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Martian aqueduct as a first phase to a Martian mobility system

Abstract

The recent discovery of underground frozen lakes at the South Pole of Mars marks a milestone in the exploration of the planet. Water is essential for sustaining human presence, and while it may hint at the possibility of ancient life forms, its primary importance lies in supporting future human settlements on Mars. The location of these future settlements will be heavily dependent on the presence of water, limiting the choice to a few sites with underground ice deposits. However, we must also consider alternative locations that, although not close to water sources, may offer other advantages. In such cases, we should explore the possibility of constructing a network of aqueducts to supply water to these locations, originating from a central extraction point near the South Pole. Depending on the design criteria, this aqueduct system could be developed as a versatile infrastructure capable of expansion. In the future, it could be upgraded into an advanced transportation network, utilizing maglev-powered vehicles to connect Martian settlements and facilitate movement across the planet. This infrastructure would address immediate needs such as water supply while also supporting long-term development plans for Mars.

Keywords: Martian aqueduct, transportation infrastructure, surface mobility, mag lev vehicles, utilities

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Introduction

Water is a fundamental necessity for human survival. The first human settlements on the Moon and Mars will require the presence of water as one of the essential requirements for life support systems and human survival. Its production and presence on the Moon and Mars is crucial for the sustenance of any human crew or prospective settlers, and its availability will significantly influence the selection of landing sites and settlement locations. Recent discoveries have confirmed the presence of water in both bodies, in the form of underground ice lakes or just ice attached to soil, always underground. The selection of the South Pole of the Moon for the Artemis mission is mostly due to the fact that there is water in such location, especially in the Shackleton crater. While the following considerations may be valid for several bodies that contain water, let s consider, as an example, planet Mars, the closest to us. When we consider Mars we must remember that in the 19th century, Italian astronomer Giovanni Schiaparelli, using primitive telescopes, observed features on Mars that he termed “canali” (canals).[1]

Subsequently, American astronomer Percival Lowell theorized that these canals were constructed by intelligent beings to transport water from the poles to potential settlements, sparking numerous assumptions about Martian life and inspiring early science fiction narratives (Figure 1). In recent years, Martian probes have revealed a desolate planet, bitterly cold and seemingly devoid of life. However, they have also uncovered the existence of water in the form of ice mixed with soil in various underground locations.[2]

More recent findings indicate the presence of a network of underground icy lakes in the South Pole region. While alternative methods for water production, such as extracting components from the atmosphere or existing minerals, exist, the most practical approach is to extract water from underground ice formations without the need of chemical processes. Future settlements will undoubtedly require water, and since extraction processes will likely be centralized, there will be a need to transport water from extraction areas to settlement sites. The need for a Martian aqueduct becomes evident and represent a priority in the development plans for the planet (Figure 2).[3]

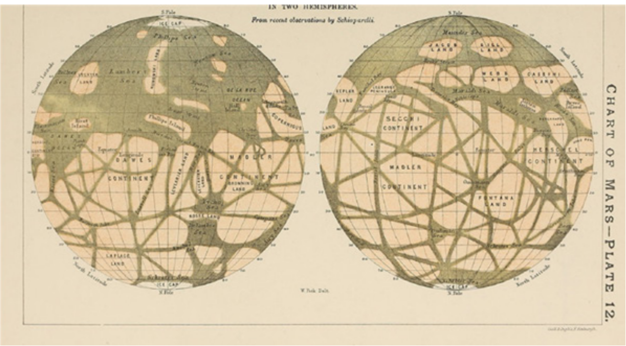

Figure 1 Canals in 19th century map of Mars.

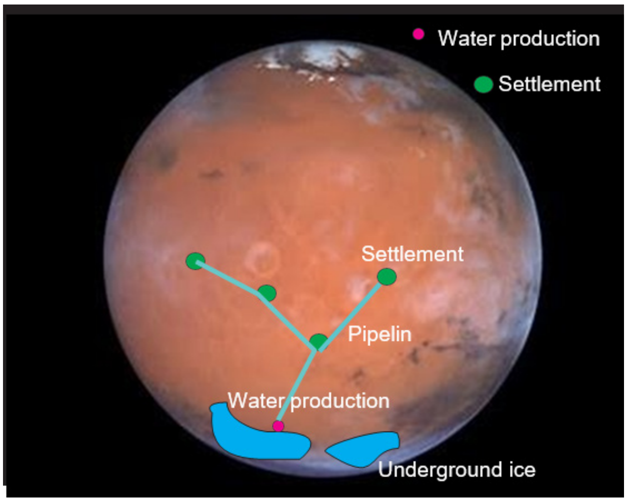

Figure 2 Aqueduct network concept.

