GeoDaze 2024 Abstracts!

Keynote Speaker: Tomas Capaldi, Scripps Institution of Oceanography, University of California San Diego

The Earth Needs More Earth Scientists

The current number of geoscience graduates entering the workforce each year will not be sufficient to meet the demand for geoscientists. This talk will explore the drivers and consequences of decreasing student enrollment in geoscience programs and will include some personal insights on how to engage the next generation of geoscientists.

Sedimentary Record of Andean Mountain Building and Magmatism

The southern Central Andes record higher strain rates (~2x) than comparable Cordilleran systems in North and South America. My talk will focus on integrating the structural geology and sedimentary record to constrain the timing, style, and tempo of mountain building in this region. I then leverage existing arc magmatism datasets to speculate on the feedbacks and relationships among subduction, magmatism, and retroarc deformation along this segment of the Andes to understand the drivers/causes of the high strain rates in the southern Central Andes from Miocene to present.

Oral Session I

Geochemistry, Petrology, and Volcanology

María Paula Marroquín-Gómez

Geochemistry of the Northern Andean Volcanic Zone, Colombia

The North Volcanic Zone (NVZ) of the Andes is the result of subduction of the Nazca Plate beneath the South American Plate in Ecuador and Colombia. While the age, composition, and thickness of the continental crust vary significantly along this segment of the Andes, the influence that these parameters have on the geochemical characteristics of volcanic products in the NVZ remain poorly known. Several previous works on the geochemical and isotopic nature of Quaternary volcanic rocks in Ecuador have been used to constrain the effects that the different characteristics of the subduction system have in influencing their composition. Nevertheless, the dearth of major and trace element as well as radiogenic isotope data from Quaternary volcanic centers in the Colombian portion of the arc has obscured more regional interpretations and hinders our understanding of the NVZ arc as a whole. This study seeks to fill this data gap, and use new geochemical results to elucidate processes of magma generation and differentiation currently occurring under the northern Andes. Whole rock major elements, trace elements, as well as 176Hf/177Hf and 143Nd/144Nd analyses from arc-front polygenetic volcanoes in Colombia were measured and are used to track lithospheric and crustal processes such as mixing, assimilation, and fractional crystallization, as well as elucidate the main source materials and their contributions in magma generation.

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Isaiah Spring

Trace Element Analyses of Plagioclase from Troctolite 76535 and Implications for Mg-suite Petrogenesis

Troctolite 76535 is a phaneritic sample, with an annealed texture that lacks impact alteration (Gooley et al 1975). The high pristinity of 76535 makes it ideal to study the petrogenesis of the Mg-suite of lunar samples. Four plagioclase grain separates from 76535 were analyzed using electron microprobe, SIMS, and LA-ICPMS. 80 trace elements, including Rare Earth Elements (REE) were measured many of which have not been previously reported. The REE pattern for these grains is enriched in light REEs and closely resembles existing values for 76535 (Haskin et al 1975). Plagioclase-melt partition coefficients calibrated to lunar compositions from Sun et al. (2017) allow for the inversion of the plagioclase REE composition

into a parental melt REE composition. Due to the annealed texture of 76535 and the absence of chemical zoning (Haskin et al 1974), subsolidus reequilibration of REEs between major minerals was modeled using mineral-mineral partition coefficients at subsolidus conditions and then mineral-melt partition coefficients at magmatic conditions. At subsolidus temperatures the mineral-mineral partition coefficients (Sun et al. 2014) heavily favor olivine and orthopyroxene leading to a predicted bulk concentration highly enriched in REEs and a parental melt REE composition that is several order of magnitude more enriched than modeled urKREEP compositions. Further modeling work is needed to test the feasibility of reproducing this parental liquid through magma mixing between rising primitive cumulates and urKREEP, the extreme partial melting of those cumulates to produce the parental liquid, or the enrichment of REEs through later metasomatism involving an REE enriched fluid.

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Geomorphology

Tanner Johnson

Prefire Assessment of Postfire Debris Flow Hazards near Flagstaff, Arizona: Insights from Debris Flow Runout Modeling and Climate Change Implications

We use debris flow volume and runout models to conduct a prefire assessment of postfire debris flow hazards in an area near Flagstaff, Arizona. We calibrated model parameters through a back-analysis of a nearby debris flow that initiated after the 2022 Pipeline Fire. Estimating debris flow volume is a critical component of our analysis since flow volume influences runout potential. Debris flow volume increases with watershed relief, watershed area burned at moderate to high severity, and peak 15-minute rainfall intensity. Our hazard assessment included estimating the area inundated by debris flows under different rainfall and burn severity scenarios. For a rainstorm with a 2-year recurrence interval, we found that the area inundated varied from 0.26-0.42 km2 as watershed area burned at moderate-high severity increases from 20% to 100%. We observed an analogous trend for rainstorms with greater recurrence intervals (10, 25, 50, 100-year storms), though higher 15-minute rainfall intensities result in larger debris flows with greater inundation areas. An additional challenge in prefire assessments is estimating how the frequency and intensity of rainfall may unfold in the future due to climate change. We found that the area inundated by debris flows in response to a 2-yr recurrence interval rainstorm increases from 0.26-0.42 km2 under present day conditions to 0.41-0.64 km2 under the RCP8.5 scenario. Results demonstrate that prefire assessments of postfire hazards would benefit from accounting for the effects of rainfall intensification under future climate scenarios.

Authors: Tanner Johnson, Luke McGuire, Alexander Gorr

Joseph Martinez

Insights into temporal changes in debris flow susceptibility following fire in the southwest USA from monitoring and repeat estimates of soil hydraulic and physical properties.

Fire influences rainfall-runoff partitioning and geomorphic process rates, increasing the potential for runoff-generated debris flows in steep watersheds. Postfire debris flows (PFDFs) often begin via rapid mobilization of sediment due to infiltration excess overland flow from steep hillslopes and channels. Soil hydraulic properties, altered by fire, dictate the extent of debris flow potential and the timing of heightened hazards. However, there is limited, high resolution data on temporal changes in soil hydraulic properties immediately after fire, a crucial period when debris flow susceptibility fluctuates. In a study in southern Arizona, USA, we monitored rainfall and debris flow activity in two burned watersheds over a period of 1.5 years. Through repeated in-situ measurements with a tension infiltrometer, we assessed changes in soil hydraulic properties, including field-saturated hydraulic conductivity (Kfs), wetting front potential (hf), and sorptivity (S). We also tracked soil water repellency, ground cover, and soil physical properties, including bulk density, carbon, and organic matter content. Seasonal variations in Kfs, hf, and S were significant, resulting in non-monotonic relationships with time since fire. Immediate declines in Kfs, hf, and S were observed postfire, coinciding with two debris flows within the first three months. Short-term changes in soil hydraulic properties, coupled with increased ground cover, explain why PFDFs predominantly occur in the initial rainy season postfire in Arizona.

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Oral Session II

Geophysics

Aubrey Bennett

A Model for Strain Accumulation in Zones of Distributed Faulting

Crustal displacements that accumulate across long strike-slip faults during the interseismic period have traditionally been modeled in one-dimension using a buried planar dislocation in an elastic half-space, the so-called "screw dislocation." Despite its simplicity, this model fits geodetic data during the interseismic period well. Together, the screw dislocation and elastic rebound theory create an idealized framework permitting strain accumulation and earthquake potential to be quantified in terms of accrued slip deficit, but screw dislocation models make no predictions as to how upper crustal deformation will be distributed during future earthquakes. To integrate upper crustal faulting complexity we replace the traditional screw dislocation with a distribution of dislocations in an attempt to characterize the finite width of real-world fault zones. We infer the width of the dislocation distributions from fault map data, in effect, using the accumulated finite strain implied by mapped faults to approximate the potential distribution of future permanent strain. We applied this distributed dislocation model to Southern California, where we utilized variational Bayesian Gaussian Mixture Modeling to objectively determine the distribution of dislocations from fault map data. This distributed dislocation model predicts broad areas of potential upper crustal deformation, and thus seismic hazard, between the San Jacinto and the San Andreas faults, and on the northeastern side of the San Andreas fault.

