

# Department of Geoscience Faculty Research Areas

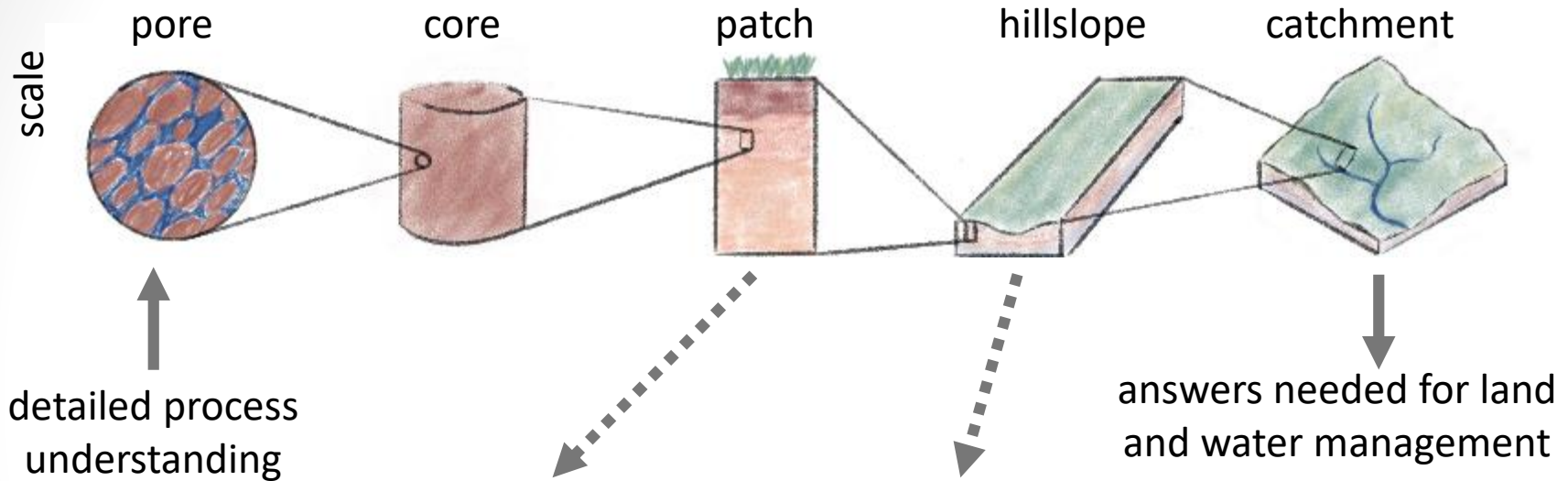
# Critical Zone Hydrology

- **Dr. Hannes Bauser**
- Assistant Professor
- Department of Geoscience
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- 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



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](mailto:Brenda.Buck@unlv.edu)
- Website: <https://unlv-fia.github.io/UNLV-FIA-Group/index.html>



## Expertise

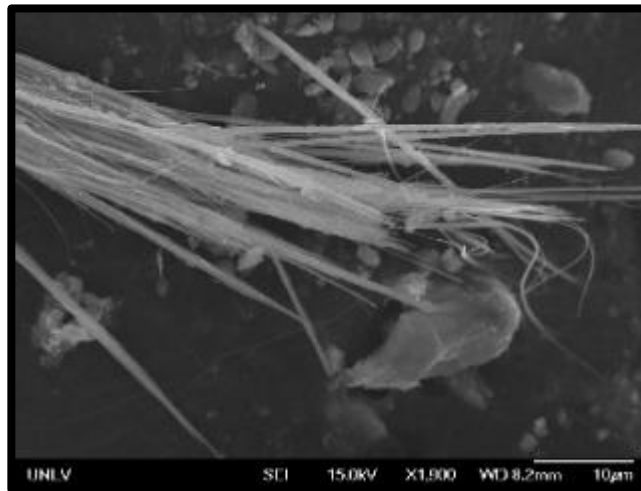
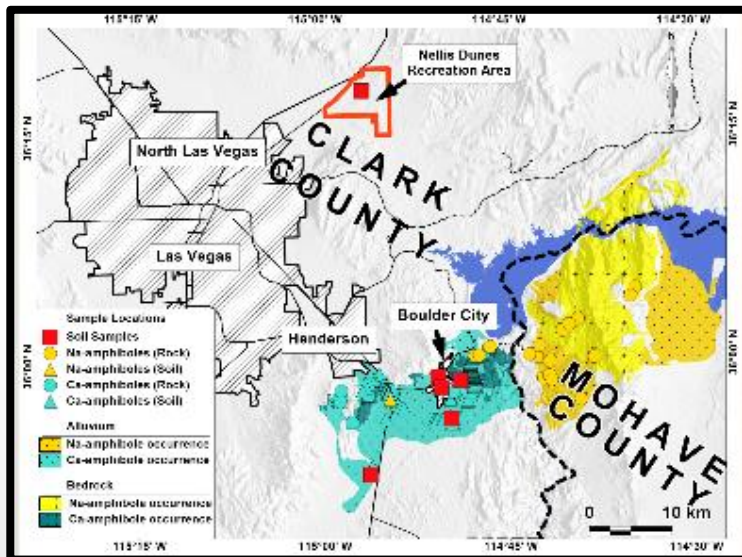
- University partner to USDA-FIA. Area of emphasis is information management research and development to optimize the storage, delivery, and display of forest inventory data.
- The support we provide helps policy makers, land stewards and non-governmental groups base decisions and assessments related 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](mailto: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](mailto:pamela.burnley@unlv.edu)

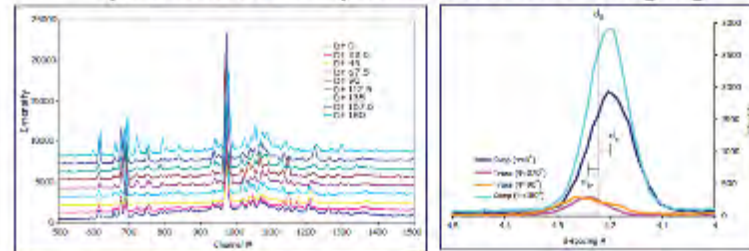
## **Expertise:**

High Pressure Rock Deformation

# High Pressure studies of Deformation and the Acoustoelastic effect



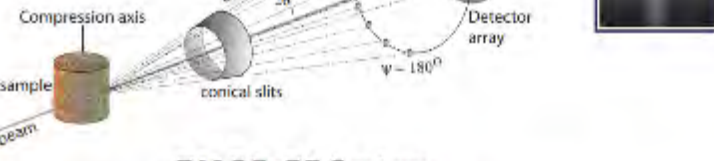
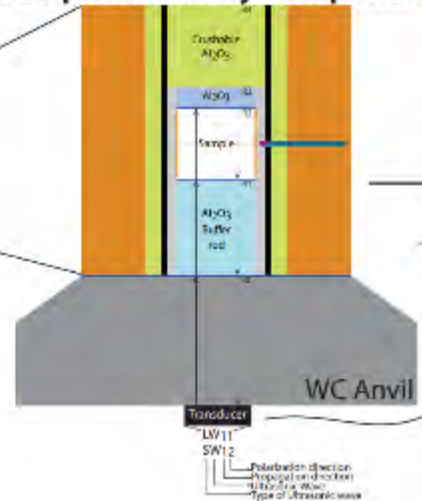
Synchrotron X-ray diffraction and imaging



