



# Martian Rocks - A New Pedagogical Approach to Closing Achievement Gaps in Underrepresented Minority Classrooms.

Dr. Strawser

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FEEC-STEM Workshop 2022 – Room 316A, 2:20-3:10 pm

# Presenter

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# During this workshop, you'll skills, confidence, AND lessons to:

- Discover new problem-based learning experiences, using NASA Martian rocks and remote access through the nanoHUN and On-line Spectrometry community hubs.
- Learn how to tailor the problem-based experiences to Next Generation Science Standards (NGSS).
- Explore learning experiences and insights into using advanced research tools in their classrooms.

## What the Research suggests:

“Despite positive and best efforts trends in high school, fewer minorities [including women] enter college intending to major in a STEM field.”

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Glasson, G. E. (2020)

# Connecting Content, Community, and Careers

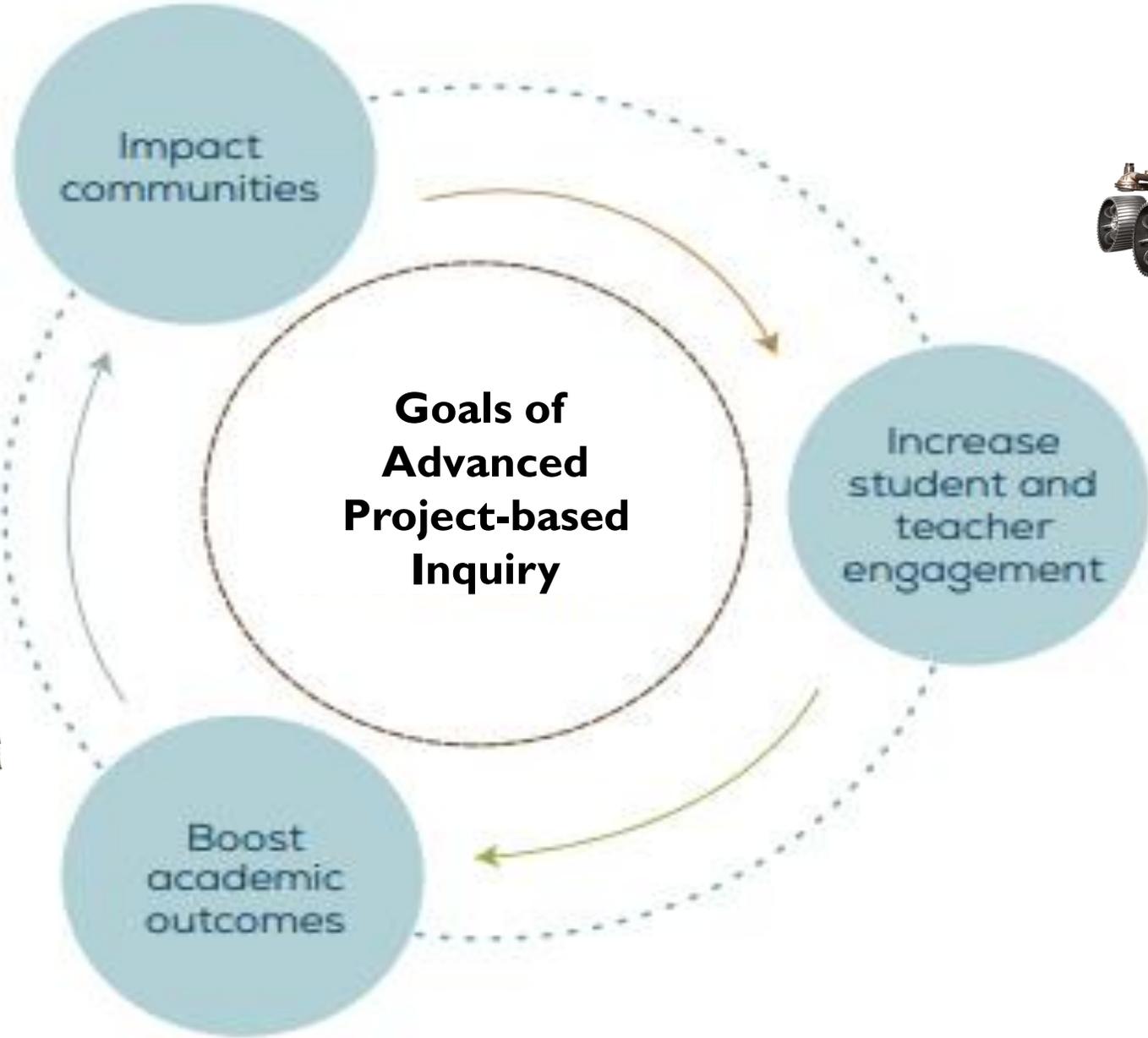
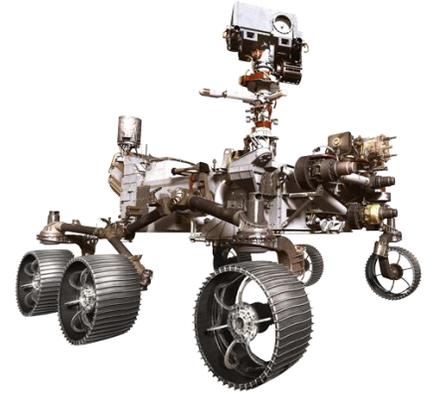
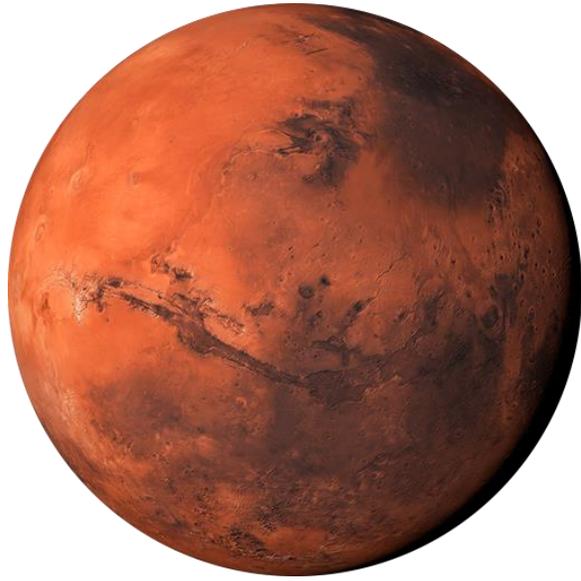
“Advanced Project-Based inquiry is the marriage of engagement and authenticity. – real problems, real tools, and real solutions”

Strawser, C L. (2021)

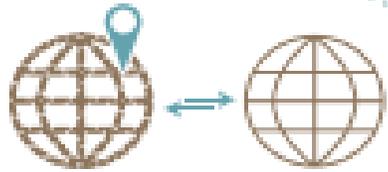
# Emerging Thought from Research

strategies, paradigms, theories, and experiences

- Understanding *place* is becoming increasingly important in our rapidly-changing and interconnected world.
- The goals and practices of both place-based learning and STEM education *complement* each other.
- Place-Based Learning helps connect local communities, schools, and place in ways that produce more *engaged, thoughtful learners*.



Advanced  
Project-Based  
Inquiry



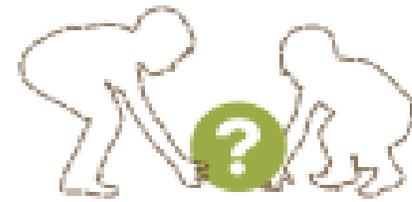
**LOCAL TO  
GLOBAL CONTEXT**

Local learning serves as a model for understanding global challenges, opportunities and connections.



**LEARNER-CENTERED**

Learning is personally relevant to students and enables student agency.



**INQUIRY-BASED**

Learning is grounded in observing, asking relevant questions, making predictions, and collecting data to understand the economic, ecological, and socio-political world.