Authors: Rick Bennett- U of A and NGS; Amanda Hughes

Sankha Subhra Mahanti

Seismicity of the Southern Central Andes (~23-24° S) Recorded by the TANGO Seismic Deployment

The Andes Mountain Range exhibits distinct along-strike variations in crustal thickness, shortening, and uplift. To understand the driving processes for these variations, two dense arrays of three-component nodal and broadband seismometers were deployed at ~23-24°S and ~35-36°S as a part of the TransANdean Great Orogeny (TANGO) project. The northern array nodal data at ~23-24°S was recorded from July 2022 to December 2022 at 298 locations with 2-3 km node spacing on a line across the Andes that runs from the coast of Chile to the Chaco Plain in Argentina covering ~700 km distance. A backbone of 42 broadband stations with ~30 km average spacing were deployed in the region surrounding this line and will record data between July 2022 and summer 2024. We have used four months of broadband and nodal seismic data from the northern array to build an earthquake catalog of this region using a deep neural-network-based phase picker (PhaseNet) to identify seismic P and S phases (Zhu &

Beroza, 2019). The catalog shows abundant seismicity along the subducting Nazca slab. However, the crustal seismicity is mostly observed in the back-arc fold-and-thrust belt and the crust of the Puna plateau is mostly aseismic. This catalog will be used to identify the relationships between deep and shallow seismicity, active faults across the Andes, regional volcanism, and deformation of the subducting Nazca Plate.

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Jim Bradford

Receiver Function Analysis Across the Andean Cordillera at ~24ºS from a Node and Broadband Seismic Deployment

The Andes across northern Chile and Argentina are of the largest and widest mountain belts associated with subduction. As part of the TransANdean Great Orogeny (TANGO) project, we deployed 300, 3-component nodal seismometers across the Andes to investigate the lithospheric structure at ~24ºS. Leveraging the spatial density of the nodal array with 38 broadband stations, we compute time-depth migrations of receiver functions (RFs) with detail never seen within the Puna Plateau of northern Chile and Argentina. Nodal seismometers have been shown to provide more robust interpretations for shallow crustal features (Wu, et al., 2017) and lithospheric scale structures (Ward, Lin, & Schmandt, 2018). Broadband data provide added frequency resolution and quality control. Our investigation thus far has revealed greater resolution of the Altiplano-Puna Magma Body (APMB), intense continent-mantle contrasts in the Chaco Plain, and curious dipping features in the shallow crust between the Santa Barbara and Eastern Cordillera ranges we hypothesize to be related to either a basal decollement or shear zone between the brittle upper and ductile lower crust. In the forearc, we identify conversions related to the Nazca slab that extend to ~180 km inboard along our transect until its amplitude diminishes. This area is collocated with a hypocenter cluster that is thought to be the result of serpentinite dehydration in the slab and the transition of the basalt oceanic crust to eclogite. TANGO has revealed seismic discontinuities across the entire Andean Mountain belt, contributing to our understanding of the cordilleran mountain system and orogenic cycle.

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Eric Cicero

Improving GRACE Gravity Field Resolution with Altitude-Cognizant Slepian Functions

The Gravity Recovery and Climate Experiment (GRACE) and its Follow-On (GRACE-FO) missions have collected data on Earth's gravitational field since 2002, providing us with invaluable information about mass loss in ice sheets. Most studies currently use GRACE's Level 2 data products as their starting point, which are globally estimated gravity fields. Data centers provide these solutions monthly complete to spherical harmonic degree and order 60. In order to be of use in tracking ice sheet mass loss the Level 2 data products require localization to prevent signal leakage from outside the region of interest. Unfortunately, localization also decreases the resolution of the fields and makes separating signal from noise more difficult. We demonstrate a new approach for generating localized gravity fields for polar regions, using only the inter-satellite potential differences collected above those regions to generate altitude-cognizant slepian functions. By localizing the data before performing the inversion and taking satellite altitude into account, we improve both the spatial and temporal resolutions of the resulting fields. Fields now can be generated every 10 days complete to degree and order 120. With these improvements, we are able to better constrain ice mass change and track smaller scale changes in ice sheets.

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Oral Session III

Economic Geology

Eytan Bos Orent

Implications of ore-related carbonates in the Paradox Basin

A long history of fluid-rock interaction in the Paradox Basin has resulted in geologically diverse products caused by a range of fluid sources and drivers. An important subset of the fluid-mediated products within the basin are sandstone-hosted U(-V) and Cu(-Ag) deposits and the distinct carbonate minerals associated with each. These minerals, present as cements, concretions, and veins, provide insight into the diverse geochemical conditions that were present throughout the basin's evolution. Mapping in the La Sal Creek Canyon at multiple scales highlights the spatial relationships between ore- and carbonate-related fluid systems found in the district that are representative of those in the Paradox Basin. SEM, EMPA, and LA-ICP-MS analyses offer geochemical constraints for ore formation and absolute timing of key geologic events. U(-V) deposits contain ore minerals intergrown with calcites that contain less Fe and Mg and higher □OSMOW than younger dolomites found in barren host rocks. U-Pb geochronology of ore-stage calcite indicates an early-Cretaceous age of mineralization. Variations in Mg, Fe, and Mn in carbonate minerals from Cu(-Ag) deposits is testament to the range of mineralizing conditions from deposit to deposit. Formation waters reconstructed from carbonate □OSMOW measurements overlap with those from modern oil and gas well brines from the Paradox Basin and provides evidence for the involvement of hydrocarbons in mineralization. U-Pb dating of Cu(-Ag) deposits presents a cluster of ages in the middle to late Miocene that raises questions concerning the timing of mineralization with respect to major tectonic events in the North American Cordillera.

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Sydney Acito

Exploring the exhumation of Laramide porphyry Cu-related intrusions using multiple thermochronometers: new insights from the Ruby Star pluton, southeastern Arizona, USA

Arizona is host to world-class porphyry copper deposits that formed during Laramide continental arc magmatism that were subsequently exhumed during Basin and Range extension. This study aims to constrain the emplacement and exhumation history of the Ruby Star pluton, the mineralizing pluton associated with the Sierrita-Esperanza porphyry Cu-Mo deposit 30km southeast of Tucson. The Ruby Star pluton has been tilted ~55°, exposing an oblique crustal section; this study utilizes this exposure to analyze the thermal history of a paleo-vertical transect using a multi-thermochronometer approach. We combine zircon U-Th/He (ZHe),

apatite fission track (AFT), and apatite U-Th/He (AHe) dating techniques to constrain the pluton's passage through 40-200˚C, corresponding to ~1.5-7.5km depth assuming an average crustal geotherm. Our new ZHe and AFT dates show no date-depth relationship and fall within 2σ error of 28 Ma, suggesting a thermal event that reset these thermochronometers, which is consistent with regional 26-31 Ma magmatism. Our new AHe dates display a negative date-depth relationship, suggesting cooling through the AHe partial retention zone from 27 to 21 Ma, and is interpreted as the final exhumation stage of the Ruby Star pluton. This age range is contemporaneous with the exhumation of the Catalina Metamorphic Core complex. These new temporal constraints on the exhumation of the porphyry Cu mineralized Ruby Star intrusion place it in the context of regional extension, and reenforce the fact that highly extended areas are optimal for ore deposit exhumation and subsequent exploration in the American Southwest.

Authors: Sydney Acito, Hervé Rezeau, Stuart Thomson

Elijah Mullins

Peralkaline Sodic Metasomatism from the Wilson Ridge Pluton, Northwest Arizona

Sodic metasomatism, characterized by the presence of riebeckite and aegerine, impacted over 20 km² of the Miocene-aged Wilson Ridge pluton in northwest Arizona. Despite similarities to peralkaline alteration linked with highly alkaline magmas, investigations reveal show that, the large volumes, low concentrations of high-field-strength elements (HFSE), and geologic associations at Wilson Ridge are distinctive and, apparently, globally unique. Mapping and remote sensing across >50 km2 show that alteration is concentrated in the western parts of the Wilson Ridge pluton, possibly due to post-formation structural tilting. Where mapped, the pluton primarily comprises biotite-hornblende granodiorite with subordinate diorite, aplites, and late biotite-bearing rhyolitic dikes. Large areas contain magnesio-riebeckite veinlets enveloped in albite-magnesio-riebeckite replacement of the igneous K-feldspar, plagioclase and biotite. Locally, intense zones contain albite + aegirine-augite ± magnesio-riebeckite, often accompanied by quartz dissolution. Alteration, brecciation, and veining postdate all but the late rhyolite; the latter is affected only by a widely pervasive albite-magnesio-riebeckite flooding. Notably, high-field-strength elements (Ti, Zr, REE, Nb) are little changed. This non-peralkaline sodic alteration is common in various ore-forming systems, suggesting involvement of near-neutral NaCl-rich fluids. Phase equilibria requires that the Wilson Ridge hydrothermal system involved a peralkaline fluid from either a peralkaline magma or terrestrial evaporitic Na-CO3-SO4-Cl source (e.g., modern and ancient alkaline lakes). The lack of peralkaline igneous rocks and HFSE enrichment argues against a magmatic source. An alkaline lacustrine source is consistent with the large volumes, the contemporaneous arid climate, and isotopic evidence for a source of Sr.

