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Origin and Possibilities of Life on MARS Environment: Theoretical Overview

Dheva Dharshini[1], Ankit Kumar Mishra[2]
[1]*Research Fellow, Department of Research and Development, ASTROEX RESEARCH ASSOCIATION, Uttar Pradesh, India*
[2]*Research Supervisor, Department of Research and Development, ASTROEX RESEARCH ASSOCIATION, Uttar Pradesh, India*

Abstract—For many years, there has been interest in and debate about the possibility of colonising Mars. The likelihood of establishing a human presence on Mars is increasing due to the quick development of technology and the growing desire to explore new horizons. An overview of the current state of research and development for Mars colonisation is given in this paper, along with information on opportunities and challenges related to the project. The study emphasises the advantages of colonising Mars, including the prospect of finding new resources and carrying out investigations that could advance human knowledge and technology. The paper also discusses the difficulties in settling on Mars, such as the hostile Martian environment, the requirement for sophisticated life support systems, and the psychological and physical effects of prolonged spaceflight. Overall, this paper offers a thorough examination of the state of research and development in relation to Mars colonisation and offers insights into the difficulties and possibilities presented by such a bold endeavour.
Keywords--- possibility of life in mars, environment in mars, habitat in mars, aquatic system in mars

I. INTRODUCTION

Mars, a cold, dry, dusty planet with a thin atmosphere, is the fourth planet from the Sun. Along with having seasons, polar ice caps, canyons, extinct volcanoes, and evidence that it was once even more active, Mars is a dynamic planet.Mars is one of the solar system's most explored planets, and it's the only one where we've sent rovers to explore the strange terrain.Currently, NASA is exploring the Martian surface with two rovers (Curiosity and Perseverance), one lander (InSight), and one helicopter (Ingenuity).The biggest and most sophisticated rover NASA has ever sent to another world, the Perseverance rover landed on Feb 18 2021, after 203 days covering 472 million kilometers.

II. WHERE ARE WE NOW?

As humans gradually overcome the technological obstacles to deep space missions, space agencies and commercial organisations are seriously considering the prospect of exploring and settling extraterrestrial outposts. But should we proceed simply because we might be able to? Is such a clearly dangerous adventure justified in terms of economics, law, and ethics? And even if it is, do we have the tools needed to manage these aspects of colonisation in a just and efficient manner? This essay examines a wide range of current arguments for and against Mars colonisation made by space enthusiasts with training in economics, materials science, and space technology.[1]
State-driven and monopolised space activities characterised the dawn of the space age. High costs, military interference, and the hazy prospects for civilian use all served to exacerbate this. But as space technology advanced, the enormous advantages brought about by space activities gradually encouraged private companies to invest more money and use space for commercial purposes. Two significant private space companies, SpaceX and Mars One, are said to have recently announced their Mars colonisation plans. On the other hand, appropriation of the Moon and other celestial bodies, such as Mars, is expressly forbidden by the Outer Space Treaty and the rest of Corpus Juris Spatialis.

All legal actors will face a new challenge as a result, particularly in the context of to investigate this idea in the outer space regime. The methodology used in this study is normative legal research. According to the study, the non-appropriation principle in the current Outer Space Treaty, in particular, is not relevant to the advancement of space technology and activities. The non-appropriation principle will then be reviewed in this study based on the mechanism of customary international law. Second, by creating an independent entity to authorise and coordinate the activities as well as by putting several stages into practise when appropriating the Martian areas, this study discovered the appropriate scheme of appropriation during the Mars Colonization Plan. In order to reach a compromise between the non-appropriation principle and the growth of space commercialization, this study's third recommendation was to amend and modernise the Outer Space Treaty. [2]

III. COLONIZATION ON MARS

The idea of human migration to Mars and permanent human habitation there is known as "colonisation" or "settlement" of Mars. Public space agencies and private corporations are both interested in the idea, and science fiction literature, film, and art have all extensively explored it.The first step in any colonisation effort would be a human mission to Mars, but no one has ever visited the planet, and there have been no resupply missions either. Landers and rovers, on the other hand, have successfully explored the planet's surface and transmitted data about the local environment. The asteroid belt and the Earth's orbit are both close to Mars' orbit. Although Mars' day and general makeup resemble Earth's, the planet is inhospitable to life. Mars has an atmosphere that is too thin to be breathable.

