

MARS REEFS

We will live and thrive in our grown up hive

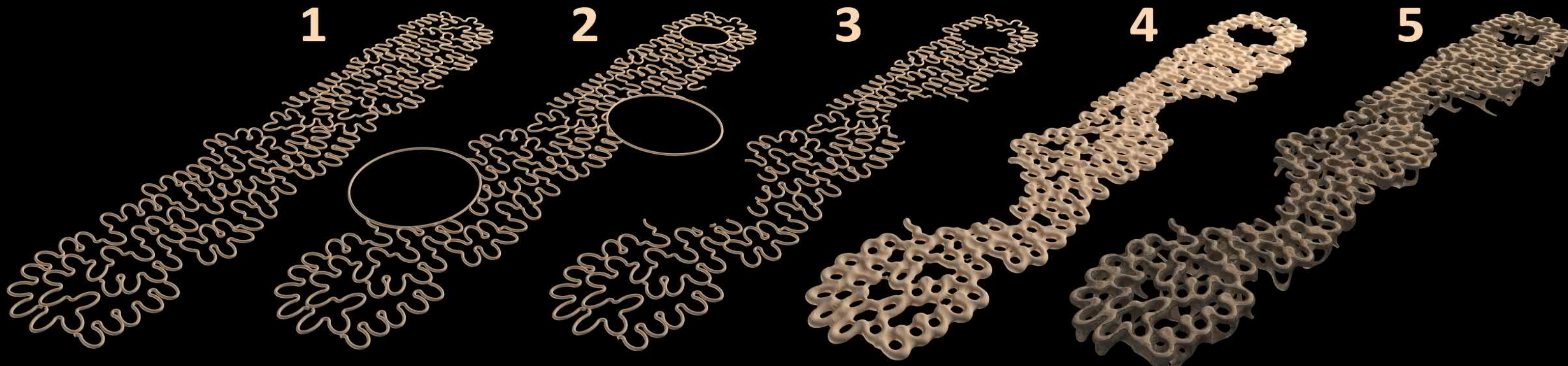
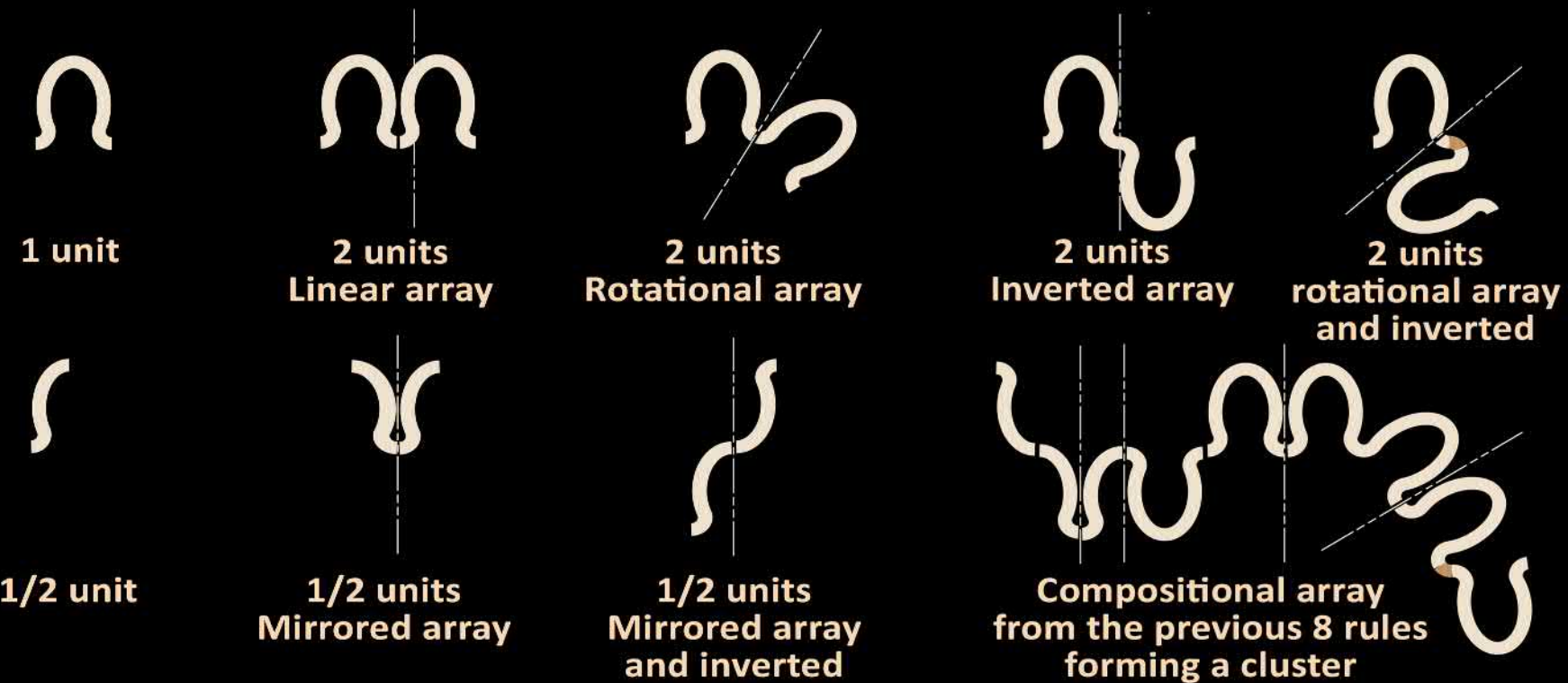
Coral reefs are considered one of the oldest forms of colonization on earth. They survived the worst apocalyptic events due to its formation and sophisticated modularity. Corals secrete hard carbonate exoskeletons that support and protect the coral. They even protect coastlines from storms and erosion better than any man made structures. Coral reefs are made up of a multitude of species which together form the most complex and balanced ecosystem on planet earth, i.e. a very specific natural environment made up of different life forms living in symbiosis. Natural coral reefs serve as refuges, food reserves and nurseries for their many inhabitants: from the smallest creatures to numerous larger life forms.

BIOMIMICRY STRATEGY - (GRAMMAR OF THE FORM VOCABULARY)



**Main source of inspiration,
(The brain coral reef pattern)**

The natural pattern formed on the brain coral reef was analyzed and deduced to 8 main units with their rules of assembly to create a flexible formation that can expand infinitely in any direction and taking any geometrical formation.



