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LEAG Report

Planetary Sciences Subcommittee

4 September 2014

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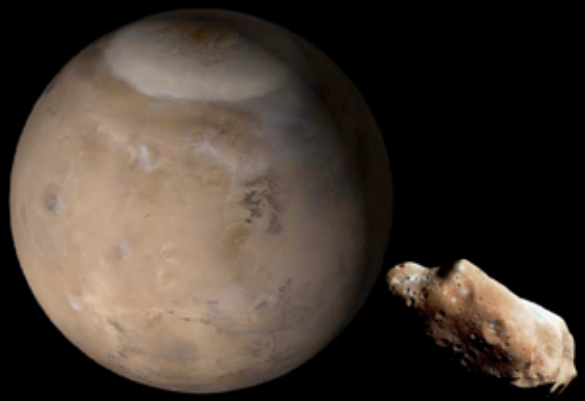

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Topics

Activities

- LEAG Annual Meeting
- RPM SAT - addendum
- Polar Volatiles SAT
- Roadmap update
- Technology Plan/Roadmap

Initiatives

- International Lunar Workshop
- Next “New Views of the Moon”

Nuggets

Issues

- Facilities & Planetary Cartography

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Activities: LEAG Annual Meeting

- October 22-24, 2014
- Applied Physics Laboratory, Laurel MD
- Over 70 Abstracts – Focus on Lunar Volatiles
- 3 Day Program
  - LEAG / Programmatics
  - Lunar Volatiles – Current Understanding I-III
  - Future Exploration – Instruments, Missions, Techniques
  - Future Exploration – Strategies and Opportunities
  - Poster Session
- 5 student travel stipends
- Web Page www.hou.usra.edu/metings/leag2014

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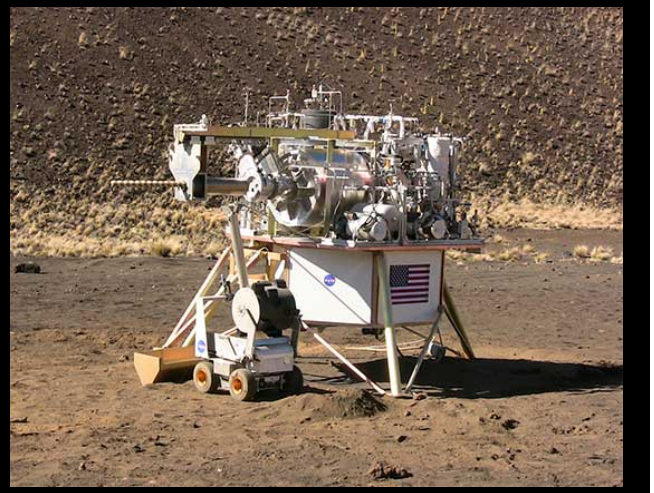
Activities: RPM-SAT

- Met at NASA Ames in March, draft report delivered in early summer and response requested.
- RPM Team responded to the draft SAT report with a number of questions and requests for clarification.
- Working these through the SAT membership and providing a response to the mission.
- We're not done yet!



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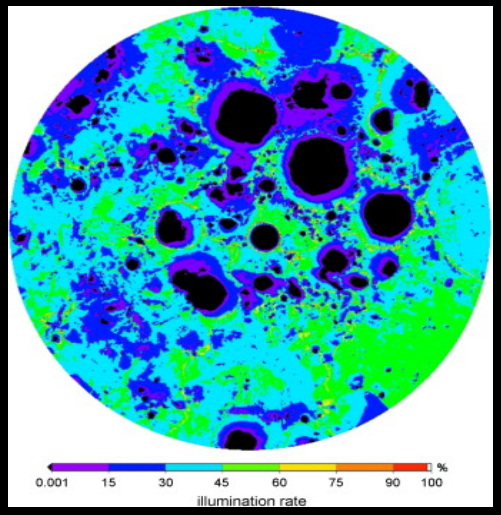
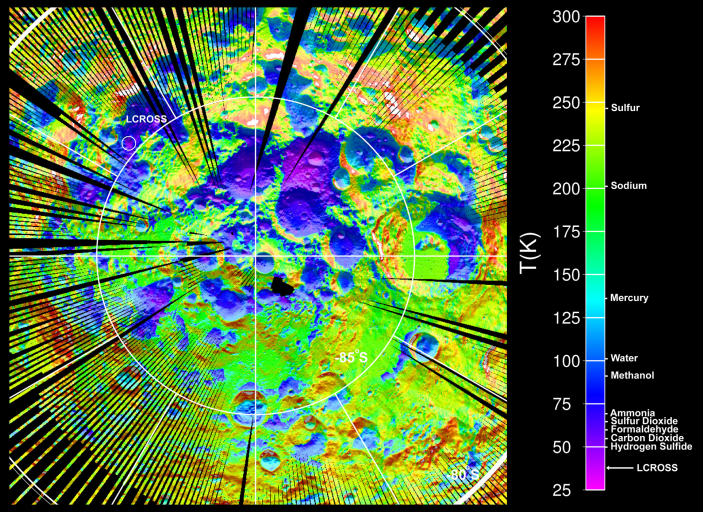
Activities: Polar Volatiles SAT