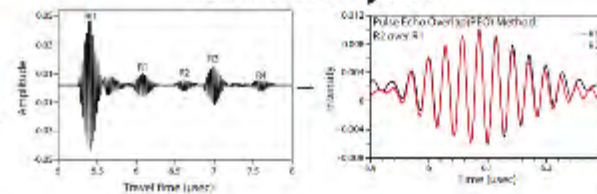
D-DIA module



Ultrasonic D-DIA Modified Sample Assembly Components



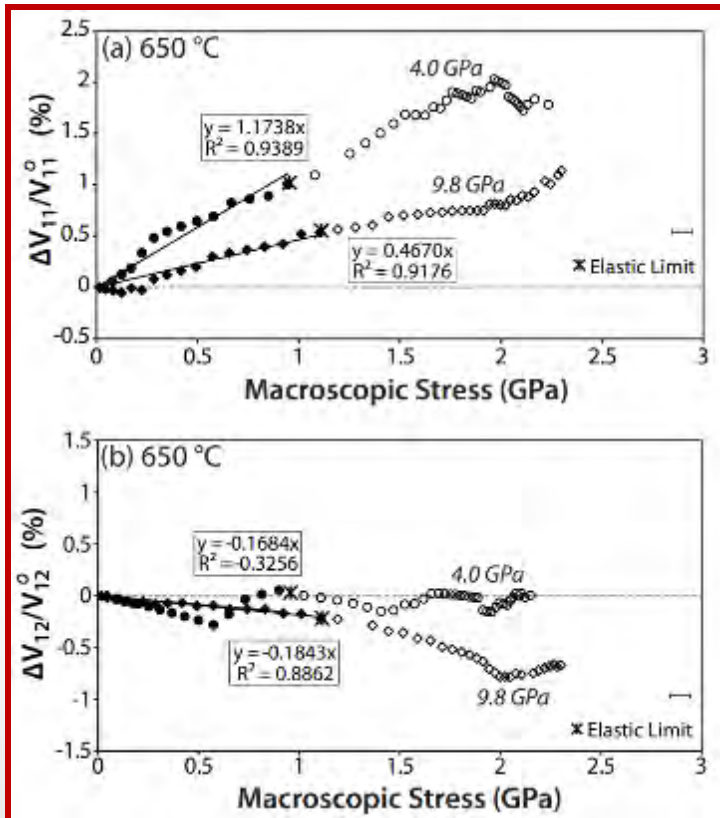
DIASCoPE System



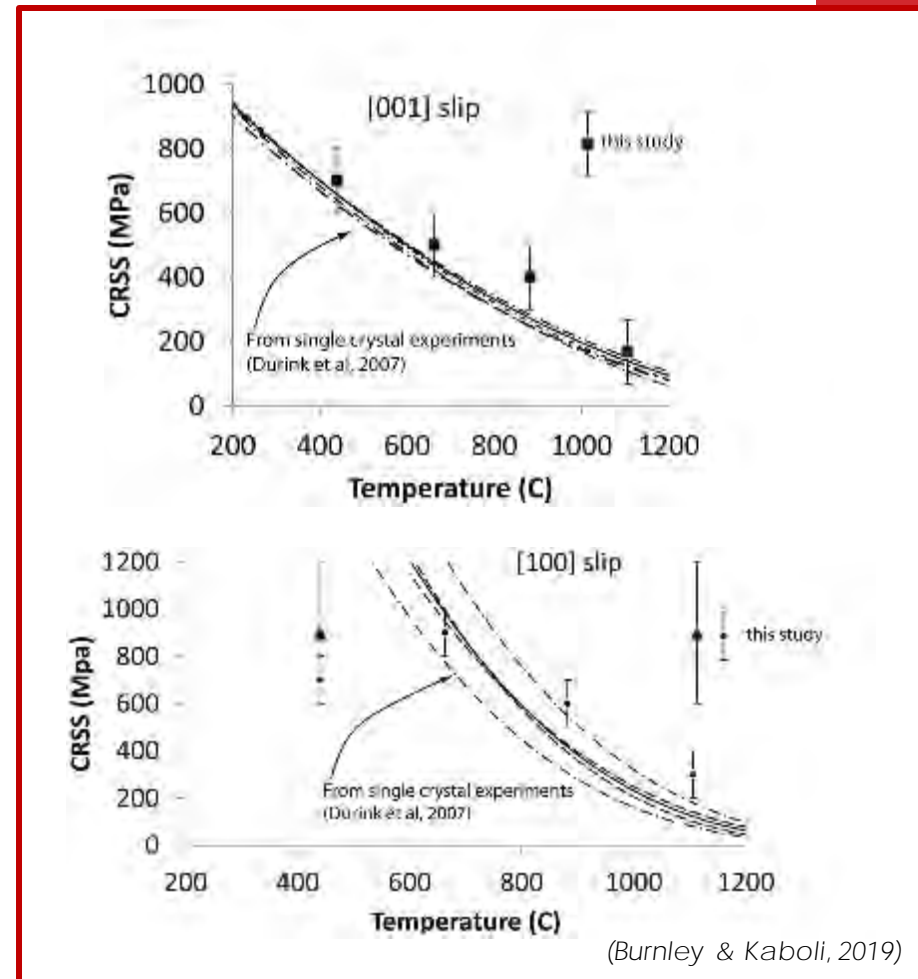
# High Pressure studies of Deformation and the Acoustoelastic effect

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

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



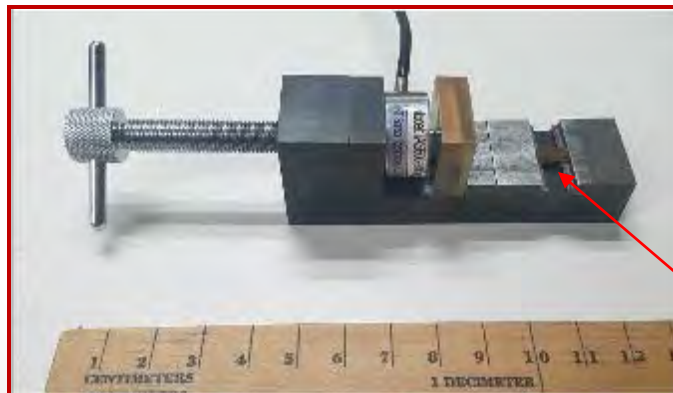
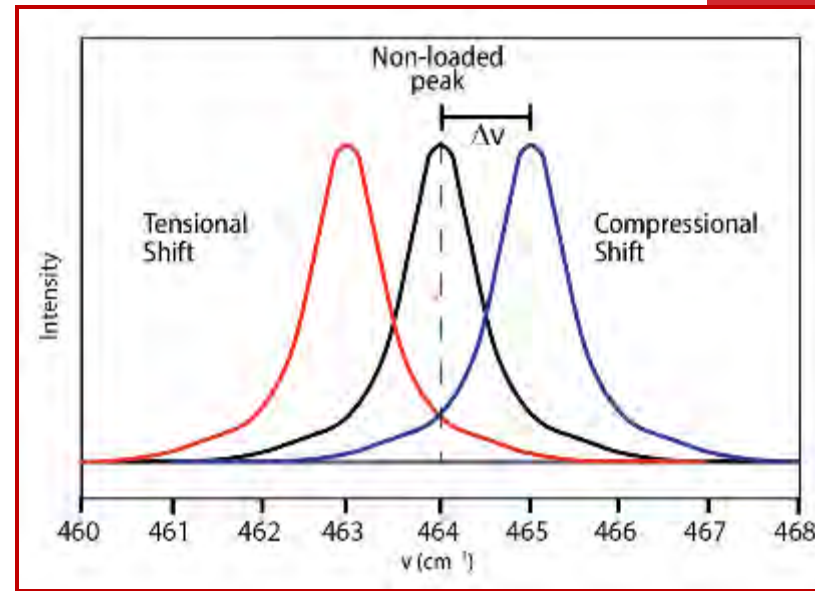
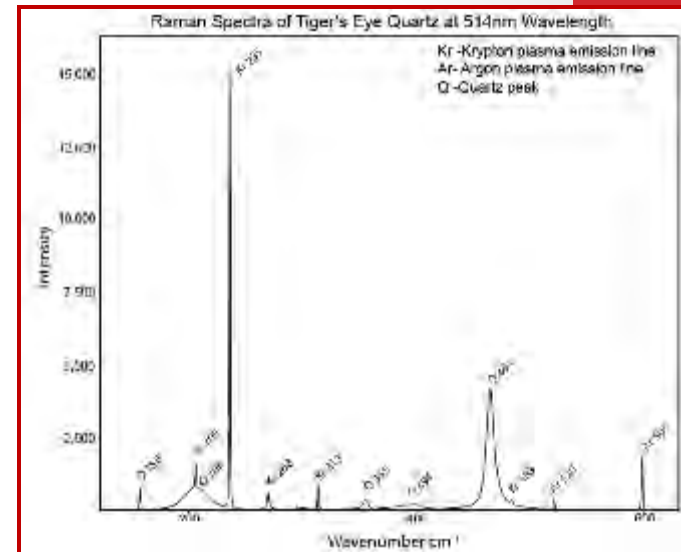
(Traylor, Whitaker & Burnley, in prep)



(Burnley & Kaboli, 2019)



