

Department of Geoscience Faculty Research Areas

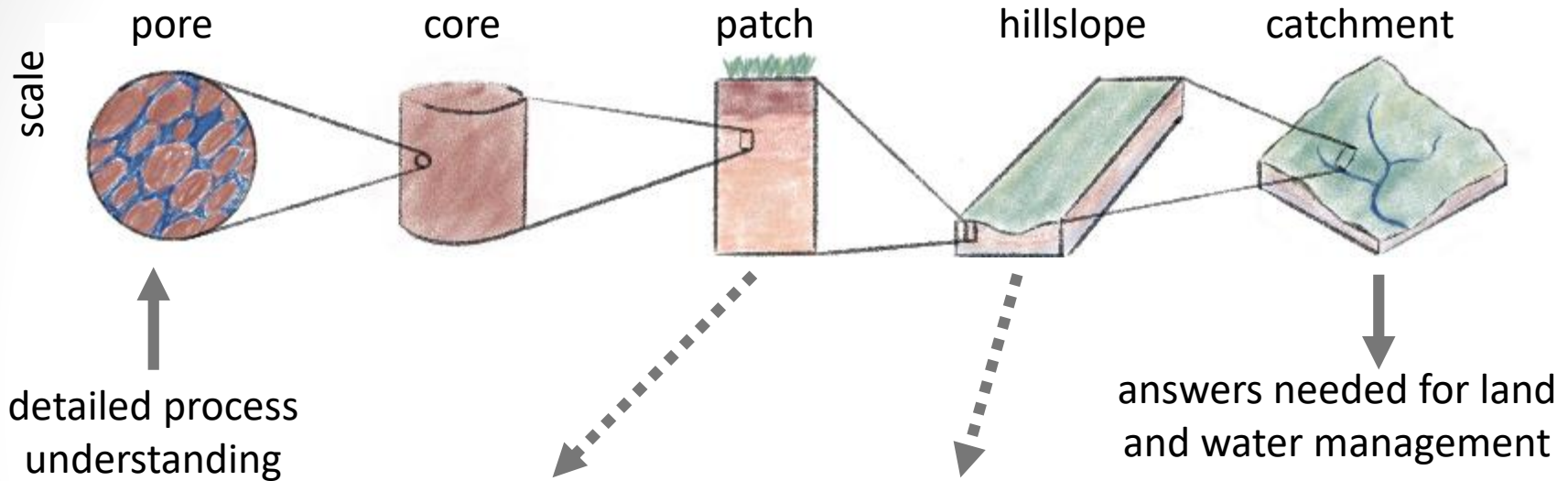
Critical Zone Hydrology

- **Dr. Hannes Bauser**
- Assistant Professor
- Department of Geoscience
- Email: hannes.bauser@unlv.edu
- Website: <https://geoscience.unlv.edu/people/departement-faculty/hannes-bauser/>

Expertise

- Vadose Zone Hydrology and Soil Physics
- Hydrologic Modeling
- Data Assimilation
- Machine Learning

Hydrologic Scaling Challenge



detailed process understanding

answers needed for land and water management

Collaboration with the Desert Research Institute for access to the [SEPHAS Lysimeters](#) in Boulder City.



Collaboration with the University of Arizona for access to the [Landscape Evolution Observatory](#) at Biosphere 2.

How can we use data science (e.g., data assimilation, machine learning) to combine process understanding and data to solve the hydrologic scaling challenge?

Forest Inventory and Analysis

- **Dr. Brenda J Buck**
- Professor
- Department of Geoscience
- Email: Brenda.Buck@unlv.edu
- Website: <https://unlv-fia.github.io/UNLV-FIA-Group/index.html>



Expertise

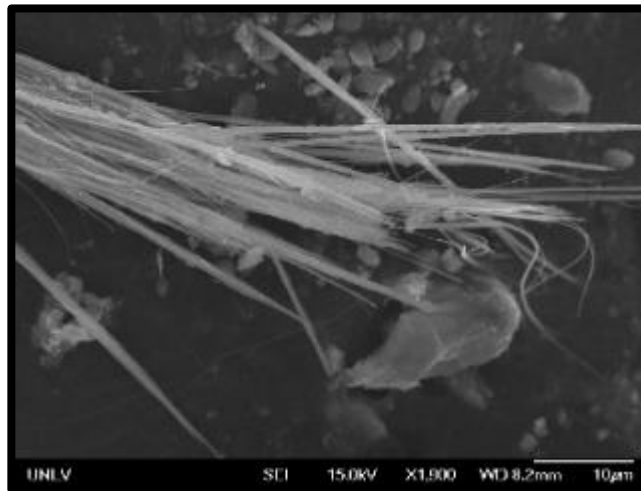
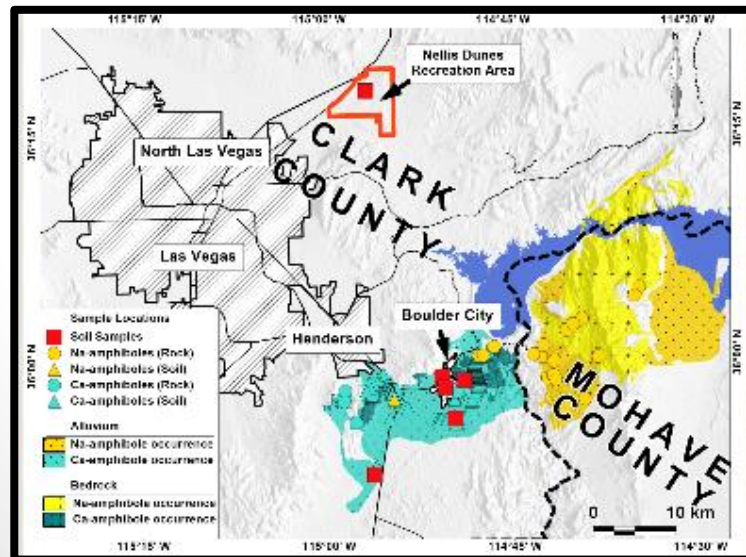
- University partner to USDA-FIA. Area of emphasis is information management research and development to optimize the storage, delivery, and display of forest inventory data.
- The support we provide helps policy makers, land stewards and non-governmental groups base decisions and assessments related to the health, diversity, and productivity of U.S. forests and grasslands on scientifically credible information.

Medical Geology

- **Dr. Brenda J Buck**
- Professor
- Department of Geoscience
- Email: Brenda.Buck@unlv.edu

Expertise

- Expertise: Health effects of mineral dust; Asbestos; Heavy Metals; Soil Science/Geology



Materials Deformation

Dr. Pamela Burnley

Department of Geoscience

Phone: (702) 895-5460

Email: pamela.burnley@unlv.edu

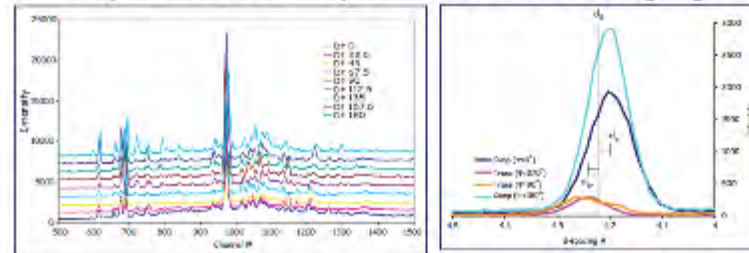
Expertise:

High Pressure Rock Deformation

High Pressure studies of Deformation and the Acoustoelastic effect



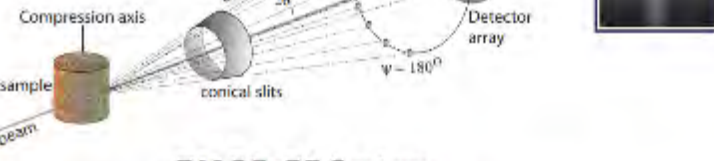
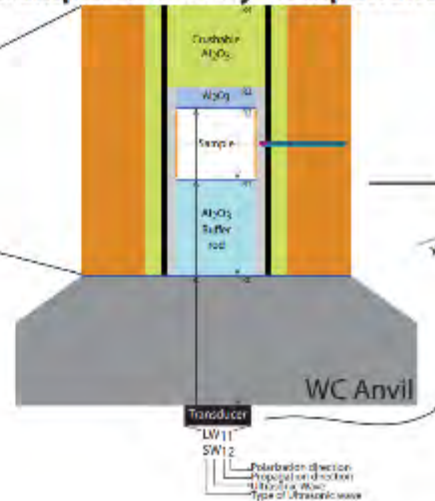
Synchrotron X-ray diffraction and imaging