Requested by HEOMD; Deadline = end of CY2014

Topics:

- Summarize the current understanding:
  - What do we know?
  - What don't we know?
  - How do we find out?
- Candidate prioritized list and discussion of lunar polar regions:
  - Where would be we?
  - What are those places like?
  - How would we go?





- Paul Lucey (Chair)
  - Ben Bussey
  - Rick Elphic
  - Terry Fong
  - Randy Gladstone
  - John Gruener
  - Clive Neal
  - Jeff Plescia
  - Mark Robinson
  - Kurt Sacksteder
  - Gerry Sanders
  - Red Whittaker
  - Kris Zacny
  - Myriam Lemelin*
  - Katie Robinson*

  * Univ. Hawaii students

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Activities: Roadmap Update

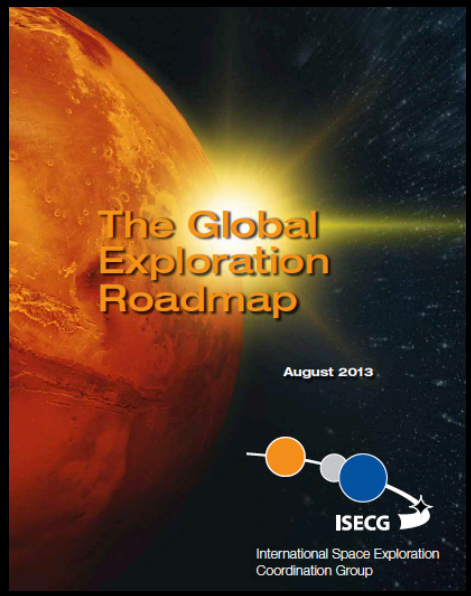
http://www.lpi.usra.edu/leag

Illustrated Executive Summary.

Integration with the ISECG Global Exploration Roadmap
http://www.globalspaceexploration.org/wordpress/wp-content/uploads/2013/10/GER_2013.pdf

Presentations at:

- European Lunar Symposium (London) in May 2014;
- GER meeting NASA Ames, July 2014;
- EPSC meeting (Portugal), September 2014.



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Activities: Technology Plan/Roadmap

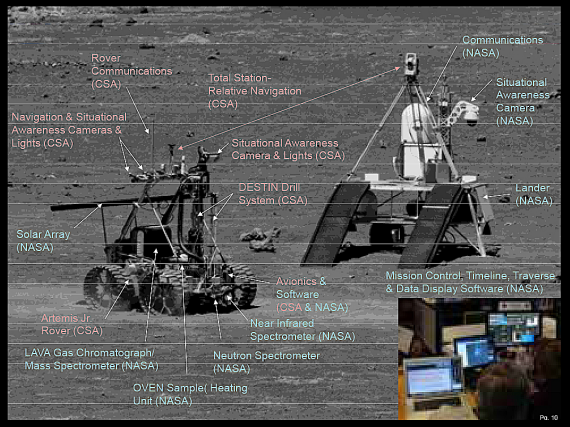
SMD technology plan for investment. Define what would be needed for future instruments and missions (e.g., cryogenic sample return).