# Raman spectroscopic measurements of stress distribution

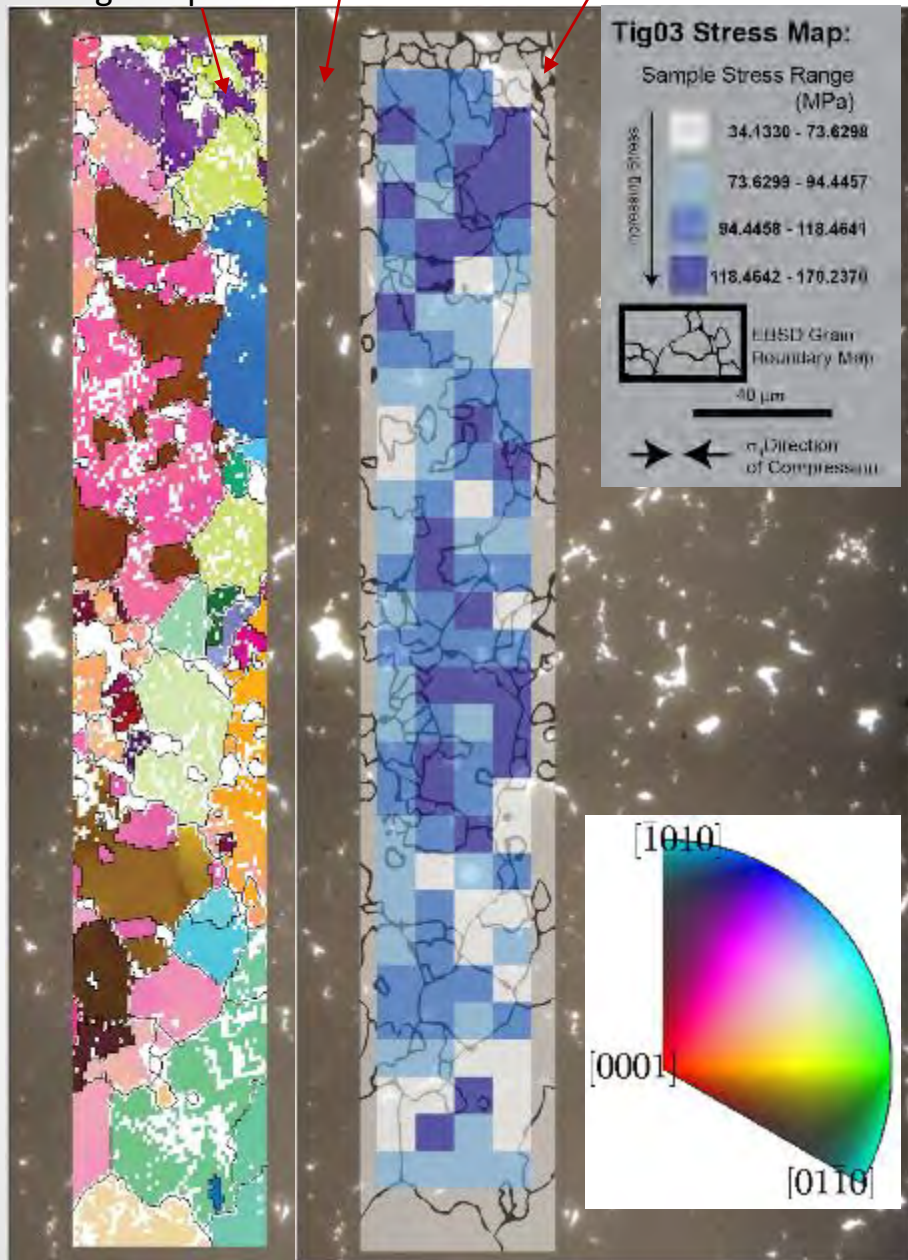


sample

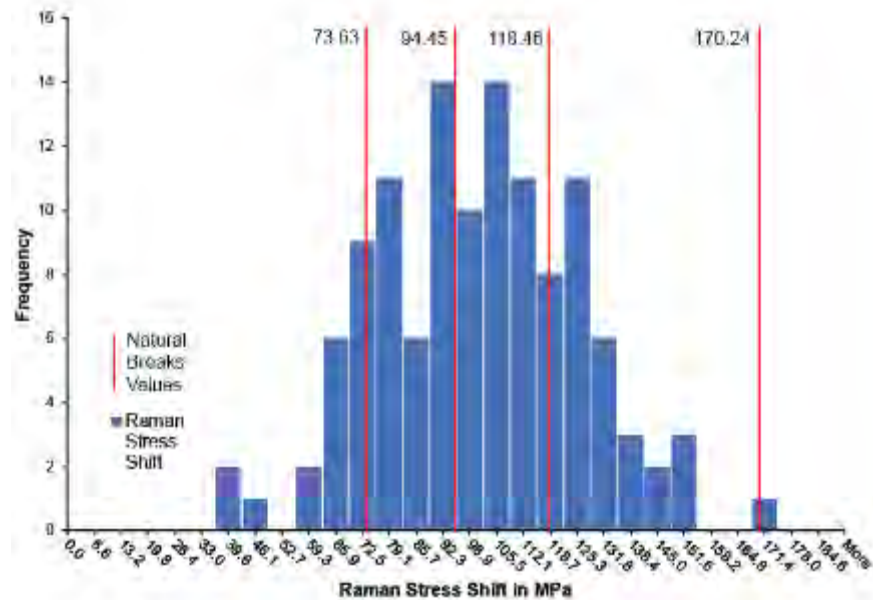
EBSD Orientation Image Map

optical image

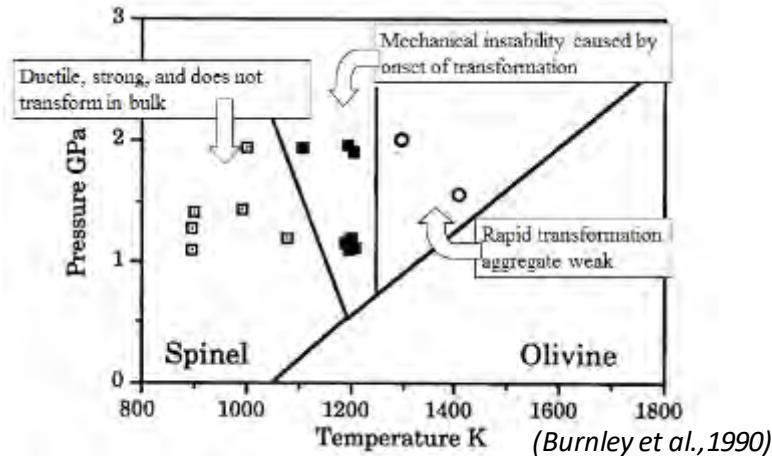
Stress map



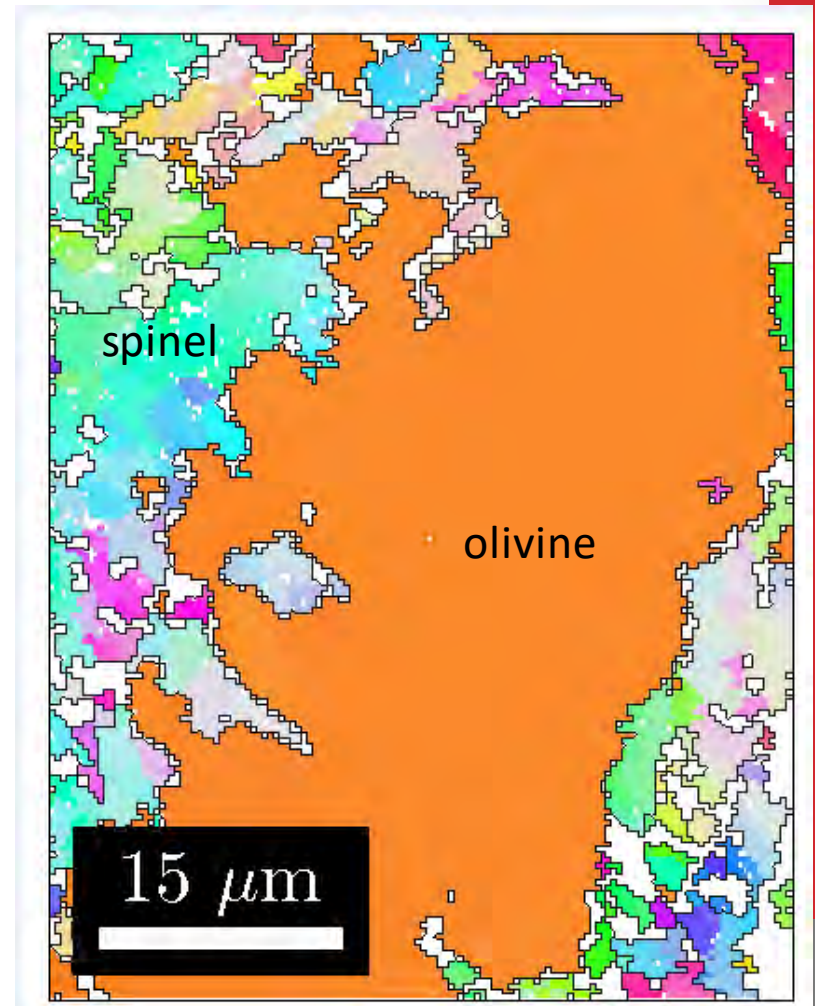
► Peak shifts converted to sample stress using single crystal measurements



