Department of Geoscience Faculty Research Areas

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Planetary Science

Dr. Christopher Adcock
Assistant Research Professor
Department of Geoscience
Email: Christopher.Adcock@unlv.edu

Expertise:
Planetary Surface Processes | Extraterrestrial Habitability

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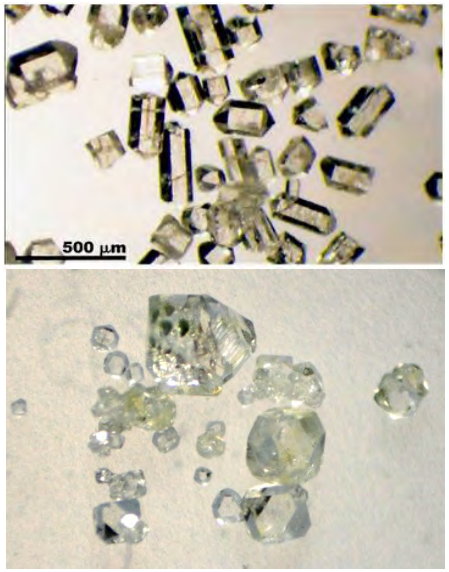
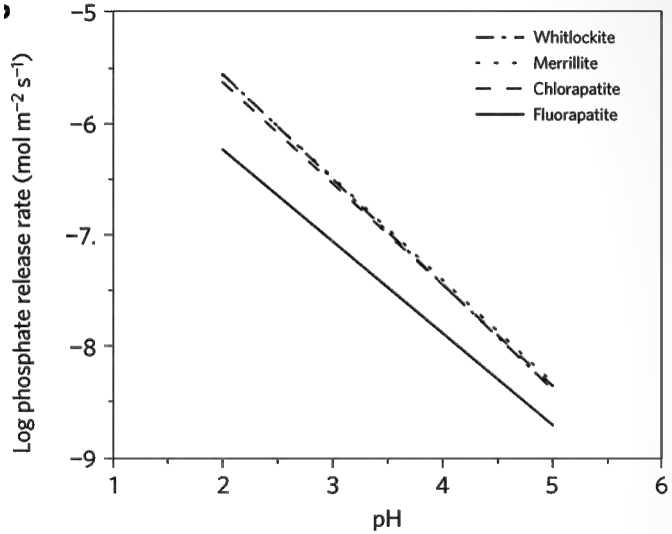
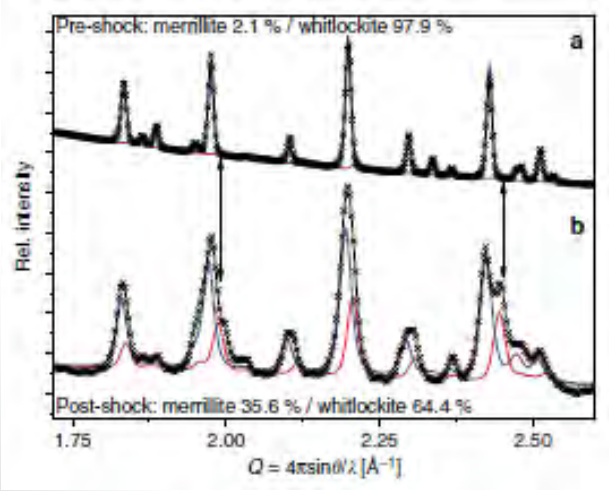
Planetary Surface Processes / Low Temperature Geochemistry: Mars



Left: Synthesized chlorapatite (top) and whitlockite used in experiments. Same scale for both images. The ability to synthesize these Mars-relevant minerals in quantity is a specialty of Dr. Adcock and the Hausrath Lab. Physical sample allow for experiments that cannot be done by calculation.

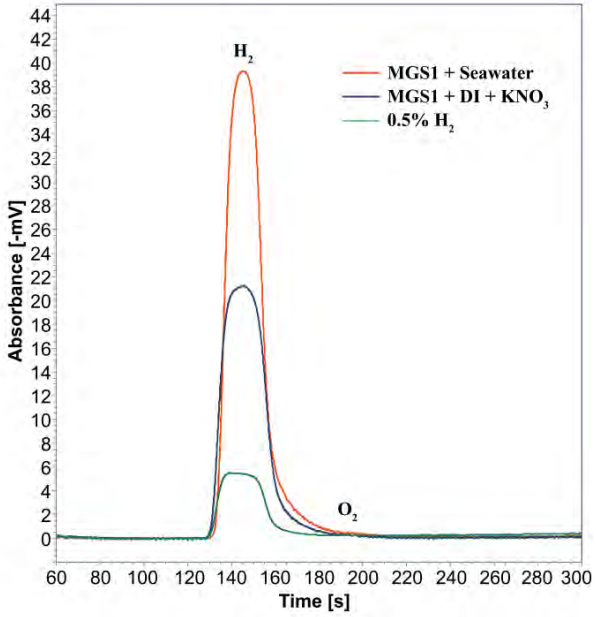


Above: Empirical Dissolution rates of terrestrial (fluorapatite / whitlockite) and more Mars-relevant phosphate minerals (chlorapatite and merrillite). 25 °C , variable pH. Higher rates mean potentially higher phosphate availability in past Martian environments – with positive implications for past life. *Adcock et al., (2013) Nature Geoscience 6 (10), 824-827.*

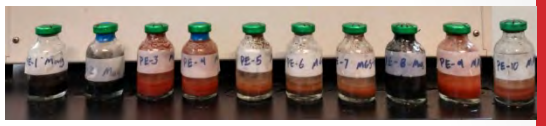


Left: Shock induced metamorphism of whitlockite (a) to merrillite/whitlockite mix (b). Shock removes the water from whitlockite to make merrillite. Since all of our current samples of Mars come from shocked meteorites, this has implications for the past hydrologic cycle of Mars. *Adcock et al., (2017) Nature communications 8 (1), 1-8.*

Extraterrestrial Habitability | *In Situ* Resources and Environments on Mars

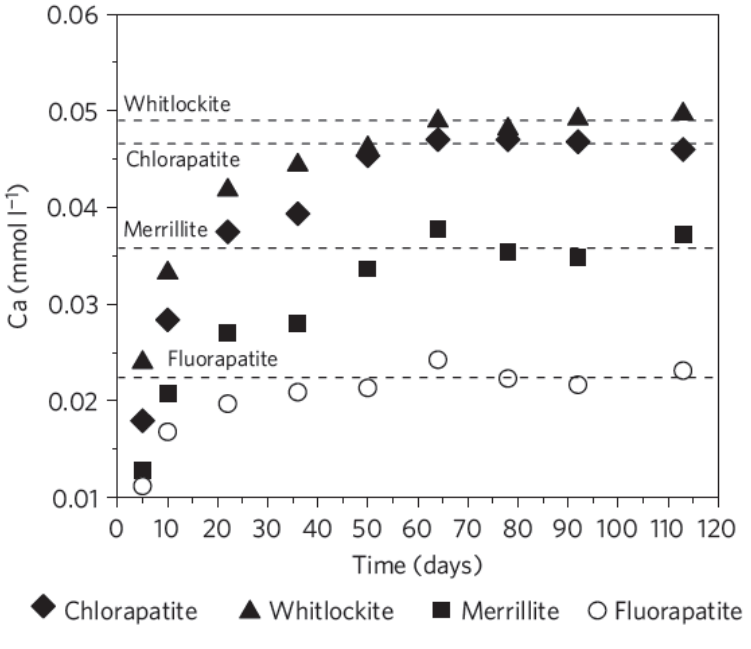


Left: Results of low temperature hydrogen generation experiments using Martian soil simulants. These experiments show it is possible to use Martian materials and a low energy system to generate H_2 for fuel, energy, or water for future human missions to Mars. *Adcock et al., (2020), 51st LPSC.*



Above: A typical set of hydrogen generation experiments. Simulants and solution are slowly shaken at 25 °C to produce hydrogen.