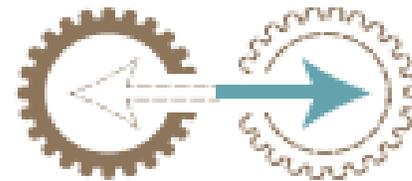
**DESIGN  
THINKING**

Design thinking provides a systematic approach for students to make meaningful impact in communities through the curriculum.



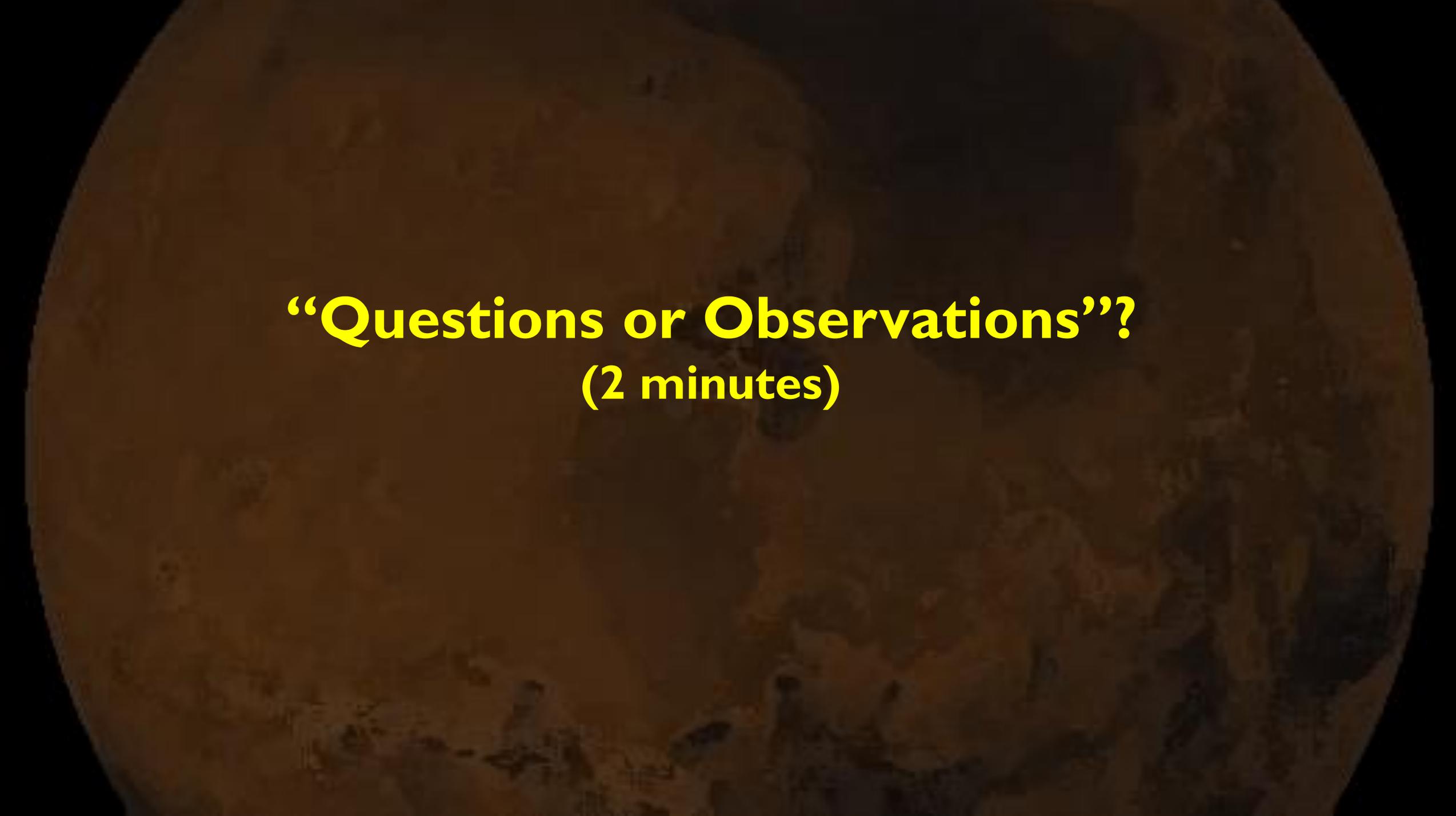
**COMMUNITY AS  
CLASSROOM**

Communities serve as learning ecosystems for schools where local and regional experts, experiences and places are part of the expanded definition of a classroom.



**INTERDISCIPLINARY  
APPROACH**

The curriculum matches the real world where the traditional subject area content, skills and dispositions are taught through an integrated, interdisciplinary and frequently project-based approach where all learners are accountable and challenged.



**“Questions or Observations”?**  
**(2 minutes)**

# Martian Geography

PHOENIX

## MARS FACTS

Mean distance from Sun: 1.524 AU (228,000,000 km/141,700,000 mi)

Diameter: 6,792 km (4,220 mi)

Length of year: 687 days

Rotation period: 24 hr 37 min

Mean orbital velocity: 24.14 km/sec (15 mi/sec)

