LUNAR EXPLORATION ANALYSIS GROUP
Day 3, November 18, 2009
SPACE RESOURCE ROUNDTABLE

Robert S Wegeng, President SRR
Battelle Memorial Institute
Lunar resources – and other resources of near-Earth space – can be used to:

1) Make space exploration beyond LEO more affordable
2) Bring direct benefits back to the Earth
Lunar Resources

Recent Confirmations

Cold traps “may sequester all sorts of materials, from multiple sources, including comets and asteroids”:

- Hydrogen
- Oxygen
- Carbon*
- Sulfur*
- Nitrogen*

* Still pending confirmation
During the Next Decade...

2011-2020

1. Confirm the presence, form, quantities and locations of Lunar Resources
   • Continue remote sensing
   • Conduct resource prospecting (*and science too!*)

2. Reduce Technology Risks
   • Conduct ISRU (and other) technology demonstrators

3. Determine the Economics of Lunar Resource Utilization
Wednesday, November 18, 2009
LUNAR IN SITU RESOURCE UTILIZATION
8:30 a.m. Lecture Hall

Moderator: Robert S. Wegeng

Sessions on Wednesday, November 18, have been organized and are sponsored by the Space Resource Roundtable (SRR). A nonprofit organization, the SRR seeks to bring together interested parties to discuss issues related to the In Situ Resource Utilization of lunar, asteroidal, and martian resources.

Premise: Lunar resources can be used to make space exploration beyond LEO more affordable and to bring direct benefits back to Earth. Discussions will include “on-ramps” for inserting lunar resources into the lunar architecture, resource prospecting, technologies and technology demonstrations, and lunar resource products and applications.

8:30 a.m. Wegeng R. S. *
Introduction: Bringing the Moon into Earth’s Economic Sphere

9:00 a.m. Session: NASA R&D Activities

Sanders G. B. *
Exploration Sustainability: Benefits and Hurdles of Incorporating In-Situ Resource Utilization [#2069]

Ambrose R. * Maria Bualat
Summary of the Robotics Program (TBC)

10:30 a.m. Panel: Lunar Prospecting “Desirements”

Taylor L. A. (University of Tennessee, Knoxville)
Jolliff B. L. (Washington University, St. Louis)
Taylor G. J. (University of Hawai‘i, Manoa)

12:00 p.m. LUNCH

Kurt Sacksteder
Wednesday, November 18, 2009
LUNAR IN SITU RESOURCE UTILIZATION (continued)
1:15 p.m.  Lecture Hall

Moderator: Robert S. Wegeng

1:15 p.m.  Panel: Robotic Lunar Rover Prospectors

Boucher D. S. (Northern Centre for Advanced Technology Inc.)
Dean M. C. (NASA Ames Research Center)
Whitaker W. (Carnegie Mellon Institute)

3:00 p.m.  Session: Lunar Resource Technologies, Products, and Applications

Larson W. *
Field Test of Lunar In Situ Resource Utilization System

Sacksteder K. *
Thermal Wadis

Faierson E. J. *  Logan K. V.
Lunar Construction Material Production Using Regolith Simulant in a Geothermite Reaction [#2002]

Clark P. E. *  Boyle R.  Ku J.  Beaman B.  Rogers R. D.  Smigliak M.  Nagihara S.
Knowles G.  Bradley M.
Geothermal System Designs for Lunar Surface Environment Science Activities [#2019]

Marone M. *  Paley M. S.  Donovan D. N.  Karr L. J.
Lunar Oxygen Production and Metals Extraction Using Ionic Liquids [#2034]

Discussion
NAS Decadal Study

Town Hall Meeting Tonight

Wednesday, November 18, 2009
TOWN HALL MEETING
6:30 – 9:00 p.m.  Lecture Hall

Microgravity and Partial Gravity Research
Hosted by: Space Resources Roundtable

- Microgravity and Partial Gravity Fundamental, Applied and Translational Research
  - Biology
  - Physics

What research should be performed on the lunar surface during the next decade?
BRINGING THE MOON INTO EARTH’S ECONOMIC SPHERE

One Notional Approach
Sustainability

*Attributes*

- It isn’t just about politics
- Affordability
- Productivity
  
  Productivity = Value/Cost
- “Think like an economist”

next decade?
Surviving the lunar night was previously thought to require nuclear material.

Computer simulations confirm thermal advantages provided by thermal wadis.

Staged from thermal wadis, rovers can be expected to survive months to years on the lunar surface.

Substantial temperature margins possible.
Standard Compact Rovers

*Reducing the Cost Barrier for Lunar Exploration*

- Typical rover development costs: $1-5 M per kg hardware mass
- Thermal margins allow the development of a standard compact rover class
  - 100-200 kg
  - Common chassis, power, comm, nav, mobility
  - Unique combinations of instruments
- Amortized across tens of rovers, lunar exploration entrance barriers are substantially reduced
Global Lunar Exploration

International and Public Participation
Resource Characterization

Paving the Way for Humans

- Robotic prospectors, based from thermal wadis, identify resource concentrations & sites
- Promising sites are selected for near-term lunar resource extraction demonstrations
  - Oxygen from regolith
  - Water/Hydroxides
  - Other Volatiles
- ISRU technology demonstrators, operated at thermal wadis, further reduce cost and performance risks
- Architectural and engineering studies confirm the economic potential of lunar resources
- Humans return to the Moon with clear economic goals: To make space exploration beyond LEO more affordable and to provide benefits to Earth
BRINGING THE MOON INTO EARTH’S ECONOMIC SPHERE

A Notional Sequence
Resource Prospecting
Technology Demonstrators
ISRU Pilot Plant
Initial Human Outpost
Mining Settlement