# 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

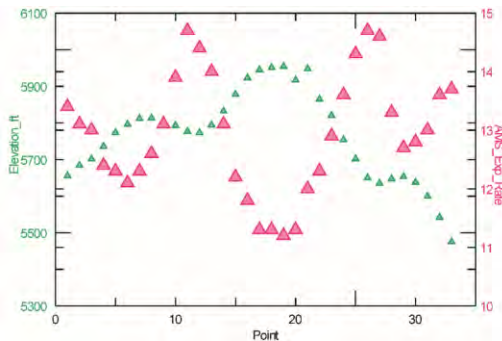
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## **Expertise:**

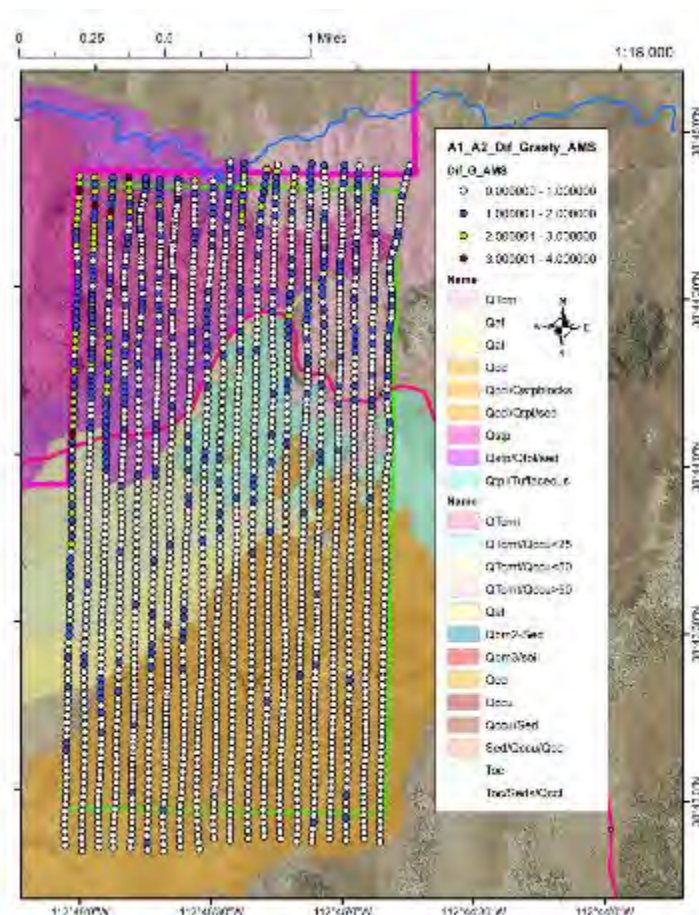
Gamma ray background radiation

# $\gamma$ -ray Background Radiation



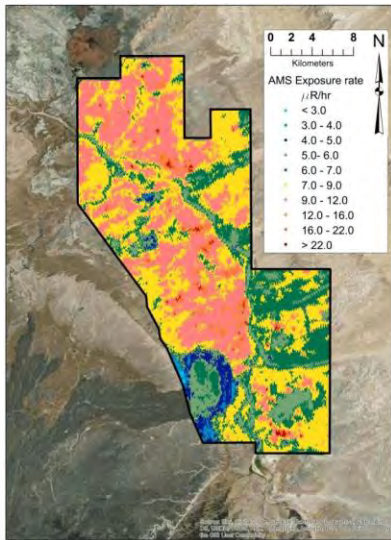
- Predictive model based on legacy NURE data & geologic map units
- Most points within  $1\mu\text{R/hr}$
- Largest deviations associated with steep topography
- Led to D. Haber's PhD research on topographic corrections

## Difference between AMS flight data and predictive model

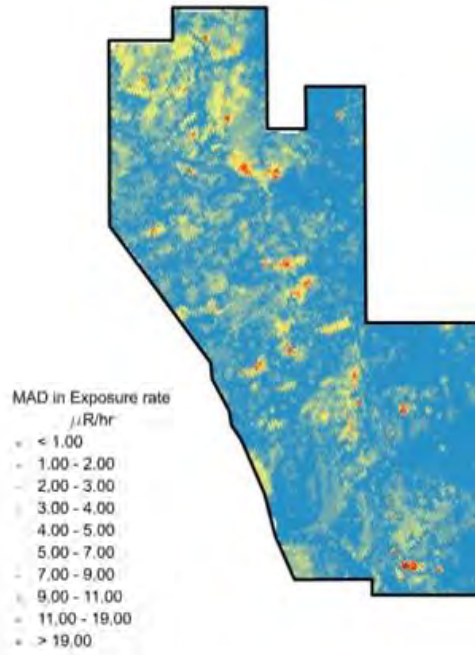


# $\gamma$ -ray Background Radiation

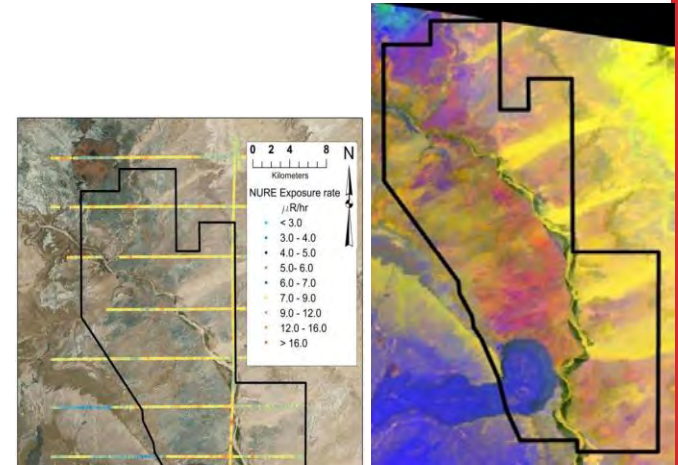
AMS flight data  
Cameron, AZ



Difference between  
AMS data and model



Model based on ASTER data,  
NURE survey & geologic map



(Adcock et al. 2019)

Highlights Uranium  
mines

# Aqueous Geochemistry and Astrobiology

- **Dr. Elisabeth (Libby) Hausrath**
- Professor
- Department of Geoscience
- Email: Elisabeth.Hausrath@unlv.edu
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## 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