Authors: Elijah Mullins, University of Arizona

M. Camila Sojo

Geochemical and textural characterization of Filo del Sol porphyry-epithermal mineralization, Central Andes of San Juan, Argentina

Filo del Sol (FDS) is a Cu-Au-Ag epithermal-porphyry system located at 28.3° S latitude in the Central Andes of San Juan, Argentina. This deposit belongs to the recently defined Vicuña Metallogenic Belt and constitutes a new discovery between two world-class Maricunga and El Indio Cu-Au-Ag belts. Yet, the physicochemical evolution of the ore minerals and the source of the fluids remain unconstrained. Here, we present new detailed textural and geochemical data in sulfides, sulfosalts and sulfates, including major and trace elements together with in-situ S isotopes. High-sulfidation (HS) epithermal Cu-Au-Ag mineralization is characterized by pyrite, enargite-luzonite, tennantite, Cu sulfides (covelline, chalcocite) and a variety of Ag ± Pb-Cu sulfosalts associated with acid-sulfate alteration minerals (quartz-alunite-kaolinite). The sulfosalt billingsleyite, containing up to 75wt% of Ag and associated with cinnabar, is a new mineral species described in FDS. The deeper, porphyry Cu-Au mineralization is characterized by chalcopyrite and minor bornite ± digenite associated with potassic alteration (secondary K-feldspar, biotite, magnetite). Compared to other sulfides with homogeneous texture and compositions, pyrite is widespread throughout the system and exhibits a diversity of textural types that correlate with compositional variations. In-situ δ34S isotopic compositions of sulfides and sulfates in the porphyry-environment range between -10.8‰ and +9.2‰ and chalcopyrite-anhydrite pairs indicate precipitation at high-temperature ~500°C. In contrast, the extreme S isotopic variations observed in the HS epithermal environment (-44.6‰ to +13.6‰) reflect different fluid sources temperature together with variable H2S/SO4-2 ratio. Collectively, this argues for a complex interplay of magmatic-hydrothermal fluids at the origin of FDS.

Authors: Sojo, M.C., Rezeau, H. & Pribil, M.

Jennifer Wiess

Imaging Geologic Time: The Catastrophist-Uniformitarianist Debate in 19th Century American Landscape Paintings

The increasing popularity of geophilosophy has led to extended discussions of geologic time, how geologists view and interact with time in their practice, and what the characteristics ilof time are. However, there is still no overarching definition of what geologic time is. The answers to this can be found in examining the catastrophist-uniformitarianist debate and how it played out in the 19th century. Geological surveys and landscape artists at the time were highly entrenched in this debate, and thus it influenced their works, leading artists such as Frederic Church, Charles Wilson Peale, Albert Bierstadt, Thomas Moran, Dewitt Clinton Boutelle, and Thomas Cole to adopt either a more catastrophist or uniformitarianist aesthetic style.

Through investigating the various characteristics of geologic time and how they are discussed and understood by landscape artists in the 19th century, this presentation offers a new interpretation of both these landscape paintings which shed light on how this debate impacted American society and artists of the time and how geologic theory was utilized as a tool by artists to construct a new visual language of landscape. Eventually, what is posited is a cyclical definition of geologic time that merges catastrophism and uniformitarianism and places America and humanity within nature and deep time and constructs America's identity as nature's nation. This methodology, which combines art, geoscience, and philosophy, offers endless possibilities for exploring the impact of nature and geologic theory on artists and their artworks, as well as understanding what inform geologists' scientific practice

Authors: Jennifer Wiess, U of A

Oral Session IV

Climate and Glacial Studies

Mudith Weerabaddana

Tropical western Pacific hydroclimate inferred from paired coral trace elements and δ18O records from the Marshall Islands

Regional climate variability of the Pacific Ocean modulates sea surface temperature (SST), sea surface salinity (SSS), and precipitation of the tropical Pacific region. The SSS in this region is primarily influenced by spatial changes in the inter-tropical convergence zone (ITCZ), which varies according to the inter-hemispheric temperature gradient in response to global warming, decadal variability, and El Niño Southern Oscillation (ENSO). However, salinity measurements are scarce in time and space for this region, thus proxy reconstructions are important to understand tropical Pacific hydroclimate variability. We use paired coral trace-elemental (Li/Ca, Li/Mg, and Sr/Ca) and δ18O records from the Republic of the Marshall Islands to isolate seawater δ18O and reconstruct salinity changes in the mid to late twentieth century. We screened the coral for diagenesis using a modified X-ray diffraction technique that allowed quantifying the direct effect of calcite diagenesis on geochemistry. Out of all trace element-temperature proxies, Li/Ca was the least sensitive to diagenesis and showed a statistically significant relationship with SST ($r = -0.53$, $p < 0.01$). The reconstructed SSS captures the southward shift in the ITCZ during an El-Niño, decreasing precipitation and freshwater flux in the Marshall Islands, and high SSS anomalies. By extending the instrumental record by more than 30 years, this record also provides new key insights into decadal hydroclimate variability and trends. This study will help to understand changes in the Pacific Walker Circulation, thus changes in ENSO in the last century, and potential climate risks to tropical Pacific low-lying islands like the Marshall Islands.

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Zoe Benson

Leveraging coral Mn/Ca records from Palmyra and Tabuaeran to reconstruct Pacific El Niño events

Shifts in the strength and directionality of tropical Pacific zonal winds alter global surface warming. During the El Niño phase of the El Niño-Southern Oscillation (ENSO), easterly trade winds weaken, and strong westerly wind bursts (WWBs) accelerate warming. Predicting global climate thus relies on accurate zonal wind records, which remain scarce in the tropical Pacific prior to 1985. Reef-building corals can bridge such gaps, recording modulations in the climate state while calcifying their skeletons. At remote atolls in the equatorial Pacific including Abaiang, Tarawa, Butaritari, and Kiritimati, spikes in the manganese-to-calcium (Mn/Ca) ratio within coral skeletons coincide with WWBs. Mechanistically, trade winds carry Mn4+ to atolls, where it deposits and reduces to Mn2+ within western-facing lagoons. In El Niño years, WWBs mix lagoon waters, releasing accumulated Mn2+ into the water column, which can be incorporated into coral skeletons. The timing and magnitude of Mn/Ca spikes in corals are variable, reflecting different manifestations of El Niño and the diverse morphology of atolls. Here we extend the Mn/Ca proxy record at two atolls east of the dateline, Palmyra and Tabuaeran, via geochemical analysis by Finnigan MAT 252 mass spectrometer. These novel Mn/Ca records capture the 1997-98 and 2002-03 El Niño events. Comparing the magnitude and timing of Mn/Ca spikes between atolls provides new data on how lagoon morphology and atoll longitude affect the Mn/Ca signal. These records also affirm the use of Mn/Ca as a wind proxy and provide new insights into the spatial pattern of El Niño events over the late 20th century.

