypotheses: 1) Dissolved uranium is attenuated moving down drainage, further away from the orphan mine; 2) The West Horn Creek drainage is hydraulically connected with Salt Creek drainage; and 3) There is a significant lag time between meteorological events and fluctuations in dissolved uranium concentrations. As dissolved uranium concentrations have been consistently sampled relative to other springs and drainages in the Grand Canyon, the volume of data allows for seasonal comparison of uranium concentrations, making Horn Creek an ideal site for this study.

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MAPPING SURFACE FEATURES ON MARS USING ARCGIS

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This project uses ESRI's ArcGIS software tools to digitize geomorphologic surface features on Mars caused by fluvial processes and meteor impacts. This research is in an effort to answer the question of what geological and geomorphological features on Mars might be of interest for future rover missions. The methodology used in this research is heads-up digitizing for features of interest with points, lines, and polygons. Additionally, a quantitative analysis of selected features is performed from measurements using ArcGIS software tools. To overcome problems with differing projections, the study area is within 10 degrees of latitude of Mars' equatorial region, and a Universal Transverse Mercator (UTM) system is used to reduce distortion issues which might be caused by other methods. It can be concluded from this research that Mars and Earth have undergone comparable surface processes creating similarities within the features of interest. Identifying, digitizing and measuring these features will assist in selecting future landing and study sites for rovers and probes.

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CONCENTRATIONS OF U AND TH IN PYRITES USING THE STANDARD ADDITION METHOD

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The standard addition method is a quantitative analytical technique used in mass spectrometry to determine elemental concentrations of unknown samples. We prepared two dissolved pyrite solutions to identify uranium and thorium concentrations measured with inductively coupled mass spectrometry (ICP-MS) using the standard addition method. This method was used to minimize interference caused by the matrix effect, whereby other elements present in the solution may affect the signal of the chosen analytes. Each pyrite solution was seperated into five solutions of equal volume that were spiked with increasing amounts of a prepared 10 parts per billion U and Th standard solution. The resulting measurement is a linear function in which the sample's signal increased as a function of the known amount of U and Th added to each sample. The function's slope determines the concentration of the unknown sample solution by extrapolating concentration when the signal is zero. Errors due to slight measurement differences were accounted and adjusted for using a calculated dilution factor and instrumental drift was corrected using internal standards.

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HOW URBAN EXPANSION IN LAS VEGAS WESTWARD HAS IMPACTED THE LAND

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In this research poster we will examine the urban residential expansion of a specific area where residential meets undeveloped land and correlate how it has impacted geography of the immediate area and surrounding areas. We will also be looking at and evaluating if those impacts are negative or positive. To thoroughly examine the impacts, we viewed qualitative and survey data, as well as satellite imagery for dislocated and reallocated land. We focused specifically on loss of natural land compared to the development of houses and recreational areas. Our conclusions were drawn on both past and present data to further explore and validate implications. We conclude that the fast-paced development in this area has offered little compensation in return and disturbs the natural environment in an irreversible way. The recent expansion in this area impacts wildlife, habitats, fluvial and natural processes, and resident safety. We argue that the aggressive expansion implies that Las Vegas values development over safety, without thinking about long-term implications. Continued expansion westward could increase lost natural land and worsen safety impacts on residents.

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TREE POLLINATION ON UNLV CAMPUS

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This project aims to analyze the air quality on UNLV campus and the connection that trees on campus may have to air quality. Certain trees stand out as high pollinators and may affect certain populations with sensitive respiratory systems, such as asthmatic populations, we are attempting to identify which trees are high pollinators, and which may be candidates for removal. We gathered several attributes of data, such as species, diameter, health, and coordinates of all the trees on the UNLV campus grounds, narrowing out high pollinating trees such as Mulberries. High pollinating trees in bad condition could be removed to both improve air quality and conserve resources on a dying investment. Using data gathered from the UNLV Arboretum Department, the trees were mapped onto a geographic projection of the UNLV campus.

This tells us how many pollinators are spread around campus and gives us insight to their importance and potential removal with the implications to populations sensitive to such air quality changes.