Right: Solubility of terrestrial and more Mars-relevant minerals. Along with dissolution rates, the increased solubility of the more Mars-relevant minerals merrillite and chlorapatite over terrestrial fluorapatite suggest bio-essential phosphorus may be a recoverable resource for future missions to Mars. *Adcock et al., (2013) Nature Geoscience 6 (10), 824-827.*



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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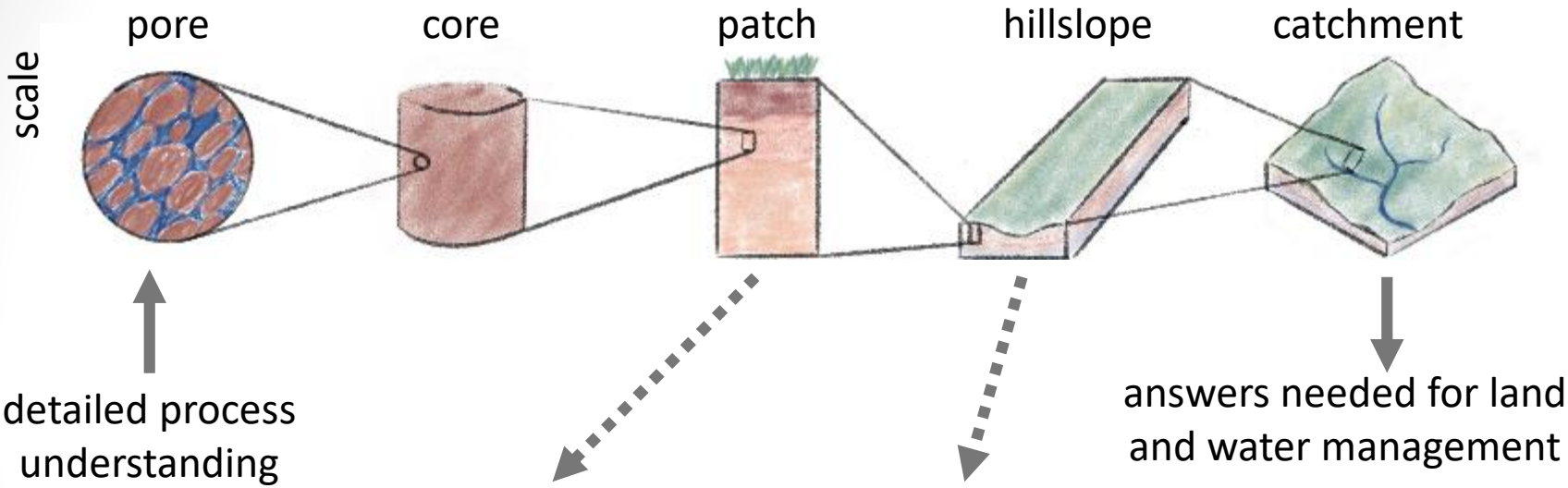
Hydrologic Scaling Challenge



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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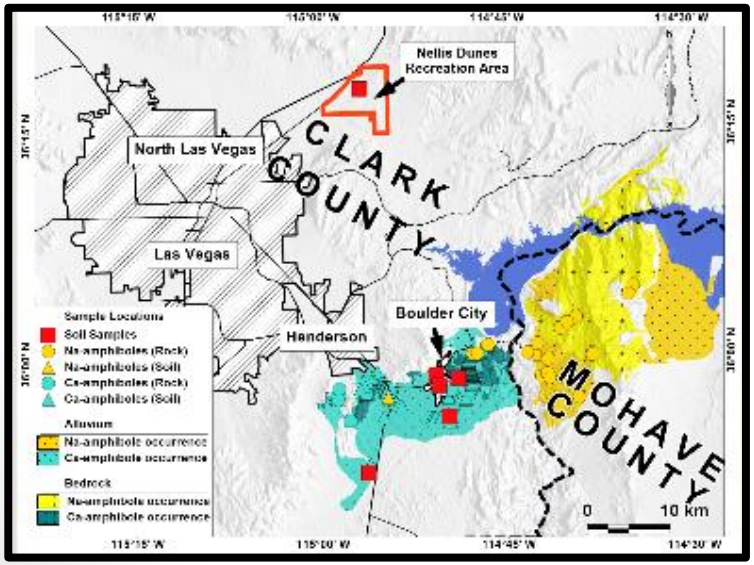
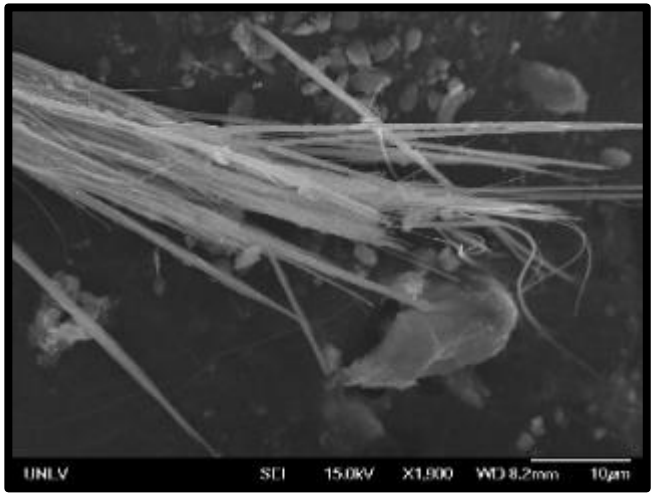
Medical Geology

- **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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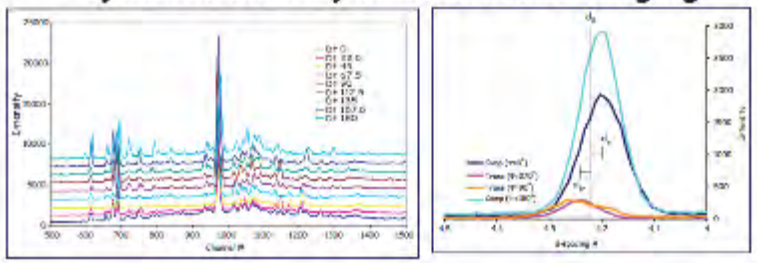
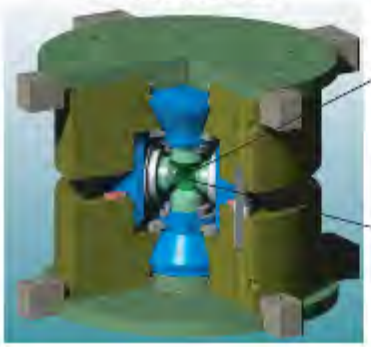
High Pressure studies of Deformation and the Acoustoelastic effect

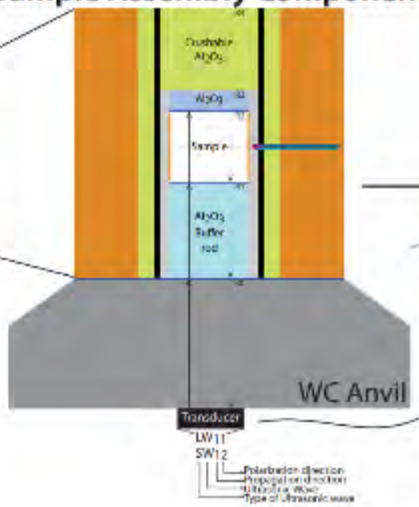
Synchrotron X-ray diffraction and imaging

