Department of Geoscience Faculty Research Areas

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Critical Zone Hydrology

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

Expertise

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

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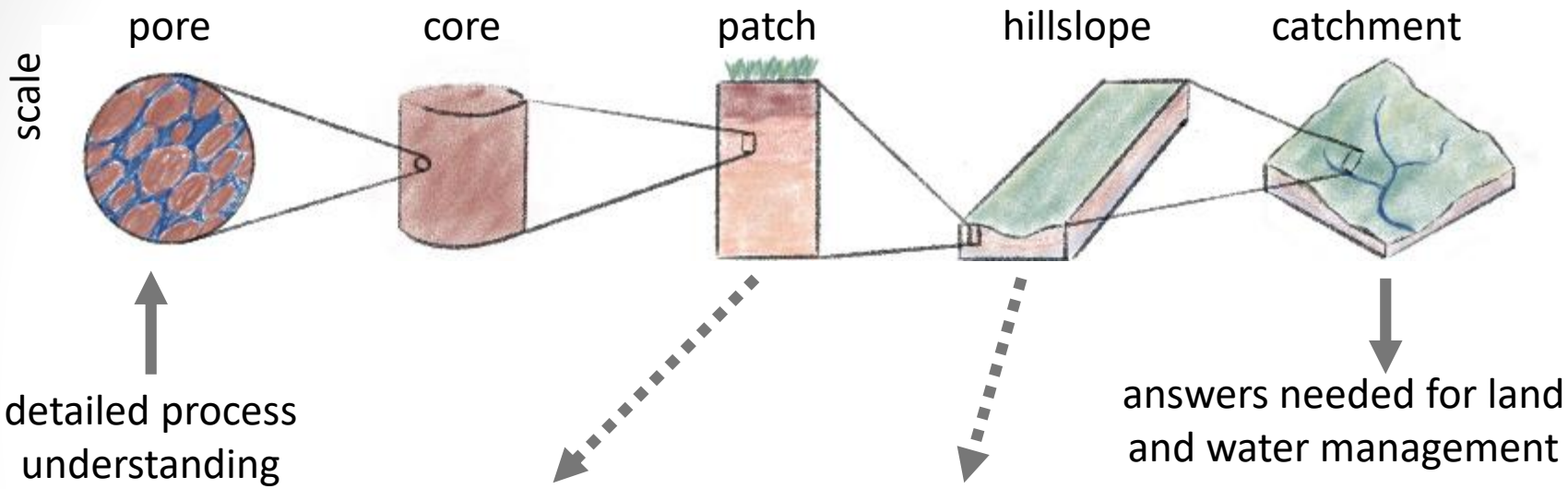
Hydrologic Scaling Challenge



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?

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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.

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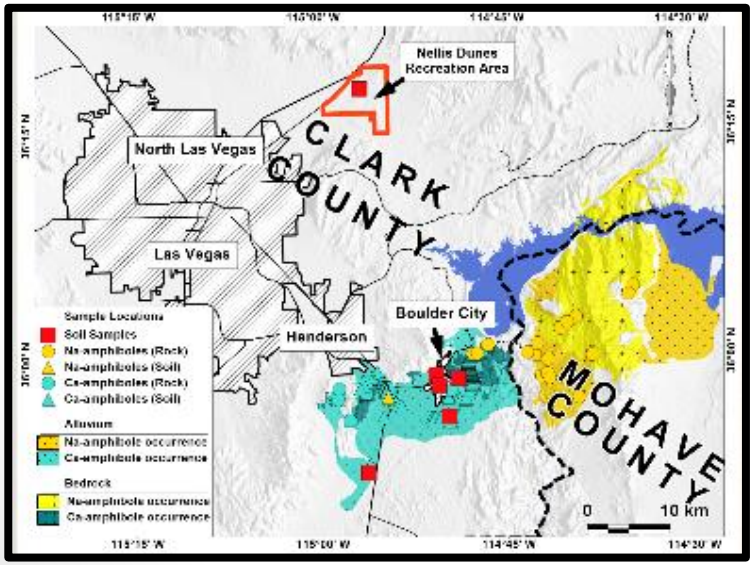
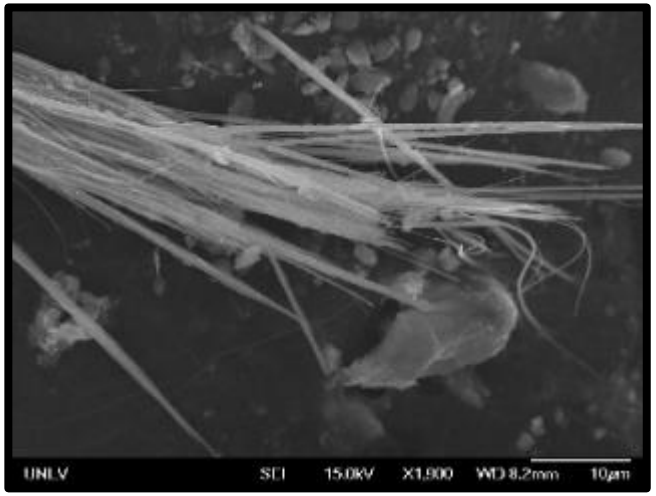
Medical Geology

- **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





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Materials Deformation

Dr. Pamela Burnley
Department of Geoscience
Phone: (702) 895-5460
Email: pamela.burnley@unlv.edu

Expertise:

High Pressure Rock Deformation

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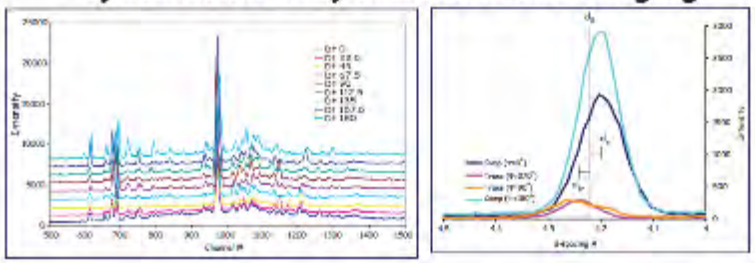
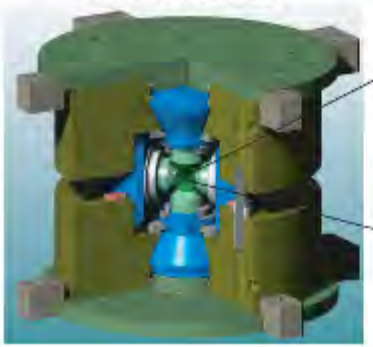
High Pressure studies of Deformation and the Acoustoelastic effect

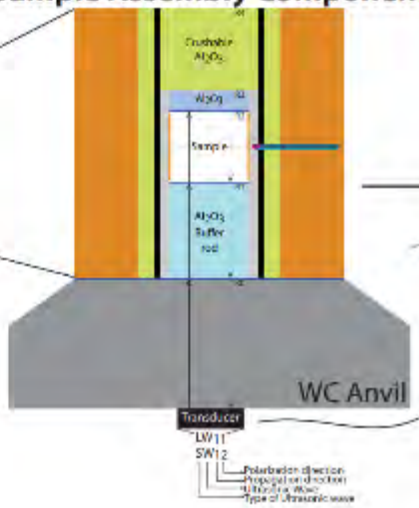
Synchrotron X-ray diffraction and imaging