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Asiya B.Sainudeen

South American Hydroclimate in High-Resolution Global Climate Model: Pushing Boundaries with Variable Resolution Simulations

The South American continent has a complex topography and a range of climate regimes. As such, Earth system models with high spatial resolution are required to resolve the intricate topography to accurately represent local-scale features, such as monsoonal convection, that drive regional precipitation. Utilizing models like the variable resolution version of the Community Earth System Model (VR-CESM) with regional high-resolution grids embedded within a coarse global grid helps mitigate the high computational costs of running a uniformly high-resolution global model. In this study, we employ VR-CESM with regional refinement of 1/8° over the Andes and 1/4° over the rest of South America to investigate the regional hydroclimate over the continent. Analysis of daily precipitation data from VR-CESM and a corresponding simulation with coarser (nominal 1°) resolution confirm that higher horizontal resolution is necessary to resolve the local climate regimes that arise over the complex terrains of South America. Data from VR-CESM exhibit realistic variability in daily precipitation over Amazonia and the sub-tropics compared to the coarser resolution simulation. This study highlights the necessity of employing high spatial resolution to investigate the impact of extreme hydroclimatic events in the South American region. Further, we introduce a new VR-CESM simulation, specifically designed with moisture tracking capabilities to identify sources and pathways of tropical South American precipitation. This simulation provides an opportunity to understand the influence of internal modes of climate variability on precipitation variability across the region in different climates.

Authors: Asiya B. Sainudeen, Marcus Lofverstrom, Diane Thompson, and Madelyn cook

Aniket Dhar

Five centuries of Indian Summer Monsoon dynamics from Indian speleothem archives

Speleothem-derived geochemical time series offer high-resolution insights into Indian Summer Monsoon (ISM) variability over the last millennium. Whereas many paleomonsoon records exist from northern India, data from southern and peninsular India are limited, leaving a distinct gap in our understanding of ISM hydroclimate dynamics over this period. Here, we report a novel speleothem flowstone record from Kona Cave, Andhra Pradesh (15o9'11" N, 77o55'9" E), southern India. We used U-Th disequilibrium dating to constrain the age model (n=X) of this sample to the past five centuries with ~2 yr sample resolution. Stable isotope analysis (δ13C and δ18O) of this flowstone sample reveals a high correlation between $\delta^{13}C$ and $\delta^{18}O$ (R2=0.71) and comparisons with another lower-resolution record from the region support the Kona Cave flowstone as a high-fidelity paleomonsoon record. Next, we performed principal component analysis (PCA) on published speleothem $\delta^{18}O$ records (n=7) spanning the last millennium from the Indian subcontinent, segregating them into northern Indian (n=4), southern

Indian (n=3), and All-India domains. We then performed field correlations of the first principal components (PC1SPELEO) for each domain with Last Millennium Reanalysis v2.0 (LMR) Sea Surface Temperature (SST) data and found strong ties between ISM water isotope variations and Pacific Ocean SST dynamics. For 1710-1900 CE, $\delta^{18}O$-SST correlations inversely mirror rainfall-SST correlations with the PCs from all ISM domains, suggesting the operation of an "amount effect". In contrast, during 1450-1690 CE, correlation patterns indicate altered moisture sources or circulation regimes affecting the $\delta^{18}O$-ISM rainfall relationship, particularly in northern India. Our study pinpoints variability in the Indo-Pacific control of ISM circulation and hydroclimate over the past five centuries.

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Oral Session V

Tectonics, Thermochronology, Geochronology

Liam O'Connor

Assessing the effects of fluvial hydraulic sorting on detrital zircon age spectra by coupling CT-measured grain morphology with U-Pb geochronology

Uranium-lead (U-Pb) detrital zircon geochronology is frequently used to determine the provenance of sediments for tectonic, paleoclimate, and basin history models. Hydraulic sorting of particles during fluvial transport is known to influence the characteristics of sedimentary deposits. However, its effects on detrital zircons remain poorly studied. Typical measures of dissimilarity between samples, such as Kolmogorov-Smirnov, do not account for these processes. Here, we present early results of a new methodology that integrates rapid U-Pb dating of large-n samples using LA-ICP-MS and x-ray computed tomography to fully quantify individual zircons' age, size, and morphology from the tributary-free Río Bermejo in northern Argentina, whose course traverses an overfilled retroarc foreland basin. Improvements in 3D image processing software allow for the quantification of zircon grain morphology data from x-ray computed tomography scans. Using a large-n approach (n = 500-1,000) ensures that

analyses better capture the 'true' distribution of all variables. Preliminary results show that a greater proportion of younger zircon populations consist of larger and more euhedral grains while older zircon populations are smaller and more rounded. Samples' age spectra repeatedly rejected the null hypothesis, which usually infers that they shared a common provenance, for multiple similarity tests commonly used in the detrital zircon community. This integrated methodology allows us to more comprehensively understand the physio-mechanical biases in detrital mineral studies and demonstrates the need to develop a Maximum Likelihood Estimation statistical approach for assessing the sources of a basin's sediments.

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Tshering Z.L Sherpa

Evaluating role of fold-thrust geometry and development in dichotomous timing of exhumation in the Himalaya

Low temperature thermochronometric ages of orogenic systems can provide information about rates and timing of cooling due to crustal deformation. In the Himalaya, timing of fold-thrust belt development influences temporal and spatial patterns of exhumation and cooling. In this study, I employ new and published low-temperature cooling ages with kinematic restorations and balanced cross-sections from the Himalayan fold-thrust belt of Nepal to assess how fold-thrust belt geometry and kinematics affect exhumation and cooling pathways.

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Priscilla R. Martinez

Controls on the late Miocene marine vertebrate death assemblage in the Atacama Region of northern Chile

The Miocene–Pliocene Bahía Inglesa Formation in the Chilean Atacama Region (27°S) hosts one the world's best-preserved marine vertebrate death assemblages attributed to harmful algal bloom (HAB)-mediated mass mortalities. However, the lack of a well-dated depositional model prevents understanding of the timing of fossil accumulation and associated paleoenvironmental conditions. We present a revised chronostratigraphic framework for the Bahía Inglesa Formation at the Cerro Ballena (CB) and Mina Fosforita (MF) paleontological sites based on detailed sedimentology, ichnology, U-Pb zircon and phosphate geochronology, and published biostratigraphy. Detrital zircon U-Pb geochronology and 87Sr-86Sr dates of bivalve shells indicate that the highly-articulated cetacean carcasses preserved at CB deposited in a barrier-

protected shoreface environment during voluminous volcanic ash and diatom accumulation on the shelf between 6.8 ± 0.8 Ma and 4.4 ± 0.07 Ma. Evidence of Glossifungites ichnofossils and disarticulated, taxonomically-diverse vertebrate fossils within the MF Bonebed suggest deposition in an unsheltered nearshore environment with strong wave action and rapid flooding conditions. We propose that the CB and MF fossil assemblages are time-correlative and record storm-dominated sedimentation events within distinct bay configurations. U-Pb analyses of a phosphate nodule from MF produced an age of 6.8 ± 0.2 Ma, providing new constraints on the timing of bonebed generation and phosphogenesis along the northern Chilean coast. A comparative analysis of these results with a dataset of >4,000 magmatic ages from the Central Andes suggest a correlation between volcanism, ocean fertilization, HAB blooms, and marine mammal deaths during the late Miocene.

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Emilia Caylor

The Southwest Trainwreck from Laramide Bulldozing in the SW U.S.A.

The transition from normal to flat-slab subduction during the Late Cretaceous to early Cenozoic in the North American Cordillera marks dramatic tectonic, paleogeographic, and paleoenvironmental shifts. While much attention has been given to understanding the development of the Cordilleran system during the Laramide period, the southwestern segment remains relatively enigmatic. However, this region stands out as the sole area retaining evidence of tectonic erosion and underplating of the Pelona-Orocopia-Rand schists (PORS), offering direct insight into flat-slab subduction processes. We resolve the tectono-thermal history of the Mojave region within the southwestern Cordillera through (U-Th)/He (ZHe) and 40Ar/39Ar mica thermochronology, allowing for determination of the source to basin time-temperature history through the ~400–180 °C temperature window. We present 85 new single-grain ZHe ages from detrital samples throughout the ~7 km thick McCoy Mountains Formation and from basement samples along the Mule Mountains thrust and Maria fold-thrust belt. Thermochronological ages suggest that regional exhumation occurred in two major phases at ca. 70–40 Ma and ca. <40 Ma. Our results suggest that emplacement of the PORS beneath the Mojave and northeastward bulldozing of lithosphere driven by the Farallon flat slab, facilitated Late Cretaceous–Paleogene regional uplift of a vast orogenic plateau in the southwestern Cordillera. Subsequent cooling is consistent with late Cenozoic extensional collapse of

thickened North American crust and metamorphic core complex extension within the Colorado River Extensional Corridor.