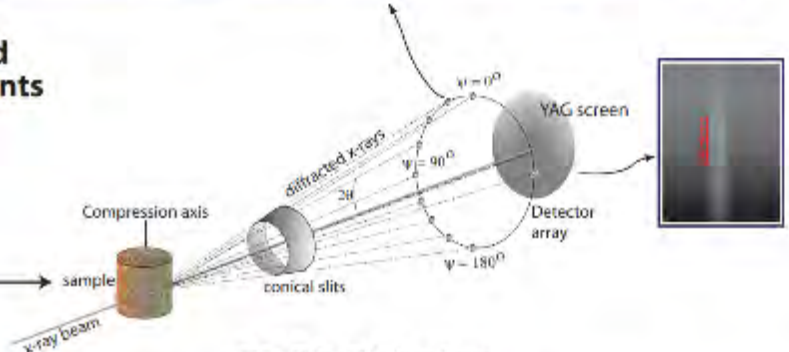


D-DIA module

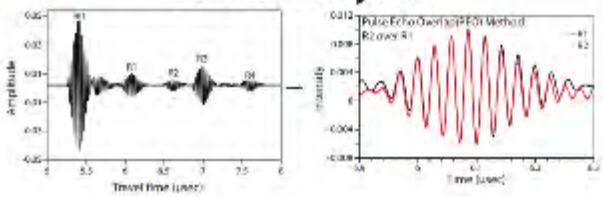


Ultrasonic D-DIA Modified Sample Assembly Components



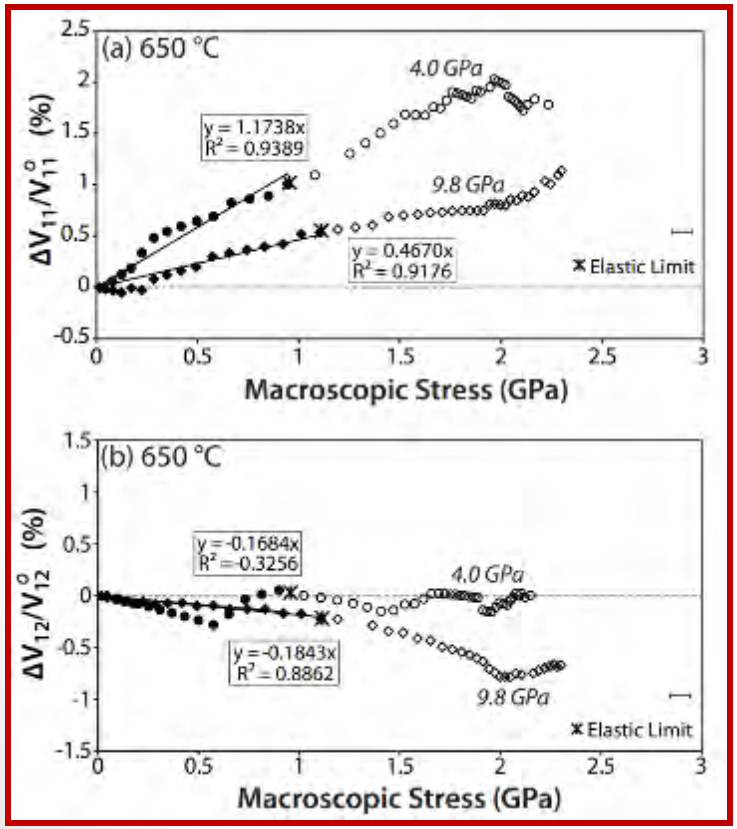


DIASCoPE System



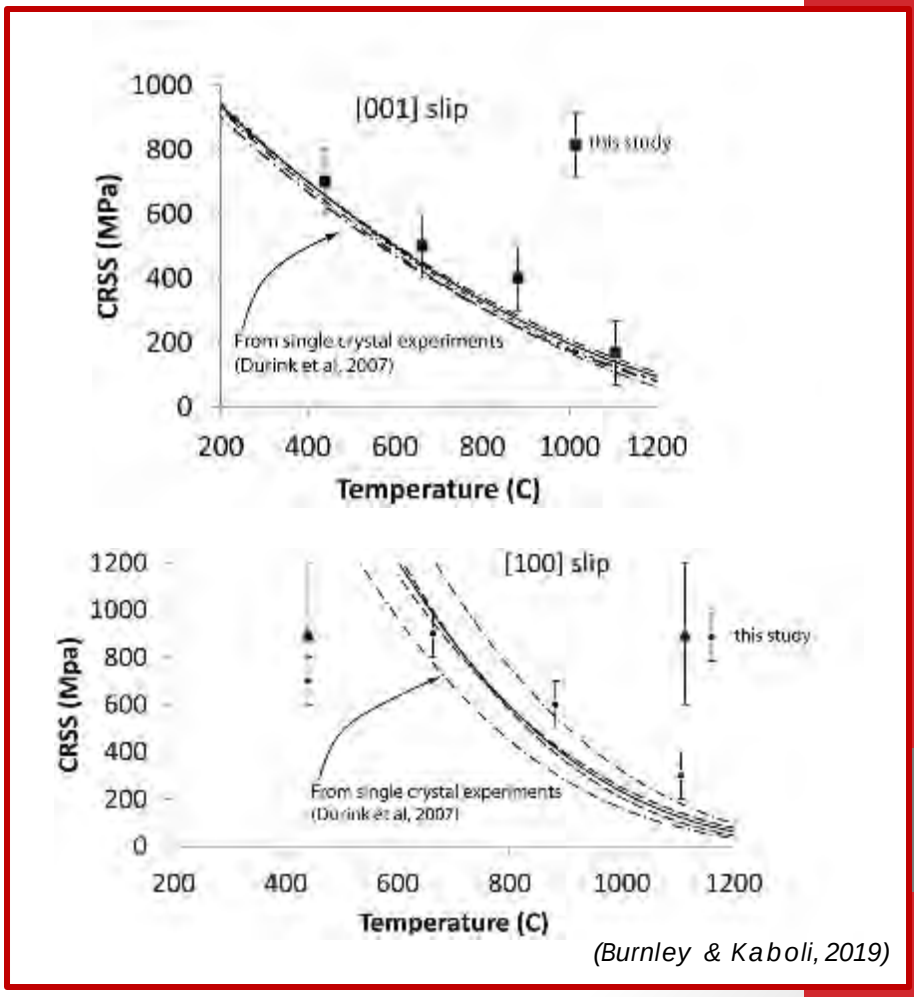
High Pressure studies of Deformation and the Acoustoelastic effect

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



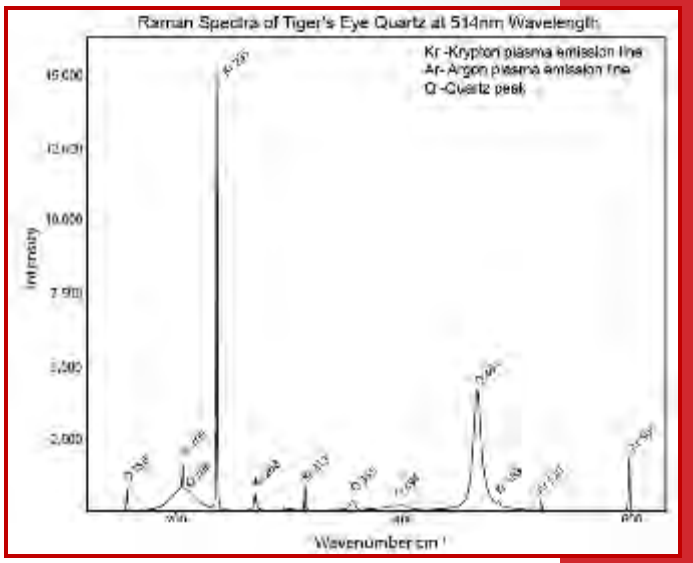
(Traylor, Whitaker & Burnley, in prep)

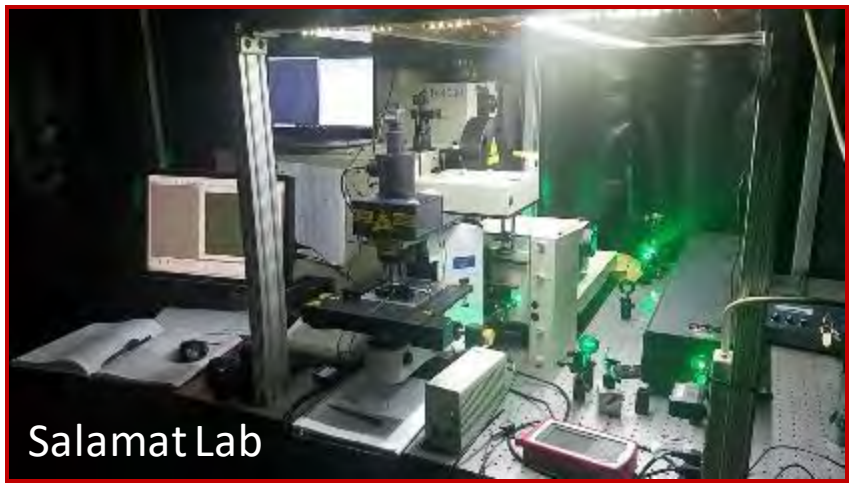
Details of multiple slip systems derived from a single multi step experiment

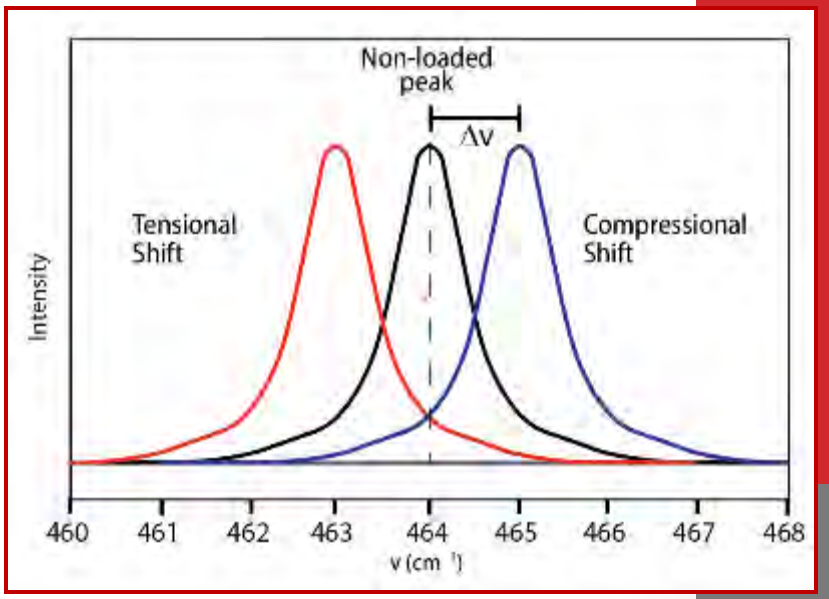


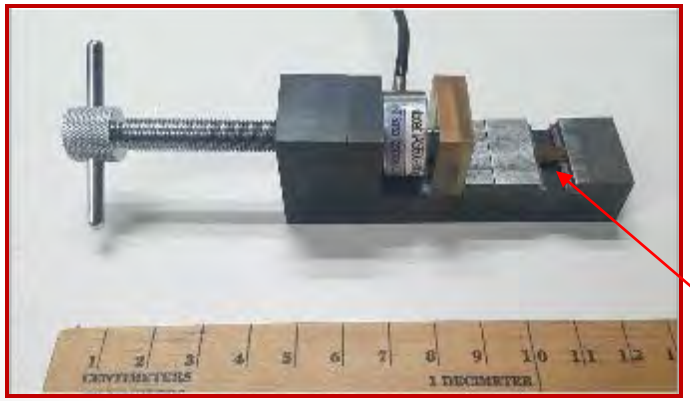
(Burnley & Kaboli, 2019)