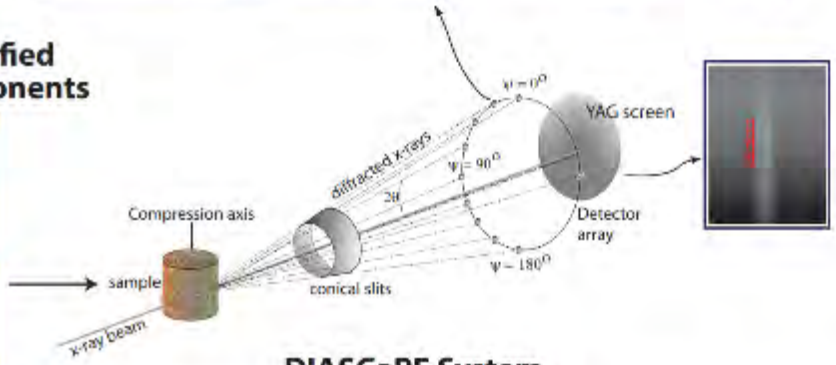


D-DIA module

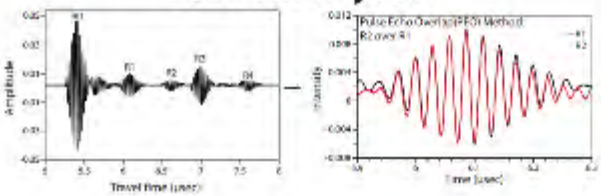


Ultrasonic D-DIA Modified Sample Assembly Components



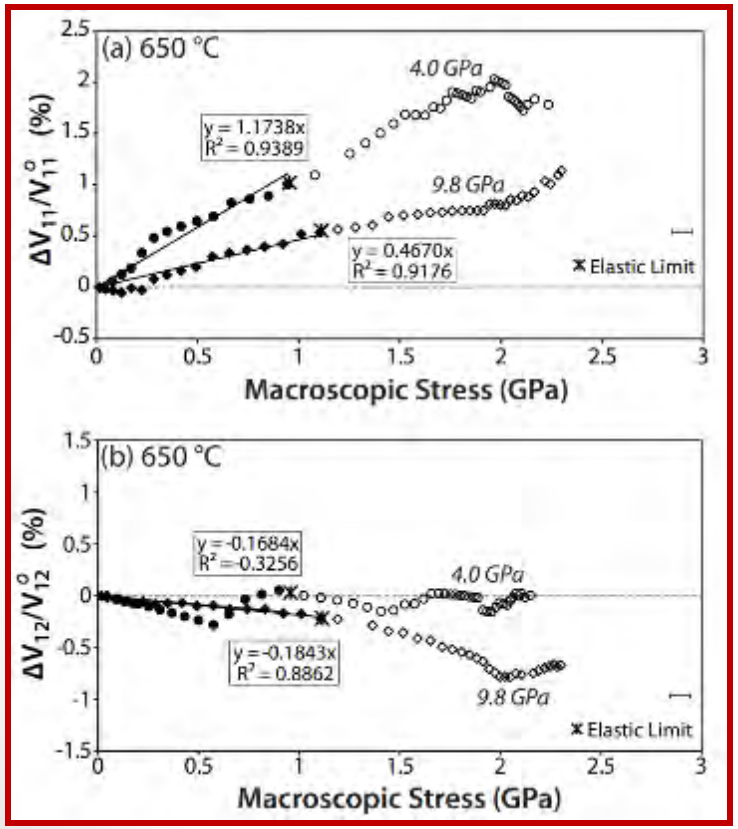


DIASCoPE System



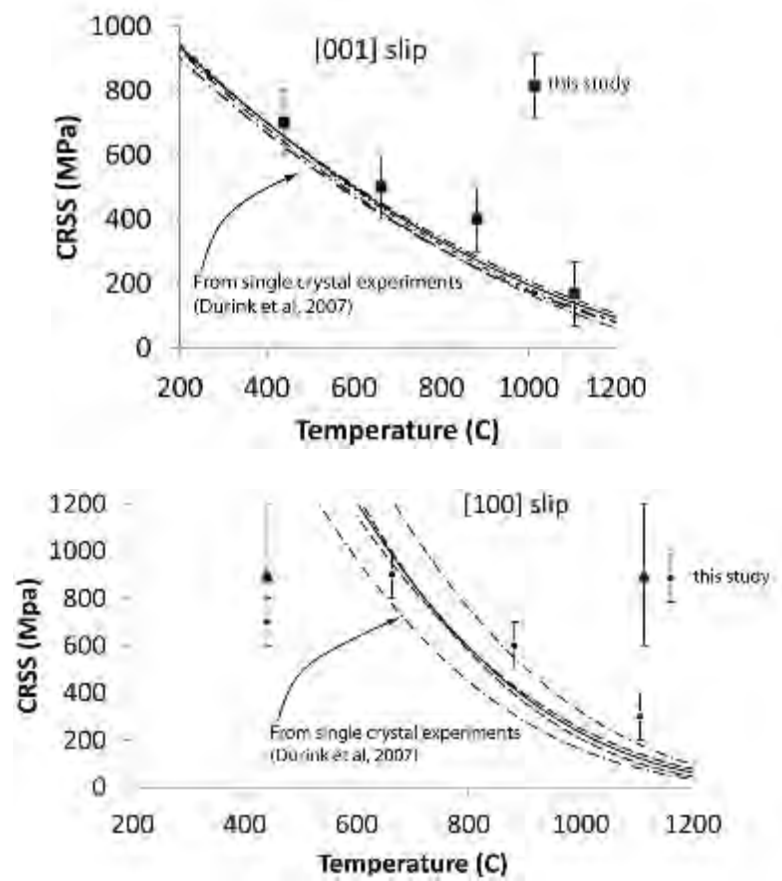
High Pressure studies of Deformation and the Acoustoelastic effect

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



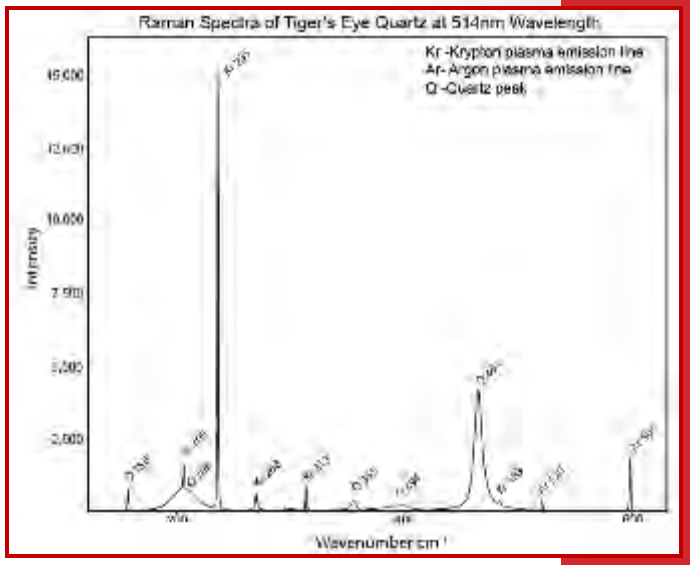
(Traylor, Whitaker & Burnley, in prep)

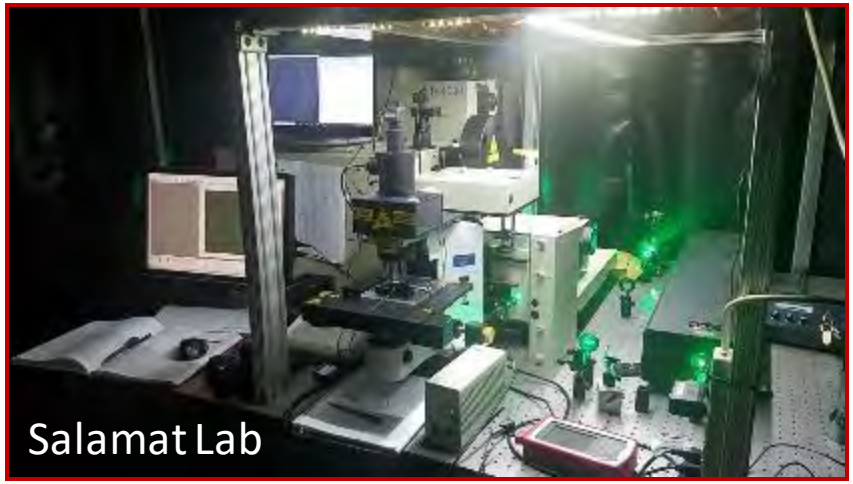
Details of multiple slip systems derived from a single multi step experiment

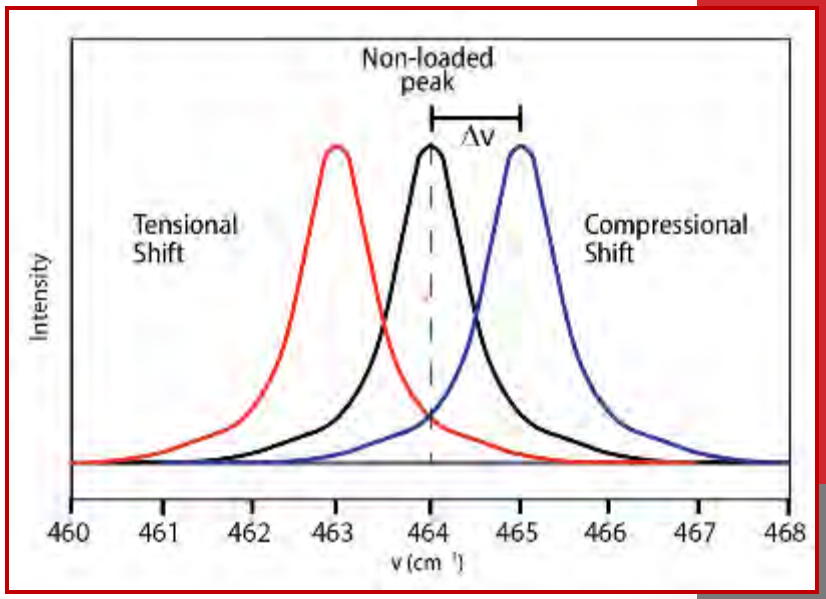


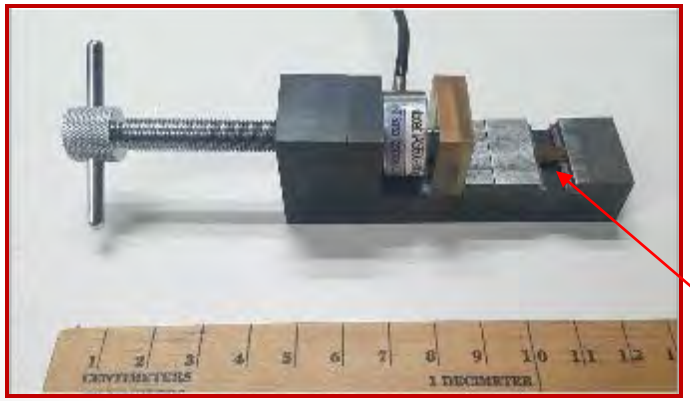
(Burnley & Kaboli, 2019)