Inclination of axis: 25.2°

Mean density: 3.95 grams/cm<sup>3</sup>

Inclination to ecliptic: 1.85°

Number of observed satellites: 2

## Comparisons with Earth

Average distance from Sun: 1.52 x Earth

Diameter: 0.532 x Earth

Mass: 0.108 x Earth

Density: 0.7 x Earth

VIKING 1

PATHFINDER

OPPORTUNITY

Eagle Crater

VIKING 2

PERSEVERANCE

Jezero Crater

INSIGHT

CURIOSITY

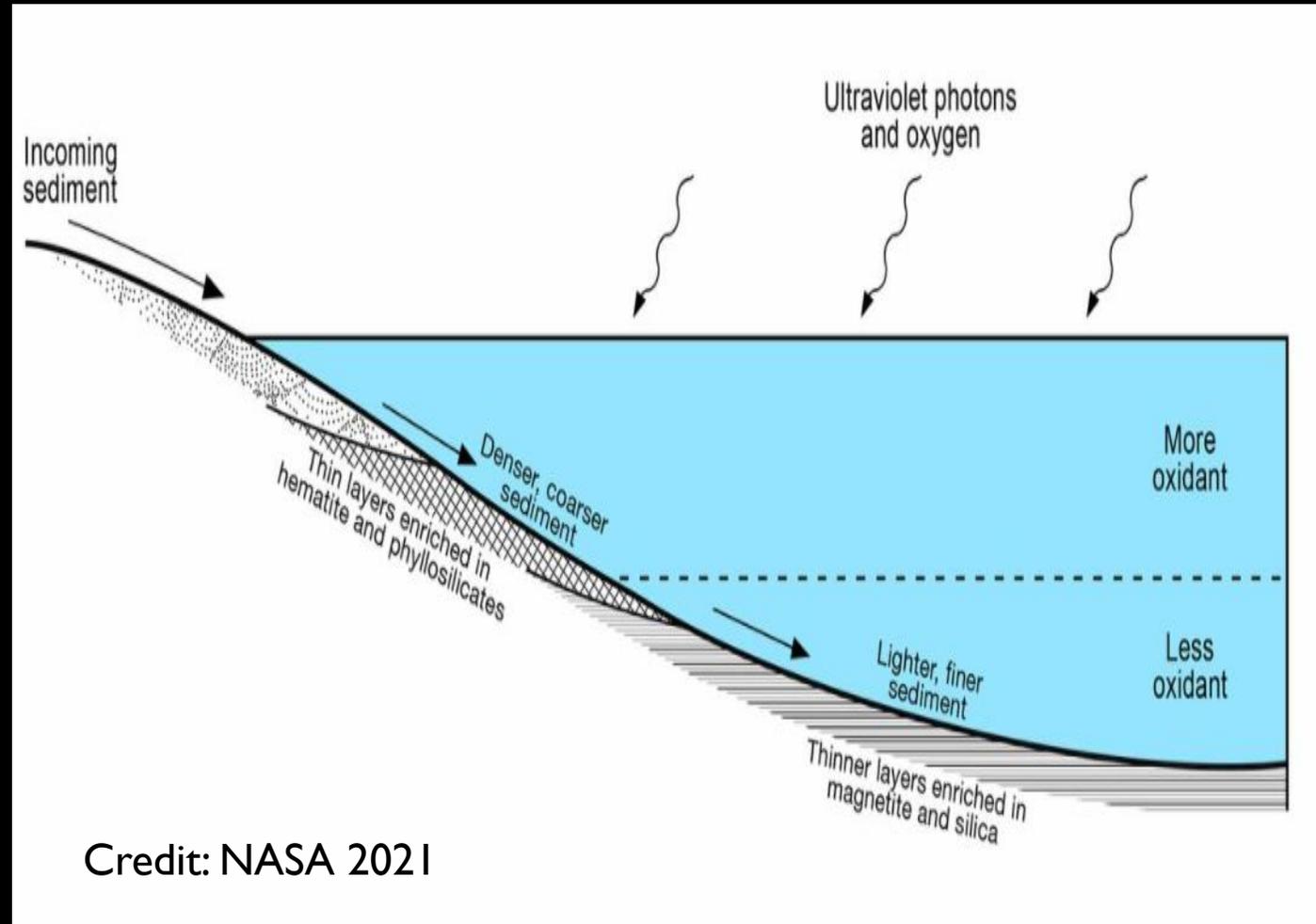
Gale Crater

SPIRIT

# A quick lesson in astrogeology

## Fast Facts:

- NASA's Curiosity Mars rover mission has provided an unprecedented level of detail about an ancient lake environment on Mars that offered favorable conditions for microbial life.
- A lake in Mars' **Gale Crater** long ago was stratified, with oxidant-rich shallows and oxidant-poor depths.
- The lake offered multiple types of microbe-friendly environments simultaneously.



# A quick lesson in astrogeology

Minerals are like a time capsule; they provide a record of what the environment was like at the time they formed. Clay minerals have water in their structure and are evidence that the soils and rocks that contain them came into contact with water at some point.

## Fast Facts:

- NASA's Curiosity Mars rover is finding patterns of change in rock composition at higher, younger layers of a mountain.
- Ancient Mars sedimentary basins with groundwater were chemically active, a factor favorable for possible life.
- Curiosity found boron on Mars, a first for this very soluble element.



Credit: NASA 2020/JPL

# NASA's Current Mars Exploration Missions

- **Geologic Exploration**
- Habitability and Biosignatures
- Prepare Returnable Artifacts
- Prepare for Human Exploration

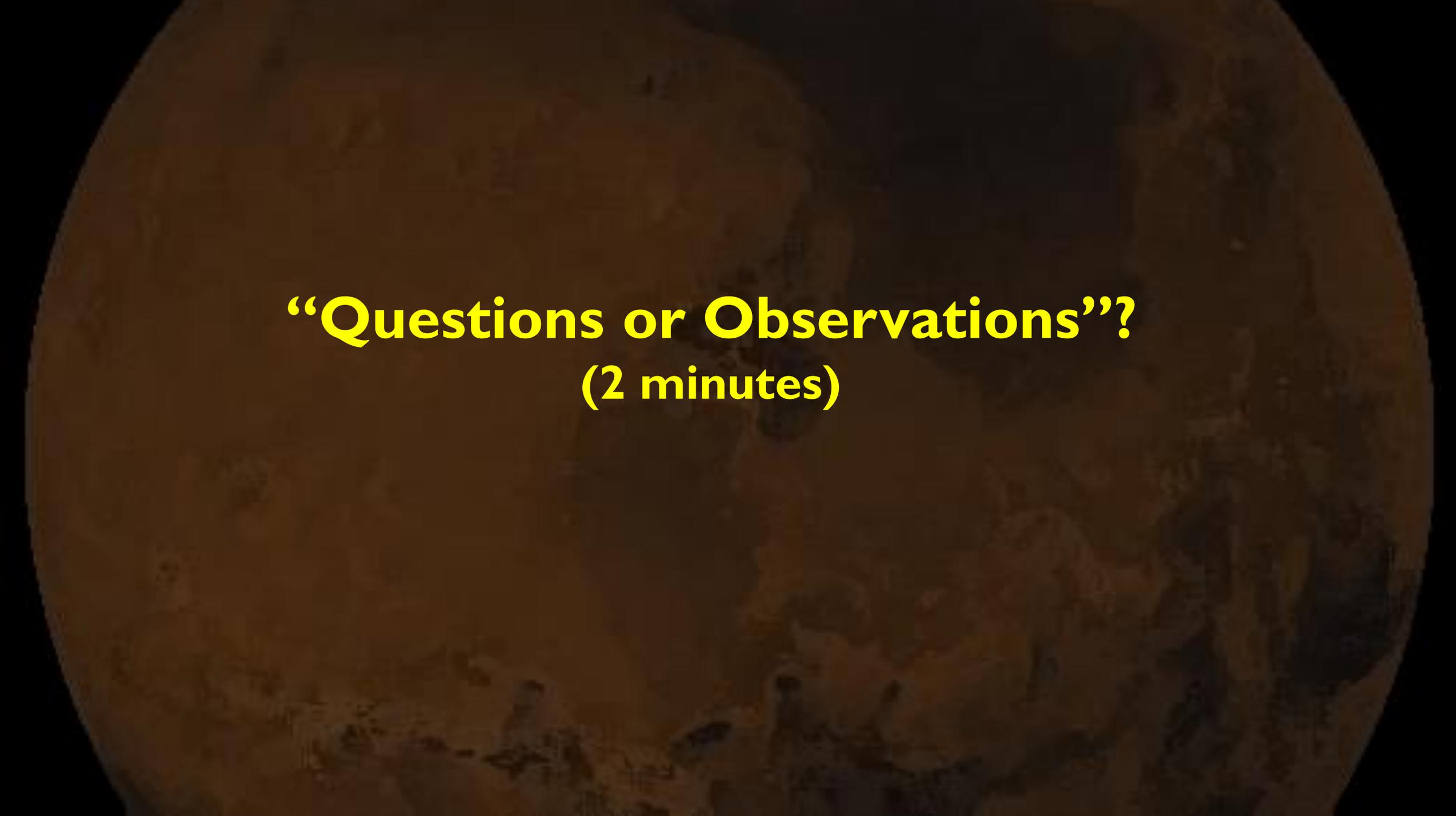


**Insight, Hope Orbiter, Perseverance, Curiosity, Ingenuity**

**Earth-based Telescopes, Space Telescopes, Orbiters, Landers, Rovers**

# A quick lesson in Science Packages

- Weather Station
- Mars Environmental Dynamics Analyzer (MEDA)
- Mars Oxygen ISRU Experiment (MOXIE)
- Planetary Instrument for X-ray Lithochemistry (PIXL)
- Radar Imager for Mars' Subsurface Experiment (RIMFAX)
- Scanning Habitable Environments with Raman & Luminescence for Organics & Chemicals (SHERLOC)
- SuperCam
- CheMin