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Poster Sessions

Gigi Giralte

Mechanistic Drivers of the North American Monsoon

The North American Monsoon (NAM) is defined as a seasonal shift in the wind pattern from a dry, westerly flow across northwestern Mexico, Arizona, and New Mexico to a moist, southerly flow. The NAM season occurs between June 15th and September 30th but typically peaks near the end of July through mid-August. The NAM extends along the Sierra Madre Occidental in western Mexico through the Desert Southwest of the United States, including parts of Arizona, New Mexico, and California. Understanding how the NAM is fueled can help improve weather forecasts and messaging for high-impact events. Analysis of climate model simulations shows that the southern part of the NAM region, mainly western/northwestern Mexico, is fueled differently than the northern half, which primarily includes the Desert Southwest of the United States. This is partly caused by various jet influences and their flow, such as the California Low Level Jet. From this, it has been determined that a weaker California Low Level Jet correlates to a stronger monsoon. In addition, it has been determined that the southern NAM is connected to a tropical circulation, predominantly ENSO (El Niño-Southern Oscillation) variability. These varying influences help explain how precipitation values differ between the two halves of the region.

Gigi Giralte, Hydrology and Atmospheric Science; Marcus Lofverstrom, Geosciences

Kay Poonawala

Is the Last Interglacial warm period a good process analog for future Greenland mass balance?

The substantial Greenland melting in the Last Interglacial warm period (LIG, 127,000 years ago) is often used as a process analog for Greenland sensitivity and melt under anthropogenic climate change. However, the LIG warmth was due to high boreal summer

insolation controlled by Earth's orbital configuration, whereas the observed anthropogenic warming is primarily attributed to elevated concentrations of atmospheric greenhouse gases. To this end, we investigate the Greenland ice sheet (GrIS) and the North Atlantic response to insolation versus greenhouse gas concentrations in simulations from the Community Earth System Model, version 2. The model simulations suggest that the differences in spatial signature of GrIS surface mass balance is controlled by local precipitation. In future simulations, reduced winter precipitation over the GrIS is tied to an equatorward shift in the storm track, as well as a local cold anomaly in the North Atlantic, which is related to weakening of the meridional overturning circulation. In high insolation simulations, precipitation seems to be influenced by different processes, related to a stronger seasonal cycle and an increase in cyclonic wave breaking in winter months, shifting the jet stream. Thus, we should be cautious when using the LIG as an analog for anthropogenic change, especially when considering 21st century sea level rise.

Kay Poonawala, Marcus Lofverstrom, University of Arizona

Caitlin Salanga

Identifying tropical Pacific climate and hydroclimate changes through the transition from preindustrial to industrial time using coral skeletal geochemistry

Stable oxygen isotopes δ18O measured in subfossil coral skeletons are instrumental in understanding past climate and oceanographic changes, as coral δ18O (δ18Ocoral) is impacted by both δ18O of seawater (δ18Osw) and temperature. In this study, we used a sub-fossil coral from Arno Atoll (7.05°N, 171.4°E) to measure the δ18Ocoral. Since it is from a region with relatively stable temperatures year-round, most variation in δ18Ocoral is due to changes in salinity (or δ18Osw) rather than temperature. Furthermore, changes in the salinity can be linked to precipitation, so the fluctuations in the value of δ18Ocoral can help us understand the changes (frequency and amount) of precipitation in the past. The top of the coral core used in this study was dated 1896, and it expands through the 19th century into preindustrial times. Therefore, this study will provide insights into the tropical Pacific climate and oceanographic changes during the transition from preindustrial to industrial time. Additionally, the Arno Atoll is in the region where the Inter Tropical Convergence Zone (ITCZ) shifts seasonally, which will be reflected as changes in δ18Osw. As the ITCZ shifts towards the equator during the boreal winter we should see an increase in salinity and δ18Osw followed by a decrease in salinity and δ18Osw in the summer. Thus, by analyzing δ18Ocoral we can understand changes in ITCZ variability through the transition from preindustrial to industrial time. This study will broaden our understanding of the past tropical Pacific hydroclimate variability and future trends in freshwater availability in tropical Pacific Islands.

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Daniel Conley

Investigating the relationship between stable isotope measurements of precipitation and weather sound data in Tucson, AZ

Stable isotope measurements of oxygen (δ18O) and hydrogen (δD) in precipitation are influenced by rainfall amount, distance from the moisture source, continentality, and elevation. One common paradigm of addressing rainwater isotope variability is termed the "amount effect", which describes a negative relationship between rainwater amount and stable isotope values—a relationship used to infer past rainfall amount in paleoclimate studies. Recent studies have also begun to link rainwater isotope variability to meteorological processes such as the nature of organized convection and sub-cloud processes. This project aims to investigate the presence (or lack thereof) of the "amount effect" in precipitation in Tucson, AZ, and investigate the relationship between precipitation stable isotopes and meteorological parameters. We compiled rainwater δ18O and δD from 1981-2023 by building on the compilation of Eastoe and Dettman (2016). We also compiled weather-sounding data for Tucson, AZ (1981-2023) including the lifted condensation level (LCL) temperature and pressure, mean mixed layer potential temperature (MMLT), and 1000 hPa to 500 hPa thickness. Our results confirm previous findings by Eastoe and Dettman (2016) and establish the absence of the amount effect in Tucson rainwater. Instead, we observe strong seasonality where summer rainwater isotope values are, on average, higher than winter values. We additionally find stronger correlations between rainwater isotopes of summer precipitation and meteorological parameters relative to winter precipitation, consistent with more organized convection occurring with summer monsoon dynamics. Our findings indicate that paleoisotope records in the desert southwest region may be indicative of precipitation seasonality rather than rainfall amount.

Daniel Conley1, Kaustubh Thirumalai1

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Tyler BylandRio

Grande Freshwater Influence on Gulf of Mexico Hydrography Over the Holocene

The Gulf of Mexico's (GOM) chemical and thermal signature of the upper mixed layer is influenced by atmosphere-ocean heat exchange, surface currents, and hydrologic inputs from rivers. Previous palaeoceanographic reconstructions in the northwestern GOM demonstrate a long-term increase in $\delta^{18}O$ of upper mixed layer seawater throughout the Holocene (11 ka – present), which suggest a shift to a more saline northwestern GOM since ~8 ka. These records are presented at millennial and centennial timescales; however, variability at shorter timescales has not yet been considered. This study investigates the short-term variability during two time slices from modern (core-top) and early Holocene (7.6 ka) sediments extracted from the Garrison Basin, northwestern Gulf of Mexico (26.5° N, -94.0° W). Three species of planktic foraminifera occupying varied depth habitats were used for stable isotope geochemistry: surface-dwelling G. ruber and T. sacculifer and thermocline-dwelling N. dutertrei. For each time slice, we picked 40-60 individual foraminifera specimens from each species. A Kiel IV paired with a MAT253+ isotope ratio mass spectrometer was used to perform Individual Foraminifera Analysis (IFA) to derive $\delta^{18}O$ and $\delta^{13}C$ values on independent specimen. Our results suggest that a steeper thermocline and increased mixed layer productivity existed during the early Holocene timeslice--features that may have formed through more frequent discharge from the Rio Grande. Our new observations from the Garrison Basin are consistent with published reconstructions of increasing $\delta^{18}Osw$ over the Holocene and provides further insight into the environmental factors influencing GOM hydrography.

