



Lunar Surface Innovation

C O N S O R T I U M

LSIC ISRU Focus Group Monthly

<http://lsic.jhuapl.edu/>

<http://lsic-wiki.jhuapl.edu/> (Confluence sign-up required)

October 19, 2022

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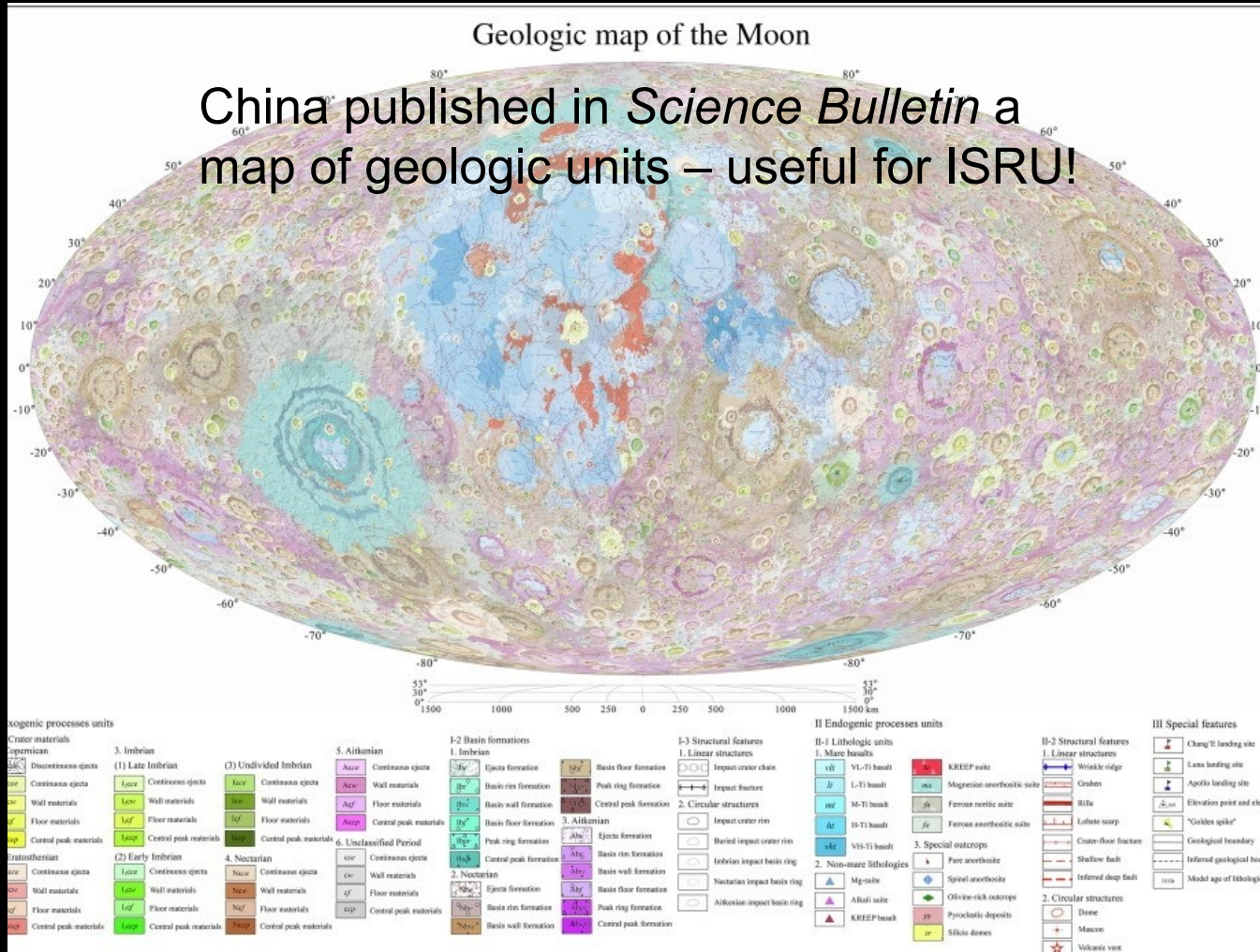
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JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

Agenda

- General updates and house-keeping
 - APL is happy to consult as appropriate with ISRU and related technologies. We can provide advice on how to build for launch and operate in extreme environments.
 - Upcoming Meetings
 - Funding Opportunities
- Karl Hibbitts (APL): Debrief from ISRU TPR and LSSW-18
- Paul Burke (APL): CFD Modeling of Molten Regolith Electrolysis and Water Electrolysis, Scaled Across Gravity Levels
- Coffee and Donuts discussion, teaser for future Facilities Workshop: “If you had unlimited resources (money, time), what aspect of your technology would you test on Earth to prepare for the Moon?”