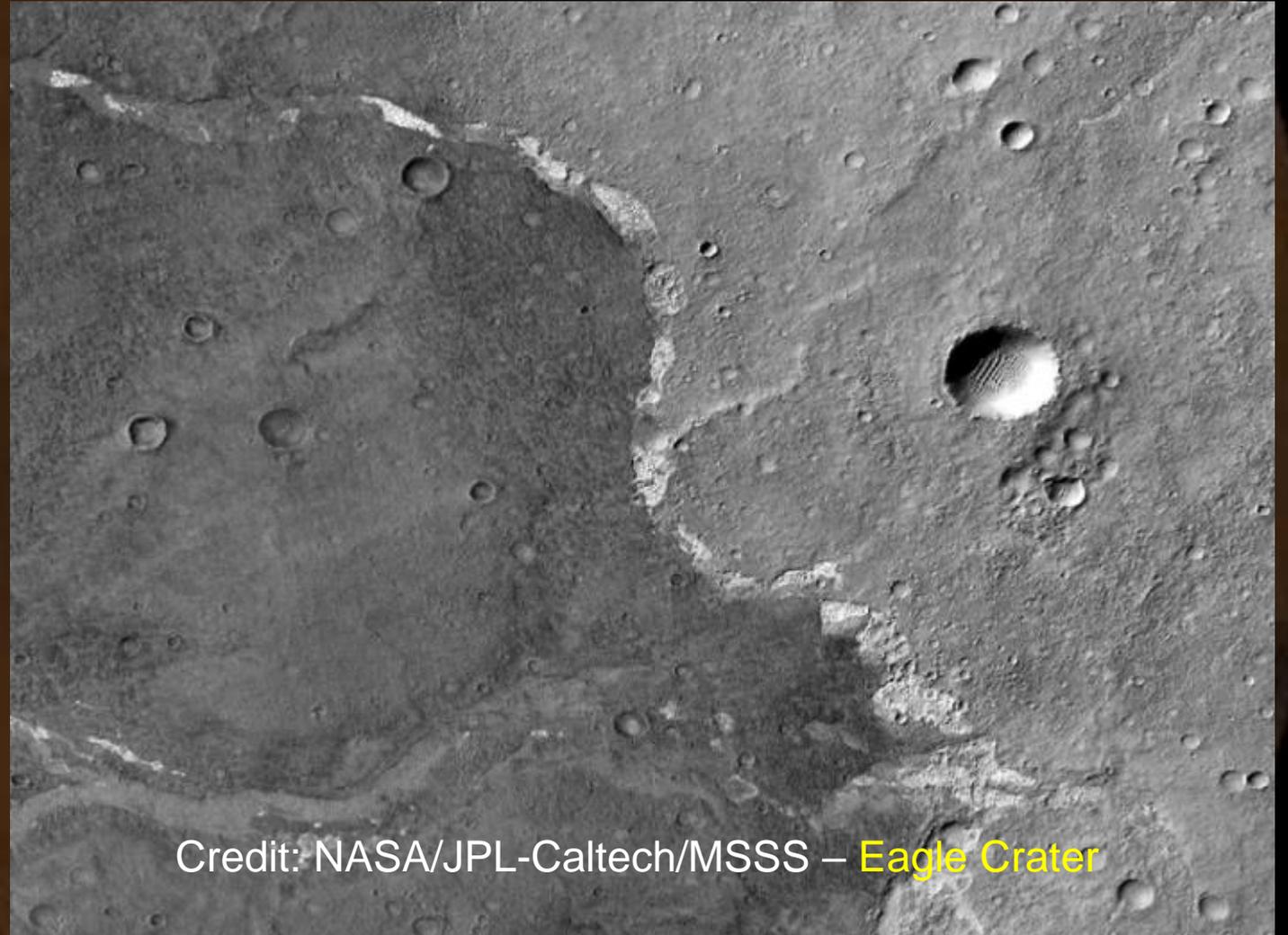
A large, dark, textured sphere, possibly representing a planet or moon, with a bright yellow text overlay. The sphere has a mottled, cratered appearance with various shades of brown and black. The text is centered and reads: 

**“Questions or Observations”?**  
**(2 minutes)**

# Putting it All Together

## Mineral Mystery Lab

**Background:** Even before Dawn arrived at Ceres, scientists had observed bright regions on the dwarf planet through telescopes, but their origin remained a mystery. The Dawn spacecraft's close-up view allowed scientists to gain a better understanding of how the hundreds of bright regions, known as faculae (meaning bright areas) came to be. Even before Dawn arrived at Ceres, scientists had observed bright regions on the dwarf planet through telescopes, but their origin remained a mystery. The Dawn spacecraft's close-up view allowed scientists to gain a

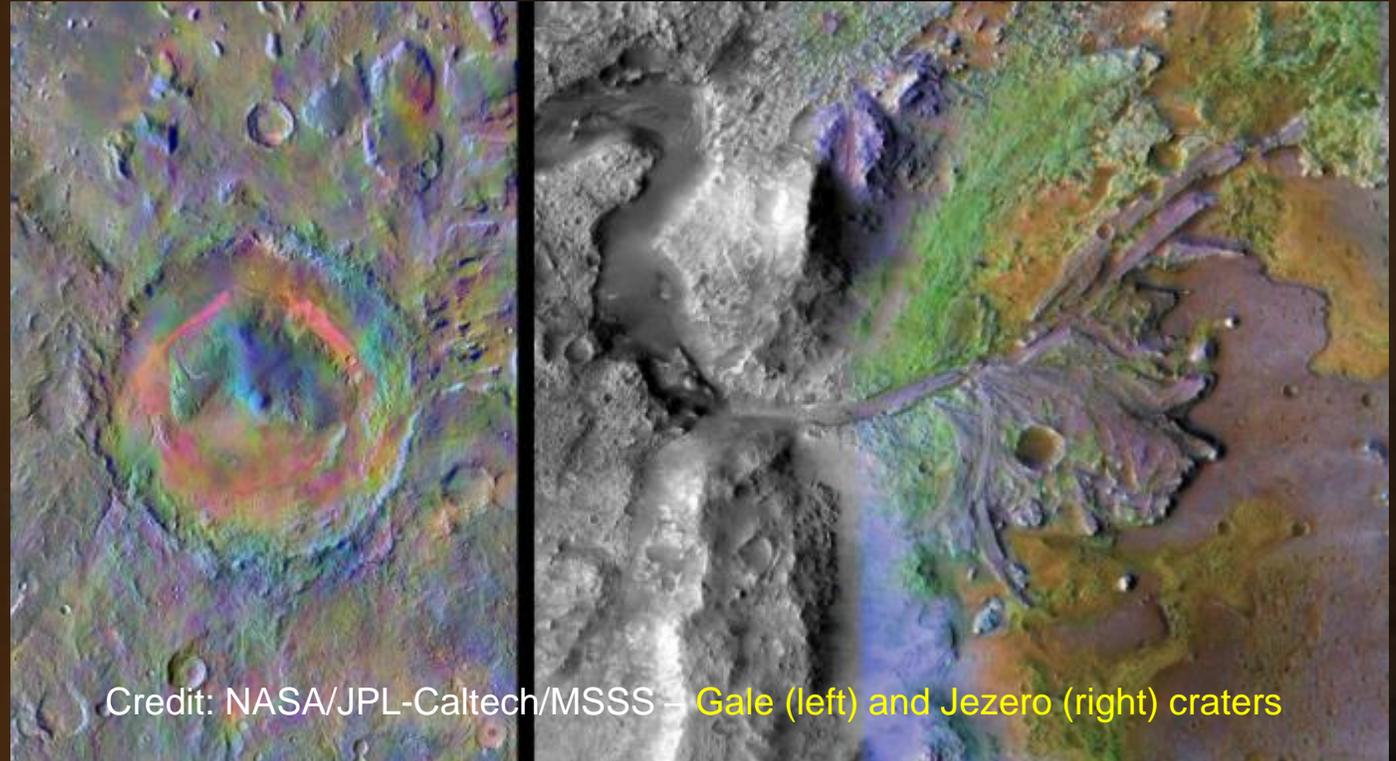


Credit: NASA/JPL-Caltech/MSSS – Eagle Crater

# Putting it All Together

## Mineral Mystery Lab

**From Space:** These satellite images of the Curiosity and Perseverance Mars rover landing sites in Gale and Jezero craters, respectively, have been colored to show the presence of various minerals at each location. Credit: NASA/JPL-Caltech | > Full image and caption: Left image (Gale crater) | Right image (Jezero crater)



[Mineral Mystery Lab](#)