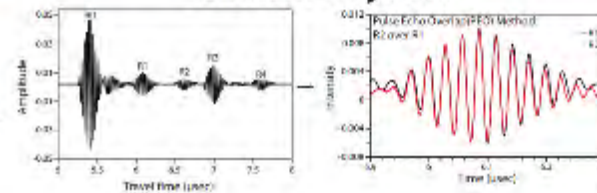
D-DIA module



Ultrasonic D-DIA Modified Sample Assembly Components



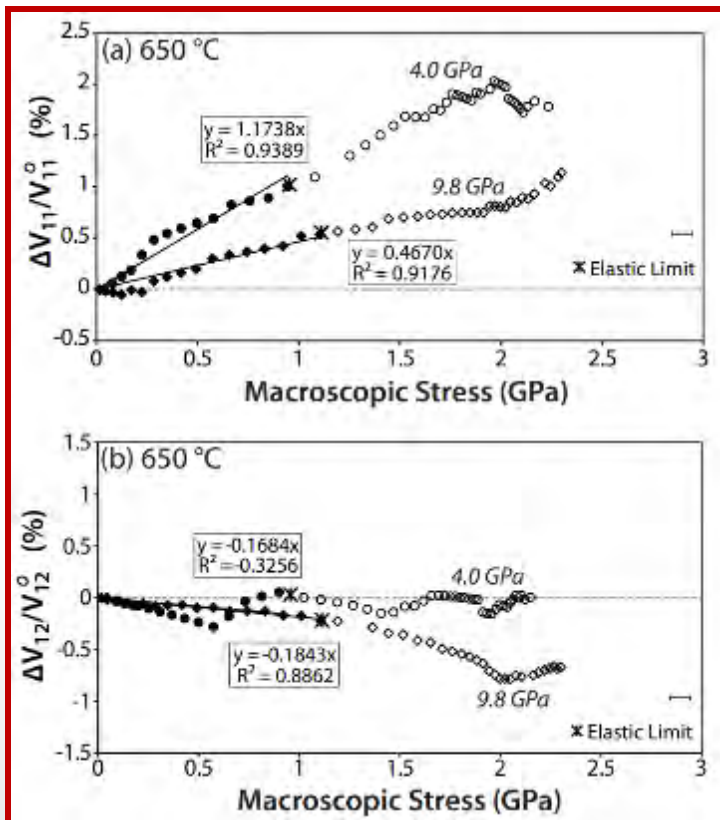
DIASCoPE System



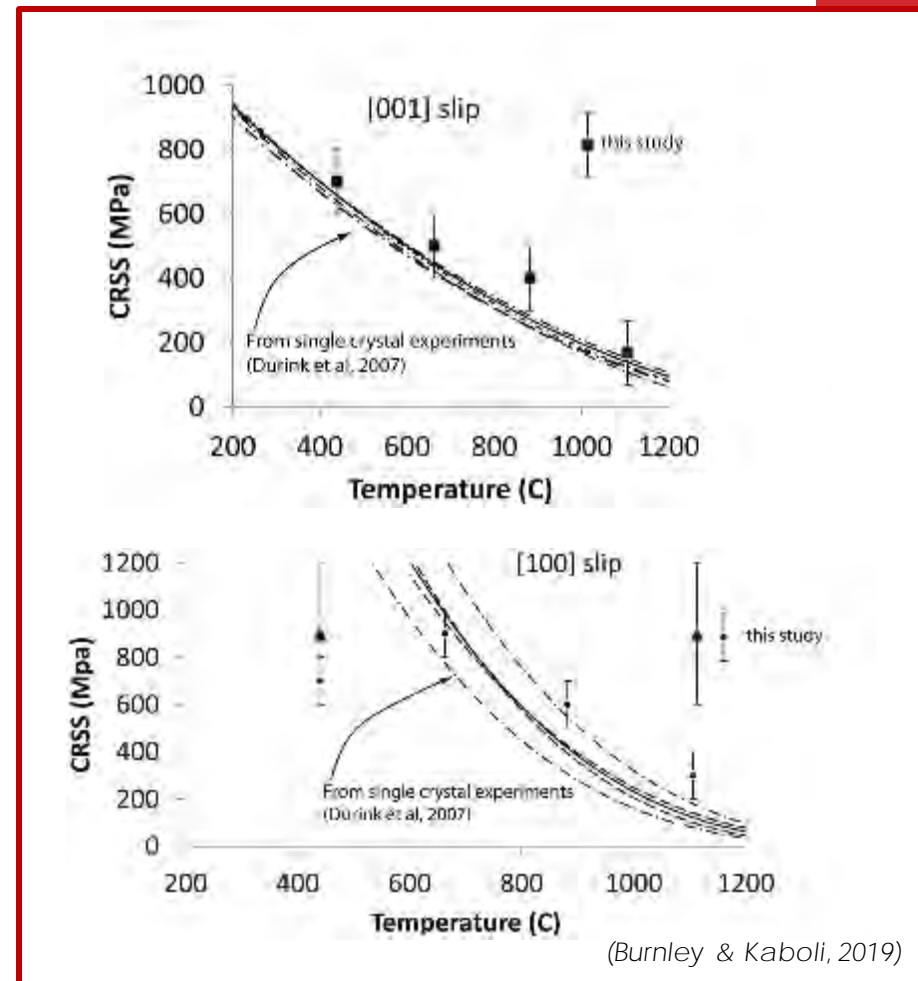
High Pressure studies of Deformation and the Acoustoelastic effect

Details of multiple slip systems derived from a single multi step experiment

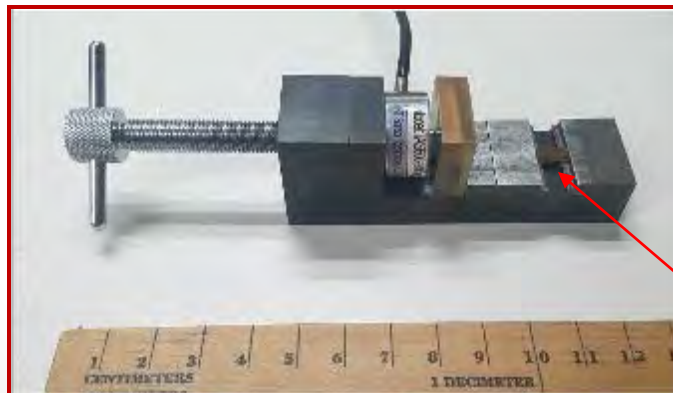
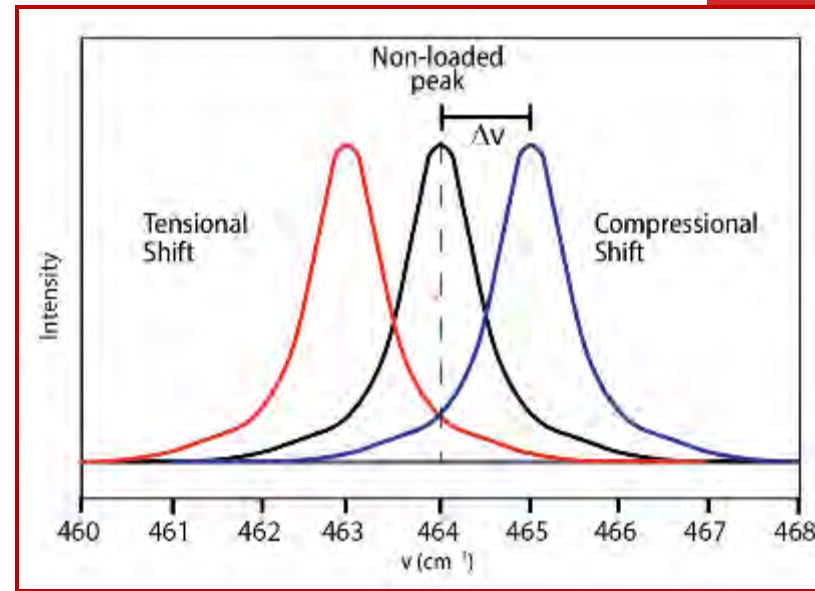
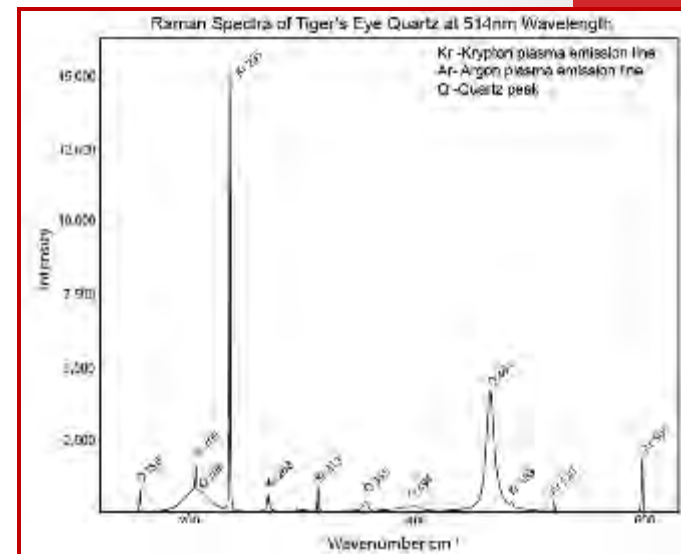
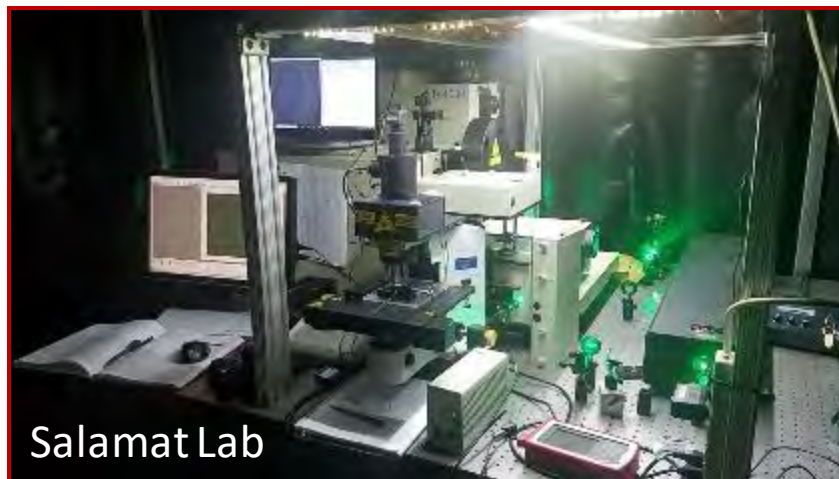
Compression- and shear-wave velocities are a function of compressive stress



(Traylor, Whitaker & Burnley, in prep)



Raman spectroscopic measurements of stress distribution

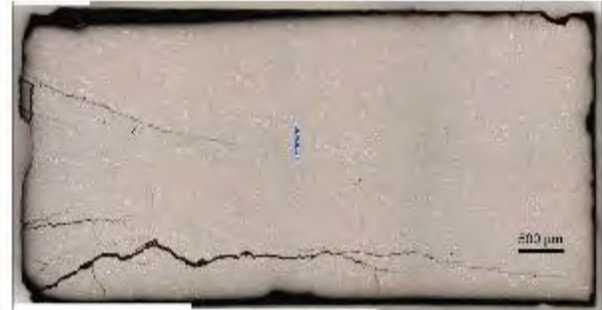
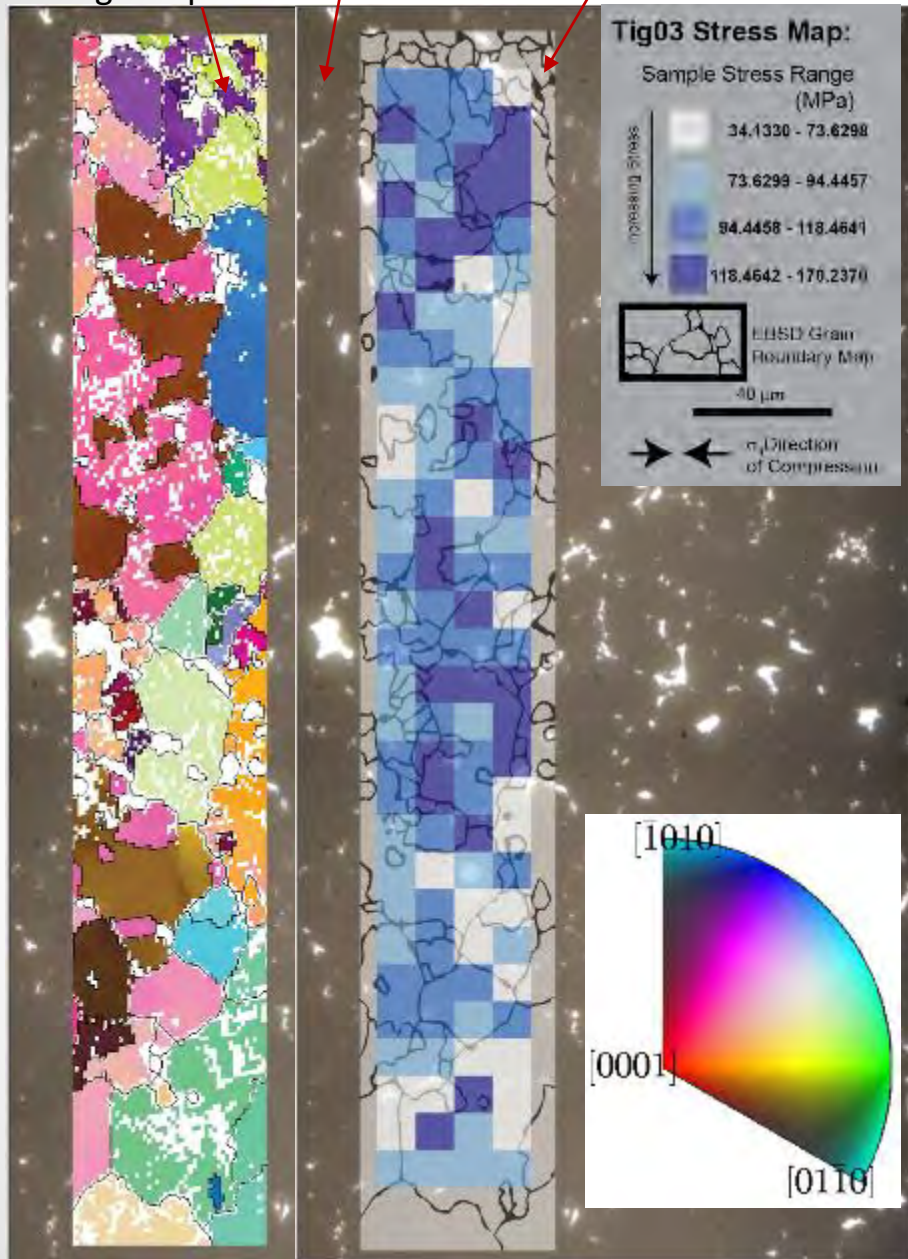