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HABITAT

In light of the most recent knowledge about the planet and the recently identified non-photosynthetic microbial ecosystems on Earth, deep sea hydrothermal vent communities and deep subsurface aquifer communities, we have reexamined the question of extant microbial life on Mars. Even after the surface of Mars became inhospitable, life may have persisted in protected subsurface niches connected to hydrothermal activity. Such habitats might still exist today, according to geomorphological and geochemical evidence from the SNC meteorites and recent volcanism, respectively. Additionally, there are numerous geological features that demonstrate how commonplace volcano-ground ice interactions are on Mars. We propose a potential deep subsurface microbial ecology that is comparable to those found at depths of several kilometres below the Earth's surface. We emphasise anaerobic systems that use CO_2 as their main carbon source. The heat from geothermal or volcanic activity may melt permafrost or other subsurface water sources, releasing liquid water. A microbial community based on chemolithoautotrophy could emerge as a result of reducing power (as CH_4, H_2, or H_2S) percolating up from below in the form of gases from deep within the planet's crustal eruptions. We propose a sulfur- and methanogen-based microbial ecology as a potential foundation for microbial primary production. Current observations of Mars do not support or disprove our hypothetical ecosystem. Locating active geothermal areas connected to

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ground ice or looking for minute amounts of reduced atmospheric gases that would leak from such a system are two ways to test for it. [3]

It has frequently been suggested that Mars is the most likely location to look for past or even present Martian life. The only place on Mars where life could have persisted over geologic time is in subsurface settings because the surface of Mars is essentially lifeless. Drilling is necessary to find a deep biosphere in the Martian basement. The mission's payload, which excludes heavy drilling equipment and limits the missions to only digging the top metre of the Martian soil, is a constraint on near-future Mars sample return missions. As a result, it has been suggested that sampling and 413ypothesi Martian impact ejecta could be used to gain access to the planet's deeper subsurface without the need for expensive drilling machinery. A natural geological process is impact cratering,able to extract and bring to the surface a significant amount of rock material from very deep levels. The preservation of pre-impact biosignatures, such as 413ypothesiz organisms and chemical biological markers, is demonstrated by numerous studies of terrestrial impact deposits. Therefore, it is reasonable to assume that biosignatures derived from the Martian subsurface could also be preserved in the Martian impact ejecta if the subsurface of Mars contains a record of life.[4]

