ISSN 2616-5872 Vol.5, Issue 8: 10-15, DOI: 10.25236/AJEE.2023.050802

Evidence of Water on Mars and the Consequences of Its Release

Shuyi Li

Keystone Academy, Beijing, 101300, China
annaluciali1025@gmail.com

Abstract: *The search for water on Mars has made remarkable progress. On July 31, 2008, NASA announced that Phoenix confirmed the presence of water ice on Mars. Then the Mars rovers Spirit and Opportunity found plenty of evidence of past water on the planet. It is now a matter of common knowledge that there is water on Mars. This naturally raises the question of what would happen if all the water on Mars were released once humans had high enough technology. Will it lead to a temporary change? Subsurface interaction? Or what people care most about, the potential of life? These are all possible outcomes; People today still do not have the capacity to know exactly what its impact was on Mars. The paper begins with an overview of the historical context of Mars water exploration, highlighting key milestones and breakthroughs achieved by various missions and rovers. Following the historical overview, the paper attempts to an in-depth analysis of the potential implications of water release from hydro mineral, or ice on Mars. It examines the environmental and climatic consequences that could result from introducing significant amounts of water to the surface of Mars. The effects on the composition of the planet's atmosphere, the potential for creating a thicker atmosphere through the release of water vapor, and the consequent greenhouse effect are explored. The paper also addresses anticipated climate changes and their implications for future habitability and potential terraforming efforts. In addition, the paper addresses practical aspects and challenges related to water release. It examines engineering requirements for the distribution, storage and management of released water, taking into account factors such as infrastructure development, resource sustainability and long-term maintenance. Potential benefits, such as the creation of habitable environments and support for future colonization efforts, were also discussed.*

Keywords: *Mars, water studies, historical overview, water release*

1. Introduction

The search for and understanding of water in Mars has been of paramount importance in the quest for extraterrestrial life and future colonization of the “Red Planet”. Over the years, numerous missions and rovers have made ground-breaking discoveries, unraveling the mysteries surrounding Martian hydrology and reshaping our perception of our neighbor. This review paper aims to comprehensively analyze the development of Mars water research, tracing its evolution from initial discoveries to the potential implications of transformative endeavors, such as water release.

Investigations of Martian water began with early orbiting missions that provided crucial insights into the planet's geology and surface features. Yet it was Mars rovers such as Spirit, Opportunity and Curiosity that revolutionized our understanding by revealing compelling evidence of past water activity on the planet. The detection of water ice in polar regions, the identification of ancient riverbeds, and the observation of recurring slope lineae (RSL) pointing to transient liquid water have all contributed to the growing body of knowledge surrounding Martian hydrology.

This historical overview sets the stage for a deeper exploration of the potential impact of water release on Mars. The transformation of Mars into a more habitable environment has become a subject of great interest as humanity contemplates the possibility of a sustained presence and future colonization efforts. The introduction of significant amounts of water to the surface of Mars has the potential to significantly alter the composition of the planet's atmosphere, thereby affecting its climate and long-term habitability. Understanding these potential consequences is critical for informed decision-making and responsible utilization of Martian resources.

This paper delves into the environmental and climatic implications that could arise from the release of water on Mars. It investigates the mechanisms by which the introduction of water could thicken the planet's thin atmosphere, potentially initiating a greenhouse effect and triggering climate change. In addition, it explores practical aspects and challenges associated with water release, such as water distribution, storage and engineering requirements for long-term maintenance. The potential benefits of water release, including the creation of habitable environments and support for future colonisation efforts, are also examined.

However, the discussion surrounding the release of water on Mars is not without its ethical and ecological considerations. Preserving any existing Martian ecosystem and ensuring responsible and sustainable utilization of resources is paramount in pursuing scientific exploration and potential terraforming efforts. Careful deliberation and interdisciplinary collaboration are therefore essential in shaping the future trajectory of Mars water research.

In conclusion, the journey of Mars water research has progressed significantly, shedding tantalizing light on the planet's hydrological past and opening up possibilities for its transformation. By examining the historical development of water research and evaluating the potential implications of water release, this research paper aims to contribute to a broader understanding of Martian hydrology, habitability, and responsible utilization of resources for future exploration and colonization efforts.