sample

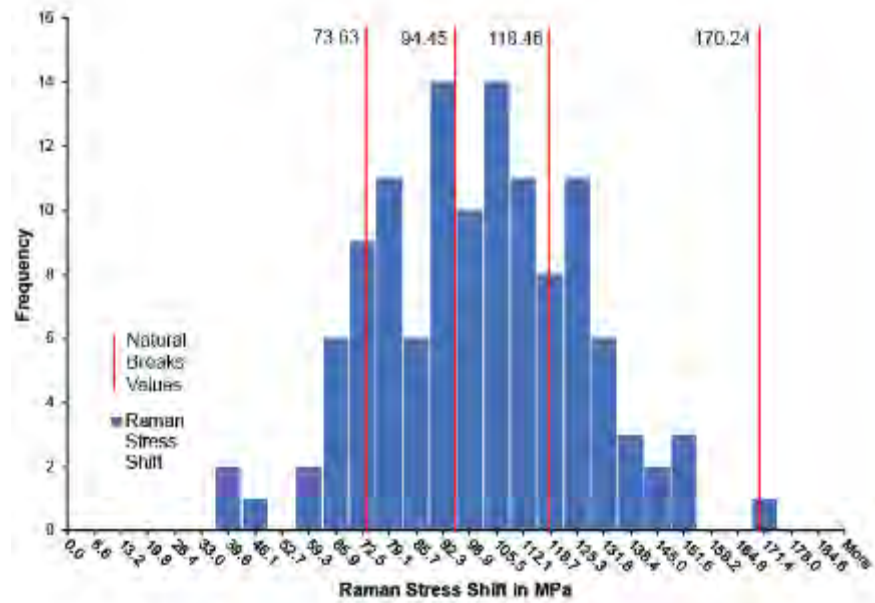
EBSD Orientation Image Map

optical image

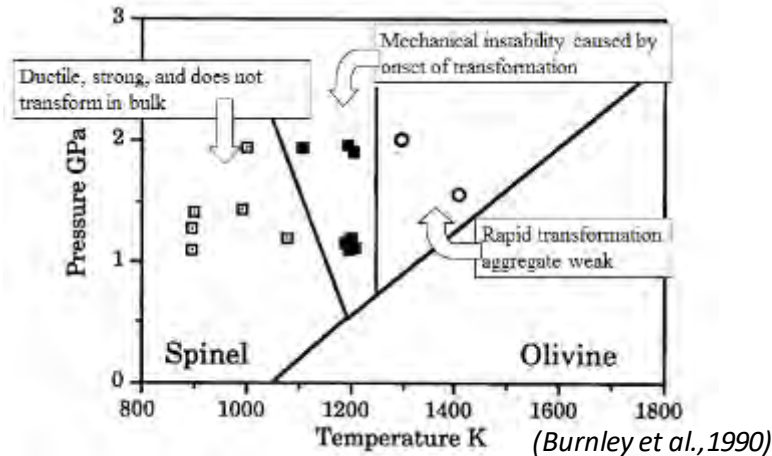
Stress map



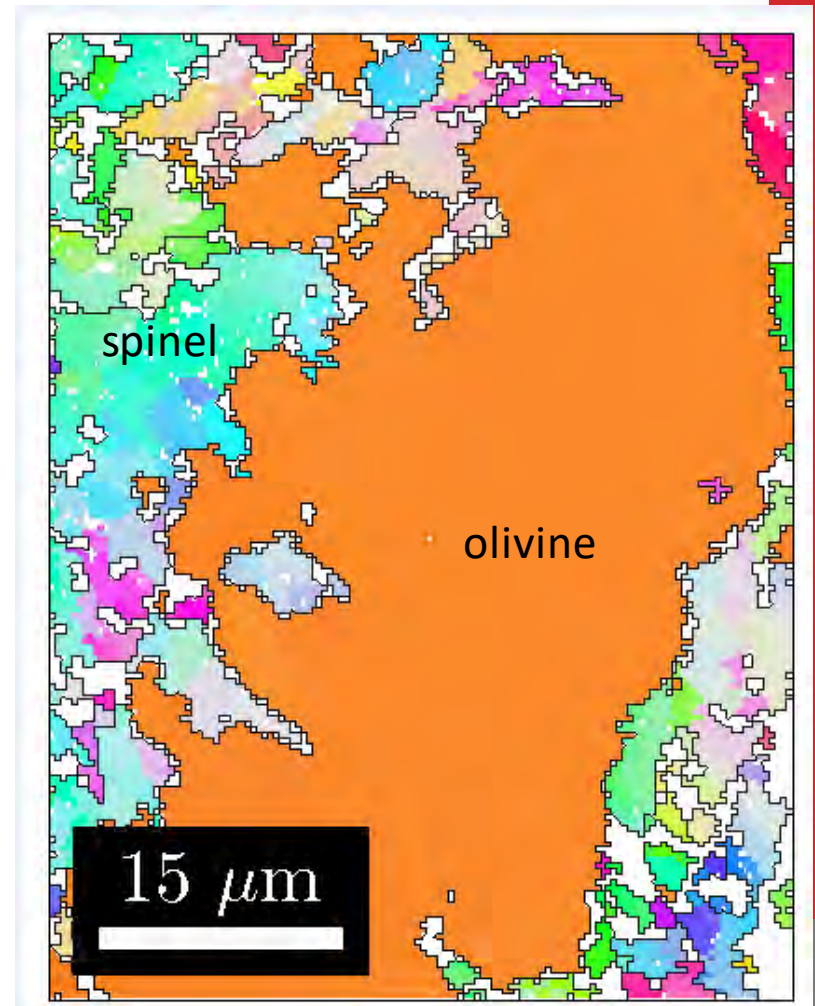
▶ Peak shifts converted to sample stress using single crystal measurements



Interaction of Phase Transformation and Deformation



- Growth of spinel in metastable olivine creates mechanical instability
- New microstructural analysis clarifies nature of instability



Electron Backscatter Diffraction
Orientation Image Map
(Burnley et al., in prep)

Radioactive Materials and Radiation

Dr. Pamela Burnley

Department of Geoscience

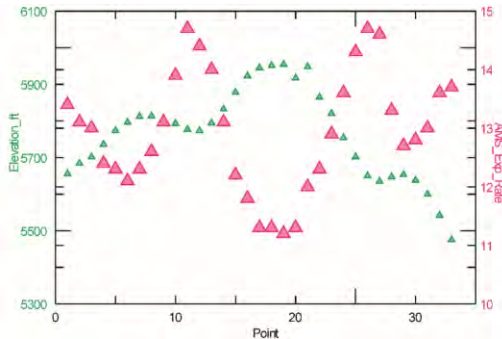
Phone: (702) 895-5460

Email: pamela.burnley@unlv.edu

Expertise:

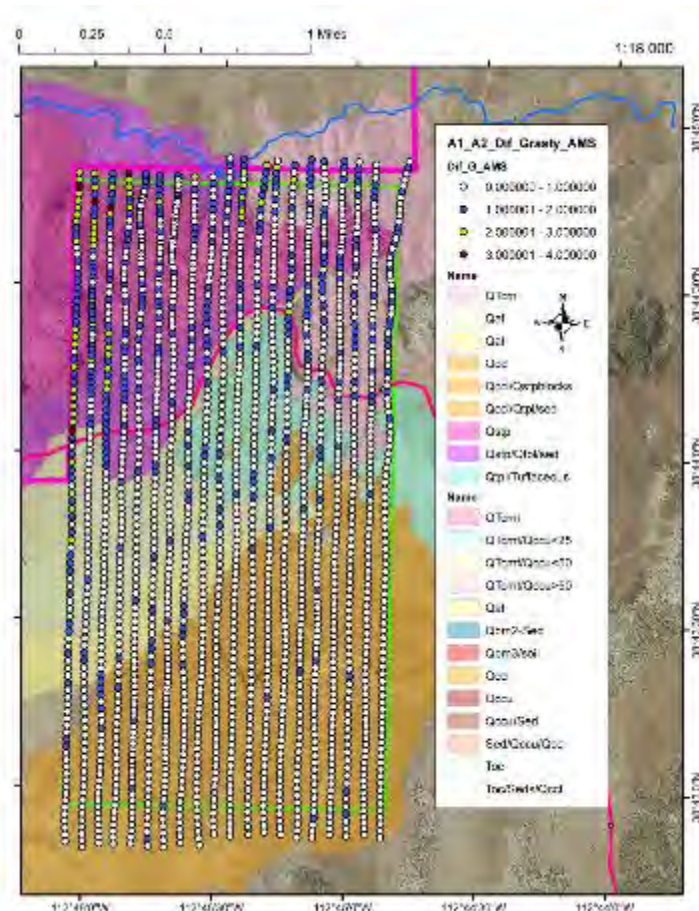
Gamma ray background radiation

γ -ray Background Radiation



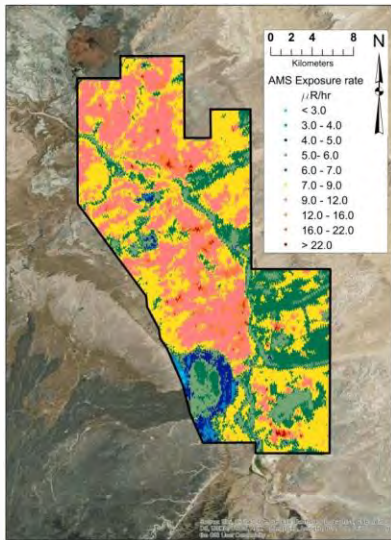
- Predictive model based on legacy NURE data & geologic map units
- Most points within $1\mu\text{R/hr}$
- Largest deviations associated with steep topography
- Led to D. Haber's PhD research on topographic corrections

Difference between AMS flight data and predictive model

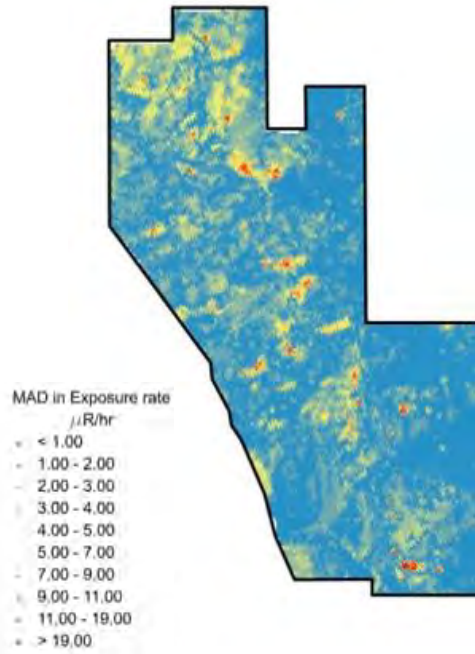


γ -ray Background Radiation

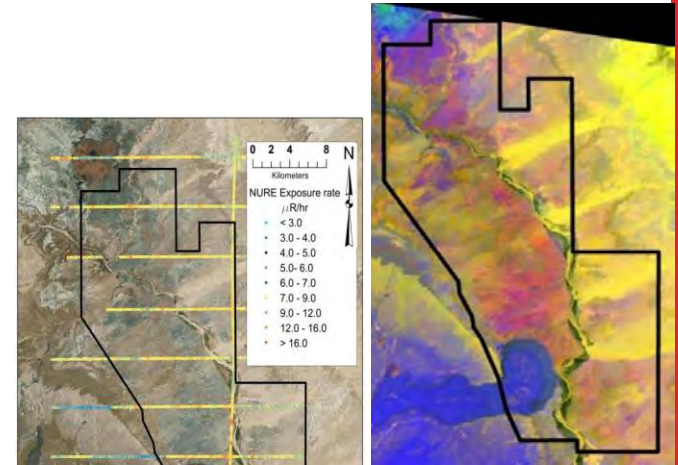
AMS flight data
Cameron, AZ



Difference between
AMS data and model



Model based on ASTER data,
NURE survey & geologic map



(Adcock et al. 2019)