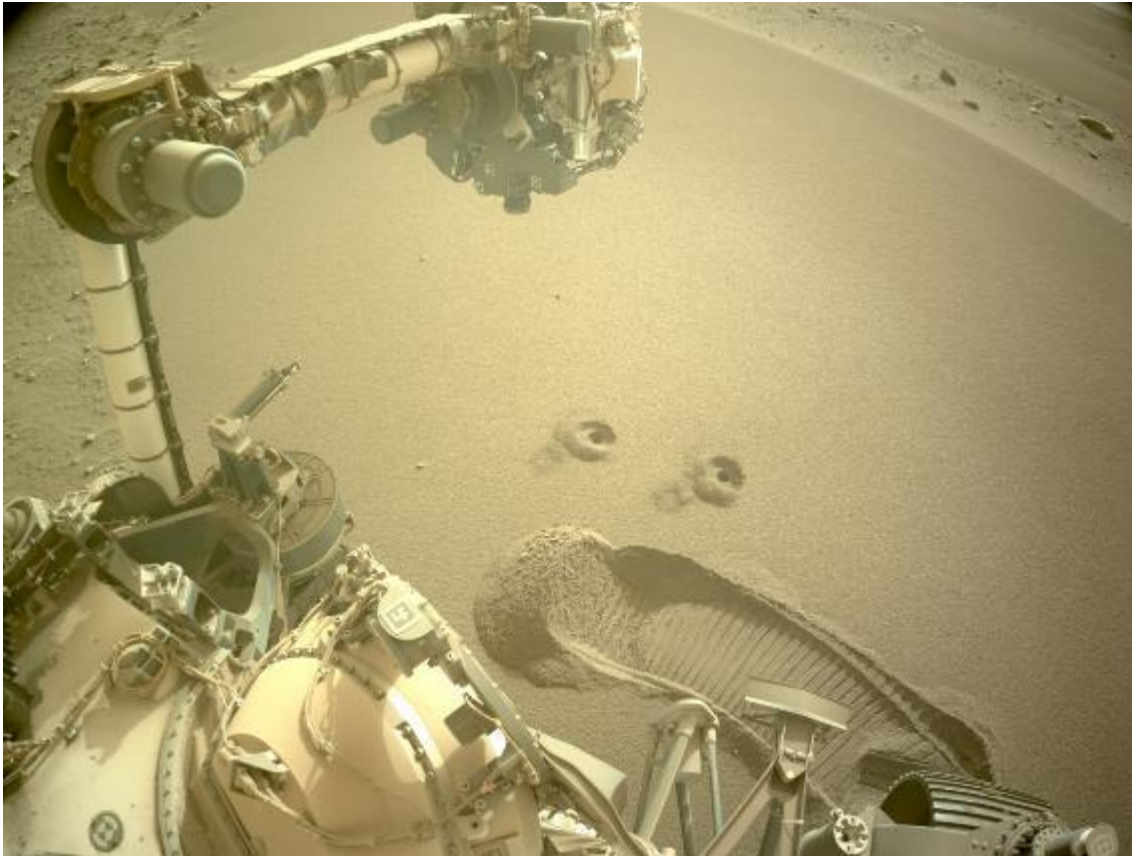


Image credit: NASA/JPL-Caltech

<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.>



# Sedimentary Geology

## **Dr. Ganqing Jiang**

Professor

Department of Geoscience

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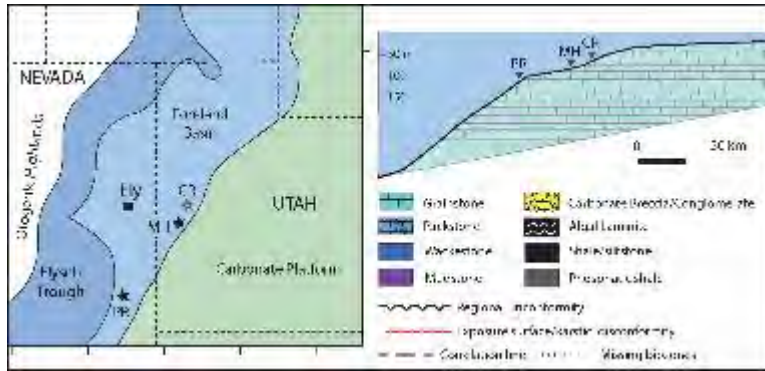
Email: [Ganqing.Jiang@unlv.edu](mailto:Ganqing.Jiang@unlv.edu)

## **Expertise:**

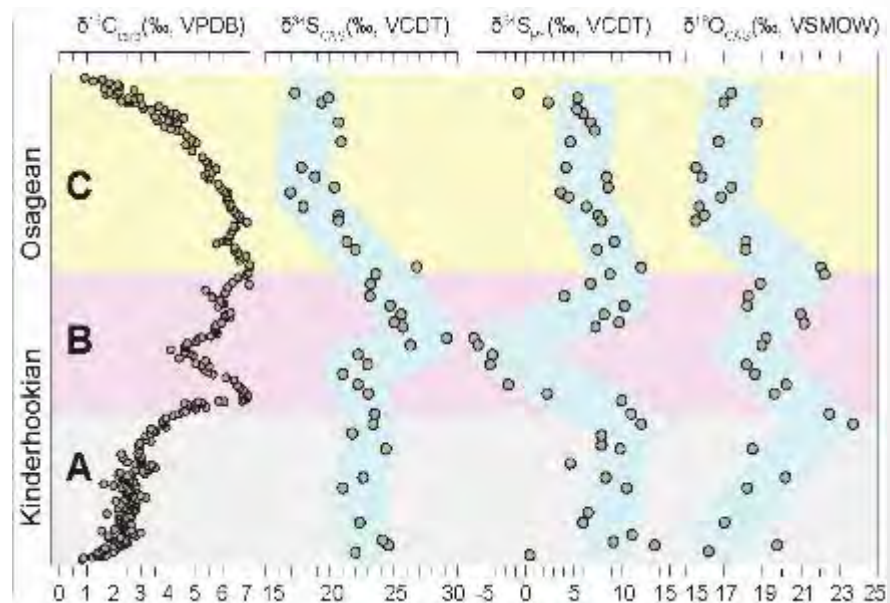
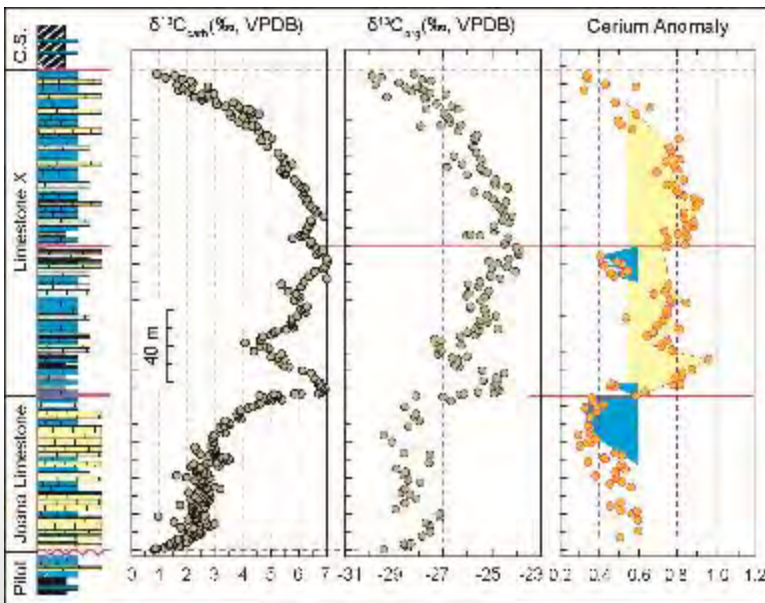
Sequence and chemostratigraphy

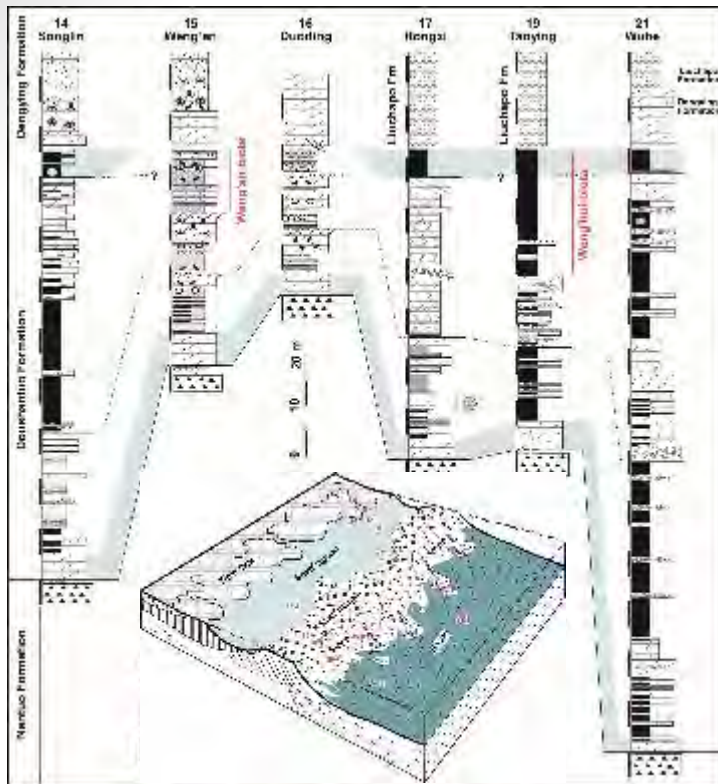
sedimentology

Carbonate diagenesis

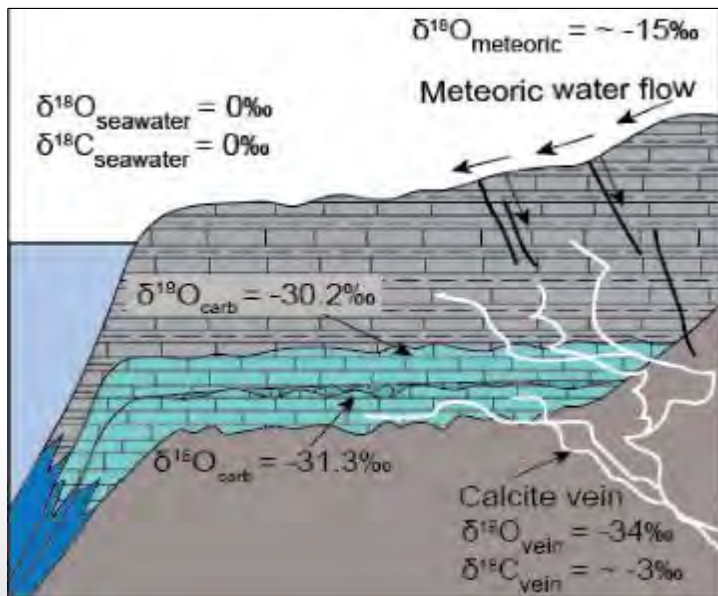


- Sequence and chemostratigraphy
- Paleogeographic reconstruction
- Applications of stable isotopes and rare earth elements
- Paleoenvironmental change across major perturbations of the carbon cycle and mass extinctions