2. Evidences for water exists on Mars

2.1. Water

As shown in Fig.1, it has been confirmed that there is a large amount of water that exists on Mars since the Gamma Ray Spectrometer (GRS) on board the Mars Odyssey discovered huge amounts of water over vast areas of Mars. Mars has enough ice just beneath the surface to fill Lake Michigan twice. In both hemispheres, Mars has a high density of ice just below the surface, from latitude 55 degrees to the poles; A kilogram of soil contains about 500g of water ice, But, close to the equator, there is only 2 to 10% of water in the soil.

Figure 1: View underneath Phoenix lander towards south foot pad, showing patchy exposures of a bright surface that was later proven to be water ice, as predicted by theory and detected by Mars Odyssey.

Research, reported in the journal Science in September 2009, demonstrated that some new craters on Mars show exposed, pure, water ice as shown in Fig.2. After a while, the ice disappears, evaporating into the atmosphere. The ice was only a few feet deep. The ice was confirmed with the Compact Imaging Spectrometer (CRISM) on board the Mars Reconnaissance Orbiter (MRO). Ice was found in five locations. Three of the locations are in the Cebrenia quadrangle. These locations are 55.57° N, 150.62° E; 43.28° N, 176.9° E; and 45° N, 164.5° E. Two others are in the Diacria quadrangle: 46.7° N, 176.8° E and 46.33° N, 176.9° E. This discovery proves that future colonists on Mars will be able to obtain water from a wide variety of locations. The ice can be scooped up, melted and then broken apart to provide fresh oxygen and hydrogen for rocket fuel. Hydrogen is the powerful fuel used in the shuttle's main engines.

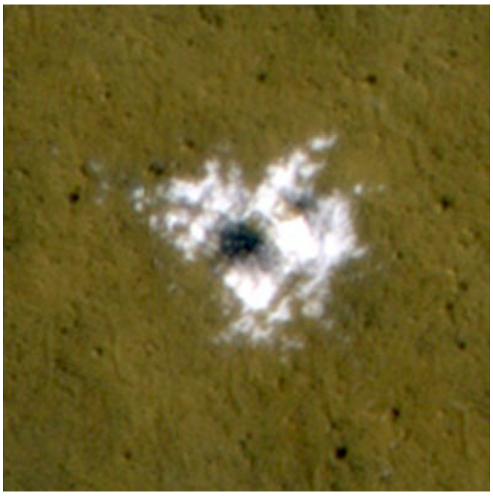

Figure 2: The HiRISE camera on NASA's Mars Reconnaissance Orbiter took this image of a meteorite impact crater in the topographically flat, dark plains within Vastitas Borealis, Mars, on November 1, 2008. Bright water ice was excavated by the crater. This entire image is 50 meters (164 feet) across.

Separately, Odyssey has sent back thousands of images supporting the idea that Mars once had vast amounts of water flowing across its surface, such as delta shown in Fig.3. Some of the images show branching valley patterns. Others show layers that may have formed under the lake. Deltas have been identified.

Figure 3: Delta in Ismenius Lacus quadrangle.

2.2. Chaotic terrain

The Viking orbiters revolutionized our thinking about water on Mars by discovering many of the geologic forms typically formed from large amounts of water as shown in Fig.4. Huge river valleys are found in many areas. They showed that floods of water broke through dams, carved deep valleys, eroded grooves into bedrock, and traveled thousands of kilometers. Large areas of the southern hemisphere contain branched valley networks, suggesting that rain once fell. The flanks of some volcanoes are believed to have been exposed to rainfall because they resemble those occurring on Hawaiian volcanoes [6]. Many of the craters look as if an impactor fell into the mud. When they were formed, ice in the soil may have melted, turned the ground into mud, then the mud flowed across the surface [1]. Normally, material from an impact rises and then falls. It does not flow across the surface and around obstacles, as it does in some Martian craters [2]. Regions, called "chaotic terrain", seemed to have quickly lost great volumes of water which caused large channels to form downstream. The amount of water involved was almost unthinkable—estimates for some channel flows run to ten thousand times the flow of the Mississippi River. The subsurface volcanism may have melted the ice; The water then flowed away, and the ground simply collapsed, leaving a chaotic landscape.

Figure 4: Ravi Vallis, as seen by Viking Orbiter. Ravi Vallis was probably formed when catastrophic floods came out of the ground to the right (chaotic terrain). Image located in Margaritifer Sinus quadrangle.

