EXOTERRA 1-2-3

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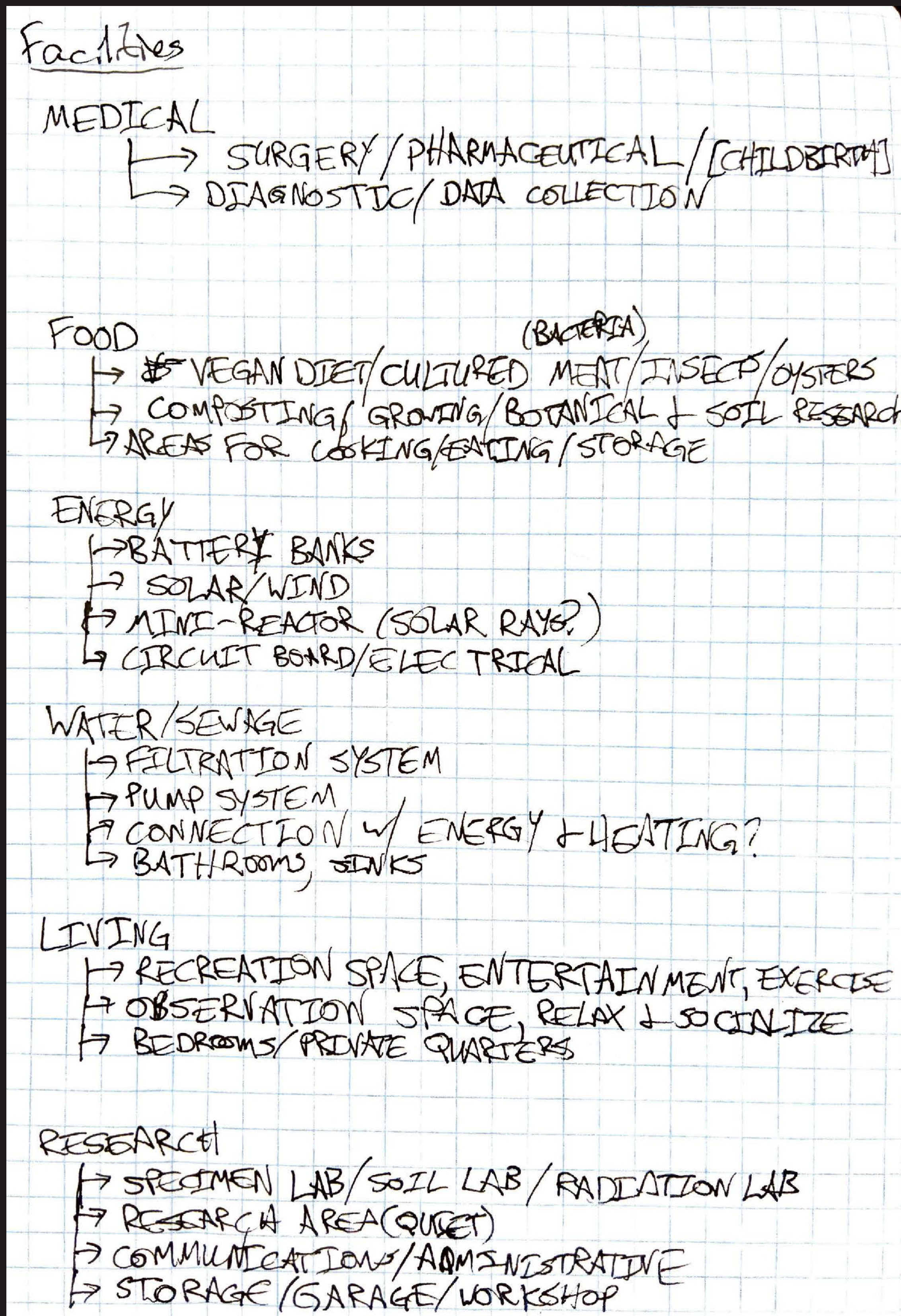
INITIAL SKETCHES

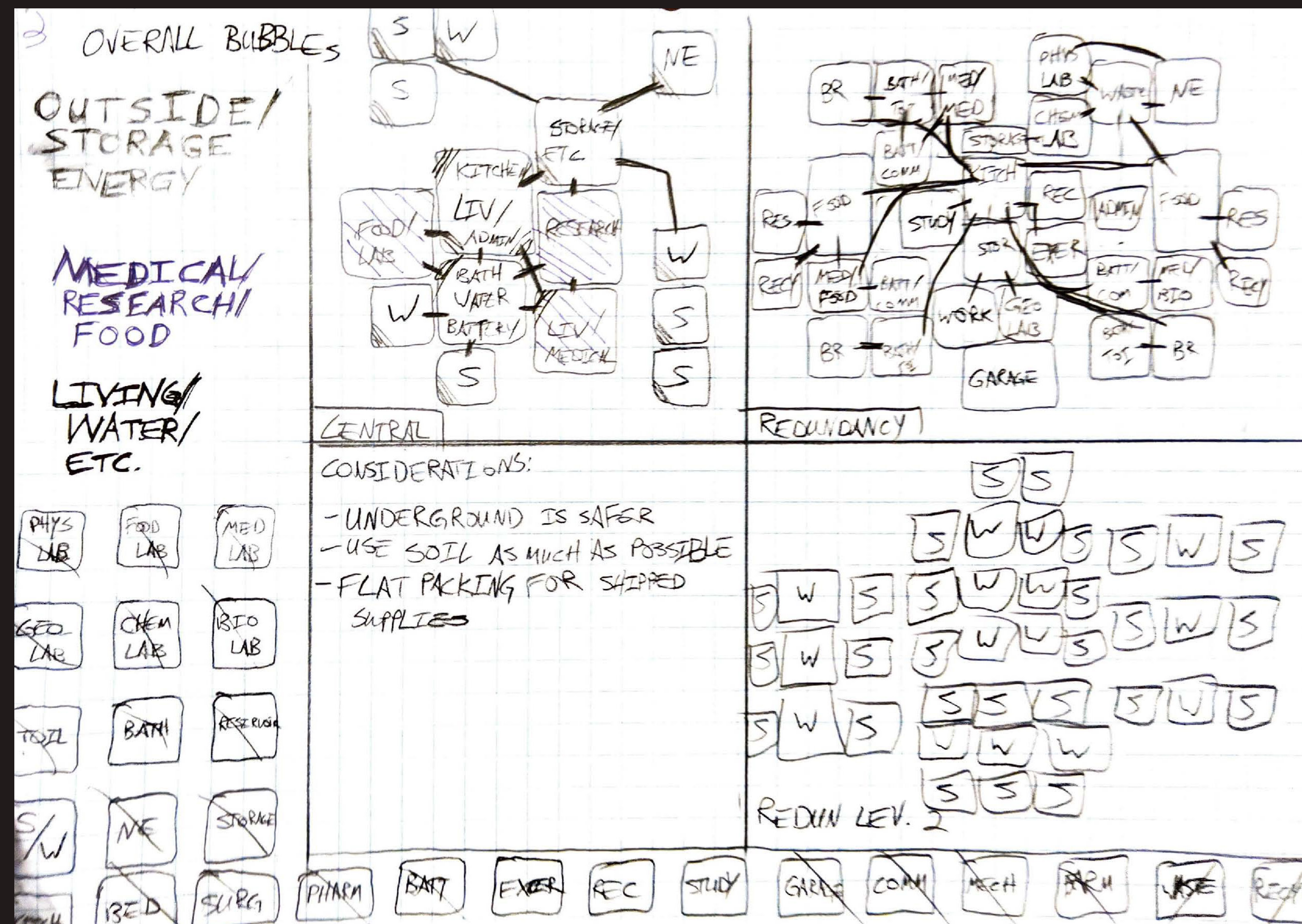


All needs must be identified in advance for an extra-terrestrial colony: there are no fallback measures beyond what the design provides. Multiple small pods/units are one way to build in redundancy in the event of failure, which these sketches explore.

FEASABILITY

CONTINGENCY

AFFORDABILITY



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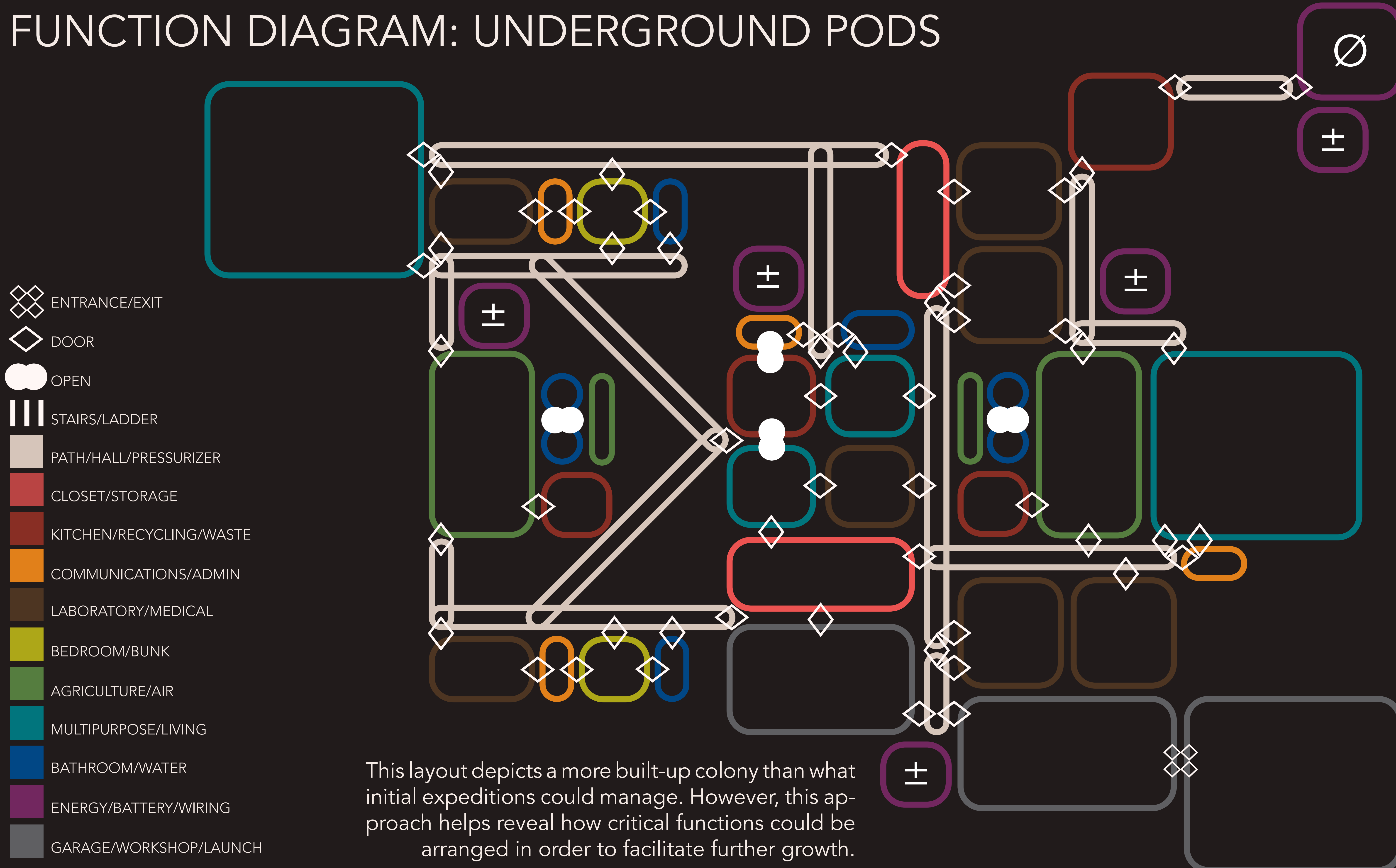
FUNCTION DIAGRAM: UNDERGROUND PODS



This layout depicts a more built-up colony than what initial expeditions could manage. However, this approach helps reveal how critical functions could be arranged in order to facilitate further growth.