Highlights Uranium
mines

Geochronology and Thermochronology

- **Dr. Cody Colleps**
- Assistant Professor
- Department of Geoscience
- Email: cody.colleps@unlv.edu
- Website: www.CoCoGeo.com

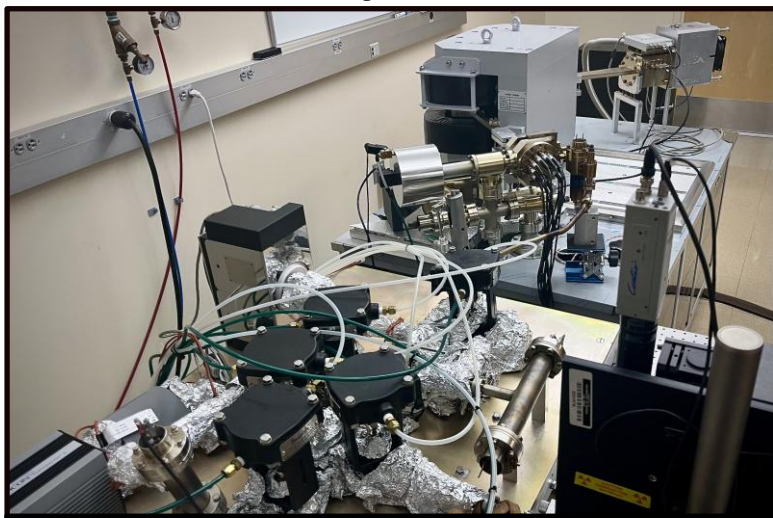
Expertise

- Noble gas-based thermochronology
- Geochronology
- Tectonic and climatic interactions
- Deep-time erosional processes
- Himalayan geology
- Irradiation of geological materials

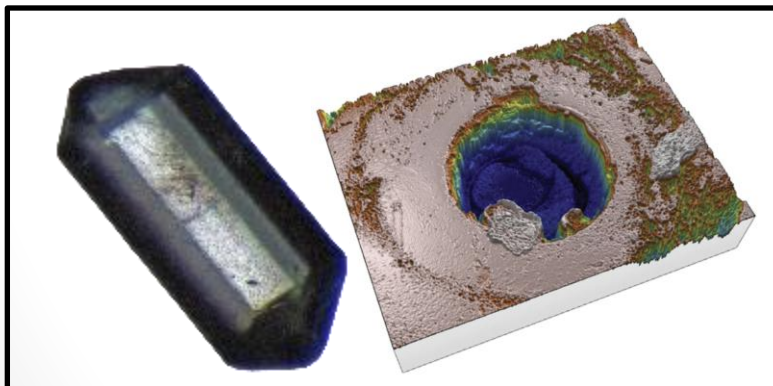


What drives crustal exhumation, and how do distinct erosional events impact Earth's dynamic systems?

Nevada Isotope Geochronology Laboratory (NIGL)



Isotopx NGX-600 Mass Spectrometer for $^{40}\text{Ar}/^{39}\text{Ar}$ Dating



Laser Ablation (U-Th)/He Dating of Apatite and Zircon

We develop and apply novel analytical dating techniques to obtain high-resolution insight into crustal exhumation across multiple temporal and spatial scales.

Greater Himalaya of Northwest India



Basin Analysis and Tectonics

- **Dr. Erin Donaghy**
- Assistant Professor
- Department of Geoscience
- Email: erin.donaghy@unlv.edu

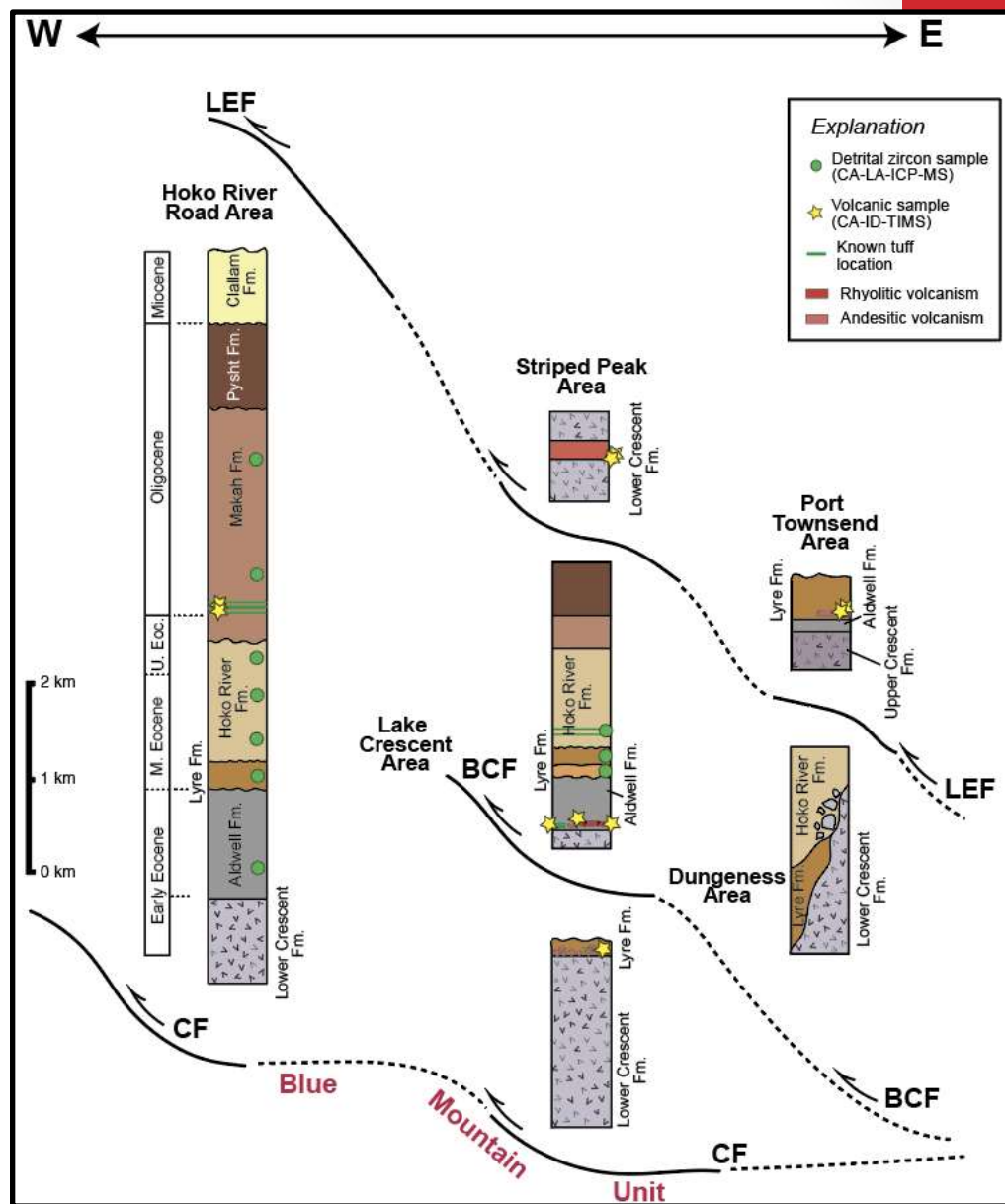
Expertise

- Forearc basin processes
- North America Cordilleran tectonics
- Strike-slip basin evolution
- U-Pb zircon geochronology
- Oceanic plateau collision



My group uses the sedimentary record to tackle large-scale tectonic questions by integrating both field and analytical methods

- Measured stratigraphic sections and lithofacies mapping are used to reconstruct depositional environments
- U-Pb detrital zircon geochronology to determine sediment provenance
- Establish a high-precision chronostratigraphy for regional stratigraphic correlations



Aqueous Geochemistry and Astrobiology

- **Dr. Elisabeth (Libby) Hausrath**
- Professor
- Department of Geoscience
- Email: Elisabeth.Hausrath@unlv.edu
- Website: <https://hausrath.faculty.unlv.edu/>

Expertise

- Using laboratory experiments, field work, and modeling to interpret water-rock interactions and soil-forming processes on Earth and Mars
- Interpreting the signatures of past aqueous and biological impacts on minerals
- Participating Scientist on the Mars Science Laboratory Curiosity and the Mars2020 rover Perseverance and member of the Network for Life Detection ([NFOLD](#)) Steering Committee..

Holes made by sampling soil on Mars



Image credit: NASA/JPL-Caltech

<https://mars.nasa.gov/news/9311/nasas-perseverance-rover-gets-the-dirt-on-mars/#:~:text=The%20mission's%20first%20two%20samples,prepare%20for%20future%20missions%20there.>

Geochemistry & Cosmochemistry

Dr. Yan Hu

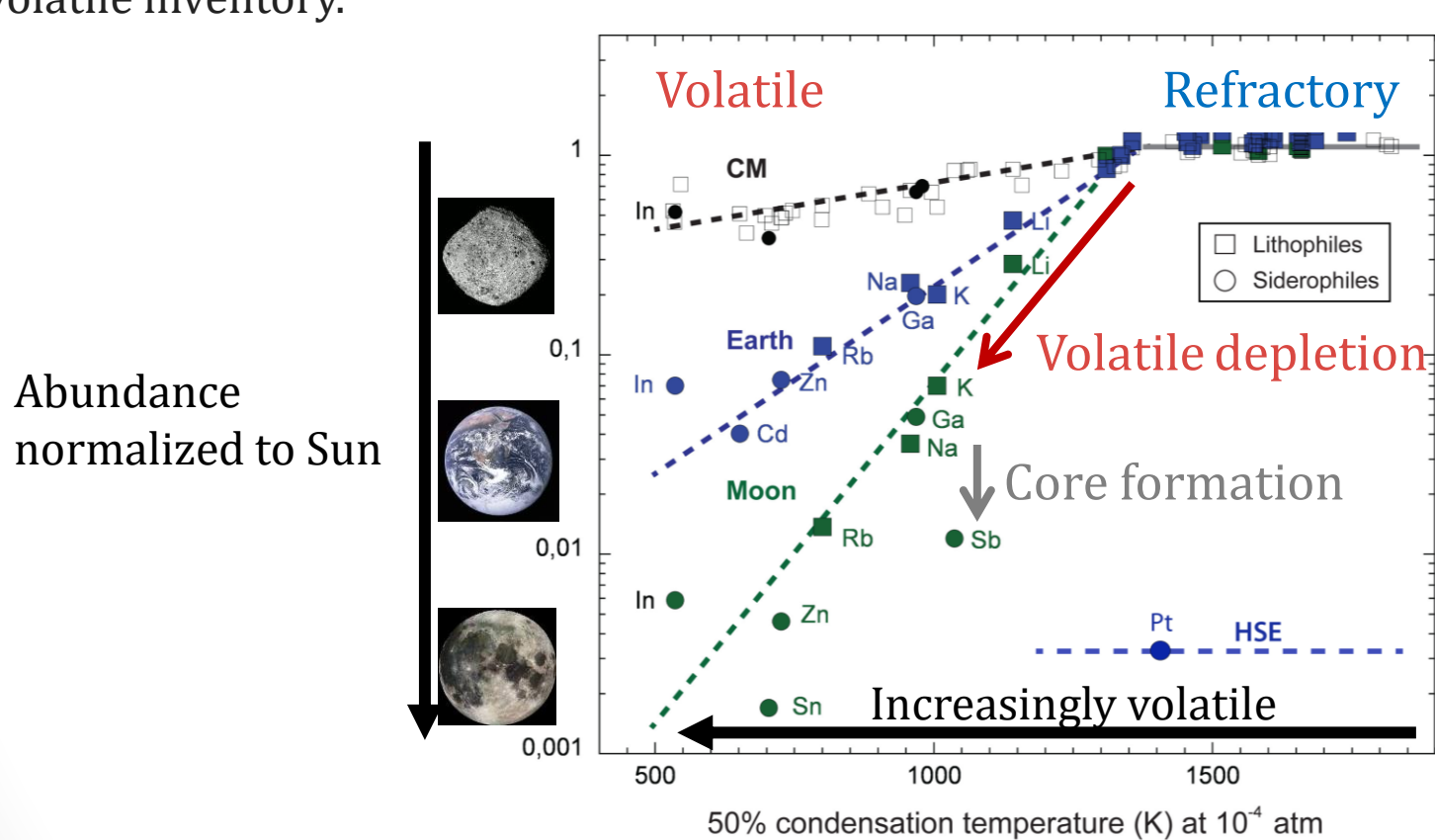
- Assistant Professor
- Department of Geoscience
- Email: yan.hu@unlv.edu
- Website: <https://sites.google.com/view/yan-hu>; [Google Scholar](#)