2.3. Soil constituent

There are chemicals in the Martian soil that contain sulfur and chlorine, similar to what remains after sea water evaporates. Sulfur is more concentrated in the crust above the soil than in the bulk soil below. It was then concluded that the upper crust was cemented together with sulphates, which were transported to the surface and dissolved in water. This process is common in Earth's deserts. Sulfur may be present as sulfates of sodium, magnesium, calcium, or iron. A sulfide of iron is also possible. Using results from the chemical measurements, mineral models suggest that the soil could be a mixture of about 90% iron-rich clay, about 10% magnesium sulfate (kieserite?), about 5% carbonate (calcite), and about 5% iron oxides (hematite, magnetite, goethite?). These minerals are typical weathering products of mafic igneous rocks. The presence of clay, magnesium sulfate, kieserite, calcite, hematite, and goethite strongly suggest that water was once in the area [3]. Sulfates contain chemically bound water, so its presence suggests that water was around in the past.

The Mars Global Surveyor's Thermal Emission Spectrometer (TES) is an instrument able to detect mineral composition on Mars. The mineral composition gives information about the presence or absence of water in antiquity. As shown in Fig.5, TES identified a large (30,000 square-kilometer) area (in the Nili Fossae formation) that contained the mineral olivine. The ancient impact that created the Isidis basin is thought to have caused the fault that exposed the olivine. Olivine occurs in many mafic volcanic rocks; In the presence of water, it weathers into minerals such as goethite, chlorite, smectite, magnesite, and hematite. The discovery of olivine is strong evidence that parts of Mars have been extremely dry for a long time.

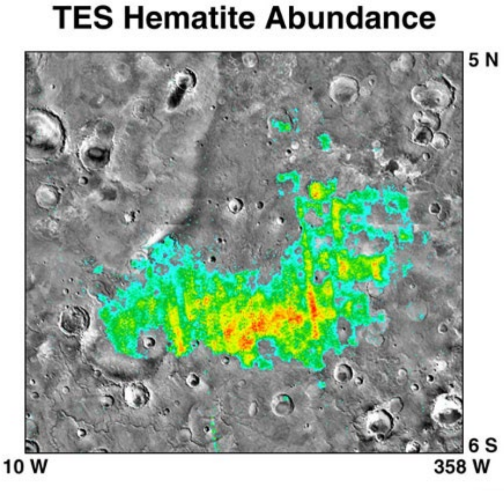

Figure 5: Map showing distribution of hematite in Sinus Meridiani, as seen by TES. This data was used to target the landing of Opportunity Rover. Hematite is usually formed in the presence of water. Opportunity landed here and found definite evidence for water.

2.4. Dark streaks on steep slopes

As shown in Fig.6, many places on Mars show dark streaks on steep slopes, such as crater walls. Dark slope streaks have been studied since the Mariner and Viking missions. It seems that streaks start out being dark, then they become lighter with age. Often, they originate in a small narrow patch, which then widens and extends downhill for hundreds of meters. The streaks do not appear to be associated with any particular layer of material, as they do not always start at a common level along a slope. Although many of the streaks appear very dark, they are only 10% or less dark than the surrounding surface. The Mars Global Surveyor has found that new streaks have formed on Mars in less than a year.

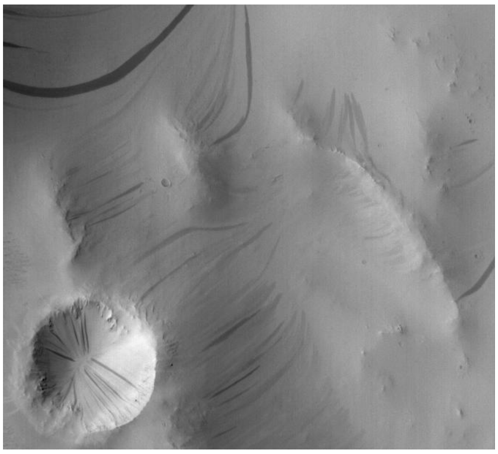

Figure 6: Dark Streaks in Arabia quadrangle. Crater is about the size of Earth's Meteor Crater in Arizona.

2.5. Inverted relief

Some places on Mars show inverted relief. At these locations, a streambed appears as a raised feature rather than a depression. The inverted former creek channel may have been caused by the deposition of large rocks or by cementation of loose material. In either case, erosion would erode the surrounding land and thus leave the old channel as a raised ridge, which would be more resistant to erosion. Fig.7, taken with HiRISE show sinuous ridges that are old channels that have become inverted [4].

