

Overview

- Introduction
 - Context for the workshop is the President's initiative
 - Need for continued community interaction with NASA exploration initiative
- Major findings of the workshop
 - Identify and characterize resources
 - Permit safe landing
 - Select landing site
 - Moon as a test bed for exploration of Mars & other sites
 - R&D program
- Usefulness of in-situ resources for long duration exploration
- Strategy for a series of missions

Resources

- Identify & Characterize lunar resources
 - Polar volatiles (is there H₂O?)
 - Polar environment
 - Pyroclastics
 - Non polar regoliths (e.g. ilmenite)
- Demonstrate techniques to extract & utilize in-situ resources

Permit Safe Surface Operations

- Safe Landing & Operations
 - High resolution characterization of surface topography and boulder location
 - Nature of the regolith
 - Improved geodetic control & gravity
- Long duration physiology
 - Radiation environment
 - Radiation effects
 - Dust effects

Landing Site Selection

- Landing site selection dependent on mission goal
- Ability to choose optimal site
 - 15 m/pixel resolution mineralogic characterization
 - Analyze small crater ejecta that samples below the regolith
 - Example: spectrometer covering from 380-2800 nm @ 5 nm
 - 3D Regolith properties
 - block distribution
 - substrate roughness
 - Regolith thickness
 - Polar lighting conditions (eclipse durations)
 - Image coverage of permanently shadowed region

Moon as a Test Bed

- In situ resource utilization
- Key in situ measurement capabilities
 - Drilling
 - Instruments
- Exploration infrastructure
 - Sample handling
 - Mission operations experience
 - Autonomous data analysis
 - Long duration power generation
 - Engineering tests
 - Remote operations
- Flight opportunity for Mars instruments

Research & Development Program

This workshop has identified an urgent need to develop a significant R&D program to enable effective “robotic missions to the Moon to prepare for and support future human exploration activities”

- ISRU to TRL 6-7
- Instrumentation development to TRL 6-7
- Operations in cold regions
- Post mission data analysis program
- Algorithm development
 - e.g. mineral determination
- Develop new generation scientific and technical workforce

The nature of polar volatiles, currently unknown, is a crucial input to the architecture of the exploration program

Orbital Knowledge Requirements

- Radiation impact on human operations
- Characterize the polar environment
 - Spatial concentrations
 - Image of permanently shadowed regions
 - Temperature map
 - Synoptic illumination study
- Geodetic Model
 - Topography, gravity
- High resolution characterization of potential landing sites
 - morphology
 - topography
 - regolith structure
- Resource relevant studies
 - Element maps (including Mg & Al)
 - Mineral identification
 - Magnetic field analyses
 - Atmospheric study
 - Electric field analyses

Lander Knowledge Requirements

- The presence and abundance of water or hydrogen
 - The outcome affects future lander missions
 - If a useable resource exists then a detailed characterization mission could follow
- Other high priority data
 - Radiation environment
 - Regolith structure
 - Ground truthing of orbital data
- Lower priority measurements
 - Electric field surface plasma analyzer
 - Atmospheric characterization

2009 Lander

- Combo ISRU experiment and polar penetrometer mission?