From Atom to Universe

Planets: Earth, Mars, & Beyond Research

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Planetary Science

Dr. Christopher Adcock
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Department of Geoscience
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Expertise:
Planetary Surface Processes | Extraterrestrial Habitability

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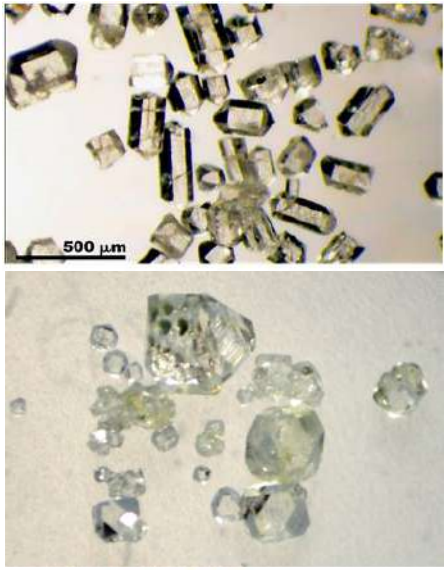
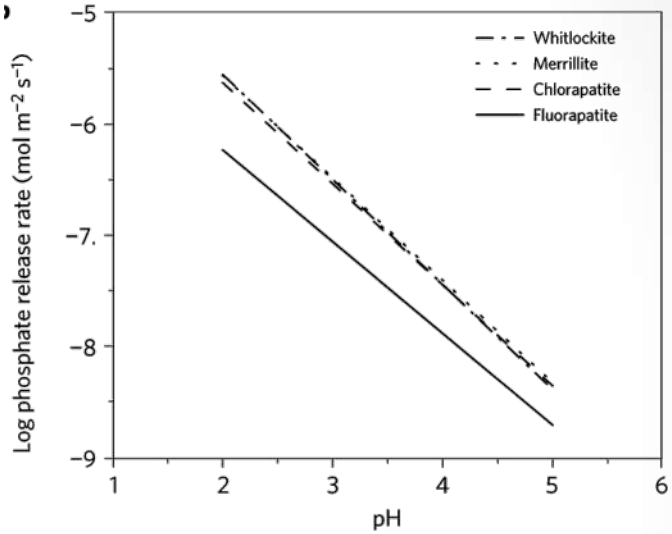
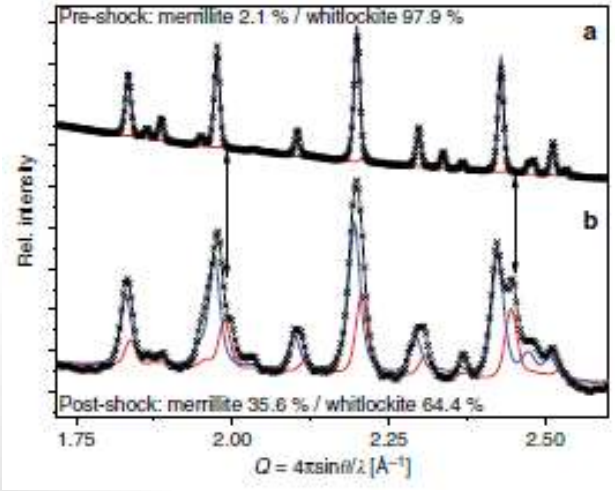
Planetary Surface Processes / Low Temperature Geochemistry: Mars



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.

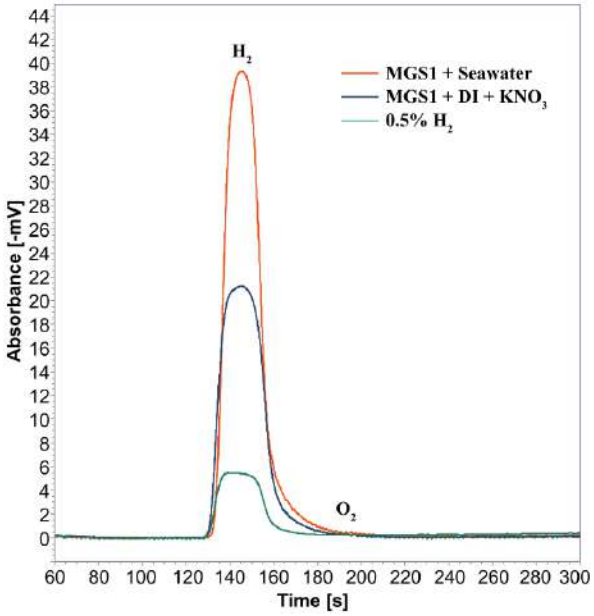


Above: Empirical Dissolution rates of terrestrial (fluorapatite / whitlockite) and more Mars-relevant phosphate minerals (chlorapatite and merrillite). 25 °C , variable pH. Higher rates mean potentially higher phosphate availability in past Martian environments – with positive implications for past life.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

