A LITTLE ABOUT ME

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Curiosity Rover Update and Preview of Mars 2020

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What is Geology?

The study of the earth’s physical structure and substance, its history, and the processes that act on it.
How do scientists do geology on other planets?

- Observations from telescopes on Earth
- Measurements from orbiters
- Measurements from landers and rovers
- Returned samples
- Meteorites
- Send people
Why do scientists explore Mars?

• Mars has geologic features similar to Earth.
• Water once flowed on Mars.
• We want to know if Mars could have once supported microbial life (i.e., if Mars was “habitable”).
What are the Requirements for Habitability?

- **Solvent** (water)
- **Raw Materials** (C, H, N, O, P, S)
- **Energy** (light, chemical)
- **Favorable Conditions** (T, pH, salinity, etc.)

adapted from graphic by Tori Hoehler
Early Earth vs. Early Mars

On Earth, <1% of truly ancient crust is still present – due to plate tectonics.

On Mars, plate tectonics didn’t resurface the planet. We can look at 3-4 Gyr sedimentary rocks with little alteration since they were deposited.

Therefore, we can study the habitability of early Mars.
How do we know that water once flowed on Mars?

A. We see water on the surface today.
B. Surface features provide evidence of water that once flowed across the surface.
C. Remote sensing instruments detect minerals on the surface that form in water.

Put your answer(s) and any supporting information in the chat.
How do we know that water once flowed on Mars?

A. We see water on the surface today. Dark slope streaks?
B. Surface features provide evidence of water that once flowed across the surface. River and lake deposits
C. Remote sensing instruments detect minerals on the surface that form in water. Clay minerals and salts
Water on Modern Mars?
Water on Ancient Mars
Color Image of a Region in Mawrth Vallis
Red – Fe/Mg phyllosilicate
Green – Al phyllosilicate
Blue - hydrated sulfates
What happened to Mars’ Water?

This video is an artist’s concept showing the transition from an ancient, habitable Mars capable of supporting liquid water on its surface to the cold desert world of today.

Credits: Michael Lentz/NASA Goddard Conceptual image Lab
Where did we land?

- Phoenix
- Viking 1
- Pathfinder
- Viking 2
- Perseverance
- Curiosity
- Spirit
- Opportunity
Curiosity at Gale Crater
150-km Gale Crater contains a 5-km high mound of stratified rock. Strata in the lower section of the mound vary in mineralogy and texture, suggesting that they may have recorded environmental changes over time.
• What were these ancient climates like?
• Were they habitable?
Curiosity’s Science Payload

- **Mastcam** (Imaging)
- **REMS** (Weather)
- **DAN** (Subsurface Hydrogen)
- **SAM** (Chemistry and Isotopes)
- **CheMin** (Mineralogy)
- **APXS** (Chemistry)
- **MARDI** (Imaging)
- **MAHLI** (Imaging)
- **RAD** (Radiation)
- **Drill Scoop Brush Sieves**

*Image credit: NASA/JPL-Caltech*
Mars Science Laboratory Traverse
Site 79, Drive 2330
Sol 2780
Mastcam mosaic of Mount Sharp, descent rocket scours, and rover shadow

NASA/JPL-Caltech/MSSS
Rocks uncovered by Curiosity’s descent rockets
Rounded pebbles and sand in the conglomerate indicate water flowed ankle to hip deep.
Curiosity and its tracks captured by HiRISE on the Mars Reconnaissance Orbiter

Bradbury Landing

Yellowknife Bay

Rover Tracks

Curiosity
Yellowknife Bay
Curiosity’s 1.6-cm drill bit, drill and test holes, and scoop full of acquired sample

How is the drilled sample from beneath the surface different from what we see on the surface?

Put your answer(s) in the chat.

The drilled sample is GRAY!
Kimberley Sandstone
Thickly Laminated Mudstone at Pahrump Hills
Thinly Laminated Mudstone at Pahrump Hills
Marias Pass

Stimson Sandstone

Murray Mudstone
“Old Soaker” Target

- Describe the features on the surface of the rock?
- What might these features provide evidence of?

Put your answers in the chat.
Evidence for Groundwater
Evidence for Groundwater
Animation of CheMin
The drill powder contains abundant phyllosilicates (clay minerals), indicating sustained interaction with water.
Minerals in Ancient Sedimentary Rocks in Gale Crater

Minerals demonstrate differences in pH, salinity, temperature, and redox conditions

*Normalized without amorphous component*
Ancient Gale Crater

• Gale crater had a system of rivers, lakes, and deltas ~3.5 Ga
• Groundwater moved through sediments
• Mineralogy and geochemistry suggest many different environments, which would have been habitable to ancient microbial life
Perseverance in Jezero Crater

- Phoenix
- Viking 1
- Pathfinder
- Opportunity
- Viking 2
- Perseverance
- Curiosity
- Spirit
Perseverance Goals

- Identify past environments capable of supporting microbial life
- Seek signs of possible past microbial life in those habitable environments
- Collect core rock and “soil” samples and store them on the martian surface
- Test oxygen production from the martian atmosphere

NASA/JPL
Perseverance Mission

• Launch window opens July 17th at 9:15 am EDT
• Landing on February 18, 2021
• Primary mission is 1.5 Mars years (3 Earth years)
“Ingenuity” Helicopter

4 lb
4 ft rotor, 2400 RPM
Solar-powered
2 cameras
Why did the Mars science community decide to send Perseverance to Jezero crater?
Notional Mission Scenario for Jezero crater

Option 1: Eastern Landing + Delta Remnants (15 km traverse)
Option 2: Western Landing + Crater Rim (15 km traverse)
A typical Mars sample return mission would be done in three phases:

1. Sample selection and collection
2. Sample retrieval and transfer
3. Sample return