Expertise

- Composition and evolution of Earth and early Solar System
- Subduction zone processes
- Non-traditional stable isotopes (e.g., Li, Mg, K, Ca, Fe)
- Multi-Collector Inductively Coupled Plasma Mass Spectrometry

How planets formed and became habitable?

I study meteorites and mission-returned samples to learn about the building blocks of terrestrial planets and how condensation/evaporation shape their volatile inventory.



Volatile elements are variably depleted, making each planetary body unique.

Sedimentary Geology

Dr. Ganqing Jiang

Professor

Department of Geoscience

Phone: (702) 895-2708

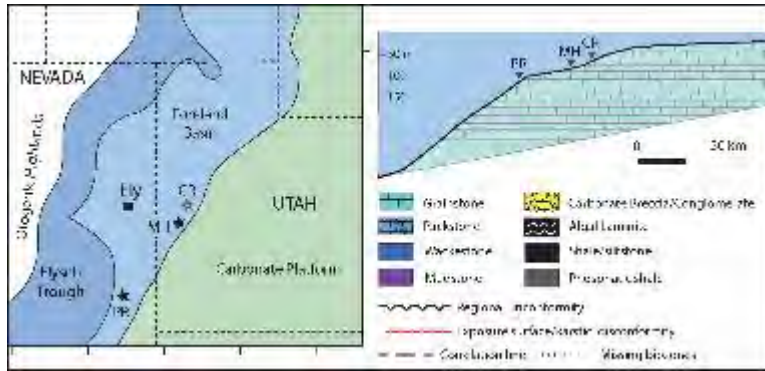
Email: Ganqing.Jiang@unlv.edu

Expertise:

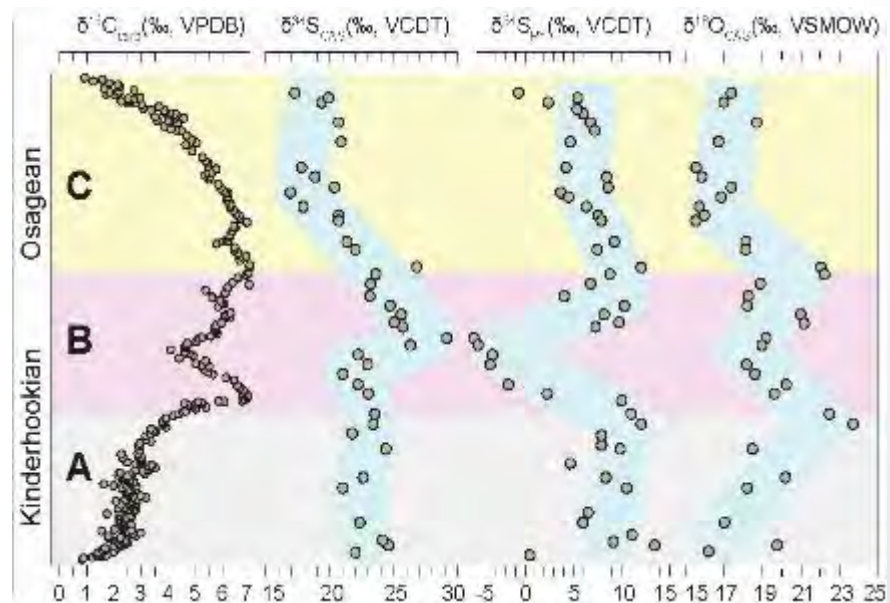
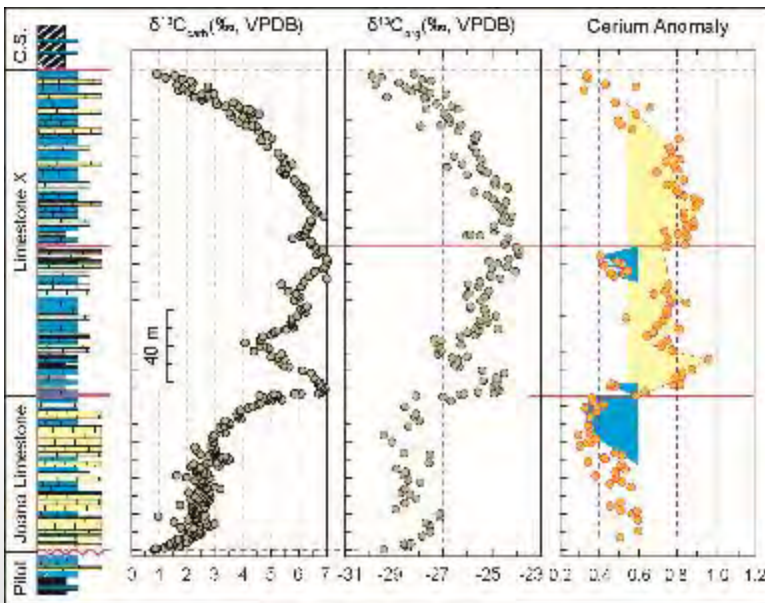
Sequence and chemostratigraphy

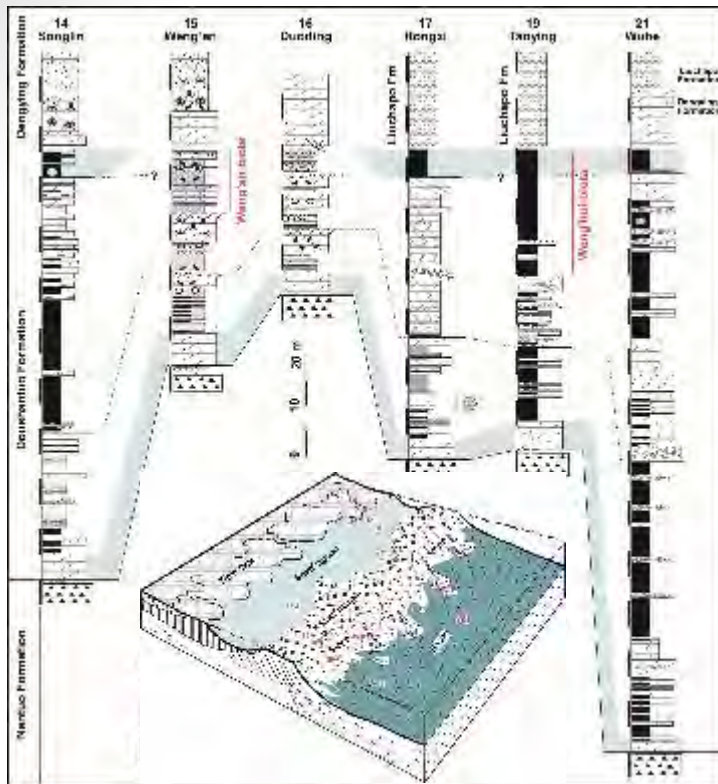
sedimentology

Carbonate diagenesis

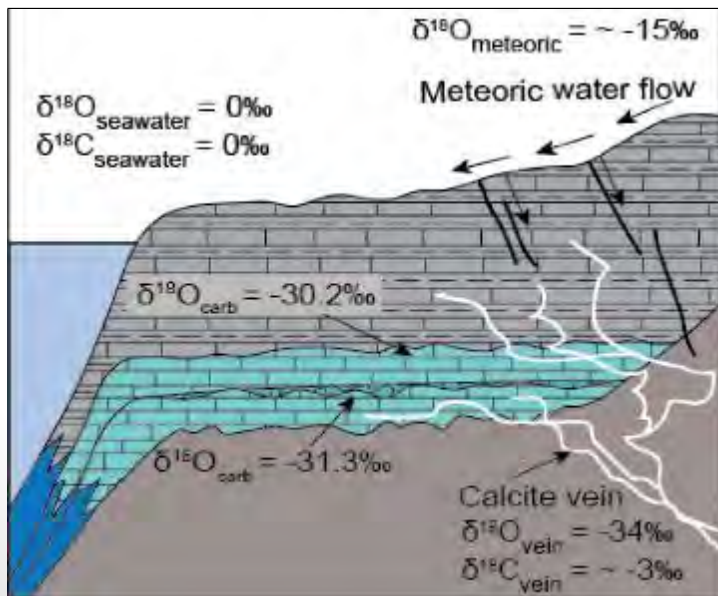


- Sequence and chemostratigraphy
- Paleogeographic reconstruction
- Applications of stable isotopes and rare earth elements
- Paleoenvironmental change across major perturbations of the carbon cycle and mass extinctions





- Basin analyses and paleoceanography
- Fluid migration and carbonate diagenesis
- Tracing fluid migration in sedimentary basins using stable isotopes and trace elements
- Carbonate aquifer



Climate Science and Paleoclimatology

Matthew S. Lachniet

Professor

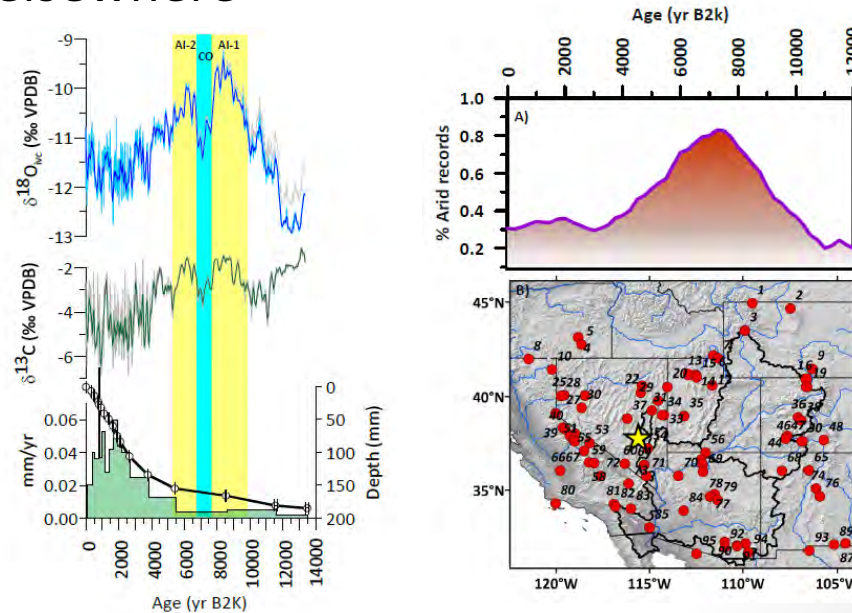
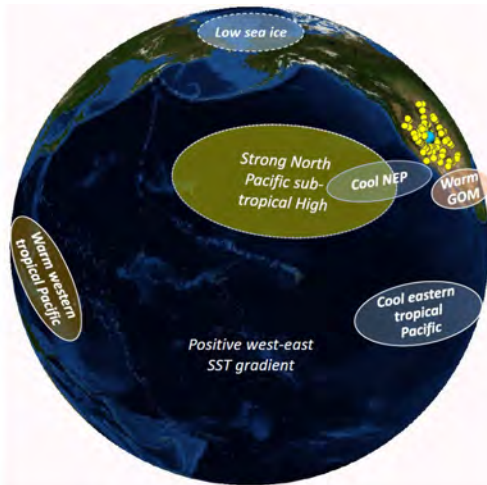
Department of Geoscience