Raman spectroscopic measurements of stress distribution

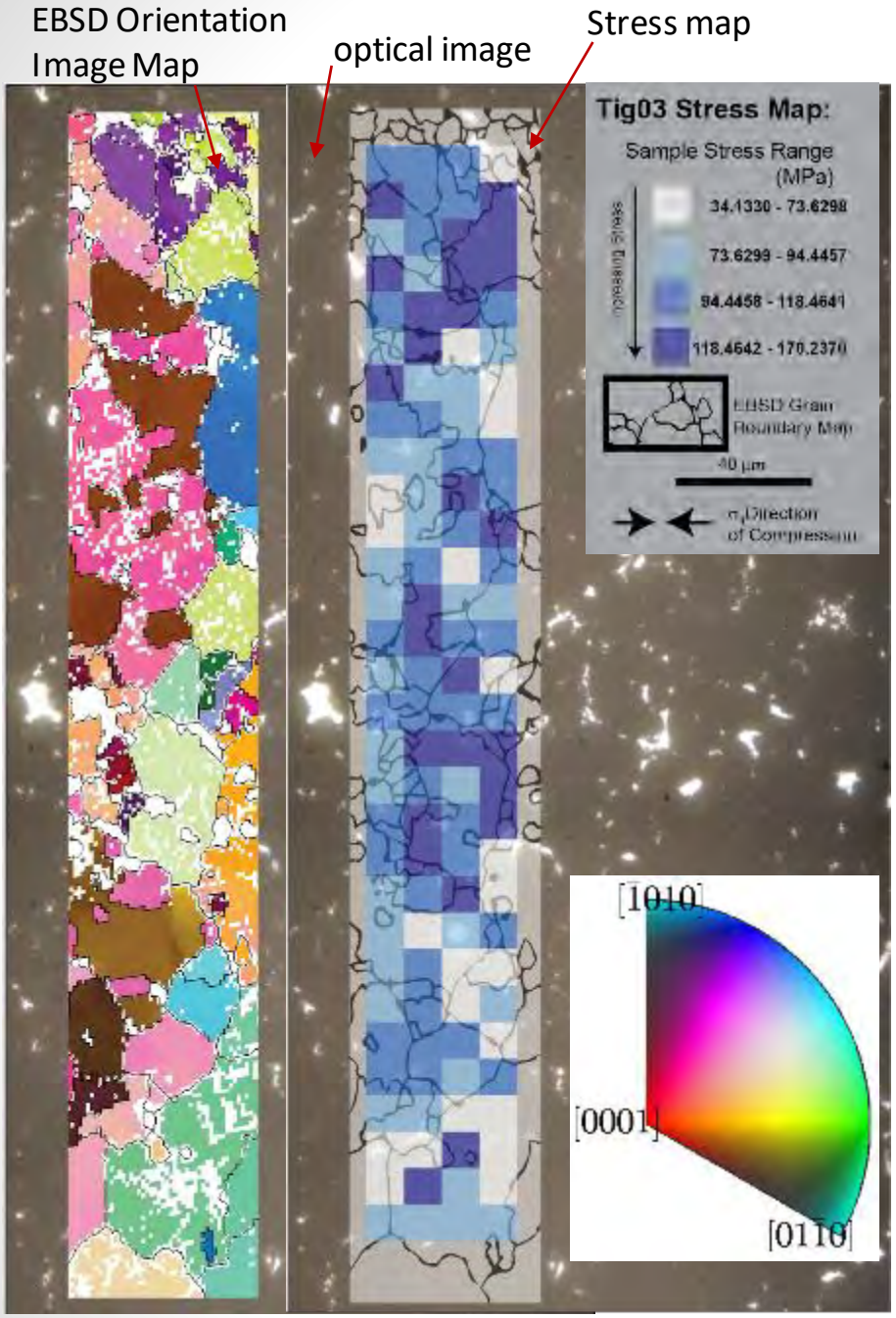




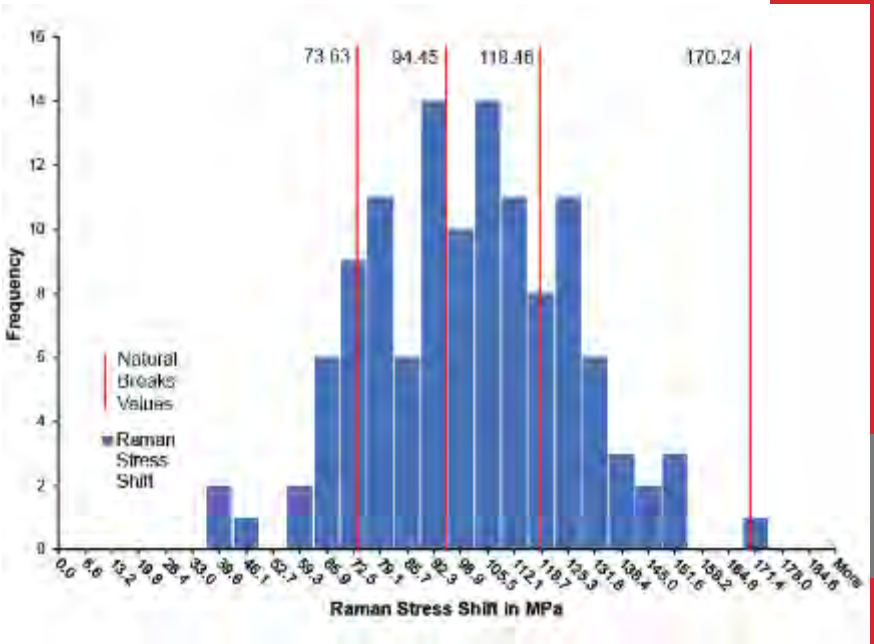




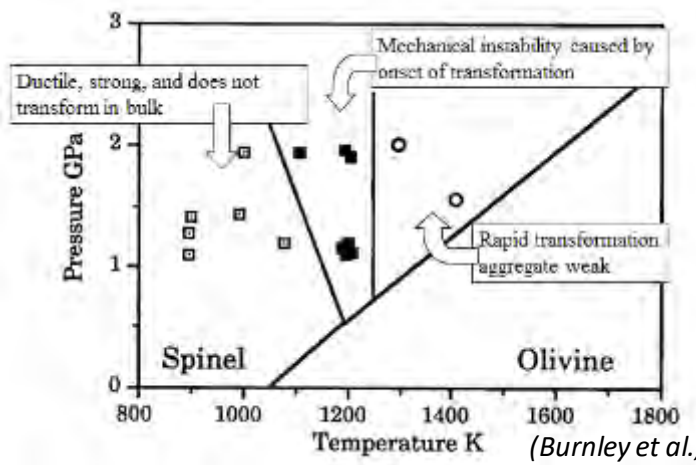
sample



- Peak shifts converted to sample stress using single crystal measurements

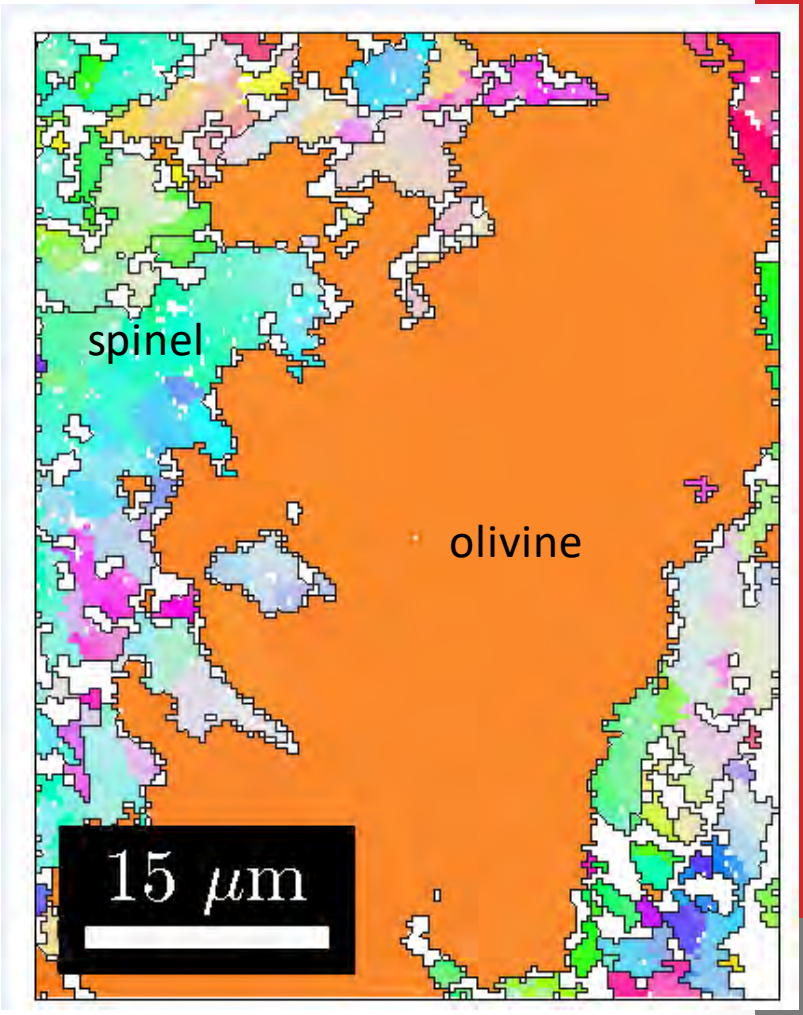


Interaction of Phase Transformation and Deformation



(Burnley et al.,1990)

