

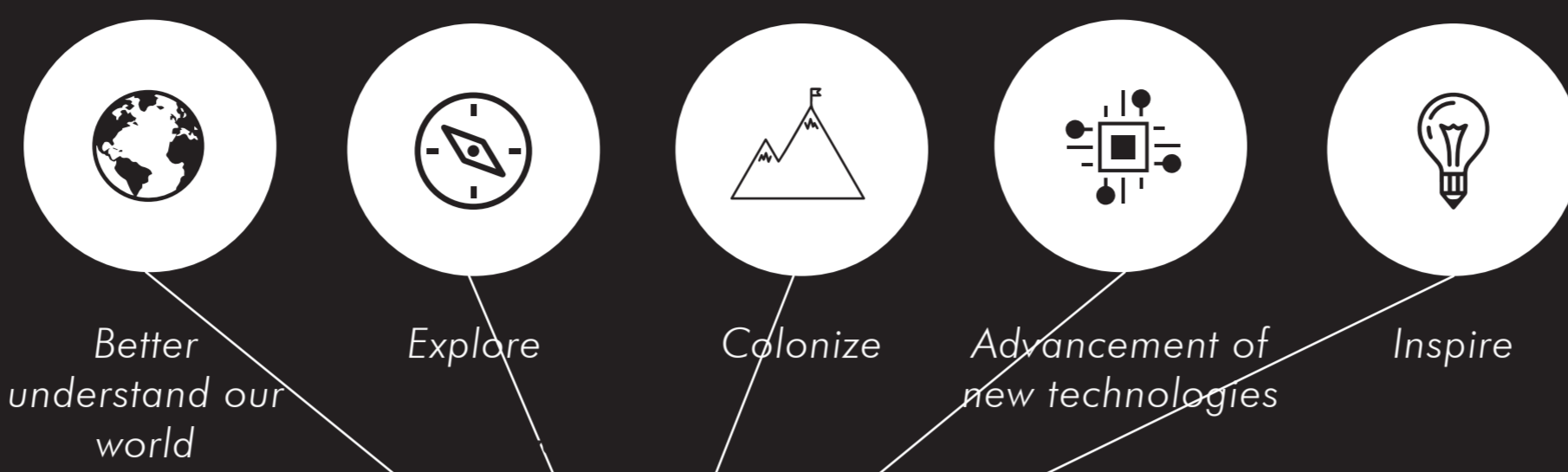
BUILDING ON MARS

QUESTIONS

OPTIONS

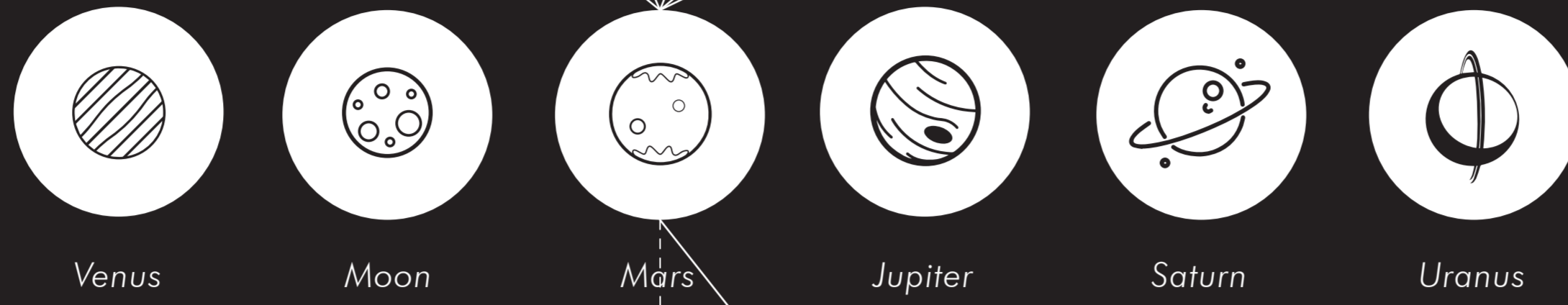
ANSWERS

01 Why are we exploring deep space?



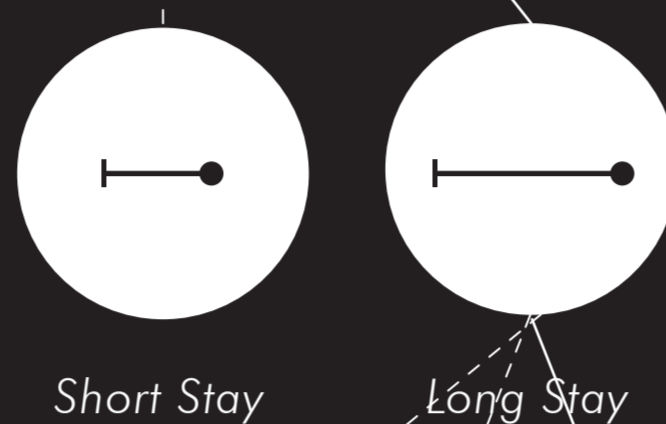
Mars was very similar to Earth once: warmer and wetter. However the planet was subjected to drastic alterations. Many scientists find the exploration of Mars very crucial to better understand the history of Mars in order to apprehend what alterations our planet may be subjected to. However sending humans to another planet necessitates an extremely sustainable habitat, advancement of new technologies and many other improvements in different fields that may possibly have grand impacts and benefits to our daily life on Earth.