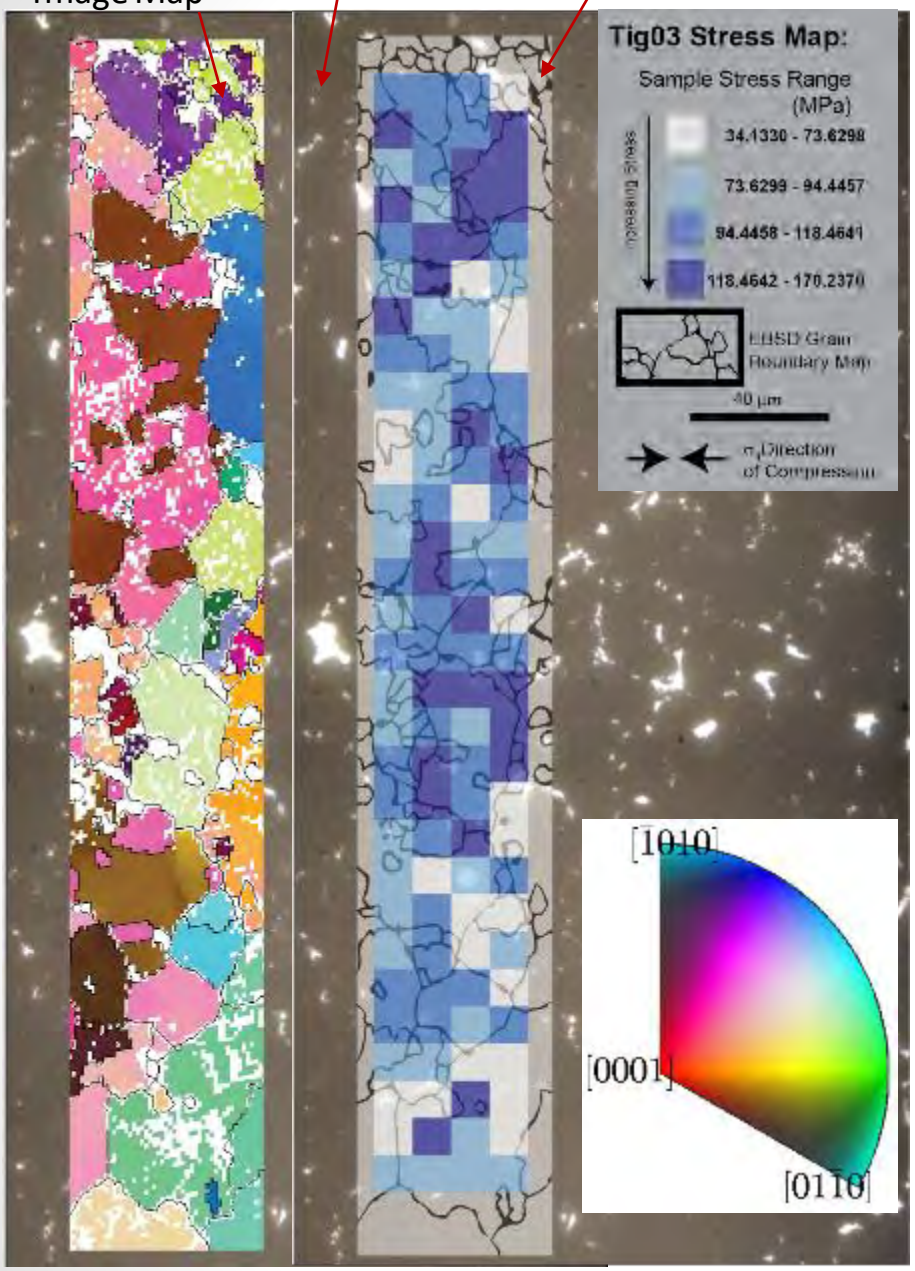
Raman spectroscopic measurements of stress distribution