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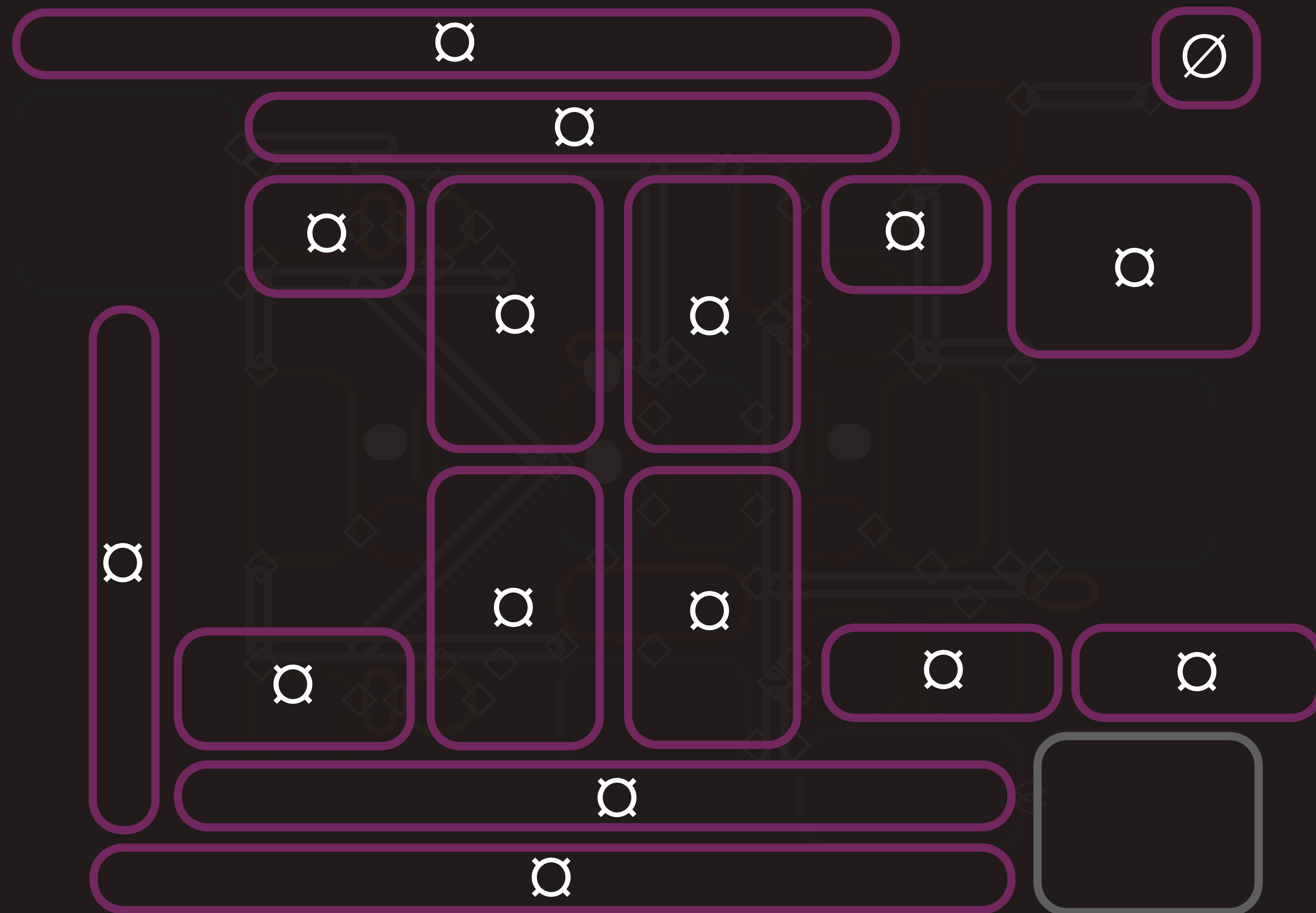
SYSTEMS DIAGRAM: SURFACE ENERGY INSTALLATIONS

- BATTERY
- FISSION
- WIND
- SOLAR
- ENTRANCE/EXIT
- DOOR
- OPEN
- STAIRS/LADDER
- PATH/HALL/PRESSURIZER
- CLOSET/STORAGE
- KITCHEN/RECYCLING/WASTE
- COMMUNICATIONS/ADMIN
- LABORATORY/MEDICAL
- BEDROOM
- AGRICULTURE/AIR
- MULTIPURPOSE/LIVING
- BATHROOM/WATER
- ENERGY/BATTERY/WIRING
- GARAGE/WORKSHOP/LAUNCH



Energy sources are kept as close to the pods as possible, exploiting the contours they create to position solar panels and wind turbines for optimal exposure. If a small nuclear reactor is installed at the site, it would be kept at a distance from the rest of the pods and cooled in a nearby ice bank.

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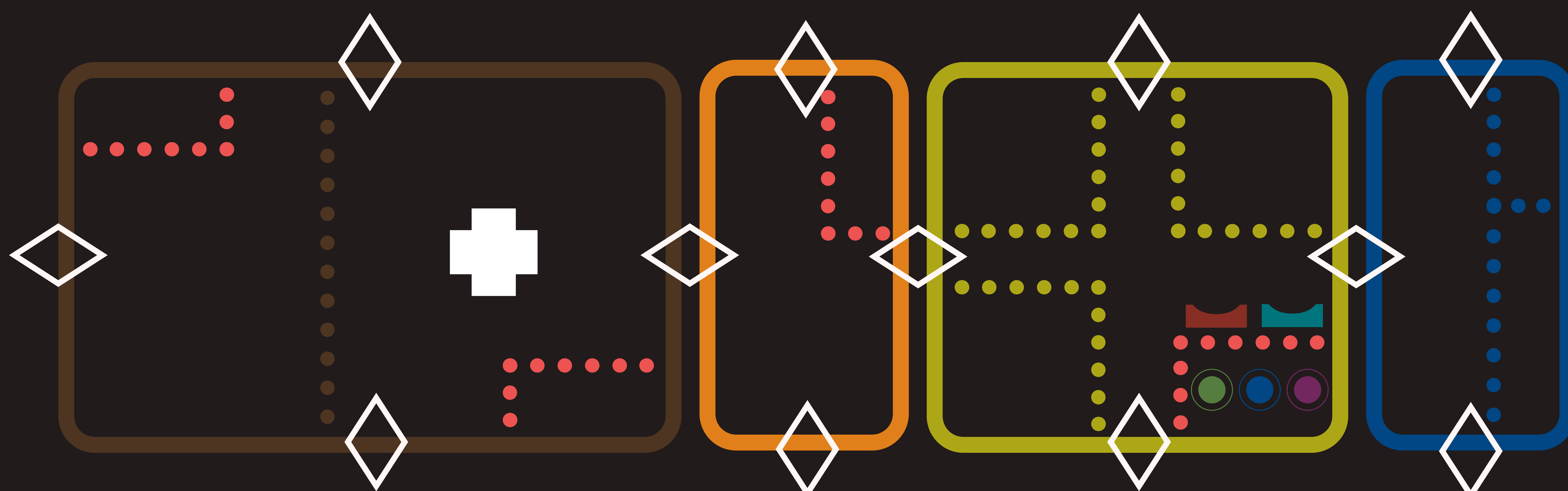
FUNCTION DIAGRAM: BEDROOM COMPOUND DETAIL

- DOOR
- BACKUP
- MEDICAL
- STATION
- PATH/HALL/PRESSURIZER
- CLOSET/STORAGE
- KITCHEN/RECYCLING/WASTE
- COMMUNICATIONS/ADMIN
- LABORATORY/MEDICAL
- BEDROOM
- AGRICULTURE/AIR
- MULTIPURPOSE/LIVING
- BATHROOM/WATER
- ENERGY/BATTERY

Pods contain modular installations that cover the basic functions of other pods. In this way, any pod can be autonomous for a certain period of time. This “fractal” design approach helps to maintain viability in the event of partial system failure.

By harvesting all structural materials locally, the bulk of payload may be invested in redundant technological infrastructure to enhance contingency preparation.



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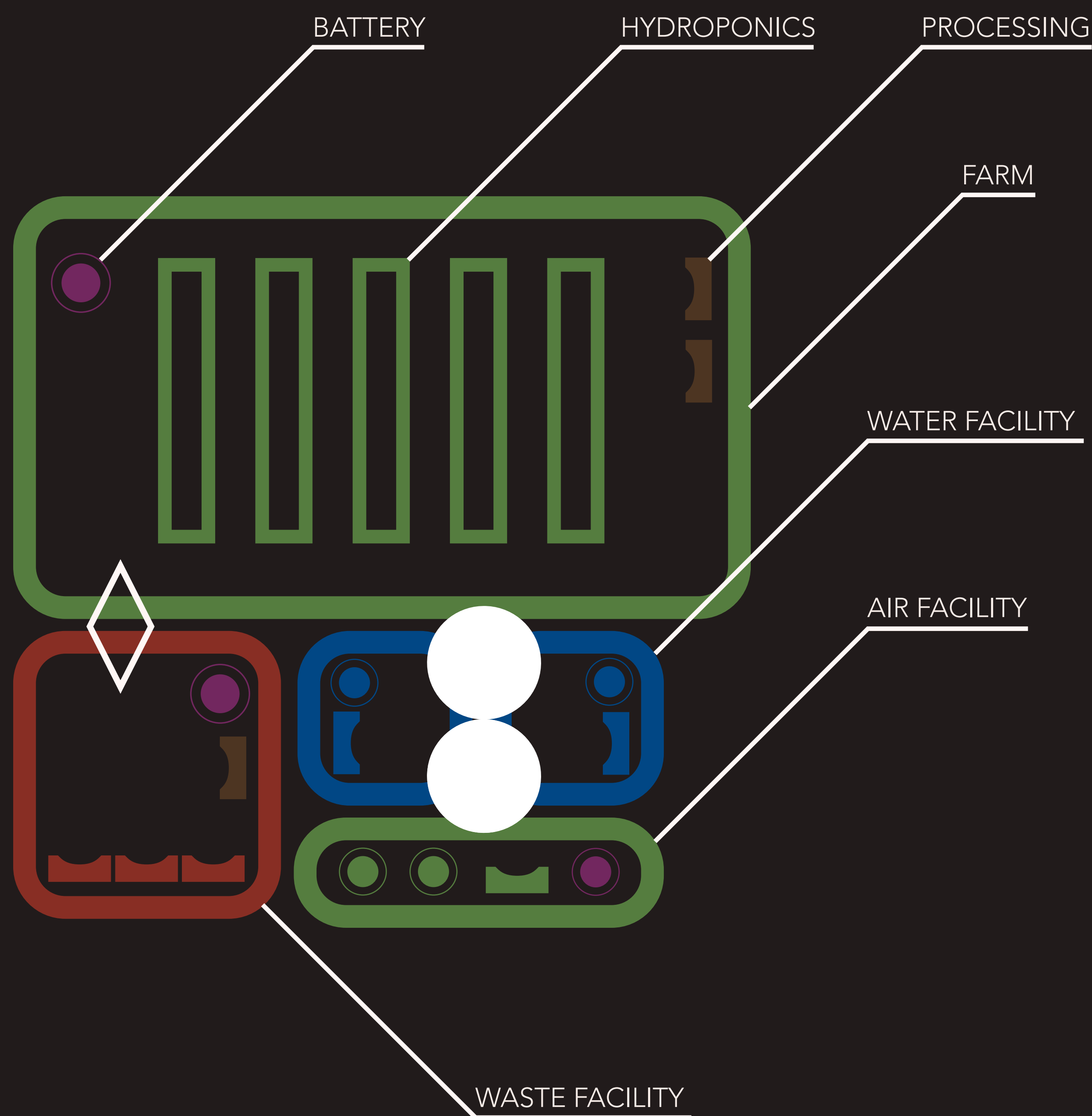
SYSTEMS OVERVIEW: FOOD, AIR, WATER DETAIL

- DOOR
- BACKUP
- OPEN
- STATION
- PATH/HALL/PRESSURIZER
- CLOSET/STORAGE
- KITCHEN/RECYCLING/WASTE
- COMMUNICATIONS/ADMIN
- LABORATORY/MEDICAL
- BEDROOM
- AGRICULTURE/AIR
- MULTIPURPOSE/LIVING
- BATHROOM/WATER
- ENERGY/BATTERY



Dedicated greenhouse areas handle food production as well as water, air, and waste systems for hydration, pressurization, and sewage. Water oxygen from electrolysis and nitrogen harvesting from the Martian atmorphere.