02 Which planet are we going for?



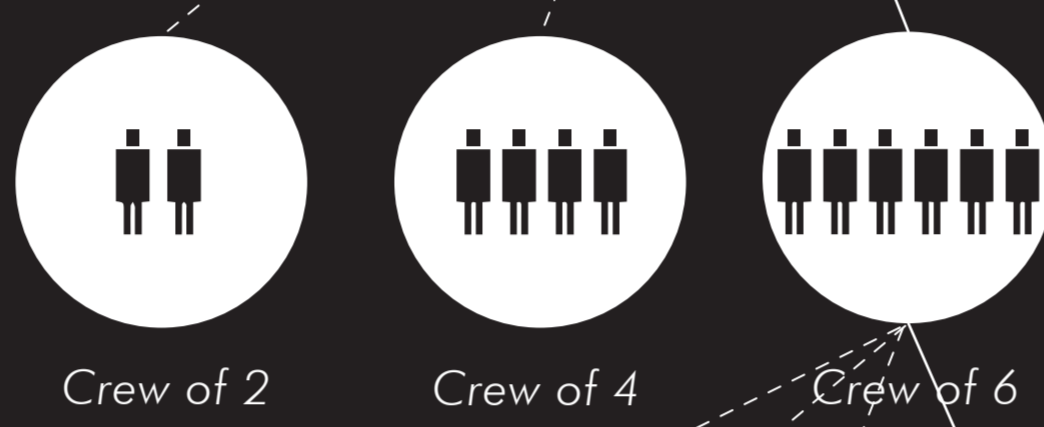
Mars, except for the Earth, is the only planet within our solar system that is orbiting within the circumstellar habitable zone which indicates its planetary surface may support liquid water thus life.

03 What is the mission duration?



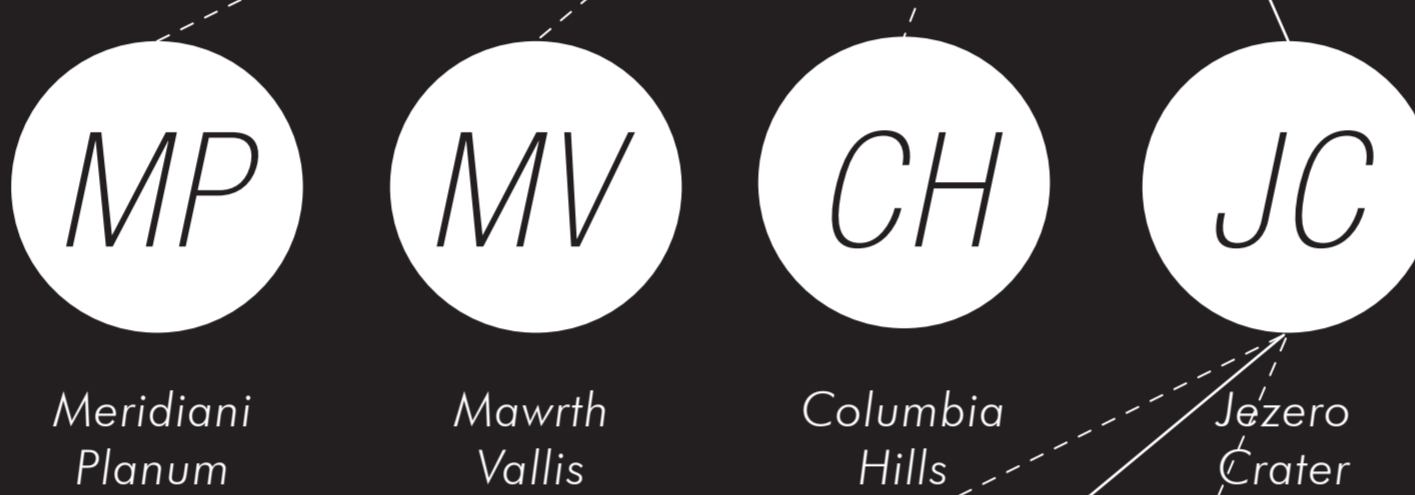
Long stay mission that lasts for 30 months gives the crew the opportunity to being less exposed to free space heavy ion environment and a longer time to recover from the deterministic effects.