- 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

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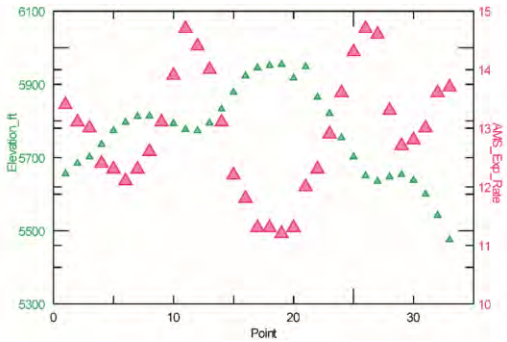
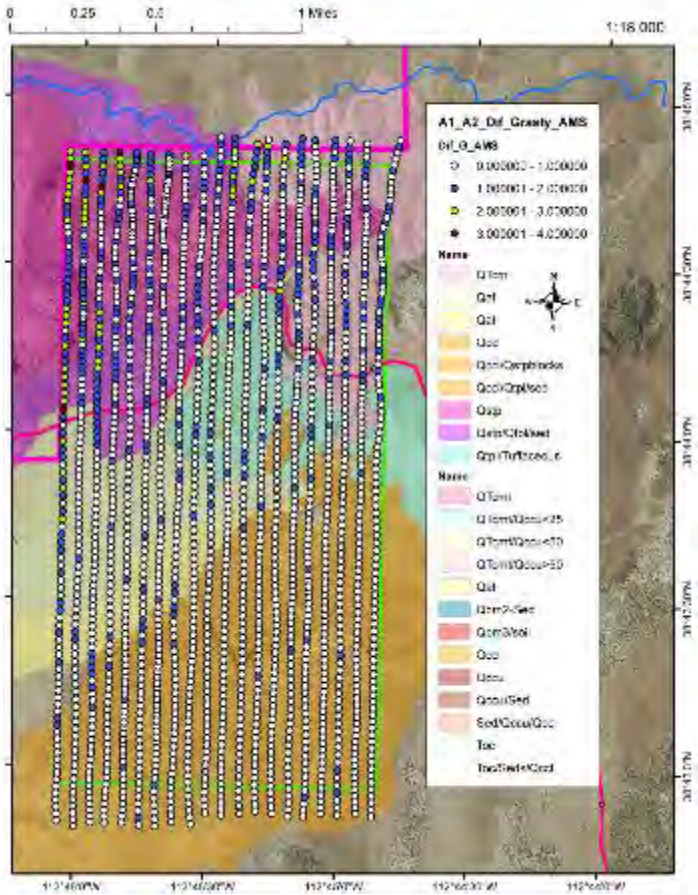
γ-ray Background Radiation



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

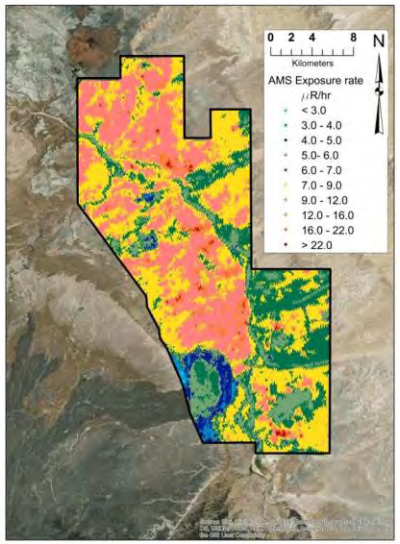
Difference between AMS flight data and predictive model



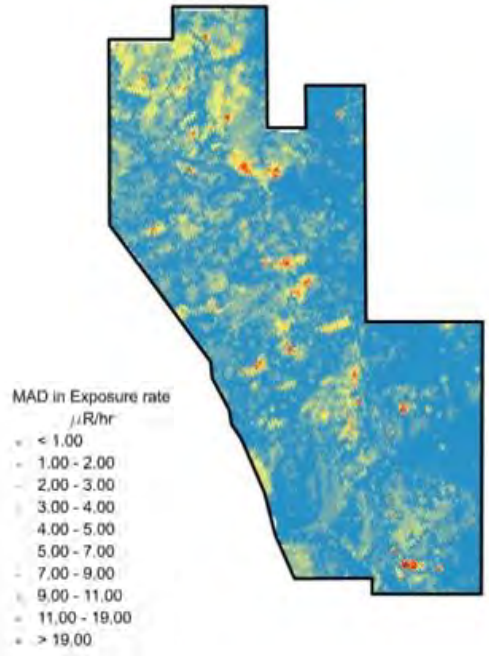
γ-ray Background Radiation

AMS flight data

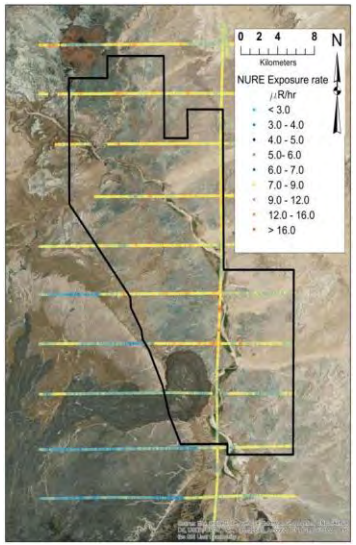
Cameron, AZ



Difference between AMS data and model



Model based on ASTER data, NURE survey & geologic map



(Adcock et al. 2019)

Highlights Uranium mines

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

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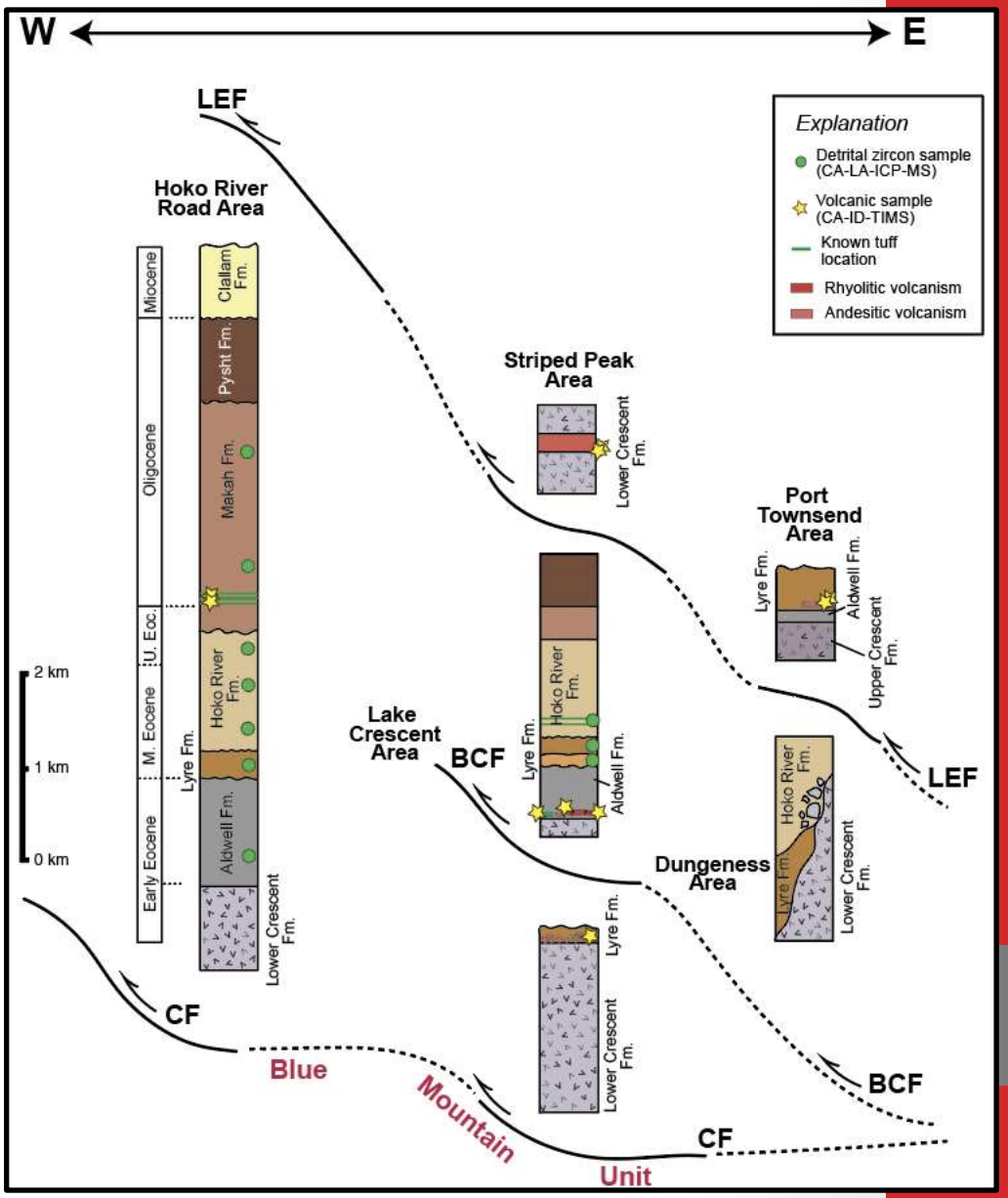
My group uses the sedimentary record to tackle large-scale tectonic questions by integrating both field and analytical methods

- 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..