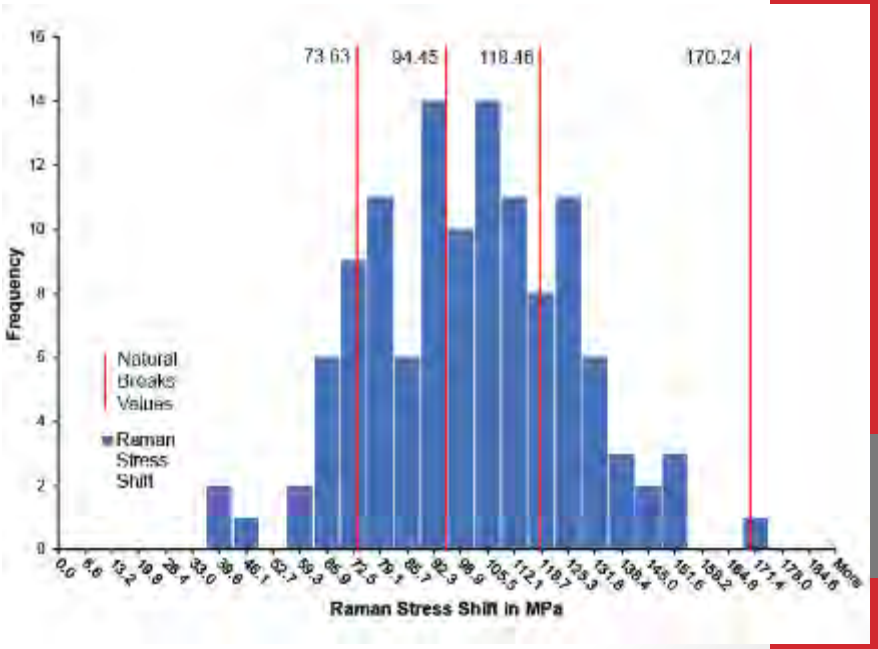




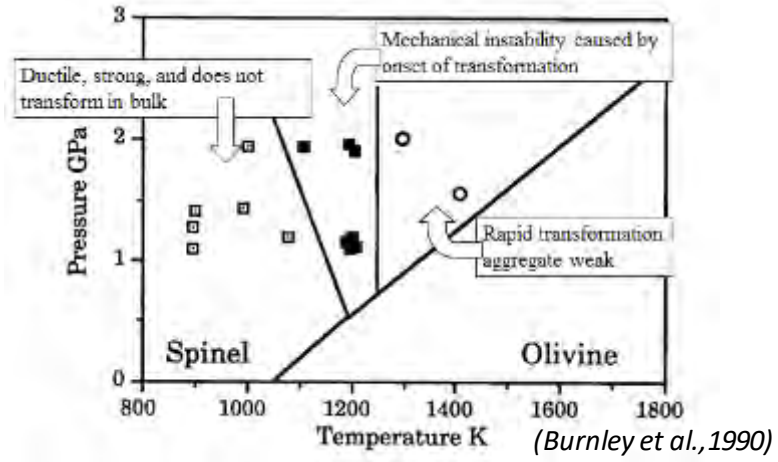




- Peak shifts converted to sample stress using single crystal measurements

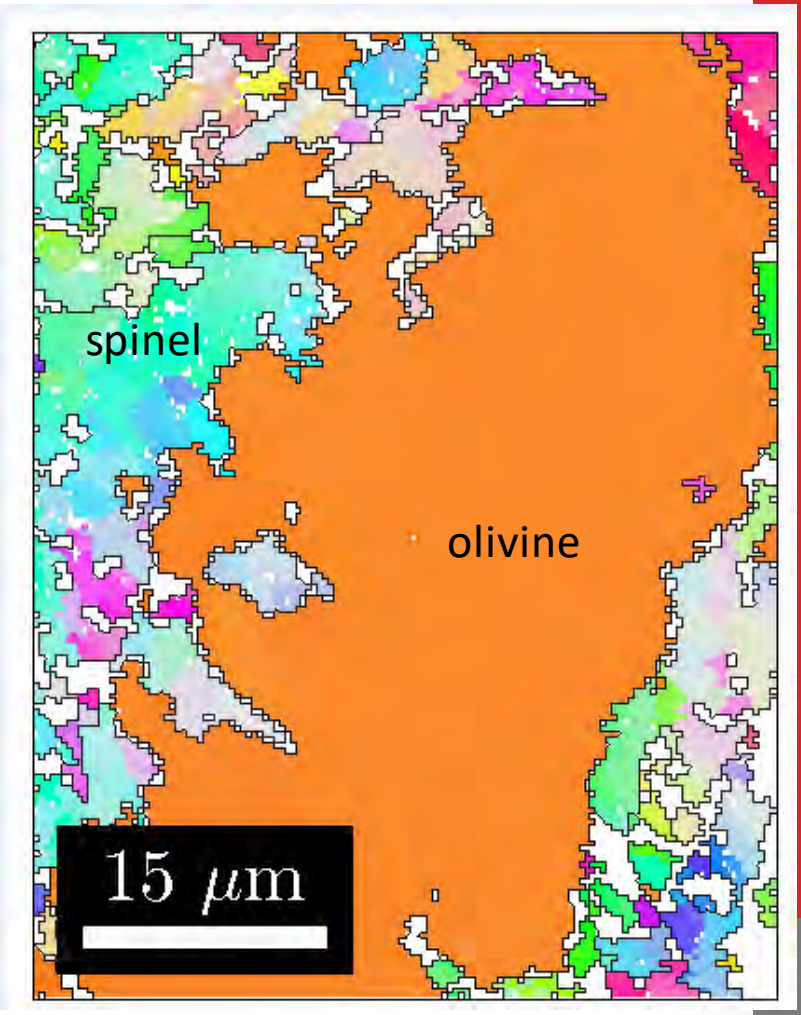


Interaction of Phase Transformation and Deformation



(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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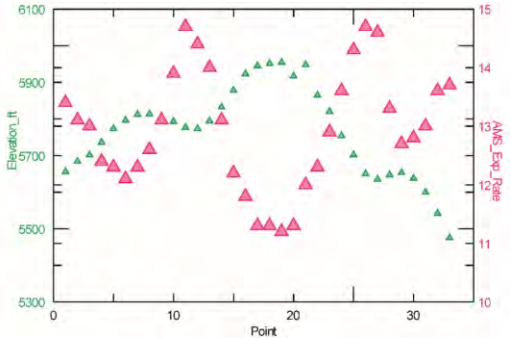
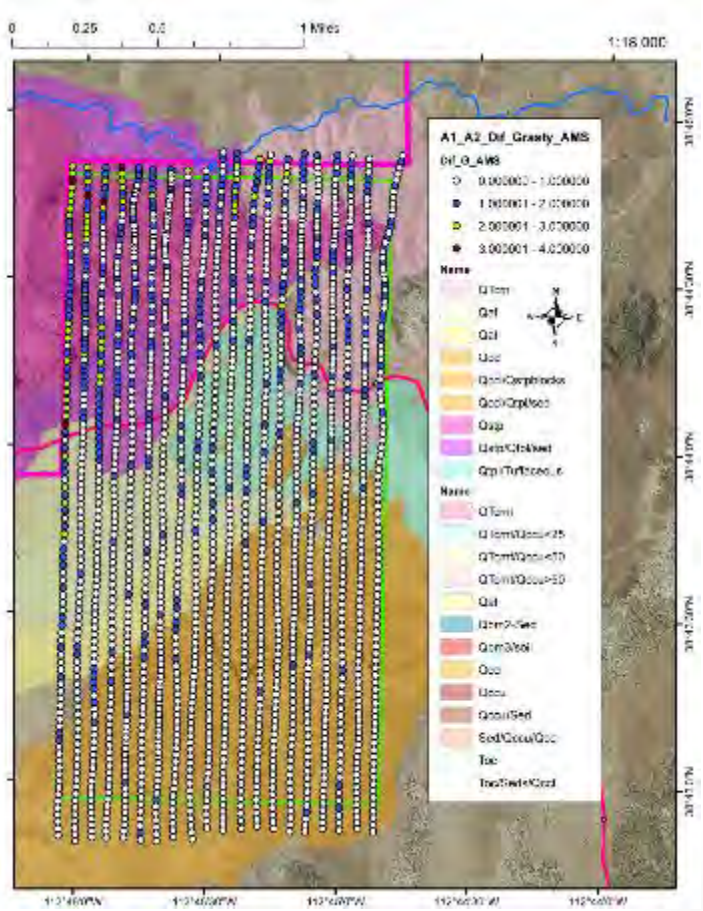
γ-ray Background Radiation



- 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

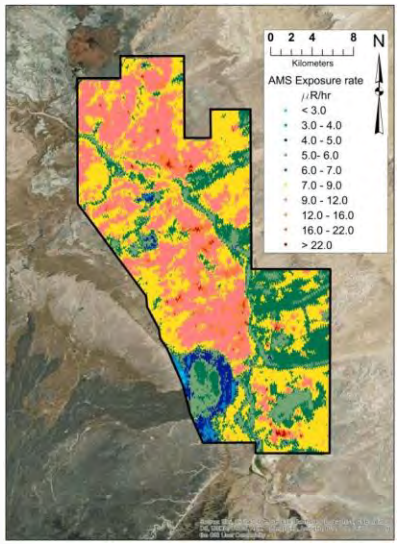


SDRD

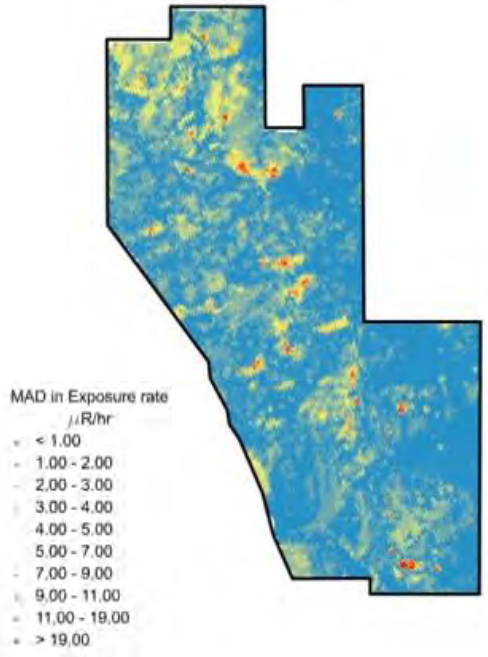
γ-ray Background Radiation

AMS flight data

Cameron, AZ



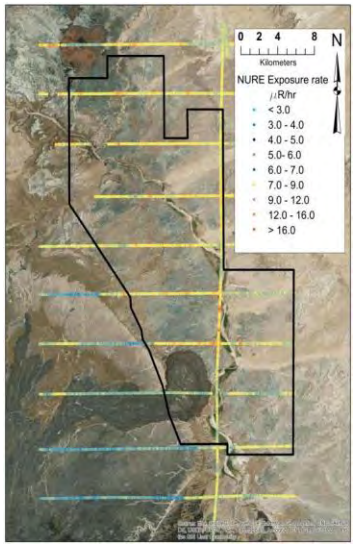
Difference between AMS data and model



(Adcock et al. 2019)

Highlights Uranium mines

Model based on ASTER data, NURE survey & geologic map



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

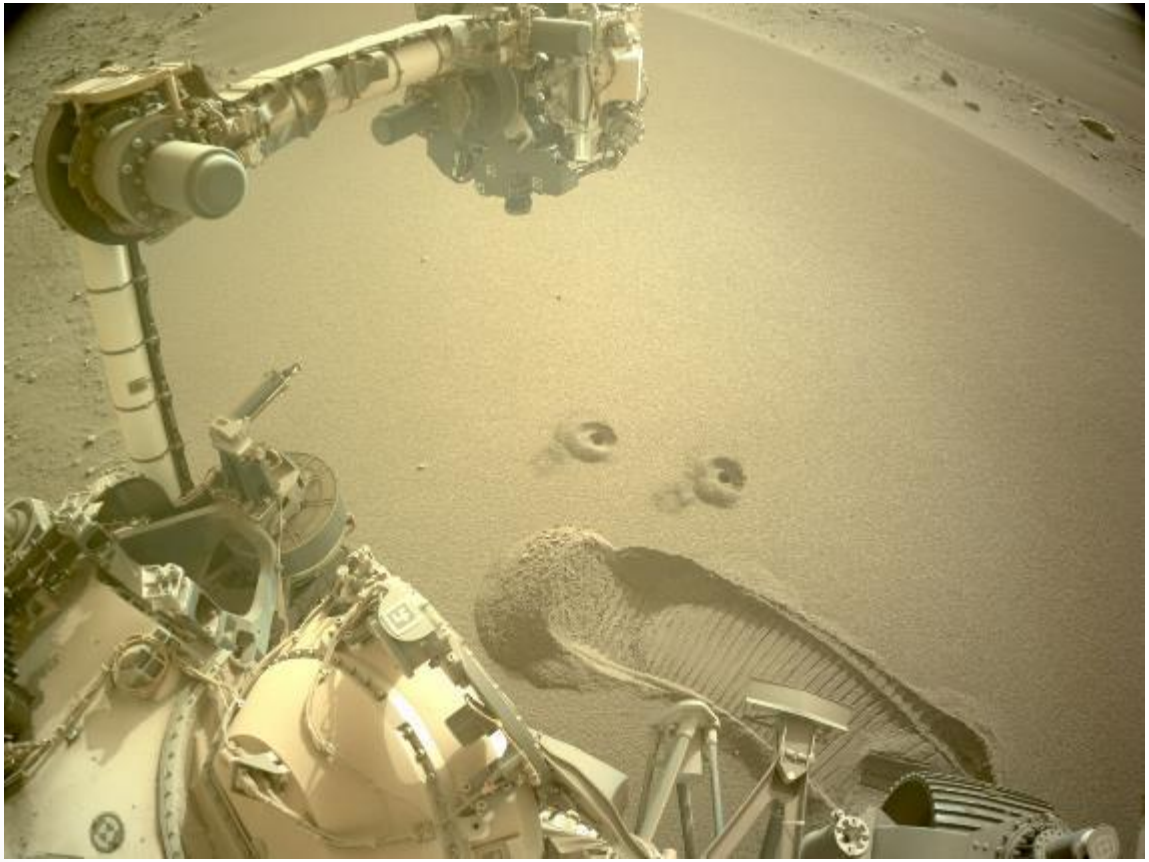

Image credit: NASA/JPL-Caltech

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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Sedimentary Geology