# Putting it All Together

## Mineral Mystery Lab



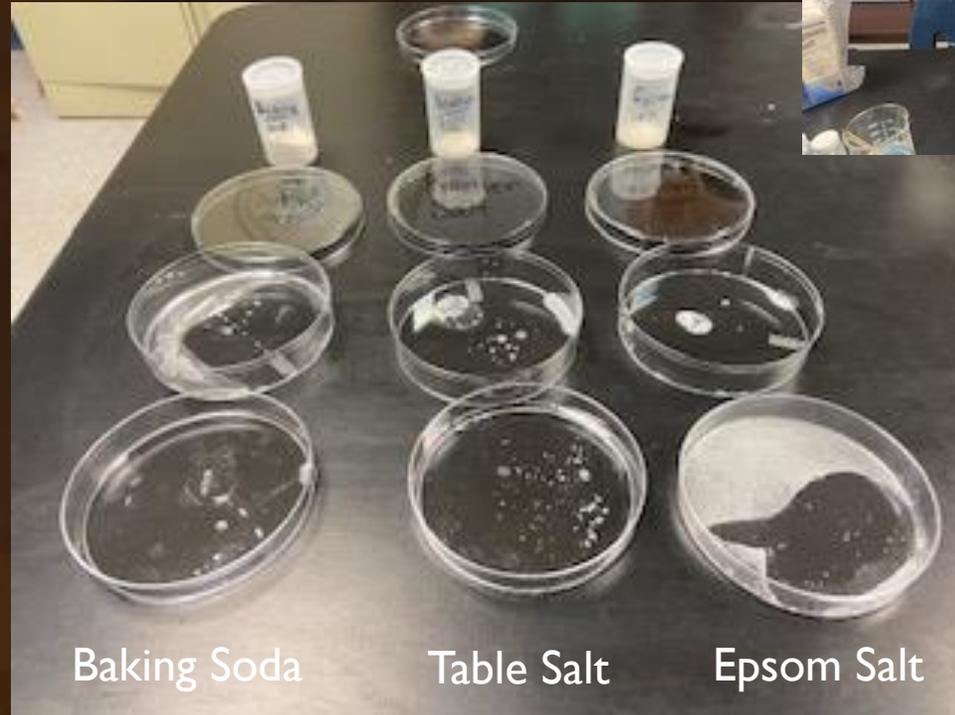
Table Salt



Epsom Salt



Baking Soda



Baking Soda

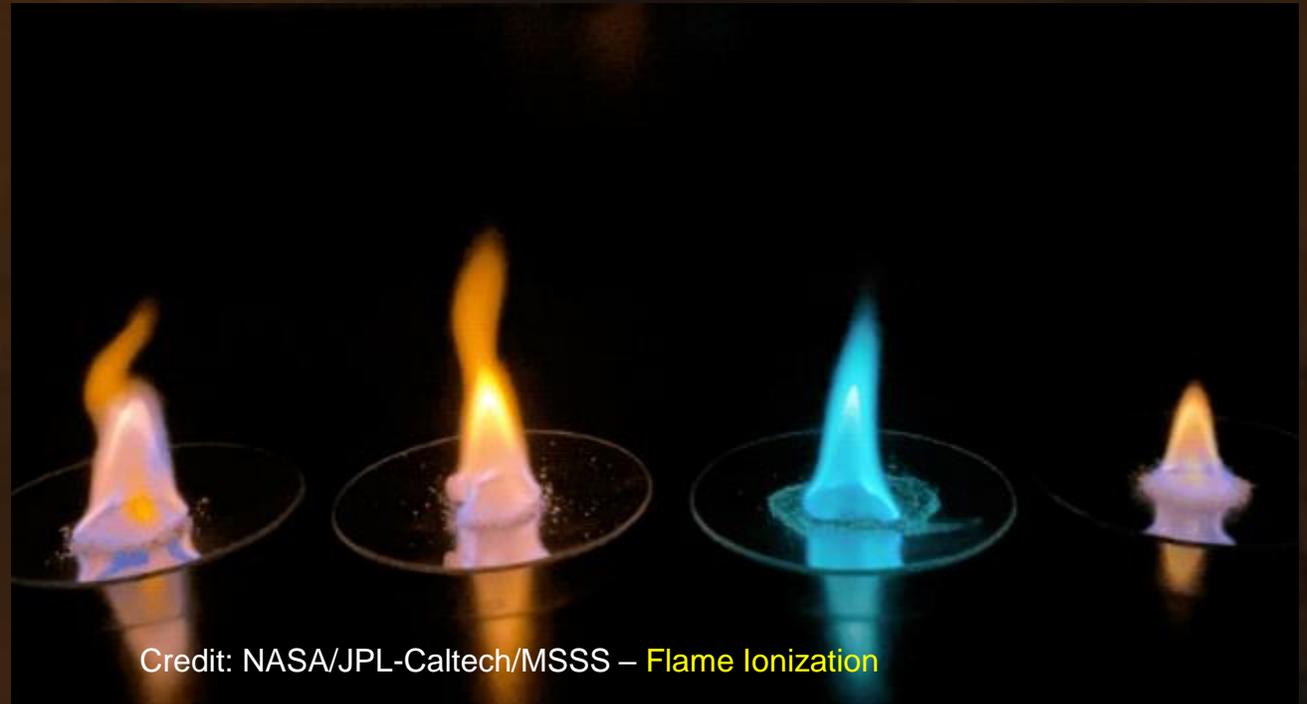
Table Salt

Epsom Salt

# Putting it All Together

## Flame Ionization Lab

**Background:** A flame test is used to detect the presence of certain metal ions. The test involves heating a sample of the element and observing the resulting color of the flame. When atoms of elements are heated to high temperatures, some electrons may absorb enough energy to allow them to move to higher energy levels. As the electrons return to their ground state, the energy that was absorbed is given off in the form of visible light. The color of this light can be used to identify the elements involved.

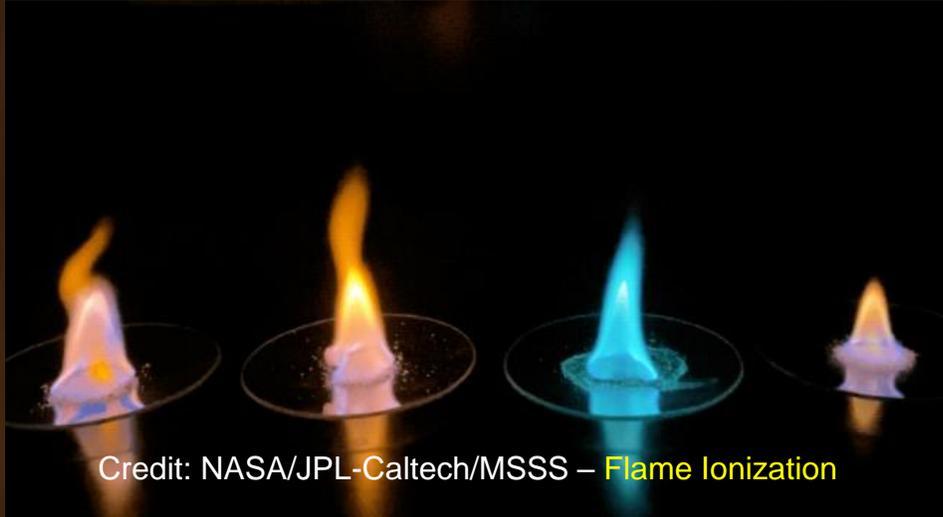


Credit: NASA/JPL-Caltech/MSSS – Flame Ionization

[Flame Ionizations Lab](#)

# Putting it All Together

## Flame Ionization Lab



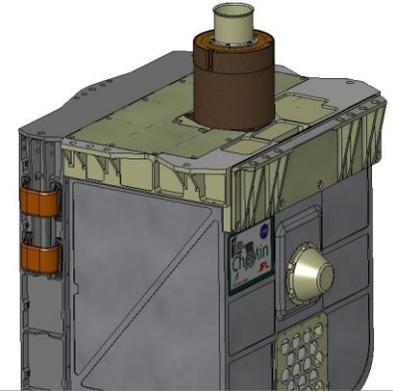
Credit: Dr. Strawser – Flame Ionization Lab