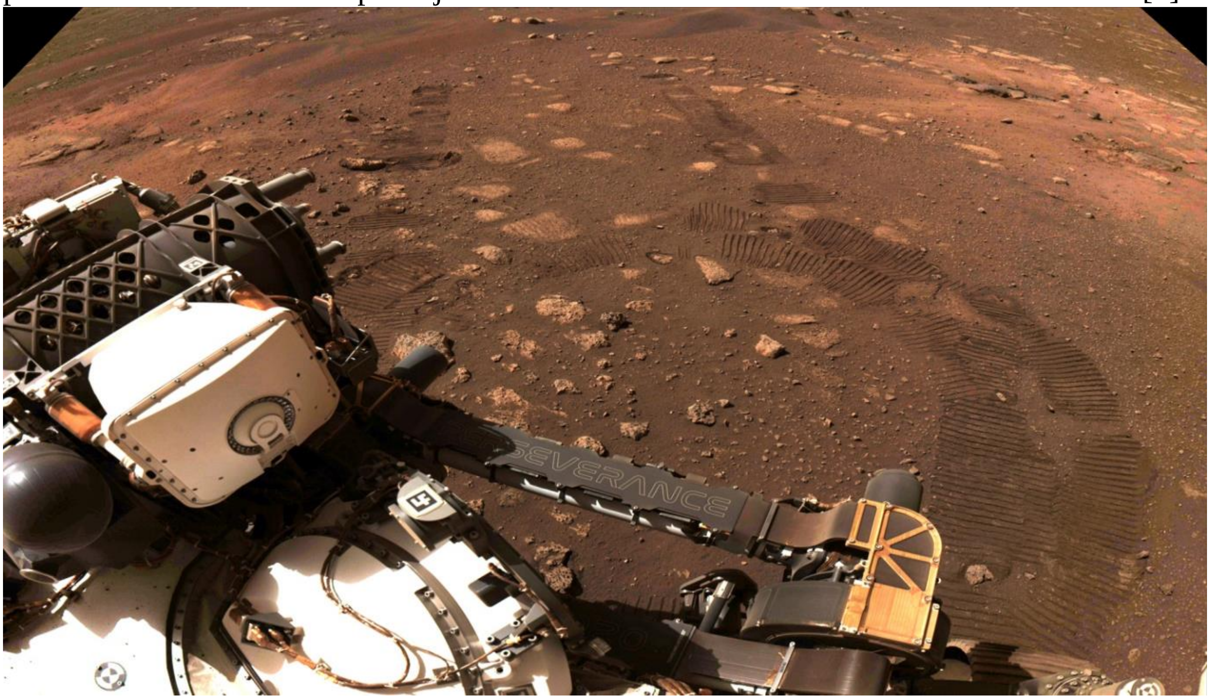

FIGURE 1: NASA'S PERSEVERENCE ROVER NAILS 21 FT TEST DRIVE

ENVIRONMENT

The meeting materials and discussions are 413ypothesiz in this review of material pertinent to the Conference on Biosignature Preservation and Detection in Mars Analog Environments, which is then expanded upon by specific citations to published literature. The potential for habitability and biosignature preservation in five main analogue environments—hydrothermal spring systems, subaerial environments, subaerial environments, subsurface environments, and iron-rich systems—is thoroughly discussed. Challenges common to all of these important environments are outlined in the context of examining past habitable environments on Mars, and then each environment's specific challenges for orbital and ground-based observations and sample collection are discussed. This introduces a brief section on how these issues might affect our plans and top priorities for Mars astrobiological exploration .The development of instrumentation and continued investigation into how Mars may have evolved differently from Earth and what that might mean for biosignature preservation and detection are among the crucial issues that are highlighted in a list of urgent needs

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and future research. Major Words: Astrobiological research, conference report, preservation of biosignature, detection of biosignature, and analogue environments on Mars.[5]
The evolution of Earth's environment and biology are inextricably linked. This coevolution has become a cornerstone idea in astrobiology and is essential to the hunt for extraterrestrial life. Whether coevolution occurred on Mars is unknown, but examining the relevant variables demonstrates how different each planetary experiment is, despite any similarities. Early Mars and Earth shared characteristics. The distinctive context of an irreversible atmospheric collapse, greater climate variability, and unique planetary characteristics would have forced any biological processes, if present, to proceed. Mars serves as a crucial test site for evaluating the effects of a particular set of spatiotemporal changes on a planet that is similar to Earth but also different. The early environment of Mars is still a subject that raises many questions. Nevertheless, existing data sets offer a basis for a theoretical framework that enables the investigation of notional coevolution models. The prospect of habitats, microbial ecotones, pathways for biological dispersal, biomass repositories, and their significance for exploration are now the main focus in this framework rather than planetary-scale habitability. Importantly, this focus highlights the significance of beginning to consider early Mars as a biosphere and actively integrating an ecosystem approach to landing site selection and exploration as we look for biosignatures.[6]

FIGURE 2: SOIL ON MARS

FIGURE3: The enigmatic evolution of the surface of Mars

AQUATIC SYSTEM

Setting up a production unit that allows for partial or complete food autonomy would be necessary for the long-term presence of a human community on the Moon or on Mars. The provision of food sources for crewed missions using locally available resources and their conversion into the food required to sustain life in space is one of the main goals of a bioregenerative life-support system. Aquatic organisms are potential candidates to supplement the nutrients provided by photosynthetic organisms already studied in the context of space missions due to their high nutritive value. Studying fish's potential to be the first vertebrate raised within the framework of space agriculture is pertinent in light of this. Through a summary of the potential for space aquaculture, this article thorough presentation of the outcomes so far of the Lunar Hatch programme, which is looking into the possibility of space aquaculture, and the main space missions involving fish in low orbit. Recirculating aquaculture systems and integrated multi-trophic aquaculture, which recycle fish waste to turn it into food, are two promising approaches. As a result, the development and use of space aquaculture could indirectly contribute to the preservation of our planet since its goals are similar to those of sustainable aquaculture on Earth.[7]

Liquid water is not possible to exist on the surface of Mars due to the low pressure that results from the planet's absence of a significant atmosphere. However, it has long been 415ypothesized by scientists that there may be water trapped beneath Mars's surface, possibly as a holdover from a time when the planet had lakes and seas billions of years ago. If such reservoirs are present, they might serve as potential Martian life habitats. In places like Antarctica, subglacial lakes on Earth are able to support life.