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Holes made by sampling soil on Mars

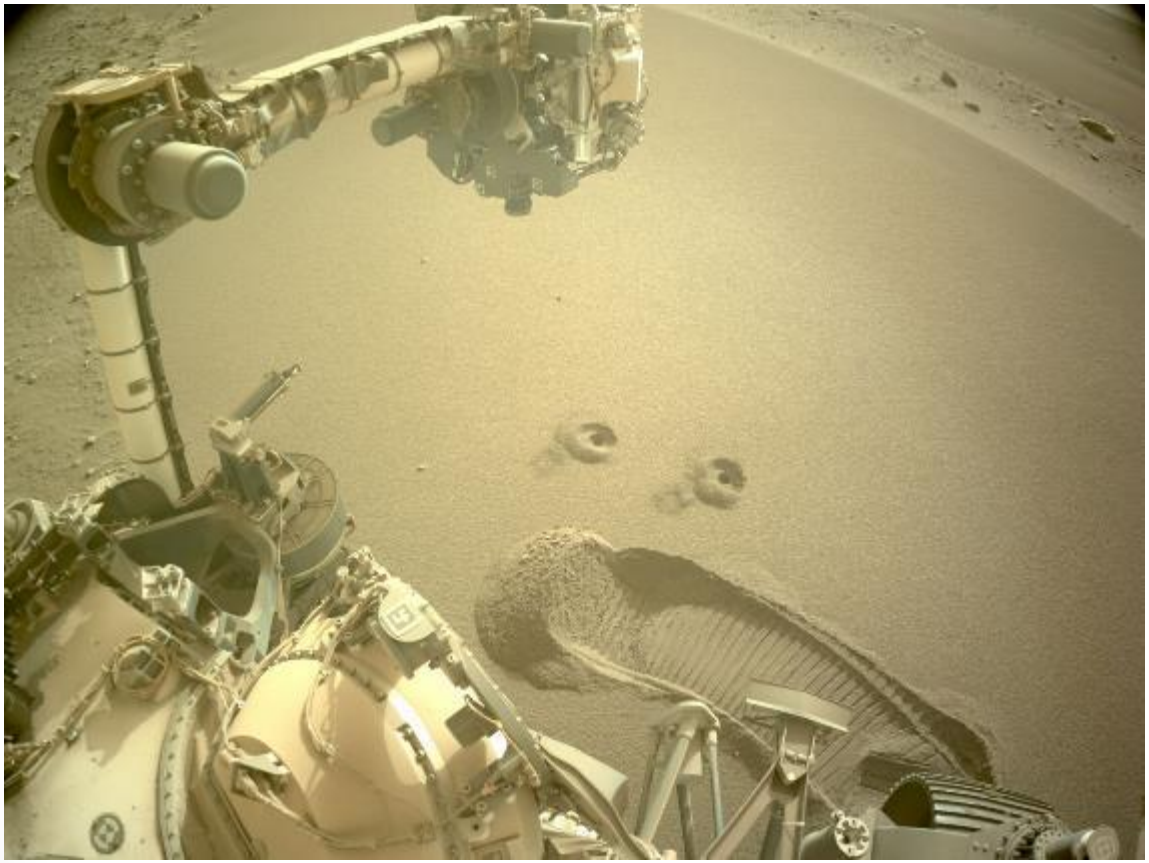

Image credit: NASA/JPL-Caltech

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.

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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

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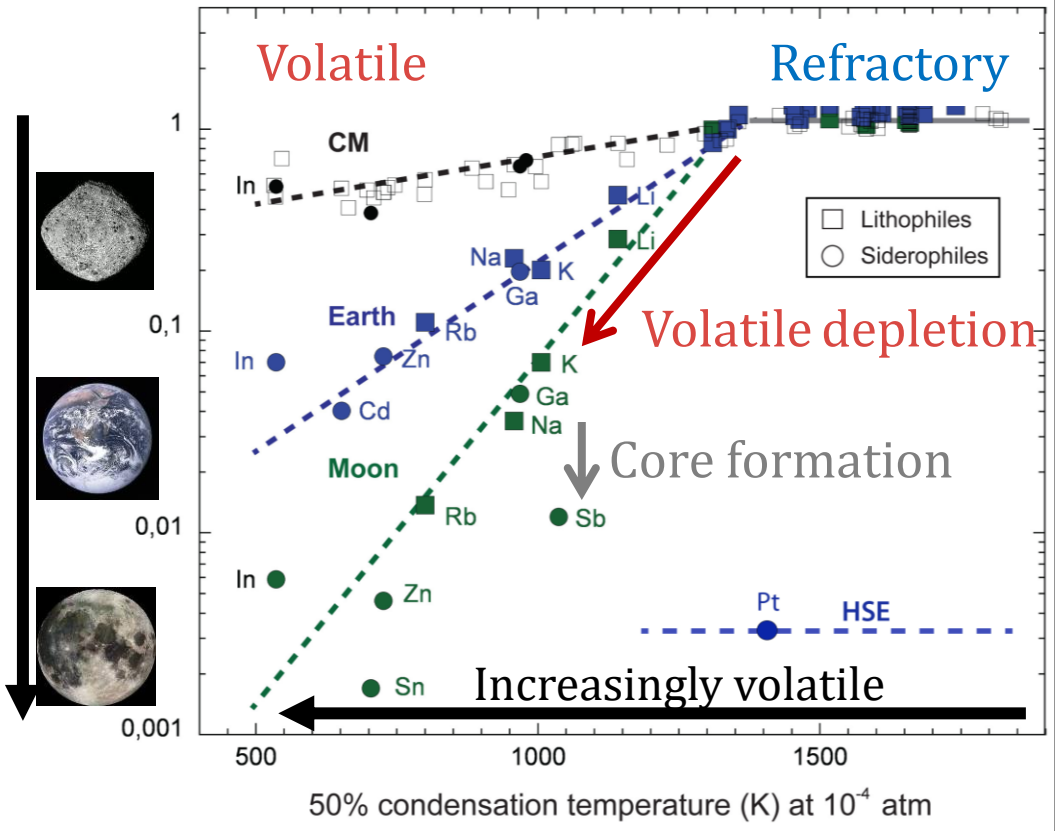
How planets formed and became habitable?

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

Abundance normalized to Sun



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

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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

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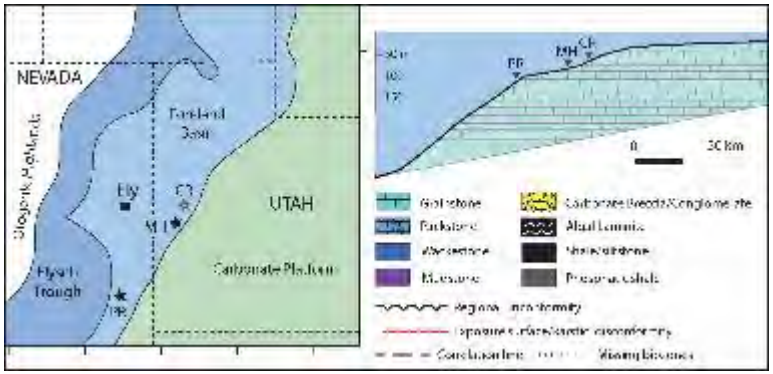
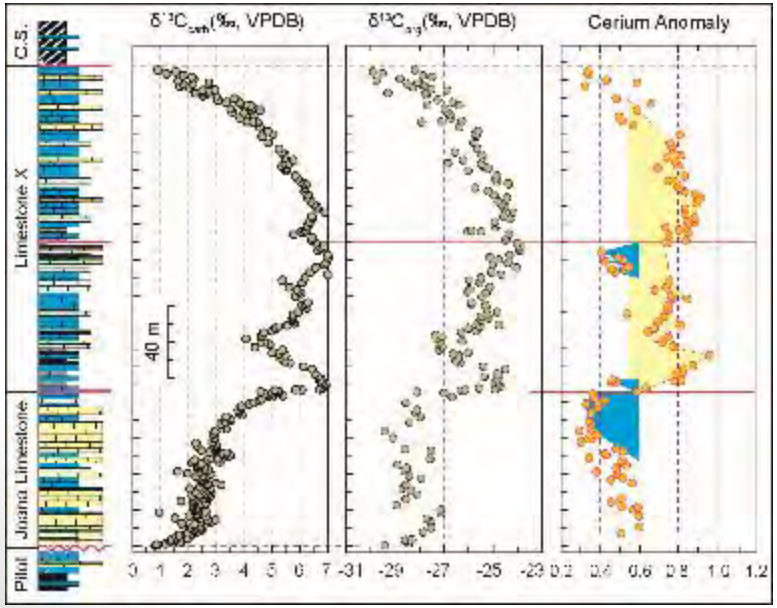
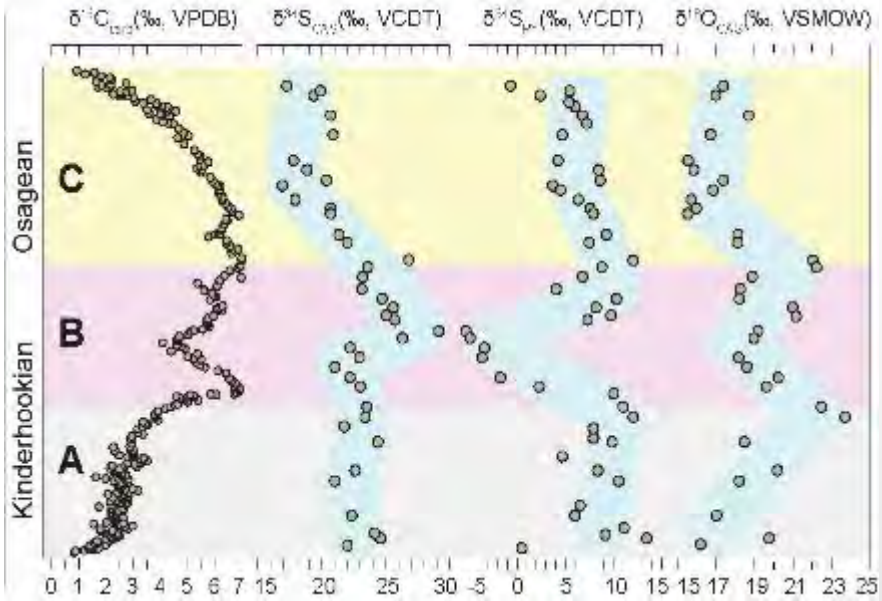
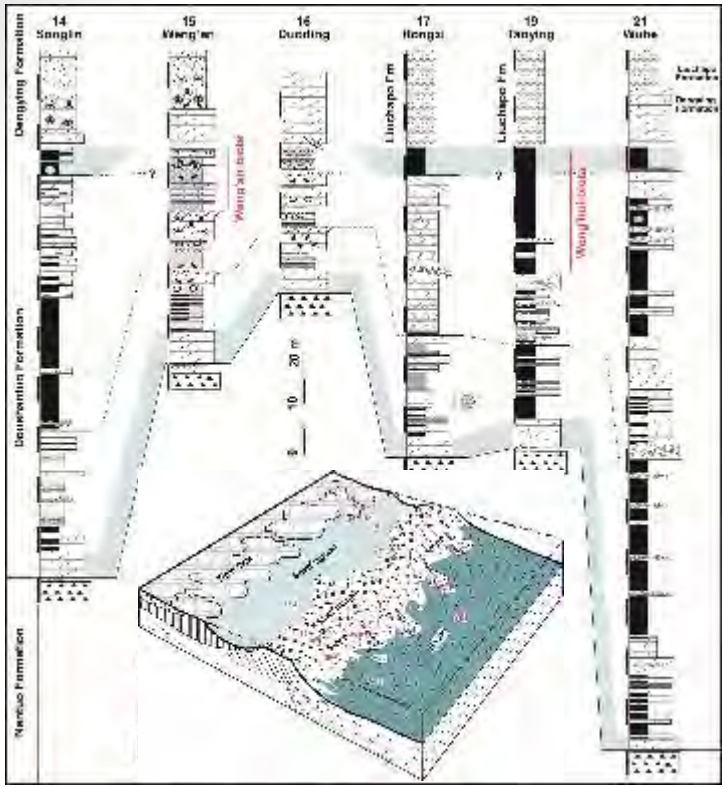


