Kiyani Breaux

Professor

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Astronomy Cause and Effect Paper: The Future of Mars

In our Solar System, perhaps no planet has intrigued human beings as much as the ‘Red Planet’, Mars. An obvious reason for the added curiosity is the relative potential suitability of the Planet’s surface to support conditions that may allow life in some form to exist, owing to its comparatively hospitable climate. Exploring the past, present, and future of life on Mars, a number of missions and geological and astrobiological experiments have informed our current understanding of what Mars' surface conditions are like, and yet, the probability of finding life, with current technology, remains low. However, organizations such as NASA along with privately funded companies such as SpaceX are continually developing ambitious plans and laying out strategies for a manned mission to Mars that can enhance our understanding of what the future holds for life on Mars.

 Human curiosity with mars can be traced to the 19th century when Giovanni Schiaparelli described observing a network of canals on the planet's surface in 1877. Analyzing and mapping those canals took decades of effort, eventually leading Schiaparelli to hypothesize that an Intelligent Martian civilization may have built these structures to transport water from Mars’ polar regions, however, some catastrophic event may have occurred which caused their mass extinction (Gross). Though Schiaparelli’s theories seem far-fetched, ideas like these have continued to fascinate human beings until today and perhaps contributed to the sustained drive to explore the Red Planet.

Current theories and observations about Mars agree that the planet had a thick earth-like atmosphere to sustain the presence of liquid water billions of years ago, yet now the extreme temperatures and high Ultra-violet (UV) radiation levels make life unsustainable on the planet. The Earth, in contrast, is protected by its atmosphere blocking the sun’s UV radiation through an ozone layer, which on Mars has an insignificant presence. However, studies suggest that despite not being the ideal atmosphere, it may not solely be a limiting factor for life to exist (Ridder, Maan, and Summerer). The current surface of Mars is barren and dry, with its polar ice cap holding most of its water. The remaining portion is exposed to the sun's radiation to the extent that prevents liquid water to form on the surface. Nevertheless, there is still evidence that water once flowed on the planet's surface in the form of streams, rivers, and oceans which may have created habitable conditions for life, but the planet lost its water over time (Redd).

 A number of factors prevent explorers and scientists to dig deeper into the planet's history and conditions. A thorough investigation could only be carried out through a manned mission with the ability to return to the Earth. This would require a ship that could not only reach Mars safely but hold enough fuel to escape Mars atmosphere again and make a year-long trip back to the Earth or the ISS. Thus, carrying fuel propellants safety nearly 35 million miles away and returning back safely remains high risk with current technology. Moreover, the gravity on the surface is only 38% of Earth, and the health conditions of the astronauts in low gravity and high radiation environment are also critical factors to consider before a manned mission.

 However, despite all the constraints, a number of unmanned missions to Mars have launched in recent decades. The first Viking mission photographed the planet near its orbit and dispatched two landers to study its surface in 1976. Subsequently, the orbiter 1 mission provided. Further, in 2003, two rovers were dispatched to investigate Mars' surface and atmospheric conditions and determine whether life-forms could possibly exist. Following that, the Spirit and Opportunity missions (MER) were launched to carry out analysis and surveys of the planet’s geological conditions. Both the MER and Orbiter missions observed traces of water vapor in the atmosphere, especially near the planet’s North Polar region during its Summer and Spring seasons (Harland). These missions were highly significant in developing our understanding of Mars, with the presence of water vapor indicating that a suitable atmosphere could have existed in the past that could support life. Furthermore, the rover Opportunity also discovered Hematite on the planet’s surface near its Meridiani Planum. It was significant because. the substance can serve as a preservative for biotic and pre-biotic processes. Opportunity further discovered sedimentary rocks that were composed of sandstone and sulfate salts, indicating erosion. Moreover, the hover also indicated the presence of aqueous processes in the plains both in the sub-surface and surface regions (Howell). Yet, despite the existence of such processes, the presence of liquid water could not be ascertained and water vapor was restricted to the regions surrounding Mars’ polar regions. In 2012, the rover Curiosity investigated the Gale Crater and detected the presence of methane and other organic compounds, besides discovering water-soaked areas (Howell).

