Mars Geological Universal Human Viability Base

Technical Report

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Abstract

The planetary history of Mars can be compared to a dystopia of Earth, where the examination of the processes the planet is currently and has gone through will provide critical information in determining preservation efforts of Earth and/or a future permanent Mars settlement. Within the context of the mission Mars Geological Universal Human Viability Base (MGUHVB), a base will be established on the surface of Mars in order to draw conclusions of the geo-planetary history of Mars and to test the viability of a human settlement on Mars. The requirements, timeline, location, constraints, risks, and responsibilities of the crew will be discussed within the body of the paper. Additionally, a press release will be included in order to summarize the mission in colloquial terms. A scope summary is provided below which briefly discusses key elements of the mission. Ultimately, this report is to provide details regarding MGUHVB for a possible base, lay the groundwork, and provide a platform for critical discourse on space exploration.

*Keywords*: human settlement, Mars, geo-planetary history, viability

**Scope Summary Page**

* Need: Earth is losing its ability to support life; lack of knowledge on universal function
* Goal: Prove a human settlement possible on Mars and/or the preservation of Earth
* Objectives:
  + Demonstrate human viability on Mars and conduct the research required for that
    - Includes observing possible ancient life
  + Understanding planet formation, both specific to Mars and in general
  + Understand geological processes that exist on Mars and their relation to its planetary history
* Mission: Transport forty personnel to Mars for research and have them return after one decade on Mars
* Constraints: Must be sent before 2040 and return before 2050 or during 2050
  + Between 10-40 People
  + Phase III Mars Base
* Authority and Responsibility: NASA has complete jurisdiction and a partnership with SpaceX and ESA to complete the mission
* Assumptions: Current technology suits the needs of the mission
* Operational Concepts:
  + Launch equipment, Launch Personnel (over a period of two days)
  + Begin preparations for Mars landing
  + Mars landing (after nine months), base setup, base fully operational
  + After research has been conducted for one decade, pack up some equipment, return to Earth, approximately nine months

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Earth is, as current knowledge dictates, the only source of life in the universe. A relatively near planet, Mars, is thought to have possibly been similar to Earth due to the water that exists there (albeit usually in ice form). Mars, in its distant past, also contained a functional atmosphere and magnetosphere, two planetary aspects often cited as absolutely necessary for initially supporting life. Although Earth fulfills the requirements of life, the resources of this planet are ultimately finite, even if they may be recycled. At the current rate of human expansion (for most population curves, epidemics/pandemics are not considered so COVID-19 will not be considered) and if no measures are taken, Earth will no longer be viable. Mars Geological Universal Human Viability Base (MGUHVB) is designed for that very purpose. A Mars base will be established in order to examine planetary scale preservation methods or, if a pessimistic future occurs, a complete movement to Mars if deemed habitable. Mars’s rich history will offer a new insight into Earth’s future and will not only possibly be responsible for the salvation of the planet, but also provide new knowledge on the creation of planets and the universe.

**Mission/Base Name**

Mars Geological Universal Human Viability Base is the name for this mission concept. This name has been chosen to summarize some basic concepts of the mission. The mission will be taken on Mars with the creation of a base. The base personnel will examine Mars for its geo-planetary history. This will help give an understanding of the universe and its creation. Ultimately, this mission is to prove human viability on Mars. The name of the base itself is Human Observation Mars Environment (HOME) where the acronym HOME is to ease in the transition from Earth to Mars for the personnel. The environment of Mars is of interest in this mission, where personnel are assigned to make observations and conduct experiments. Because one of the goals of this mission is to further preservation efforts of Earth on a planetary scale, creating a sense of welcoming is imperative, which makes HOME ideal for a base name.

**Mission Statement**

MGUHVB serves to provide critical data on geo-planetary processes on Mars and Mars’s history. It also hopes to prove a long-term human settlement on Mars and its implications. The preservation of Earth is part of the culminating goal of MGUHVB, as certain human-initiated processes as well as natural phenomena are expediting the destruction of Earth. This mission serves to ultimately guarantee the survival of life on Earth, or at least life from Earth. Besides the longevity of life, the amount of knowledge to be gained from this mission is immense. Currently, satellite and rover data have given NASA much intel on Mars and the processes that occur on it. However, there is a substantial amount to be learned on the deeper geo-planetary processes that explain the lack of a magnetosphere and atmosphere on Mars. Mars, as explained earlier, can be compared to a dismal future of Earth if preservation efforts are not correctly implemented.