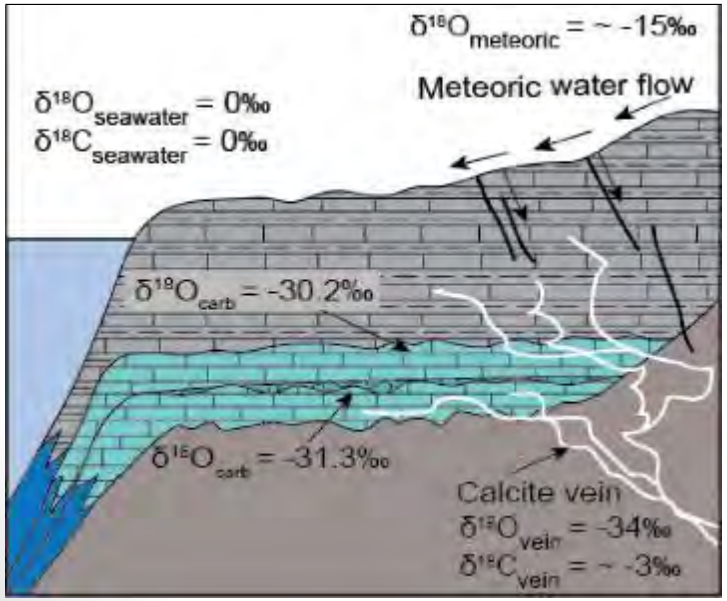
- **Sequence and chemostratigraphy**
- **Paleogeographic reconstruction**
- **Applications of stable isotopes and rare earth elements**
- **Paleoenvironmental change across major perturbations of the carbon cycle and mass extinctions**







- **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

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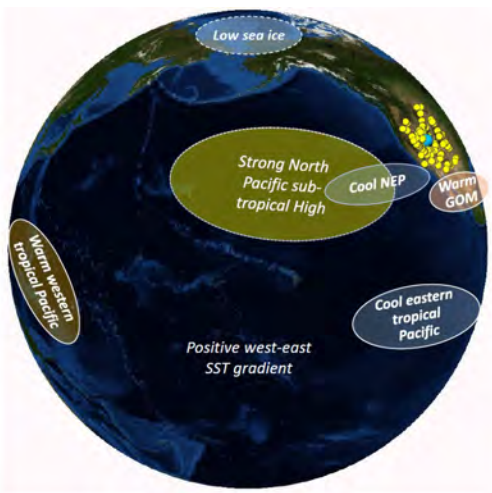
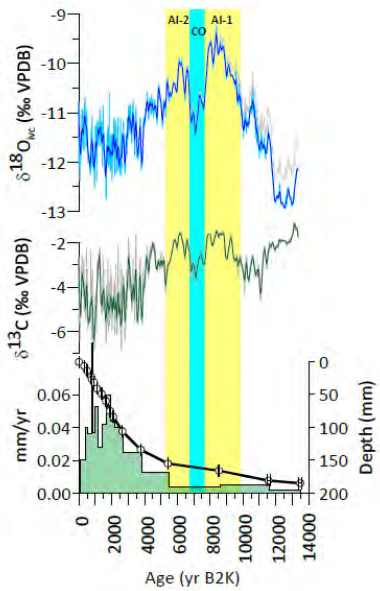
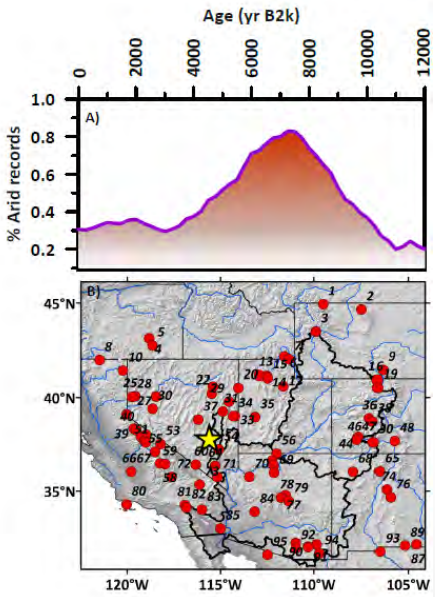
Paleoclimatology

- 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.

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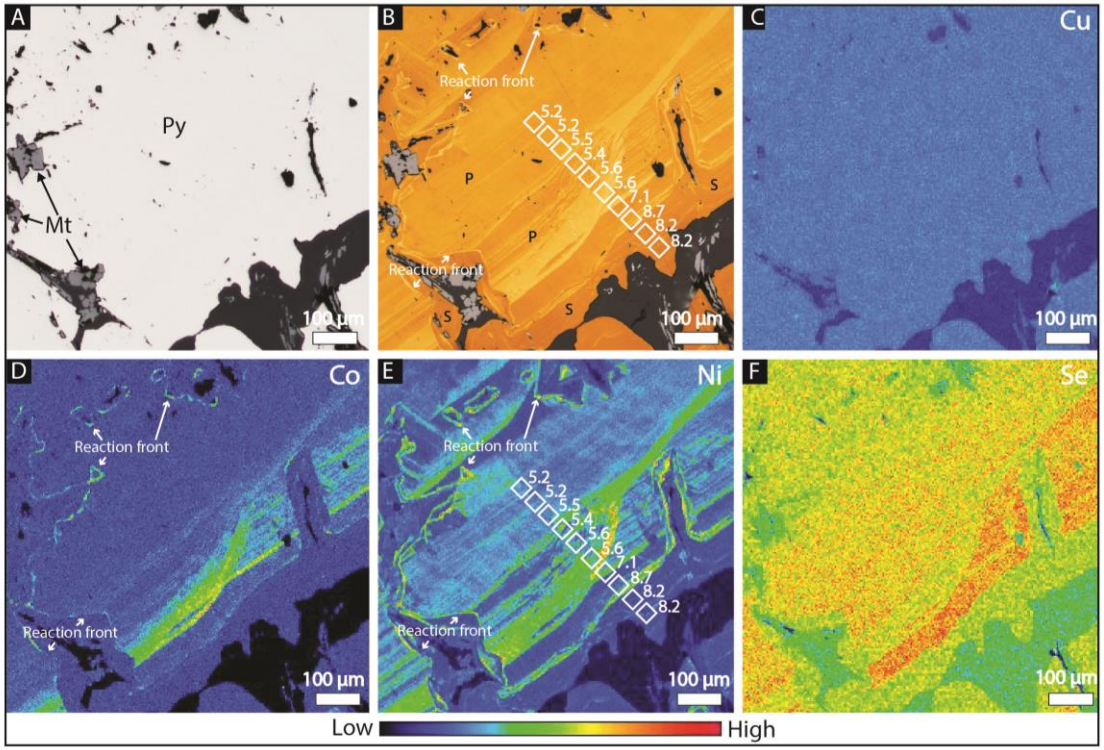
Understanding evolving metal and sulfur sources in mineral deposits



- 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.