1
Linear formation
with varying length
and width as required

2
Manoeuvre around
circular gaps due to
rotational mechanism

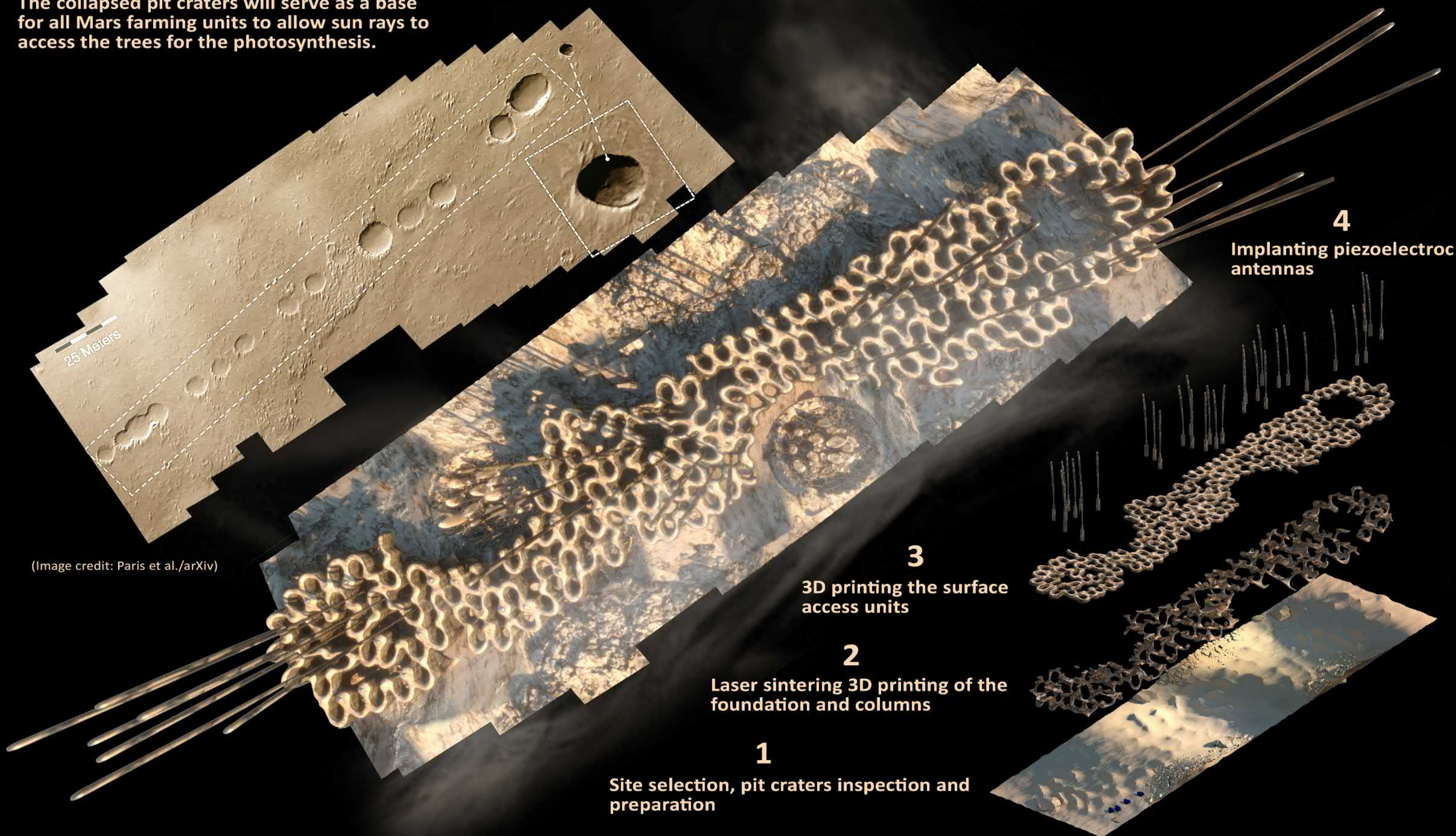
3
Flexible formation to
adapt to various
challenges

4
Real final output
thickness forming
durable strong formation

5
Real final output with the
supporting structure beneath to
create a shelter for Eva equipments

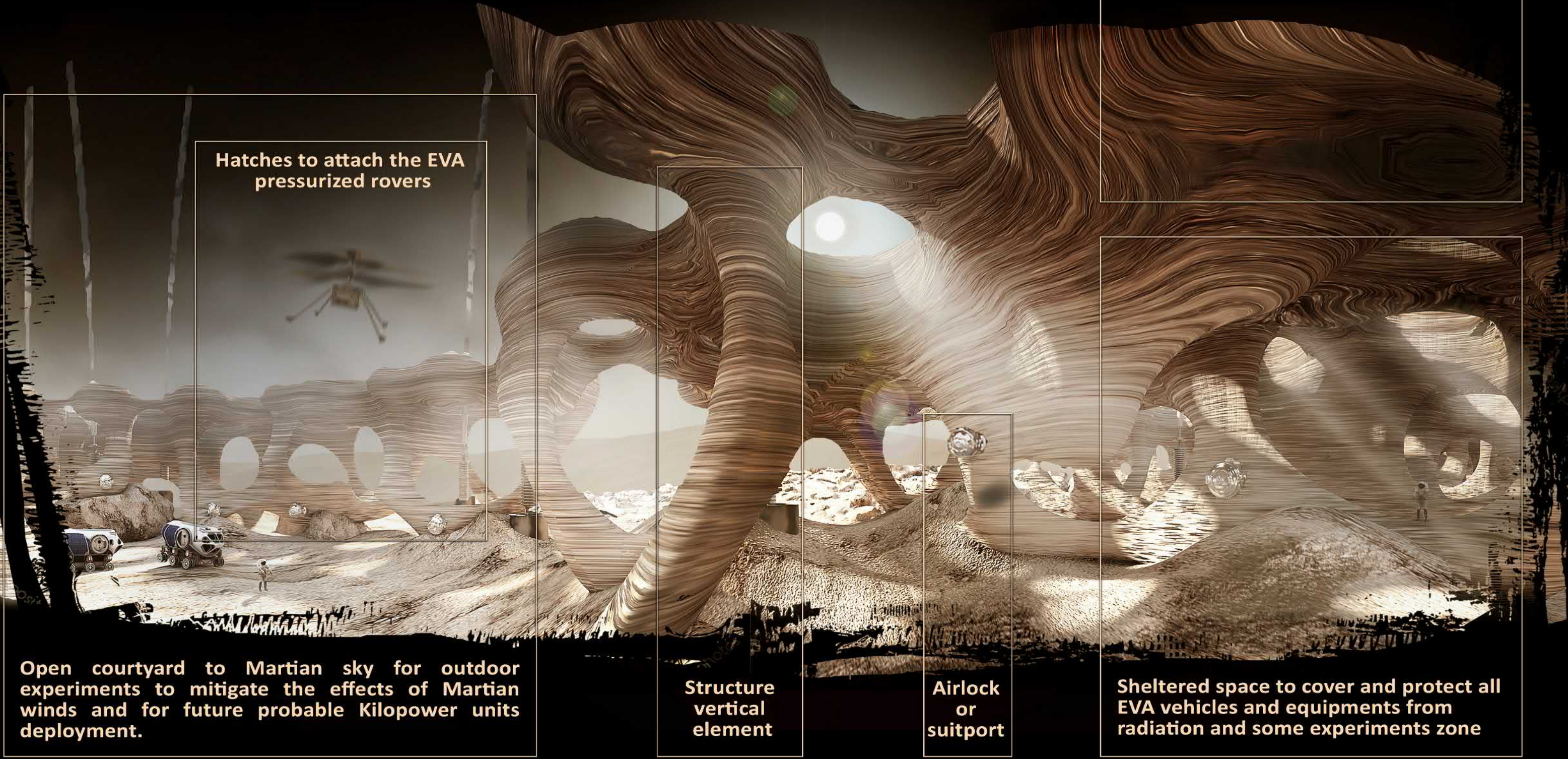
SELECTED SITE

The selected site is a set of partially collapsed pit craters chain covering a lava tube at Hellas planitia. The existing Lava tube will host all subterranean pressurized modules for habitation for protection against radiation and harsh environmental hazards. The collapsed pit craters will serve as a base for all Mars farming units to allow sun rays to access the trees for the photosynthesis.