Artemis 1: next launch attempt
Nov. 14



Break The Ice Challenge:
Phase 2 Team Participants Announced
<https://breaktheicechallenge.com/phase-2-team-participants-announced/>

Upcoming Meetings

Some upcoming IRSU-related meetings to be aware of:

- **AIAA ASCEND, Oct. 24-26**

- Registration (in-person and virtual) open: <https://www.ascend.events/registration/>

- **CLPS: Survive the Night Technology Workshop, Dec. 6-8**

- Abstract deadline passed, but registration opening soon: <https://www.hou.usra.edu/meetings/clps2022/registration/>

- **Lunar Polar Volatiles, Nov. 2-4:** <https://www.hou.usra.edu/meetings/lunarpolar2022/>

- **Intertribal Space Conference, Nov. 15-17**

- Bring the space industry and tribal leaders together, to form new mutually beneficial tribal-space partnerships.
- Opportunity for participation by the space industry!
- <https://intertribalspaceconference.wpcomstaging.com/>

- **Surface Power FG (Oct. 27, 11am ET):**

- Lee Mason and Jeff Csank of NASA GRC will present a Notional Concept for Testing Distributed Lunar Power Systems. Soliciting community input.



- **November 2-3, 2022**
- University of Texas El Paso, **Hybrid!**
- Focus will be on how the 6 Focus Areas (think ISRU!) relate to Excavation and Construction.
- Registration extended to Oct. 21!
- <https://lsic.jhuapl.edu/Events/Agenda/index.php?id=350>



Credit: UTEP

Funding Opportunities

- Announcement for Partnership Proposals (AFPP) to Advance Tipping Point Technologies

- Final proposals (invited) due Nov. 22 on NSPIRES

- **2023 NASA BIG Idea Challenge (grads/undergrads)**

- Lunar Forge: Producing Metal Products on the Moon
- E.g., storage vessels for liquids and gases, extrusions, pipes, power cables, and supporting structures
- Proposals due Jan. 24: <https://bigidea.nianet.org/>

- NASA Innovation Corps Pilot

- Provides support to train teams in innovation and entrepreneurship skills.
- Rolling deadline, but applications reviewed Nov. 18 (every few months), on NSPIRES
- Overview Webinar Nov. 3, 12pm ET

- NASA Innovative Advanced Concepts (NIAC) Phase II

- Notice of Intent due Oct. 21
- Proposal due Dec. 15

NSTGRO due Nov. 2

The National Aeronautics and Space Administration (NASA) Headquarters has released a solicitation, titled NASA Space Technology Graduate Research Opportunities (NSTGRO) - Fall 2023, on September 2, 2022. The solicitation is available by opening the NASA Research Opportunities homepage at <https://nspires.nasaprs.com>.

This fellowship opportunity, titled *NASA Space Technology Graduate Research Opportunities – Fall 2023 (NSTGRO23)*, solicits proposals on behalf individuals pursuing or planning to pursue master's or doctoral (Ph.D.) degrees in relevant space technology disciplines at accredited U.S. universities.

NASA Space Technology Graduate Research Fellows will perform research at their respective campuses and at NASA Centers. Each recipient will be matched with a technically relevant and community-engaged NASA researcher who will serve as the research collaborator on the award. Through this collaboration, graduate students will be able to take advantage of broader and/or deeper space technology research opportunities directly related to their academic and career objectives, acquire a more detailed understanding of the potential end applications of their space technology efforts, and directly disseminate their research results within the NASA community.