Tyler Byland, The University of Arizona Department of Geosciences

Jonothan Chappell

Formation of the Diamond Joe Pluton and Associated Mineralization, NW Arizona, USA: New Geochronology and Mineralogical Constraints

Diamond Joe is a composite pluton formed in the Hualapai Mountains located in northwestern Arizona within the Basin and Range zone. The pluton is concentric in geometry and grades from equigranular granodiorite on the exterior portions of the pluton to porphyritic quartz monzonite, quartz monzonite porphyry, and granite towards the center of the pluton. The presence of NE-SW-oriented lamprohyres dikes crosscut all the intrusive units. This study's zircon U-Pb weighted mean ages indicate that the four intrusive units crystallized within 2 m.y. between 74.4 ± 0.4 and 72.4 ± 1.0 Ma, whereas the lamprophyres are significantly younger yielding an age of 23.3 ± 0.3 Ma. Diamond Joe hosts two predominate mineralized vein systems, namely the Leviathan Vein and the Silver Trail Vein. The Leviathan veins consists of Cu-Mo quartz veinlets and lode veins with well-developed sericitic alteration that has been dated at 72.6 ± 0.3 Ma using molybdenite Re-Os dating. These features suggest that the magmatic-hydrothermal porphyry copper system that emplaced the Leviathan Vein is

temporially and spacially related to the emplacement of Diamond Joe. The Silver Trail vein is a Pb-Cu-Ag quartz lode vein with occurrences of barite; furthermore, the absolute timing of the mineralization remains unconstrained. Its theorized that the Silver Trail mineralization could either be coeval to the Leviathan vein and part of the same magmatic-hydrothermal system or represent a distinct and younger hydrothermal ore-forming system associated with mid-Cenozoic magmatism and mineralization documented elsewhere in the region.

Jonothan Chappell, Dr. Hervé Rezeau, Dr. Carson Richardson

Alexus Wuertemburg

Isotopic Constraints on the Origin of Mesoproterozoic Anorogenic Granites Across Arizona

A prominent Mesoproterozoic magmatic episode across North America resulted in multiple granitic intrusions known as the anorogenic(A)-type magmatic belt. Granites are commonly formed during orogenic processes (e.g., subduction, continental collision). However, A-type granites are unique because they are not clearly associated with regional orogenic events, raising the question of what processes–and magma sources–were involved in their formation. We are studying Proterozoic A-types granites exposed throughout the three distinct crustal provinces of Arizona, the Mojave, Yavapai, and Mazatzal, to determine their ages and differences in magmatic source (i.e., proportion of crust versus mantle). The A-types granites of northern Arizona that are associated with the Yavapai and Mojave crustal province have been dated to ca. 1.4 Ga. However, similar A-type granitic intrusions in southern Arizona in the Mazatzal province have yet to be studied in detail. Three main objectives of this project include: (1) characterize granites based on mineralogy and modal abundances, (2) constrain the ages of samples through U-Pb zircon geochronology, and (3) determine the magmatic source(s) based on zircon Lu-Hf isotopic composition. This research is the continuation of a summer research experience for undergraduates, which initially focused on Oracle Granite. Preliminary U-Pb data of two samples from Oracle give ages of 1446±11 and 1435±10 Ma with complementary average initial Hafnium compositions of +5.0 and +5.5 εHf, which are similar to published compositions of A-type granites derived from the Central Yavapai Province. Future isotopic analysis of 14 additional localities will reveal the magmatic history of Arizona during the Mesoproterozoic.

Michelle Foley, Mauricio Ibañez-Mejia

Mitchell Baird

Assessing the Lithological Diversity of Lunar Meteorite Northwest Africa (NWA) 10203

The samples collected from the Apollo, Luna, and Chang'e-5 missions consist of diverse types of rocks including basalts with various mineralogies, textures, grain sizes, and ages that represent ancient lunar magmatic products from geographically restricted areas (Heiken et al., 1991; Che et al., 2021). However, remote sensing has revealed the lunar crust is more compositionally diverse than exemplified by samples returned from its surface (Heisinger and Head III, 2006). Fragmental and regolith lunar meteorite breccias allow for analyses of a more diverse sampling area to better understand ancient magmas, crust building, impact bombardment, and space weathering on the Moon (Joy et al., 2023). Lunar meteorite NWA 10203 was found in 2015 near the border between Mauritania and Mali and determined to be a polymict breccia with a high shock stage and a moderate weathering grade (Bouvier et al., 2017). It was cut into a 0.93g slab based off of XCT scans, mounted in indium, and polished using diamond powder before analysis was conducted. Instruments in the Kuiper-Arizona Laboratory for Astromaterials Analysis, such as a digital microscope, SEM, and electron microprobe, were used to characterize clasts in the sample. Overall, impact melt breccias, gabbro breccias, gabbronorite, symplectic textures, and feldspathic breccias were observed. Numerous accessory minerals including zircon, baddeleyite, apatite, and ilmenite were also found. So far, one spherule has been documented. Future work aims to interpret implications for the lunar crust, calculate modal abundances, and age date zirconium-bearing phases.

Mitchell Baird, Dr. Jessica Barnes - Lunar and Planetary Laboratory, Zoe Wilbur, Nicole Kerrison , Ken Domanik, Dolores Hill

Lunar and Planetary Laboratory

Angela Tatsch

Petrologic comparison of high- and rare very low-titanium lunar basalt clasts derived from ANGSA core 73001.

Questions remain concerning the behavior of magmatic volatiles on the Moon and their roles in lunar magma evolution and mare basalt formation. As part of the Apollo Next Generation Sample Analysis (ANGSA) program, we are investigating the petrogenesis of designated high-titanium (73001,531 from 73001,1095B) and low-titanium (73001,538 from 73001,1234B) lunar basalts collected from the recently processed Apollo 17 drive tube, 73001. The clasts were scanned using XCT, cut into thick sections, and polished, and then were analyzed using a digital microscope, SEM, electron microprobe, and ImageJ and Dragonfly software, in 2D and 3D respectively. The 3D analyses aid understanding of lunar lava flows' crystallization and degassing histories (Wilbur et al., 2023). Modal recombination of bulk TiO2 shows the designated low-Ti clast is a very low-Ti basalt (VLT), which is much rarer in our collection. Larger ilmenite grains in 73001,531 contain exsolutions of ulvöspinel—suggesting an

originally Cr-rich ilmenite composition—and rutile—with unusual triple junctions. 2D modal mineralogy aligns with ranges reported for high-Ti Apollo 17 and low-Ti Apollo 15 basalts (Bell et al., 2023; Wilbur et al., 2023). XCT studies of the clasts show different textures compared to their thick sections, such as higher abundances of lath-like ilmenite in 3D within 73001,1095B, and pyroxene and plagioclase sawtooth-like textures, aligning with findings by Wilbur et al. (2023). Future work involves in situ studies of volatile-bearing phases, like apatite, to understand the eruptive signatures and degassing histories of the basalts (Tartèse et al., 2013; Wilbur et al., 2023).

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The ANGSA Science Team (List of co-authors includes all members of the ANGSA Science Team (https://www.lpi.usra.edu/ ANGSA /teams/))

Gabriel Sanchez

Bisbee Turquoise Provenance Analysis

Gem and mineral provenance studies are often conducted through the analyses of trace and rare Earth elements using either laser induced breakdown spectroscopy (LIBS), or laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS). Provenance studies of the past that considered turquoise have mainly focused on trace element geochemistry and have been met with limited success due to the complex nature of the gemstone. To circumvent these complications, we have performed U-Pb detrital zircon provenance analysis using LA-ICPMS on the Cretaceous Glance Conglomerate. The Glance is the host rock of all Bisbee turquoise sourced from the Lavender Pit, the only locality providing large yields of turquoise

from the region. A total of 695 U-Pb laser analyses have been conducted on three samples of Glance Conglomerate, each sample resulting in a complex age spectrum containing seven prominent peaks within its distribution. The resemblance of these major age peaks remains consistent for all three of the age spectra. When combined, the resulting age distributions provide a unique signature that should work to distinguish Bisbee turquoise from that of other regions. To test this hypothesis, one turquoise sample from Kerman, Iran and one from Erdenet, Mongolia will undergo the same U-Pb detrital zircon analysis. Different age distributions from these alternate localities would show that U-Pb detrital zircon analysis of the host rock will provide a unique signature that distinguishes Bisbee turquoise from other localities.