SPATIAL QUALITIES OF THE BIOMORPHIC STRUCTURE

The Bio morphic approach offered numerous spatial qualities for the hive different needs. The surface access units are elevated above ground to mitigate the dust and to envelope the pressurized modules with a 3D printed layer of regolith for protection against radiation and extreme thermal swings, whereas the elevated units offers a shaded zone beneath to store all external equipments including the EVA pressurized rovers.



Hatches to attach the EVA pressurized rovers

Elevated structure wrapping all pressurized modules for habitation and work

Open courtyard to Martian sky for outdoor experiments to mitigate the effects of Martian winds and for future probable Kilopower units deployment.

Structure vertical element

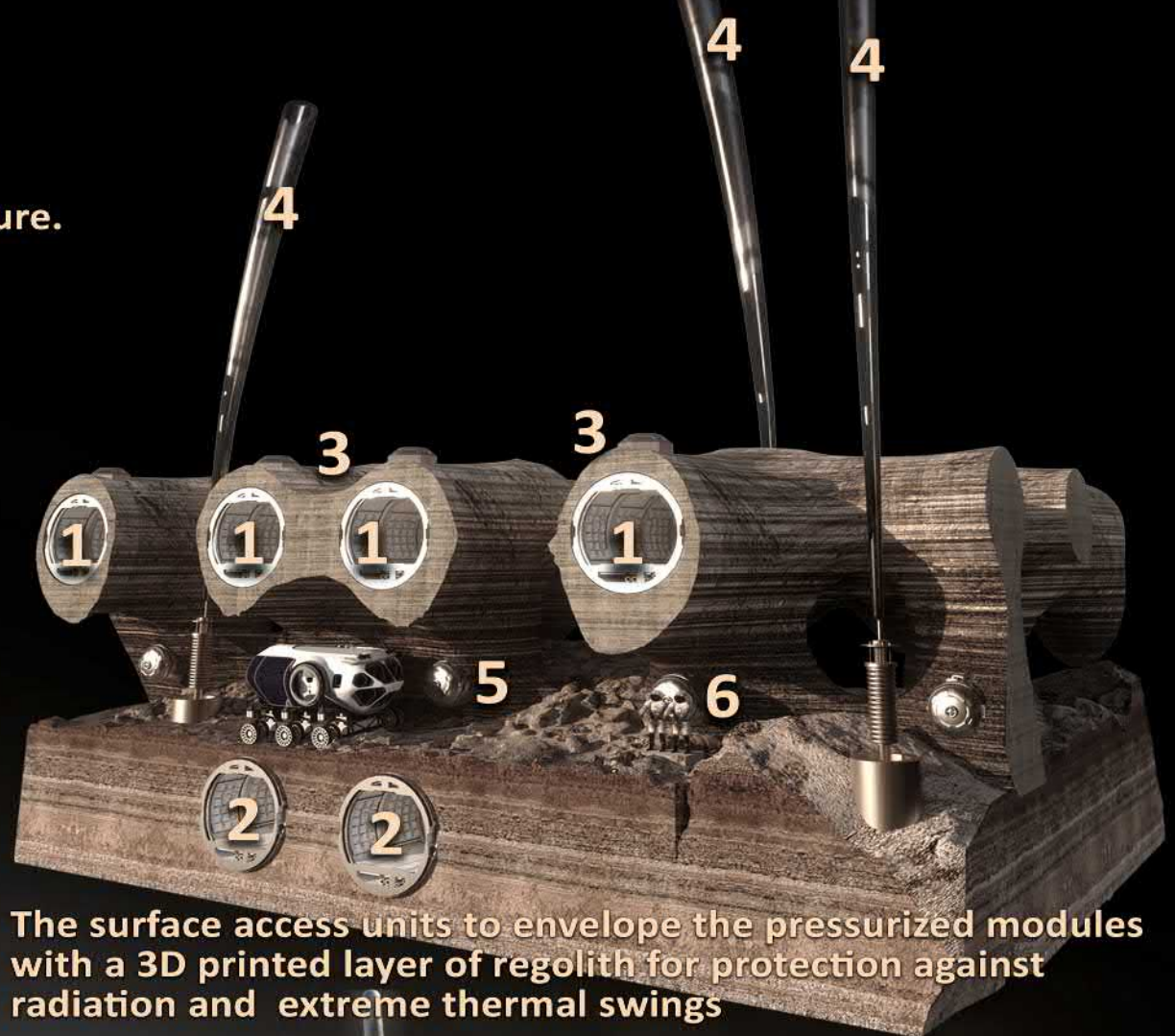
Airlock or suitport

Sheltered space to cover and protect all EVA vehicles and equipments from radiation and some experiments zone

ANATOMY OF THE REEFS HIVE

COMPONENTS OF THE HIVE ELEMENTS

- 1. Surface access pressurized modules for surface operations shielded in 3D printed regolith structure.
- 2. Subterrean pressurized modules for habitation and maintenance
- 3. Cupola to enable day light to enter for circadian cycle
- 4. Piezo-electric rods and antennas to receive low microwaves from solar based satellites
- 5. Hatches for EVA rovers
- 6. Suit ports for crewed EVA operations



The surface access units to envelope the pressurized modules with a 3D printed layer of regolith for protection against radiation and extreme thermal swings