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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

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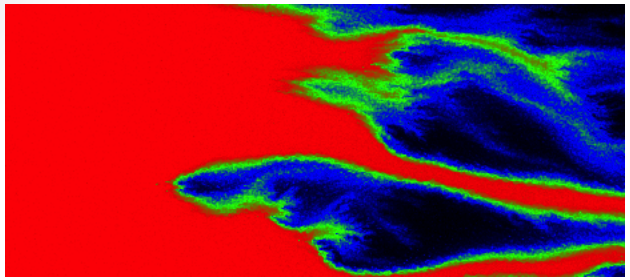
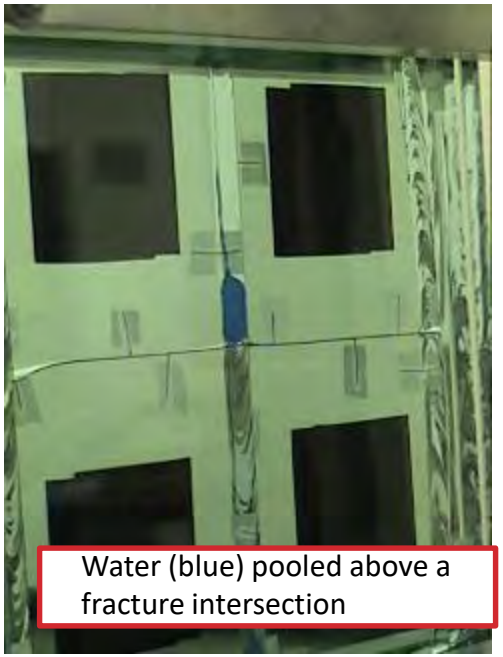
Fractured Rock Hydrology



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



Water (blue) pooled above a fracture intersection

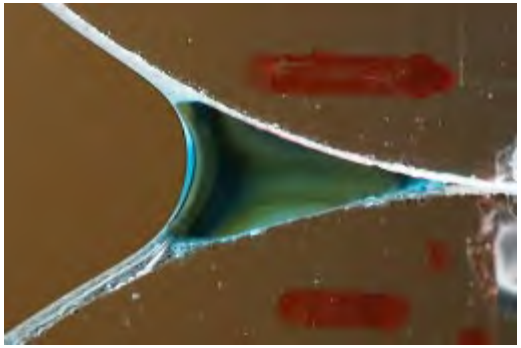
Field mapping of fracture networks
blue dye (right foreground) is from an infiltration test

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

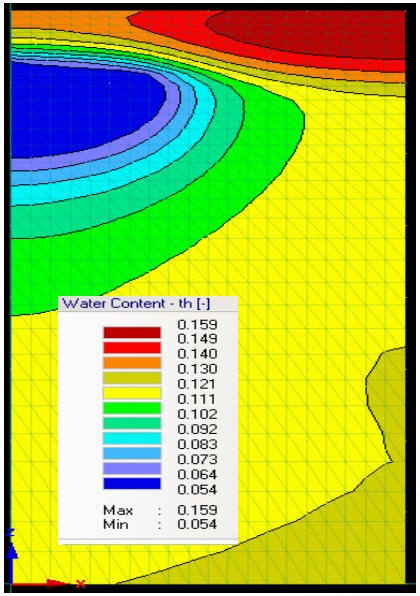
Seepage through gravel-sized capillary barrier materials



Millimeter-scale transport experiment

Sampling Chloride as a proxy for root-driven horizontal flow

Hydraulic conductivity of a rock slab



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

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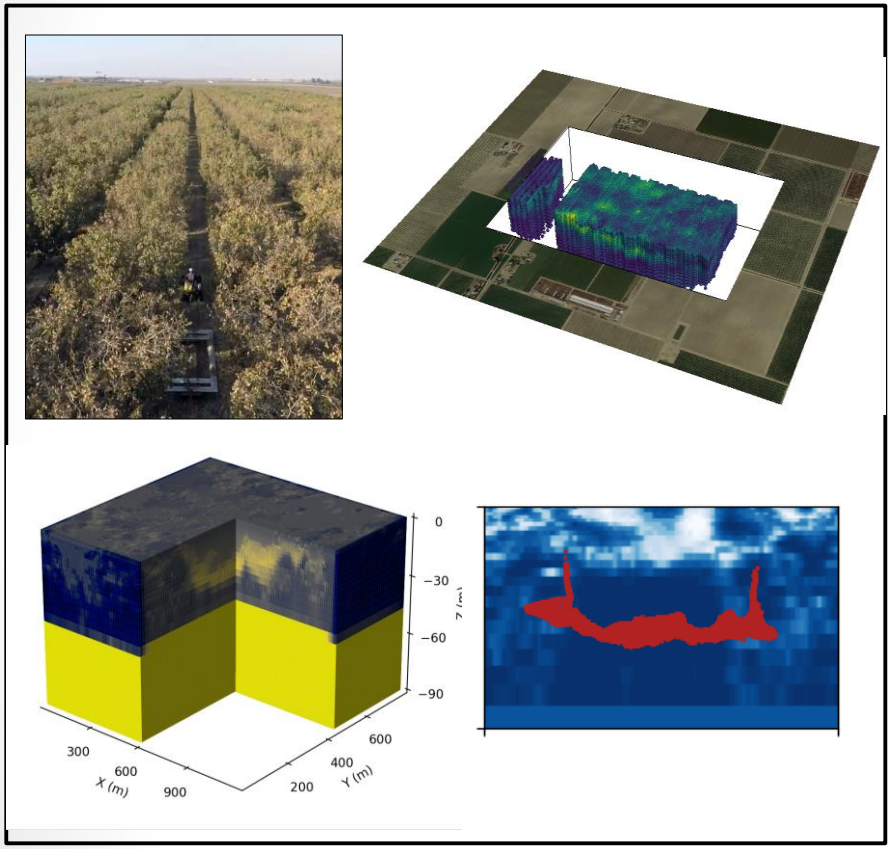
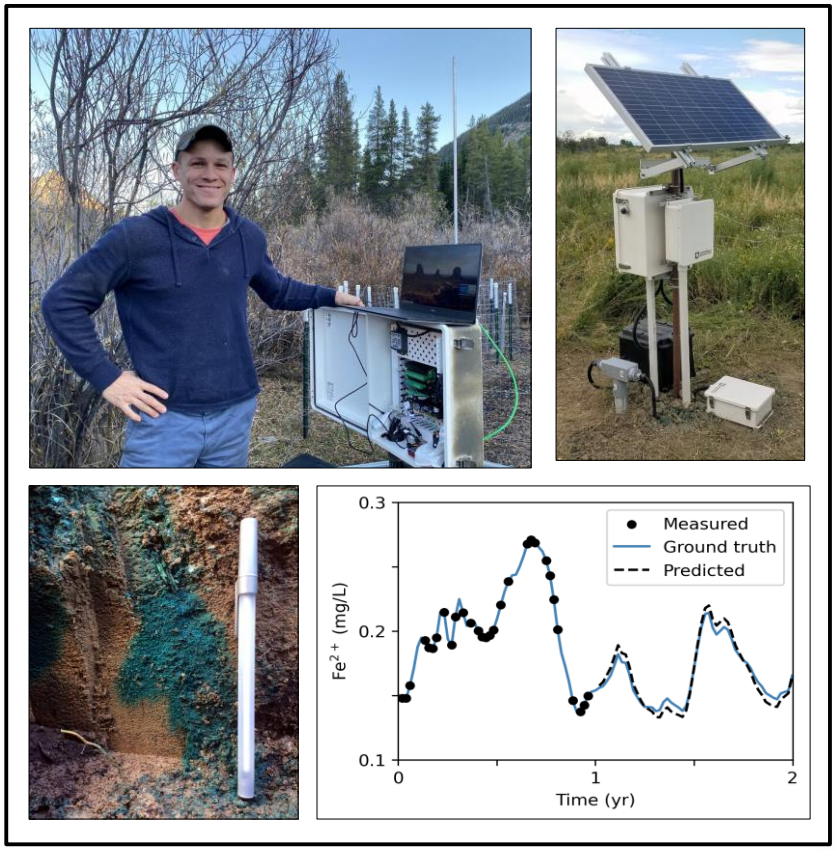
Understanding how hydrologic extremes (droughts and floods) impact water quality

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).

Research Oliver Tschauner

- **Dr. Oliver Tschauner**
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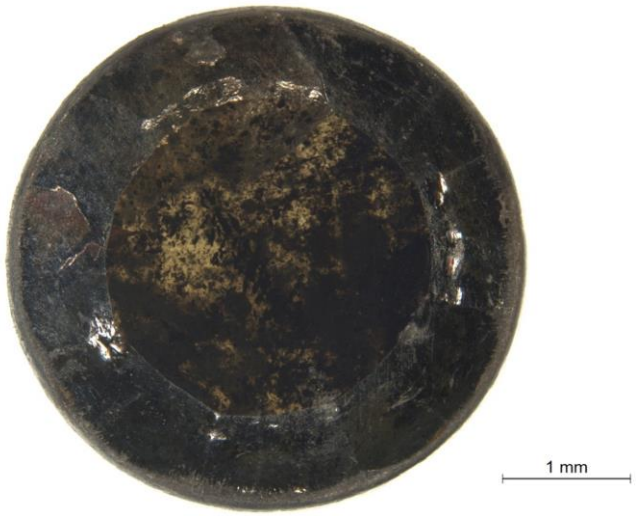

Natural diamond with CO_2 inclusions at a pressure of 20000 atmospheres

Expertise

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

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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 (Ca, Na, □) $AlSi_2O_6$, 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, Przemyslav Dera and Lawrence A. Taylor, **Earth Planet. Sci. Lett.** 422,194-205 (2015).
- Ahrensite, gamma-Fe_2SiO_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