**Mission/System Requirements**

Since this mission is quite long and far away, many items will be required, the most difficult of all being food supplies, water, etc., for the personnel to live. Under “Outpost Location”, it is explained that water can be found, mostly in ice form, in the region that MGUHVB will be conducted in. This could solve the issue of water. Under “Mission Constraints”, it is shown that certain plants could potentially grow on Mars with the necessary adjustments. Ideas for food and water still need to be formulated in order to better achieve the goals of the mission. The requirements to deal with a few potential risks are under “Risks/Dangers” where some solutions are labeled. The mission requires experienced and specialized personnel (“Crew Responsibilities/Functions” houses some details about this) and would require many resources poured into the facilitation of their training. The instruments will vary depending on the experiments approved to be conducted on Mars. In general, refractometers, spectrometers, radiometers, thermometers, microscopes, etc., will be needed to check on the environment. Specialized types of lidar and radar will also be useful for determining geo-planetary makeup. Exercise equipment, such as a treadmill, will be necessary for maintaining muscle and bone density throughout the mission. A processing plant for materials will be needed so as to facilitate research. Medical equipment is also necessary for the mission, with at least 100 fully equipped medkits, 5 hospital beds, heart monitors, IV, needles, and other standard hospital equipment. An oxygen plant is extremely crucial which could utilize some of the plants brought up for food. A baseline amount of oxygen tanks would be necessary to bring to start this process. Power requirements for the base may vary depending on the experiments occurring but solar panels should suffice to maintain all power needs. If adjustments are needed, nuclear power is a potential alternative. A communication center is necessary, requiring Deep Space Network satellite dishes for regular communications.

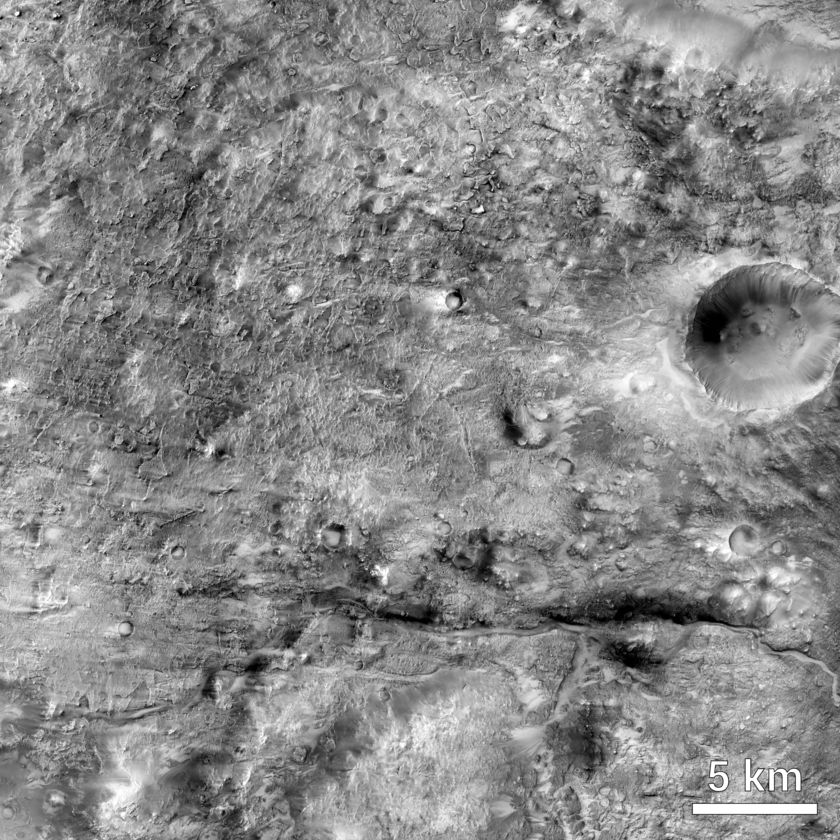
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**Mission Timeline**

The mission will be launched in June 2035. This date has been selected due to the relative close proximity that Mars will have to Earth at this time (McClure, 2018). There is no other period where Mars is extremely close inside of the constraint time so the return date does not particularly matter. The journey to Mars should take roughly 9 months; the mission timeline has been adjusted to accommodate the 18 month travel time going to and returning from Mars. The date to leave Mars will be in December of 2046. Due to the location of the base, no extreme weather patterns should be happening during any time, so that should not affect the schedule (refer to “Outpost Location” down below). If a dust storm is to occur, the launch date can be shifted slightly. Additionally, if any early return is necessary due to emergency, the mission can be recalled; however, more planning will be sought if the mission concept is accepted since it will be difficult to call back the crew on a whim. In the beginning stages, the base will be set up. It should take one month before the base is fully operational. Afterwards, the crew will conduct experiments for a period of roughly one decade before leaving for Earth. All data will be sent continuously throughout the mission. The exact dates for tests that will be conducted in the base is up to the discretion of NASA managers.