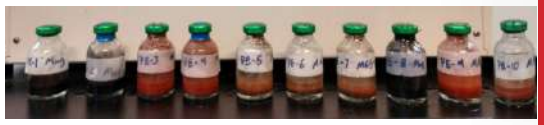


Left: Shock induced metamorphism of whitlockite (a) to merrillite/whitlockite mix (b). Shock removes the water from whitlockite to make merrillite. Since all of our current samples of Mars come from shocked meteorites, this has implications for the past hydrologic cycle of Mars. *Adcock et al., (2017)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

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

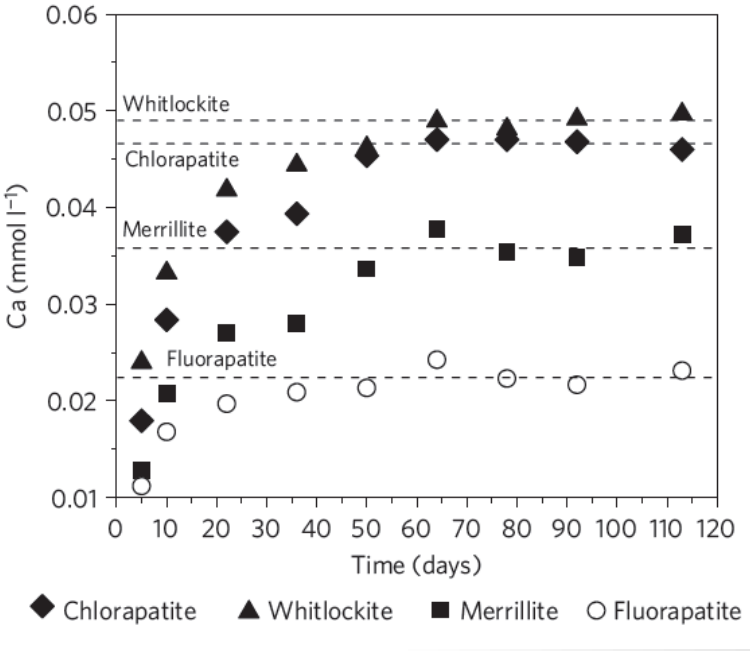


Left: Results of low temperature hydrogen generation experiments using Martian soil simulants. These experiments show it is possible to use Martian materials and a low energy system to generate H_2 for fuel, energy, or water for future human missions to Mars. *Adcock et al., (2020), 51st LPSC.*



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

Right: Solubility of terrestrial and more Mars-relevant minerals. Along with dissolution rates, the increased solutbility of hthe 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.*



Astrobiology and Geomicrobiology

Dr. Elisabeth Hausrath
Associate Professor
Department of Geoscience
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Email: Elisabeth.Hausrath@unlv.edu

Expertise

- Geomicrobiology
- Biological impacts on water-rock interactions
- Astrobiology

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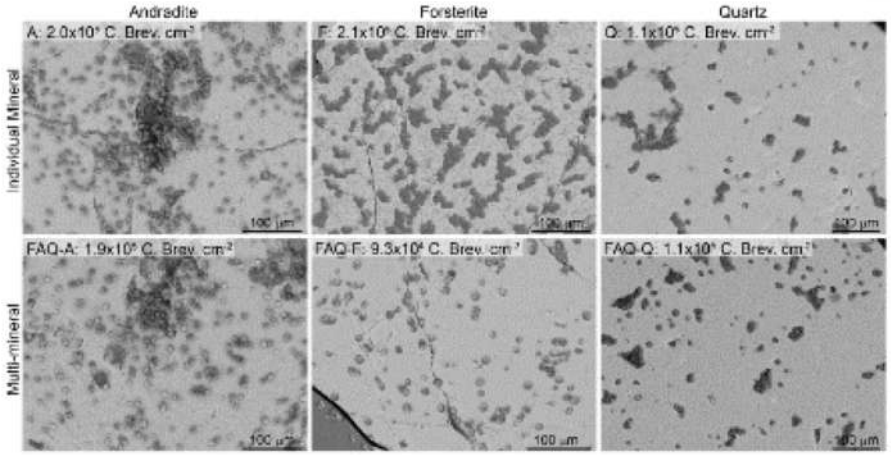
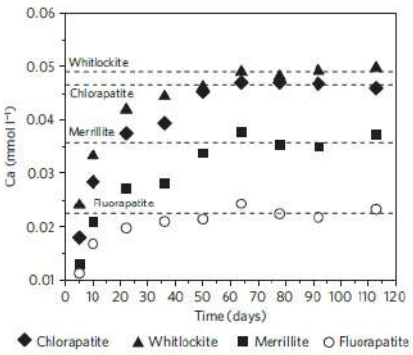
Biological Impacts on water-rock interactions

