Research Enabled by the Lunar Environment

June 14-15, 2007

The National Academy of Sciences Building

2100 C Street, NW

Washington, DC 20418

Workshop Objectives

- Identify key scientific (and technological) questions whose examination would be enabled by access to the Moon and cis-lunar space
  - Consistent with NASA's proposed architecture
- Identify lunar-based research goals that are useful or necessary
  - Increase knowledge
  - Support NASA's exploration goals
  - Unique concepts that require utilization of the Moon or cis-lunar environment are highest priority

Technical Areas/Coordinators

- **Food Supply/J. Kiss**
- **Power Generation and Storage/R. Wegeng**
- **In-Situ Resource Utilization (ISRU)/M. Duke**
- **Human Physiology and Performance/J. Pawelczyk**
- **Life Support Challenges/B. Cantwell**
- **Lunar Surface Operations/R. Vondrak**

Workshop Format

- Invited talks to each topical area
- Brief discussion following the talks
- Session coordinators developed summaries/conclusions for presentation in plenary
- Briefing materials from many talks are on line at: http://www7.nationalacademies.org/ssb/LunarRT2007.html

Workshop Conclusions

- NASA did not provide enough money for a full NRC study
  - NRC is now determining whether NASA wants to continue to full committee evaluation
- Quality of material developed at workshop is not consistent with NRC rules for publication
- Consequently, there has been no report to NASA

ISRU Summary

- General agreement on where we are and what we need to do
  - Some development projects underway
  - Good community involvement, communication
  - Broad NASA participation – Jerry Sanders' role
- Challenges and Strategy (Gustafson)
  - Many problems are engineering issues
  - Significant environment issues with some processes
  - Testing on Earth and Moon are needed
  - A vigorous robotic program could demonstrate oxygen production before 2020

ISRU Summary - 2

- Excavation is a key supporting function (Gertsch)
  - Plenty of ideas about adapting terrestrial systems to Moon
  - Need to demonstrate excavation of tightly packed lunar regolith
  - Flow of particulates in vacuum may be an issue
  - Excavation useful for other activities (shielding, roads)
- Chemical processing – demonstration projects underway (Clark)
  - RESOLVE and PILOT are building breadboard oxygen extraction systems

ISRU Summary - 3

- Exploration (Cooper)
  - Exploration of polar cold traps needed to characterize environment, potential resources
  - Oxygen extraction easiest with high-iron ores
  - Exploration for high iron content still may demonstrate high iron materials near South Pole

Synergies

- With Energy systems
  - ISRU requires energy
  - ISRU may produce energy systems
    - Energy collection
    - Energy storage
    - Energy distribution
  - Common subsystems
- With food supply and life support
  - May provide replacement consumables – Oxygen, water, carbon, nitrogen
  - Common subsystems
- With surface operations
  - Robotics
  - Dust
- With life support, physiology
  - Radiation protection

Priorities

- Near term
  - Exploration missions – LRO
  - Polar surface exploration
  - Demonstrate several potential O_2 extraction techniques
  - Ground experiments and technology R&D
- Longer term
  - Wide range of ISRU applications to lunar outpost
  - Cost effectiveness of investment in early robotic ISRU demonstrations