Most food would be grown hydroponically under a red-violet light bath to avoid reliance on natural insolation and the need for terrestrial soil.

However, these pods would also experiment with "terraforming" Martian soil to be suitable for Earth crops. Beds of species tolerant to the poisonous perchlorates in the local soil could help "purify" the soil, while the perchlorate-rich plants themselves could be used as a type of biofuel. Similar experiments could be conducted with bacterial treatment, which could potentially also serve as a source of oxygen.

The waste facility might contain biohazard bins for collecting human waste and compost for fertilizer and also contain appliances for breaking down excess/used materials for recycling.

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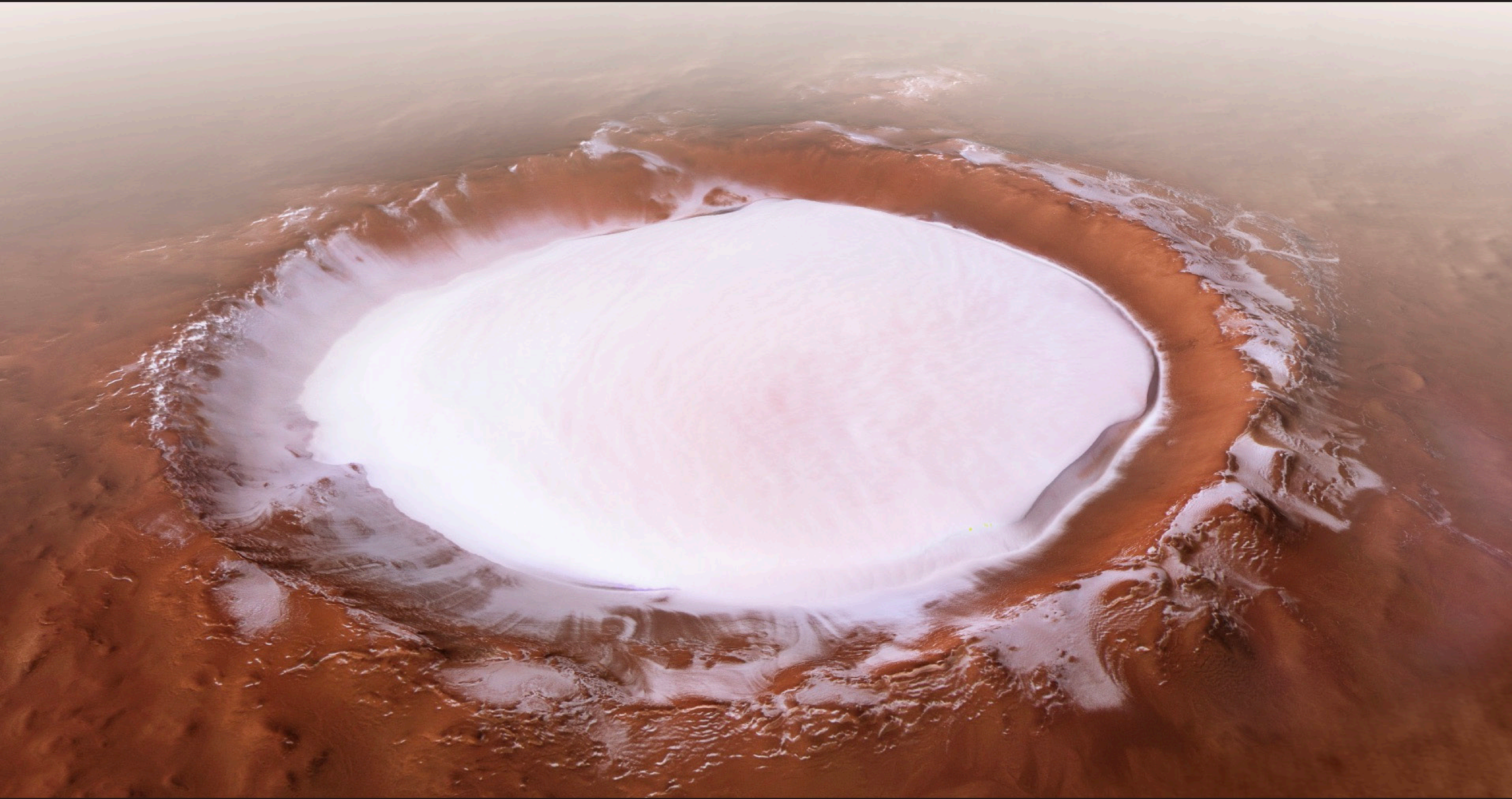
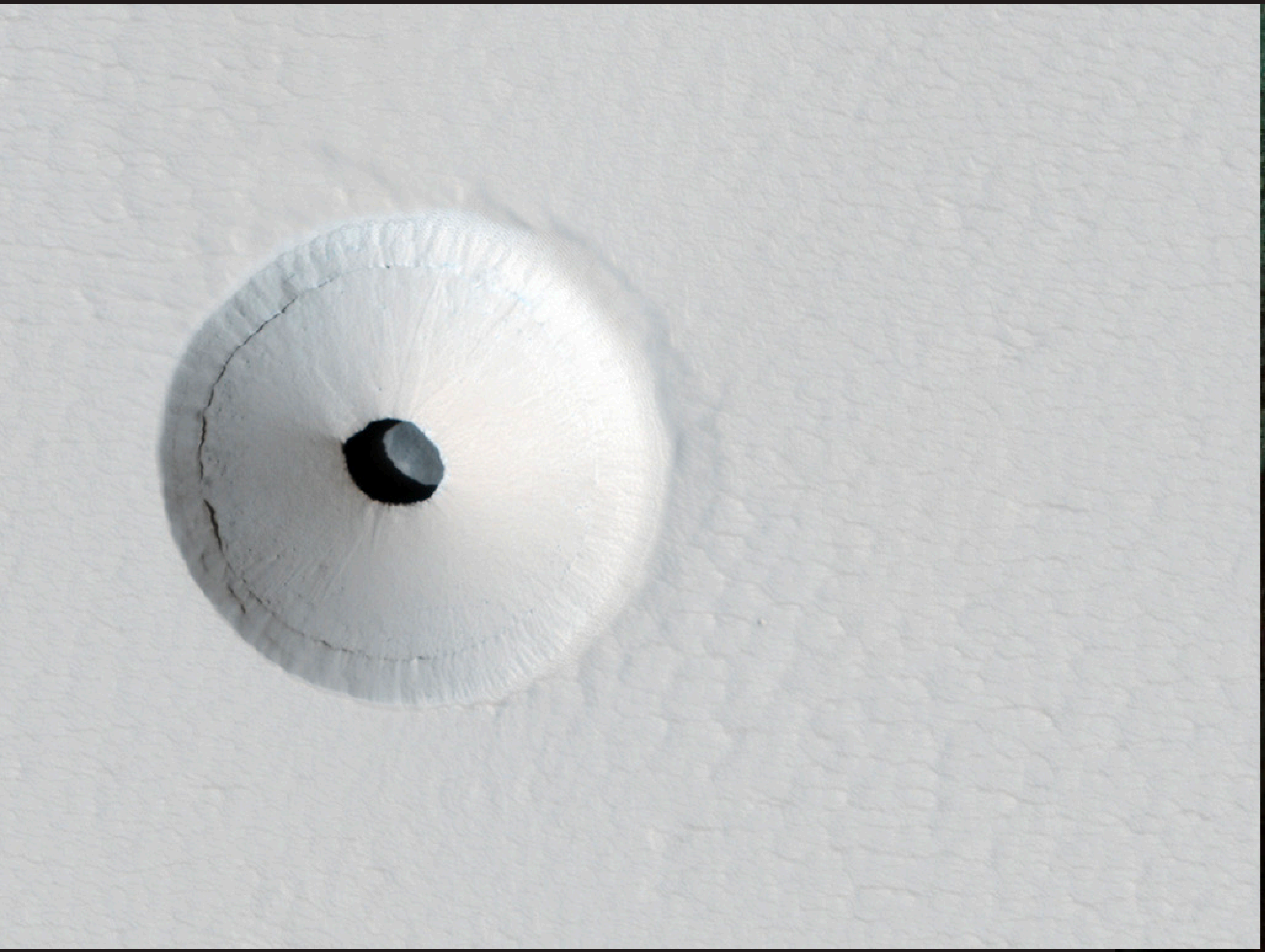
LOCATION (MACRO): ICE CRATER OR DEAD VOLCANO