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SEA LEVEL RISE IN MIAMI-DADE COUNTY, FL

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The purpose of this project is to identify which areas in Miami-Dade County, FL, are the most vulnerable to sea level rise (SLR) and how soon partial or total submersion of these areas is expected to occur. We are using ArcGIS to pinpoint and map rising sea levels based on data of sea level projections to demonstrate the rate at which and to what extent Miami-Dade County will be susceptible to water. Using documented rates of SLR seen in this area, we are able to determine the time at which different areas will be flooded and visually demonstrate SLR at different points in time and in different areas on a map. At the rate at which sea level is rising due to climate change, the solutions that Florida is employing to mitigate the impacts of coastal erosion due to SLR for the future may not be effective enough to protect vulnerable communities. Based on the found data, Miami-Date County may need to implement different methods to facilitate more immediate change in the protection of their coasts. The sea level rise, demonstrated by ArcGIS, provides a spatial view of possible endangered areas over time in Miami-Dade County due to rising sea levels. The timing of when the county is submerged shows how much climate change contributes to sea level rise. Understanding how SLR will affect this area and developing a timeline will provide important insight to aid in the planning and preservation of the county.

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GREENLAND ICE SHRINKAGE

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The Greenland ice sheet contains over 8 percent of all the freshwater on earth, which makes Greenland an area of concern when it comes to climate change. Our constant reliance on fossil fuel continues to be a driving factor for the shrinking ice sheets around the world, especially in the region we are observing. If all of Greenland were to melt away, sea levels would rise over 6 meters. This presentation displays the geospatial changes of Greenland throughout the years, and the potential shrinkage of Greenland's ice sheets. The data displayed will compare both current and future areas of focus such as temperature and ice density.

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COMPLEX ZONING IN NAKHLITE AND CHASSIGNITE METEORITES

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The nakhlite (clinopyroxene-rich cumulates) and chassignite (dunites, olivine-rich cumulates) martian meteorites comprise the largest single-origin suite of rocks from Mars. The 29 total samples share an average crystallization age (1340±40 Ma) and ejection age (11±1.5 Ma), indicative of a shared provenance. The relationship between the nakhlites and chassignites is poorly constrained, and they may have formed and been emplaced together as lava flows or sills, or they may have formed from separate magmas. Furthermore, the two cumulate phases of the nakhlites (olivine and clinopyroxene) may have formed together in a single magma, or one phase may have formed from an earlier magma and then incorporated in another magma. All cumulus phases in nakhlites and chassignites have undergone reequilibration, and do not consistently retain much zoning of divalent cations (i.e., Mg, Fe). Slowly-diffusing cations (e.g., P in olivine, Cr in pyroxene) are preserved and can provide insights into relative eruption rates, potential magma storage, and magma mixing. In this study, we analyze cumulate phases nakhlite samples Caleta el Cobre 022, Northwest Africa (NWA) 10643, NWA 11013, and chassignite sample NWA 2737 for slowly-diffusing cation zoning. We conduct imaging and major and minor element concentration analyses on the electron probe microanalyzer (EMPA) and trace element concentration analyses on the laser-ablation inductively coupled plasma mass spectrometer (LA-ICP-MS). We find that the nakhlite olivine contains P-enriched cores with rounded granular morphologies. In contrast, chassignite olivine is characterized by relict skeletal or hopper morphologies, as well as highly oscillatory zoning. Likely, olivine in the nakhlites and chassignites represent at least two unique populations. Pyroxene in nakhlites displays Cr and Mg depletion with incompatible element (e.g., La) enrichments in the rims, possibly indicative of Cr depletion by fractionation or polybaric crystallization.