**Outpost Location**

The location of the base is crucial and based on previous data; Northeast Syrtis Major (NESM) has been selected as a good candidate. The region is located at 18°N,77°E within the northern hemisphere. NESM refers to the northeastern part of Syrtis Major, a shield volcano. NESM is representative of a larger ancient region, making it extremely important to Mars’s geological history (Bramble et al., 2017). Due to this, NESM will aid the understanding of geo-planetary processes, creation of planets, the history of the solar system, and possibly the universe. Those processes can then be used to understand the Earth and the likelihood of its preservation. NESM also contains a “diversity of hydrated minerals” which may have been “conducive to life” (NASA, 2010). This points to the possibility of finding life, dead or alive. If life is to be found in NESM during this mission, these processes can more directly be applied to Earth since Mars can be likened to a post-cataclysmic Earth. This base, because of the presence of water, may be crucial for refueling rockets in the future, the base, or for just drinking water. Water will be a valuable commodity in space and in some places on Mars, so NESM is ideal for serving multiple purposes.



Pictured above is a bird’s eye view of Northeast Syrtis Major. It was taken by the

Mars Reconnaissance Orbiter Context Camera, originally at a resolution of 5m/pixel.

*NASA / JPL-Caltech / MSSS / Tanya Harrison*

**Mission Constraints**

There are some constraints given by NASA, including that the mission launches before 2040, the personnel return to Earth no later than in 2050, and that the base is a Phase III base (10-40 people). The mission fits within these constraints. One particular constraint may be lack of necessary technology but most studies seem to include technology capable or almost capable of completing the necessary tasks. It is a fair assumption that before the launch date, the necessary technologies will have been improved upon. The food that the personnel will be able to eat is also going to be restricted. It may not be possible to send a supply of dehydrated rations that would last the entire time or to constantly supply the base. Efforts into growing plants on Mars have been made and some plants may be available for growing on Mars, granted that they are able to be transported to Mars. The list includes kale, carrots, lettuce, sweet potatoes, onions, dandelions, and hops, as they have been proven to grow in Martian soil, with some adjustments (Cartier, 2018). Naturally, normal soil can be brought but that may prove to be unnecessary weight. The amount of EVAs has to be limited as well. The surface temperatures on Mars at night are far colder than Earth’s average nightly temperatures and are going to restrict EVA time. Lastly, the duration of the mission itself must be constrained. The time of MGUHVB cannot be greater than a decade as the health effects would accumulate over time. Frankly, one decade with current technology may need to be reconsidered. Again, this mission is considered with the assumption that certain technologies and/or methods (refer to “Risks/Dangers” below) will improve.

**Risks/Dangers**

As with anything worthwhile, there are definitely risks involved. The primary risks would be radiation, reduced gravity, and waste mitigation. Although there are others, these risks must be addressed first. Radiation (ionizing), whether it be a wave or subatomic particle, transmits energy to the cells of astronauts at the genetic level (Tran, 2019). When these waves/particles interact with genes, nitrogenous bases (molecules that determine protein function depending on the order) may be rearranged, added, or deleted out of the code. This is damaging to humans and most life as it messes up the formation of functioning proteins, even to the point of death. On Mars, exposure to radiation can be from 10 rem/year to 20 rem/year (Williams, Nov. 2016). The space flight itself would expose the astronauts to dangerous ionizing radiation. Hydrogenated boron nitride nanotubes (BNNTs) could be used as a material in the suits to mitigate the radiation exposure on the personnel (Garner, 2015). The reduced gravity also poses a threat to the personnel. Gravity on Mars is 0.376 Gs, with a gravitational acceleration of about 3.71 m/s2 as opposed to Earth’s 1 G and 9.80 m/s2 (Williams, Dec. 2016). The primary concern from reduced gravity is that there will be less force on the bones, muscles, and other systems, resulting in the deterioration of those (Howell, 2017). Essentially, the personnel will grow weak and will not be able to return to Earth without adjustments, potentially dying after returning. To solve these issues, among the others not listed caused by reduced gravity, a solution is proposed in one study. As outlined in the study, “an optimal solution could be represented by a combination of centrifugation with (i) intensive aerobic exercise for cardiovascular system protection and (ii) moderate exercise to prevent musculoskeletal system deterioration” (Demontis et al., 2017). Of course, if the personnel are put in a centrifuge, they could be subject to motion sickness from the Coriolis effect but this solution is theoretically the best outlined in the study. Waste is another issue the crew will have to deal with. The largest problem with waste is that it can be unhealthy to keep around the base/spacecraft and simply takes unnecessary space (Mahoney, 2013). While in the spacecraft and when close to Earth, the waste may simply be ejected back towards Earth and collected by NASA personnel. However, a much more efficient use of waste is to convert at least some of the waste into fertilizer or useful gases, or essentially just reuse it. Technology for this does already exist. If nothing can be done with some waste, then it will simply have to be taken back to Earth on the return trip. There are always methods to attempt to circumvent risks, although there will always be some risk present and that has to be considered when framing this mission.

