

National Aeronautics and
Space Administration



EXPLORE SCIENCE

Lunar Updates

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Developing an Artemis Surface Science Team

Artemis Science Team Structure

It's been 50 years since we've had humans doing science on the surface of another planetary body!

Artemis and Apollo goals and implementation are different

- Building on Apollo and Constellation planning

- Lunar science community is different

- NASA is different: we have a large cadre of talented lunar scientists among our Civil Servants

- Our approach is different: commercial/international

The overall Artemis Science Team will be composed of a mixture of assigned internal NASA scientists and competed roles.

The current plan is relevant only for the “sortie” phase of Artemis (short stand-alone missions), we will evolve these plans as we enter the sustainability phase.

Artemis III Science Team

Artemis Science Lead (Sarah)

Exploration Rep (Jake)

Internal Artemis Science Team

- NASA scientists already working with Artemis
- Currently Human Exploration funded/Transitioning to SMD funding
- Conflicted from competition

Competitively selected Geology Team

- ~10-member team, including PI
 - C.25 in ROSES22 (placeholder released)
- ~10 Participating scientist roles
 - call timing TBD

Competitively selected Payload Teams

- Artemis III/V payloads
 - F.12 in ROSES22 (placeholder released)
- Lunar Terrain Vehicle (LTV) payloads
 - F.13 in ROSES22 (placeholder released)

Role of Internal vs. Competed Teams

Internal Team

Make sure the architecture/systems can support science

- Embedded on boards and working groups across the agency, reviewing documents
- Rapid response to requests and queries from across the agency

Interface between NASA and competed teams to maximize science return

- Lead classroom, field, and ops training for crew
- Lead operational training for competed teams

Program Level Strategic Planning
Mission-to-Mission continuity

Competed Geology Team

Focused on Artemis III sortie

Develop mission science objectives for that sortie

- Field science goals
- Traverse planning
- Sampling strategy

Support training as needed

Real-time operations support

Preliminary Examination of Samples

Post Mission Geology Report

Artemis Internal Science Team

Artemis Science Lead (Sarah)
Exploration Rep (Jake)

Internal Artemis Science Team:

Training
and Ops

- Training and Strategic Integration Lead - **Cindy Evans**
- Science Flight Operations Lead - **Kelsey Young**
- EVA Hardware and Testing Integration Lead - **Trevor Graff**

Samples

- Sample Integrity Lead - **Barbara Cohen**
- Contamination Control Scientist (TBD)
- Artemis Curation Lead - **Ryan Zeigler, Acting**

Planning
and Data

- Mission Planning and Science Implementation Lead - **Sam Lawrence**
- Spatial Planning and Data Lead - **Noah Petro**
- Software Systems Lead - **Matthew Miller**

Payloads

- SMD Payload Integration Officer - **Renee Weber**



Artemis Planetary Science Training - Phased Approach

PHASE 1

Initial Training

During astronaut candidacy

- JSC Classroom Training Modules
 - Geo-Science Fundamentals
 - Earth Systems
 - Planetary Science & Missions
- Field Training
 - Geologic Mapping & Traverse Planning
 - Sampling & Instrumentation
- Expeditionary Components
 - Team Experiences & Leadership Opportunities



PHASE 2

Intermediate Training

Between completion of initial training & flight assignment

- Advanced Field Opportunities
 - Astronaut Field Assistant Program
- ISS Training
 - Crew Earth Observations
- Analog Mission Operations
 - Science in relevant environments under operational conditions (e.g., NEEMO, CAVES, etc.)
 - Additional leadership and teamwork opportunities



PHASE 3

Assigned Crew Training

Mission specific science training

- Destination-Specific Training
 - Target-specific approach
 - Detailed focus on science objectives & operations
- Extensive Field Experiences
 - Numerous geologic/operational training trips
 - Variety of relevant terrains
- Extensive Geologic Education
 - Broad mastery of multiple geologic disciplines



Artemis Analog Testing for Science Ops

We are conducting ongoing Artemis testing events in various analog facilities and environments.