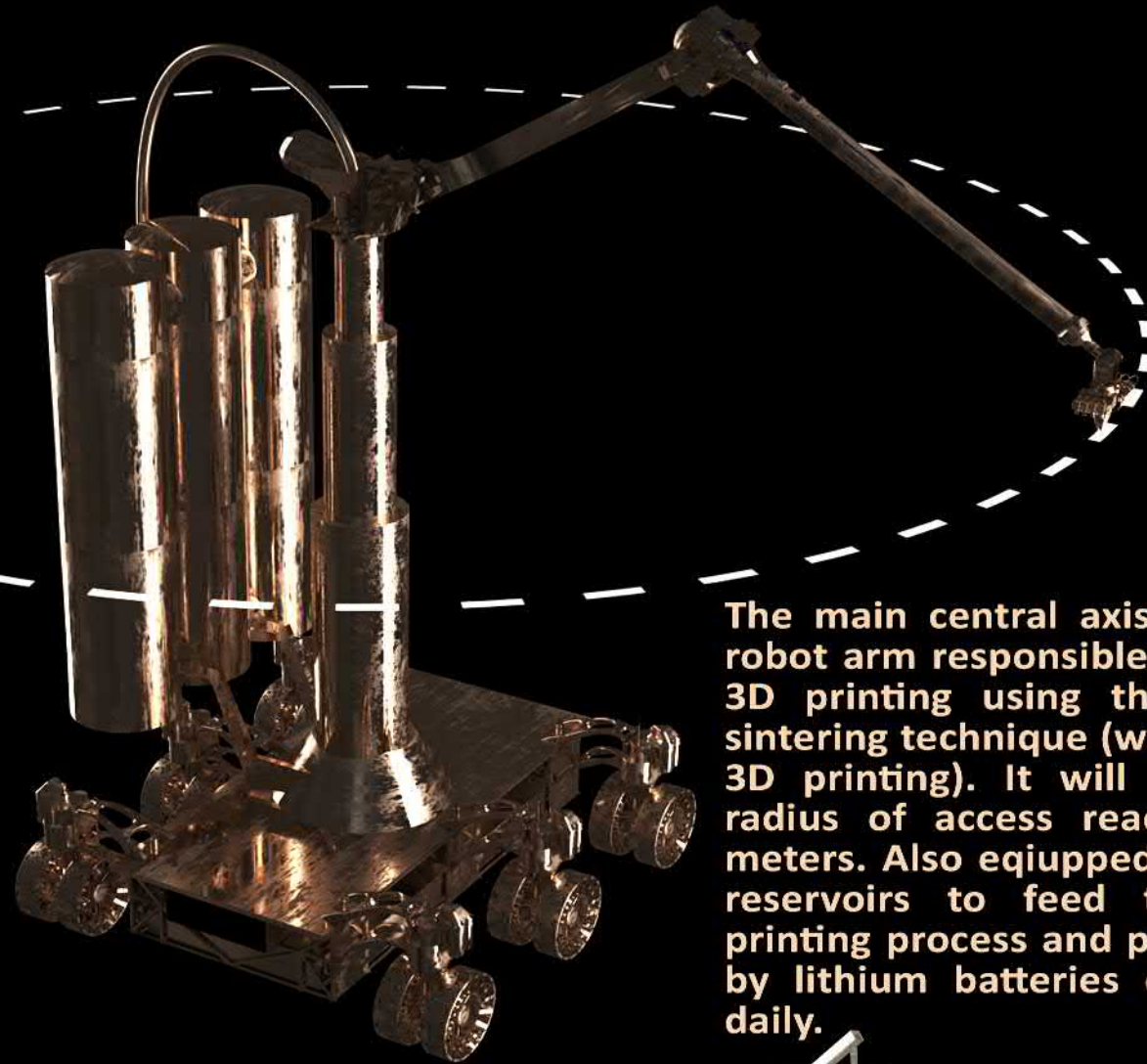


The proposed design is a response to the Martian environmental parameters to shield and protect crewed mission from radiation, regolith, extreme temperature swings, low pressure...ect.

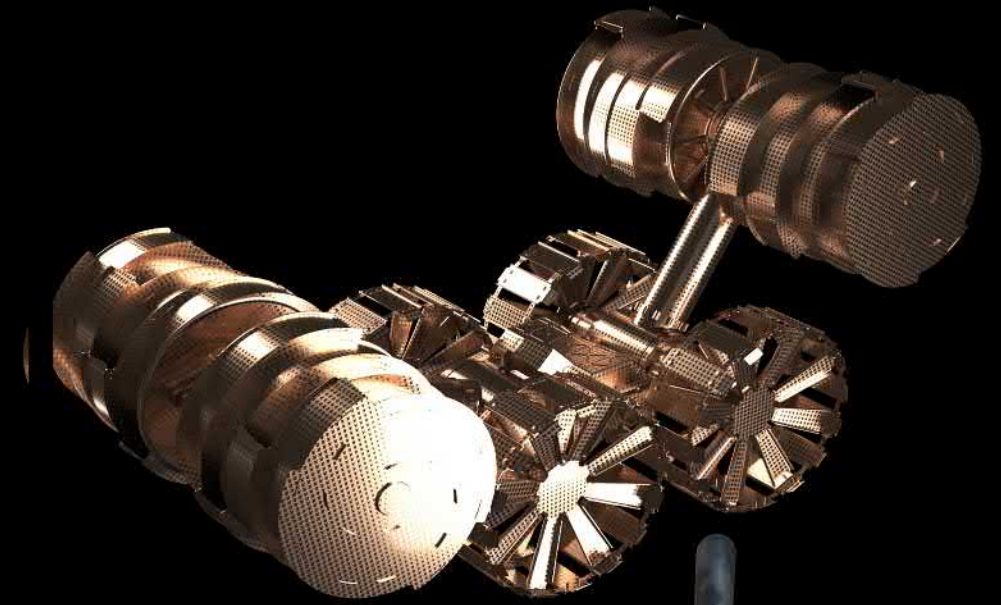
NEW MARTIAN VERNACULARISM- ISRU

Vernacular architecture is a form of regional local building that utilizes traditional available materials and resources from the region in which the habitat is located.

Also the ISRU is the insitu resource utilization which coincides with the same notions of vernacularism, it evolves and develops consequentially to a site specific culture. The new construction techniques using the local resources confirms the identity due to its respond to immediate demands, and hence reflects the regional new cultural practices.



The main central axis of the robot arm responsible for the 3D printing using the laser sintering technique (waterless 3D printing). It will have a radius of access reaching 5 meters. Also equipped with 3 reservoirs to feed the 3D printing process and powered by lithium batteries charged daily.

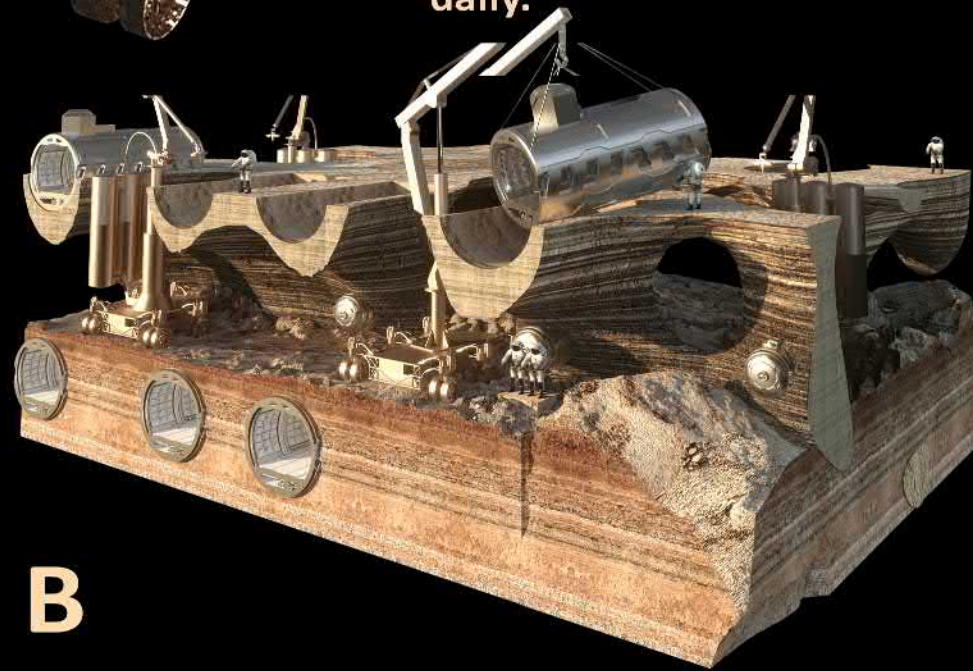


Regolith Advanced Surface Systems Operations Robot (RASSOR) Excavator (KSC-TOPS-7) for excavating and gathering Martian regolith for the 3D laser sintering printing. A swarm of these robots will operate to provide the 3D print arm with the regolith.