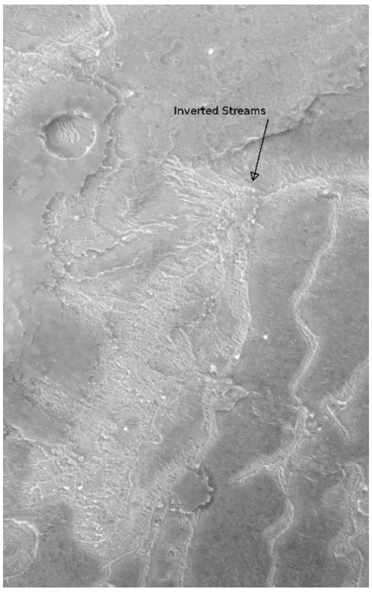

Figure 7: Inverted Streams near Juventae Chasma, as seen by Mars Global Surveyor. These streams begin at the top of a ridge then run together.

3. Conclusion

Having learned the basics about water on Mars, it's natural to wonder what would happen if the planet's water were released over a long period of time, from ice to liquid water. As we mentioned, the pressure measured by Pathfinder would not permit the presence of water or ice on the surface. But, if ice were insulated with a layer of soil, it could last a long time [5]. Because the surface pressure varies diurnally over a range of 0.2 mbar, but exhibits two daily minima and two daily maxima. The average daily pressure dropped from about 6.75 mbar to a low of just under 6.7 mbar, corresponding to the time when the maximum amount of CO2 had condensed on the south pole. Pressure on Earth is generally close to 1,000 mbar, so pressure on Mars is very low.

But assuming a long-term steady release of water on Mars, what would it bring to the planet?

First, the introduction of large amounts of water into Mars' atmosphere would have a notable impact on its climate system. Water vapor is a potent greenhouse gas, capable of trapping heat and raising temperatures. Increased humidity could potentially lead to the formation of more persistent clouds, altering atmospheric circulation and weather patterns on a global scale. This could lead to more frequent and intense precipitation events, such as rain or snow.

Second, the presence of water over an extended period of time would initiate erosion processes on Mars. Flowing water would carve channels, gullies and riverbeds into the terrain, reshaping the planet's surface features. Over time, the geological landscape will show evidence of weathering, sedimentation, and the formation of distinct landforms shaped by the action of water.

Third, the release of water on Mars would establish a functioning hydrological cycle. Evaporation from the surface leads to the formation of clouds, which subsequently precipitate as rain or snow. The water would then flow back into the lake and other bodies of water, completing the cycle. This sustained water cycle would enhance the potential for the long-term presence of liquid water, increasing the likelihood of a habitable environment for microbial life.

So, it can be seen that the release of water has a huge impact on Mars and may even lead to a more hospitable environment for humans to migrate to. In order to release water, it’s needed to make sure that we can have a steady and enduring release of water on Mars. There are two ways to do this. The first was to design a technique that would allow the release of ice water without subsequent evaporation; The other is to use natural factors, such as stimulating underground volcanic activity, to melt the ice. It is possibly believed that the second one is better because it does not require as much technological progress as the first one. That's my idea for future Mars research.

References

[1] Feldman W C, Prettyman T H, Maurice S, et al. Global distribution of near-surface hydrogen on Mars [J]. Journal of Geophysical Research: Planets, 2004, 109(E9).
[2] Kieffer, Hugh H., ed. Mars: Maps [M]. University of Arizona Press, 1992.
[3] Baird A K, Toulmin III P, Clark B C, et al. Mineralogic and petrologic implications of Viking geochemical results from Mars: Interim report [J]. Science, 1976, 194(4271): 1288-1293.
[4] Byrne S, Dundas C M, Kennedy M R, et al. Distribution of mid-latitude ground ice on Mars from new impact craters [J]. Science, 2009, 325(5948): 1674-1676.
[5] Clark B C, Baird A K, Rose Jr H J, et al. Inorganic analyses of Martian surface samples at the Viking landing sites [J]. Science, 1976, 194(4271): 1283-1288.
[6] Irwin III R P, Howard A D, Craddock R A, et al. An intense terminal epoch of widespread fluvial activity on early Mars: 2. Increased runoff and paleolake development [J]. Journal of Geophysical Research: Planets, 2005, 110(E12).