KOROLEV IMPACT CRATER

LOCATION (MICRO): ICY LAVA TUBES



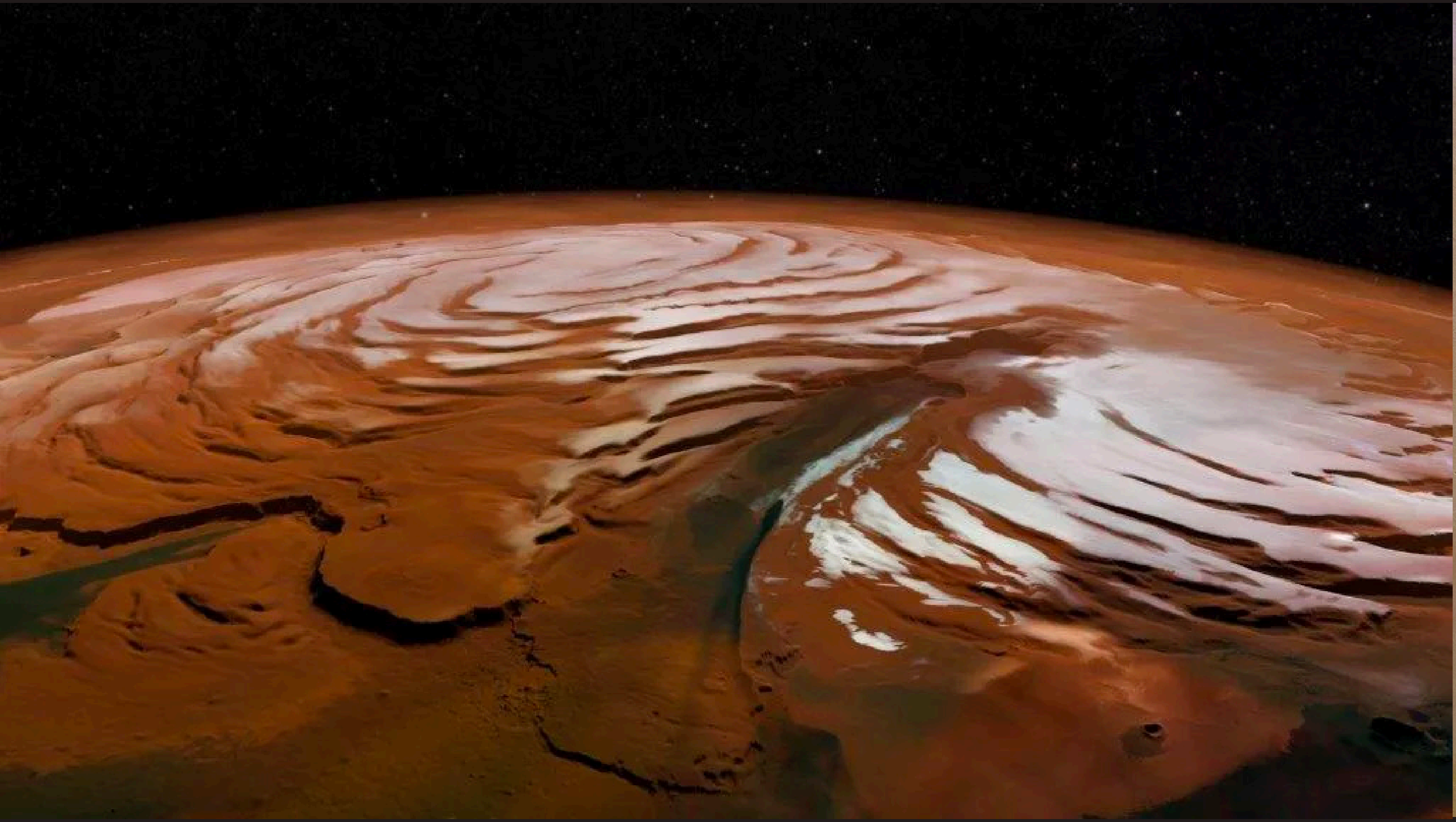
LAVA TUBE SKYLIGHT (FALSE COLOR)

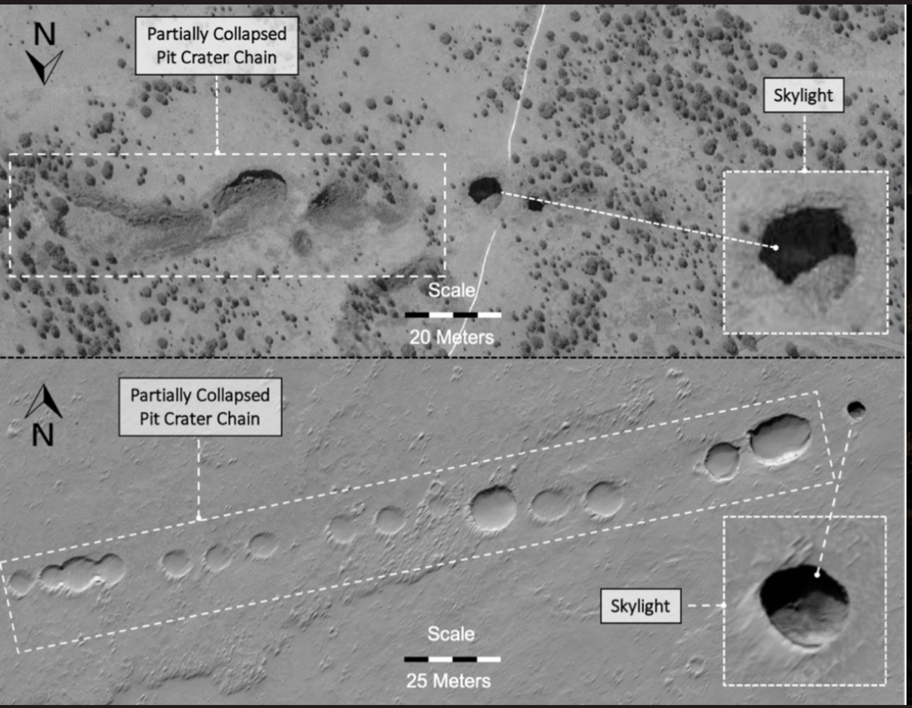
THURSTON LAVA TUBE IN HAWAII

In order to search for large amounts of liquid water, extant life or evidence of past life, valuable mineral deposits, and geological activity, icy craters and volcanoes are good places to start. Because they are explicit evidence of geological activity, they are sites likely to be rich in planetary history and resources.

Such locations may prove doubly valuable if they have openings into lava tubes or cave systems, as such environments would offer both access to the planet's interior and a more controllable setting for building habitats, while also providing natural protection against cosmic radiation and sandstorms.

ADDITIONAL LOCATION PICTURES





METHOD: PARALLEL 3D PRINTING AND ADVANCE HABITATION

An initial unmanned mission would arrive at Mars in advance in order to confirm site viability and begin preparatory work. Special technological elements like airlocks, empty water tanks, empty oxygen tanks, solar panels, electrolysis machines etc. would be transported with this vessel, along with autonomous drones capable of various surveying and construction tasks.

As regolith is thought to be at least 3 meters deep nearly everywhere on Mars, the compound would be constructed by digging roughly 2 meters into the ground, tamping and leveling the surface, and using the dug regolith as a component of a 3D-printable concrete.

The concrete would be used to build domes over the dug-out pits and add more structure and definition to their sides for radiation protection and additional structural integrity. A secondary round of 3D printing could take place within the dome – a more controlled environment – to fashion high-precision plastic pods.

A small space between the outer regolith shell and inner plastic shell could be filled with water to offer additional insulation and maintain an emergency seal in the event of shell compromise.

The entire compound would be made (and expandable) with 3 basic printed regolith shapes: outer tunnel, dome, and garage. Inside these shapes, two printed plastic shapes – pod and inner tunnel – create the actual pressurized shell for habitation.

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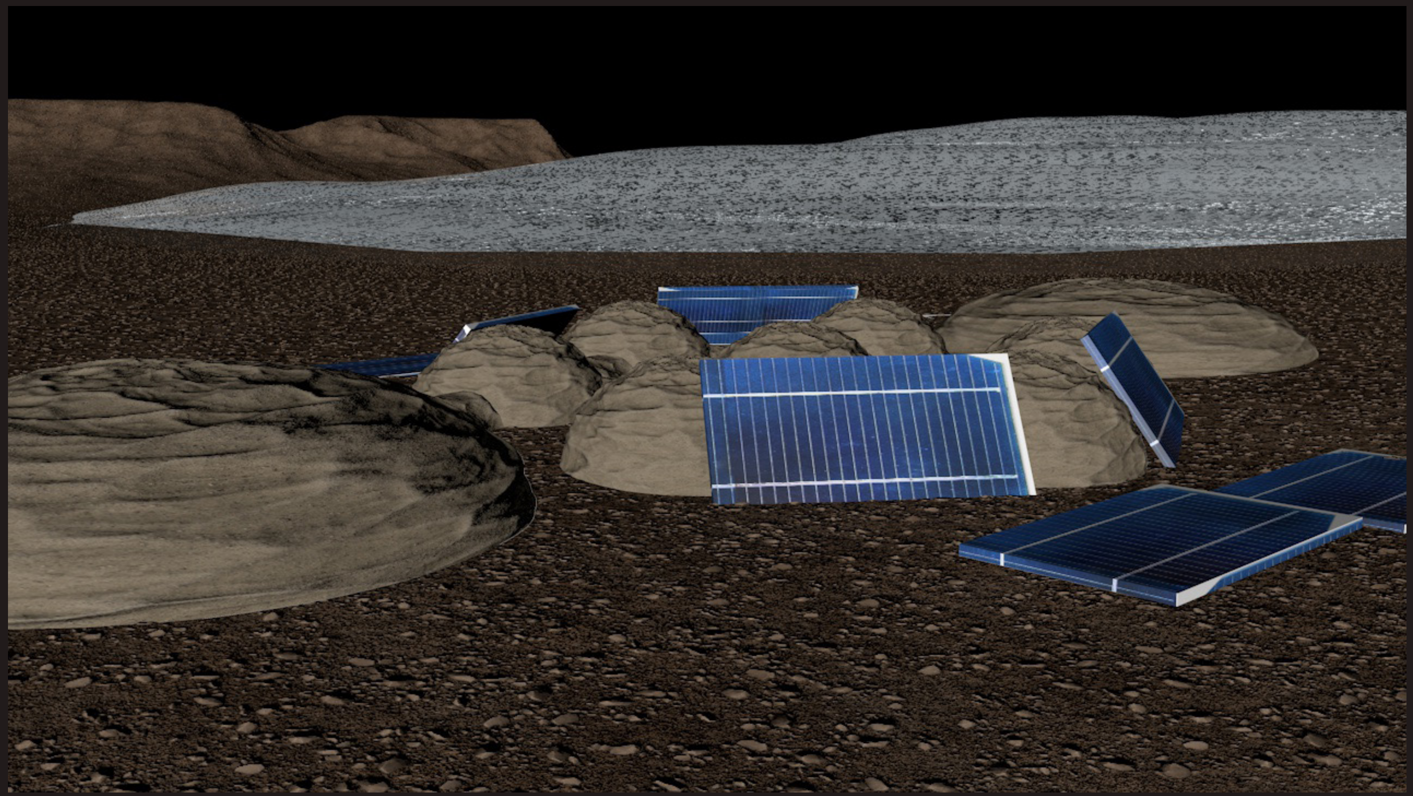
METHOD: PARALLEL 3D PRINTING AND ADVANCE HABITATION