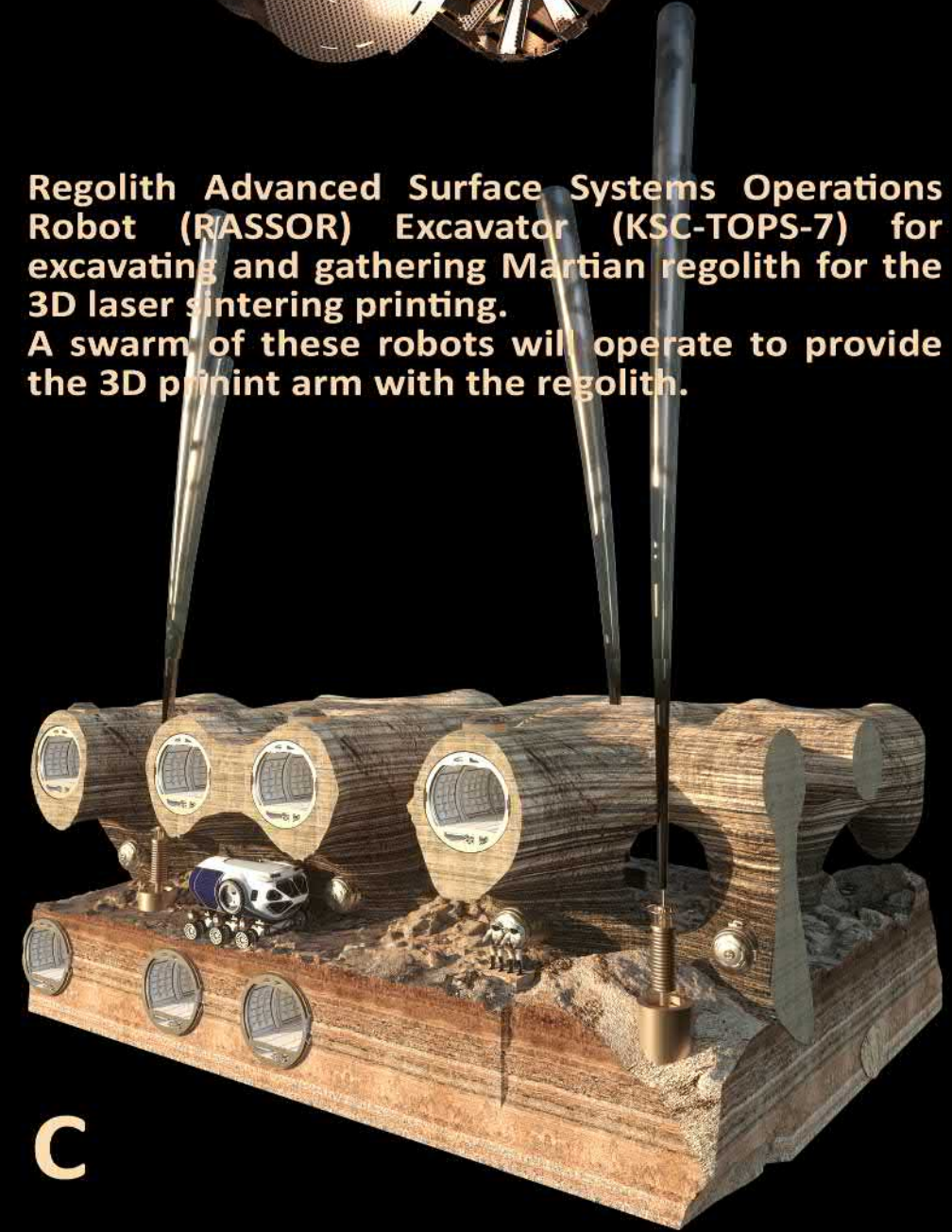
A

PHASE 1- 3D PRINTING OF THE SURFACE ACCESS MODULAR UNITS



B

PHASE 2- POSITIONING THE PRESSURIZED MODULES



C

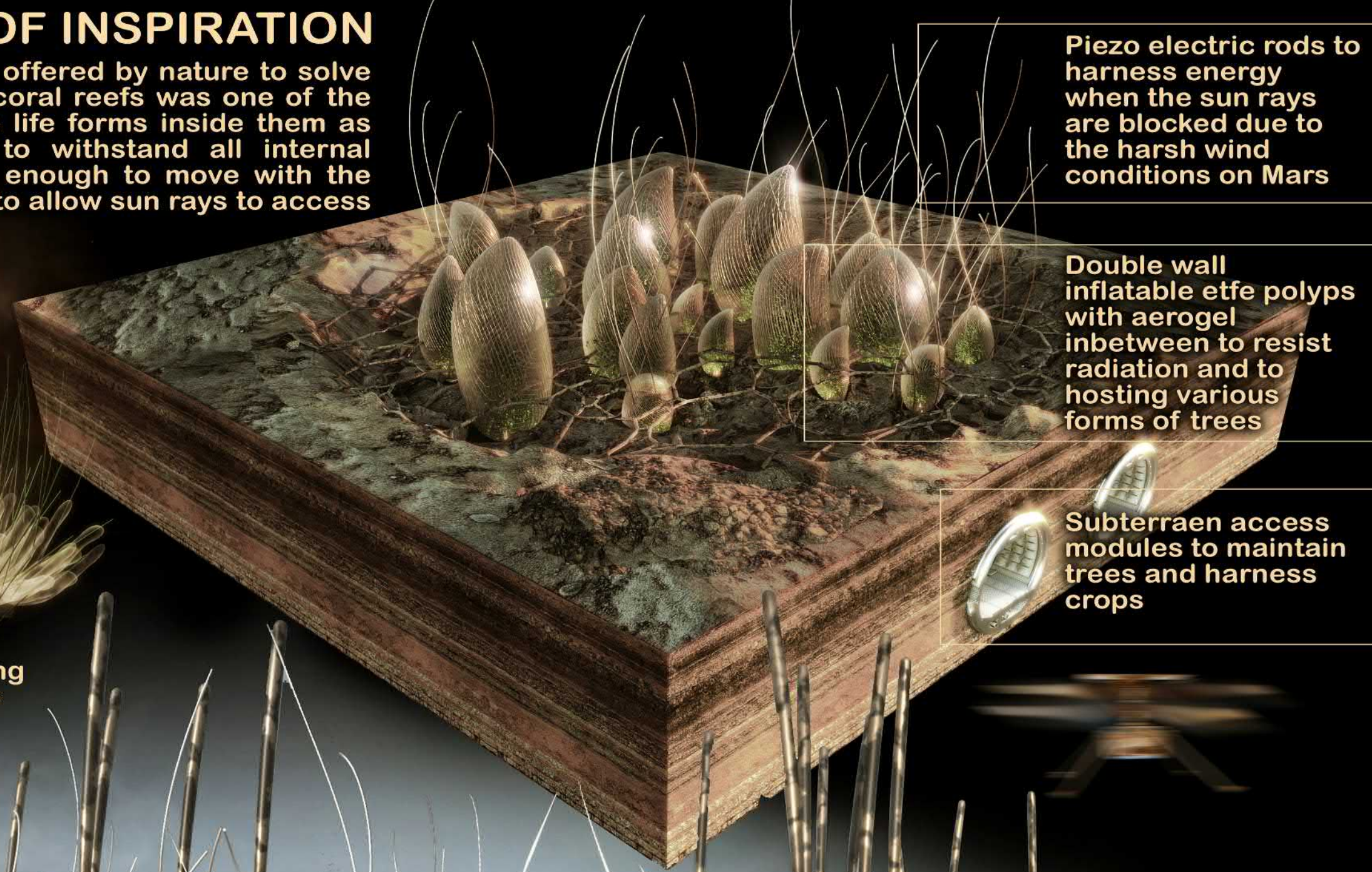
PHASE 3- INSTALLING THE ANTENNAS AND PIEZOELECTRIC RODS

BIOMIMICRY- SOURCE OF INSPIRATION

The biomimicry is the use of solutions offered by nature to solve our complex problems. The polyps of coral reefs was one of the most effective solution to host various life forms inside them as trees. They have strong membrane to withstand all internal pressure, loads and impacts. Flexible enough