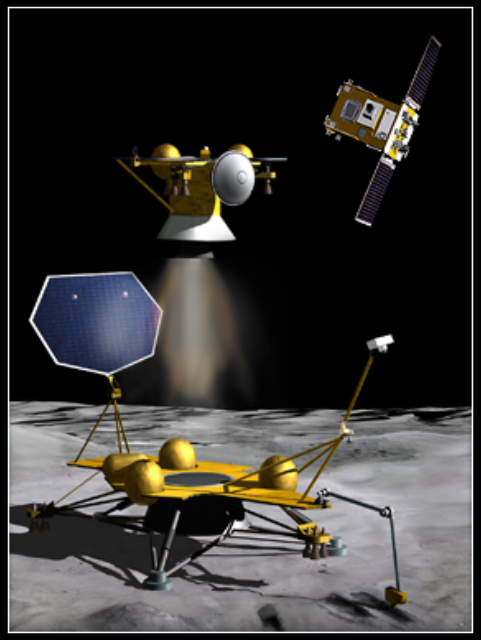
Ramping up a SAT to respond.

Clarifying the request so we don't waste time.

Two phase process:

1) Robotic;
2) Human.





Initiatives: International Lunar Workshop

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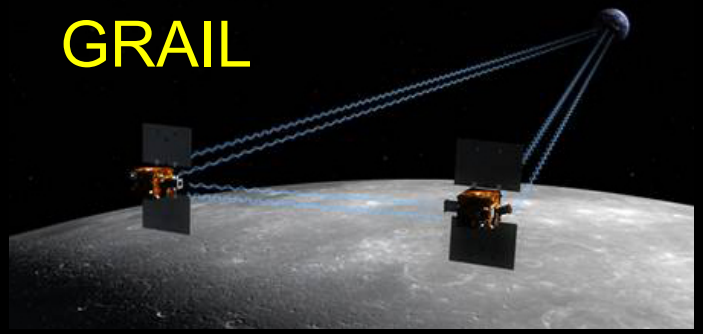
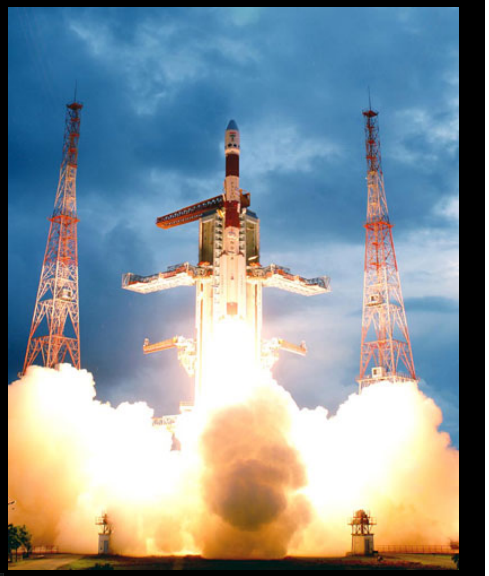
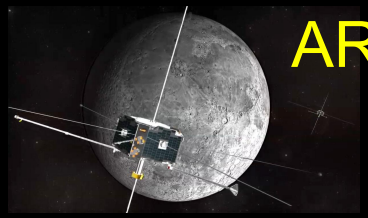
LRO/LCROSS

GRAIL



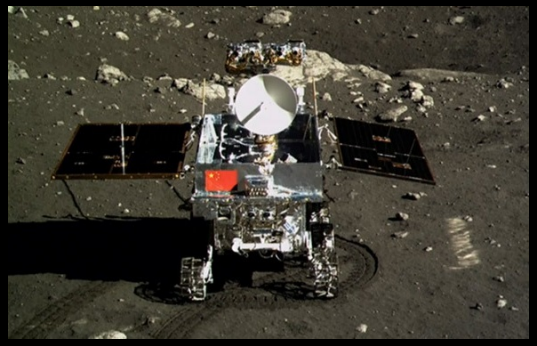


Chandrayaan-1



ARTEMIS

Chang'e 1 & 2 & 3



Kaguya

SMART 1

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Initiatives: International Lunar Workshop

- Evaluate the SCEM report on the basis of recent mission data.
  - What questions have been addressed?
  - What new questions have arisen?
  - How might these questions be addressed? [Missions, instruments, research]
- Reaffirm the outstanding science questions.
- Evaluate lunar SKGs.
- Make this report an international document that the lunar community can get behind and point to when interacting with their respective space agencies.
- Coming in 2015.