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GEOCHEMISTRY AND CRYSTAL SIZE DISTRIBUTION OF NORTHWEST AFRICA 13669, A NEW NAKHLITE

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Nakhlites are cumulate clinopyroxenite-rich rocks from Mars linked by shared crystallization ages (1340 ± 40 Ma) and cosmic ray exposure ages (11 ± 1.5 Ma). These shared properties make the 26 known nakhlites the largest suite of igneous rocks from a common provenance on any planetary body besides the Moon and Earth. As such, nakhlites are vital to understanding relatively recent igneous processes on Mars. Northwest Africa (NWA) 13669 is a recently found nakhlite that provides an opportunity to better constrain how the nakhlites were formed and emplaced on Mars. We conducted major, minor, and trace bulk-rock and mineral chemistry analyses and quantitative textural analyses on two thin sections to determine how NWA 13669 was formed and emplaced and its relation to other nakhlites.

Northwest Africa 13669 exhibits a cumulate textures, typical of nakhlites with an average mineral modal abunance of 62.9% augite, 16.4% olivine, 9.6% plagioclase, 8.3% glass, and 2.8% titanomagnetite. Major, minor, and trace bulk-rock chemistry is distinct from other nakhlite, though, CI-normalized rare earth elements (REE) for NWA 13669 are consistent with previous nakhlite studies for a depleted mantle source. Augite is normally zoned, albeit weakly, from Ca and Mg-rich cores ($En_{36}Fs_{25}Wo_{39}$) to Fe-rich rims ($En_{31}Fs_{32}Wo_{37}$). Olivine is homogeneous (average of $Fo_{28.8}$). Homogeneous olivine and weakly zoned augites in NWA 13669 suggest long term magma storage for some nakhlites. Based on the crystal size distribution (CSD) profiles, NWA 13669 was likely emplaced under similar conditions to the flows or sills, which produced NWA 10645 and the paired Yamato samples, further supporting recent models for nakhlite emplacement with multiple flows or sills. The unique bulk-rock and mineral chemistry in tandom with CSD analyses suggest NWA 13669 could potentially represent a previously unsampled flow or sill from the volcanic edifice on Mars which produced the nakhlites.

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EXAMINING STRESS DISTRIBUTION AND IN POLYCRYSTAL MODELS

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Shear localization is typical in deforming rocks and can be used to determine the applied stress direction. For example, ductile shear zones form 45° to compression. What is unclear about shear localization is how stress affects the spacing of shear bands. By modeling the compression of a polycrystalline rock, precise analysis of the stress distribution and the resulting strain distribution can be acquired. Previous finite element modeling of heterogeneous, polycrystalline material by Burnley [Nature Communications, DOI: 10.1038/ncommons3117 (2013)] has shown a vertical stream-like pattern of high stress. When there was a higher density of the high-stress features, the spacing of shear bands in the model was closer. The high-stress pattern resembles force chains, which are linear, high-stress features that form parallel to compression. Polycrystalline materials have not been examined within the paradigm of force chains and might yield new insights into shear localization.

Adapting clustering techniques from granular materials, I will extract force chains and quantify statistics that could be useful for describing force chains. Granular studies represented their experiments/simulations as a contact network and stress-weighted network for analyses. A contact network defines grains as nodes and grain contacts as edges. A stress-weighted contact network weighs edges based on the stress between the nodes and is used for clustering techniques. Clustering techniques extract force chains that are then quantified using metrics such as the length of the force chain, how much stress the force chain carries, and how linear the force chains are. These force chain metrics can later be compared to the strain distribution of a series of models and assessed for correlations. Using clustering on finite element models of polycrystalline materials, I will explore the possibilities of force chains in polycrystalline materials.

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RESIDUAL STRESS IN POLYCRYSTALS

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Residual stress is common within polycrystalline material that formed at high pressure and temperature conditions. The anisotropic nature of single crystal elasticity and thermal expansivity will result in internal residual stress in a polycrystalline rock at ambient conditions, even if the polycrystal formed under hydrostatic conditions. Residual stress present in a polycrystal has the potential to influence the stress patterning of the same polycrystal if it is subsequently used in a deformation experiment. Therefore, reducing or eliminating residual stress in a polycrystal will simplify any influence that residual stress may have in the stress patterning of a loaded polycrystal.