to move with the wind and at the same time transparent to allow sun rays to access the plants for photosynthesis process.



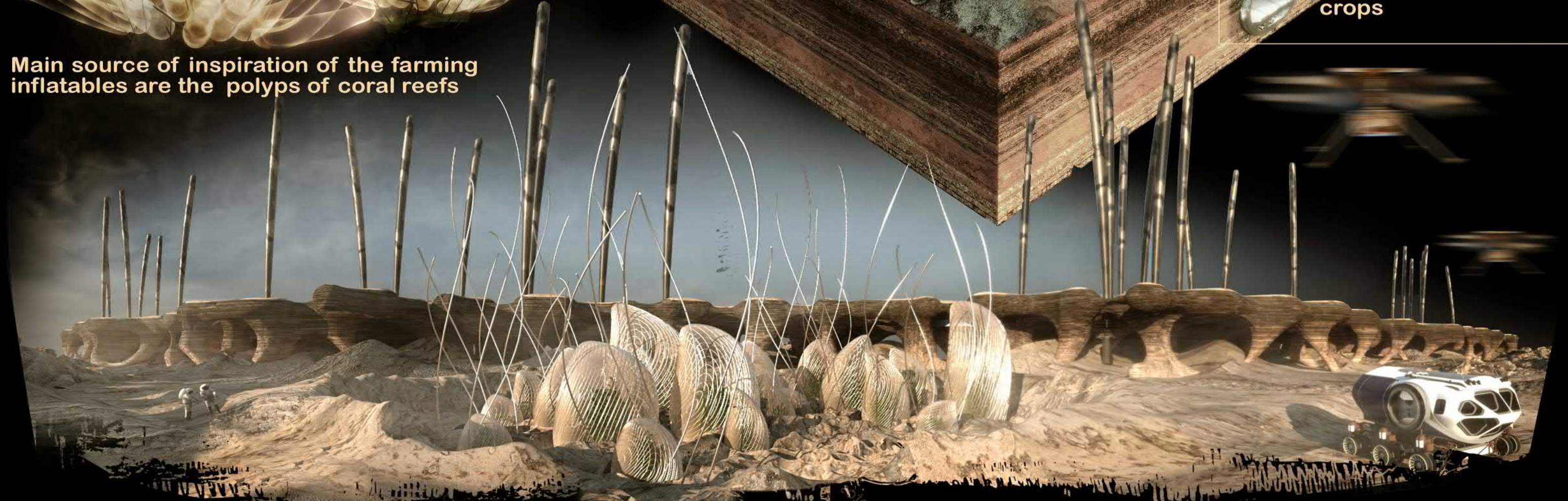
Main source of inspiration of the farming inflatables are the polyps of coral reefs



Piezo electric rods to harness energy when the sun rays are blocked due to the harsh wind conditions on Mars

Double wall inflatable etfe polyps with aerogel inbetween to resist radiation and to hosting various forms of trees

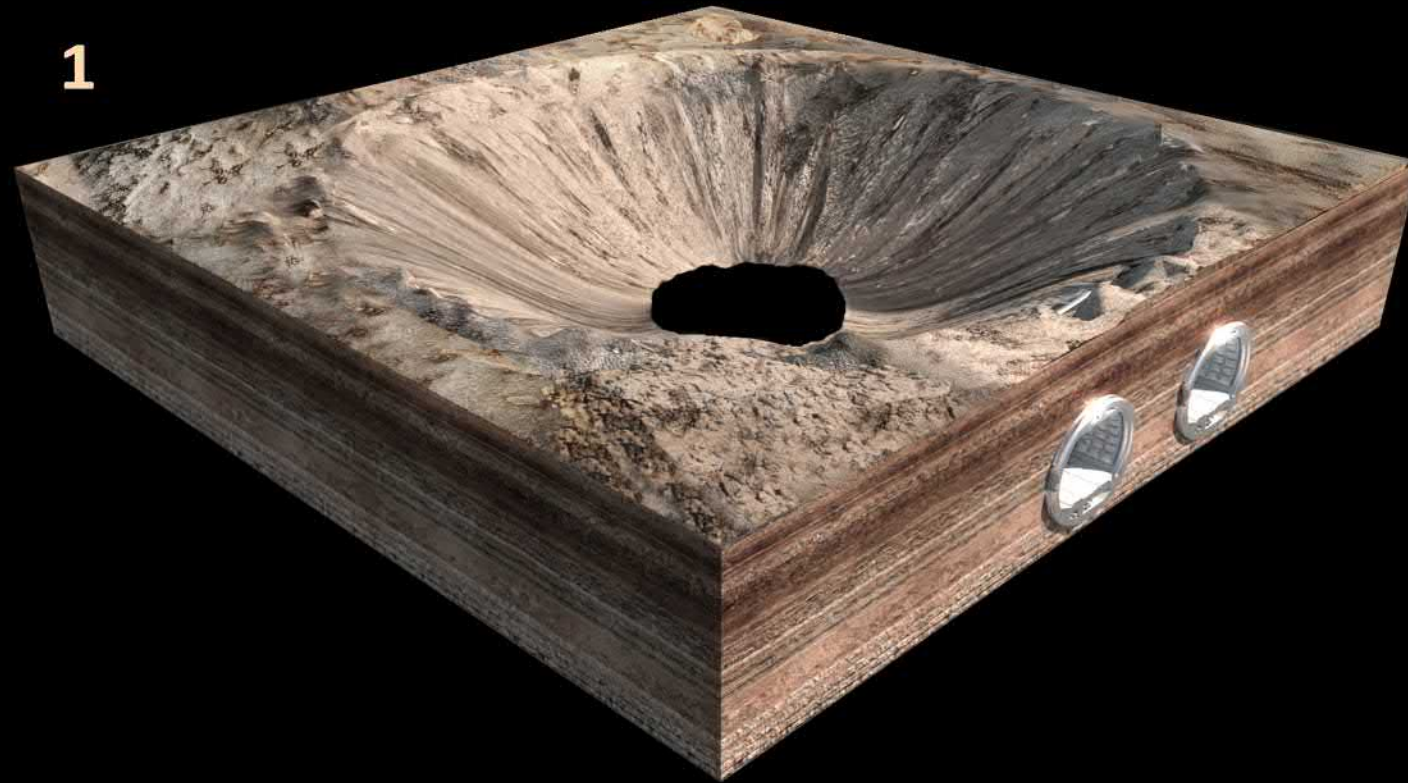
Subterraen access modules to maintain trees and harness crops



