Lava Tube Analog Mission for Lunar Science and Human Performance Studies

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SIMULATION OF ROBOTIC AND HUMAN "FIRST CONTACT" WITH A LUNAR LAVA TUBE

SCIENCE

Lunar Geology

- Understanding the volcanic history of the Moon
- Access to fresh outcrops of volcanic rock for analysis and sampling (i.e., rocks not affected by space weathering or micrometeorite bombardment)
- Understanding the geologic processes associated with ancient lunar basaltic lava flows
- Understanding the changes in composition of layered lava flow sequences

Astrobiology for Mars Exploration Applications

- Understanding the volcanic history of Mars
- Access to fresh, dust-free outcrops of volcanic rock
- Understanding the potential of lava tubes as habitats for life
- Test hypotheses and understand biogeochemical processes, & the signatures that these processes leave in mineral deposits
- Potential for access to permafrost and ground ice without drilling

REMOTE SENSING

Remote Sensing Tools and GIS Applications

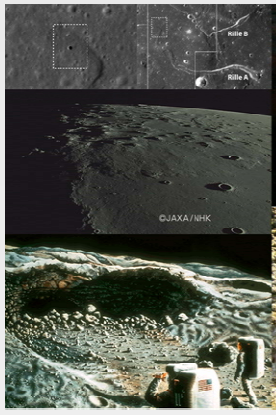
- Improvements in remote sensing and detection technologies such as ground penetrating radar
- Use of Geographic Information Systems (GIS), geo-spatial analysis, GPS, and traverse planning tools

FLEXIBLE PATH MISSION

Candidate Destination for NASA Flexible Path Mission Planning

- Scientific expedition to Marius Hills Skylight offers mission of opportunity which satisfies many goals of NASA's newly revised exploration direction:
  - Terrestrial analog phase
  - Robotic lunar precursor phase
  - Human lunar return phase
  - New technology development
  - International participants
  - Knowledge gained for Mars planetary cave exploration
  - Participatory exploration
  - Commercialization opportunities

Skylight Discovered at Moon's Marius Hills Region



1st Human Expedition to a Lunar Lava Tube (NASA Image)

Nisga'a Lava Tube Entrance

Nisga'a Lava Tube Analog Site

Human & Robotic Performance Assessments at Analog Site

Cave Profiling Technology for Lunar Habitation/Science Research

courtesy Natural Resources Canada

Analog Site at Nisga'a Memorial Lava Bed Park in British Columbia, Canada

- The recent discovery by the science team of the Japanese Kaguya lunar sensing satellite of a "skylight" or cave opening in the area of the Moon's Marius Hills region is a potentially important find for the existence of intact lunar lava tubes. This discovery raises the specter of investigative science focusing remote sensing efforts for planning robotic and eventually human expeditions to these subsurface environments for in situ investigations.
- The operational scenarios, technologies, and human and robotic performance feats associated with planetary cave exploration can be benefited by terrestrial analog mission testbeds.
- Certain geomorphologic features found at the Nisga'a Memorial Lava Bed Park in British Columbia, Canada can serve as a terrestrial analog site for science research and testing of mission operations to lunar subsurface sites. We propose an analog mission investigating required science measurements with human performance objectives simulating robotic and human "first contact" with a lunar lava tube. The proposed geographic location for conducting the analog studies is within the protected area of the Nisga'a Lava Bed in proximity to the Tseax River Cone or Aiyansh Volcano where unmapped lava tubes exist.
- *Scope and Objectives of the Research:* The idea is to get some understanding of first robotic and human contact with a lunar lava tube through the use of comparable terrestrial lava tube features. Basic scientific understanding of the features is necessary to locate them on the Moon as well as techniques of entering and examining them robotically and by astronauts.
- *Proposed Methodology:* Essentially we simulate a first scientific expedition to a lunar lava tube. By simulating missions to the features on Earth researchers can better understand direction and techniques of exploration of those features on the Moon. An international team of planetary scientists, caving and mining experts, robotic experts, and human performance experts has been assembled to investigate the best path for technology development and how sampling and science can be done on the lunar surface and underground.

TECHNOLOGY

Applied Technologies and Technology Development

- Robotic and autonomous mobile systems
- Spectral analysis
- Laser measurement systems for cave profiling and mapping
- Pressurization techniques
- Human factors and radiation protection
- Navigation & communications
- Logistics
- Science instruments
- Photo/video/vision systems
- 3D visualization
- Structures & materials
- EVA suit mobility testing
- Power and lighting
- Program management tools

Technology Commercialization

- Technology application to other subterranean environments on Earth & other planetary bodies
- Security, civil construction, public safety and mining applications

HUMAN PERFORMANCE

In-Situ Monitoring Of Human Health & Performance

- Improve understanding of the biological, psychological and social effects of stress in an ICE (Isolated, Confined, and Extreme) environment
- Model human decision-making process and personal and social information processing
- Investigate the emotional needs of crews related to workload stress, isolation, and human/robotic interactions
- Develop methods to measure and evaluate human performance and behavior on long-duration missions

TEAM STRUCTURE