Raman spectroscopy was used to map the stress states across several differently prepared samples of non-loaded polycrystalline columnar Tiger's Eye quartz. To determine if sample preparation could reduce residual stress, we prepared samples measuring approximately 4x6x2 mm in width, length, and height. Each sample was hand polished using diamond polishing spray to ¼ microns. The first sample was prepared only with a ¼ micron polish, the second sample was etched and polished further to .05 microns, and the third sample was annealed at 1000° C for 48 hours. Raman measurements were taken at the center of each sample where residual stress from elastic anisotropy would be best preserved.

Stress maps indicate a heterogenous residual stress distribution in all samples of Tiger's Eye quartz. The annealed sample showed the largest range of stress from -60 MPa (tensile) to 51 MPa (compressional). Etched samples showed the second largest range -14 MPa to 38 MPa, followed by the polished sample -2 MPa to 36 MPa. The polished sample shows to be the best option for sample preparation that minimizes residual stress. These findings are important for understanding how residual stress influences a natural polycrystalline sample and will aid in future stress distribution experiments.

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DISSOLVED URANIUM DISTRIBUTION AT HORN CREEK, GRAND CANYON

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I examine the spatial distribution of dissolved uranium concentrations in springs and surface water at the Horn Creek drainage (directly below Lone Orphan uranium mine) within Grand Canyon National Park. Historical data sets show significant variation in dissolved uranium across springs in the drainage as well as significant variation in dissolved uranium concentrations over time at respective springs. Using ArcGIS 10.8 I geocoded historical data from Horn Creek and then created several maps depicting change in concentration across over 10 sampling sites in the Horn Creek drainage, which ultimately drain into the Colorado River. The data show a trend of decreasing concentrations of dissolved uranium moving further down the drainage. Additionally, the data show significant spikes in dissolved uranium concentration at springs with a broader trend of decreasing concentrations of dissolved uranium over time.

There is a clear relationship between the proximity to Lone Orphan uranium mine and elevated levels of dissolved uranium, with nearly an order of magnitude difference in concentrations between springs sampled directly below the mine and surface water sampled at the base of the drainage. Using the springs data and GIS I will make corrections to their geolocations and bring in additional data to better understand the spatial and environmental context for these spring sites recorded with less precision in older studies. Further understanding of the historical impacts of uranium mining in the region is necessary as uranium mining in northern Arizona continues to be debated at a national level.

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SAMPLING THE LIFE IN THE DEEP SUBSURFACE: THE SHIFT IN MICROBIAL COMMUNITES DURING THE PUMPING OF A DEEP BOREHOLE

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Deep subsurface water harbors microbial life that is unique to this biome. The study of this ecosystem may answer questions about the limits and diversity of life on Earth, and the possibilities for life on other planets. One major challenge in this field is obtaining samples that are free from contamination and are representative of the subsurface. A common source of contamination is the microbial community associated with the static water in the cased portion of a borehole, which is typically very different from the formation water due to water-metal interaction. This study aims to describe the shift in microbial community from the cased to the formation water in Inyo-BLM-1, a borehole located in discharge zone of the Death Valley Regional Flow System (DVRFS). Timepoint data was collected over 55 hours at pump rates between 35 to 300 GPM, with samples for 16S rRNA sequencing, qPCR 16S rRNA absolute abundance, physicochemical parameters, and water chemistry. Together these data document a clear distinction between the cased and formation water, which is useful in determining which samples are appropriate for studying the deep subsurface biome.

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THE ACOUSTOELASTIC EFFECT: MEASURING THE EFFECT OF STRESS ON P- AND S-WAVE VELOCITIES

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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. An experimental ultrasonic acoustic system, the Directly Integrated Acoustic System Combined with Pressure Experiments (DIASCoPE), was used with the D-DIA multi-anvil apparatus to transmit ultrasonic sound waves and collect the reflections. We use the DIASCoPE to obtain longitudinal (P) and shear (S) elastic wave velocities from San Carlos olivine at pressures ranging from 3.2–10.5 GPa and temperatures from 450–950°C which we compare to the stress state in the D-DIA derived from synchrotron X-ray diffraction. We use elastic-plastic self-consistent (EPSC) numerical modeling to forward model X-ray diffraction data collected in D-DIA experiments to obtain the macroscopic stress on our sample. We can observe the relationship between the relative elastic wave velocity change ($\Delta V/V$) and macroscopic stress to determine the acoustoelastic constants, and interpret our observations using a linearized first-order equation based on the model proposed by Hughes and Kelly (1953). This work supports the presence of the acoustoelastic effect in San Carlos olivine, which can be measured as a function of pressure and temperature. This study will aid in our understanding of the acoustoelastic effect and provide a new experimental technique to measure the stress state in elastically deformed geologic materials at high pressure conditions.