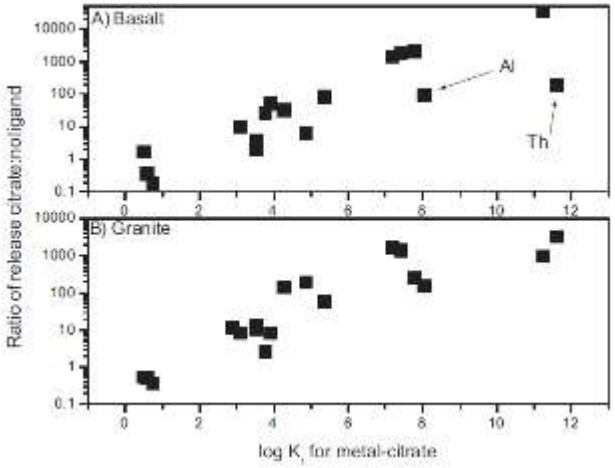
Field studies (e.g. Baumeister et al., 2014)



Laboratory studies (e.g. Phillips-Lander et al., 2020)



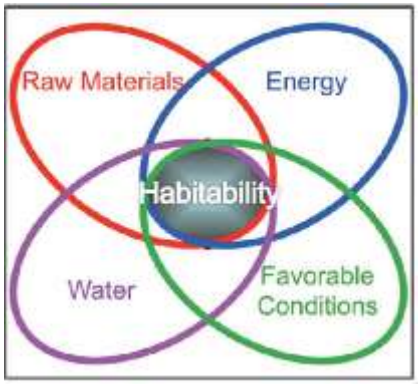
Nutrient release (e.g. Adcock et al.., 2013)



Signatures of biological alteration (e.g. Hausrath et al., 2009)

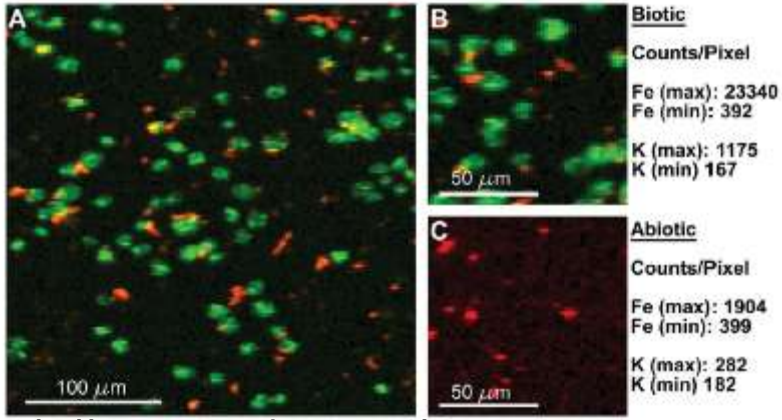
Astrobiology

Habitability



Hays et al., 2017

Potential biosignatures



Phillips-Lander et al., 2020

Mars 2020 and Mars Sample Return

NASA.gov

High Temperature Geochemistry

Dr. Shichun Huang
Department of Geoscience
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Expertise:

Chemistry of earth's mantle and early solar systems

Non-traditional stable isotopes

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UNLV Inductively Coupled Plasma Mass Spectrometer (ICP-MS) lab

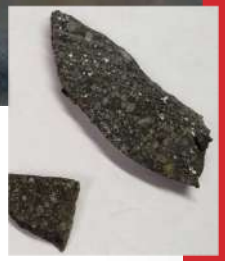
iCAP Qc ICP-MS from ThermoFisher (installed in 2015)

Multi-Collector ICP-MS (to be installed in 2021, funded by NSF MRI)

193 nm excimer laser ablation system (to be installed in 2020, funded by NASA PME)

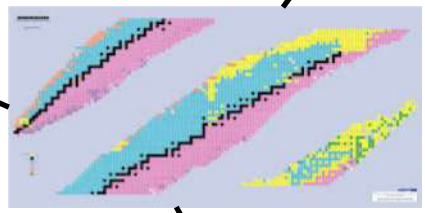
wet chemistry lab under positive air pressure

