

EXPLORE SCIENCE

Enabling Map Data Interoperability within Artemis Lunar Surface Operations

Presenter: Matthew Miller, Ph.D.

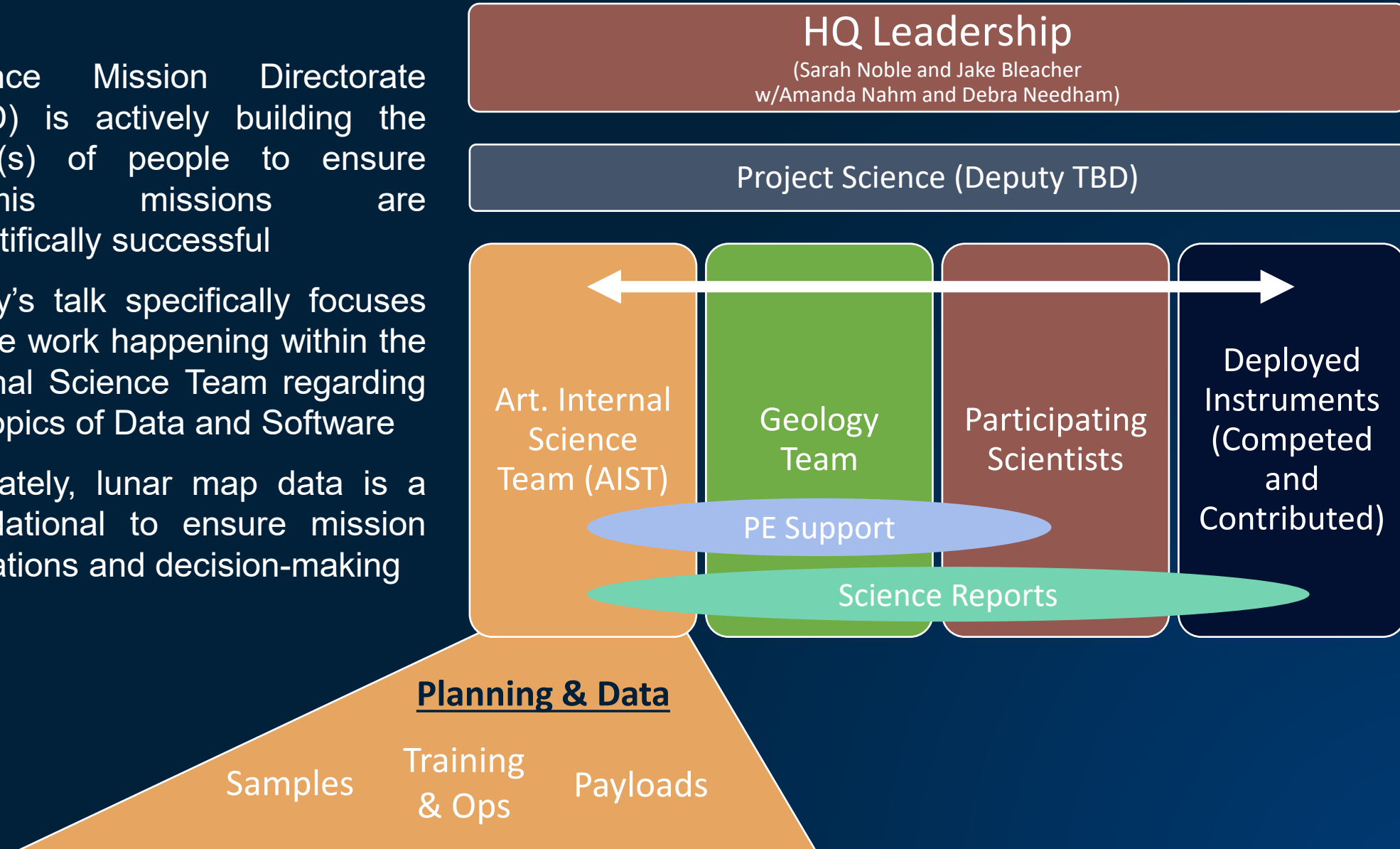
Artemis Internal Science Team – Software Systems Lead