Gabriel Sanchez, Mark Pecha

Arizona Laser Chron (ALC)

Zoe Gineris

Geochronology of the Rincon Valley Mountains

Zircons from the Rincon Mountains can provide information about the geology of this mountain range that surrounds Tucson. Using instruments in the Arizona LaserChron Center, agemaps were created for zircons collected from the Rincon Mountains. The prediction was that the zircon crystals would have originated from the known igneous units- Rincon Valley Grandodiorite (~1.7 Ga), Oracle Granite (~1.4 Ga), Wilderness Granite (~50 Ma), and Loma Alta Granite (~26 Ma). Our methodology involved the systematic separation of the original sediment sample, creation of a mount integrating standard and collected zircons, SEM Imaging for zircon zone identification, and Laser-Ablation ICP Mass Spectrometer analysis to determine the U-Pb ratio across crystals. This comprehensive process facilitated the creation of an age map capturing the entire zircon crystal. The objective of our study was to uncover the geologic history of the Rincon Mountains. Intriguingly, our findings revealed that each crystal contained domains associated with multiple intrusive bodies. This observation is interpreted as indicative of an extended history involving magma generation and zircon crystallization. Our agemaps of several zircon crystals provided a unique window into the geological evolution of the Rincon Mountains, highlighting the complexity of magmatism during the past 1.7 Ga. This research not only contributes to our understanding of the Rincon Mountains but also adds valuable insights into the broader field of geology. The discovery of multiple intrusive bodies within zircon crystals prompts further exploration into the intricate dynamics of magmatic events and crystallization processes in mountainous terrains.

Zoe Gineris, Ava Haines, and Sienna Polischuk

Bennett Greenfield

Geochronology of Detrital Zircon Crystals Collected from Tanque Verde Wash

Surrounding Tucson on the north and east are the Catalina and Rincon Mountain Ranges, which consist primarily of the Oracle Granite (1.4 Ga) and Wilderness Granite (~50 Ma). Sediment eroded from these two rock bodies primarily settles within Tanque Verde Wash, on the north side of the Rincon Mountains. Using detrital zircon U-Pb geochronology on sediment collected from Tanque Verde Wash, we aim to learn more about the geological history of the Catalina-Rincon area.We gathered our samples from Tanque Verde Wash during field work done in September 2023. To isolate zircons from the larger sample, we employed the use of a water table, Methylene Iodide heavy liquid separation, and a Frantz Magnetic Barrier. We used an inductively coupled plasma mass spectrometer to obtain age maps of each zircon by analyzing U/Pb ratios at different locations within the crystal. These maps were then compared to detailed images of the crystals generated by an SEM (with a cathodoluminescence detector) and Raman spectrometer showing the intensity of damage within different sections of the zircons. Most zircon crystals we analyzed appeared to have formed approximately 1.4 billion years ago. Sections of the zircon crystals which displayed an age which did not match with any pre-existing granite bodies were also consistently shown to be more damaged, indicating lead loss in those areas. Our results suggest that most of the zircons formed inside the Oracle Granite. These results were unexpected as Tanque Verde is located between the Oracle and Wilderness Granite.

Bennett Greenfield, Devin Maroney, Keel McQuilkin, Robert Vloemans, William Reeser

Luke Basler

Reconstructing the mechanisms of Cenozoic crustal thinning in southeastern Arizona using paleocrustal thickness proxies

The mechanisms regulating the collapse of thickened orogenic plateaus remain unconstrained. In the southwestern U.S., recent application of paleocrustal thickness proxies has identified a late Cretaceous and early Cenozoic orogenic plateau (the "Arizona-plano"), characterized by thick (~55 km) crust and high (>3 km) inferred paleoelevation by ca. 70 Ma. Given the modern crustal thickness of ~28 km in this region, thick late Cretaceous crust requires over 25 km of Cenozoic crustal thinning, exceeding the magnitude attributable to Miocene to present Basin-and-Range extension. Here we present new paleocrustal thickness data and reanalyze existing data using recently published paleocrustal thickness calibrations to reconstruct the timing, rate, and thus mechanisms of crustal thinning. We calculated crustal thickness using paired zircon rare earth element data and U-Pb dates from syn-extensional Oligocene-Miocene basin deposits in southeast Arizona. Results corroborate previous work that indicates the presence of thick (54 ± 6 km) orogenic crust from 60-70 Ma. Paleocrustal thickness data further suggest the crust remained relatively thick (~50 km) until the late

Oligocene, before thinning rapidly. This result imposes a ceiling on the magnitude of crustal thinning caused by pre-MCC lower crustal flow and implies that pre-Basin-and-Range thinning was largely controlled by syn-MCC detachment faulting.

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Angela Tatsch

Geophysical Survey of the Harshaw Creek Area in the Patagonia Mountains, Arizona

The Patagonia Mountains in southern Arizona are characterized by a rich mining and ranching history, both requiring water resources. Investigating the structural geology of this late basin and range graben, in conjunction with the hydrology of the Patagonia Mountains, aids in understanding the secondary porosity of the fractured Patagonia Fault system, its potential water pathways, and water/lithologic subsurface composition. We set up direct-current resistivity surveys using surface dipole-dipole and strong gradient electrode arrays containing 56 electrodes at 5-meter spacing and an AGI SuperSting R8 connected to a 2kW generator. The surveys included a 275-meter line (Line PC) and 555-meter line (Line PD) southwest of Patagonia, projected to contain the Patagonia Fault. We produced resistivity pseudo sections using the AGI EarthImager 2D software. Correcting for topography, we produced a smooth-model inversion model for each location. Line PC showed a relatively high resistivity layer (140 Ohm-m) from 14 to 21 meters depth and a relatively low-resistivity layer (22 Ohm-m) between 42 and 57 meters depth, likely due to an increase in water. Line PD had a relatively low resistivity, likely due to a surface creek to the west. The 80-meter northwest portion of the line has a relatively high resistivity (138 Ohm-m) from 0 to 56 meters depth. A very high resistivity, north-dipping layer (10000 Ohm-m) intersects the surface at 440 meters southeast of the start of the line, extending to 56 meters depth. A lower resistivity layer (1000 Ohm-m) forms a discontinuous bed, surrounded by a 550 Ohm-m lithology.

Angela Tatsch, Bridgett Holman, Lindsey Frenia, Layan Alziyadi, Cole Stokes, Hannah Mo, Dr. Ben K. Sternberg

US Geological Survey

Trang Tran

Biomarker reconstructions of 600,000 years climate variability in the Indo-Pacific Warm Pool

The Indo-Pacific Warm Pool (IPWP) is the world's greatest "steam engine," driving global atmospheric circulation. Yet, the scarcity of paleoclimate records from IPWP extending far beyond the LGM limits our understanding of the mechanism for past climate variability in this region. Here, we present preliminary results of sea surface temperature and hydroclimate variability in IPWP spanning the last 600,000 years based on biomarker records from marine core IODP-1482, which is located at the southernmost edge of the IPWP and tropical rain belt. The overarching goals are (1) to investigate the expansion–contraction of IPWP over glacial/interglacial cycles, (2) to re-examine the roles of orbital forcings and glacial/interglacial variability on IPWP hydroclimate, and (3) to address how warm pool hydroclimate response to changes of ITCZ over the past 600,000 years.

Trang Tran.

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Jory Alqahtani

The Future of Using Ocean Currents to Generate Electricity

Tides and currents can become a reliable renewable energy source through proper technical developments and awareness of environmental impacts. Using proper equipment in select locations can allow for a large amount of electricity generation. By understanding the different types of currents and how they're formed, it is possible to know where to install this equipment. One set of currents is driven by the tides, which occur due to gravitational interaction between the Earth, sun, and moon. This causes ocean water along coastlines to move up and down and also move horizontally in broad currents. Other currents that can be used to generate electricity include surface currents (gyres), which are driven by the wind, and the conveyor belt, which is driven by the freezing and thawing of water. A tidal barrage (like a dam) is used to generate electricity from the tides, whereas turbines attached to the ocean floor are used to generate power from currents. The main challenge in developing this resource is to generate power from the moving water efficiently, and with minimal impact to life in the oceans. This research focuses on the implications of tides and currents as an energy source and all the pros and cons of this process. It also covers several current examples of tidal power plants and possible future goals of tidal energy usage.