However, there might be issues due to the high salt content. Any underground lakes on Mars are believed to require a sizable amount of salt in order for the water to stay liquid. Despite being so far below the surface, there may be some heat from the interior of Mars, this alone would not be enough to melt ice into water.

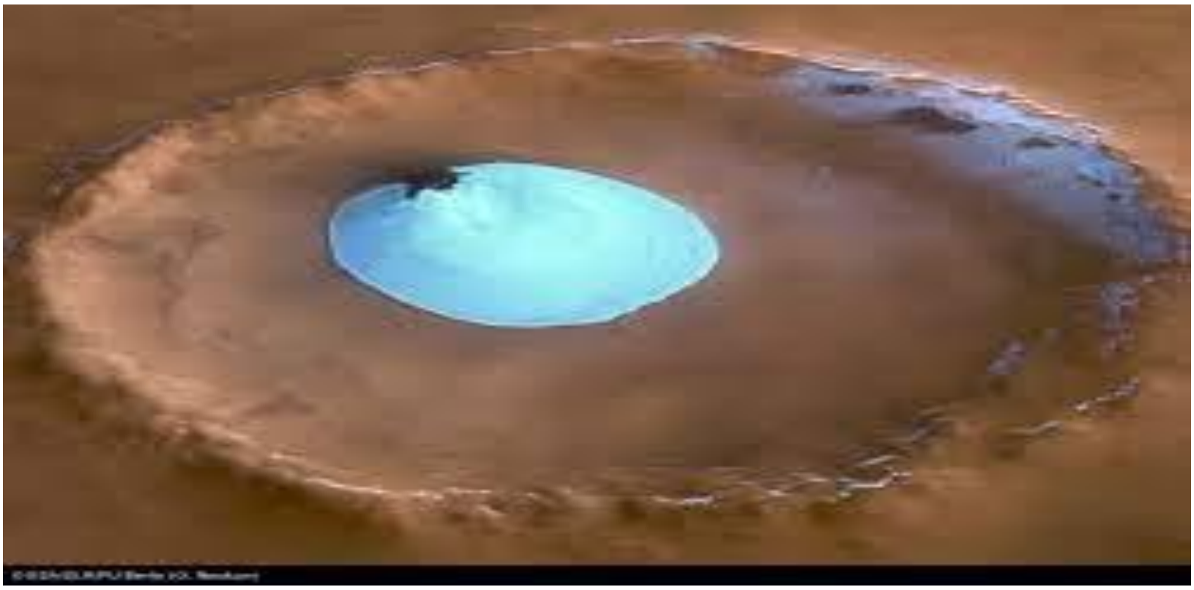

FIGURE 4: Water ice in crater at Martian north pole

IV. ENERGY AND TRANSPORTATION

The biomass, spatial distribution, and organism size of any biota on Mars will be constrained by the presence and density of biologically useful energy sources. Subsurface The oxidation of atmospheric H_2 and CO produced by photochemical processes that diffuse into the regolith could provide a significant energy flux to Martian organisms. Although only a small portion of this available flux is actually being used, surface abundance measurements of these gases show that this is the case. This suggests that biological activity that is driven by atmospheric H_2 and CO is restricted to the top few hundred metres of the subsurface. This is significant because the amount of energy that is currently available but untapped is enormous: for organisms at a depth of 30 metres, it is 2,000 times greater than estimates for hydrothermal and chemical weathering energy and significantly outweighs the energy produced by other atmospheric gases. This suggests that lack of energy is not the cause of the apparent scarcity of life on Mars. Since the photochemical energy flux can only reach depths of 100 to 1,000 m, where the majority of H2O is likely frozen, the availability of liquid water may instead be a more significant factor limiting biological activity. The discovery of brief trace gases will probably be a better indicator of any extant Martian life because soil data from the Viking lander and atmospheric data both show little evidence of biological activity.[8]

Transportation needs from Earth to Mars are calculated based on a 20-person permanent base operating in 2035. Different modes of transportation, such as propellant tankers, crew and supply transfer vehicles, orbital facilities, and extraterrestrial propellant factories, are developed in order to meet these requirements, assuming that there is already an established space infrastructure. The total amount of propellant needed, the number of vehicles needed, the flight times, the frequency of opportunities, and various other factors are compared between these modes of transportation. There are suggestions for further research and analysis.[9]

