

# Notes from ISRU Monthly Meeting

July 2020

## Notes From Discussion

*(Full discussion notes available on page 7)*

- Discussion re: LSIC Confluence being set up, should be available in near future
- Discussion re: Google doc being used to set up two subgroups (H2O and O2)
  - Should an additional Google doc be set up for funding sources? (Solicitations, collaborative opportunities, tipping points, challenges)
- Question from Steve re: availability of funds from NASA
  - Funding for hardware is in long-term planning at STMD, though it is at the discretion of Congress and executive branch.
- Are H2O and O2 the only resources of interest? To what level would NASA be interested in other volatiles?
- Oxygen and water are the obvious 'gold nuggets.' LCROSS found water and other volatiles but amounts / concentration are still unknown. As other volatiles are identified (ammonia, hydrogen), along with metals, parameters for usage and need will be established.
- Question from Angeliki re: interactions between LSIC ISRU WG and ISECG ISRU WG
  - They are separate at the moment but will be working together on gap analysis
- Question from Brad Blair re: whether NASA is hosting a 4-day ISRU Zoom meeting
  - Plans to do so in April or June, will give information to Karl to share with focus group

## Notes From Chat

(Full chat record on page 3)

- Link to Google doc for LSIC ISRU: O2 and H2O Topics:  
[https://docs.google.com/document/d/1QSOFV\\_2ckDfe8V0gvirjP7e1G0\\_YdOLMp2UzH-46H4s/edit](https://docs.google.com/document/d/1QSOFV_2ckDfe8V0gvirjP7e1G0_YdOLMp2UzH-46H4s/edit)

### Shared external resources / links:

- <http://www.spudislunarresources.com/> (Paul did not have deep drilling data to understand what the moon is made up of.)
- <https://www.airspacemag.com/daily-planet/moons-mantle-muddle-180950391/>
- <https://www.sciencedirect.com/science/article/abs/pii/S0019103520301652?via%3Dihub>
- [https://www.globalspaceexploration.org/wordpress/?page\\_id=811](https://www.globalspaceexploration.org/wordpress/?page_id=811)
- <http://specialedition.rascal.nianet.org/>

### Gathering Info About Lunar Minerals:

- Past terrestrial explorations for mining regularly drilled holes 2000 meters deep to determine local minerals
- Missions proposed to South Pole Aitken basin where lunar mantle has been exposed by impact
  - (Unsuccessful proposal made by Mike Duke as part of New Frontiers in 2002)
- Chinese mission operating a rover in South Pole Aitken Basin now, sample return launch planned next year
  
- NASA announced Astrobotic won CLPS contract for VIPER mission

### QUESTIONS:

- What power level would be needed for ISRU water extraction?
- Can NIAC studies of lunar technologies by Adrian Stoica of JPL be made available to the team?
  - NIAC reports summaries are at  
[https://www.nasa.gov/directorates/spacetech/niac/NIAC\\_funded\\_studies.html](https://www.nasa.gov/directorates/spacetech/niac/NIAC_funded_studies.html)
- Re: lunar resource property rights: When do prospecting results and ground truth translate to ownership?

## Chat Record

Andrea S. Harman (LSIC Support): ams573@alumni.psu.edu

Kirby Runyon: [https://docs.google.com/document/d/1QSOFV\\_2ckDfe8V0gvirjP7e1G0\\_YdOLMp2UzH-46H4s/edit](https://docs.google.com/document/d/1QSOFV_2ckDfe8V0gvirjP7e1G0_YdOLMp2UzH-46H4s/edit)

marshall Eubanks: Looks good

marshall Eubanks: Jerry, you are not sharing your screen

charles radley: I can see jerry's screen

Leslie Gertsch: Screen yes, video no.

marshall Eubanks: Sorry, yes, screen is fine, but I cannot see him.

Craig Peterson: Am I the only one that is seeing this cropped on the left and the bottom?

Leslie Gertsch: Same here.

Andrea S. Harman (LSIC Support): Same.

charles radley: i also see cropped

marshall Eubanks: +1

Andrea S. Harman (LSIC Support): Also I think he has his video muted.

Chuck Lauer: Same here

marshall Eubanks: Maybe if he shrunk the size pf the presentation on his side

Karl Hibbitts: unless the cropping begins to impair our understanding of the presentation, i suggest we leave 'good enough' alone. let me know if it becomes an issue and we'll stop and figure it out

Sanae Kubota: I think we should ask for the full screen

Andrew Annex: It is for this slide...

pvenneri: Will the presentation be shared?