ROSES-22 Amendment 51: F.10 PRISM Final Text and Due Dates

Step 1: Oct. 22 | Step 2: Dec. 20

Debrief from ISRU TPR and LSSW-18

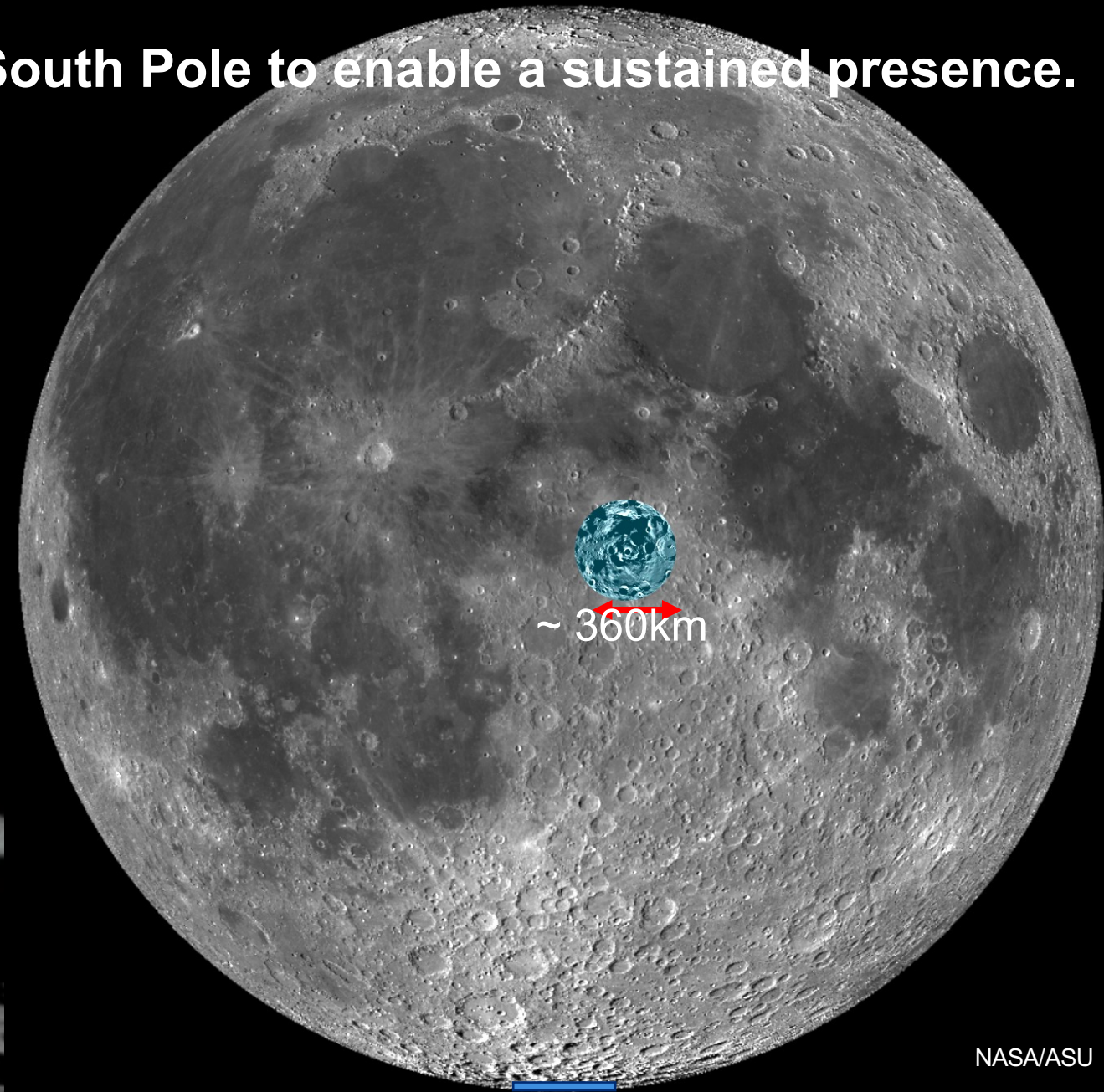
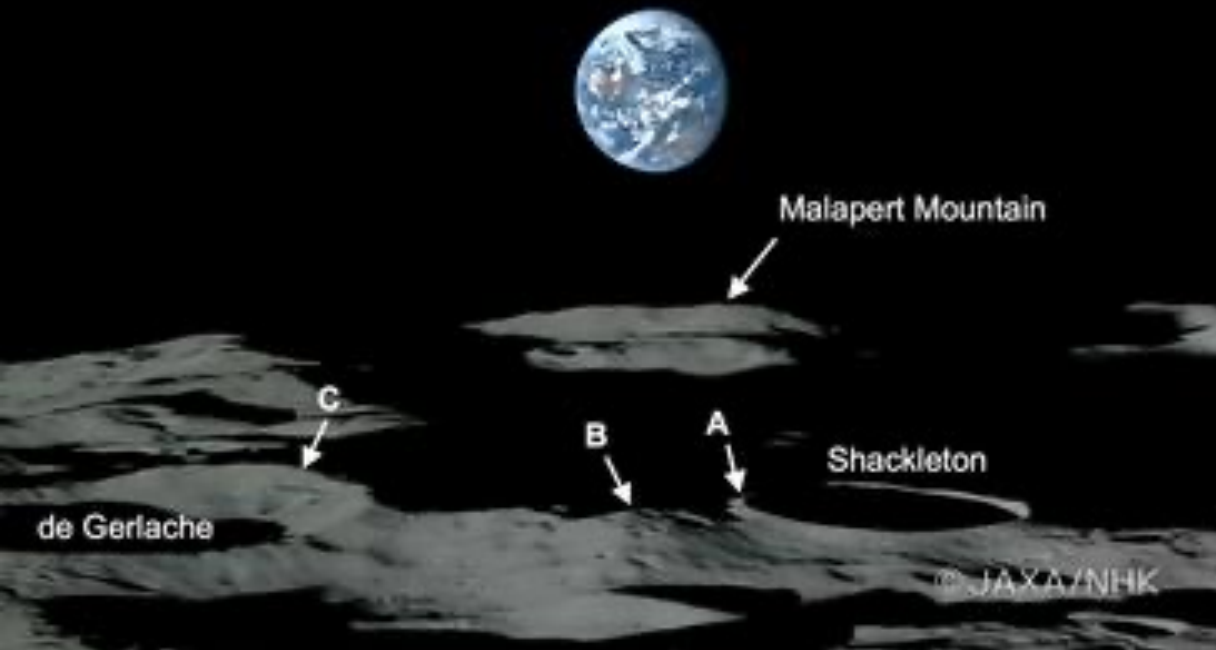
Karl Hibbitts (APL)