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



# Hydrology



- **Dr. David K. Kreamer**
- **Professor**
- **Department of Geoscience**
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- **Website: <https://geoscience.unlv.edu/people/department-faculty/david-k-kreamer/>**

## Expertise

- **Hydrologist, Water Quantity and Quality**
- **Research in Groundwater Tracing and Dating in National Parks and Preserves, Surface Water/ Groundwater interactions, Spring Sustainability**
- **Research in Hazardous Site Characterization and Remediation**
- **International Water Development and Security**
- **Climate Change Research – Lake Studies**
- **Expert Witness in Court Cases, Testimony to United States Congress, Invited Address to the General Assembly of the United Nations**
- **President – International Association of Hydrogeologists, largest truly international professional organization focused on the wise use and protection of groundwater. A scientific, educational, and charitable volunteer organization with thousands of members in over 130 countries, founded in 1956.**
- **National and International Lectures and Short Courses including presentations in the Middle East, Africa, Pacific Ocean, People's Republic of China, Europe, and United States**

# David K. Kreamer – Examples of Research and Service Interests

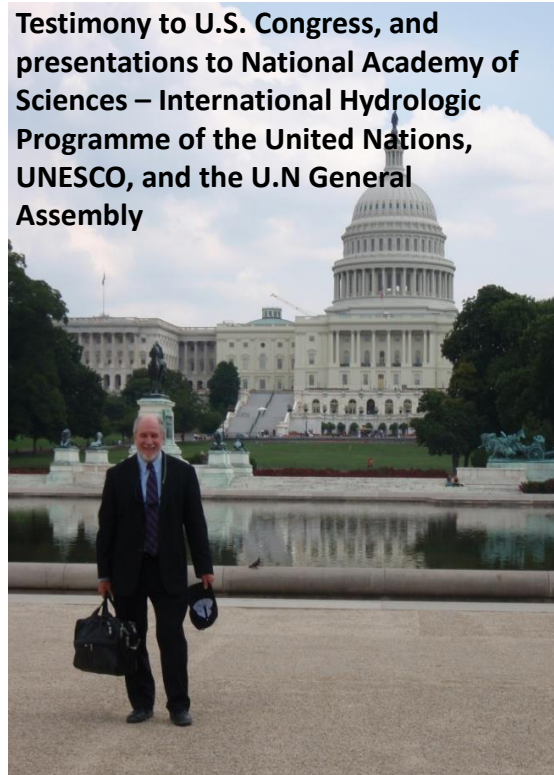
**Contaminant Transport Studies**



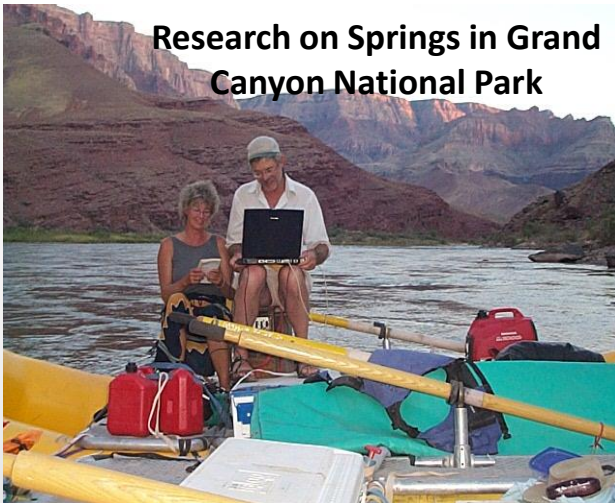
**Students sampling springs as part of sustainability studies in the Mojave desert**



**Testimony to U.S. Congress, and presentations to National Academy of Sciences – International Hydrologic Programme of the United Nations, UNESCO, and the U.N General Assembly**



**Research on Springs in Grand Canyon National Park**



**Groundwater Modeling Training, Niger, Africa**

# Climate Science and Paleoclimatology

Matthew S. Lachniet

Professor

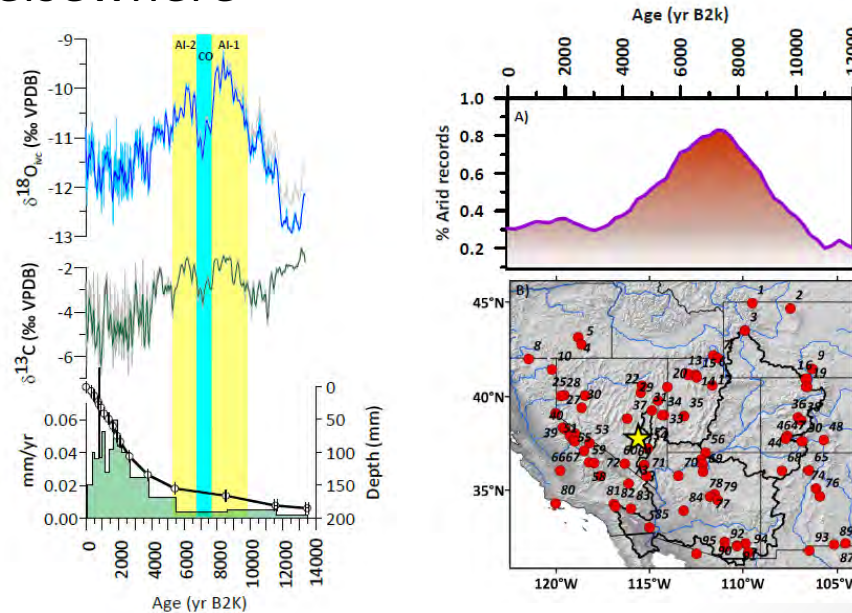
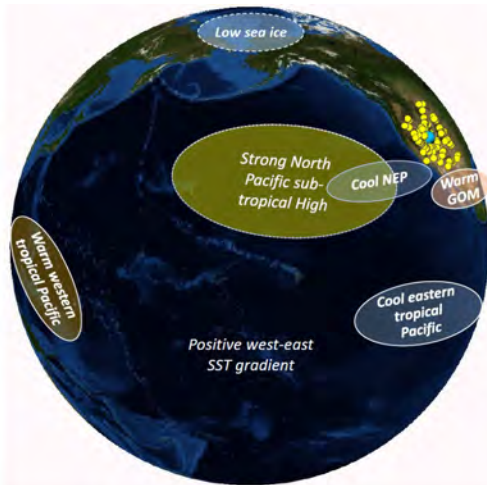
Department of Geoscience

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[Matthew.Lachniet@unlv.edu](mailto: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



# Hydrology

## **Dr. Michael Nicholl**

Department of Geoscience

Phone: (702) 895-4616

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## **Expertise:**

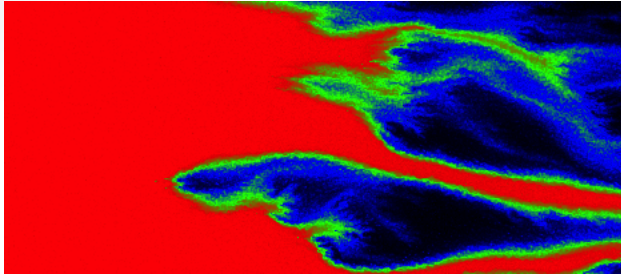
Unsaturated zone hydrology

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



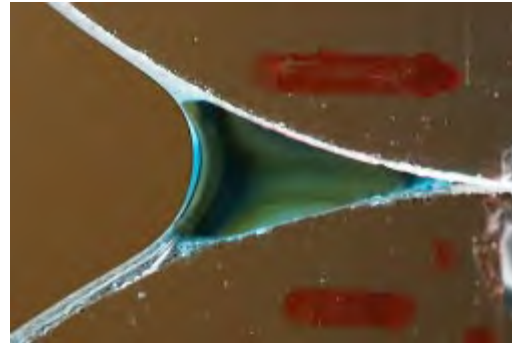
Water (blue) pooled above a fracture intersection