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GEOGRAPHIC INFORMATION SYSTEMS MAP OF BEDROCK FAULT SCARPS AND HEMATITE FAULT MIRRORS IN THE NORTHERN COLORADO RIVER EXTENSIONAL CORRIDOR NEAR LAKE MEAD, NV

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This study investigates a series of hematite coated fault mirrors along bedrock fault scarps in Miocene volcanic rocks near Lake Mead, Nevada. The studied faults are located at the intersection of the NE-SW trending strike slip faults of the Lake Mead fault system, the NWSE striking Las Vegas Shear zone, and the N-S detachment faults of the Northern Colorado River Extensional Corridor (CREC). This study utilizes Geographic Information System (GIS) to create an interactive map from georeferenced existing maps of the area. The project will display different layers of information including the geologic units, faults, and locations of samples studied within the Boulder Beach Quadrangle. The resulting map details complex data specific to this scale of the Lake Mead region of Nevada that has not been created previously. The interactive map will not only provide geovisualization of the complex area but inform on the geologic setting and locations of samples collected from the hematite coated fault mirrors in bedrock through cartographic interaction of data sets.

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REMOVAL OF ORNAMENTAL GRASSES AT THE UNIVERSITY OF LAS VEGAS NEVADA

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With the application of geographic information systems, I determined the amount of water used annually on watering ornamental grasses on the University of Nevada Las Vegas campus. Removal of these grasses would help to mitigate the water crisis the Las Vegas Valley is experiencing, reserving more water for residents. Ornamental grasses are those not in recreational use but purely aesthetic. The techniques I used to determine my calculations included, using basemaps from ArcMAPS, imagery and topological maps, as well as use of ariel footage from google maps for larger area calculations. I created a new polygon, feature class layer of the removeable ornamental grasses in ArcMaps and digitized my data. Without knowing the exact species of grass or soil type and water holding capacities, my estimations for water used annually were determined from research articles and the Southern Nevada Water Authorities restrictions. My calculations have determined that removing x_{grass} amount of grass from the University of Nevada Las Vegas campus, x_{water} amount of water was saved annually. I have also determined that if that grass were to be replaced with less water intensive vegetation that x_{water} would be used annually for the selected areas, saving x_{water} per year which would offer an aesthetic alternative to ornamental grasses.

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TIMING OF EXHUMATION OF THE WINTERS PASS THRUST SHEET IN SOUTHEASTERN CALIFORNIA: CORRELATION TO THE WHEELER PASS THRUST SHEET?

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Crustal thickening during the Late Jurassic to mid Cretaceous generated a series of thrust sheets along the southern Sevier fold and thrust belt. Southern Nevada and southeastern California host several thrust sheets related to this tectonic event. The Winters Pass thrust, located in the Mesquite Mountains, California, is regarded to be the southern continuation of the Wheeler Pass thrust of the NW Spring Mountains, 50km to the north. Zircon (U-Th)/He thermochronology data for the Wheeler Pass thrust sheet suggests it was exhumed during thrust motion between 160 Ma and 140 Ma. Current timing constraints for the Winters Pass thrust are derived from regional correlation, with no direct geo- or thermochronometric constraints. Correlations to the Wheeler Pass thrust to the north, and the Pachalka thrust to the south, suggest a Late Jurassic age for thrust slip. Mylonitic shear zone(s) developed in Paleoproterozoic basement are alternatively interpreted to represent Mesozoic shortening deformation at the base of the Winters Pass thrust sheet and Miocene deformation associated with extensional detachment faulting. The proposed study of the shear zone will resolve which of these interpretations is correct by integrating thermochronology with field and microstructural data. Integration of the resulting cooling curve with estimates of deformation temperatures from microstructures will date exhumation and deformation to allow testing of the proposed correlation to the Wheeler Pass thrust sheet. Should the kinematics be compatible with thrusting, this study will better resolve the influence of the Proterozoic rift architecture on superimposed deformation kinematics of the Sevier fold-and-thrust belt, and improved timing constraints will allow the relation between high flux events in the magmatic arc and thrusting to be assessed.