SAMPLE DAILY SCHEDULES

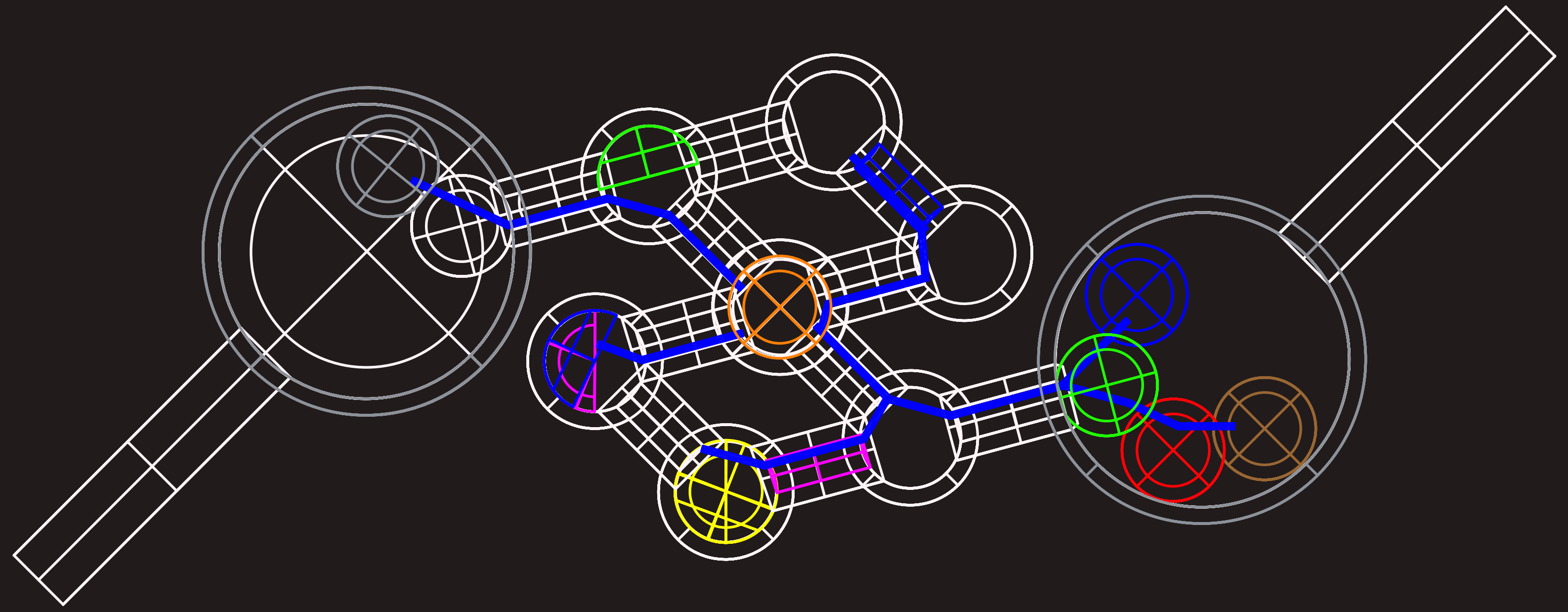
ENGINEER
0900: WAKE
0915: BREAKFAST
1000: PERSONAL TIME
1100: EXPEDITION
1500: RETURN AND LUNCH
1600: VEHICLE MAINTENANCE
1630: SYSTEMS MAINTENANCE
1800: DINNER
1900: ADMINISTRATIVE DUTIES
2000: PERSONAL TIME
0000: SLEEP

BIOLOGIST
0900: WAKE
0915: BREAKFAST
1000: PERSONAL TIME
1100: AGRICULTURE MAINTENANCE
1200: LAB EXPERIMENTS
1500: LUNCH
1600: FOOD PROCESSING DUTIES
1800: DINNER
1900: ADMINISTRATIVE DUTIES
2000: PERSONAL TIME
0000: SLEEP

Simultaneously, individuals chosen for the mission could live in a terrestrial recreation of the facility in order to familiarize themselves with maintenance and construction processes of the design while determining their own ideal function flow.

On top of providing training in its use and revealing maximally efficient resource placement, advance experimentation with the design offers the opportunity to personalize the space and make it feel like "home" in advance.

Upon arrival on Mars, the layouts and personalization explored on Earth could be recreated locally to establish a familiar environment, easing the adjustment process.



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METHOD: MODULAR INFRASTRUCTURE AND LOCAL HARVEST

$$2H_2O_{(s)} \rightarrow 2H_2O_{(l)} \rightarrow 2H_2 + O_2$$

$$\text{atmosphere} \rightarrow CO_2 + N_2$$

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

$$CH_4 + O_2 + \text{sugars} + \text{bacteria} \rightarrow \text{PHA}$$

In order to avoid increased costs from the transport of pre-fabricated machines, the crew could bring modular infrastructural elements for non-specialized tasks.

Lighting, water and air flow, and simple machines for heating, cooking, etc. could be assembled and disassembled as needed from a bank of parts. This bank would consist of elements such as tubes, wiring, microprocessors, electronic components and LEDs, motors, and connectors, along with a 3D printer for the construction of structural elements.

A set of general instructions for creation, programming, and repair would cover most basic needs and enable easy harvesting of materials in the event of structural compromise. This resource flexibility would ensure that any single pod can be outfitted for an emergency survival scenario.

Ice is harvested and melted for water supply. Hydrolysis of a portion of this water supply yields hydrogen as emergency fuel and oxygen for habitat. Nitrogen is initially harvested from atmosphere for habitat.

Once the habitat stabilizes, glass could be made on-site from silicates, feldspar, sodium oxide, dolomite, and calcium oxide sifted from Martian dust. Methane synthesized from local carbon dioxide and hydrogen gas from water electrolysis via the Sabatier process can be used to replenish plastic stores for future 3D printing or used as a fuel source for launches off the Martian surface.

Human sewage and composting offer a fertilizer source for creating agriculture-viable Martian soil, while other forms of waste can be broken down/recycled for additional 3D prints or for chemical synthesis/experiment.

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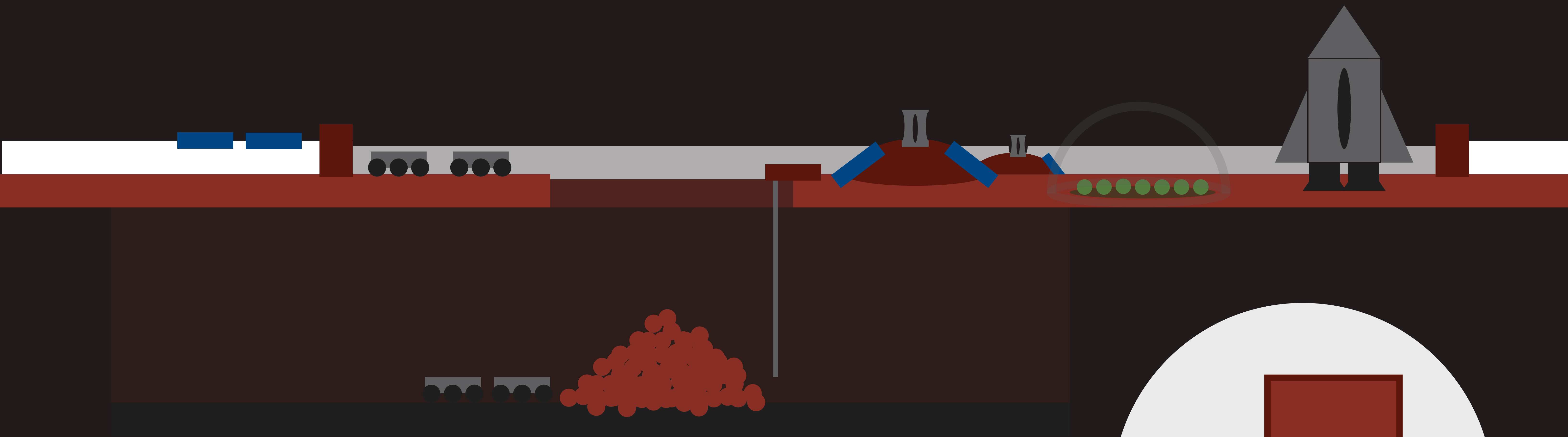
SITE APPROACH: RIM



If an initial unmanned expedition finds that the lava tube region is too unstable for construction or may have a delicate soil composition, etc., then a nearby location on the rim of the skylight may be chosen for the installation.

In this case, a winch could lower colonists into and out of the tube for exploration, while the base remains on the surface.

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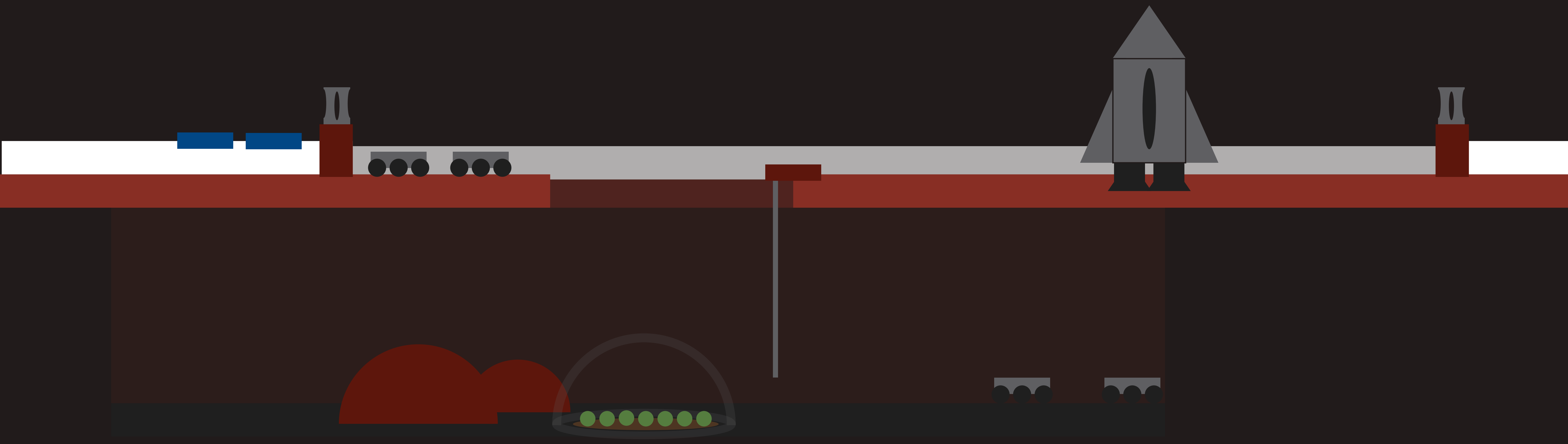
SITE APPROACH: TUBES



If the lava tube/cave seems safe and otherwise appropriate for building, construction drones could use the loose regolith on the tube floor as the construction material for the underground base. All energy sources would be on the surface, with power transmitted to batteries down below.

In this case, the spacecraft would likely need to remain on the surface, creating some distance between the colonists and their emergency ride off the planet.