- ❑ elemental and isotopic measurements for almost all non-volatile elements
- ❑ solution mode: detection limits at **10s of ppq (10^{-15}) level** for lanthanides and **actinides**
- ❑ in situ measurement: spatial resolution at **< 5 micron**



chondrite

peridotite



diamond inclusion

lunar rock

HT Tauri by ALMA

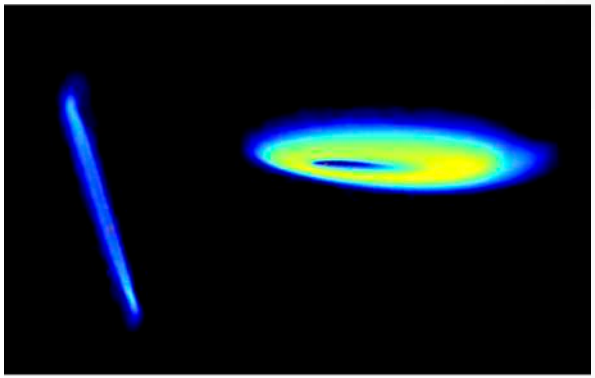
- I use elemental and isotopic tracers to study the solid Earth and the early solar systems
- applied science: trace metals in local aqua systems; Cr remediation

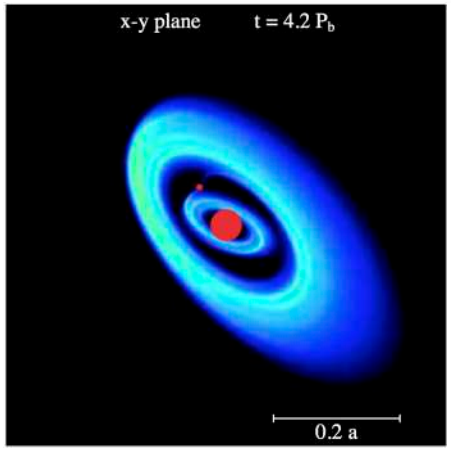
Rebecca Martin

- Assistant Professor of Astronomy, Department of Physics and Astronomy
- Ph.D., BPB 233, Rebecca.Martin@unlv.edu
- http:/www.physics.unlv.edu/~rgmartin/Rebecca_G._Martin.html

Areas of Expertise

- Star and plant formation
- Astrophysical Fluids
- Binary Star Systems
- Planetary System Dynamics





Research Summary:

- My research deals with highly topical questions in astrophysics, such as how star and planetary systems form. I use analytic and numerical methods to study the theory of accretion disc dynamics, few body dynamics and planet-disc interactions.

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Geomicrobiology

Dr. Aude Picard

Assistant Research Professor

School of Life Sciences

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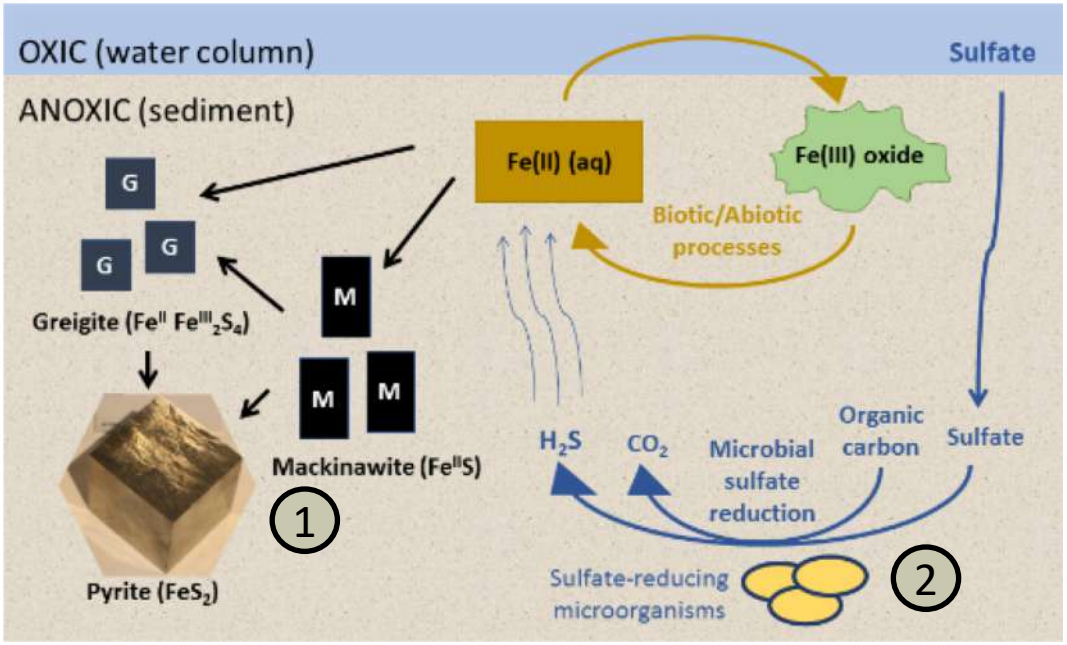
Expertise