Phone 702-895-4388

Matthew.Lachniet@unlv.edu

Paleoclimatology

- Study of the causes, timing, and consequences of climate change on timescales ranging from decades to millennia
- Cause of aridity in the Great Basin and Western United States
- Influence of ocean temperatures on precipitation in Nevada
- Cave archives of past climate with sites in Nevada, Mexico, Central America, and elsewhere



Economic Geology Research Group



- **Dr. Andrew Martin**
- Assistant Professor
- School of Geoscience
- Email: andrew.martin@unlv.edu



Expertise

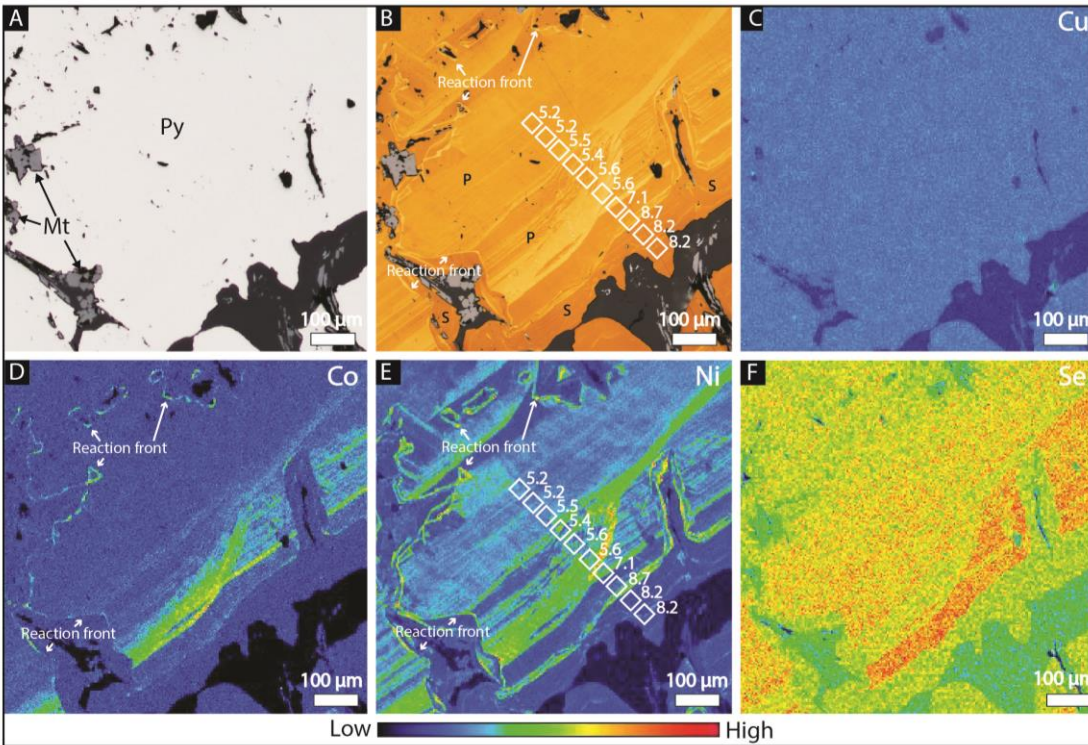
Geochemical Research: Studying hydrothermal mineral deposits using mineralogy, geochemistry and stable isotopes.

Temporal Tracking: Expertise in in situ microanalysis of sulfide minerals.

Integrated Methods: Combining mineral-scale observations with bulk-rock geochemistry, mineralogy and field mapping.

Specialization: Expertise in critical metals, volcanogenic massive sulfide (VMS), seafloor massive sulfide (SMS) deposits and Carlin-type Au mineralization.

Understanding evolving metal and sulfur sources in mineral deposits



- As minerals grow they record changes - just like rings on a tree.
- My research group combines mineralogy with geochemical and isotopic studies to understand how these changes relate to the formation of an ore deposit.
- Above is an example from deep below the ocean, this sample was collected from the Semenov vent field on the Mid-Atlantic Ridge.

Hydrology

Dr. Michael Nicholl

Department of Geoscience

Phone: (702) 895-4616

Email: michael.nicholl@unlv.edu

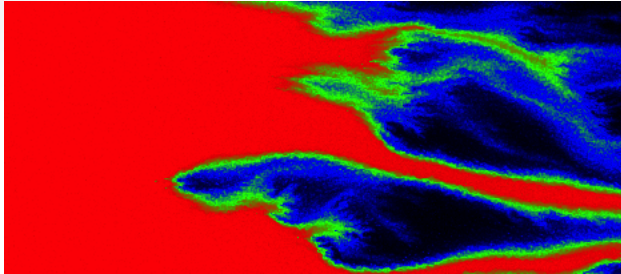
Expertise:

Unsaturated zone hydrology

Fractured rock hydrology

Environmental fluid mechanics

Fractured Rock Hydrology



False color image of a miscible displacement experiment in a single fracture



Field mapping of fracture networks
blue dye (right foreground) is from an infiltration test



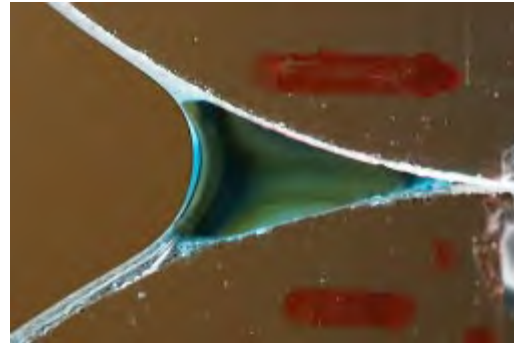
Water (blue) pooled above a fracture intersection



Isothermal flow across a single rock fracture (matrix-to-matrix flow)

- ❑ Two-phase flow and transport in fractured rock
- ❑ Laboratory experimentation, field mapping, numerical simulations
- ❑ Contaminant transport, geothermal energy, enhanced petroleum recovery

Unsaturated Porous Media



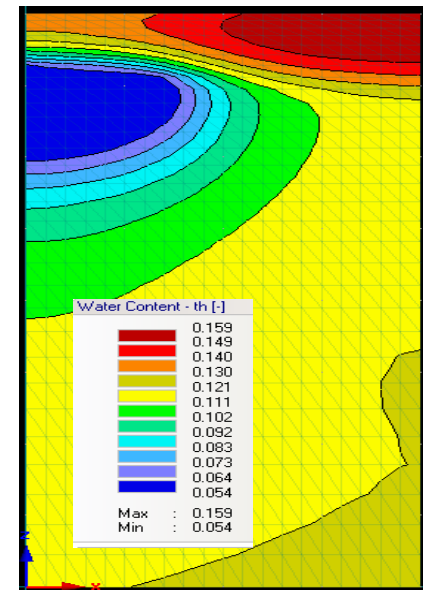
Millimeter-scale transport experiment



Hydraulic conductivity of a rock slab



Sampling Chloride as a proxy for root-driven horizontal flow



2D simulation of root-driven transport

- ❑ Challenging existing conceptual models for unsaturated and two-phase flow
- ❑ Design and execution of critical laboratory/field/numerical experiments

Environmental Geochemistry

Dr. Zach Perzan

- Assistant Professor
- Department of Geoscience
- Email: zach.perzan@unlv.edu
- Website: <https://zperzan.github.io/>

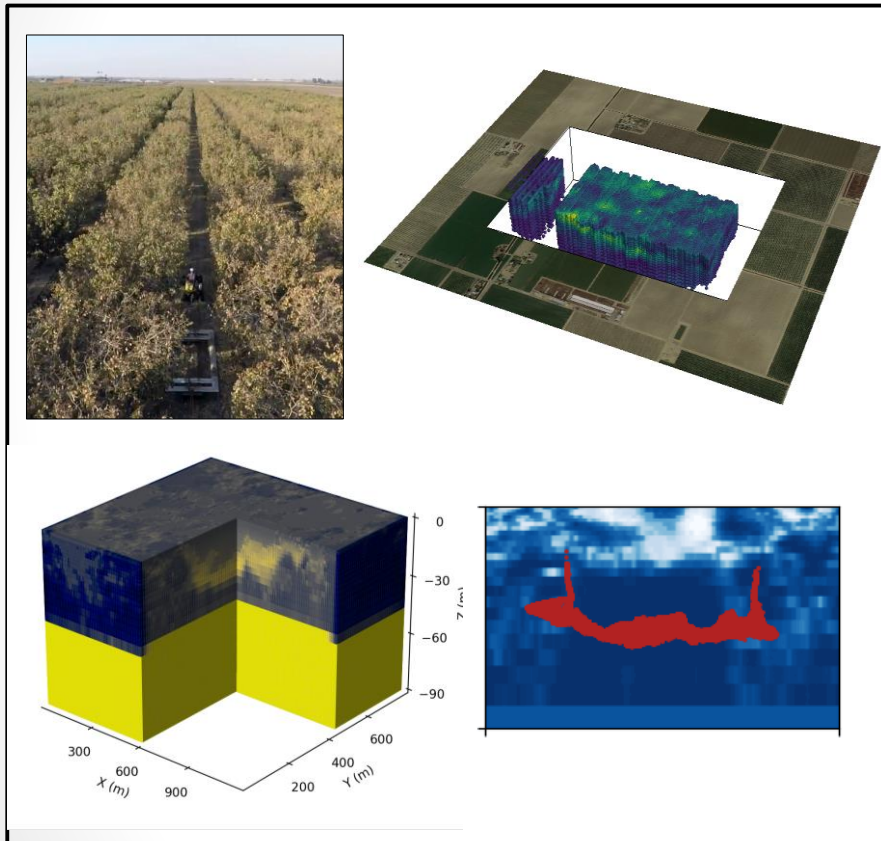
Expertise

- Environmental geochemistry
- Surface water-groundwater hydrology
- Machine learning
- Uncertainty quantification
- Managed aquifer recharge