The vision

We should capitalize on the recent discoveries of subterranean ice lakes on Mars by converting this ice into water and creating surface ponds for storage near existing or planned human settlements. If possible, we should utilize small existing craters, properly prepared, to serve as these storage ponds.[4]

Future settlements should be located near these ponds, thereby establishing a living ecosystem using Martian water populated with terrestrial water plants and fish. Our ultimate goal is to establish a multiplanetary society, with Mars being the first serious candidate for a second home for humanity. The future possibilities of terraforming Mars should be considered from the beginning of its exploration. Creating a network of ponds, which could grow into small lakes, would not only supply water to future settlements but also establish an early ecosystem, marking a first step towards this long-term goal.[5]

The proposal suggests a straightforward and efficient water distribution network to convey water from production areas to Martian settlements, ensuring swift and sustainable delivery.[6] We aim to address these needs by establishing a practical water transportation system tailored to the limitations and characteristics of the red planet. Departing from the antiquated concept of canals, our proposal envisions a network of water pipes spanning the planet (Figure 2), extending from the water production points at the South Pole to various existing or proposed settlements across Mars.[7]

The accompanying diagram (Figure 3) illustrates the proposed system. It shows the extraction point where water is drawn from subterranean ice lakes, an aqueduct network for transportation,[8] and a pond created in an existing crater for water storage near a settlement.[9]

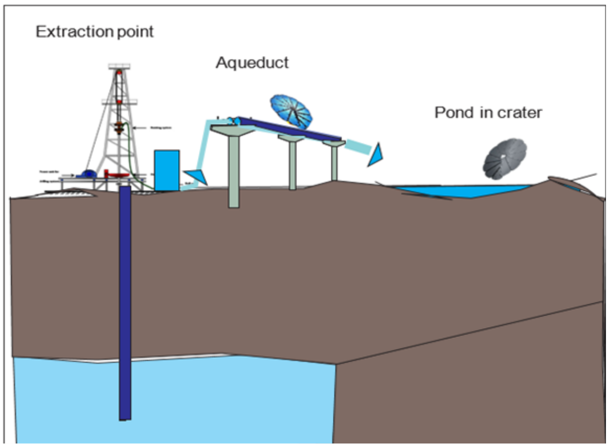

Figure 3 Activities flow.

Goals

Several goals are associated with this proposal:

Simplicity: The network should be easy to construct, utilizing minimal and straightforward components, even under harsh Martian conditions. No earth movements or heavy equipment are required.[10]

Sustainability: The system should rely on renewable and non -polluting energy sources.

Expansion: As a basic infrastructure, the system must allow for future expansions and enhancements.

ISRU (In-Situ resource utilization): It should be based on local materials and cutting -edge local technology.

Affordability: The system should be cost -effective with minimal construction time.

Flexibility: The system should allow future expansion and different utilizations, serving as an essential instrument of planetary colonization (Figure 4).[11]

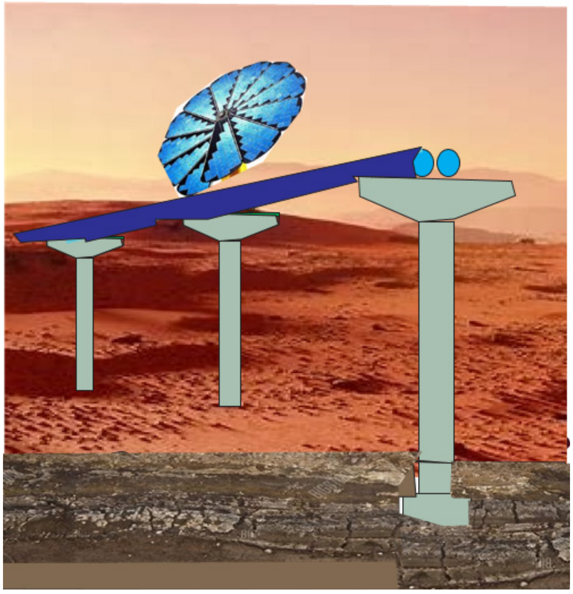

Figure 4 Concept design.