Jory Alqahtani, George Gehrels

Benjamin Bucey

Using Nsumbu Ostracode Taphonomy To Determine Human Impacts On Lake Tanganyika

Lake Tanganyika (LT) is a rift lake in southern Africa bordered by Zambia, the DRC, Tanzania, and Burundi. It is the second largest lake by volume (18,880 km3), and the second deepest (1,470 m) lake in the world. It was formed about 10 million years ago and is home to hundreds of endemic species. Human activity on and around the lake could pose a threat to these species, specifically through deforestation causing accelerated siltation. This blankets important shell bed habitats, potentially destroying nearshore ecosystems. To better understand these impacts we analyzed the taphonomy of ostracod shells collected from these shell beds and adjacent habitats. We collected sediment samples from shell beds near Nsumbu, Zambia (southern LT) a site that is relatively unimpacted by humans, using SCUBA and a Ponar grab sampler. We then sieved and counted the samples to determine ostracode abundances and the percentages of shells with oxygen reduction stains, oxidation stains, broken vs intact, juveniles vs adults, and if the shells were intact carapaces. We are comparing these data with depth and habitat characteristics and will also compare our findings with previously collected data from 3 other sites in Tanzania (Luiche, Buhingu, and Utinta). At Nsumbu, ostracodes are abundant compared to other sites. We observed declines in the percent of adults, oxidation stains, intact shells and % of whole carapaces with increasing depth, whereas % reduction staining increased with depth. We observed increasing abundance of ostracodes down to about 100 meters in depth, below which abundance declines sharply.

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Hayley McKenley

Can stable isotopes of individual benthic foraminifera capture deepwater current variability?

Individual foraminiferal analyses (IFA) of planktic species have been widely applied to sample the statistics of subannual-scale paleoceanographic variations in surface and thermocline waters. However, relatively few studies have investigated the utility of individual benthic foraminiferal analyses (B-IFA) in providing information on the variability of deepwater current systems. This project aims to investigate the potential of B-IFA to accurately describe expected bottom water conditions using our knowledge of modern oceanography. In this regard, B-IFA has the potential to help constrain subcentennial-scale variability of bottom waters in sedimentary time slices of marine cores, owing to the subannual lifespan of benthic foraminifera. Here, we present core-top measurements of stable oxygen ($\delta^{18}O$) and carbon ($\delta^{13}C$) isotopes in individual benthic foraminiferal tests (n=164), belonging to the epifaunal species, Planulina

wuellerstorfi (Atlantic: n=120, Pacific: n=44), a commonly used taxa for paleoceanographic applications. We report preliminary results from core-tops in the North Atlantic and North Pacific oceans, spanning from depths 1875–4109 meters. These two basins experience very different circulation patterns, leading us to believe that they will be captured in the isotopic variability between core tops. A preliminary comparison of B-IFA data between Atlantic coretops indicates similar variability in $\delta^{18}O$ and $\delta^{13}C$ (1σNewfoundland= 0.091($\delta^{18}O$), 0.132($\delta^{13}C$), 1σDover= 0.118($\delta^{18}O$), 0.362($\delta^{13}C$)), whereas the Pacific coretop indicates much larger variability (1σCombinedPacific= 0.683($\delta^{18}O$), 0.213($\delta^{13}C$)). We hypothesize that the larger-than-expected variability of B-IFA in the North Pacific coretops are indicative of bioturbation, facilitated by very low sedimentation rates in this region. We discuss the implications for reconstructing paleocurrent variability using B-IFA datasets in downcore marine sediments.

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Hinad Aqeel

Wave Hello to the Future: Harnessing Ocean's Endless Energy

In the global search for sustainable and renewable energy sources, ocean wave energy is a promising contender and should be employed more in the future. Waves are created by the interaction of the wind with the water surface, transferring kinetic energy to the water with immense potential for electricity production. The poster explores the different methods of using ocean waves to generate electricity, which are: Oscillating Water Columns (OWCs), overtopping devices, and wave-activated bodies (WAB). Through comprehensive review and analysis of existing models, this research evaluates each method's operational principles, strengths and weaknesses of the methods, environmental considerations, such as the potential impacts on marine ecosystems and the need for careful site selection, real-life applications in the current world and throughout history, and a future outlook. Certain coastal areas possess a high annual mean wave power density, such locations are prime candidates for wave energy farms, which could significantly contribute to the energy mix. This reinforces our agreement that wave energy has higher power density and a more reliable presence than the more commonly used energy sources today. The poster's focus is to guide the audience from a foundational understanding of wave energy to in-depth analyses and forward-thinking projections, encouraging increased investment and research into wave energy, highlighting the future outlook where wave energy could feasibly supply a considerable segment of the global energy demand, as per PacWave's findings that the potential energy that could be generated from the ocean's surface is over 3 terawatts globally.

Hinad Aqeel, George Gehrels

Sarah

"Salt to Volt: Harnessing Power from Seawater Chemistry"

The poster Investigates the efforts made to produce electricity using seawater. From the multiple mechanisms in which that could be achieved, the poster focuses on the chemistry of seawater, more specifically, the salinity gradient of seawater and how that can be harnessed via mixing entropy batteries. The salinity gradient energy is created due to the difference in salt concentration between two fluids. Sea Water contains ions like chloride (Cl^-) and sodium (Na^+). These charges ions cause a salinity gradient– difference in salt concentration between two fluids– which can then be harnessed into power. Osmotic (or salinity gradient) power is a renewable energy concept that can be harnessed through many different technologies. There are many methods in which Osmotic power can be harnessed, some of which are reverse electrodialysis (RED), pressure retarded osmosis (PRO) and capacitive mixing (CAPMIX) technologies. The first two methods (RED & PRO) utilize membranes while the third method utilizes electrodes and batteries. Mixing entropy batteries produces A flow of ions via its electrodes by flushing seawater with wastewater (and vice versa) which is then captured and used to produce electricity. An initial energy investment is eliminated through this method lowering the overall cost. This can ultimately achieve an independently functioning plant that is immune to blackouts (Ye et al., 2019). A case study of the Palo Alto Regional Water Quality Control Plant as well as an overview of the Saltpower company is presented to support these arguments.

This poster is done under the supervision of Dr. George Gehrels

Gabby Martin

U-Pb and T/REE Analyses of The Coast Mountains Batholith in Southeastern Alaska

The Coast Mountains Batholith (CMB) is located along the Northwest coast of North America and spans much of Southeast Alaska and Western British Columbia. According to prior research done in the area, the batholith is mostly composed of plutonic rocks from Late Jurassic to Eocene in age. The ages of older portions of the batholith have been studied extensively, whereas little is known about the ages of younger portions. The aim of this specific project is to analyze zircon samples collected from Late Cretaceous through Eocene plutons that are in northern Southeast Alaska. Field work was done in the summer of 2023 in Southeastern Alaska aboard the UA research vessel MV Whitecap. Mapping and sample collection occurred of various younger plutons in the area. Back in Tucson, Arizona, zircons were extracted and then analyzed using the Thermo Element2 single collector ICPMS at the Arizona LaserChron Center. U-Pb ratios and Trace element and REE concentrations were determined during the fall of 2023. Ages were determined from Concordia plots based on the measured U-Pb ratios. The ages were found to be between 105 and 60 Ma. The broader scope

of the project is to test whether the CMB was located (1) at the paleolatitude of California and outboard of the Mezcalera Ocean basin, or (2) along the Northern Cordilleran margin during Late Jurassic through Paleogene time. Future work will involve completing Lu-Hf analyses of the best grains from these samples. This will reveal more information about the magmatic evolution of the plutons.

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Eleanor McDonough

U-Pb Geochronology of the McCoy Mountains Formation in Arizona: Evidence for deposition within the Cretaceous McCoy foreland basin

The McCoy Mountains Formation, exposed in southern California and Arizona, preserves a ~7 km thick sedimentary record from the Mesozoic, a time when western North America experienced contrasting tectonic regimes related to intracontinental rifting along the Mexican Border rift system and the consolidation of the North American Cordillera. Recent studies suggest that the McCoy Mountains Formation in California represents the southernmost extent of the Cordillera. However, correlation of this formation across the McCoy basin remains poorly understood, hindering the development of a comprehensive stratigraphic framework and regional tectonic model. We present new U-Pb detrital zircon ages from clastic sedimentary strata exposed in the Granite Wash and Dome Rock Mountains. Youngest age populations are consistent with deposition during the Early Cretaceous and younger. These findings contradict hypotheses proposing that the McCoy basin developed during the Late Jurassic Bisbee intracontinental rifting event. Instead, our data suggest that these strata in Arizona are correlative with the lower McCoy Mountains Formation in California and were derived from similar source rocks in the Maria fold-thrust belt. This is consistent with deposition in the west-east trending McCoy retroarc foreland basin.

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