Virtual Session 20: Geological Mapping to Support Artemis Strategic Decisions

August 17, 2023

Enabling Artemis Science

- Science Mission Directorate (SMD) is actively building the team(s) of people to ensure Artemis missions are scientifically successful
- Today's talk specifically focuses on the work happening within the Internal Science Team regarding the topics of Data and Software
- Ultimately, lunar map data is a foundational to ensure mission operations and decision-making



AIST Data and Software Mission & Vision

MISSION: What are we trying to achieve?

- The AIST Data and Software Team mission is to organize and make science mission data useful for Artemis mission personnel and the broader public scientific community.

VISION: What does the world look like when we've achieved this mission?

- Interoperable science mission data and software capabilities are created and made available for mission personnel to support Artemis missions.
- All phases of Artemis missions, from concept formulation to post-mission execution, leverage traceable, consistent, applicable, valid, and necessary scientific data.
- Science mission data is made available for all internal/vendor mission support and the broader public scientific community
 - As much Artemis Mission data as possible is exposed to the public via an Artemis Mission Data - Application Programming Interface (API)
 - Long term archiving/curation systems connects to this API

AIST Data and Software Mission & Vision

STRATEGY: What's our plan for achieving the vision?

1. Consolidate, create, and curate lunar science data.
2. Distribute lunar science data to support Artemis mission activities.
3. Create and deploy interoperable data and software functionality needed for Artemis mission personnel.
4. Lower the barrier to accessing lunar science data for mission operations personnel and the broader public scientific community by creating an Artemis Mission Data API endpoint for internal NASA/vendor users and the public.

Artemis Geospatial Data Team

EVA Mission System Software

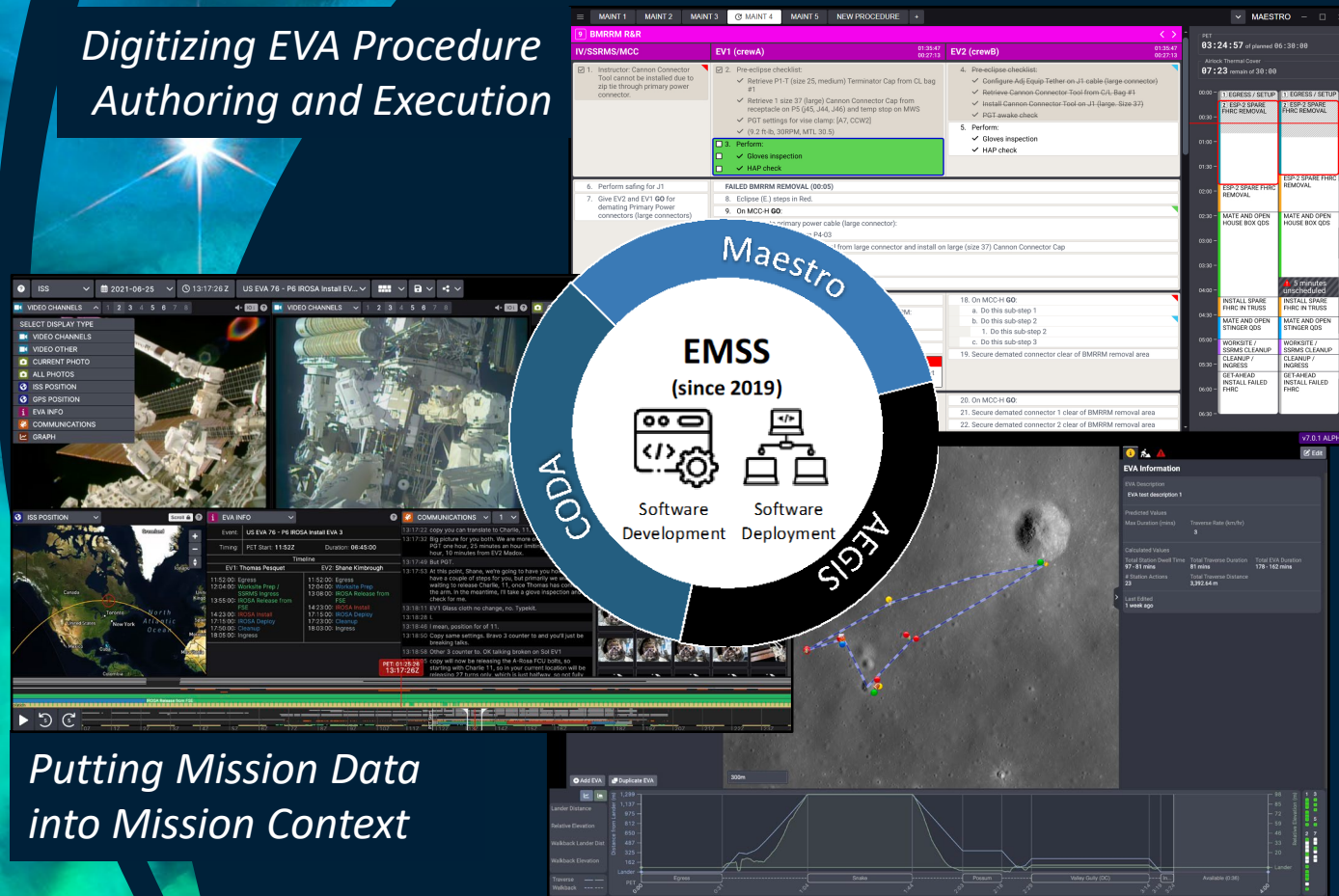
For today's conversation and venue, science data here specifically emphasizes geologic mapping focused data products