Angeliki Kapoglou: Full screen please the slides are cropped

Karl Hibbitts: Will do.

Kole: Note: use Page setup standard 4:3 presentation format for next time

Greg Baiden: I find it impossible to believe these are all the resources available for mining on the moon. This is just scratching the surface!

Leslie Gertsch: Sound is going in and out.

Andrea S. Harman (LSIC Support): Is the sound okay for everyone?

Angeliki Kapoglou: breaking but just a bit

Andrea S. Harman (LSIC Support): That answers that question. It seems to be an internet connectivity issue - mostly listenable. Also might be why his video is off, that can help boost connectivity.

Patrick.L.Thompson@NASA.gov: <http://www.spudislunarresources.com/>

Greg Baiden: Unfortunately Paul did not have deep drilling data to understand what the moon is made up of.

Greg Baiden: I ran an exploration program for a major multinational mining company and we regularly drilled holes 2000 metres deep to determine what the minerals available in the area were.

Lisa Danielson: are the slides advancing?

Tom Colvin: I still only see slide 5. It seems like Jerry's moved on.

Craig Peterson: Missions have been proceed to the South Pole Aitken basin where it is hypothesized that lunar mantle has actually been revealed due to the size of the impact. This would provide a lot of insight into lunar stratigraphy without having to do deep drilling.

Patrick.L.Thompson@NASA.gov: <https://www.airspacemag.com/daily-planet/moons-mantle-muddle-180950391/>

Craig Peterson: Missions proposed - sorry about the autocorrect

pvenneri: yes

Tom Colvin: yes

Brad Blair: Mike Duke (unsuccessfully) proposed a farside South Pole - Aitken Basin sample return mission to obtain a sample of the upper mantle to the New Frontiers program in 2002

Angeliki Kapoglou: :( so much time lost without lunar surface missions :(

Brad Blair: The Chinese are now operating a rover in the South Pole Aitken Basin and will launch a sample return mission next year

Brad Blair: We know what to do but lack the resolve to do it

marshall Eubanks: sounds good here

Chuck Lauer: when is the Prime-1 flight date?

charles radley: Thanks Brad. the Chang'e-4 is at an elevation of -5935 m

Kole: hard to read text in table

Mike Ching: NASA did announce on Jun 11 that Astrobotic won the CLPS contract for the dedicated VIPER mission

Leslie Gertsch: Hope these slides will be available.

Chuck Lauer: can the entire pdf file of this slide deck be emailed out to the list?

Craig Peterson: This came out the end of March this year and may be of interest.  
<https://www.sciencedirect.com/science/article/abs/pii/S0019103520301652?via%3Dihub>

Craig Peterson: The title is "A geologic model for lunar ice deposits at mining scales"

Douglas Stanley: We are doing a study/tech development for NASA examining laser power beaming from the crater rim to the shadowed regions. Have you looked at this option? What power level would be needed for ISRU water extraction?

Karl Hibbitts: I assume folks can see my screen? anyway, the slides will be posted on the LSIC website. Andrea...please confirm

Craig Peterson: I am aware of some NIAC studies of lunar technologies by Adrian Stoica of JPL - can these study reports be made available to the team?

Craig Peterson: I also understand JPL has done some more focused studies on lunar ISRU - are these study reports also available?

Karl Hibbitts: We will look into what resources we can post on the LSIC webpage

Karl Hibbitts: slides and recording will be posted...timeframe will be days.

Craig Peterson: Thanks, Karl - I just hate to re-invent the wheel if we can leverage previous work.

Angeliki Kapoglou: Also is there any interactions between LSIC ISRU WG and the ISECG ISRU WG ?Lots of work has been done there too

Angeliki Kapoglou: In-Situ Resource Utilisation  
Due to the launch cost of interplanetary travel and especially to planetary surfaces, sustainable exploration activities can be achieved through In-Situ Resources Utilization in areas such as life support, propulsion, radiation protection and waste management. Polar water for example, can be of direct use for crews as life support consumables or electrolysed to serve as propellant, but also the regolith itself can be used to extract metals and materials for in-situ manufacturing of hardware and landing/shielding structures.

Work ongoing [https://www.globalspaceexploration.org/wordpress/?page\\_id=811](https://www.globalspaceexploration.org/wordpress/?page_id=811)

Chuck Lauer: does anyone want to talk about lunar resource property rights issues now? When do prospecting results and ground truth translate to ownership?

Angeliki Kapoglou: Hi!

Angeliki Kapoglou: Thanks!