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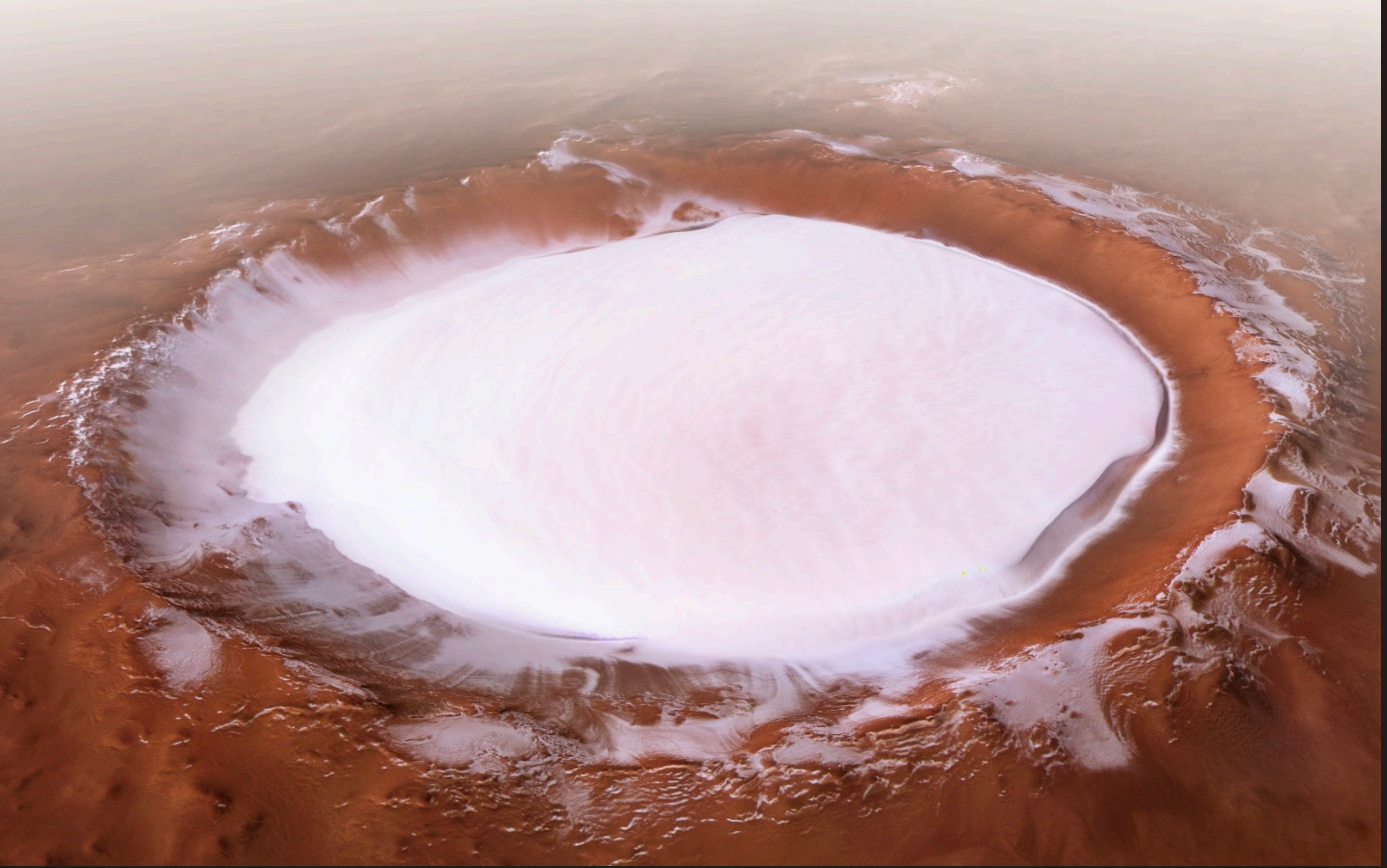
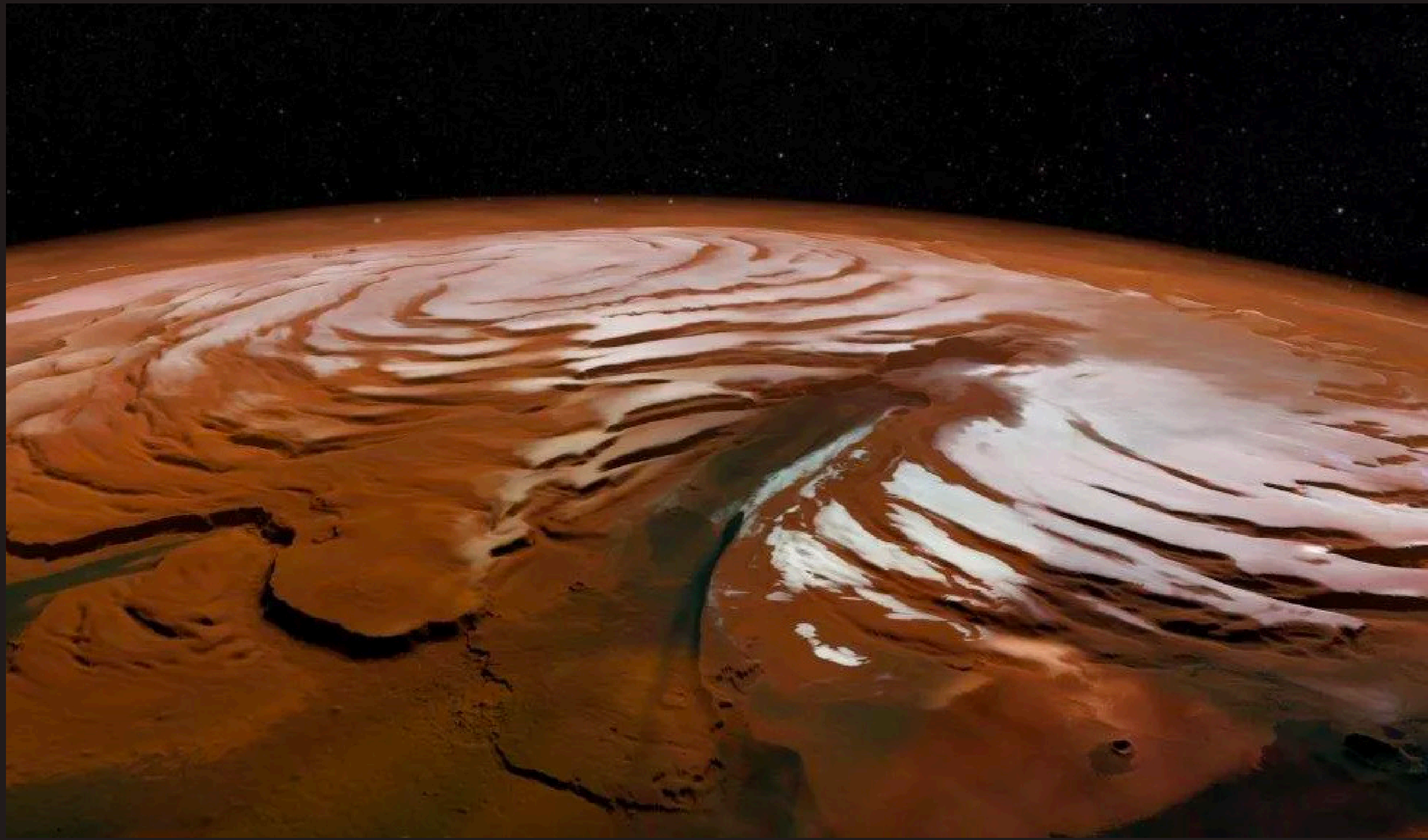
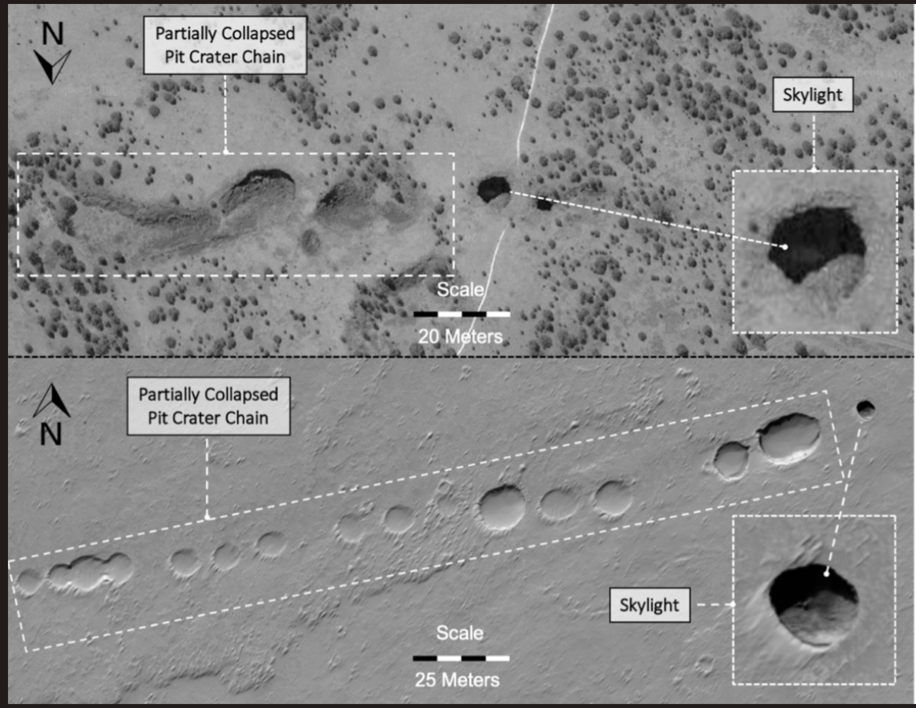
INSPIRATION LOOKBOOK







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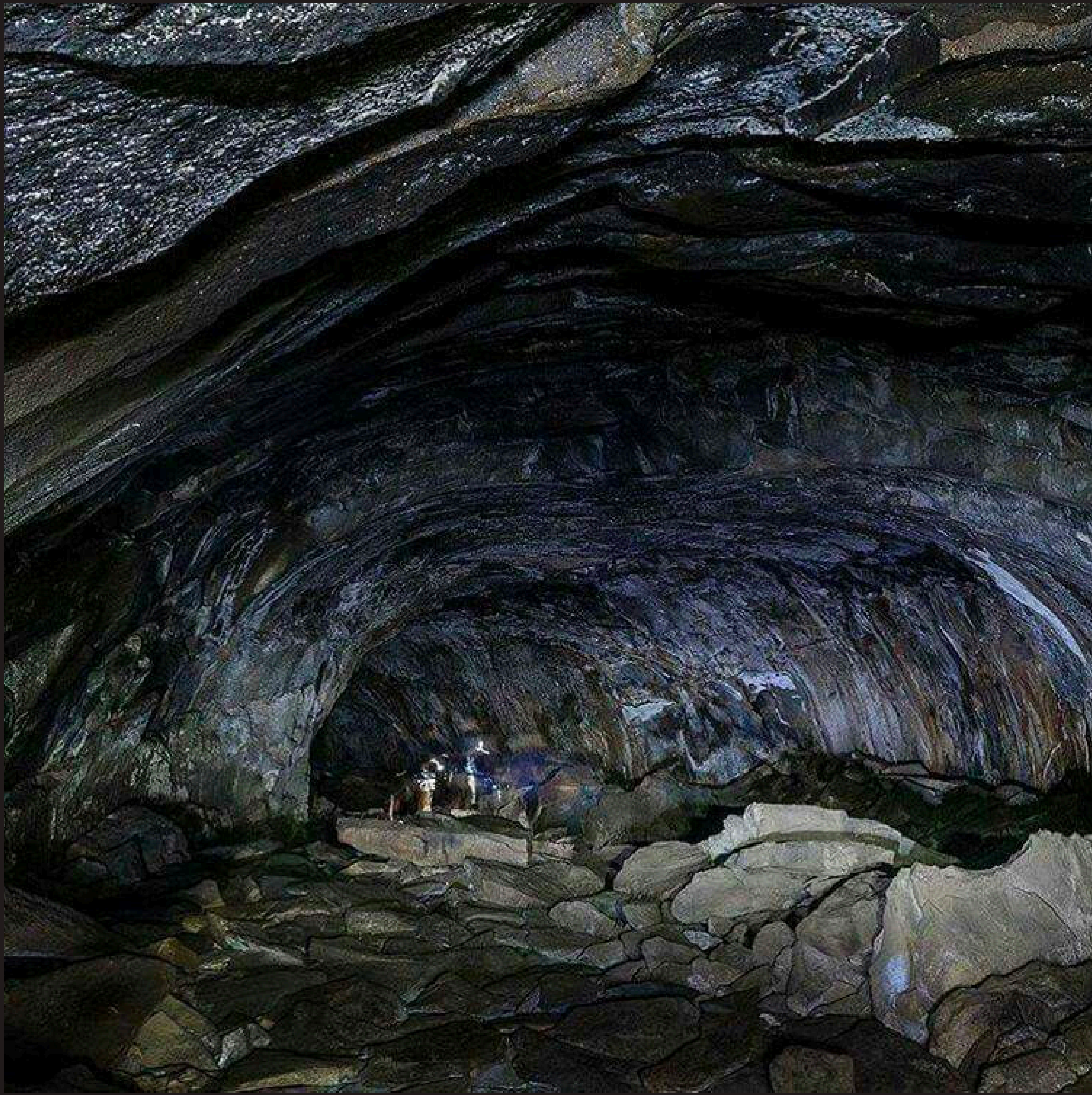