# Adding aPBI

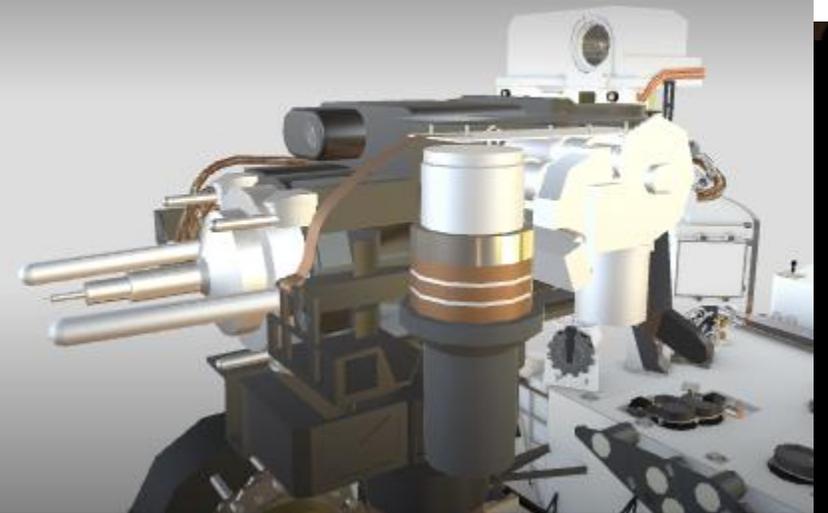
strategies, paradigms, theories, and experiences

## Chemistry & Mineralogy X-Ray Diffraction Instrument:

Designed to be about the size of a laptop computer inside a carrying case, the Chemistry and Mineralogy Instrument will identify and measure the abundances of minerals on Mars. A rotating wheel in the center of the rectangular housing will carry individual rock and soil samples for chemical analysis.



Credit: NASA/JPL-Caltech/MSSS

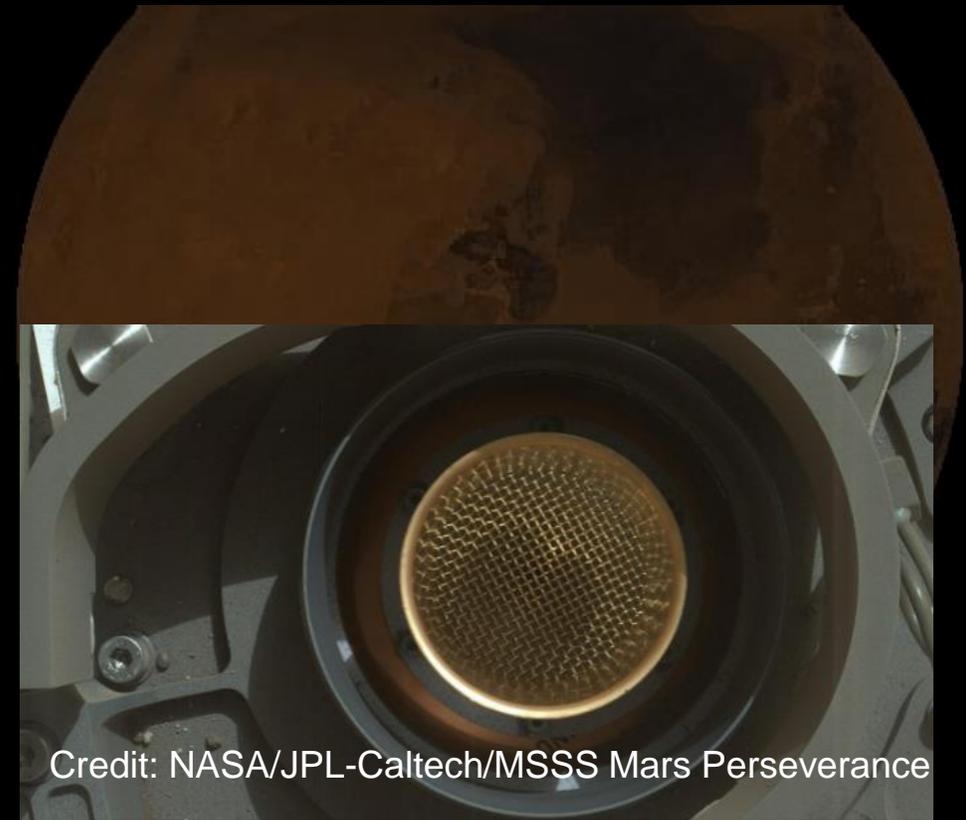


# Adding aPBI

strategies, paradigms, theories, and on-line experiences

To prepare rock samples for analysis, the rover drills into rocks, collects the resulting fine powder, and delivers it to a sample holder. It uses a scoop for collecting soil.

CheMin then directs a beam of X-rays as fine as a human hair through the powdered material. X-rays, like visible light, are a form of electromagnetic radiation. They have a much shorter wavelength that cannot be seen with the naked eye. When the X-ray beam interacts with the rock or soil sample, some of the X-rays are absorbed by atoms in the sample and re-emitted or fluoresced at energies that are characteristic of the particular atoms present.



Credit: NASA/JPL-Caltech/MSSS Mars Perseverance

# Adding aPBI

strategies, paradigms, theories, and on-line experiences

## Fundamental Principles of X-Ray Fluorescence (XRF).

The XRF method depends on fundamental principles that are common to several other instrumental methods involving interactions between electron beams and x-rays with samples, including: X-ray spectroscopy (e.g., SEM - EDS), X-ray diffraction (XRD), and wavelength dispersive spectroscopy (microprobe WDS).

The analysis of major and trace elements in geological materials by XRF is made possible by the behavior of atoms when they interact with X-radiation. An XRF spectrometer works because if a sample is illuminated by an intense X-ray beam, known as the incident beam, some of the energy is scattered, but some is also absorbed within the sample in a manner that depends on its chemistry. The incident X-ray beam is typically produced from a Rh target, although W, Mo, Cr and others can also be used, depending on the application.

When this primary X-ray beam illuminates the sample, it is said to be excited. The excited sample in turn emits X-rays along a spectrum of wavelengths characteristic of the types of atoms present in the sample.