Dr. Ganqing Jiang
Professor
Department of Geoscience
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Email: Ganqing.Jiang@unlv.edu

Expertise:
Sequence and chemostratigraphy
sedimentology
Carbonate diagenesis

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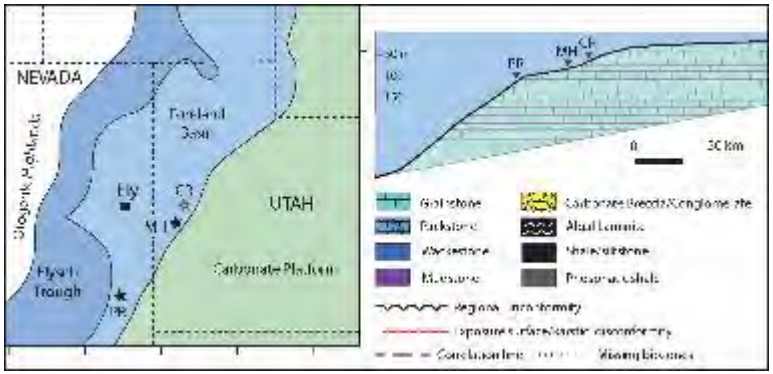
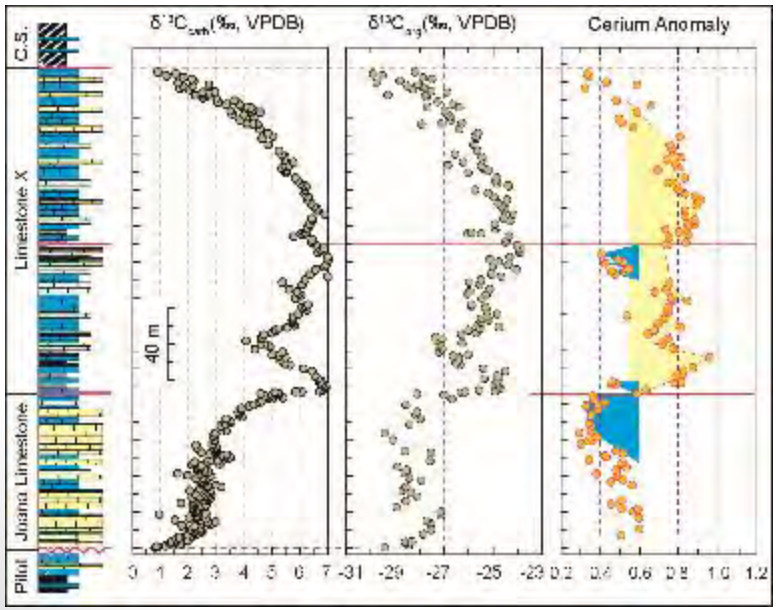
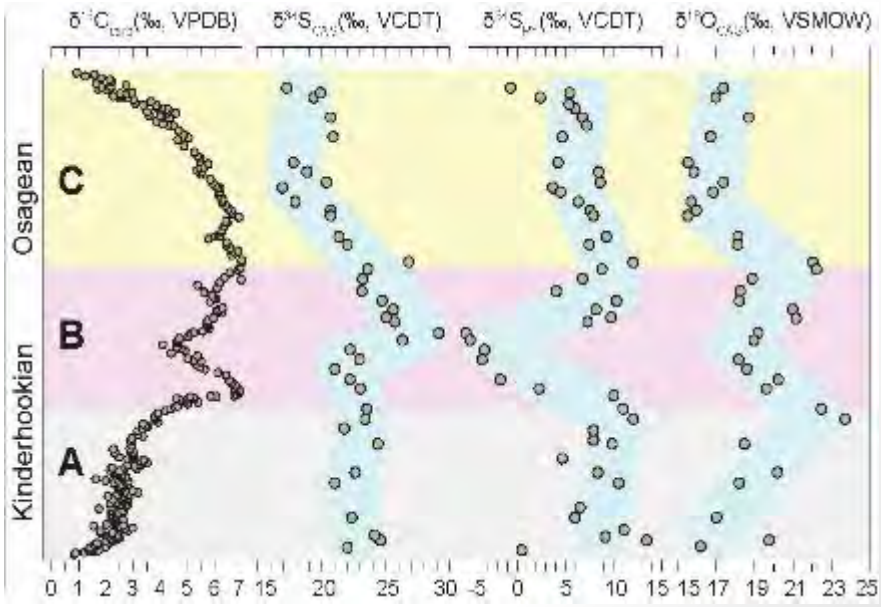
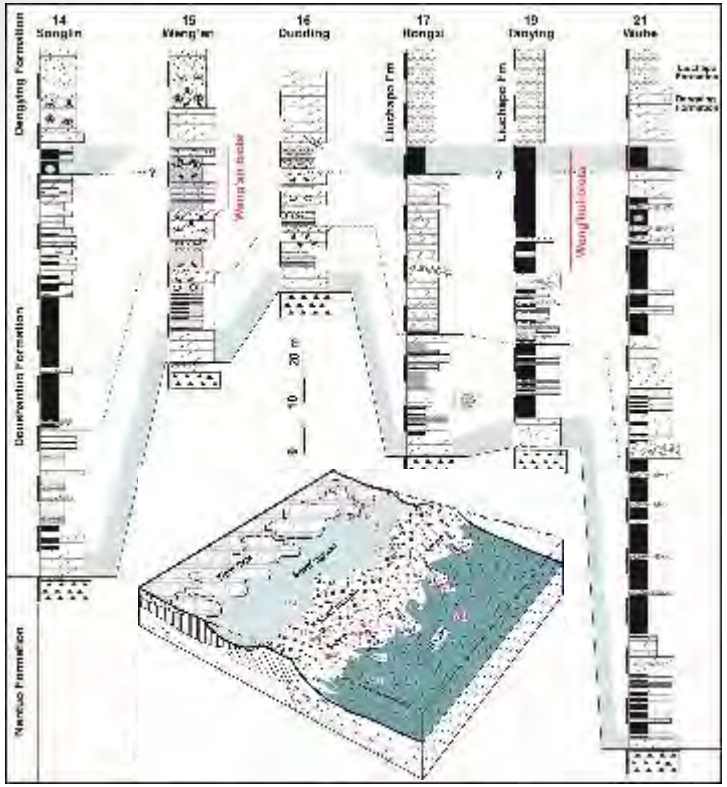
- Sequence and chemostratigraphy
- Paleogeographic reconstruction
- Applications of stable isotopes and rare earth elements
- Paleoenvironmental change across major perturbations of the carbon cycle and mass extinctions

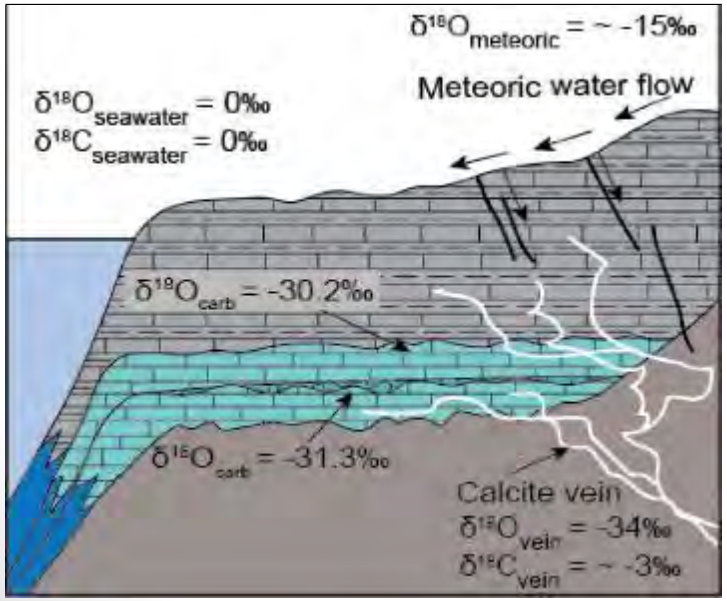








- **Basin analyses and paleoceanography**
- **Fluid migration and carbonate diagenesis**
- **Tracing fluid migration in sedimentary basins using stable isotopes and trace elements**
- **Carbonate aquifer**



Hydrology

- **Dr. David K. Kreamer**
- **Professor**
- **Department of Geoscience**
- **Email: dave.kreamer@unlv.edu**
- **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**