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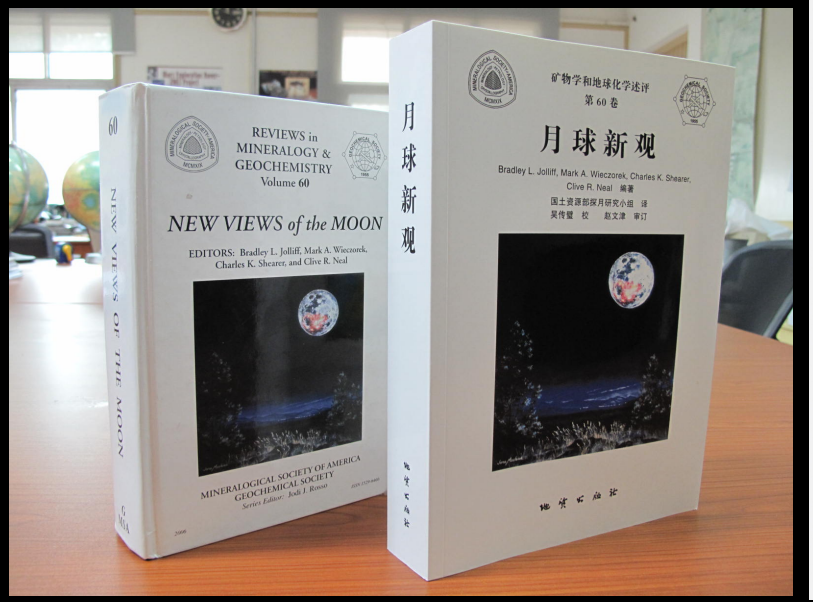
Initiatives: Next New Views of the Moon

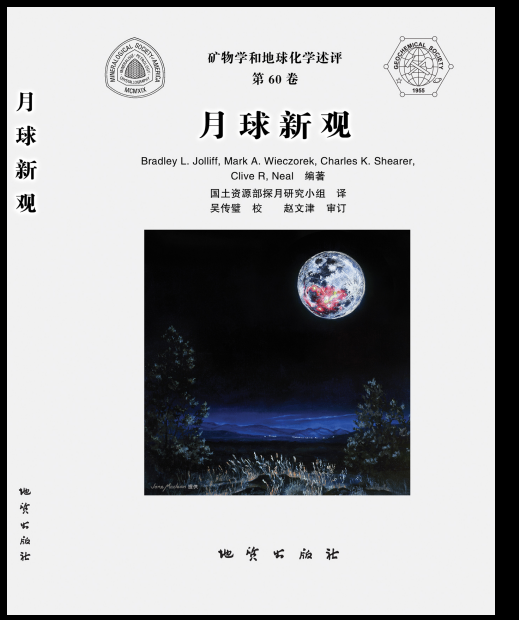
2006 volume does not include:

- Post-2000 mission data.
- Volatiles (sample and mission data).

The time is right for the next volume!

LPI-LEAG initiative that will be community-driven;
L-DAP Step 1 proposal submitted;
First workshop in early 2015 (hopefully!).





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Lunar Science Nuggets

- Lunar interior from GRAIL – data indicate a solid inner core (radius <280 km) surrounded by fluid outer core (radius <380 km). Combined mass fraction of core ≤1.5%. (Williams et al. 2014, *J. Geophys. Res.* **119**, 1546–1578).

- Global 1064 nm albedo map of the Moon. PSRs have higher albedo (even accounting for slope effects) suggesting decreased space weathering and/or surface frost (3-14 % by weight or area) (Lucey et al. 2014, , *J. Geophys. Res.* **119**, 1665–1679).

- Surface charging due to GCRs and SEPs can create large electric field potentials within the regolith. SEP events can produce potentials of $>10^6$ V/m sufficient to modify the physical and chemical properties of the lunar regolith. (Jordan et al. 2014 *J. Geophys. Res.*, **119**, doi:10.1002/2014JE004648.).

- New map of the hydrogen distribution within the non-polar highlands suggest concentrations of about 65 ppm with the highest values of 120-150 ppm. (Lawrence et al. 2014, LEAG abstract).