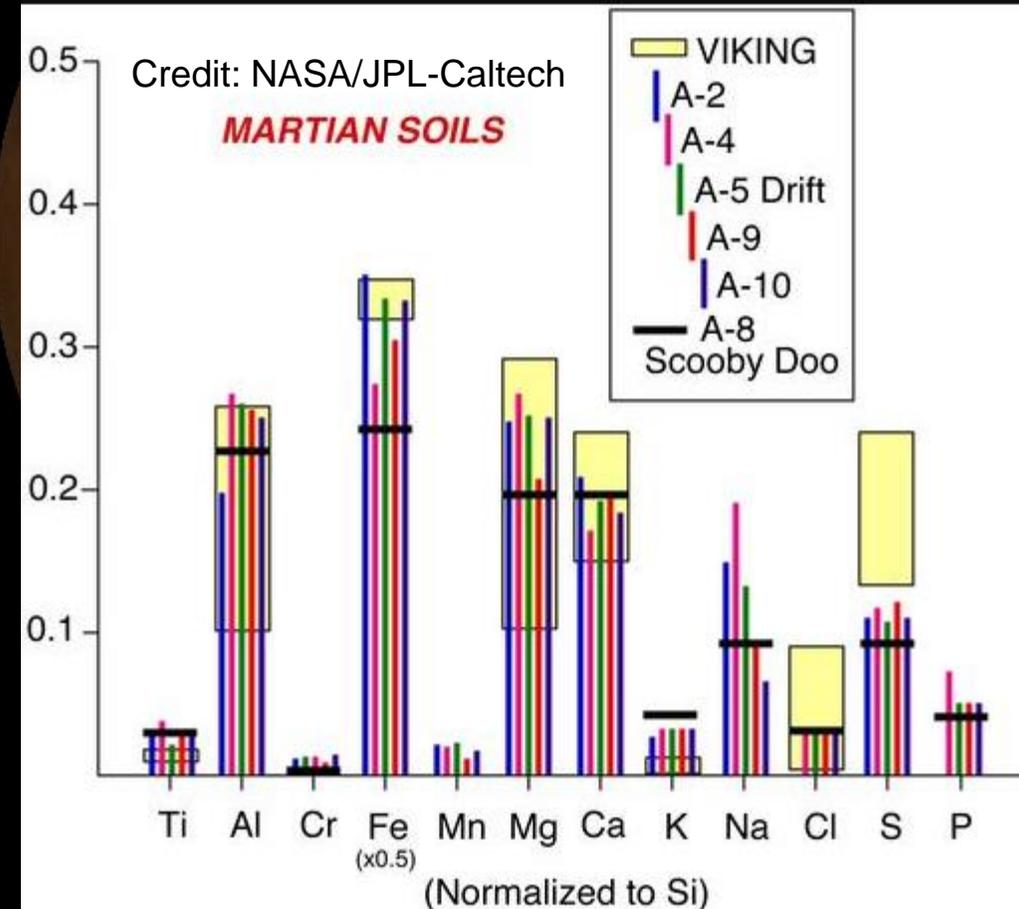
Credit: NASA/JPL-Caltech

# Adding aPBI

strategies, paradigms, theories, and on-line experiences

## Alpha Proton X-Ray Spectrometer (APXS)

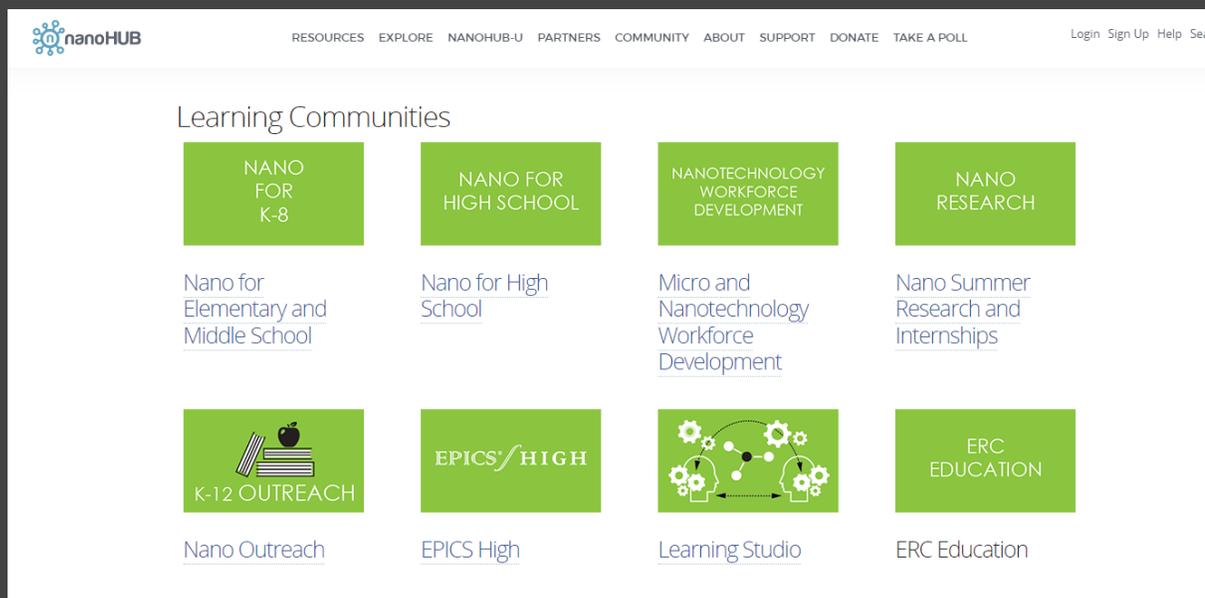
The Alpha Proton X-Ray Spectrometer on the rover measured the compositions of nine rocks. The silicon content of some of the rocks is much higher than that of the Martian meteorites, our only other samples of Mars. The Martian meteorites are all mafic and ultramafic igneous rocks, volcanic and intrusive rocks that are relatively low in silicon and high in iron and magnesium. Such rocks would be expected to form by partial melting of the upper mantle of Mars. The melt rises up through the crust and solidifies at or near the surface. The mafic volcanic Martian meteorites, referred to as basalts, are the most common rock on Earth and have also been found on the Moon.



# Adding aPBI

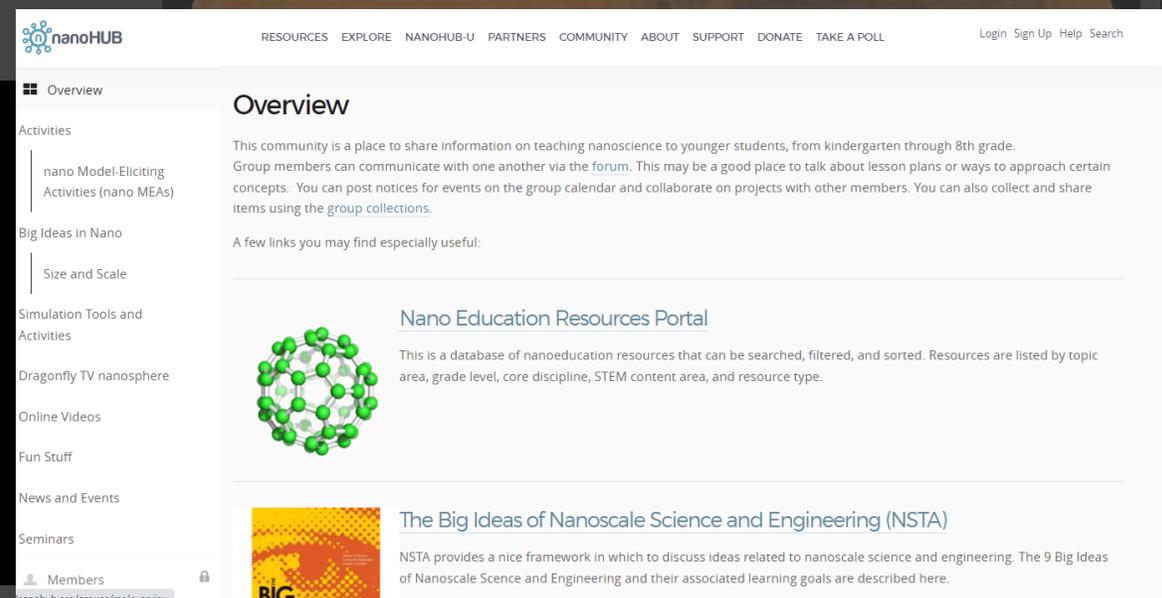
strategies, paradigms, theories, and experiences

[NanoHub](#)



The screenshot shows the NanoHub Learning Communities page. At the top, there is a navigation bar with the NanoHUB logo and links for RESOURCES, EXPLORE, NANOHUB-U, PARTNERS, COMMUNITY, ABOUT, SUPPORT, DONATE, and TAKE A POLL. On the right side of the navigation bar, there are links for Login, Sign Up, Help, and Search. The main content area is titled "Learning Communities" and features a grid of eight green boxes, each representing a different community. Each box contains an icon, a title, and a link to the community page.