04 What is the size of the crew?



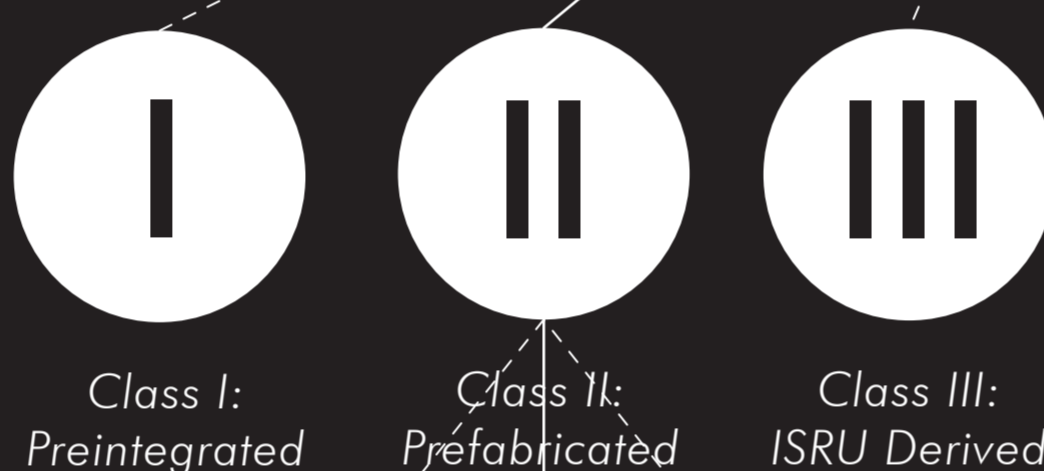
Selection of the crew size has a lot to do with the accommodation needs of the crew. Crew size of 6 is selected due to the volume of the habitat and the constructability of the ice structure and its volumetric requirements, that covers the habitat and crew cohesion, for wellbeing purposes.

05 Where will the crew be located on Mars?



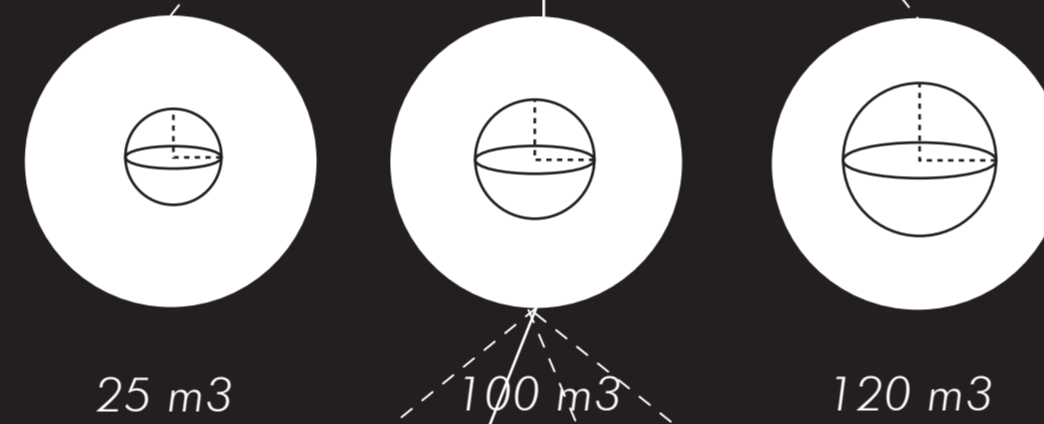
Jezero Crater is one of the most appealing locations for NASA's 2020 Rover that will be launched in 2020 and will carry science instruments to see whether the location is suitable for human habitability. Sending humans to a location on Mars, where no rovers have ever been, significantly increases the risks. Thus the location is selected according to NASA's choice of Rover 2020 that will enlighten us by the means of water presence and other environmental conditions on the exact location.