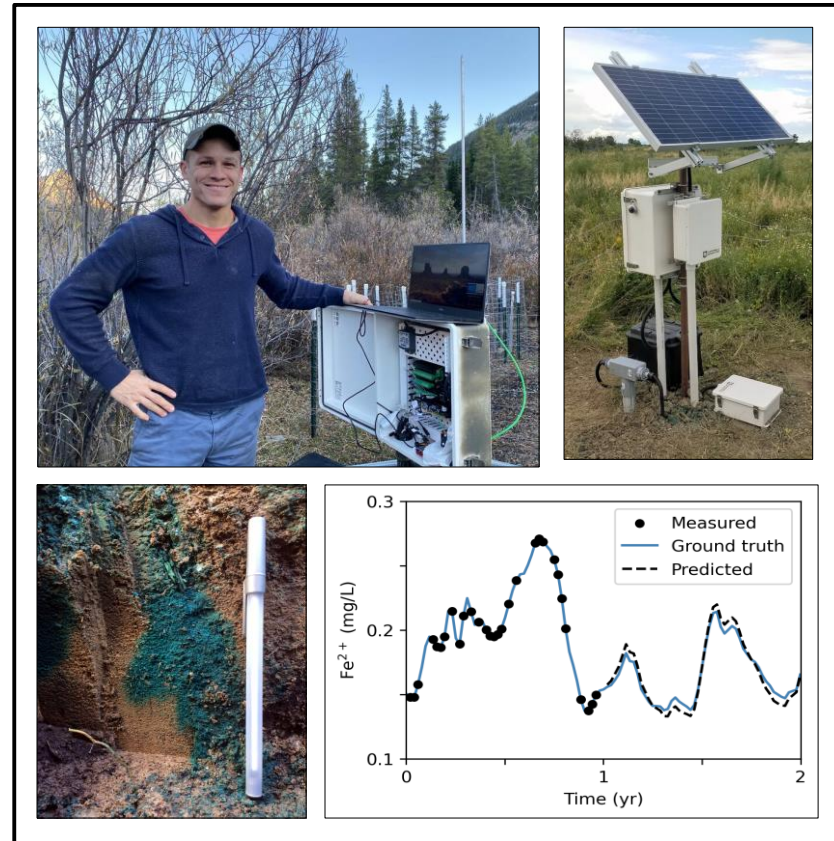
Understanding how hydrologic extremes (droughts and floods) impact water quality

Managed aquifer recharge



Geophysical surveys (top left) give us a 3D image of the distribution of sand, silt and clay within the subsurface (top right). We can then use hydrologic and geochemical models to understand how water (bottom left) and contaminants (bottom right) move through these sediments during a flood.

Floodplain biogeochemistry



Sensor arrays deployed in Colorado (top left) and Wyoming (top right) allow us to monitor sudden changes in water quality during floods. By pairing these with field experiments – such as tracer tests (bottom left) – we can develop data-driven water quality forecasts (bottom right).

Fluids and Magmas in Ore Systems

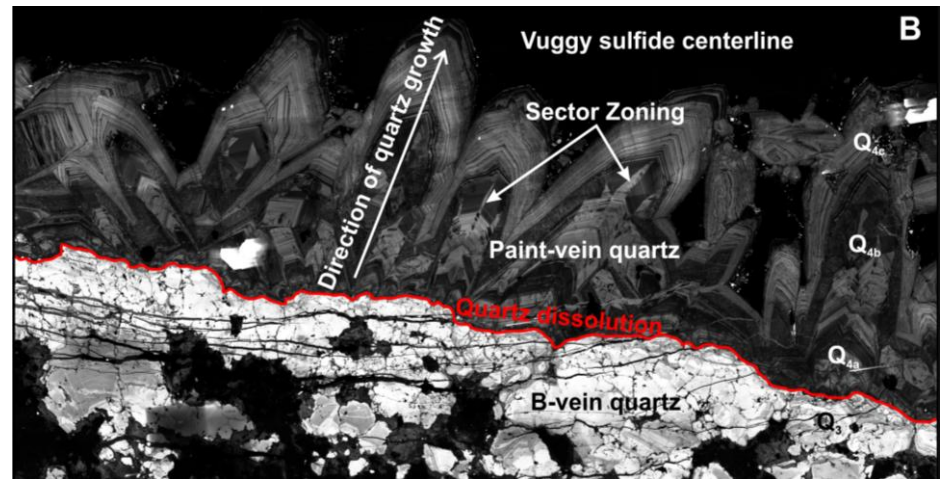
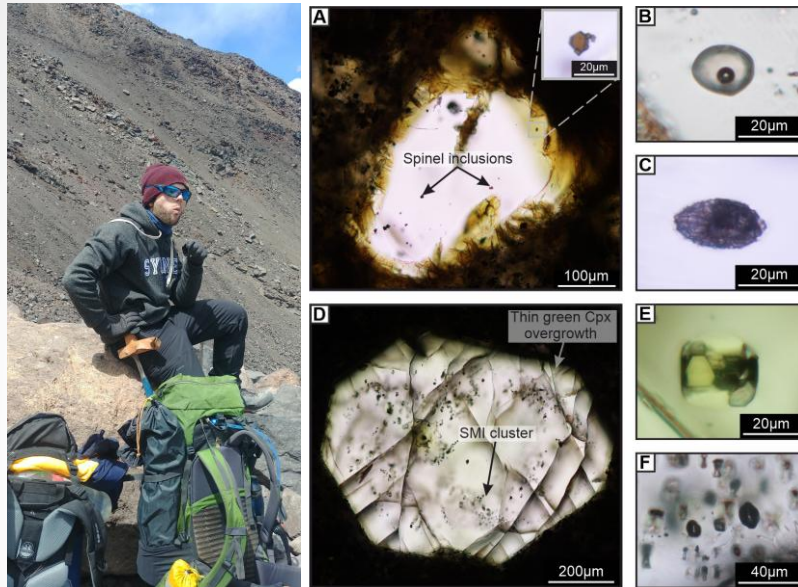
- **Dr. Michael Schirra**
- Assistant Professor
- Department of Geoscience
- Email: michael.Schirra@unlv.edu



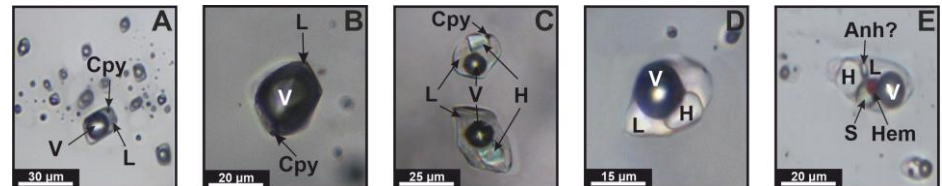
Expertise

- Economic Geology (with focus on porphyry Cu-Au, epithermal Au, intrusion-related Pb-Zn-Ag deposits)
- Fluid and Melt Inclusion Petrography and Micro-Analysis
- Igneous Petrology (with focus on magma ore-fertility)
- Mineral Exploration (vector minerals for mineralization)
- LA-ICP-MS analyses and method development

Understanding ore-forming processes at the translithospheric scale with the help of inclusions



Inclusions are the only way to directly sample paleo-fluids and –melts that have produced ore deposits. By integrating detailed petrography, state-of-the-art micro-analysis techniques and geochemical modelling, my research group investigates the fundamental principles of ore deposit formation.



Research Oliver Tschauner

- **Dr. Oliver Tschauner**
- Professor of Research
- Department Geoscience
- Email: oliver.Tschauner@unlv.edu
- Website: <https://geoscience.unlv.edu/people/department-faculty/oliver-tschauner/>

Expertise

- Crystallography.
- Mineralogy.
- Physics and Chemistry at high pressure.
- Dynamic compression.



Natural diamond with CO₂ inclusions
at a pressure of 20000
atmospheres

Selected Publications

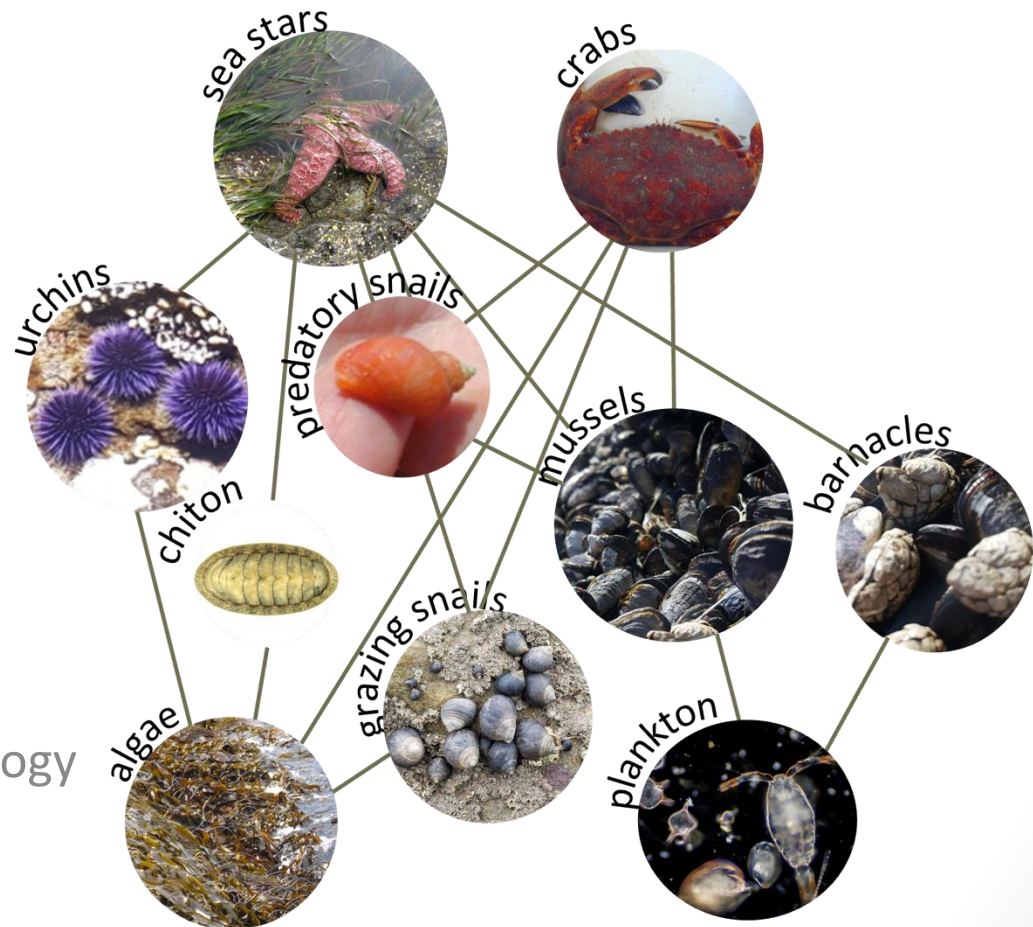
- ♦ Discovery of davemaoite, CaSiO_3 -perovskite as a mineral from the lower mantle. O. Tschauner, S. Huang, S. Yang, M. Humayun, W. Liu, S. N. Gilbert Corder, H. A. Bechtel, J. Tischler, G. R. Rossman, **Science** 374, 891-894 (2021).
- ♦ Ice-VII inclusions in diamonds – evidence for aqueous fluid in the Earth’s deep mantle O. Tschauner, S. Huang, E. Greenberg, V.B. Prakapenka, C. Ma, G. R. Rossman, A.H. Shen, M. Newville, A. Lanzirotti, K. Tait, **Science** 359, Issue: 6380, 1136 (2018) 10.1126/science.aao3030.
- ♦ Discovery of Bridgmanite – the most abundant mineral in Earth, in a shocked meteorite, O. Tschauner, C. Ma, J. Beckett, C. Prescher, V. Prakapenka, G. Rossman, **Science** 346, 1100 (2014), DOI: 10.1126/science.1259369
- ♦ Is merrillite shock-transformed whitlockite? Implications for the water budget of Mars, C. Adcock, O. Tschauner, E. Hausrath, A. Udry, Y. Cai, S.N. Luo, **Nature Communications** 8, Article Number: 14667 (2017).
- ♦ Tissintite ($\text{Ca, Na, } \square$) AlSi_2O_6 , a Highly Defective, Shock-Induced, High-Pressure Pyroxene in the Tissint Martian Meteorite. Chi Ma, Oliver Tschauner, John Beckett, Yang Liu, George Rossman, Kirill Zuravlev, Vasili Prakapenka, Przemyslaw Dera and Lawrence A. Taylor, **Earth Planet. Sci. Lett.** 422,194-205 (2015).
- ♦ Ahrensite, $\gamma\text{-Fe}_2\text{SiO}_4$, a new shock-metamorphic mineral from the Tissint meteorite: Implications for the Tissint shock event on Mars. Ma, C. ; Tschauner, O.; Beckett, J.R.; Liu, Y.; Rossman, G.R.; Sinogeikin, S.V.; Smith, J.S.; Taylor, L.A. **Geochim. Cosmochim. Acta** 184, 240-256 (2016). DOI: 10.1016/j.gca.2016.04.042
- ♦ Tschauner, O., Ma, C. (2023). Discovering High-Pressure and High-Temperature Minerals. In: Bindi, L., Cruciani, G. (eds) **Celebrating the International Year of Mineralogy. Springer Mineralogy.** Springer, Cham. https://doi.org/10.1007/978-3-031-28805-0_8