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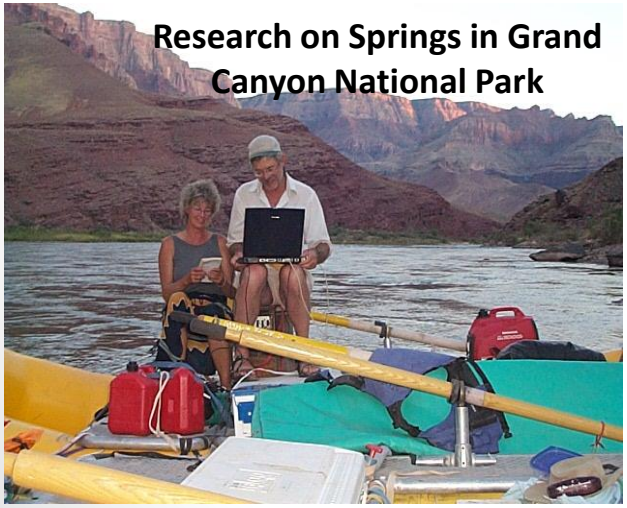
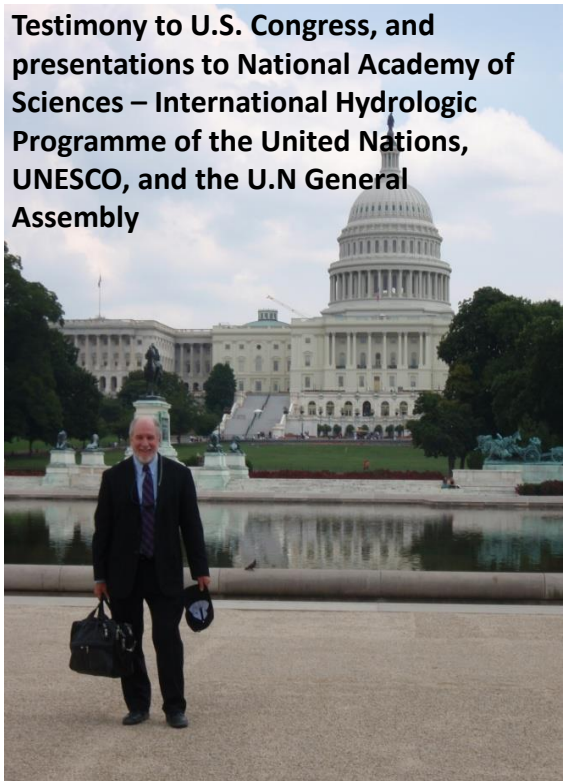
David K. Kreamer – Examples of Research and Service Interests





Groundwater Modeling Training, Niger, Africa

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Climate Science and Paleoclimatology

Matthew S. Lachniet

Professor

Department of Geoscience

Phone 702-895-4388

Matthew.Lachniet@unlv.edu

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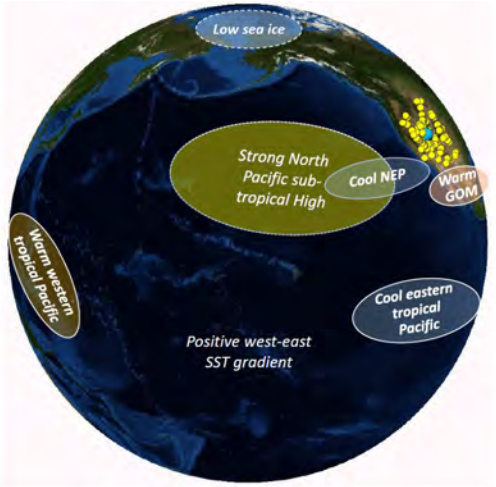
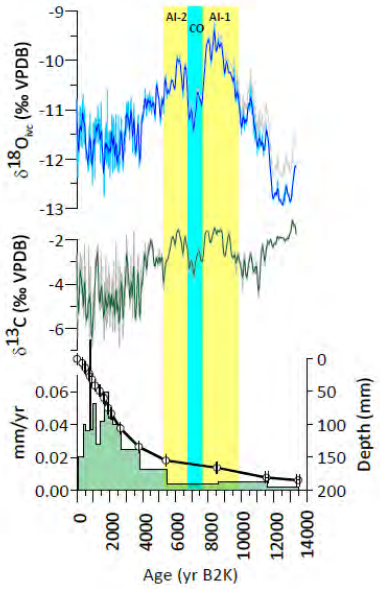
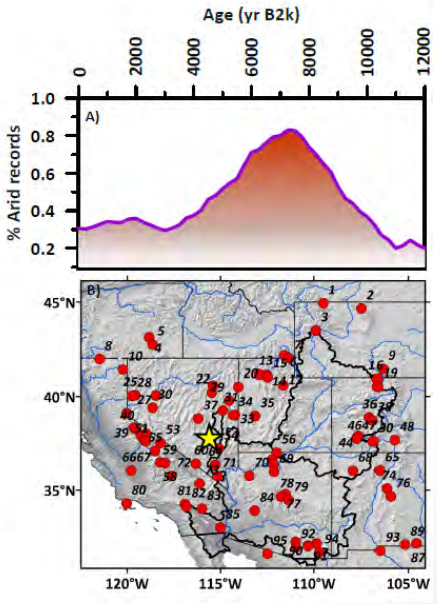
Paleoclimatology

- 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







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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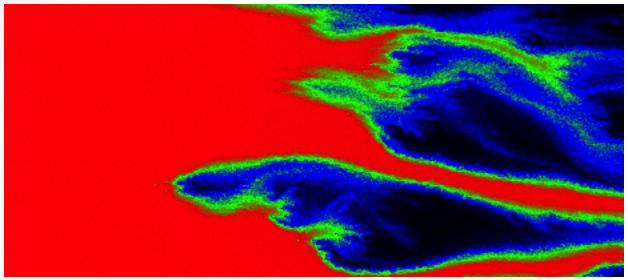
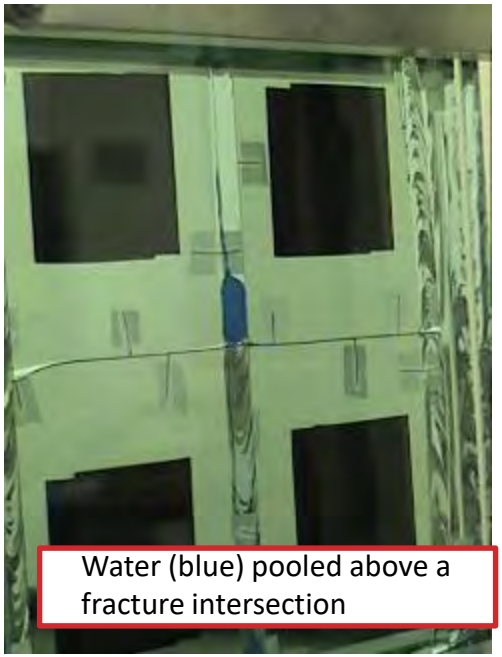
Fractured Rock Hydrology



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



Water (blue) pooled above a fracture intersection

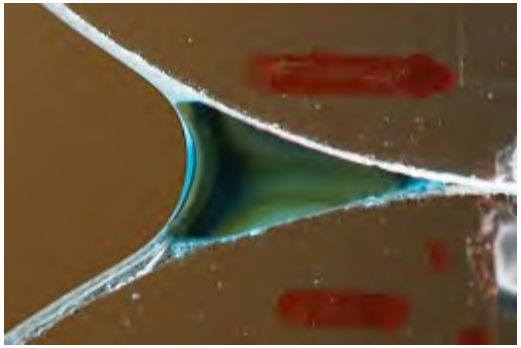
Field mapping of fracture networks
blue dye (right foreground) is from an infiltration test

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

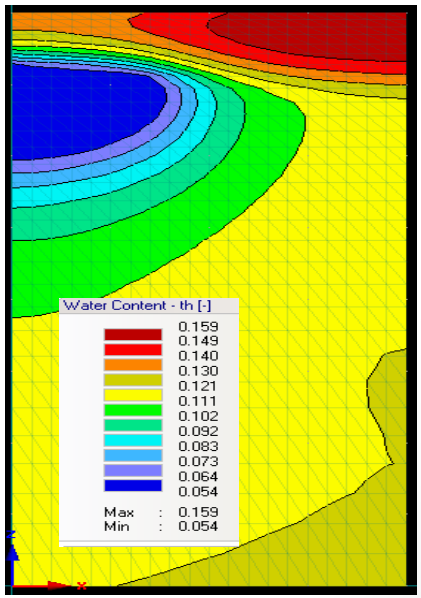
Seepage through gravel-sized capillary barrier materials