Community Name	Icon Description	Link
NANO FOR K-8	Icon of a book and an apple	<a href="#">Nano for Elementary and Middle School</a>
NANO FOR HIGH SCHOOL	Icon of a book and a graduation cap	<a href="#">Nano for High School</a>
NANOTECHNOLOGY WORKFORCE DEVELOPMENT	Icon of a gear and a person's head	<a href="#">Micro and Nanotechnology Workforce Development</a>
NANO RESEARCH	Icon of a microscope and a person's head	<a href="#">Nano Summer Research and Internships</a>
K-12 OUTREACH	Icon of a book and an apple	<a href="#">Nano Outreach</a>
EPICS HIGH	Icon of a book and a graduation cap	<a href="#">EPICS High</a>
Learning Studio	Icon of a gear and a person's head	<a href="#">Learning Studio</a>
ERC EDUCATION	Icon of a gear and a person's head	<a href="#">ERC Education</a>



The screenshot shows the NanoHub Overview page for a specific community. The navigation bar is identical to the Learning Communities page. The main content area is titled "Overview" and contains the following information:

- Activities:** nano Model-Eliciting Activities (nano MEAs)
- Big Ideas in Nano:** Size and Scale
- Simulation Tools and Activities:** Dragonfly TV nanosphere
- Online Videos:** Fun Stuff
- News and Events:** Seminars
- Members:** nanohub.org/groups/ms/overview

The main text describes the community's purpose: "This community is a place to share information on teaching nanoscience to younger students, from kindergarten through 8th grade. Group members can communicate with one another via the forum. This may be a good place to talk about lesson plans or ways to approach certain concepts. You can post notices for events on the group calendar and collaborate on projects with other members. You can also collect and share items using the group collections." It also mentions "A few links you may find especially useful:"

- Nano Education Resources Portal:** This is a database of nanoeducation resources that can be searched, filtered, and sorted. Resources are listed by topic area, grade level, core discipline, STEM content area, and resource type.
- The Big Ideas of Nanoscale Science and Engineering (NSTA):** NSTA provides a nice framework in which to discuss ideas related to nanoscale science and engineering. The 9 Big Ideas of Nanoscale Science and Engineering and their associated learning goals are described here.

# Adding aPBI

strategies, paradigms, theories, and on-line experiences

## Available Tools

### NanoHub

Title	Alias	Status
<a href="#">1-D Chain Dispersions</a>	1dchainmd	open source
<a href="#">1D Finite Difference Method Conduction Heat...</a>	1dfdmht	open source
<a href="#">One-dimensional function specification for IHCP</a>	1dfs	open source
<a href="#">1D Heterostructure Tool</a>	1dhetero	closed source
<a href="#">Toy 1-dimensional model to understand Molecular...</a>	1dmd	open source
<a href="#">1-D Phonon BTE Solver</a>	1dphononbte	closed source
<a href="#">Semiconductor Superlattice Design Tool</a>	1sl	closed source
<a href="#">Percolation Threshold Simulator for 2D...</a>	2daiperc	open source
<a href="#">Approximate self-consistent potential in a...</a>	2degpot	closed source
<a href="#">2DFET</a>	2dfets	open source
<a href="#">Electrostatic Properties Simulation of Layered...</a>	2dmatstacks	open source
<a href="#">2D material reflectance spectra</a>	2dreflect	closed source
<a href="#">3D-Atoms-Model</a>	3datomsmodel	open source
<a href="#">Hierarchical material optimization</a>	3dmatopt	closed source
<a href="#">RF Through Silicon Via for 3D IC</a>	3drftsv	closed source
<a href="#">Calculating Semiconductor Raman Spectra</a>	670raman	open source

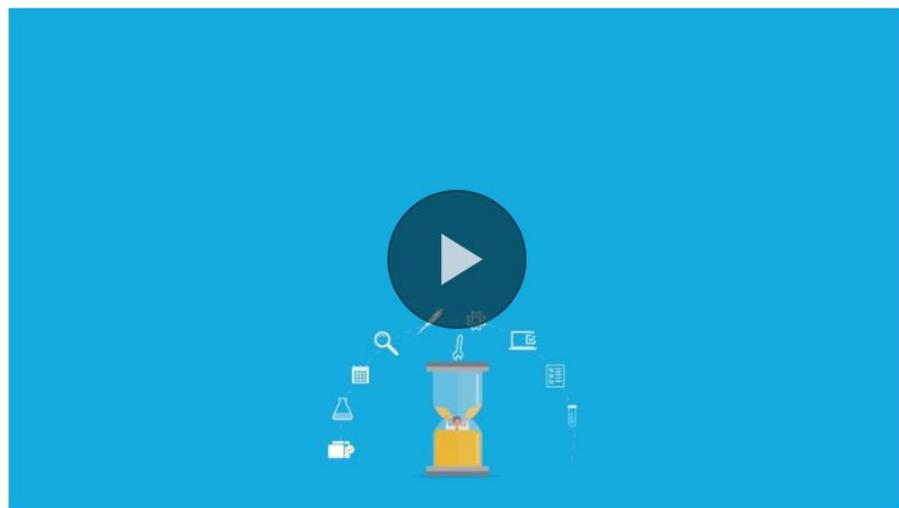


# Adding aPBI

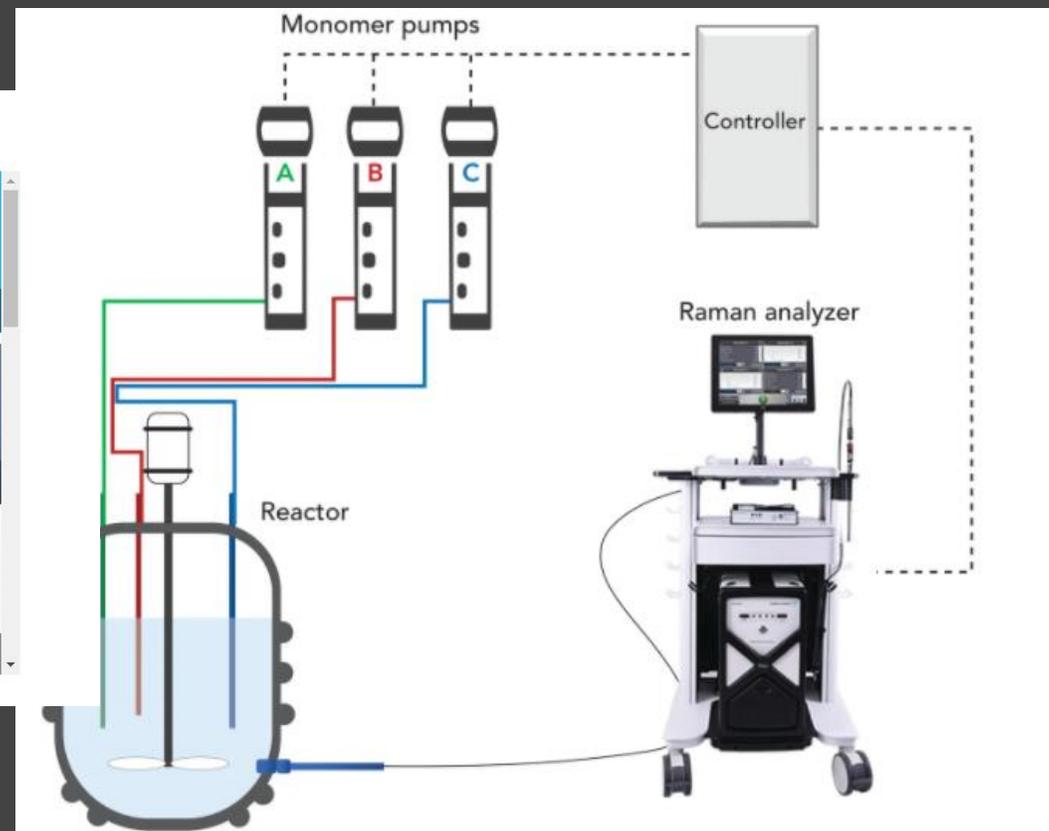
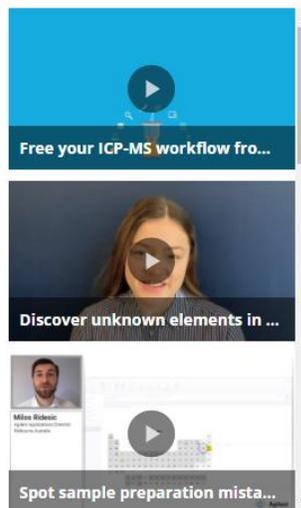
strategies, paradigms, theories, and on-line experiences

## Spectrometry On-line

ICP/ICP-MS



Free your ICP-MS workflow from common time traps



**“Questions or Observations”?**

**Thank you for Attending**  
**Email Me**