

The MAVEN Mission



Mission Facts and Stats

Name: Mars Atmosphere and Volatile EvolutionN (MAVEN)

Launch: November 2013

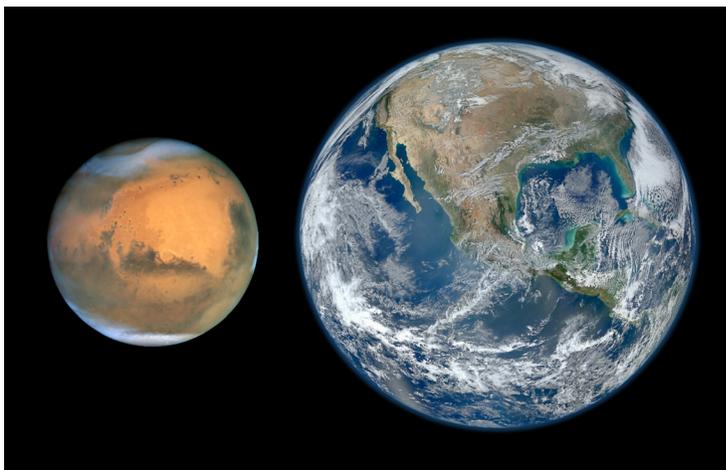
Arrival at Mars: September 22, 2014

Mission ends: April 2016

Image courtesy of NASA

Why is Mars so Dry?

At some point in its early history, Mars had a warmer and wetter climate. Around 4 billion years ago, Mars and Earth both had oceans and flowing water, and it's pretty likely Mars had a similar climate to Earth's. To have liquid water on its surface, Mars must have had a thick atmosphere with a lot of greenhouse gases that kept it warm. On Earth, greenhouse gases in our air, like carbon dioxide, keep us at a reasonable temperature. What happened to Mars? Where did all of the atmosphere and water go? Scientists aren't really sure, but they do have some guesses. Sometime around 3.8 billion years ago, Mars started to change. To search for clues about Mars' lost atmosphere, scientists first compare what Earth and Mars were like 3.8 billion years ago. That way, they can spot what happened to Mars.



This is what Mars (left) and Earth (right) look like today. Today, they are very different places, but Mars and Earth were more similar in the past. Early in their history, Mars and Earth both had rivers and lakes. Today, only Earth has flowing water. The planets are shown sized to scale (but not for distance).

Images courtesy of NASA

Let's Compare and Contrast Earth and Mars 3.8 Billion Years Ago

Earth	Mars
Volcanoes erupting ✓	Volcanoes erupting ✓
150 million kilometers (93 million miles) from the Sun	228 million kilometers (142 million miles) from the Sun
Greenhouse atmosphere ✓	Greenhouse atmosphere ✓
Frequent meteorite and comet impacts ✓	Frequent meteorite and comet impacts ✓
Magnetic Field	Magnetic field shut off (no magnetic field)
Gravity	Gravity (but about 1/3 of Earth's)

Items marked with a check were similar on both Earth and Mars 3.8 billion years ago.

The biggest differences are the distance from the Sun, the magnetic field, and gravity. Let's look at each one...

Distance from the Sun: The farther a planet is from the Sun, the colder it is, unless it has a lot of greenhouse gases in its atmosphere. Since Mars is farther from the Sun than Earth, it would have had even more greenhouse gases in its atmosphere than Earth to keep it warm. To complicate matters, the Sun was actually producing about 30% less power than it does today. That means, beginning 3.8 billion years ago, Mars had a lot of atmosphere that escaped. Once it got cold enough, some of the atmosphere became permanently frozen—like water vapor freezes and forms snow on Earth—but most of it had escaped to space long before that ever happened.

Magnetic Field: The Earth's magnetic field is generated by melted iron in the outer core. The melted iron contains charged particles, which move around as the molten iron convects and the Earth rotates. Motion of the charged particles generates a magnetic field. It's like having a giant magnet inside of the Earth, and it's the reason we can use a compass—the dial in your compass lines up with Earth's magnetic field telling you where north is located.



The molten outer core of the Earth convects, or boils, like a pot full of soup.

The Sun produces a solar wind that carries charged particles from the Sun out into the Solar System. Earth's magnetic field protects our planet's surface and atmosphere from these particles by either deflecting them or trapping them in the field. Mars had a magnetic field around 4.1 billion years ago, but something happened that made the magnetic field shut off. There is some indication that Mars still has molten iron in its core, but it must have stopped convecting. Since Mars doesn't have a magnetic field, the solar wind can impact Mars' surface and atmosphere. Ions in Mars' atmosphere could have been carried away by the solar wind.

Gravity: Gravity is a force that acts on everything that has mass, including our atmosphere. If there is less gravity, it's harder for a planet to hold on to its atmosphere. Mars probably had a lot of atmosphere—even more than Earth—but Mars doesn't have as much gravity. When a comet or meteorite hits a planet, it splashes into the atmosphere like a rock dropped into water. If you had a big splash from a big meteorite, some atmosphere could have escaped Mars' low gravity. Low gravity also makes it easier for the solar wind to carry particles away.

So, What Happened to Mars' Atmosphere? The MAVEN Mission Searches for Clues

The MAVEN mission will visit Mars to figure out what happened to Mars' atmosphere. MAVEN scientists want to know how much of Mars' atmosphere got carried away by the solar wind. MAVEN's Particles and Fields Package contains instruments designed to measure the effects of the solar wind on the Martian atmosphere, and will find, among other things, the amount of particles carried away by the solar wind today so we can calculate how much atmosphere was lost over time.

MAVEN will address another crucial question: How much water did Mars have early on? Hydrogen is a component of water (H₂O). When water evaporates, water vapor may reach the upper atmosphere where ultraviolet light from the Sun can break apart the molecule into two hydrogen atoms and an oxygen atom. Measuring hydrogen in the atmosphere gives an indication of how much water a planet had in the past. Two spectrometers, the Imaging Ultraviolet Spectrometer (IUVS) and Neutral Gas and Ion Mass Spectrometer (NGIMS) will measure isotopes of hydrogen in Mars' atmosphere so we can calculate how much water once flowed on Mars' surface.



One of the instruments in the Particles and Fields Package. Image courtesy of NASA

With these clues, we come closer to understanding Mars' history, and how the face of the planet has drastically changed from its watery, potentially habitable beginnings.

This image, created by an artist, shows the atmosphere being carried away by the solar wind. Scientists aren't sure how much of Mars' atmosphere actually got carried away over billions of years. Instruments onboard MAVEN will make measurements to find out.

Image courtesy of NASA.