Millimeter-scale transport experiment

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

Research Oliver Tschauner

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

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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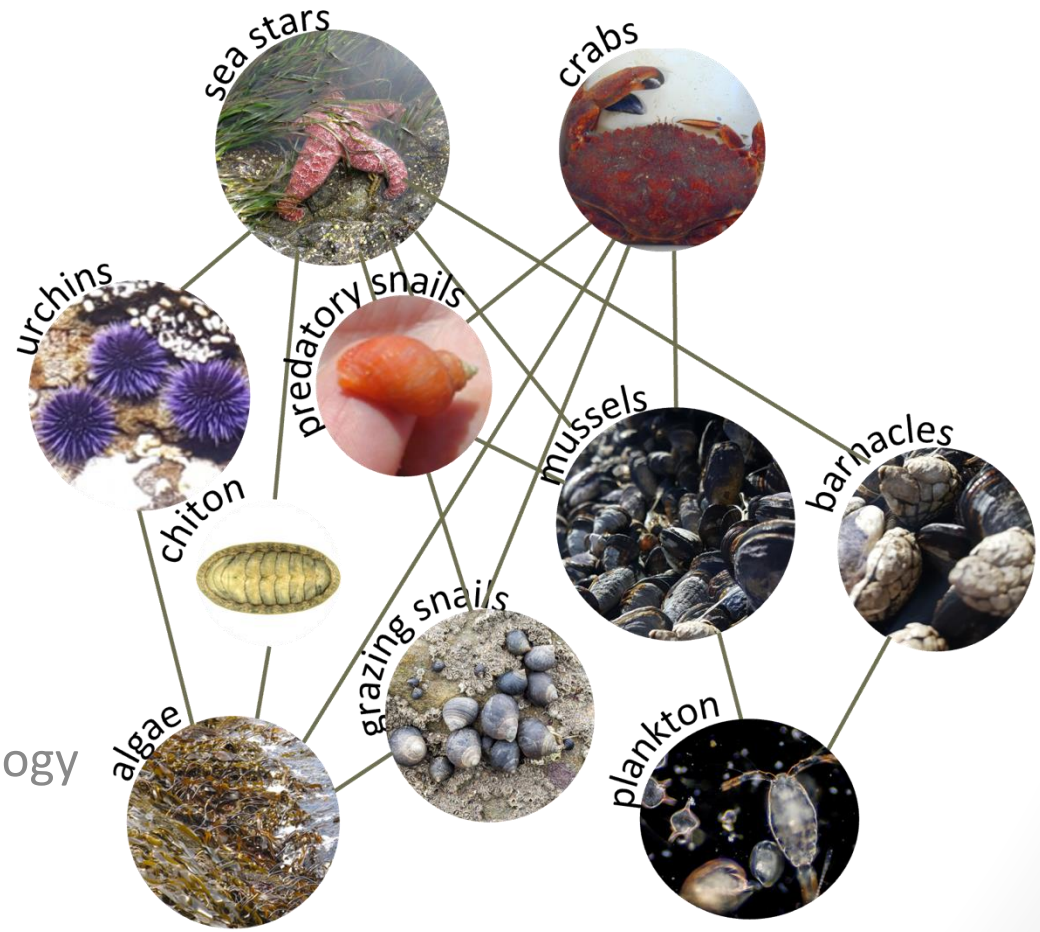
- Website: www.carrietyler.com

Expertise

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



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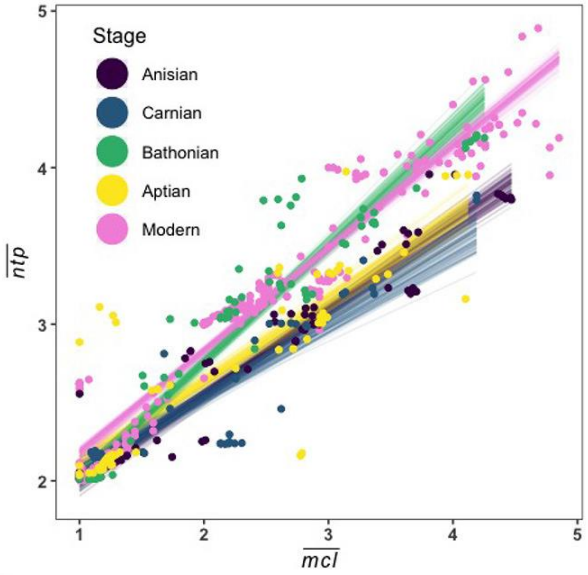


Marine food web structure from the Bathonian Stage (168 mya) resembles a modern Jamaican reef, but not the ecosystem before or after it.

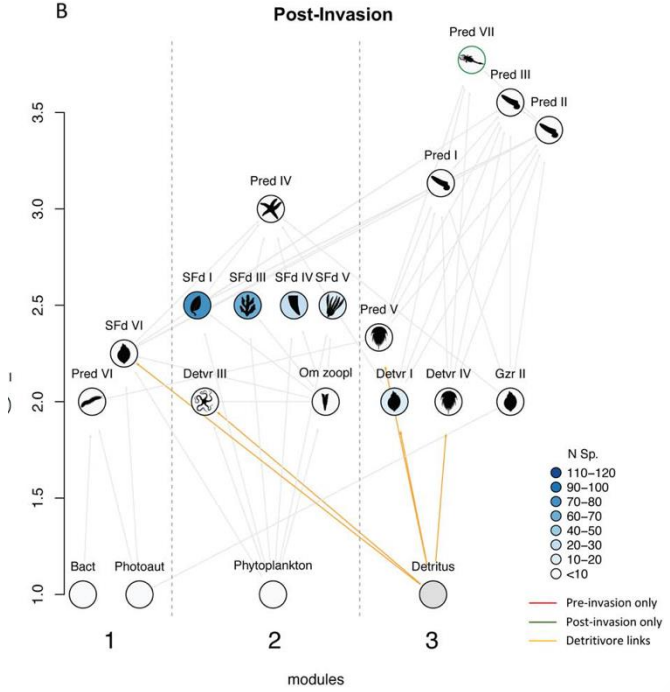
A better understanding of trophic position is needed for restoration planning, as communities may be so severely altered that restoring species or interactions may no longer be possible.

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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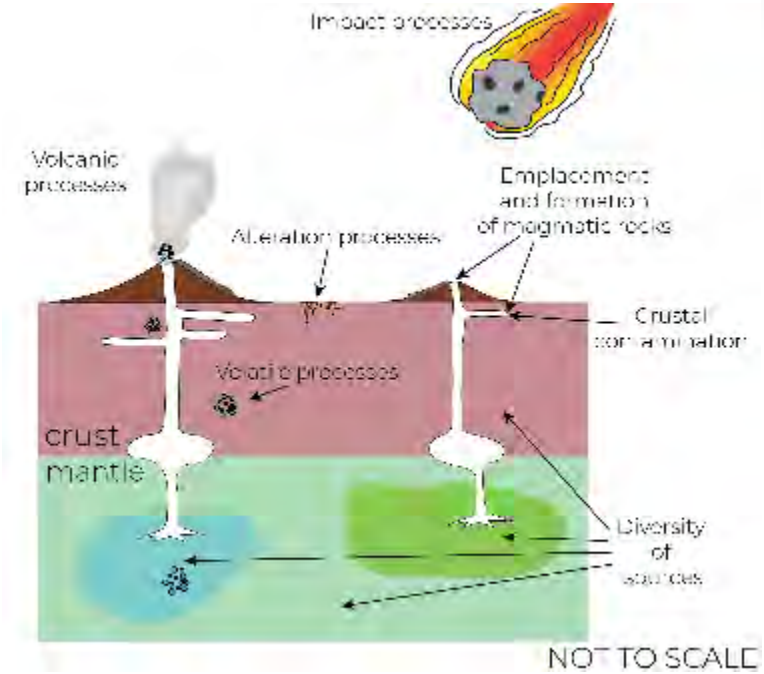
Martian geologic evolution using meteorites

Polarized thin section image of nakhlite meteorite MIL 090030



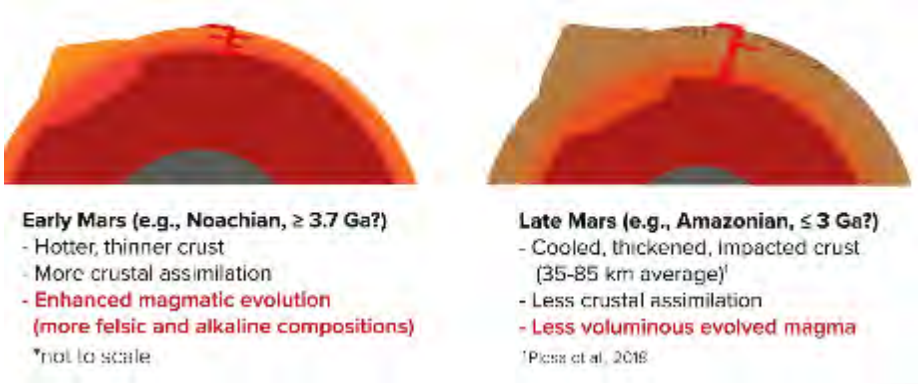
Processes that can be understood using meteorites (Udry et al. 2020)

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