IS MARS SHRINKING?

By Henry M. Holden

NASA'S MARS Atmosphere and Volatile Evolution (MAVEN) mission has identified the process that appears to have played a key role in the transition of the Martian climate from an early, warm and wet environment that might have supported surface life to the cold, arid planet Mars is today.

MAVEN arrived in Mars's orbit in 2014, after travelling 442 million miles in the course of 10 months to get there. The $671-million mission is investigating the upper atmosphere of the Red Planet, focusing on how and why the planet lost most of its atmosphere and liquid water.

MAVEN will not land, but will orbit Mars to answer questions about the extent to which losing gas to space might have been the driving mechanism behind climate change, and how ancient Mars changed so dramatically into the planet we know today.

MAVEN data have enabled researchers so far to determine the rate at which the Martian atmosphere currently is losing gas to space caused by the solar wind. The findings reveal that the erosion of Mars' atmosphere increases significantly during solar storms.

"The evidence shows that the Mars atmosphere today is a cold, dry environment, one where liquid water really cannot exist in a stable state," said Bruce Jakosky, MAVEN principal investigator. "But it also tells us when we look at older surfaces, that the ancient surfaces had liquid water flowing over it."

So where did the planet's water and carbon dioxide go? Jakosky said MAVEN would help unravel that mystery by using its scientific instruments to measure the composition and escape of gases in the Martian atmosphere.

"Mars appears to have had a thick atmosphere warm enough to support liquid water which is a key ingredient and medium for life as we currently know it," said John Grunsfeld, astronaut and associate administrator for the NASA Science Mission Directorate, in Washington.

"Understanding what happened to the Mars' atmosphere will inform our knowledge of the dynamics and evolution of any planetary atmosphere. Learning what can cause changes to a planet's environment from one that could host microbes at the surface to one that does not is important to know, and is a key question that is being addressed in NASA's journey to Mars," he explained.

MAVEN was the 10th Mars orbiter launched by NASA, and it is now one of five active probes currently orbiting the Red Planet: Mars Odyssey was launched in 2001, the European Space Agency's Mars Express was launched in 2003, NASA's Mars Reconnaissance Orbiter was launched in 2005, and India's Mars Orbiter Mission, blasted off in November 2013.

Left: An artist's rendition of MAVEN in orbit over Mars. MAVEN is the first spacecraft dedicated to exploring the tenuous upper atmosphere of Mars. (Courtesy: NASA)

Above: An Artist's rendition of a solar wind storm and its effect on the Martian atmosphere. Solar-wind erosion is an important mechanism for atmospheric loss. (Courtesy: NASA)

SOLAR STORMS A MAJOR FACTOR

MAVEN measurements indicate that the solar wind strips away gas at a rate of about 100 grams (equivalent to roughly 1/4 pound) every second.

"Like the theft of a few coins from a cash register every day, the loss becomes significant over time," said Jakosky. "We've seen that the atmospheric erosion increases significantly during solar storms, so we think the loss rate was much higher billions of years ago when the Sun was young and more active."

The solar wind is a stream of particles, mainly protons and electrons, flowing from the sun's atmosphere at a speed of about one million miles per hour. The magnetic field carried by the solar wind as it flows past Mars can generate an electric field, much as a turbine on Earth can be used to generate electricity. This electric field accelerates electrically charged gas atoms, called ions, in Mars' upper atmosphere and shoots them into space.

A series of dramatic solar storms hit Mars' atmosphere in March 2015, and MAVEN found that the loss was accelerated. The combination of greater loss rates and increased solar storms in the past suggests that loss of atmosphere to space was likely a major process in changing the Martian climate.

MAVEN has been examining how ultraviolet light also strips gas from the top of the planet's atmosphere. New results indicate that the loss is experienced in three different regions of the Red Planet: down the "tail," where the solar wind flows behind Mars, above the Martian poles in a "polar plume," and from an extended cloud of gas surrounding Mars. The science team determined that almost 75 percent of the escaping ions come from the tail region, and nearly 25 percent are from the plume region, with just a minor contribution from the extended cloud.

Ancient regions on Mars bear signs of abundant water – such as features resembling valleys carved by rivers, and mineral deposits that only form in the presence of liquid water.

These features have led scientists to think that billions of years ago, the atmosphere of Mars was much denser and warm enough to form rivers, lakes and perhaps even oceans of liquid water.

Recently, researchers using NASA's Mars Reconnaissance Orbiter observed the seasonal appearance of hydrated salts indicating briny liquid water on Mars. However, the current Martian atmosphere is far too cold and thin to support long-lived or extensive amounts of liquid water on the planet's surface.

"Solar-wind erosion is an important mechanism for atmospheric loss, and was important enough to account for significant change in the Martian climate," said Joe Grebowsky, a MAVEN project scientist. "MAVEN also is studying other loss processes -- such as loss due to impact of ions or escape of hydrogen atoms -- and these will only increase the importance of atmospheric escape."

THE SUN'S INFLUENCE

The Sun goes through an 11-year cycle of activity. The year 2013 was supposed to be its peak, but scientists were disappointed with a minimum of Sun spots that year. Two years later, 2015, saw a dramatic increase in the Sun's activity. This is important because the next predicted high point of activity is 2024, probably before astronauts land on Mars.

In 2035, the sun will be near the maximum of its 11-year activity cycle. At that time, powerful solar storms could occur as often as once a month, and could last anywhere from several hours to several days. This will be a concern for NASA and the ESA, and an obvious concern for astronauts on Mars, or in deep space.

The answer to the question: "Is Mars Shrinking?" Well, yes and no. Its atmosphere is shrinking and perhaps albeit yet to be proven maybe the actual planet is losing some of its surface, but not nearly enough to worry the astronauts 20 years from now. →