Panoramic image showing the farm trees inflatable polyps with their piezoelectric rods for food production

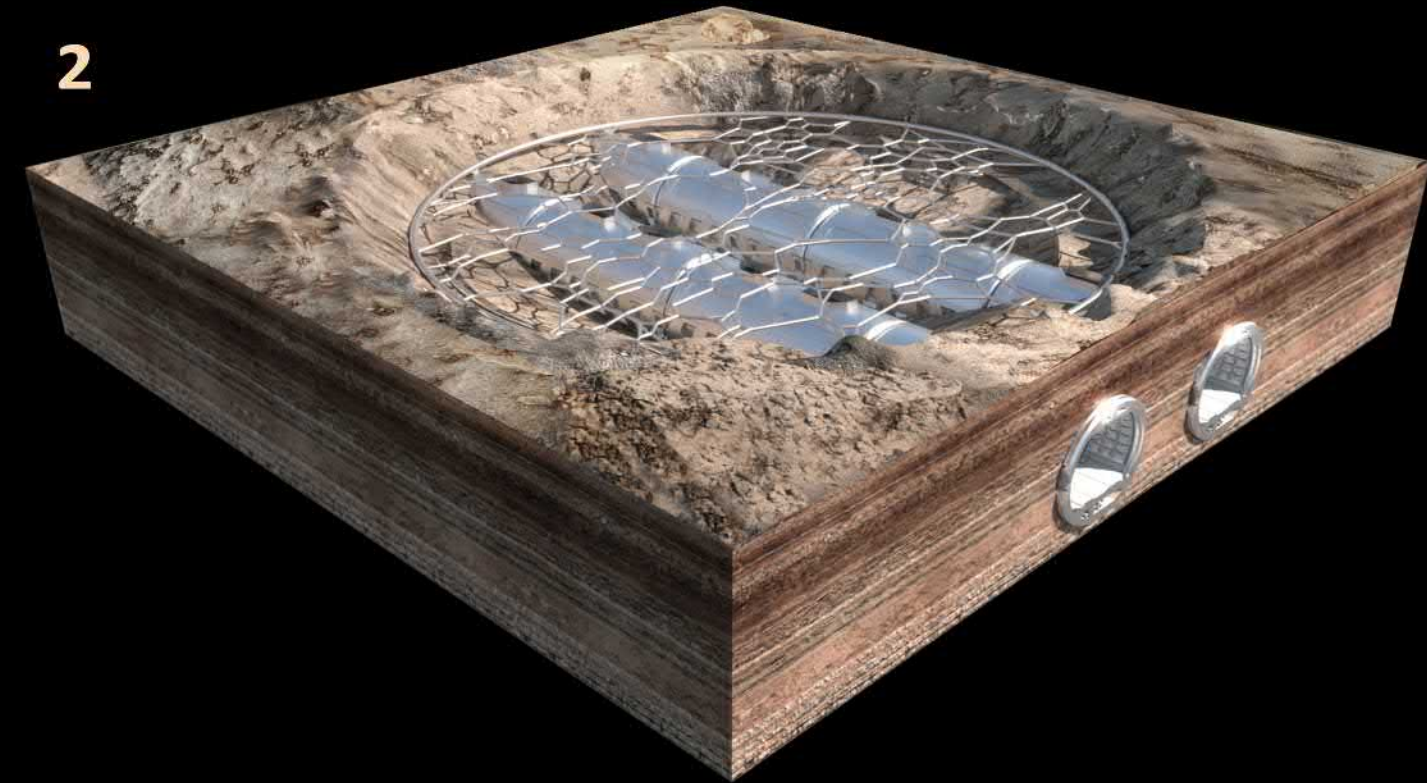
MARS FARMING UNIT (MFU) - CONSTRUCTION

1



Finding and location the appropriate pit crater to a shallow lava cave. Laying the subterranean pressurized modules for maintaining and accessing the inflatable bio-pods from below.

2



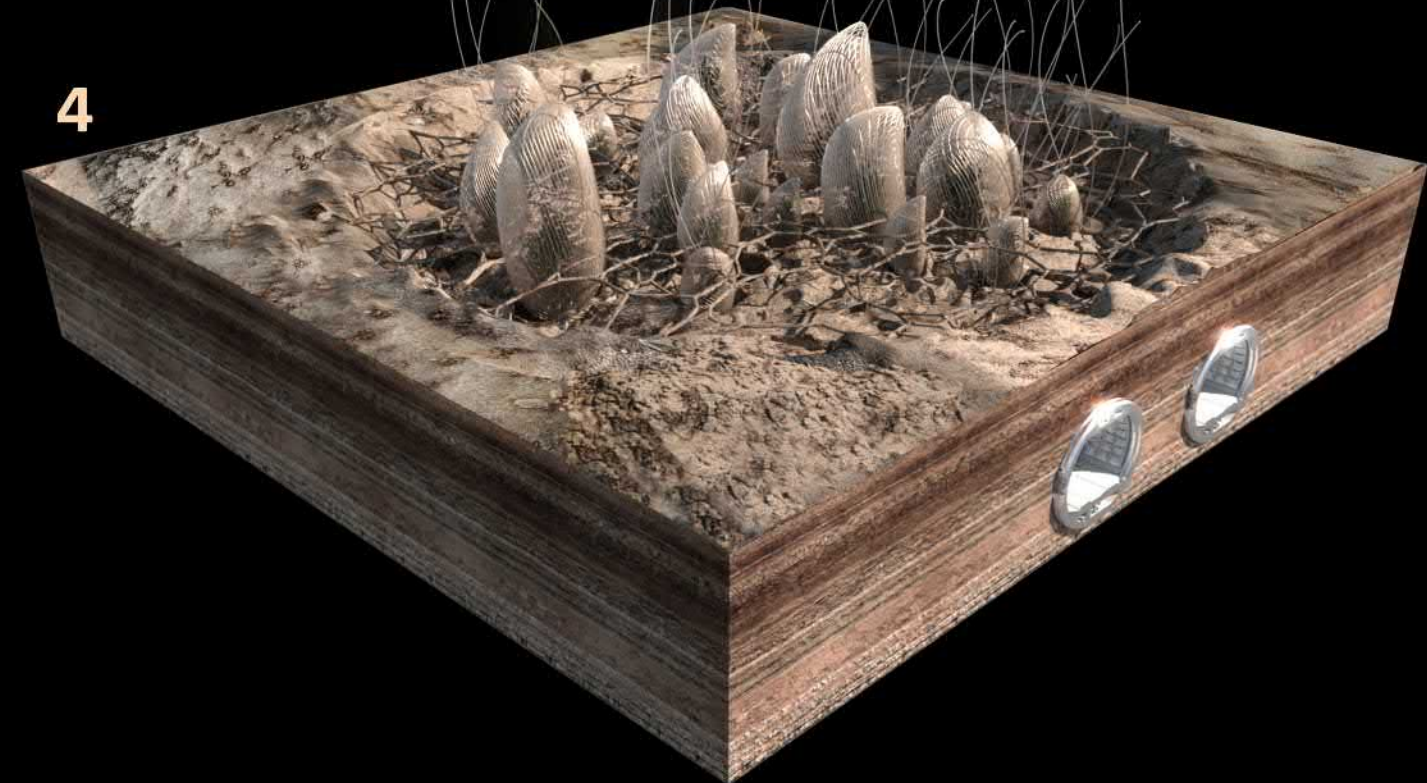
Covering the layered subterranean pressurized modules with the voronoi mesh of the memory shaped alloys as a reinforcement to the 3D printed layer.