06 Which class of habitat will be sent to the selected location?



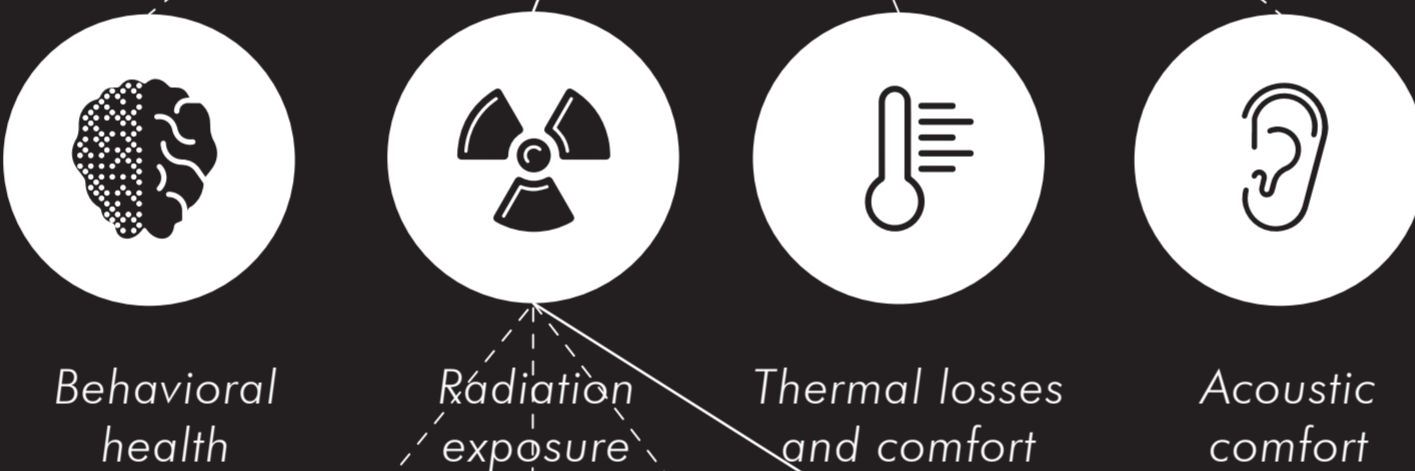
Due to the mass restrictions a fully preintegrated system is very challenging to launch. Due to the ballistic coefficient, it is very difficult to land it as well, thus Class I has been eliminated. Class III, ISRU Derived habitat type is very difficult to construct due to the low advancement levels of the construction capable robots. However a Class II, prefabricated habitat that is backed up with ISRU resources are rather feasible to construct due to its risk lowering features and its slightly lower mass.

