



Analog Missions and Field Tests

NASA is actively planning for its return to the moon. The agency's Exploration Systems Mission Directorate is developing the architecture that will transport astronaut crews to and from the moon and sustain a human presence there. NASA engineers and scientists, government agencies and industry partners have united to gather requirements and develop the technologies necessary to ensure initial and continuing success for life and work on the moon.

Because NASA's field centers do not feature terrain comparable to that of the lunar surface, NASA and its affiliates conduct analog missions. Analogs are remote field activities that map and integrate multiple features of a target mission to gain an understanding of system-level interactions. Analog locations are identified based on their similarities to one or more extreme characteristics of the target mission.

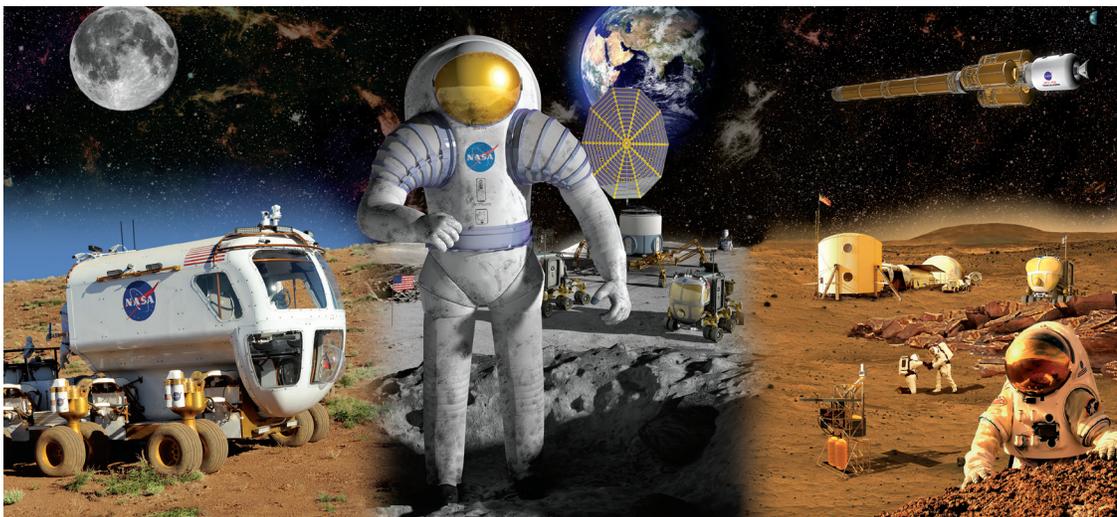
NASA's Apollo program performed several

analogs, which proved to be an effective method for developing extravehicular activities (EVAs), surface transportation and geophysics capabilities.

In preparation for upcoming lunar missions, NASA is expanding its analog mission campaign and will include international participation in future missions. Today, analogs are conducted to test robotics, vehicles, habitats, and in-situ resource utilization in realistic environments that will aid astronauts, engineers, and scientists as they define ways to combine human and robotic efforts to enhance scientific exploration.

Multiple sites that replicate the lunar environment have been added to those explored in the past. The combination of the new technology and test sites has enhanced the experiments and continues to provide NASA with data about strengths, limitations and validity of planned human-robotic exploration operations.

NASAfacts



Extreme Environments

In order to simulate a realistic environment for lunar surface systems and operational concepts testing, NASA performs analog missions in

different locations depending on the testing objectives. Locations include the antarctic, oceans, deserts, arctic and volcanic environments.

Antarctic: Inflatable Lunar Habitat



When astronauts return to the moon for extended stays, they will require shelter to live and work under for protection from the harsh lunar environment. NASA conducted an analog mission to test the inflatable habitat concept. The site selected was the cold, isolated landscape of Antarctica.

In a 13-month test beginning in January 2008 at McMurdo Station in Antarctica, NASA, in cooperation with the National Science Foundation and ILC Dover, collected information about various aspects of the habitat, including the structure's

power consumption and damage tolerance. The test also gauged astronauts' ability to assemble, pack and transport the habitat while wearing spacesuits.

Testing in the antarctic simulated what it would be like for astronauts to live in a similar structure on the moon. If selected for use in future missions, the structure's size and weight will reduce the amount of hardware and fuel necessary for transportation and logistics on the moon.

Oceans: NASA's Extreme Environment Mission Operations (NEEMO)



The Florida Keys National Marine Sanctuary, home of the National Oceanic and Atmospheric Administration Aquarius Underwater Laboratory, serves as the test site for NASA's Extreme Environment Mission Operations. NASA found the isolation and real hazards of the laboratory's lunar-like environment made it a perfect site for testing lunar exploration concepts such as advanced navigation and communication equipment. Astronauts also execute a variety of undersea "moonwalks" at Aquarius.

Similar in size to the International Space Station's living quarters, Aquarius is the world's only permanent underwater habitat and laboratory. The 45-foot long, 13-foot diameter complex is three miles off Key Largo in the Florida Keys National Marine Sanctuary, about 62 feet beneath the surface. A surface buoy provides connections for power, life support and communications. A shore-based control center monitors the habitat and crew.