A hypothetical Mars planet propulsion concept is examined. The primary energy production cycle is thought to involve the combustion of aluminium or magnesium in CO2. Analysis is done on the flight options in the rarefied Martian atmosphere. Theoretically, the issue of determining the lift force in a compressible gas near a rigid surface was resolved. It has been shown that increasing the lift force on an approaching rigid surface can ensure safe flight in the Martian atmosphere.[10]

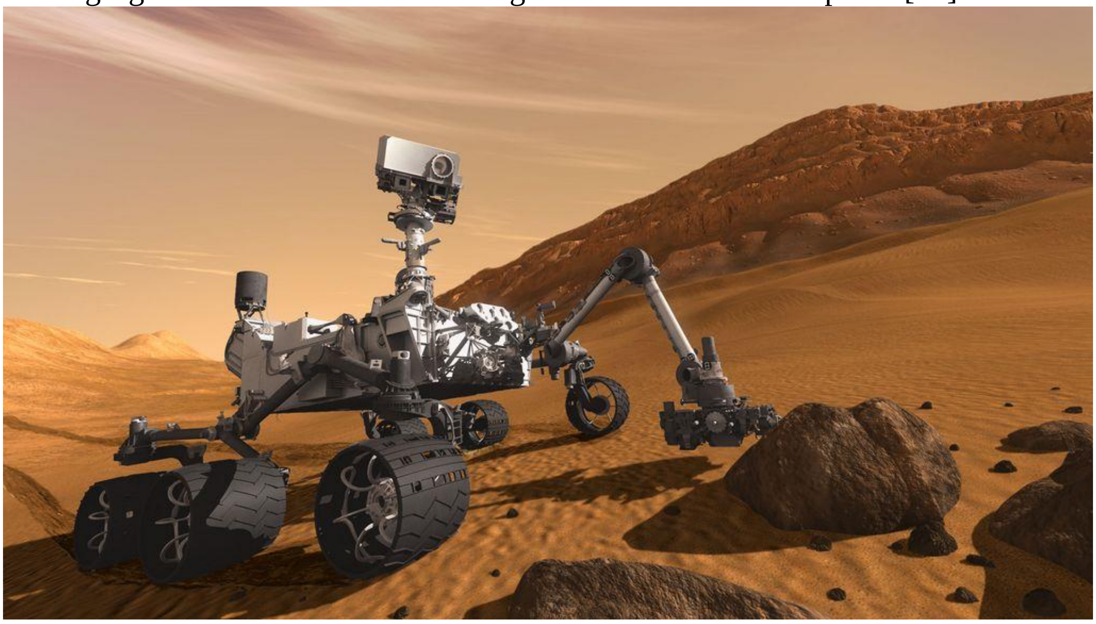

***FIGURE 5:** Curiosity Rover Mission (https://mars.nasa.gov/msl/mission/overview/)*

***FIGURE 6:** An artist's conception of NASA's Spirit rover on Mars (https://solarsystem.nasa.gov/missions/spirit/in-depth/)*

V. CONCLUSION

Mars colonisation is a huge undertaking that needs to be carefully planned out and taken into account. Although the prospect of humans settling on the red planet is intriguing, it also presents a special set of difficulties. The first step is to build a viable human habitat on Mars. Creating aquatic life, energy sources, and transportation infrastructure that can sustain life on the planet are all examples of this. We must also address moral and legal issues, including how to equally distribute resources, safeguard the environment, and guarantee public safety.

Mars's potential for human settlement is undeniable, even though much work still needs to be done to make it habitable. By collaborating, we can use our combined resources to create a new society on Mars using ingenuity, innovation, and creativity as you explore this amazing and mysterious planet. The colonisation of Mars can be a huge success with the right tools and technology.

In conclusion, colonising Mars is a challenging project. The difficulties of supplying and maintaining habitats, aquatic life, energy, and transportation will call for innovative solutions. However, with the right mix of scientific progress and human ingenuity, humans might colonise Mars in the future. Although there are many obstacles to overcome, the potential rewards in the form of scientific and economic advancement may very well make the effort worthwhile.

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