3



Covering the subterranean pressurized modules with Martian regolith layer protecting them from harsh environmental hazards as radiation, temperatures...ect.

4



Deploying and triggering the Inflatable bio-pods capsules extended from the subterranean pressurized modules with their piezoelectric rods.

MARS FARMING UNITS (MFU) - BIOPHILIC DESIGN

Mars farming units are assembled in a circular formation of a utilized pit crater surrounded by the hive modular units for ease of access by the subterrean units



Utilized pit crater

BIOPHILIC DESIGN

The farming land covering the pit crater will act as the first Marian outdoor park to be viewed from all elevated surface units through the tiny windows and could be accessed through the subterrean units

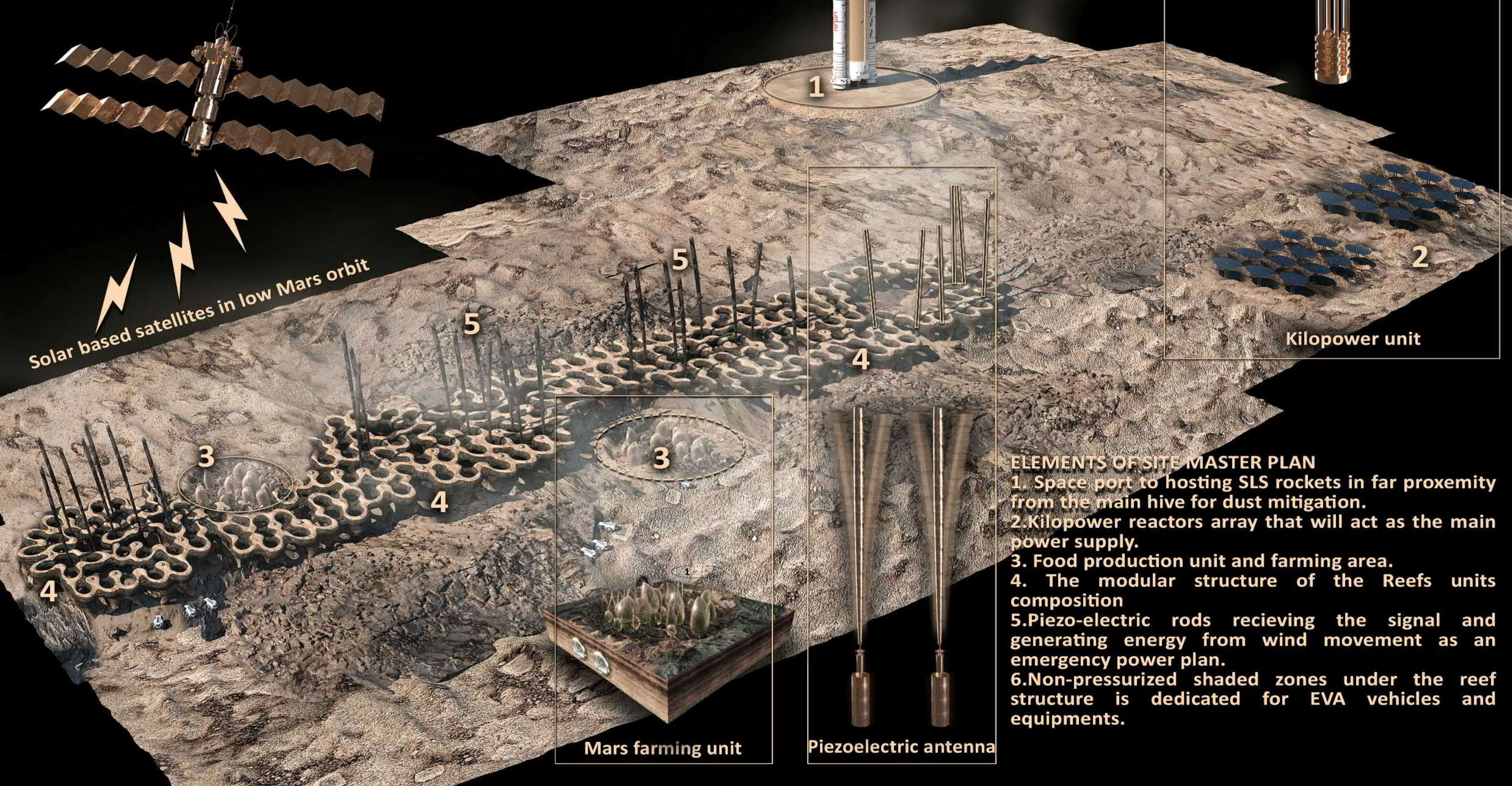


Self opening and deployment capsule containing the double layer inflatable skin inside with aerogel in between for radiation and thermal protection, Also equipped with piezoelectroc rods from memory shaper alloyes for power

POWERING SOLUTIONS OF THE HIVE

One of the key design criteria is the diversification of powering solutions. For that reason 3 powering solutions were deployed.

1. Solar based satellites deployed in Mars low orbit.
2. An array of Kilopower reactors for durable uninterrupted power supply
3. Piezo-electric rods that will function also as antennas to receive the signals of the low microwave energy beams from the solar satellites



Solar based satellites in low Mars orbit

- ELEMENTS OF SITE MASTER PLAN**
1. Space port to hosting SLS rockets in far proximity from the main hive for dust mitigation.
 2. Kilopower reactors array that will act as the main power supply.
 3. Food production unit and farming area.
 4. The modular structure of the Reefs units composition
 5. Piezo-electric rods receiving the signal and generating energy from wind movement as an emergency power plan.
 6. Non-pressurized shaded zones under the reef structure is dedicated for EVA vehicles and equipments.