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AN ILLUSTRATED GUIDE TO TINY PLEISTOCENE MOLLUSKS OF SOUTHERN NEVADA

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The purpose of this project is to provide a photographic guide to the common mollusks found in Late Pleistocene sediments of southern Nevada. In the Late Pleistocene, a cooler, wetter, and more vegetated environment supported many species of mollusks. The diversity of mollusks from that time period in this region is not well-documented nor well-illustrated, with the most thorough documentation having listed 28 species. Even though nearly all fossilized mollusks uncovered in the region thus far have been identified as genera still extant, we can use their presence as a method to further describe and reconstruct that Late Pleistocene environment based on where these genera live today. Some genera found, including *Euconulus, Pupilla, Gastrocopta,* and *Vallonia,* are terrestrial mollusks, while the majority of genera found, including *Pisidium, Valvata, Fossaria,* and *Gyraulus*, are freshwater mollusks. The freshwater mollusks appear in Late Pleistocene sediments in far greater numbers, especially *Pisidium, Ferrissia,* and *Gyraulus,* than the terrestrial mollusks, which hints to southern Nevada's history of perennial freshwater springs, most of which have since dried up due to the continuously increasing local temperatures.

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RESOURCE IMPLICATIONS OF ALGAE UNDER MARS-RELEVANT PRESSURE AND LIGHT CONDITIONS

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The search for sustainable components for human-based missions to Mars is under current investigation. Algae, due to their edible biomass and O_2 production, may serve as valuable resources. To explore this, we examine the potential use of *Chlorella vulgaris* (CV), *Dunaliella salina* (DS), and *Chloromonas brevispina* (CB) as components for potential Bioregenerative Life Support Systems (BLSS) by exposing them to Mars-relevant pressures and light conditions.

Each experiment begins with cultivation of each species in triplicates in 250 ml flasks inside low pressure, CO_2-sparged vacuum chambers, following similar methodology to our lab's prior algae research. 160 mbar was chosen as it is compatible with proposed martian greenhouse pressures. To prevent algae sedimentation, chambers are homogenized atop shaker plates (150 RPM), and are illuminated by full spectrum LED grow lights (MIXJOY GL2000) at 500 µmol m^{-2} s^{-1}. Samples of liquid media are taken by pipette in a laminar flow hood and are observed using an Olympus BH light microscope and measured on a GENESYS UV-Vis spectrophotometer for cell counts and optical density (OD), respectively. Further analyses for chlorophyll a, chlorophyll b, and carotenoid pigments are performed using methanol-based extractions. 1 ml samples of gas headspace are collected from the chamber's septa-sealed valve through gas syringe. O_2 concentration is measured using an SRI 8610C Gas Chromatograph (GC).

Results show biomass increases for all species, as measured by cell counts and OD, with CV showing the highest growth followed by DS and CB. Extractions indicated greater pigment production by CV and DS cultures compared to CB. Additionally, preliminary GC measurements show highest O_2 production by DS, followed by CV and CB. Research is ongoing and will include additional growth experiments performed under red and blue light. This work has the potential to help support human exploration through the production of O_2 and edible biomass.

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ARE THE CORAL BIOSTROMES IN THE CARBONIFEROUS-PERMIAN BIRD SPRING FORMATION A BIOLOGICAL RESPONSE TO SEA-LEVEL OSCILLATIONS?