07 What is the NHV (net habitable volume) per crew in the habitat?



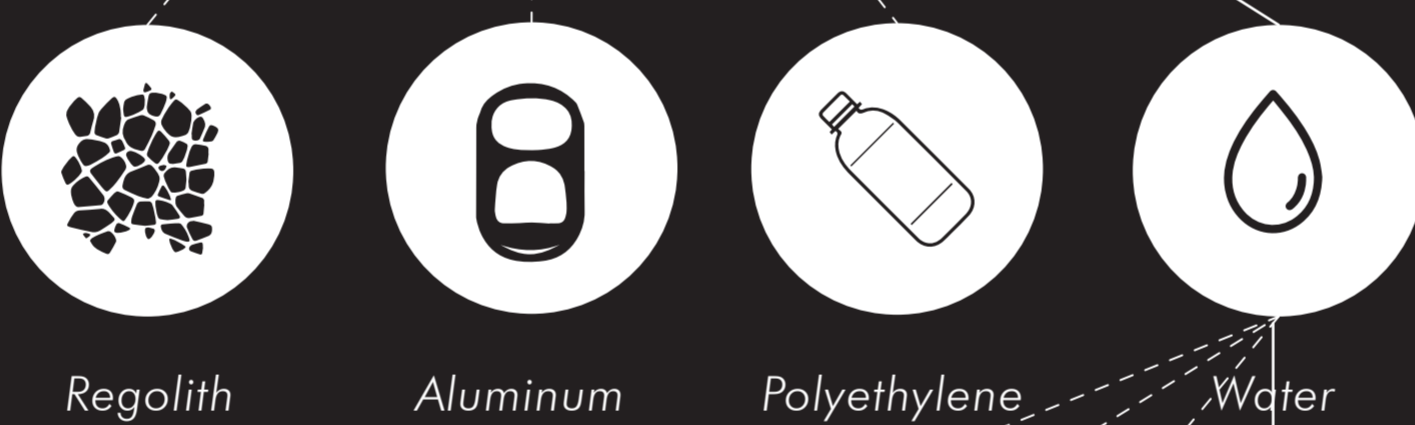
Due to the duration of the mission and the number of crews, the volume of the habitat can increase significantly. Through the Celantano curve for a mission of 500 days on the surface of Mars, 100 m3 per crew is provided to each person. NHV can be increased to secure crew's psychological well being, however this may imply a significant increase in the construction time as well as the mass of the Class II prefabricated habitat module.

08 What are the potential risks that the habitat may help to mitigate?



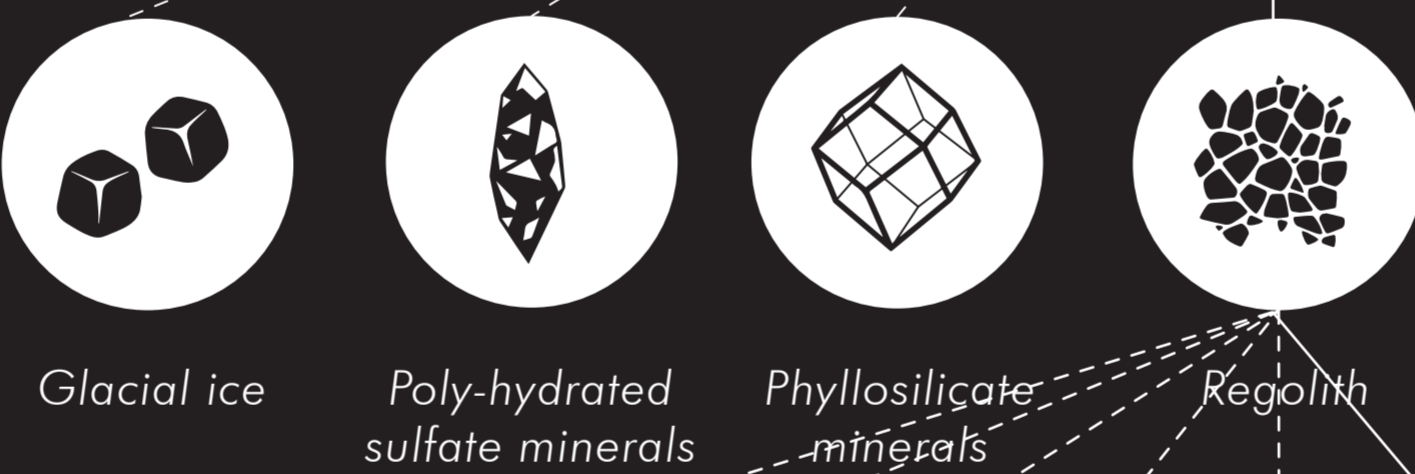
According to Global Exploration Roadmap (GER), crew's exposure to space radiation and their behavioral health (psychological well being) are two mission limiting factors that are suppose to be tackled. Radiation exposure can be partially mitigated through the adequate choice of material and its dimensional sufficiency.