Michael Nord: NIAC reports are at [https://www.nasa.gov/directorates/spacetech/niac/NIAC\\_funded\\_studies.html](https://www.nasa.gov/directorates/spacetech/niac/NIAC_funded_studies.html)

Douglas Stanley: information on Moon To Mars Ice prospecting challenge for university teams  
<http://specialedition.rascal.nianet.org/>

Brad Blair: SRR-PTMSS was cancelled - does NASA have plans to host a 4 day dialogue on ISRU using Zoom?

Brad Blair: Lots of papers from SRR are available as needed...

Paul Van Susante: LPSC in March next year is all virtual... may not be possible in April etc. (face to face that is).  
online probably needed

Craig Peterson: Unfortunately the full reports are not currently available from the NIAC site - just summaries off the work.

Douglas Stanley: What about laser power beaming to shadowed regions. How much power is needed?

Brad Blair: Karl - thanks for your leadership!

Bonnie Dunbar: Thank you, Jerry

Leslie Gertsch: Thanks for the update, Jerry!

Angeliki Kapoglou: Thank you all! Maybe we can have longer future meetings!

Paul Van Susante: thanks all

Jessy Kate Schingler (they/she/xe): Thank you

Chuck Lauer: thanks!

## Longform Discussion Notes

Information about soon-to-be available Confluence tool presented

Kirby shared Google doc, discussion of the two subgroups (H2O and O2)

Steve - I asked it earlier, my question was really you talked about pilot plant intention by NASA to fund that, the phrase you used was signed up to, and I'm trying to get a sense of to what extent you have confidence in the availability of funds to support something of that magnitude in that timeframe.

Jerry – When I say signed up, I'm the technical lead for ISRU across the agency. I work with the different mission directorates who are the financial people. STMD is creating budgets and long term plans that include the funds for those demonstrations and pilot operation. How we get to the Moon, and how CLPS missions are funded is an ongoing debate. But the hardware itself, the ground ... the selection of the different flight demos and developing them to be inserted onto a CLPS lander and the development of the hardware are all in the planning long term budget. That long again, our budgets re at the whim of congress and the White House. It's in there, whether congress and wh agrees, that's above my pay grade.

Karl - going to summarize a series of questions, which is resources - there are questions about o2 are h2o the only interest in? To what level would NASA be interested in the other volatiles? For o2 extraction, any concept for how interested NASA would be to retain one of the metals that could be released from processing a form of o2.

Jerry – So yes - this is a lot of this is done with the intention of what are the gold nuggets that obvious pop out at you. Oxygen, water, are the gold nuggets that we see a direct insertion path. We recognize water may be at a LCROSS reasonable concentration that it might be economically mineable. LCROSS also showed other volatiles. It's not clear how much of those volatiles exist, how they are retained and such, so we're not saying immediately that methane from polar volatile carbon sources and hydrogen sources is on the books, but as we fly these missions and learn about other volatiles, definitely products. If ammonia is there, that's a great nitrogen source, and hydrogen. Could be used for a fuel cell, fuel for thermal control system. We have other charts that point to those other volatiles. Metals as well - another thing that could be of great interest. Discussion we're having with our manufacturing folks in terms of how refined does the metal need to be to work in 3d printer or sintering device, vs. what's part capabilities, how strong does the part need to be. That's going on in the background, but it's not defined to the level that we could share clear metrics of, 'yes I need this amount of metal or volatile for this product.'

Could start a Google doc on that as well. For funding sources.

Jerry - I think you'll post these charts so people could review them. We could cover different questions in different focus group meetings. The point was to say there are things going on, things to start looking at in terms of solicitations, the fact that partnerships and particularly looking at what's called announcements of collaborative opportunities and tipping points are two avenues that provide opportunities for industry and small SMIR, there are opportunities to start looking at things.

You should also look at challenges. NASA just released the watts on the moon challenges, ideas for how we might get power to permanently shadowed craters. NASA is looking at excavation challenge for polar ice mining. That's another area that all of you could look at and potentially partner on and do things.

Jerry - Angeliki I see your question, the two are separate at the moment but I do plan on bringing al on board a little bit more b/c we're working on gap analysis. The results of what comes out of the ISCG activity will be presented in the next several months to everybody so that they can see the international aspect of ISRU. The work - the LSIC is not ready to see the info from the ISICG / ISRU working group, but we definitely will be sharing that with the team direction folks here to get more inputs before we release it to the public.

Less on on property rights issues but opportunities on breakout sessions, but focus group is focused on development of technologies, so let's keep that in mind.

Question from Brad Blair - At this point that's a good question. I know they're going to do it in April or June of next year - talk to Karl about how we can release some of the info