Long-duration missions, lasting up to 10 days, provide astronauts with a realistic account of what they will likely encounter on the moon. The tests cultivate an astronaut's understanding of his or her ability to carry out daily operations in a simulated planetary environment, and create realistic scenarios for crews in close quarters to make real-time decisions.

Deserts: Short Distance Mobility Exploration Engineering Evaluation Field Tests

The Short Distance Mobility Exploration Engineering Evaluation field tests were designed to measure the benefits of using pressurized vehicles as opposed to unpressurized vehicles, and incorporate the findings into upcoming lunar missions. NASA realized it needed a site to conduct short-distance mobility exploration and engineering evaluation tests to investigate the utility of its robotic vehicle concepts in an earthly moonscape. NASA found the Sand Dunes of Moses Lake, Wash. and the desert-like landscape in Black Point Lava Flow, Ariz. to be the best environments to conduct these tests.

NASA's Exploration Systems Mission Directorate Lunar Architecture Team conducted studies of the possible scenarios that may be encountered on the moon. The sand dunes, rugged terrain, soil inconsistencies, sand storms and temperature swings of the two locations are ideal for simulating lunar exploration, site surveys and outpost construction to help prepare to meet the challenges for future missions on the moon.

Another critical set of analog tests evaluate human and robotic interactions. System tests are designed by the Human Robotic System team, a group of engineers and technicians from six NASA centers and one university. Lunar human-robotic systems are essential to lunar

exploration because astronauts will rely on such systems to help them move from one point to another, conduct experiments and haul heavy equipment.



Arctic: Houghton Mars Project



Houghton Crater is located on Devon Island, Canada, and is accessible only by aircraft from Resolute Bay, Cornwallis Island, Canada. The site's rocky arctic desert setting, geological features and biological attributes provided an optimal opportunity to gather requirements for possible future robotic and human missions to Mars.

During the Houghton Mars Project, scientists and engineers

from NASA's Science and Exploration System Mission Directorates, Mars Institute, and SETI Institute performed multiple representative lunar science and exploration surface activities using existing field infrastructure and surface assets. Science and operational concepts were demonstrated, including extravehicular activity traverses, long-term hi-data communication, complex robotic interaction, and on-board rover and suit engineering.

Volcanic Terrains: In-situ Resource Utilization Demonstrations

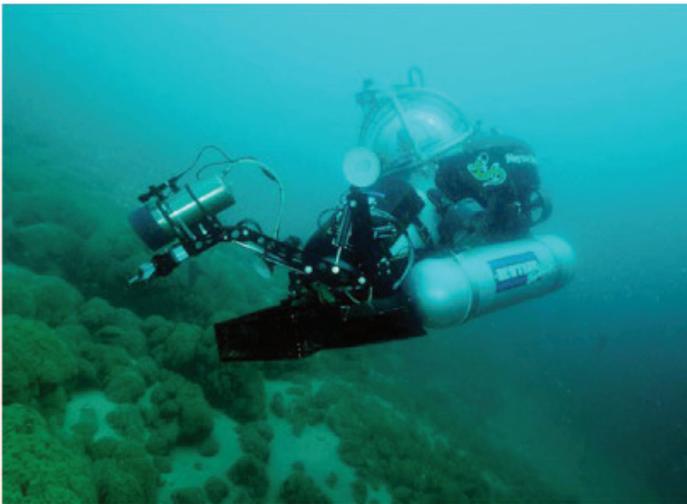
The terrain, rock distribution, and soil materials in Hawaii provide an ideal simulated environment for testing hardware and operations beyond resources available at laboratories and “rock yards.”

In-situ Resource Utilization (ISRU) has been identified as a necessary element in NASA’s current lunar exploration architecture. ISRU is a process that uses hardware or employs an operation to harness local resources for use in human and robotic exploration. Lunar resources that could be used in ISRU include regolith, minerals, metals, volatiles, water/ice, sunlight, vacuum, and thermal extremes found at the lunar poles.

NASA’s Exploration Systems Mission Directorate and Innovative Partnerships program have plans to perform field demonstrations in Hawaii in collaboration with the Pacific International Space Center for Exploration Systems and the Canadian Space Agency. The demonstrations will facilitate lowering NASA’s lunar architecture risk by demonstrating end-to-end oxygen extraction, separation and storage from the volcanic material, as well as demonstrating technologies that could be used to look for water/ice in the permanently shadowed craters at the lunar poles.



Underwater: Pavilion Lake Research Project



NASA and the Canadian Space Agency teamed up to sponsor the Pavilion Lake Research Project (PLRP), conducted in British Columbia, Canada, in June 2008 and July 2009.

This multi-disciplinary science and exploration mission aims to explain the origin of freshwater microbialites on the floor of the lake. The science data collection helps scientists understand ancient microbialites that were once common on Earth 540 million years ago, and helps NASA develop exploration methods for site surveys and data collection techniques in a harsh environment.

For more information about analog missions and field tests, visit www.nasa.gov/exploration.

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