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Paleoecology

- **Dr. Carrie L. Tyler, Ph.D.**
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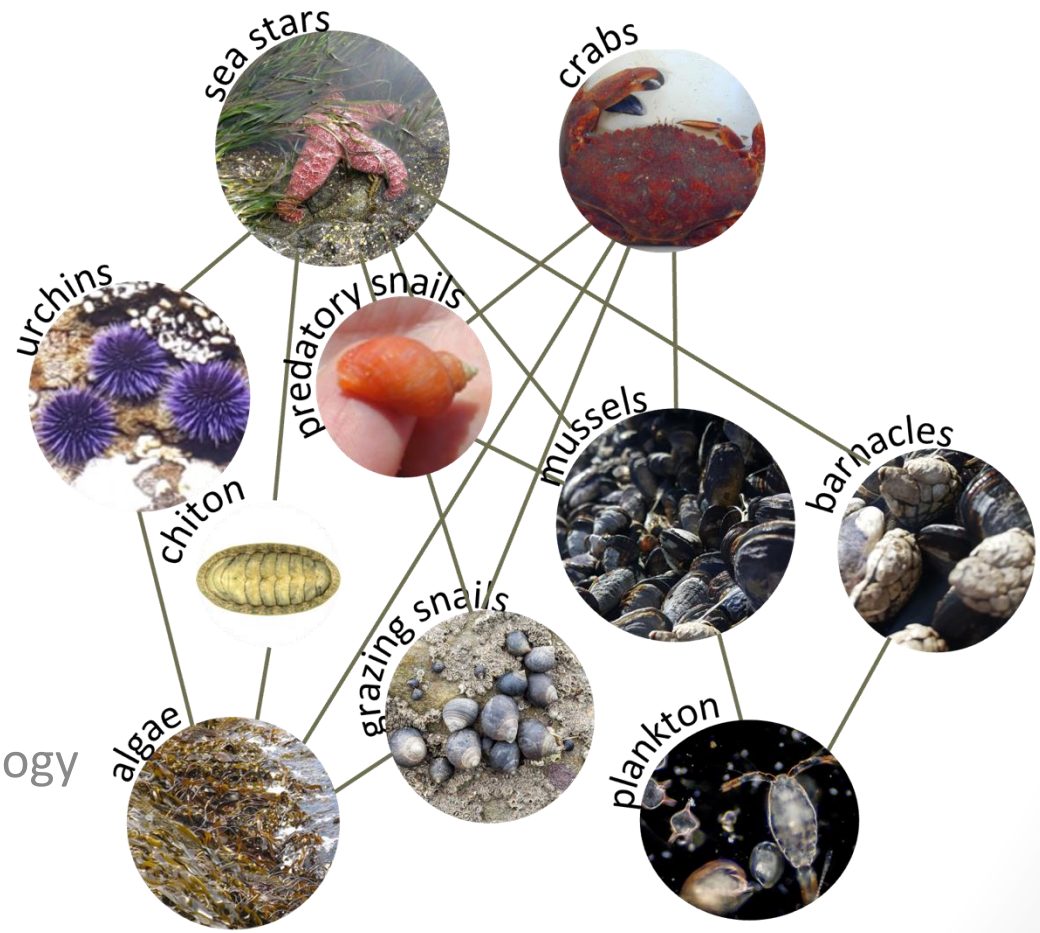
- Website: www.carrietyler.com

Expertise

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



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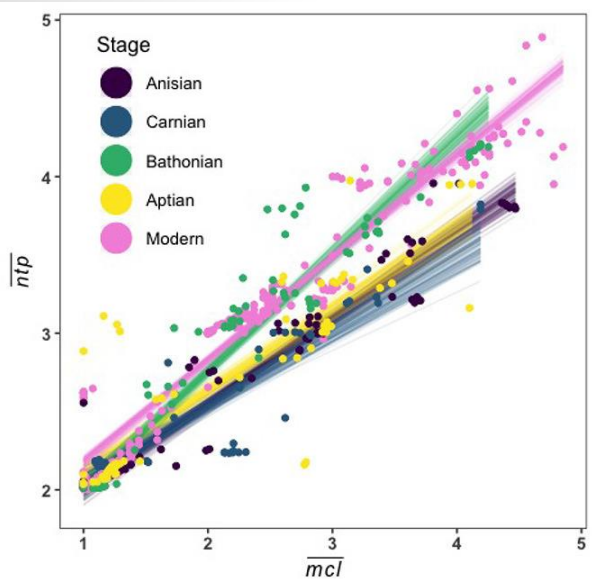


Marine food web structure from the Bathonian Stage (168 mya) resembles a modern Jamaican reef, but not the ecosystem before or after it.

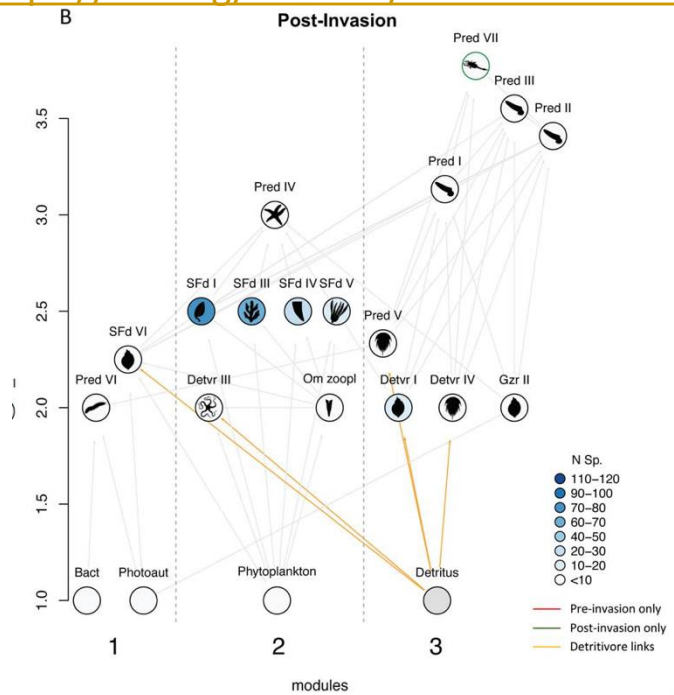
A better understanding of trophic position is needed for restoration planning, as communities may be so severely altered that restoring species or interactions may no longer be possible.

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



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Planetary petrology

Dr. Arya Udry

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Expertise:

Planetary petrology

Martian igneous geology

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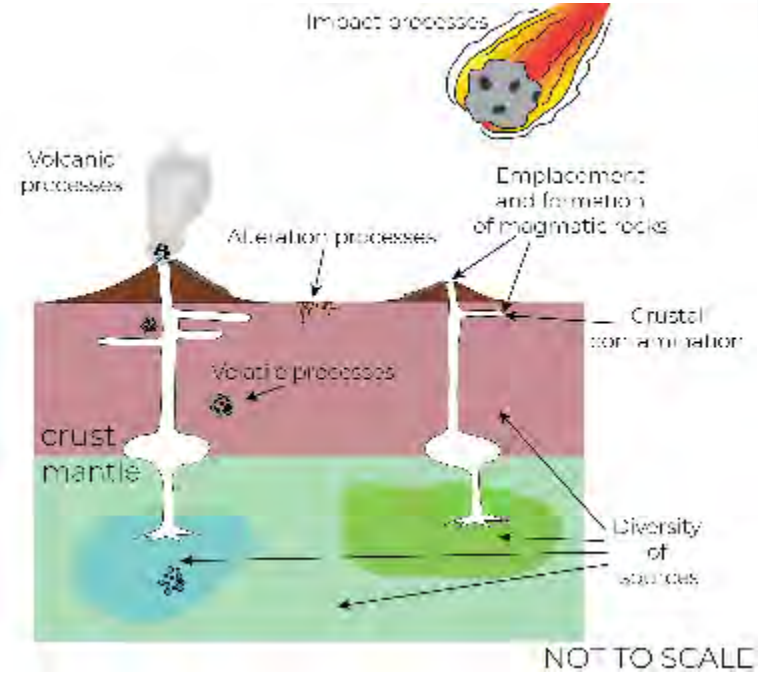
Martian geologic evolution using meteorites

Polarized thin section image of nakhlite meteorite MIL 090030



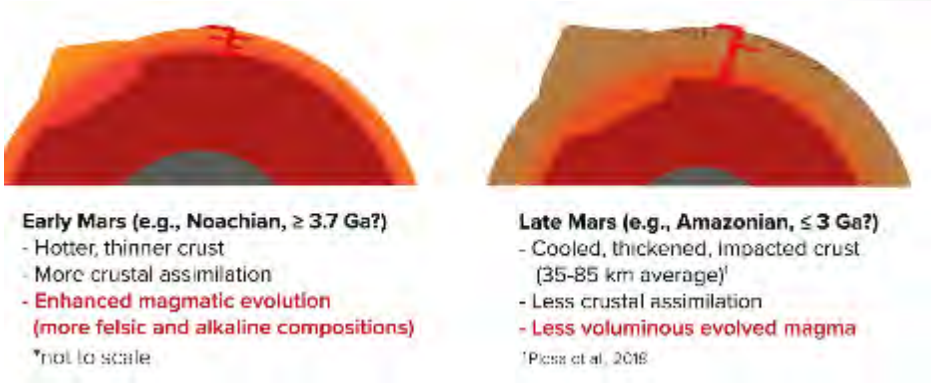
Processes that can be understood using meteorites (Udry et al. 2020)

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