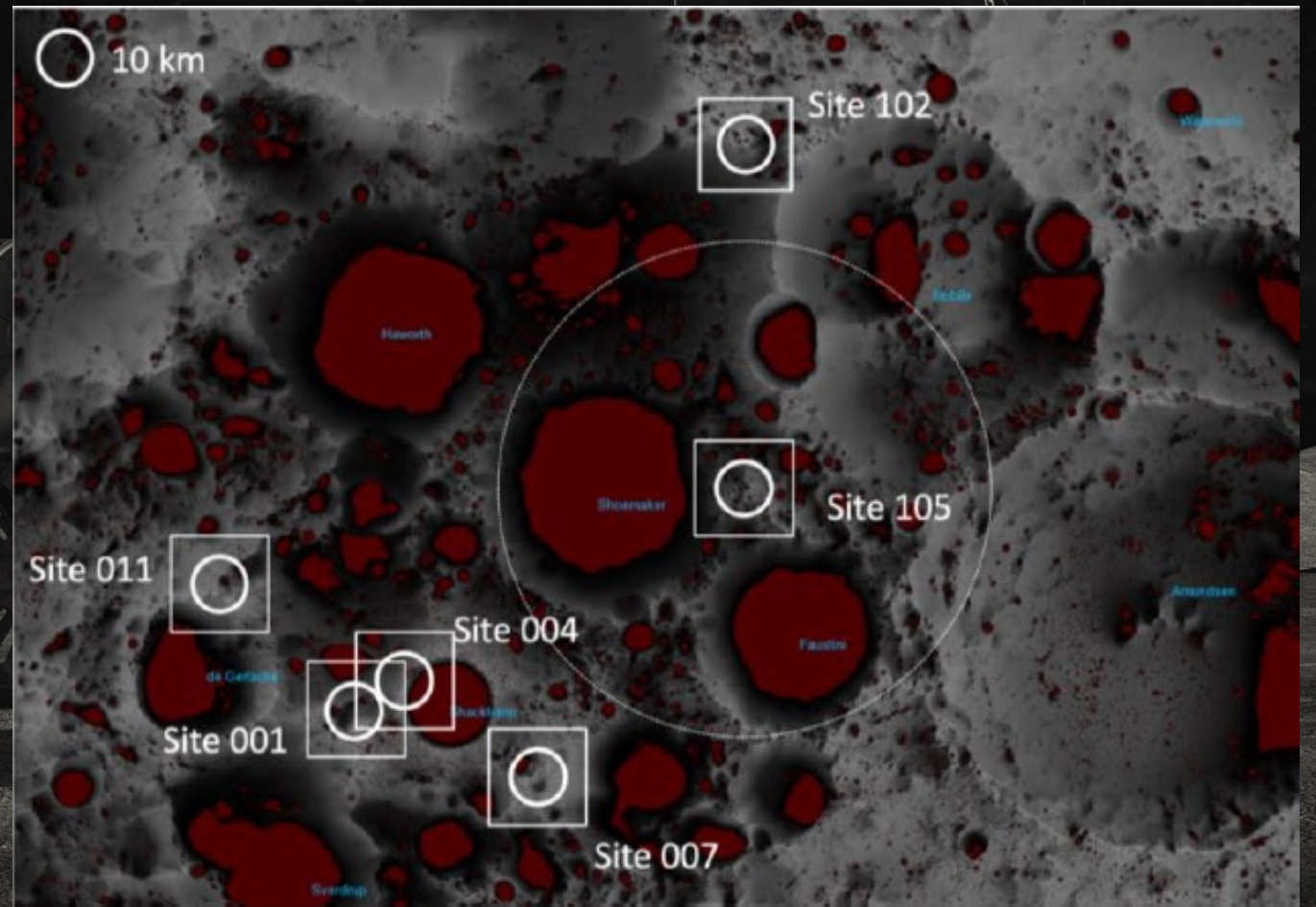
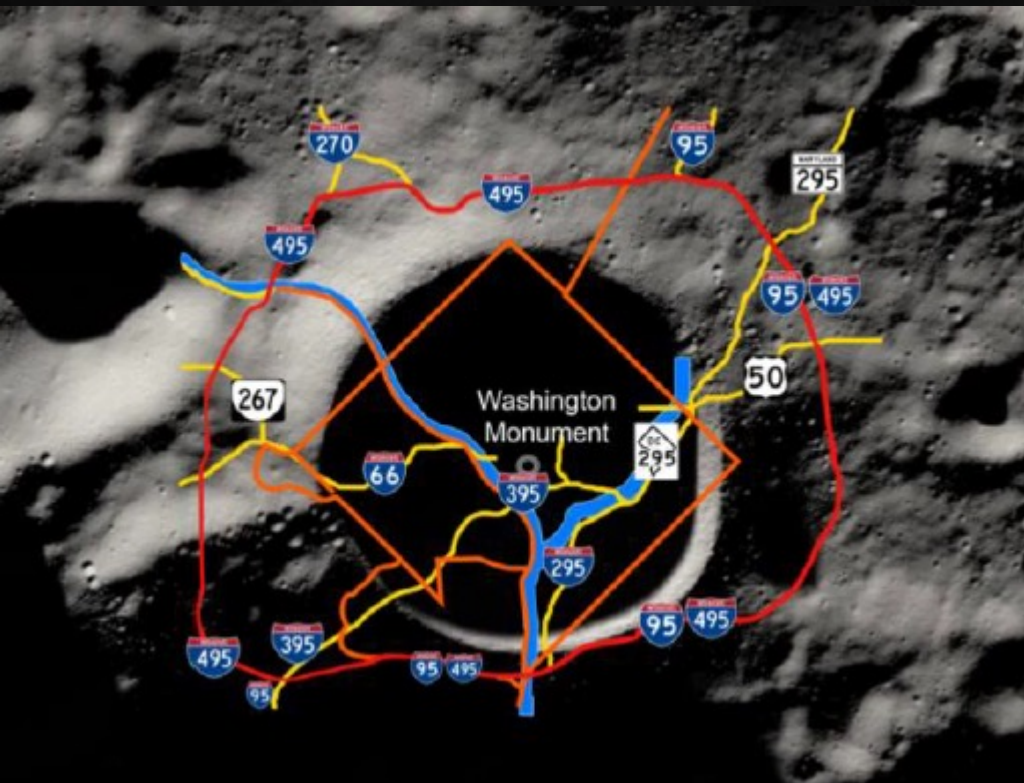
**Initial debrief from LSSW-18 –
Implementing a Prospecting Campaign**