Imaging

Sampling

Navigation

EVA Con Ops

Ops Software

Geology Tools

Mobility / Rovers

Flight Control Ops

Lunar Illumination

Reference EVA Suits

Equipment Transport

.... and more



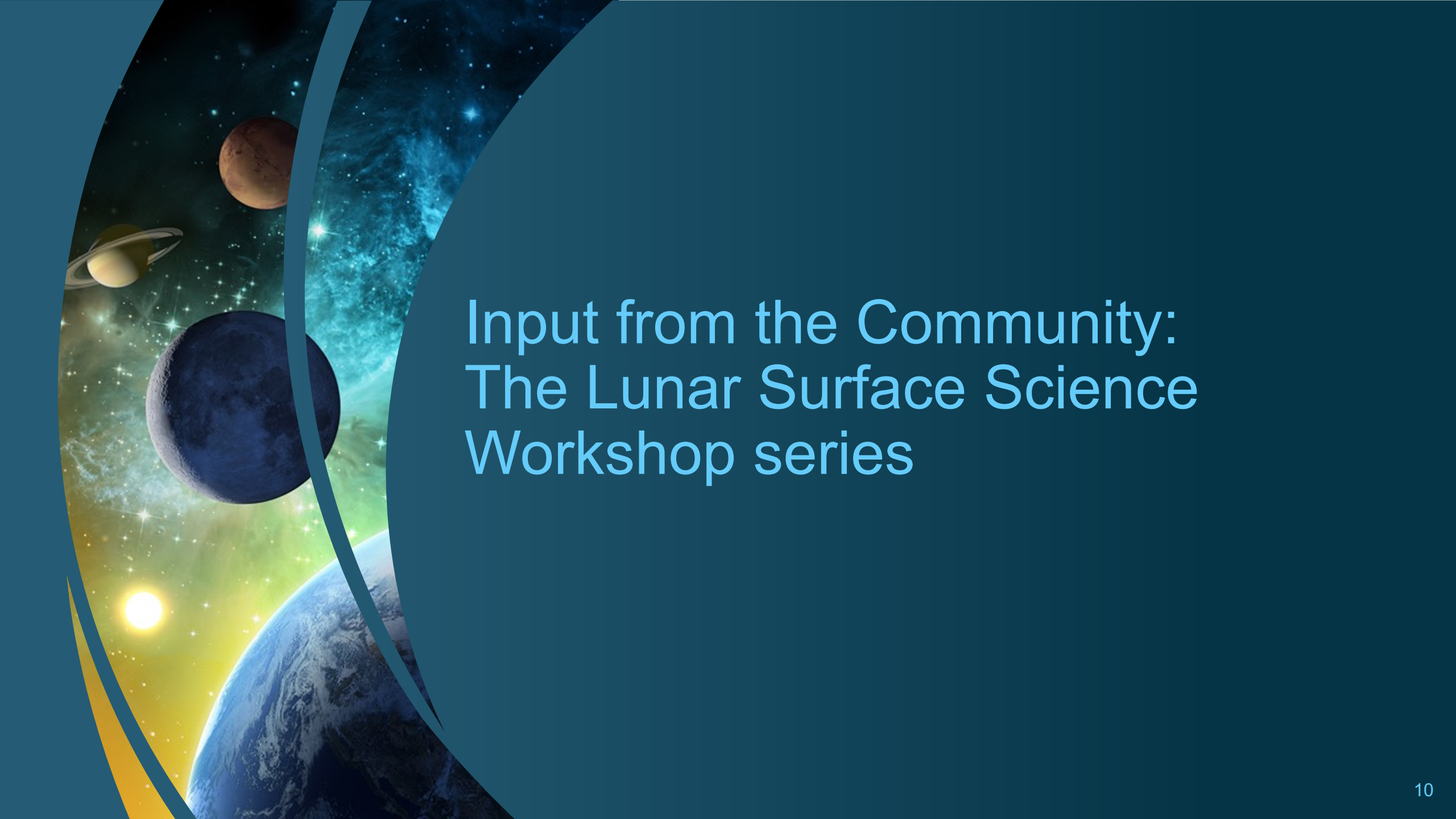
FY21

21 Test Series
160 Testing Events

Analog Activities to Support Artemis Lunar Operations

- NASA ROSES element for science support of analog activities
 - 10 Team members selected this Spring
- Most will participate in JETT-3 Artemis III-focused activity, some will also participate in D-RATS pressurized rover-focused activity
- LEAG Analog Objectives for Artemis (AOA) SAT provides prioritized objectives
 - Understanding backroom structure/communications/software
 - Science con-ops
 - Lighting conditions
- Will be a call for next year as well, open to US-persons, including “senior” graduate students