09 What is the main construction material to be used in order to decrease the crew's radiation exposure?



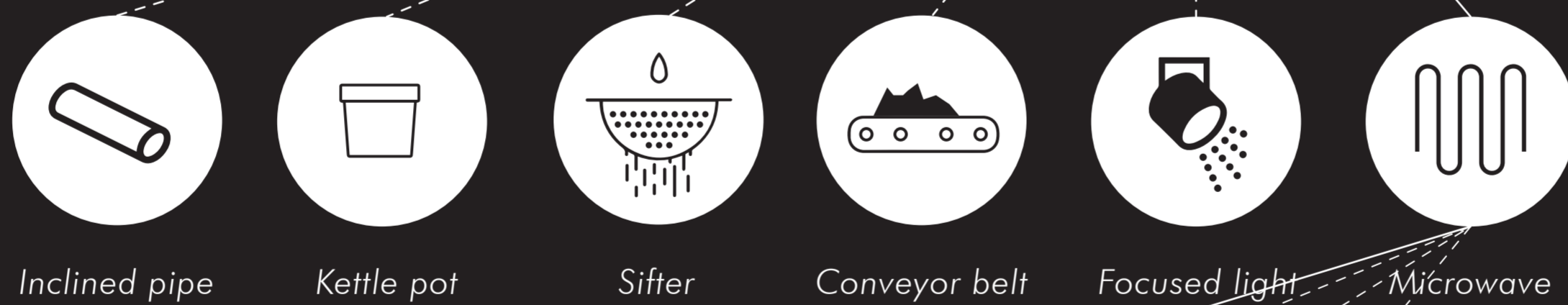
Hydrogenated materials perform the best in shielding from high energy particles (HZE) that galactic cosmic rays comprise of. They also perform well under the exposure to protons and electrons, solar energetic particles. From the options shown, water is the only material that is highly rich in hydrogen and can be IN-SITU derived on Mars.

10 What are the water sources on Mars?



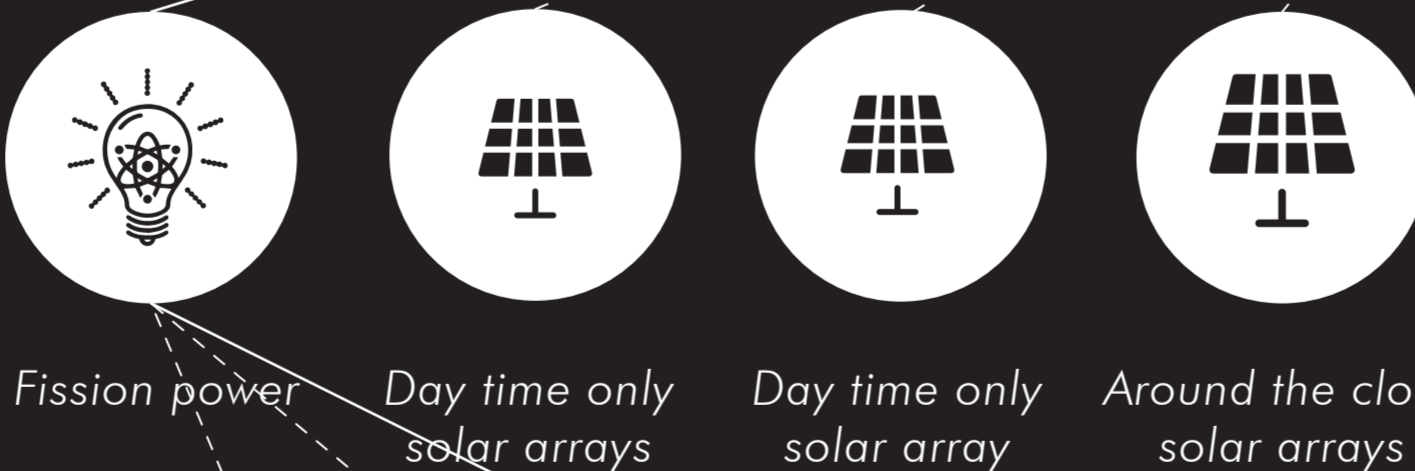
Due to selected location near the equatorial region, the glacial ice source is very unlikely to be found. Poly-hydrated sulfate minerals and phyllosilicate minerals can be found as ores in specific locations. Without explorations and identifying their exact locations, risks are two high. However, regolith covers a vast majority of the planetary surface and its hydrous content may go up to 4-6%.