The aqueduct system components

The proposed system will be an elevated aqueduct network connecting all main settlements on the planet, with transportation infrastructure for future developments. The need to elevate the water pipes arises from the necessity to avoid costly and time-consuming earthwork activities on rough terrain (Figure 4).[12]

Columns: Custom-made structures constructed on-site using Martian concrete and 3D printing technology to accommodate the varied topography. Each column can be customized according to ground elevation requirements (Figure 5).

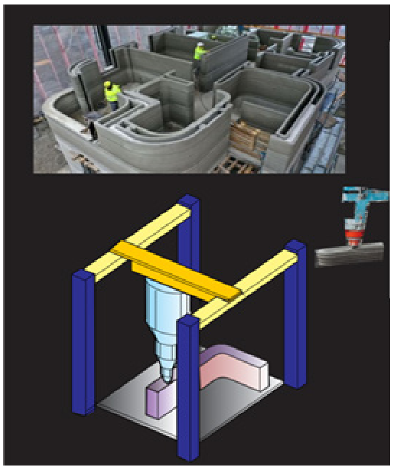

Figure 5 Columns 3D printed.

Water pipes: Plastic pipes, 30 cm in diameter and 20 m long, manufactured in a centralized plant and transported to the site for water transport. The plastic will be sourced from components present in the Martian atmosphere.[13]

Pump system: To move water inside the pipes from underground lakes to the final destinations.

Water heating system: To prevent water from freezing in sub-zero Martian temperatures, a protected incandescent cable will run alongside the pipes.[14]

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Power generation: Solar panels, conventional or flower -shaped (Figure 6), will be deployed to power water heaters and pump stations distributed along the pipeline as needed.

Figure 6 Solar flower for PV energy.

Operations: The main sequence of activities is shown in this diagram (Figure 7).

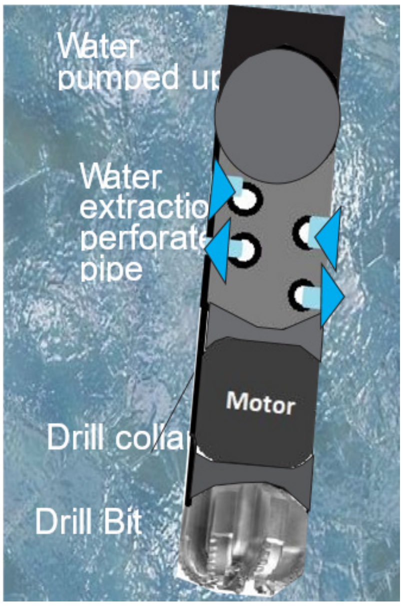

Figure 7 Drilling in ice.

Water production

Several methods have been proposed, the most common is to heat the ice through microwaves and melt the ice. Since the water must be also extracted we are proposing to drill the land above the lakes with similar equipment that terrestrial oil rigs. The final part of the rigs will be heated to about 200C to melt the ice in its vicinity. A perforated pipe will allow the water, obtained by melting the ice, to enter the pipes where pumps will direct it to the surface at specific heated water storage equipment before it is transferred to the pipeline, (Figure 8) also heated to avoid the return to the ice condition, considering the subzero Martian average temperatures.[15]

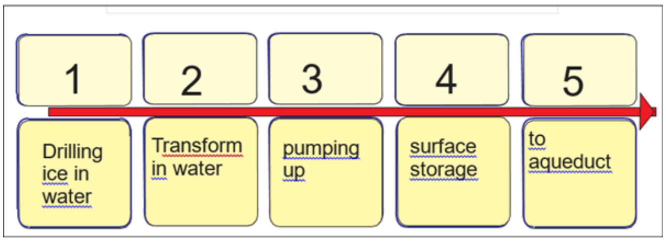

Figure 8 Activity flow.