Input from the Community: The Lunar Surface Science Workshop series

Lunar Surface Science Workshop Overview

Community input and early integration of science into the exploration architecture are essential to maximizing the science return from Artemis.

The original LSSW was planned as an in-person workshop in April 2020 but postponed due to the COVID-19 pandemic. The LSSW then spun off into a series of virtual workshops, held approximately monthly, designed around high priority topics that required community input.

18 sessions to date, with multiple in the works!

Each session is chaired by members of the community, across academia, industry, and government.

Also, annual report out from HQ/Artemis to the community

Lunar Surface Science Workshop Overview

Each workshop generates a summary report, located here:

<https://lunarscience.arc.nasa.gov/lssw>

Draft reports are open for community comment online post-workshop before being finalized.

These final reports are given to NASA HQ and key Artemis elements for incorporation into mission planning.

We are looking into other ways to make the reports more available, including a journal special issue.

Lunar Surface Science Workshop Schedule

Previous sessions:

- Overview and Background (May 2020)
- Tools and Instruments (May 2020)
- Volatiles (July 2020)
- Samples (July 2020)
- Dust and Regolith (August 2020)
- Planetary Protection (September 2020)
- The Value of Mobility (October 2020)
- Foundational Data Products (November 2020)
- Space Biology (January 2021)
- Structuring Real-Time Science Support of Artemis Crewed Operations (February 2021)
- Progress and Challenges: Updates from NASA HQ and Artemis (April 2021)

- Physical Sciences (August 2021)
- Science with Robotic Arms (Sept/Nov 2021)
- Future CLPS landing sites (December 2021)
- Inclusive Lunar Science (January 2022)
- Heliophysics (February 2022)
- We Are Going! Updates from NASA HQ/Artemis (May 2022)
- Assessing the Value of Modern Field Geology Tools for Artemis (June 2022)

Upcoming Sessions:

- **ISRU – July 11th and September TBD**
- **Human-Robotic Interactions - TBD**

Select Findings

Samples

- Mobility is critical for sampling and science objectives.
- Tools for sampling should include both sampling tools and new handheld analytical tool to use when necessary.

Planetary Protection

- Not all PSRs are created equal: we need laboratory, modeling, and in situ research to better understand their distribution and characteristics. When/how/if we protect them is inexorably linked to their characteristics.

Structuring Real-Time Science Support of Artemis Crewed Operations

- Involvement of early career researchers, the science community, and the public is key.
- Must define clear roles for science team.

Landing Sites and Capabilities for Future CLPS Deliveries

- CLPS should develop an integrated science strategy (e.g., let PRISM proposers choose the landing site that best fits their science; develop a science campaign strategy, etc.)
- CLPS-provided capabilities must continue to evolve in order to address high-priority science objectives at a variety of landing sites across the lunar surface.

Inclusive Lunar Exploration

- Broad, international engagement, mutual respect, and accountability are essential for peaceful and ethical lunar exploration.

LSSW Conclusions

- The Lunar Surface Science Workshop virtual series have been successful in gathering community input across a variety of topics.
- The reports generated from these workshops are being used across the Agency to provide science input into Artemis.
- More virtual LSSWs are being planned around a variety of high-priority topics.
- Please don't hesitate to reach out to anyone on the OC with any questions or comments or workshop topics.

Many thanks to all those who have chaired sessions, helped take notes & prepare reports, gave talks and/or posters at any LSSW session, and those who attended and provided feedback. Thanks also to LPI and SSERVI for organizing and running each session.





Questions