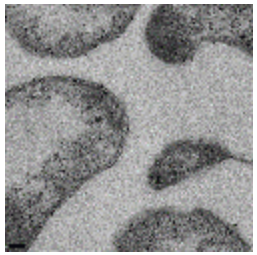
- Anaerobic microbiology
- Biomineralization
- Astrobiology and biosignatures
- Microscopy & spectroscopy

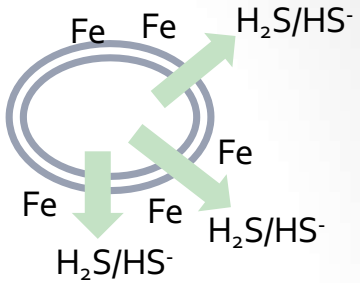
Biogeochemistry of Fe, S and C in anoxic environments

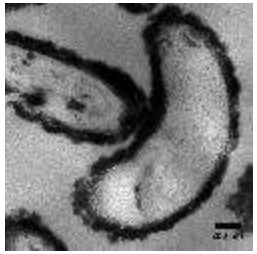
Iron sulfide mineral formation in anoxic environments



2 Microbe-mineral interactions in anoxic environments



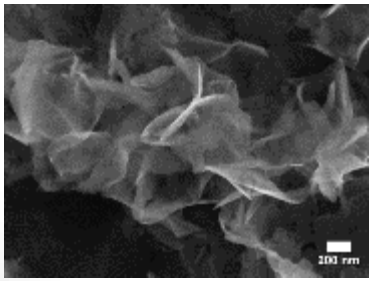




Bacteria become encrusted in Fe-rich environments

- Do minerals play a role in the physiology of bacteria?
- How do bacteria cope with mineral encrustation?

1 Properties of biominerals



Minerals produced with microorganisms have unique physical and chemical properties

- What is the reactivity of biominerals?
- What are the applications of biominerals?

3 Can we use biominerals for the search of life on Mars?

Credits: NASA/JPL-Caltech/MSSS

- Are properties of biominerals unique enough to record life in anoxic environments?

Extrasolar Planets

Dr. Jason Steffen
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Expertise:

- Data Analysis
- Computer Modeling

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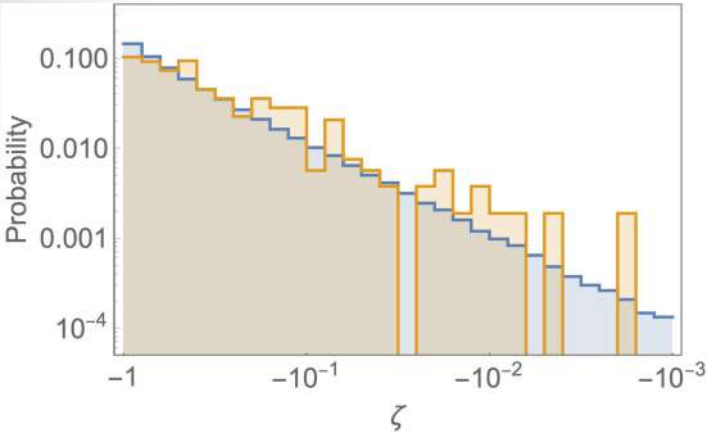
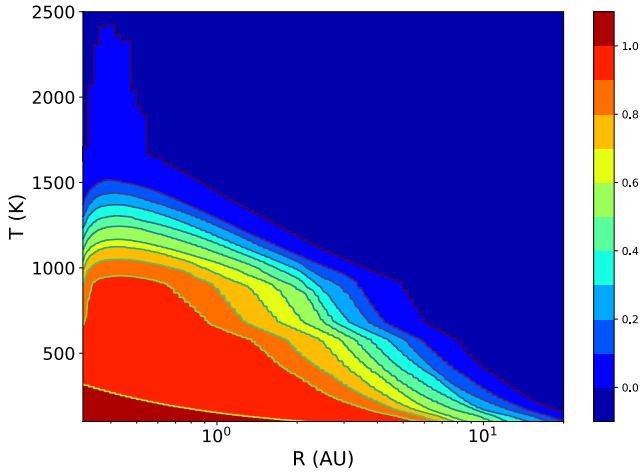
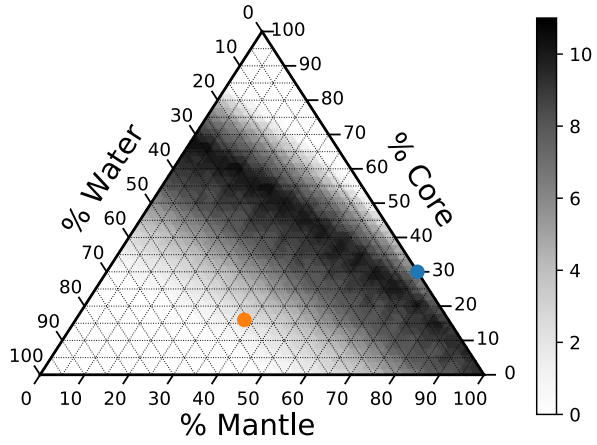
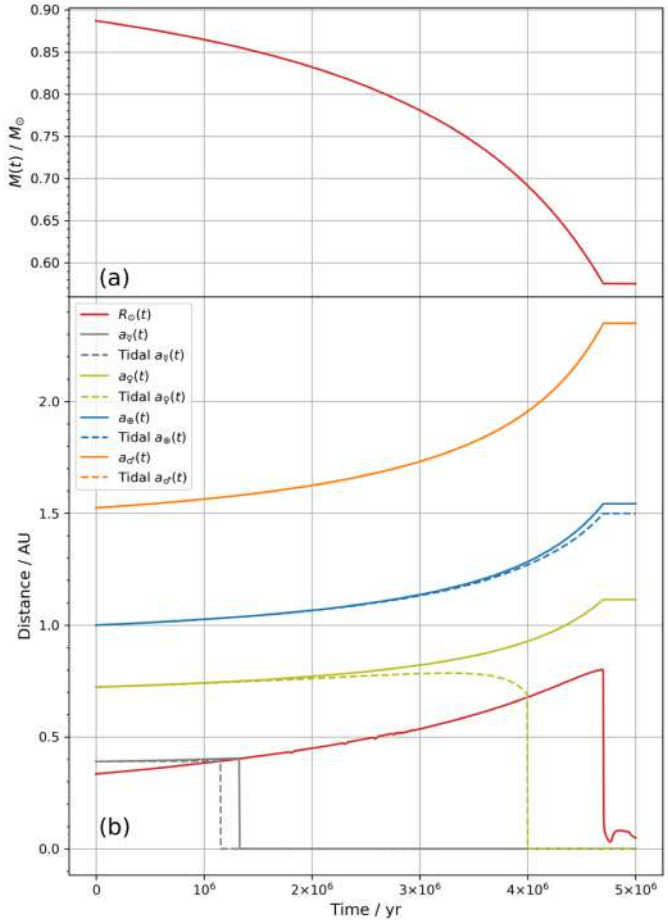
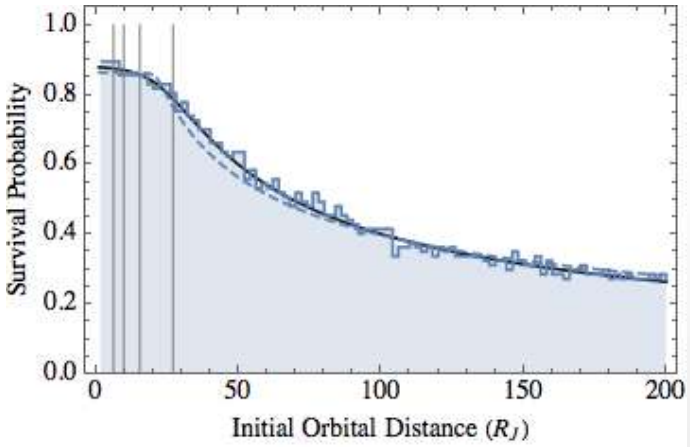

Probability
0.100
0.010
0.001
10^{-4}
−1
-10^{-1}
-10^{-2}
-10^{-3}
ζ


T (K)
2500
2000
1500
1000
500
10^{0}
10^{1}
R (AU)
1.0
0.8
0.6
0.4
0.2
0.0


% Water
% Core
% Mantle
0
10
20
30
40
50
60
70
80
90
100
10
8
6
4
2
0


$M(t)$ / $M_\odot$
0.90
0.85
0.80
0.75
0.70
0.65
0.60
(a)
$R_\odot(t)$
$a_\varphi(t)$
Tidal $a_\varphi(t)$
$a_\varphi(t)$
Tidal $a_\varphi(t)$
$a_\oplus(t)$
Tidal $a_\oplus(t)$
$a_\sigma(t)$
Tidal $a_\sigma(t)$
Distance / AU
2.0
1.5
1.0
0.5
0.0
(b)
0
10^6
2×10^6
3×10^6
4×10^6
5×10^6
Time / yr


Survival Probability
1.0
0.8
0.6
0.4
0.2
0.0
0
50
100
150
200
Initial Orbital Distance (R_J)

Planetary Petrology

Dr. Arya Udry
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Expertise:

- Meteorite petrology
- Martian igneous geology

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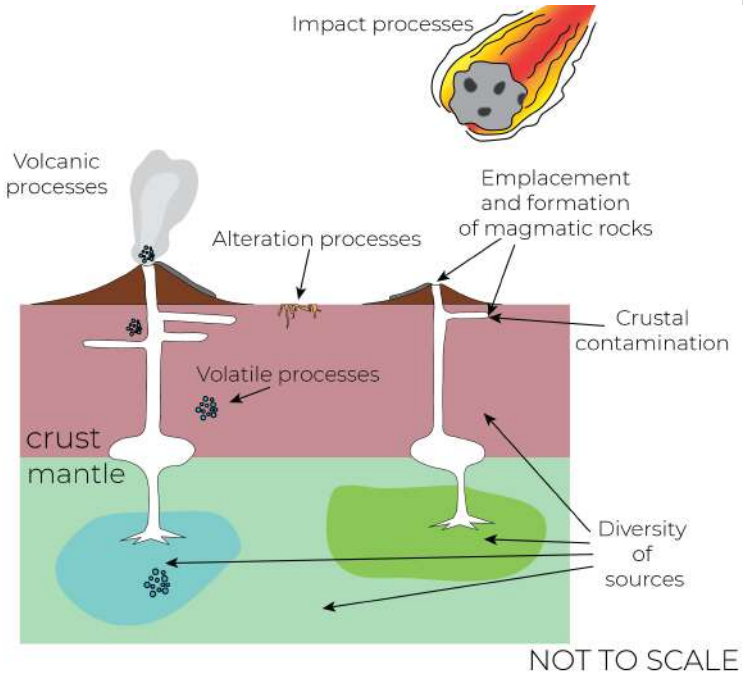
Martian geologic evolution using meteorites

Polarized thin section image of nakhlite meteorite MIL 090030



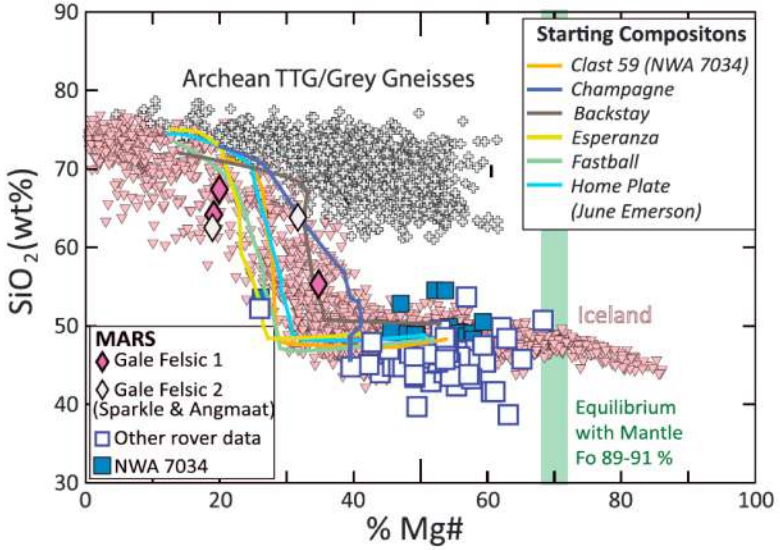
Processes that can be understood using meteorites (Udry et al. 2020)

193 nm Excimer laser ablation system –
To be installed in 2020 to analyze in situ 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

MSL rover on Gale crater – JPL/NASA image



Models of magma composition evolution for SiO_2 versus Mg/Mg+Fe compared to Gale crater felsic (i.e., Si-rich) rocks (Udry et al. 2018)

- Thermodynanmical modeling to understand formation of unique compositions of martian surface

Astrophysical Fluid Dynamics

Dr. Zhaohuan Zhu

Department of Physics and Astronomy

Phone: (702) 895- 3563

Email: zhaohuan.zhu@unlv.edu

Expertise:

- Fluid dynamics for astronomical project
- Star and planet formation

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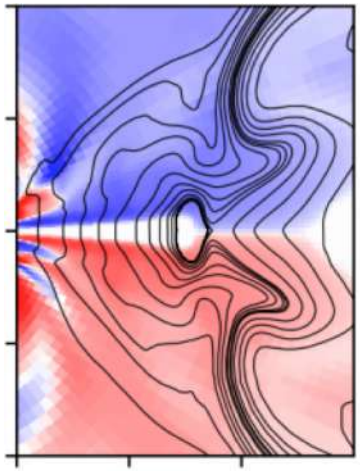
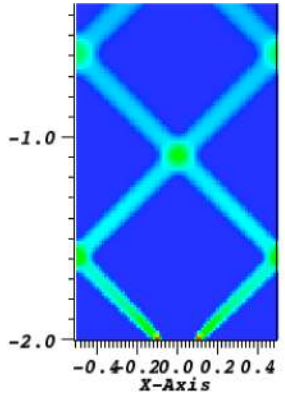
Fluid dynamics:

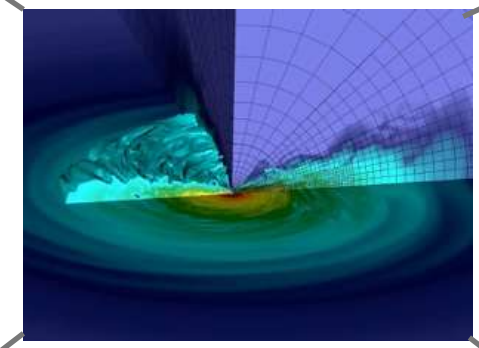
- Developing and using the state of the art numerical code to solve astrophysical fluid problem.

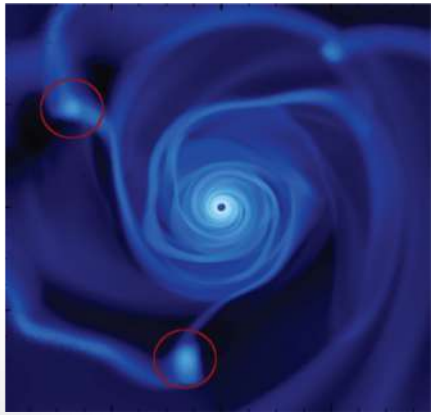


Magnetic field

Radiation

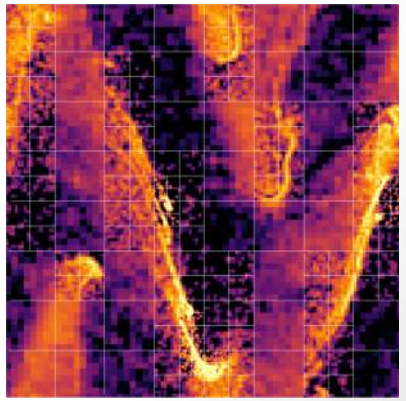






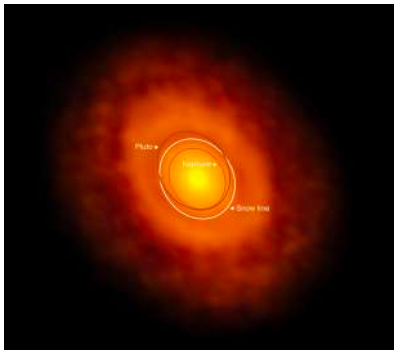
gravity

particles



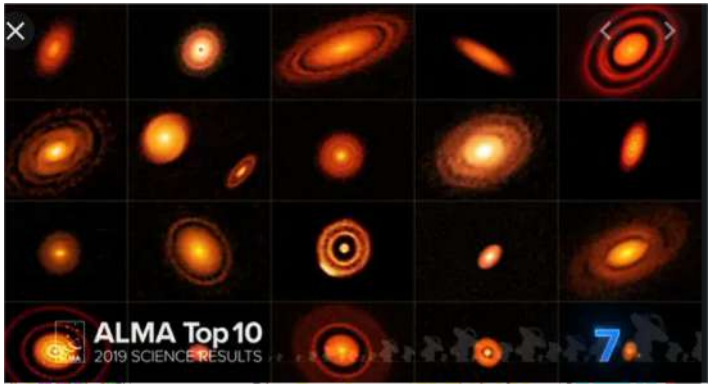
Star and planet formation:

- Protoplanetary disk dynamics:



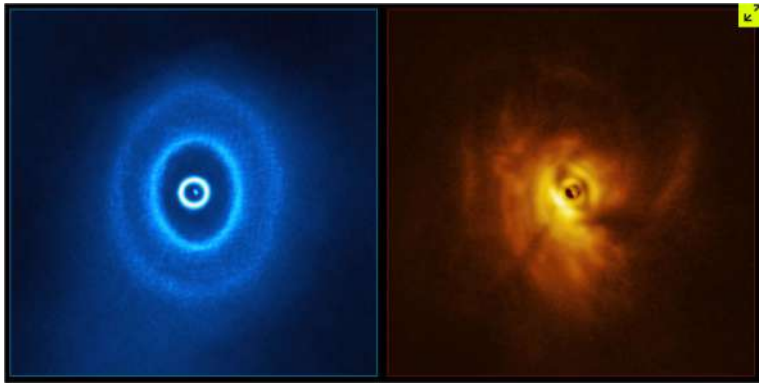
V883 Ori, *Nature*

- Planet formation



DSHARP

- Planet-disk interaction



GW Ori, *Science*