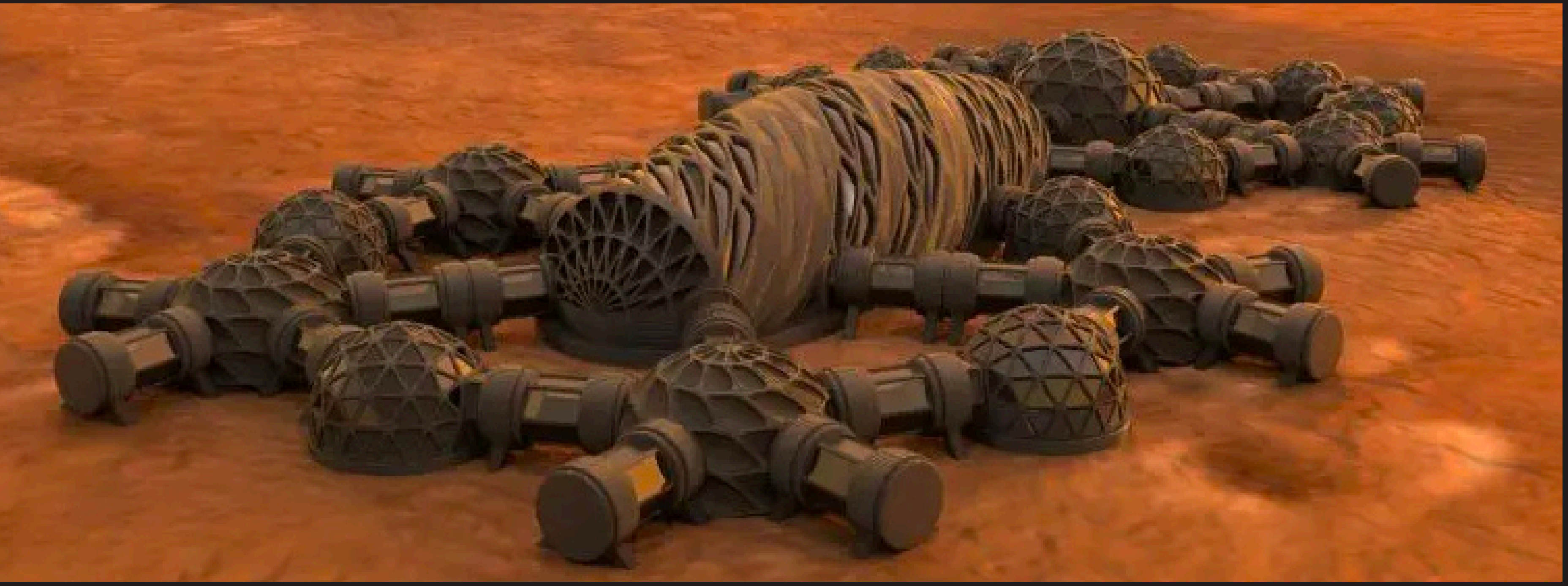
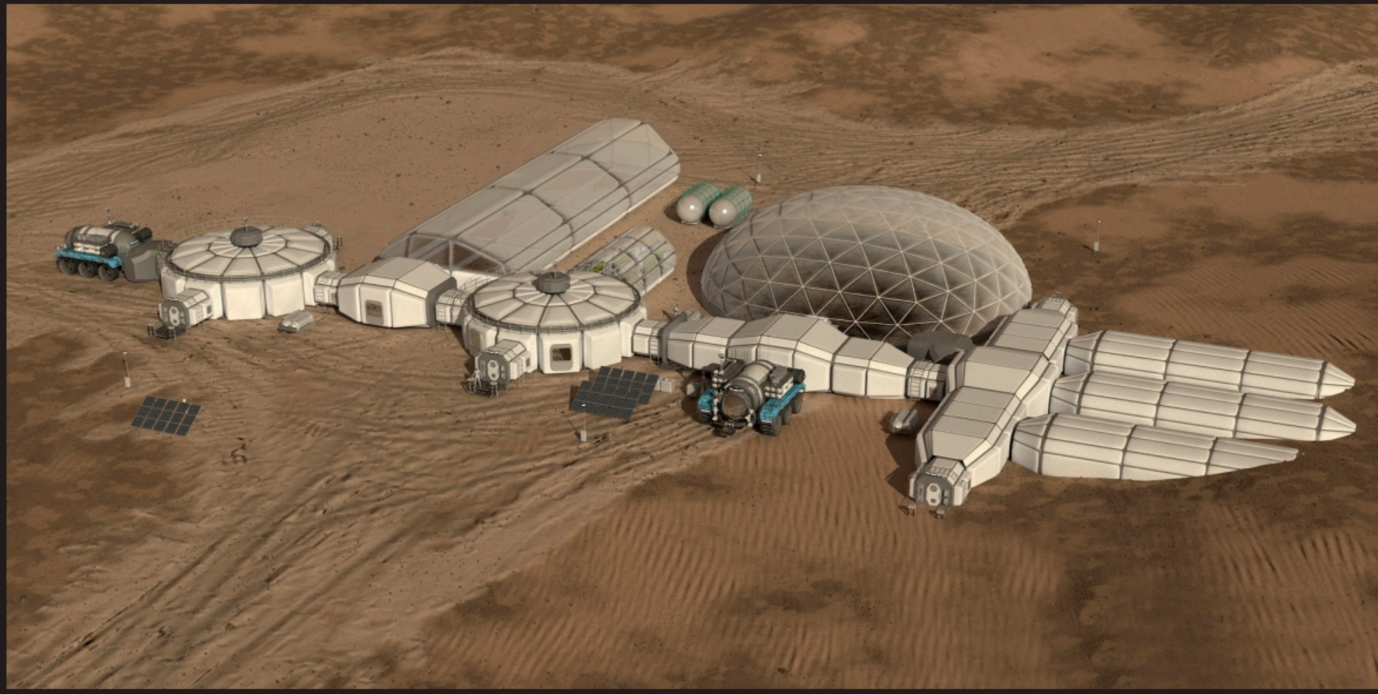