11 How to extract water through regolith?



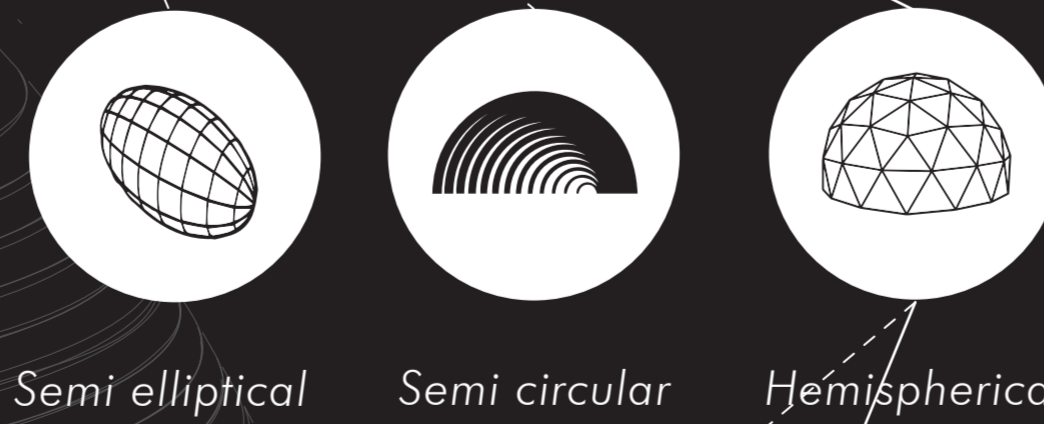
Extracting water by using microwave is more effective than the conventional way of heating up the regolith itself. This is mostly due to the fact that microwave targets the water content directly and saves energy by doing so.

12 How to provide energy to the construction and water production plants?



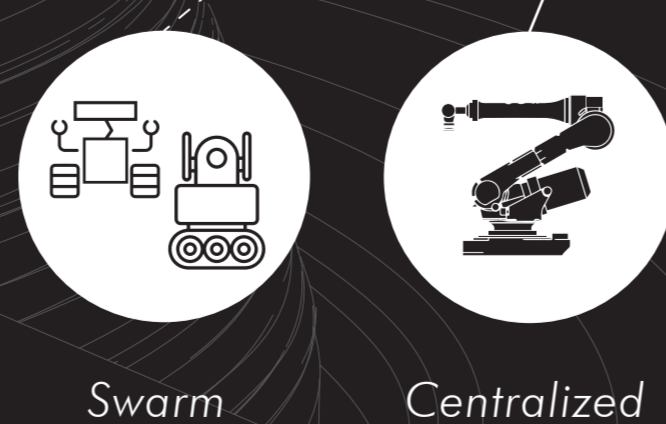
Technology Readiness Level (TRL) plays an important role in selecting certain technologies that will be involved in space missions. In the case of energy generation on Mars, high TRL of the solar arrays may influence this selection due to its reliability and maturity. However, global sandstorms on Mars may go up to 120 days reducing diffused light up to 40%. Such events may result in tremendous complications. The robustness of the fission power generators to the Martian environment is a lot higher in comparison to the solar arrays.

13 What are the possible configurations of the habitat's shape?



The highest volume with the minimum surface can be attained with a hemispherical dome, meaning the shape can provide the highest amount of volume that may potentially increase the crew's well-being while minimizing the least surface area that potentially minimizes the thermal losses. However, due to structural reasons the shape was inspired by a set of catenary arches which induces the structure to be subjected to mostly compression. Thus the shape came out through the creation of catenary arches on grasshopper, as a semi elliptical dome.

14 How to construct semi-elliptical class II [prefabricated] dome?



Construction with swarm robotics implies creation of numerous different kind of robots that should reach to certain technology maturity to be used on Mars. However this is very costly and it requires a certain amount of work to be performed in entirely different environmental conditions. On the other hand, a robotic arm that's placed within a pressurized and controllable environment may operate more time efficiently within a familiar environment. One should keep in mind the redundancy of a singular robotic arm and acknowledge the risks.

IMPORTANT:
In the scheme above, a linear selection procedure is observed. However, in the field of space engineering and space architecture this linear procedure is nearly impossible to obtain. The design becomes clearer through the utilization of an iterative process that incorporates a spiral model rather than a linear one. The scheme above shows a simplified version of the selection procedure that the space architect has conducted through this project.

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