Once in the aqueduct the water will be delivered to selected locations, equipped with the aqueduct, where craters, previously prepared will be filled with water.[16]

Aqueduct construction: Custom sized columns, will be manufactured on site with Martian concrete delivered to the site on a daily basis.[17]

All activities will be automated, employing equipment with advanced AI capabilities. Two mobile vehicles one equipped with 3D printing capabilities for column construction and the other with a crane for pipe installation will progress together with assembly operations (Figure 5). Daily deliveries of Martian concrete, pipes, and necessary equipment will support construction activities.[18]

Material transportation: Materials will be transported to the site using the ring vehicle, a space tug employing lunar landing vehicle technology, from the centralized manufacturing plant settlement on a daily basis. Pumps, water heaters, solar flowers for power generation and any other needed equipment, will be delivered on site and utilize as the pipeline advances.[19]

Water storage

The water proceeding from the Poles must be stored in existing craters previously prepared, including solar flowers to generate power for water heating, considering the fact that if left at non controlled temperature, it will return to ice.[20]

Pond preparation

Measure the dimensions of the crater and select a durable, non -toxic pond liner that matches these measurements. Such pond liner would be manufactured on Earth in rolls and delivered to Mars. Unroll the liner over the excavated area, ensuring it covers the entire pond. Smooth out any wrinkles or creases to prevent potential punctures. At the end of phase 1 the aqueduct network, including few selected craters, will be ready for utilization.[21]

Phase 2 activities

As the planet development proceed the aqueduct network infrastructure will be expanded to include a complete Martian mobility system, connecting all communities. The construction of the aqueduct infrastructure, being pivotal for the planet, should be designed to support future planetary infrastructure development, potentially integrating other transportation and mobility systems (Figure 9). This could include the addition of a maglev-powered hyper loop system for cargo or passenger transportation between settlements, as well as the incorporation of electrical lines and other pipelines for liquids or gases as needed (Figure 10). Such system would consist of :

A cargo and passenger transportation system with vehicles running in a pipe powered by magnetic levitation. Service and utilities, cables, pipes, ducts etc, running in the same structure Adding a parcel transportation system for smaller payloads could be an optional for the future.[23]

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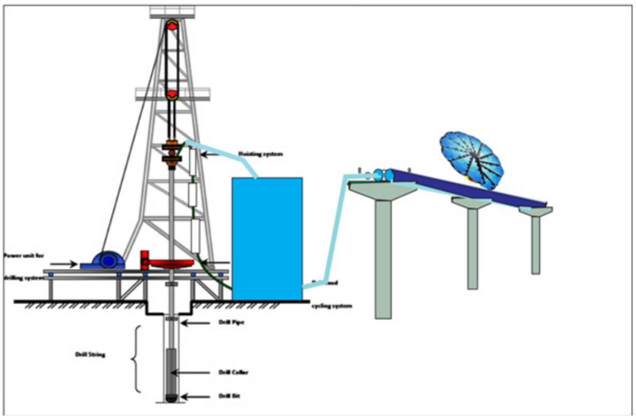

Figure 9 Water production.

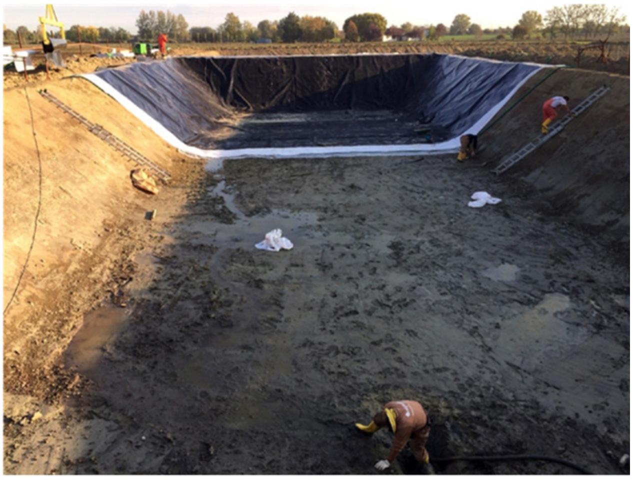

Figure 10 Pond preparation.