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



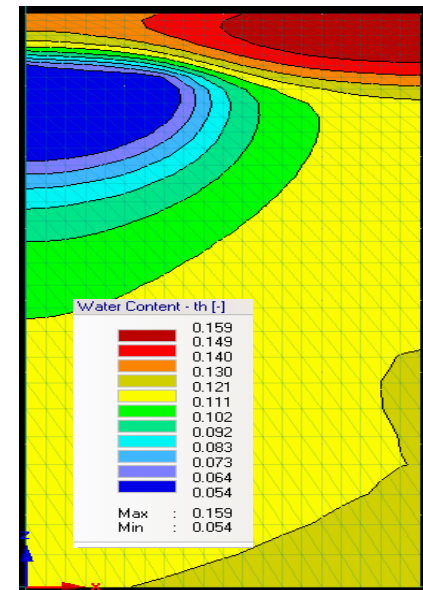
Millimeter-scale transport experiment



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/>

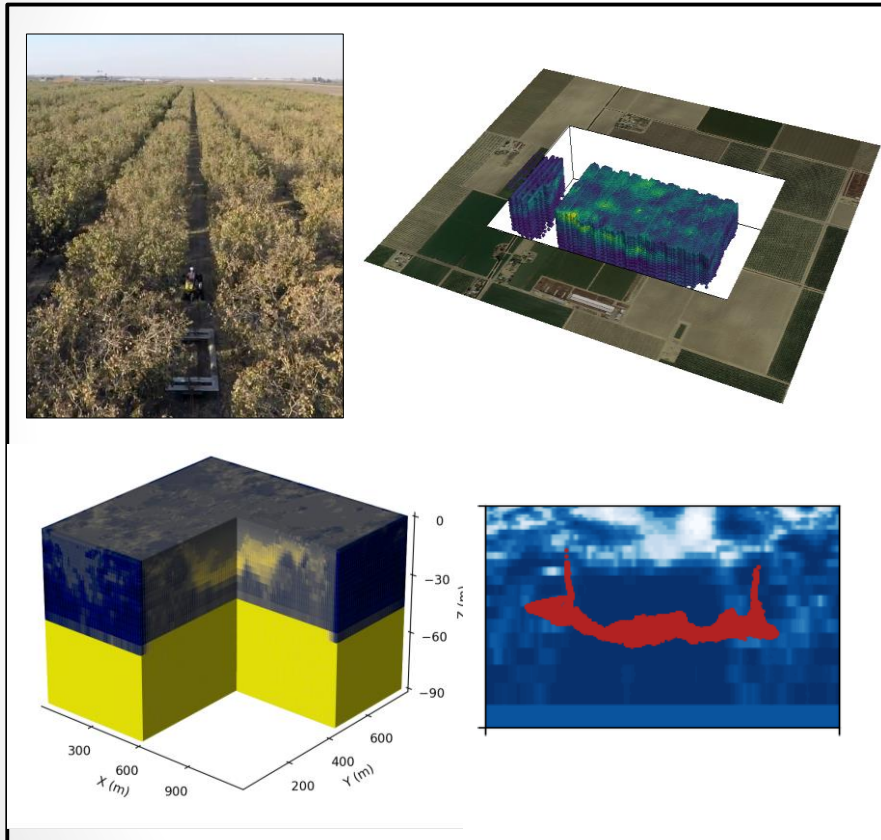
## Expertise

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



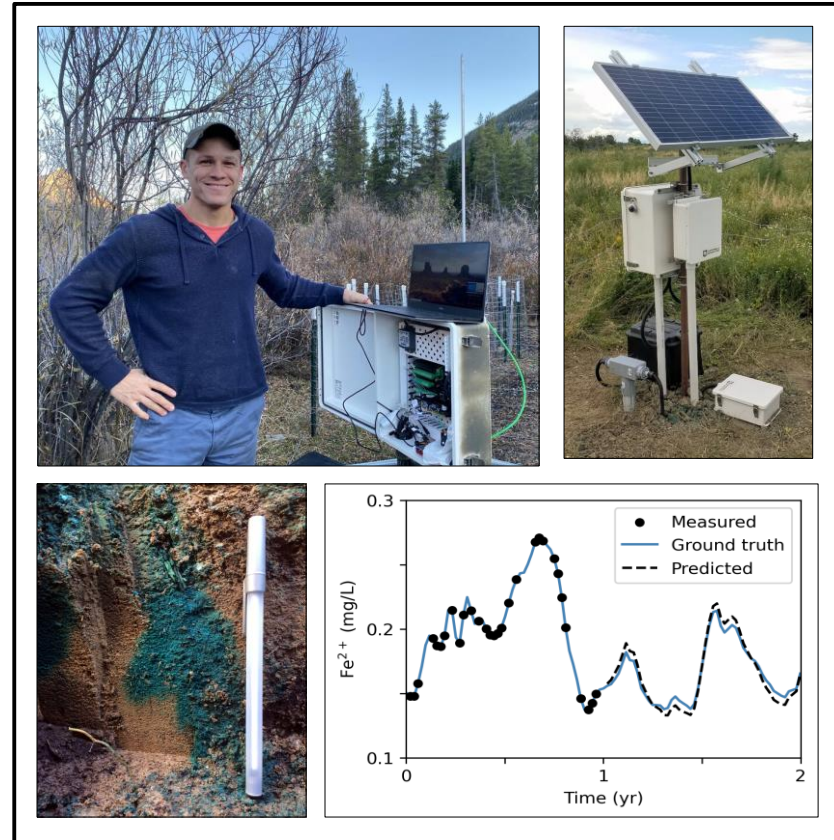
# Understanding how hydrologic extremes (droughts and floods) impact water quality

## 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).

# Research Oliver Tschauner

- **Dr. Oliver Tschauner**
- Professor of Research
- Department Geoscience
- Email: [oliver.Tschauner@unlv.edu](mailto: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 CO<sub>2</sub> inclusions  
at a pressure of 20000  
atmospheres

# Selected Publications

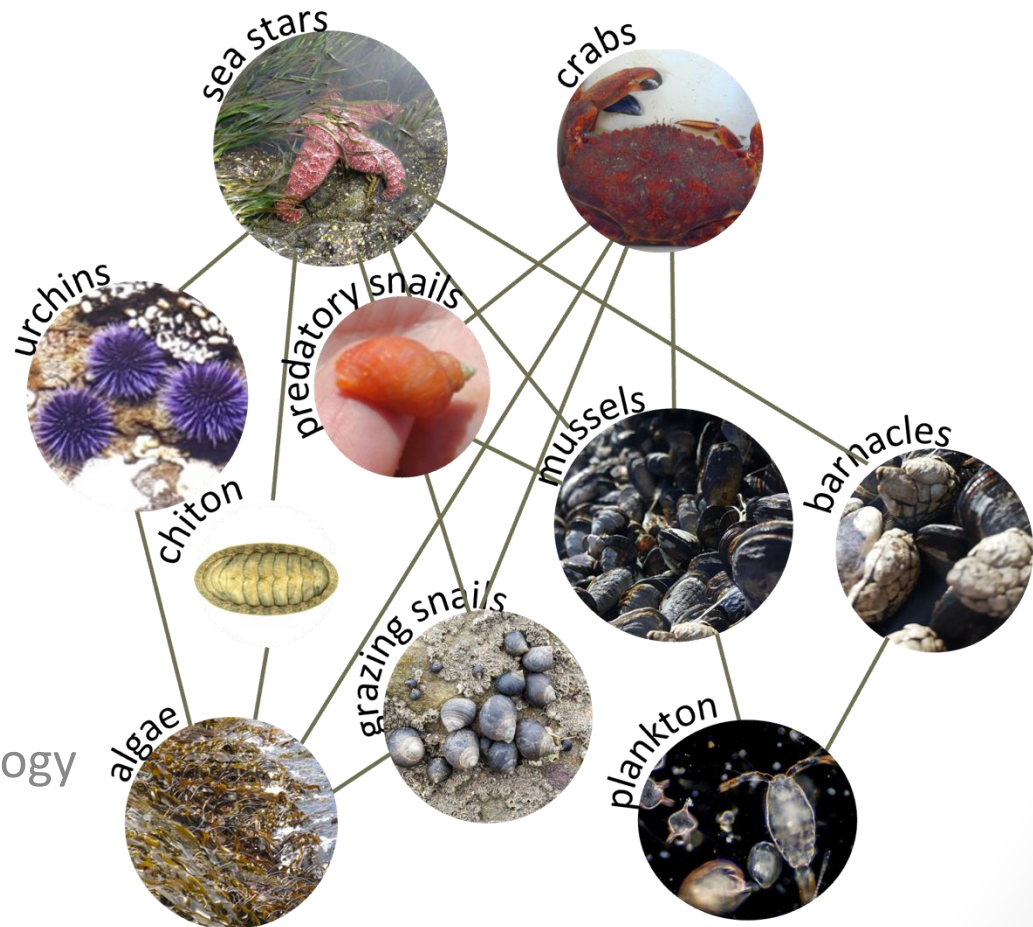
- ♦ Discovery of davemaoite,  $\text{CaSiO}_3$ -perovskite as a mineral from the lower mantle. O. Tschauner, S. Huang, S. Yang, M. Humayun, W. Liu, S. N. Gilbert Corder, H. A. Bechtel, J. Tischler, G. R. Rossman, **Science** 374, 891-894 (2021).
- ♦ Ice-VII inclusions in diamonds – evidence for aqueous 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 ( $\text{Ca, Na, } \square$ )  $\text{AlSi}_2\text{O}_6$ , 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](https://doi.org/10.1007/978-3-031-28805-0_8)