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Exposure of the Carboniferous-Permian Bird Spring Formation near Pahrump, Nevada contains a cliff-forming interval with multiple, low diversity biostromes dominated by the solitary rugose coral, *Fomichevella nevadensis*. This coral-biostrome interval, which is 1.2 m thick, contains three to five biostromes. It is laterally continuous for at least 2.5 km. The tabulate coral, *Syringopora*, crinoids, bryozoa, brachiopods, and *Chaetetes*, a Pennsylvanian sponge, occur in associated horizons; but, they typically do not occur within the rugose coral biostromes. However, the fusulinid, *Fusulinella*, occurs within the base of the coral-biostrome interval.

In this study, we are testing the hypothesis that this cyclicity of coral biostromes is a far-field response to glacio-eustatic sea-level oscillations as the Late Paleozoic, Southern Hemisphere ice cap expanded and contracted. The Bird Spring carbonate platform, which was developed in a low-latitude setting, is well-known for its alternating cliff-and-slope erosion pattern. This pattern is commonly interpreted to record sea-level oscillations. However, we are not aware of previous studies that have documented sub-meter-scale cyclicity in marine invertebrate community structures such as we observe at our “Triplehorn” site. Such an interpretation would imply that the rugose corals and other taxa lived within a surprisingly narrow range of water depths.

We are using standard carbonate sedimentology and facies analysis techniques to reconstruct water depth and wave energy conditions at successive levels within this interval of the Bird Spring Formation.

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AUSTRALIAN BLACK SUMMER FIRES: ECONOMIC AND ECOLOGICAL IMPACT

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Geographic information systems (GIS) is a powerful tool that can be used to analyze movement or spread patterns of the various spatial patterns of real-world problems. With the use of GIS and available data, we were able to demonstrate and forecast economic and ecological impacts from the 2019-2020 Australian Black Summer fires. As a result, we were able to examine and understand how the Black Summer fires economically damaged Australia's agriculture, wildlife, lumber industries, and supply chains by combining multiple datasets using ArcMap.

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IMPACT OF FIRES IN SIERRA NATIONAL FOREST ON CRITICAL SPECIES

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The focus of this study is to analyze the burn history of multiple fires over the same region in the Sierra National Forest between 2011-2021. We are interested in the impact these fires have had on critical wildlife species and vegetation and whether there is a correlation between certain species. The study area is the burn perimeter of the 2020 Creek fire near Shaver Lake, which is the fourth largest fire to occur in California state's history. The Creek fire burn zone is of interest because its perimeter contains two previous fires within the last decade, which will allow us to compare habitat conditions before and after different stages of repetitive burns. The Aspen fire burned in 2013 with the bordering French fire in 2014, followed by a period of growth before the Creek fire encompassed both fires in 2020. Through ArcGIS, mapping out impacted vegetation and species after these forest fires occurred will allow interested parties to manage the surrounding environment and critical habitats. Specifically, data collection of vegetation such as ponderosa pine, sugar pine, or giant sequoias before and after these fires will be crucial in spatially analyzing the impact of whether these species impact certain critical wildlife such as the California spotted owl. Subsequently stressed vegetation in the Creek fire burn area will continue to impact the ecosystem species present in that region so it is important to understand how critical species are affected. Population numbers of affected species can also be projected in a separate map to express the relationship between species and the environment.

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RESIDENTIAL DEVELOPMENT OF BLUE DIAMOND: RISK ANALYSIS WITH RESPECT TO GEOLOGICAL AND ENVIRONMENTAL FACTORS

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In this project, we examine the environmental risks associated with building a master planned community on Blue Diamond Hill outside of Las Vegas, Nevada in order to determine potential geologic hazards that must be mititgated for the development of this mine site. Blue Diamond Hill is home to one of Nevada's oldest and largest gypsum mines that has used a mix of mining techniques in the past to remove the target mineral, gypsum. Their mining practices, along with the geology of the hill, drainage patterns, and history of landslides in the area create a dangerous combination for the foundation of the master planned community. By looking at the previous mining methods used in certain areas of the hill and drainage patterns, we conclude that the proposed building area of Blue Diamond Hill would hold a sufficient amount of risk and possible dangers to the developers and future residents in the prospective project area and that this area should not be developed to fit into the residential environment of the nearby Las Vegas suburbs.