The power system

Power for the system would be generated by solar radiation that would activate solar flower type of photovoltaic cells to be supported by the system. In this way the road would supply the power and the vehicles will not need any additional source (Figure 11&12).[24]

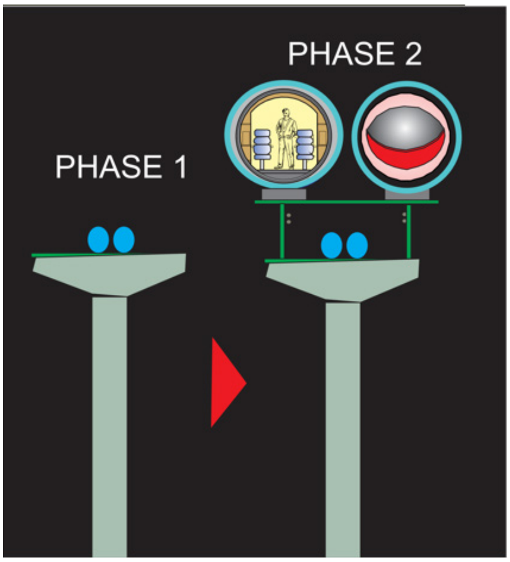

Figure 11 Transportation system.

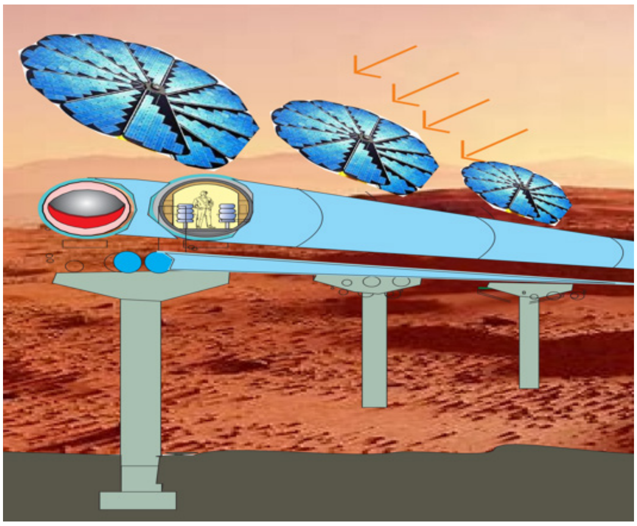

Figure 12 Martian TransNet.

Conclusion

By starting a planet development building a water supply infrastructure, with an eye on future developments, the aqueduct can become the mobility network for the entire planet, connecting communities and new cities, at a minimum cost and minimum time for realization.

The terminals could also be built in such a flexible way that could be utilized as vertical cities, with an underground section for constant human presence and protected from radiation, plus an above ground section containing all facilities from spaceport on top, to hydroponic farms and manufacturing facilities for its population. Also in this case with minimum cost and time.

For the above reasons, when planning the needed aqueduct in a celestial body, consider future possibilities of further utilization in an integrated Master Plan (Figure 13).

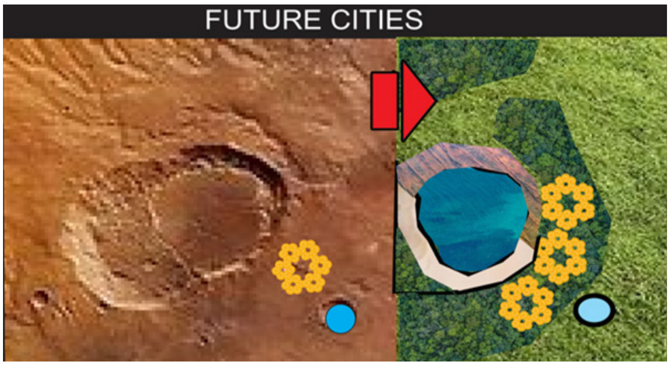

Figure 13 Terraformed city.

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None.

Conflicts of interest

The author declares that there is no conflict of interest.

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