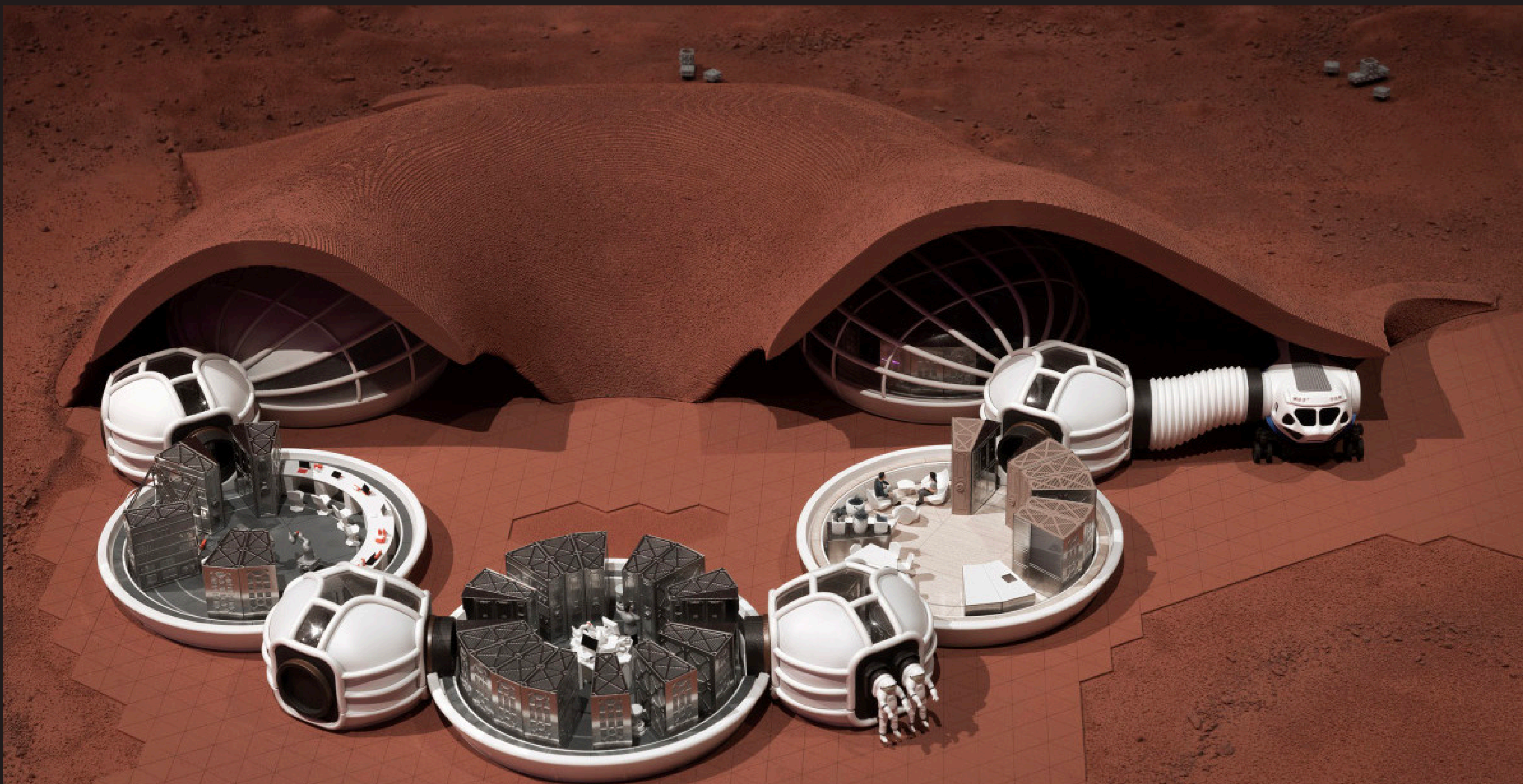

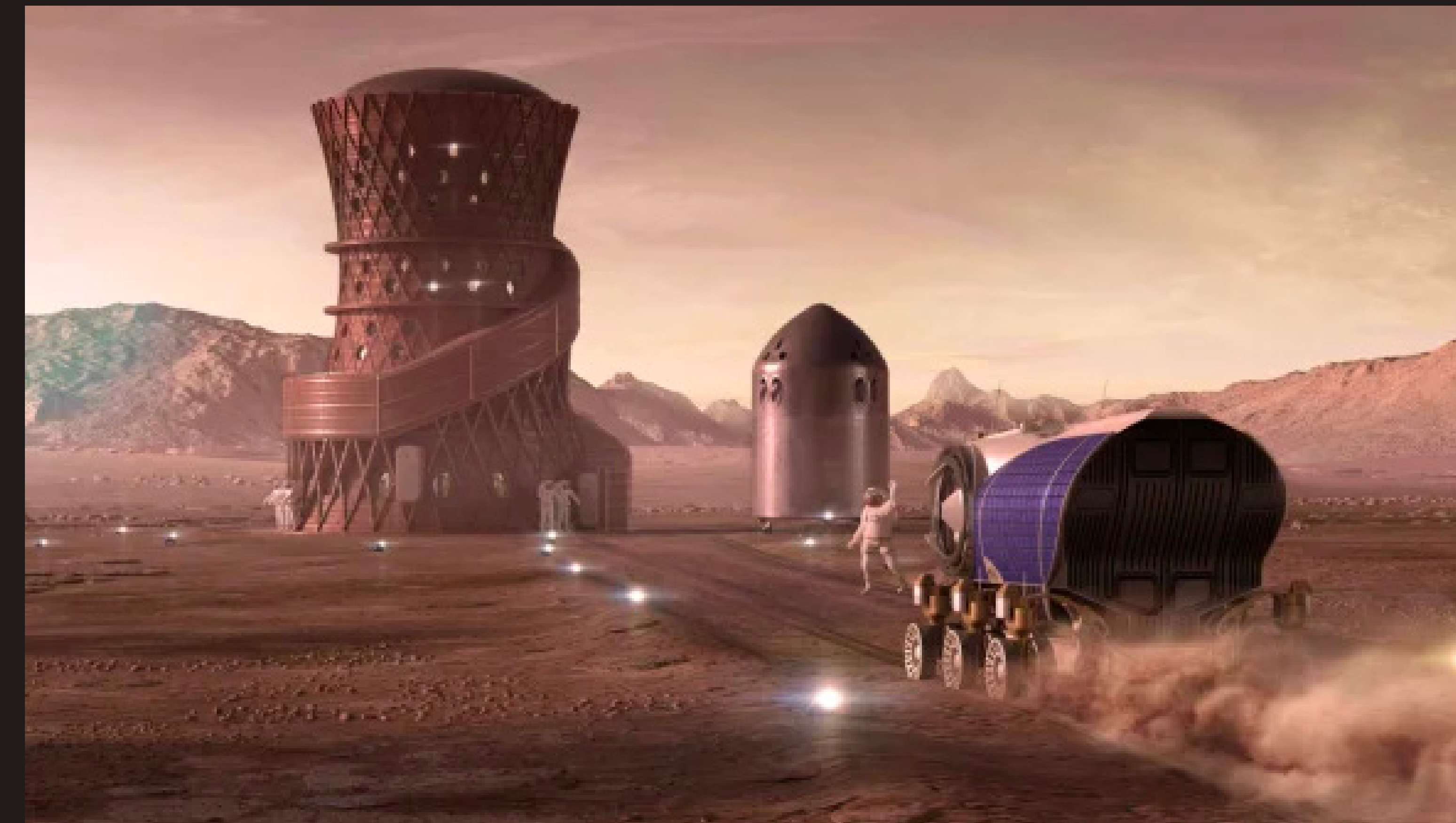

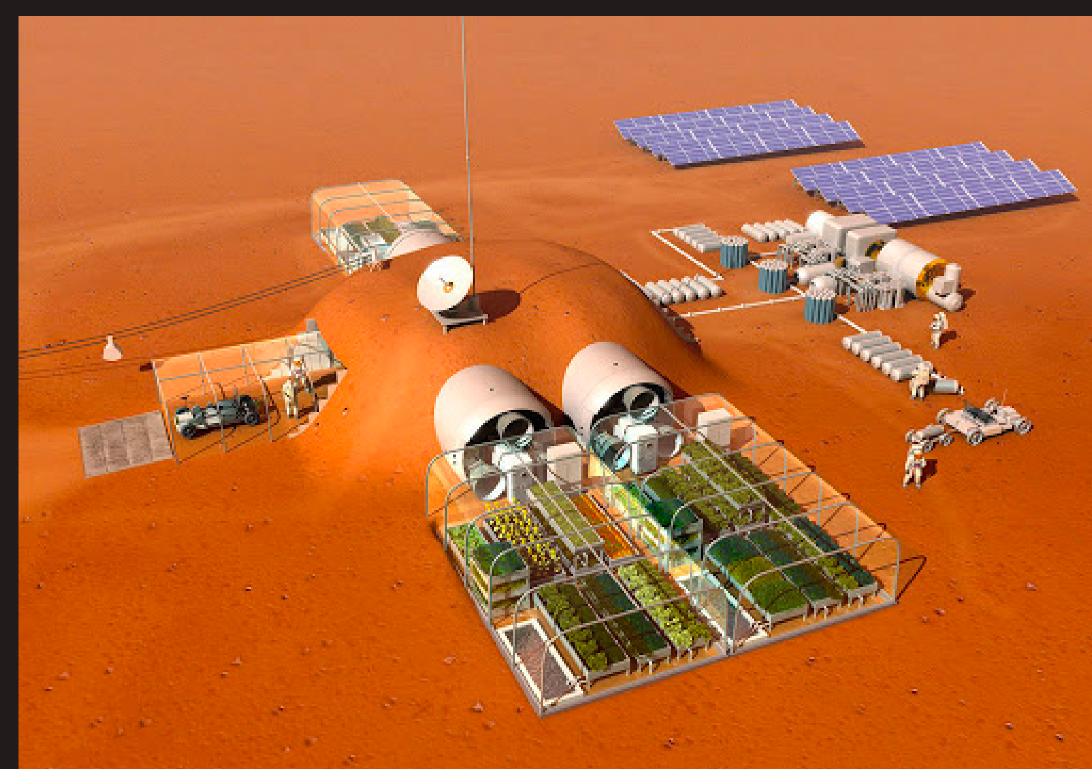

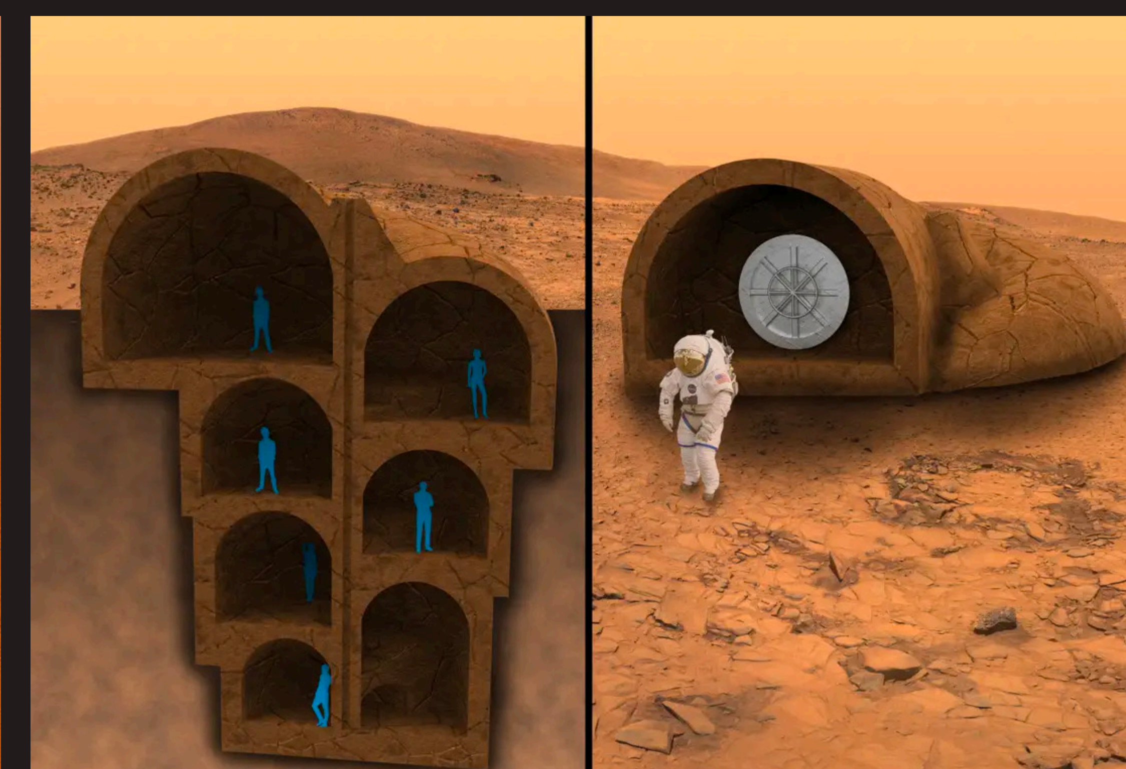

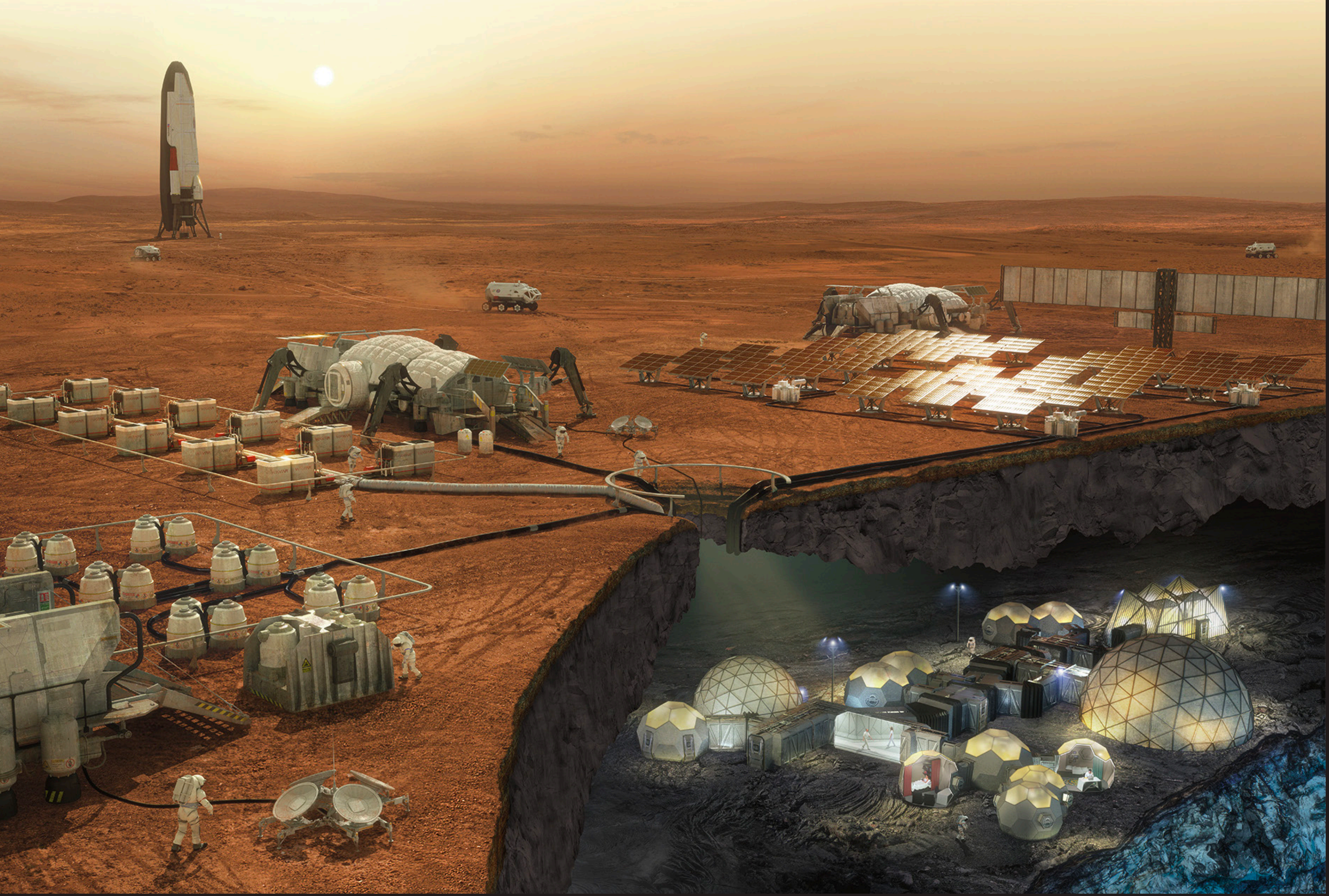

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THANK YOU

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