**Crew Responsibilities/Functions**

There will be 40 crew members operating at HOME. Carrying this many individuals at once may be difficult so two or three separate flights all flown within weeks of each other may need to be undertaken. Regardless, 40 crew members will benefit HOME. There is no actual need for a certain amount to be men or women. Because the base is Phase III and effects on pregnancy in space are unknown, the women must not get pregnant leading into the months of or during the mission. Otherwise, gender plays no role. Much experience in space will be needed beforehand, so the crew will typically be older. At least 5 medically experienced individuals need to be in the base in order to tend to any health concerns. 1 additional person must be able to tend to psychological stresses. Another additional person or two must be able to help with physical therapy and exercise. 3 would be communication specialists and receive and transmit signals. 15 individuals would be scientists, with 3 teams of 5 focusing on different science experiments. 10 would conduct field experiments and collect data using rovers and EVAs. Finally, the last 4-5 would tend to the base itself, whether it be repairs or management issues. Out of those 40, 1 leader would be chosen to manage the base as a whole, probably from the latter group. Training for the personnel would be up to 3 years of professional development, relating to each individual’s task.

**Conclusion**

Philosophically, this mission holds great importance to the sustainability of mankind. MGUHVB and HOME are crucial to the preservation of Earth or, in a pessimistic scenario, the movement to Mars. This mission concept has its flaws, however, the idea remains consistent with NASA’s overarching goals of expanding knowledge on the universe and benefiting humanity in some form or another. Mars, although not the closest planet to Earth at any given time, is the only planet that may share a similar geo-planetary history to Earth. This mission heavily expands on current observations conducted by rovers and satellites regarding Mars and can only be conducted close-up with direct human observation of various conditions on the Red Planet. Ultimately, this mission lays the foundation for future space exploration, goals only possible by starting out with Mars, being the most viable planet to conduct experiments and observe data on. This mission, if conducted, has the great possibility of saving lives, gaining a larger understanding of the origins of the solar system and universe, and understanding planet Earth.

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**2035 Mars Mission**

The famous Red Planet, occasionally gleaming in the night skies, has been something NASA has kept its eye on for quite a while. The planet is just waiting for humans to settle and study all of the wondrous processes that go on there. In Mars Geological Universal Human Viability Base (MGUHVB), NASA, along with SpaceX and the ESA, is sending people to the once-lively planet. As of now, June of 2035 is a target with December of 2046 as the return date.

This roughly 9 month journey is not for nothing, after all. Mars is like a nightmarish Earth, so if one studied Mars, he or she could learn so much about Earth if conservation and preservation efforts failed. Plus, Mars is also like an old archaeological site, where scientists can learn so much about the universe, formation of planets, and geological processes that happen everyday. This journey is the combination of years of human effort, all to better life for everyone.

The Mars base will be called HOME, short for Human Observation Mars Environment. Here, lots of equipment and specialized personnel will be needed since they will be up there for about 10 years. There is the place called Northeast Syrtis Major, a section of a shield volcano on Mars. Over there, the history is rich within the rocks, and there is even evidence of water there. Life could even be found there.

Of course, there are going to be some risks for trying to explore space. Any good adventure has a bit of risk but there are always ways to deal with those risks. So far, some answers exist but NASA will definitely do research to help minimize the potential problems those astronauts could face in space.

At the end of the day, this is a team effort. This mission needs a whole crew just to get one thing done. NASA needs everyone to do their part, whether it be paying taxes or assembling the rocket to go there. Mars is just another step in humanity’s adventures into space and knowledge.