Karl Hibbitts (APL)

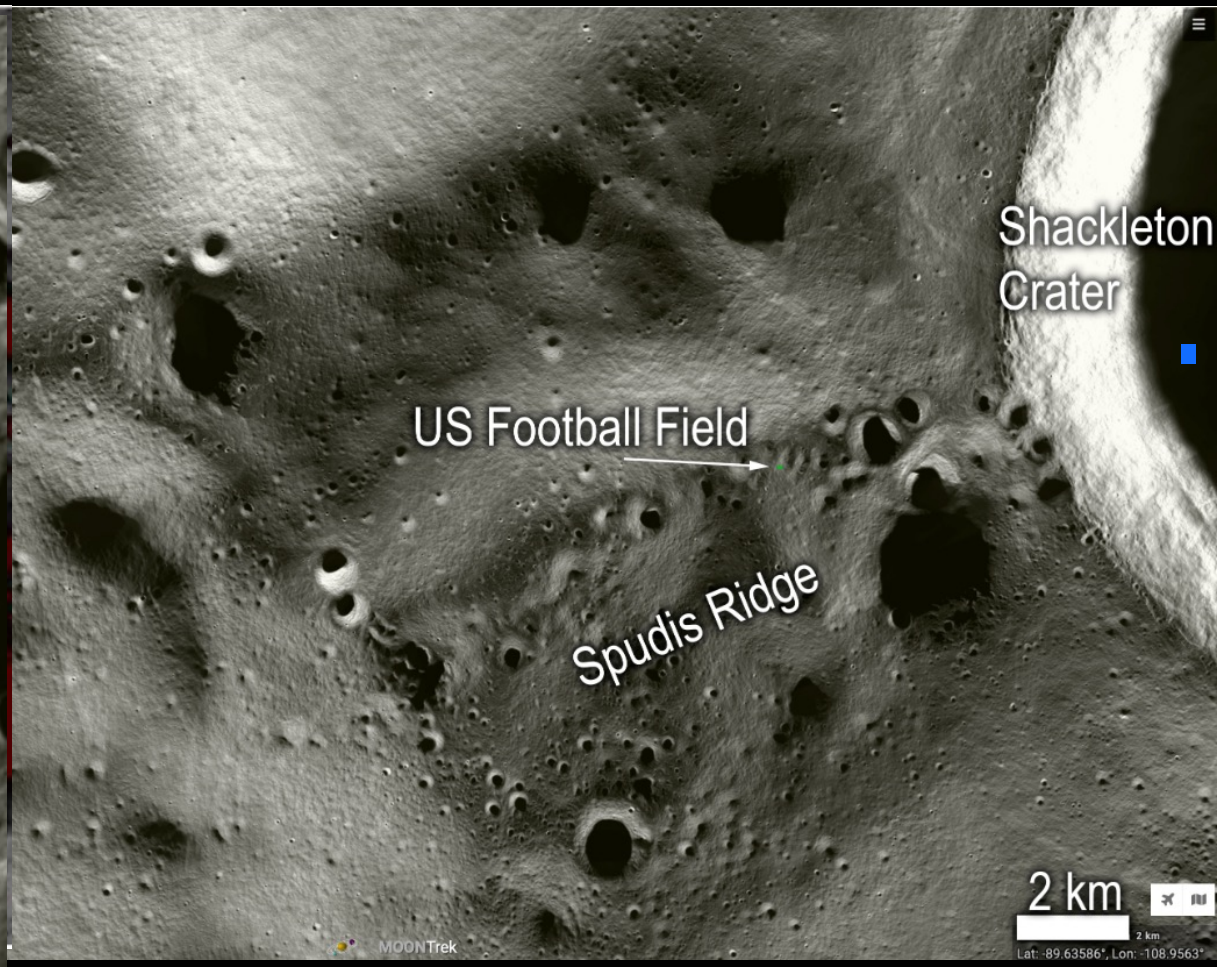
Prospecting for Water at the Lunar South Pole to enable a sustained presence.



The South Pole



Scale of Activities on the Lunar Surface



LSSW-17 Findings - Needs

| Table 1: Datasets for lunar volatile resource evaluation | | | |
|--|---|---|---------------------------|
| Dataset | Specific Data | Use | Measurement |
| Composition | Concentration of the resource Concentration & composition of impurities | Evaluate potential investment needed for refining the product | Required Fidelity? |
| Form | Cement in pore space; Layers; Irregular blocks; Loose ice grains with regolith | Develop efficient extraction techniques | |
| Distribution | Horizontal Vertical | Variability needs to be documented to understand the volume of the resource | |
| Geotechnical | Torque and power required for any drills to penetrate the deposit; Energy required to move loose regolith; Hardness of the deposit; | Understand the effort required to mine the deposit and investment needed in developing extraction capabilities. | |
| Near-surface Regolith Stratigraphy | Buried and surface rock populations Ice block/layer distribtuion | Will impact the extractibility of the regolith resource | |
| Accessibility | Traverse paths; | Ease of accessibility has an impact on cost of developing robotic miners. | |