- The Moon smells like gunpowder, space smells like a steak. (news item). http://www.popsci.com/article/technology/where-does-moons-smell-come?dom=PSC&loc=recent&lnk=6&con=where-does-the-moons-smell-come-from

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Lunar Science Nuggets

- Identification of pure anorthosite (PAN), combined with the GRAIL crustal thickness model, suggest that PAN is present as a coherent between 9 and 63 km and that the primary anorthositic crust must have been at least 30 km thick (Donaldson-Hanna et al. 2014, *J. Geophys. Res.* **119**, 1516–1545).
- urKREEP (the last dregs of the lunar magma ocean)model ages are concordant using a number of chronometers. The average of age, 4368 +/- 29 Ma, is the time at which urKREEP formed, and is attributed to solidification of the lunar magma ocean. (Gaffney & Borg 2014, *Geochim. Cosmochim. Acta* **140**, 227-240).
- Lunar topography is consistent with a crust-building process controlled by early tidal heating throughout the Moon. The remainder of the topography is consistent with a frozen tidal–rotational bulge that formed later. Also, internal density contrasts eventually reoriented the Moon's polar axis to the configuration observed today. Together, these results link the geology of the near and far sides, and resolve long-standing questions about the Moon's large-scale shape, gravity and history of polar wander. (Garrick-Bethell et al. 2014, *Nature* **512**, 181–184. 14 August 2014)

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Lunar Science Nuggets

- Characterization of space weathering from Lunar Reconnaissance Orbiter Camera ultraviolet observations of the Moon. (Denevi et al. 2014, *J. Geophys. Res*. **119**, 976-997).

- Migration calculations for water in the exosphere of the Moon: Dusk-dawn asymmetry, heterogeneous trapping, and D/H fractionation . The isotopic composition of ice deposits in the cold traps provides an excellent constraint for the isotopic composition of the source and will allow us to distinguish among different potential sources. (Schorghofer 2014, *Geophys. Res. Lett.*. **41**, 4888-4893).

- Detailed examination of the deposits rich in volatiles in 66095 suggest they formed on the Moon in a hydrothermal environment, indicating another form of volatile-rich deposit and a new process endogenous to the Moon. (Shearer et al. 2014, *Geochim. Cosmochim. Acta* **139**, 411-433).

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Lunar Science Nuggets

- Modeling of the amount of melt generated by the SPA impact indicates it differentiated into different rock compositions. Combining these results with orbital data gives a guide to the best places to sample the SPA impact melt products (Hurwitz & Kring 2014, *J. Geophys. Res.* **119**, 1110-1133).

- Resolved Hapke parameter maps of the Moon allows global regolith maturity to be viewed (Sato et al. 2014, *J. Geophys. Res.* doi: 10.1002/2013JE004580, in press).

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Issues: Facilities & Cartography

Final location of Cartography and other facilities in the new R & A organizational structure needs to be clarified.

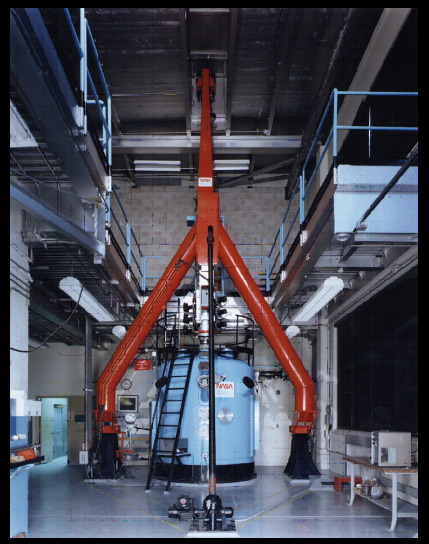
Facilities are critical to experimental aspect of planetary science research.

Ames Vertical Gun Range

RELAB

Wind Tunnel

- They are irreplaceable
- They need to be supported
  – they cannot be turned on and off
- They need to be carefully managed with scientific oversight



Cartography, photogrammetry, and image processing software important for operations, planning, and scientific research.

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Issues: Facilities & Cartography

Questions and possible responses for Cartography:

- PSS Whitepaper?
- Cartography Analysis Group (similar to CAPTEM) to focus on scientific oversight?
- Interim – chair of the PCGMWG to be on PSS?
- Where is the present Cartography program going to be, now that PGG is gone?

Findings:

PSS should conduct an official review of the science associated with the facilities and cartography.

Formal representation of Planetary Cartography on the the PSS should be approved ASAP.