 As space technology further advanced in recent decades, an unprecedented amount of research was dedicated to studying Mars which was met with considerable success. Since 1997 after the arrival of the Pathfinder probe, there is consistent reporting being transmitted from Mars, which now make up a total of five probes; three orbiters and two rovers. Recent successes of the Mars mission have once again opened mankind to the practical possibility of establishing a human colony on the planet. Previously only science fiction, companies such as Mars One and SpaceX have made it an objective to dispatch human explorers and eventually settlers to the planet. Yet, despite these ambitious plans, the overall costs of man-made missions that can return back to earth safely would still involve an amount that organizations and governments would be unwilling to invest in space research. For this purpose, a variety of ideas continue to be proposed that may involve crowdfunding and other forms of collective economy to generate the required revenue. A four-man crew to Mars would require an estimated $6 billion, yet, the cost of a return mission could steep to nearly a $100 billion. However, companies are still making progress with some even selecting participants for the program. Mars One plans to send a rover in 2020, following its communications satellite, then dispatch cargo missions by 2022 to prepare for the arrival of settlers in 2024, that is set expand to 20 settlers by the year 2033 (Gross). In 2020, the European Space Agency and NASA are planning to dispatch more advanced rovers that will further investigate any traces of life-forms while drilling the planet’s surface to areas where microbial life is suspected to be present.

 Nevertheless, exploring the past and future of biological life or human colonization of Mars has led many researchers to conclude that Mars used to have an atmosphere conducive for life, even if that atmosphere was not as ideal as the one on Earth. These theories would be further confirmed by future planned missions such as the ExoMars and the Mars 2020 programs that will specifically experiment these conditions. It is possible that organisms that have developed tolerance to high temperature and radiation, such as tardigrades, could possibly survive in the otherwise hostile conditions of the planet, yet, even such life forms would have to exist substantially below the planet's surface to survive in the long-term (Sloan, Batista, and Loeb). It is possible for sub-surface oceans to host tardigrades especially near volcanic vents, and detecting any such presence would prove to be a big leap in the search for extra-terrestrial life.

 In the future, human colonization and exploration efforts would have to start with an initially small base that sets the stage for future explorers. However, to confirm all the theories and conduct detailed investigations would require developing a self-sustaining community that remains continually present on the Red Planet to conduct regular exploratory missions, something akin to research bases in less hospitable parts of the earth. Nonetheless, the only feasible way to study Mars, its past, present, and future is a sustained human presence which in turn would require creating habitable living conditions for such a community to survive and thrive. Researchers such as McKay and DeVincenzi have theorized how it may be possible to thaw the carbon-dioxide polar ice cap in Mars to modify the living conditions on the planet and restore its climate to a more favorable one for future colonization and exploration efforts. These studies, however, remain in a preliminary state and rely on limited models.

 In conclusion, space exploration has been the subject of increased human fascination ever since the first moon landing. In the case of Mars, our current technology and budgets limit our ability to explore the surface of the Red Planet ourselves, and till then, it is only possible to hope that someday human beings make that journey and discover its secrets in person. However, with recent plans being announced by SpaceX and Boeing, that future may not be far away as the competition to be the first to step on the Red Planet is driving innovation and leading the aforementioned companies to set targets as early as 2022 for their initial missions. When considering the near-primitive hardware which was utilized for the first moon-landing and comparing it to the advanced technology at hand today, there is no reason to think that such ventures could be impossible in the near future.

# Works Cited

Gross, Michael. "The past and future habitability of planet Mars." *Current Biology* 24.5 (2014): 175-178.

Harland, David M. *Water and the search for life on Mars*. New York, NY: Springer, 2005.

Howell, Elizabeth. *A Brief History of Mars Missions*. 8 April 2019. 23 April 2019. <https://www.space.com/13558-historic-mars-missions.html>.

McKay, Christopher P. and Donald L. DeVincenzi. *Life On Mars: Past, Present and Future*. 29 January 2000. 23 April 2019. <https://ntrs.nasa.gov/search.jsp?R=20010084183>.

Redd, Nola Taylor. *Life on Mars: Exploration & Evidence*. 15 December 2017. 23 April 2019. <https://www.space.com/17135-life-on-mars.html>.

Ridder, N. N., D.C. Maan and L. Summerer. "erraforming Mars: Generating Greenhouse Gases to Increase Martian Surface Temperatures. ." *Journal of Cosmology* 12 (2010): 4100-4112.

Sloan, David, Rafael Alves Batista and Abraham Loeb. "The Resilience of Life to Astrophysical Events." *Scientific Reports* 7.5419 (2017): 1-5.