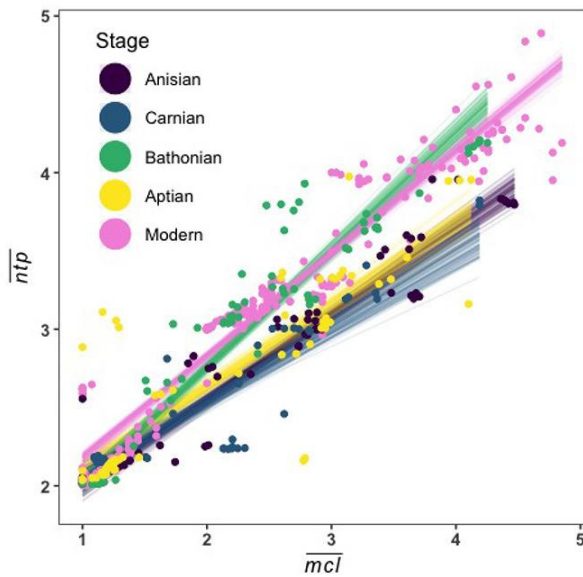
Paleoecology

- **Dr. Carrie L. Tyler, Ph.D.**
- Assistant Professor
- Department of Geoscience
- Email: carrie.tyler@unlv.edu
- Website: www.carrietyler.com

Expertise

- Marine invertebrates
- Taphonomy
- Food webs
- Conservation Paleobiology
- Predation





Marine food web structure from the Bathonian Stage (168 mya) resembles a modern Jamaican reef, but not the ecosystem before or after it.

A better understanding of trophic position is needed for restoration planning, as communities may be so severely altered that restoring species or interactions may no longer be possible.

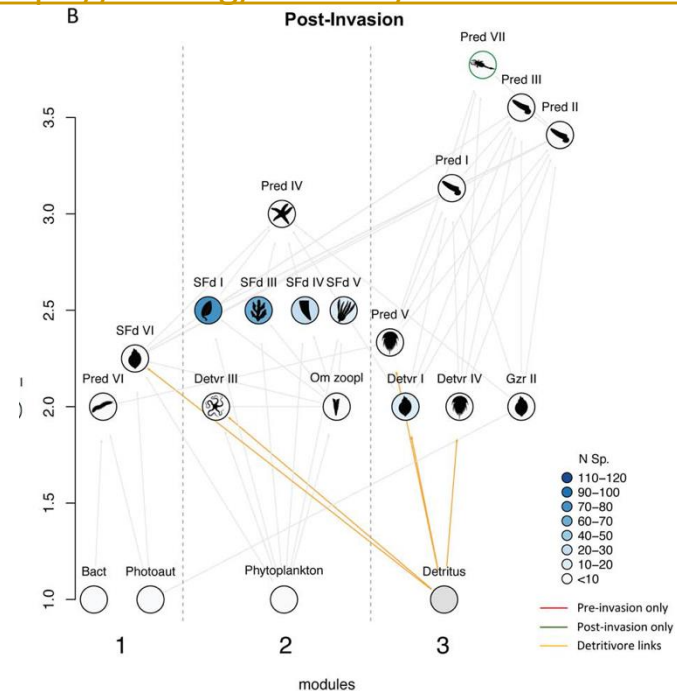
Banker *et al.* 2022 <https://doi.org/10.3389/fevo.2022.983374>

Fossil food webs before and after an invasion show changes in ecosystem dynamics, and invaders destabilized the ecosystem.

Conservation efforts may need to focus on preserving functional diversity if more diverse ecosystems are not inherently more stable.

Kempf *et al.* 2020

<https://doi.org/10.1017/pab.2020.26>



Planetary petrology

Dr. Arya Udry

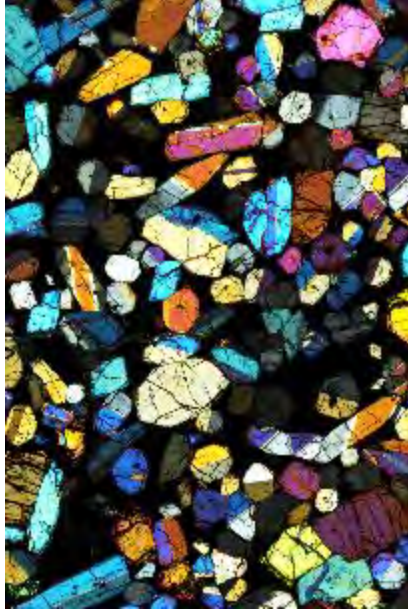
- Department of Geoscience
- Phone: (702) 895-1239
- Email: arya.udry@unlv.edu
- Website: aryaudry.com

Expertise:

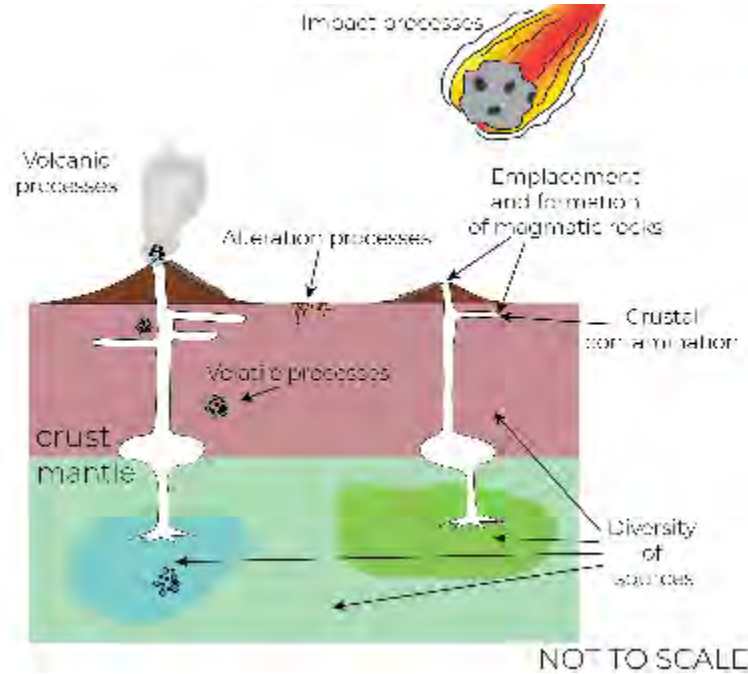
Planetary petrology

Martian igneous geology

Martian geologic evolution using meteorites



Polarized thin section image of nakhlite meteorite MIL 090030



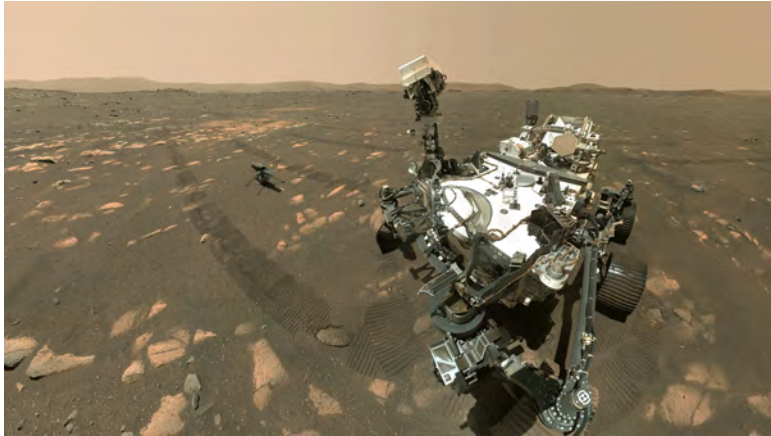
Processes that can be understood using meteorites (Udry et al. 2020)



193 nm Excimer laser ablation system – Installed in 2021 to analyze mineral trace elements

- I use meteorites, the only samples that we possess from Mars, to better constrain the interior composition and evolution of this planet
- Bulk rock and mineral geochemical down to the ppm scale

Martian geologic evolution using rover analyses



Mars 2020 Perseverance and Ingenuity on Jezero crater – JPL/NASA image



Models of magma on Mars (Ostwald et al., 2022)

- Thermodynamical modeling to understand formation of unique compositions of martian surface
- I am a participating scientist on the Mars2020 mission and I conduct modeling analyses to help understand the formation of magmatic rocks at Jezero crater

Surface Processes

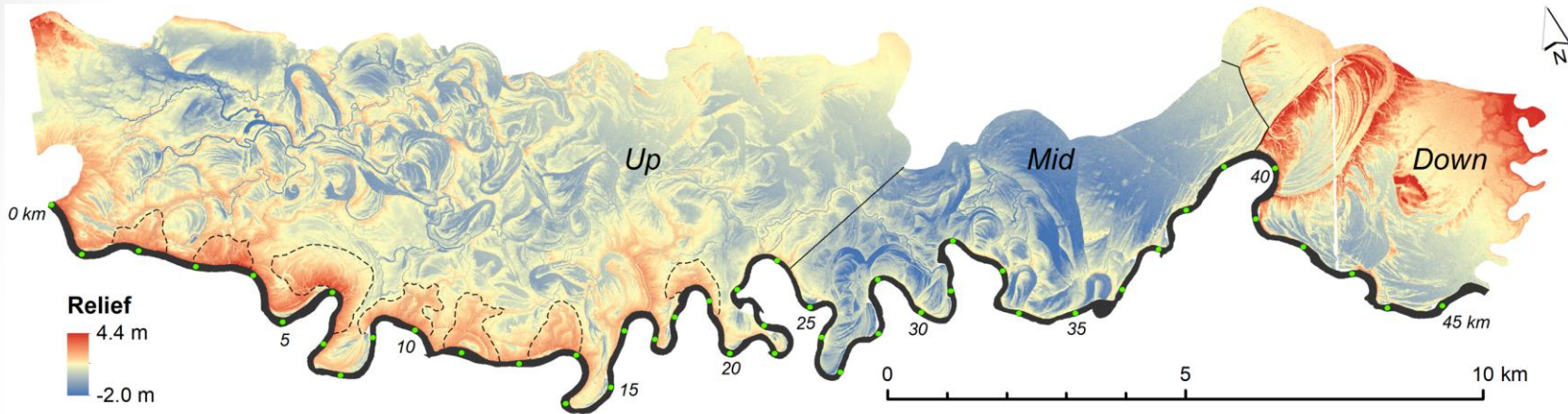
- **Dr. Haiqing Xu**
- Assistant Professor
- Department of Geoscience
- Email: haiqing.xu@unlv.edu

Expertise

- Floodplain Hydrodynamics
- Fluvial Geomorphology
- Remote Sensing



Floodplain topography, characterized by subtle surface channels, oxbow lakes, and natural levees, generates complex flow dynamics with intermittent inundation. Site: Congaree River Floodplain, SC.



Floodplain Channel



Oxbow Lake