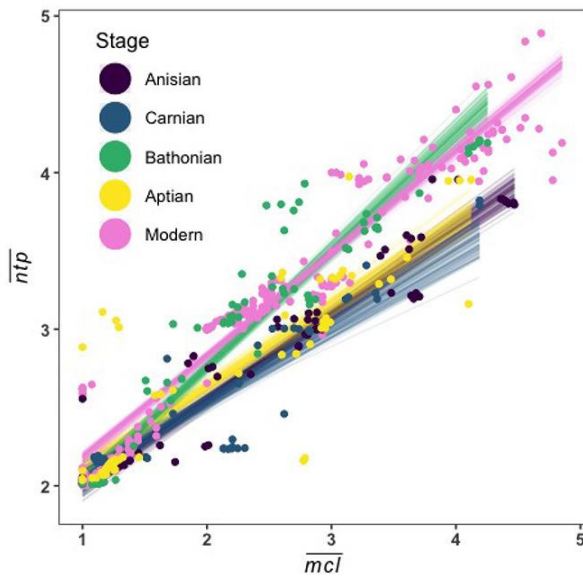
# Paleoecology

- **Dr. Carrie L. Tyler, Ph.D.**
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## 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.

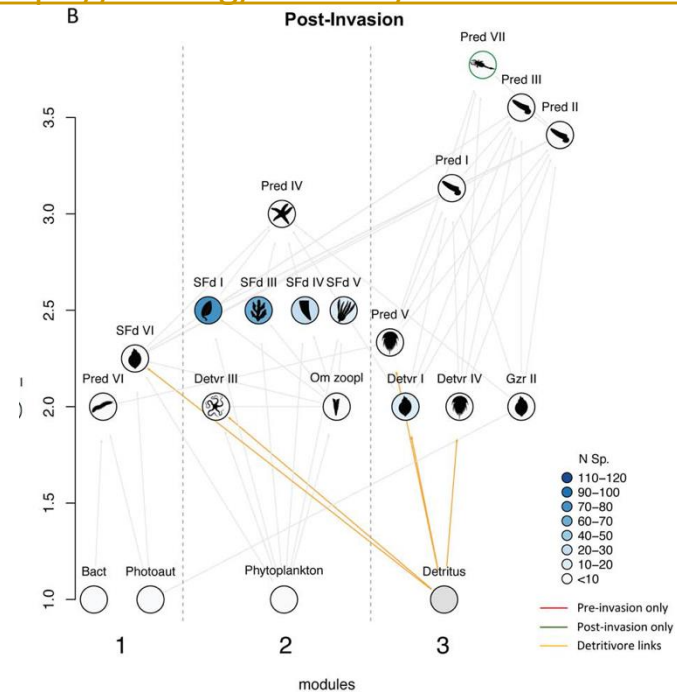
Banker *et al.* 2022 <https://doi.org/10.3389/fevo.2022.983374>

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

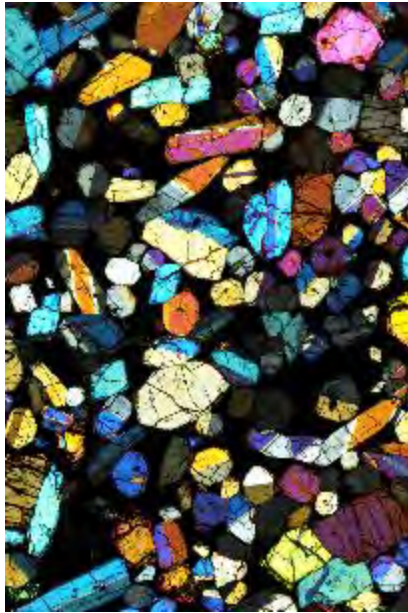
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- Phone: (702) 895-1239
- Email: [arya.udry@unlv.edu](mailto:arya.udry@unlv.edu)
- Website: [aryaudry.com](http://aryaudry.com)

## Expertise:

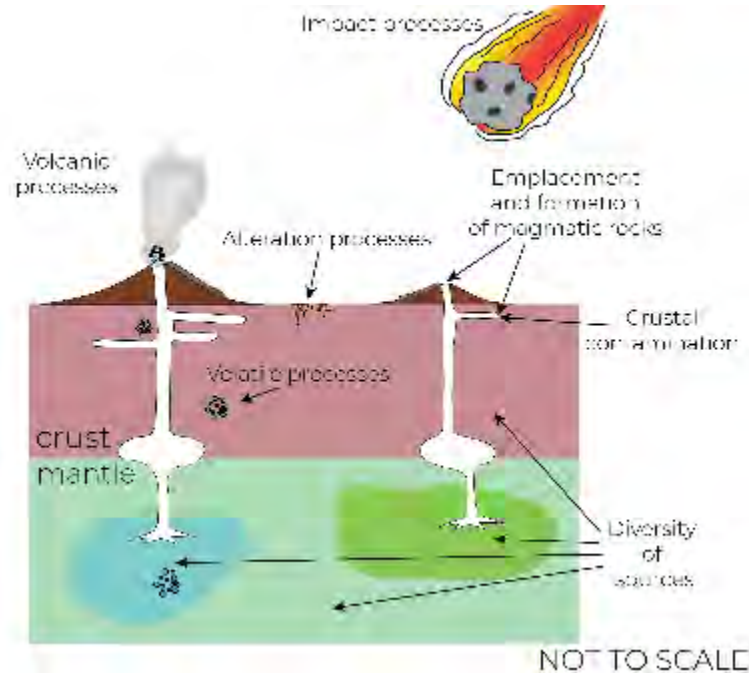
Planetary petrology

Martian igneous geology

# Martian geologic evolution using meteorites



*Polarized thin section image of nakhlite meteorite MIL 090030*



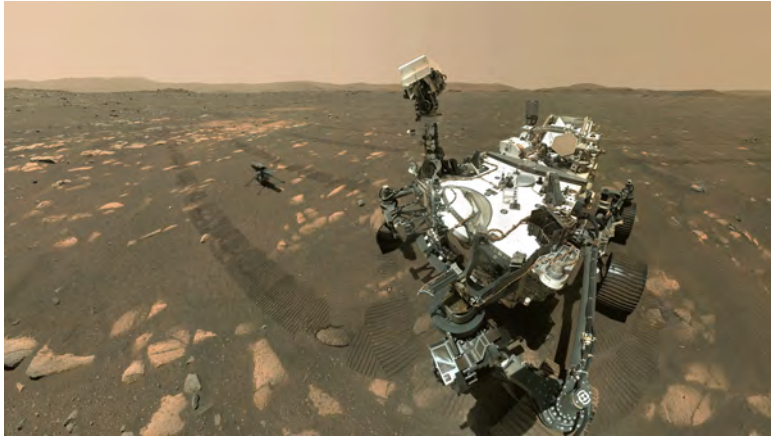
*Processes that can be understood using meteorites (Udry et al. 2020)*



*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



**Early Mars (e.g., Noachian,  $\geq 3.7$  Ga?)**  
- Hotter, thinner crust  
- More crustal assimilation  
- **Enhanced magmatic evolution (more felsic and alkaline compositions)**  
\*not to scale

**Late Mars (e.g., Amazonian,  $\leq 3$  Ga?)**  
- Cooled, thickened, impacted crust (35-85 km average)<sup>†</sup>  
- Less crustal assimilation  
- **Less voluminous evolved magma**  
<sup>†</sup>Plesa et al., 2016

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