LSSW-17 Findings – Needs that fed into LSSW-18

1. Coordination of lunar resource evaluation efforts should be international in scope and led by NASA:
 - coordinating data gathering
 - defining the data types and fidelity,
 - developing resource standards
 - inclusion of partners
 - defining a data policy
 - leveraging private industry
 - developing a list of high priority targets
 - developing mission concepts.

LSSW-18 Agenda

Friday, October 14, 2022

IMPLEMENTING A COORDINATED LUNAR RESOURCE EVALUATION CAMPAIGN

10:00 a.m.

| Times | Authors (*Presenter) | Abstract Title and Summary |
|------------|---|---|
| 10:00 a.m. | Neal C. R. * | <i>Welcome and Introduction</i> |
| 10:05 a.m. | Neal C. R. * | <i>Implementing a Coordinated International Lunar Resource Evaluation Campaign</i> [#6007] Implementing a coordinated international lunar resource evaluation campaign can be done in stages. |
| 10:15 a.m. | Salmeri A. * Schingler J. K. | <i>Implementation Strategies for a Coordinated Lunar Resource Evaluation Campaign Compatible with International Space Law and Promoting Positive Policy Precedents</i> [#6004] This abstract presents three suggestions to implement a coordinated lunar resource evaluation campaign in compliance with international space law and to promote the development of positive policy precedents for space resource and lunar activities. |
| 10:25 a.m. | Freeman R. H. PhD * | <i>On the Safety Management of Autonomous Robotic Systems: A Test of Resiliency</i> [#6008] Robot swarms show both resilience and robustness. Operational behavior is controlled through software design. This paper explores the potential standardization of modular, re-usable, inter-operable multi-agent autonomous systems and certification. |
| 10:35 a.m. | Keszthelyi L. P. * Ostrach L. R. Gabriel T. S. | <i>Data Products Needed to Identify Lunar Ice Reserves</i> [#6006] Progress needs to be made in both the scientific understanding of lunar ice as well as our ability to convert the ice into a commodity. Data products with complete description of uncertainties and fusion of landed and orbital data are essential. |
| 10:45 a.m. | Hibbitts C. A. * Nord M. N. Shannon J. Berdis J. Runyon K. Smith D. | <i>What We Don't Know About Water Ice on the Moon, and a Concept for How to Fix It</i> [#6009] This is one concept for a water ice resource evaluation campaign. |
| 10:55 a.m. | Esperjel C. * [INVITED] | <i>Lunar Ore Reserves Standard (LORS)</i> |
| 11:05 A.M. | | Q&A |

Friday, October 14, 2022

INTERNATIONAL PARTNERSHIPS, POLICY, AND SPACE LAW

11:25 a.m.

Friday, October 14, 2022

STAKEHOLDER PERSPECTIVES ON THE EVALUATION CAMPAIGN

12:05 p.m.

Friday, October 14, 2022

WRAP UP DISCUSSION: FINDING AND RECOMMENDATIONS

12:45 p.m.

LSSW-18 Some initial preliminary take-aways

1. Coordination of lunar resource evaluation efforts should be international in scope and led by NASA: - Plan, Plan, Plan....
 - coordinating data gathering – discussed priority rights allocations and accountability (to enable private industry participation) as well as possible need for regulations.
 - defining the data types and fidelity – such as data buys and explicit requirements.
 - developing resource standards – based upon Lunar Ore Reserves Standards (LORS)?
 - inclusion of partners/stakeholders – be expansive. Remember the media!
 - defining a data policy – rights, allocations, accountability, regulations
 - leveraging private industry – NASA to consider how it deals with data.
 - developing a list of high priority targets – explicitly defining requirements
 - developing mission concepts - as part of a larger explicit campaign plan.

Topical Discussion

Paul Burke
JHU/APL

“CFD Modeling of Molten Regolith Electrolysis and Water Electrolysis, Scaled Across Gravity Levels”

Coffee and Donuts

If you had unlimited resources (money, time), what aspect of your technology would you test on Earth to prepare for the Moon?