Mars Atmosphere and Volatile Evolution (MAVEN) Mission

LASP-led Mars Scout Mission
Bruce Jakosky, PI
Launch date: 2013
1 Earth Year = 365 days
1 Mars Year = 687 Earth days or 669 sols (martian days)
What is Mars Like Today?
A Comparison of the Atmospheres of Earth and Mars

- Earth
  - Troposphere
    - Cirrus clouds
  - Stratosphere
  - Mesosphere
  - Thermosphere
  - Ionosphere

- Mars
  - Troposphere
  - Stratosphere
  - Mesosphere
  - Thermosphere
  - Upper Atmosphere
    - Thin ice clouds
Water Ice is Abundant on Mars Today

Mars north polar cap is made of water ice.

The recent *Phoenix* mission uncovered buried water ice at high latitudes.
Did Mars Have a Watery Past? Surface Features Suggest “Yes”
If Mars had a thick atmosphere, where it is now?
If Mars had an ocean, where is all the water now?
If Mars had a thick atmosphere, where is it now?
If Mars had an ocean, where is all the water now?

- Frozen at the poles?
If Mars had a thick atmosphere, where it is now?
If Mars had an ocean, where is all the water now?

• Frozen at the poles?
• Not enough!

Artist’s conception
by Mike Carroll
If Mars had a thick atmosphere, where it is now?
If Mars had an ocean, where is all the water now?

- Frozen at the poles?
- Not enough!
- Locked underground?

Artist’s conception
by Mike Carroll
If Mars had a thick atmosphere, where it is now?
If Mars had an ocean, where is all the water now?

• Frozen at the poles?
  • Not enough!
• Locked underground?
  • Not *nearly* enough!

*Artist’s conception by Mike Carroll*
If Mars had a thick atmosphere, where it is now?
If Mars had an ocean, where is all the water now?

• Frozen at the poles?
  • Not enough!
• Locked underground?
  • Not *nearly* enough!

What other possibilities are left?

*Artist’s conception by Mike Carroll*
MARS HAS 2 MAJOR PROBLEMS

• Problem 1: It’s little!
• Problem 2: It has no global magnetic field.
Problem 1: It’s little so it has low gravity

Inside Planet MARS

Often visible as a reddish light in Earth’s sky, Mars captured the imaginations of those who dream of space travel. The planet’s thin atmosphere is hostile to human life, but Mars has many interesting geological features similar to those on Earth, such as volcanoes and canyons.

THIN ATMOSPHERE
95.32% carbon dioxide, 2.7% nitrogen, 1.6% argon, 0.13% oxygen, 0.08% carbon monoxide

GRAVITY
0.38 OF EARTH

SURFACE CONDITIONS
AIR PRESSURE: 0.7% of Earth
AVERAGE TEMPERATURE:
-67°F (-55°C)

 Martian sunset photographed by the Spirit rover at Gusev crater in 2005

Mars, 4,222 mi (6,794 km) in diameter, is slightly over half the size of Earth

SOURCE: ARGONNE NATIONAL LABORATORY, NASA, HSTSCI

KARL TATE, SPACE.com
Atmospheric loss **BECAUSE** of problem 1

Three views of an escaping atmosphere
Smaller worlds cool off faster and “harden” earlier

Larger worlds stay warmer inside, leading to more volcanism and tectonics

Larger worlds CAN have more erosion because they can create and hold an atmosphere
Problem 2: Mars has no global magnetic field

Early Mars:
- Warmer core generated stronger magnetic field.
- Warmer interior caused extensive volcanism and outgassing.
- Thicker atmosphere created warmer and possibly wetter climate.

Mars Today:
- Lack of core convection means no global magnetic field.
- Cooler interior no longer drives extensive volcanism or outgassing.
- Some remaining gases condense or react with surface.
- Weaker magnetosphere has allowed solar wind to strip away much of the atmosphere.
- Thinner atmosphere reduces greenhouse warming.
Problem 2: Mars has no global magnetic field

Early Mars
- Warmer core generated stronger magnetic field.
- Warmer interior caused extensive volcanism and outgassing.
- Thicker atmosphere created warmer and possibly wetter climate.

Mars Today
- Lack of core convection means no global magnetic field.
- Weaker magnetosphere has allowed solar wind to strip away much of the atmosphere.
- Thinner atmosphere reduces greenhouse warming.
- Some remaining gases condense or react with surface.
- Cooler interior no longer drives extensive volcanism or outgassing.

The End of the World – for Martians?
Solar wind blasts planets
Solar energetic particles detected by MAVEN instruments

First SEP Event Observed at Mars by MAVEN

- 35 hour orbits
- 5.5 hour orbits
- 4.5 hour orbits

MOI
SEF Turns on
X-rays from Solar Flare that produced CME
Onset of SEP Event 9/29 1720Z
5.5 hour modulation caused by shadowing of EPs by Mars

Thursday, February 5, 15
Problem 2: Mars has no global magnetic field