Artemis Geospatial Data Team

- The [Artemis Geospatial Data Team](#) was established in 2022 to coalesce agency-wide geospatial data creation and analysis skillsets to meet the growing demand for lunar surface map products and analyses.
 - This team is comprised of personnel that span many NASA directorates and centers.
 - See references [HERE](#) and [HERE](#) for more detail authored by my colleagues Dr. Lawrence and Dr. Petro.
- [Artemis III site selection process](#) is ongoing and AGDT is ensuring decision-makers have the highest-resolution and most scientifically valid lunar surface data products and analysis results
- [Artemis geospatial data management system](#) is being built to host, curate, and distribute Artemis data.
 - Server hardware and infrastructure is under active development to ensure the geospatial products necessary for Artemis can be controlled for quality, accuracy, and availability to all relevant parties.
 - This capability will ensure the correct data can reach the correct Artemis members to inform mission development and ensure we can get these products back out to the scientific community
- Documentation of products and processes is underway.
 - For example, see the [ACD-50044 Rev A Lunar Surface Data Book](#) publicly available on the NTRS
 - *Geologic Maps are currently Reserved for future development*

EVA Mission System Software (EMSS) Initiative

Digitizing EVA Procedure
Authoring and Execution



Putting Mission Data
into Mission Context

Enabling spatiotemporal awareness for
EVA Procedure Authoring and Execution

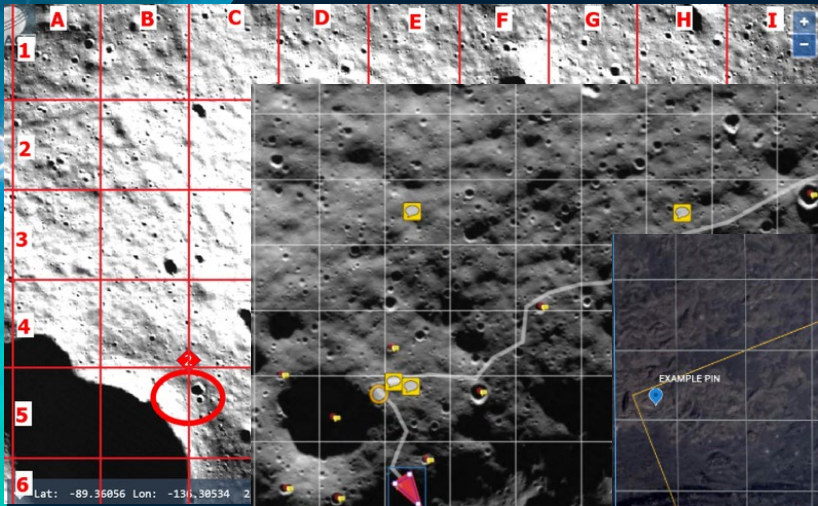
- Developing new software systems via the **EVA Mission System Software (EMSS)** Effort for the Artemis era
 - Near-term: Mission support systems development that unite spatial and temporal data to enable both mission personnel and the broader scientific public
 - Future: Advanced informatics such as spacesuit augmented reality for crewed EVAs
- Software systems development is integrated with the **EVA Human and Surface Mobility Program (EHP)** testing program
 - Using analog and testing opportunities, like JETT-5 to refine needs and improve software tools to meet science needs

EMSS is enabling Science and Operations dialog via the data connections we're enabling in our tools

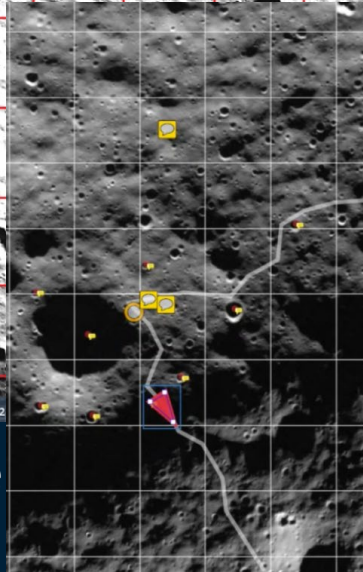
See for More Detail: Miller, M.J., et al., (2023) [Supporting Exploration Missions by Enabling Exploration Mission System Software](#), 52nd International Conference on Environmental Systems ICES-2023-242, 16-20 July 2023, Calgary, Canada

Discovering EVA Traverse Planning Capabilities

Iterative Design and Test Philosophy with EVA Flight Operations Personnel



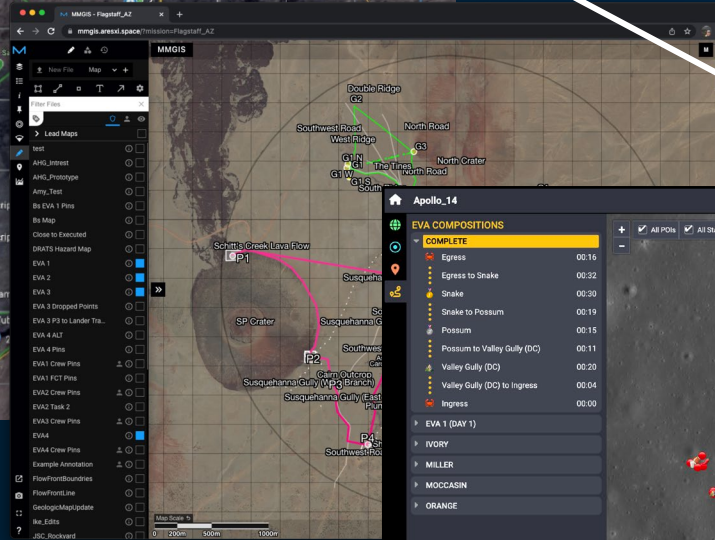
Plain image
Feb 2020
FCPTT



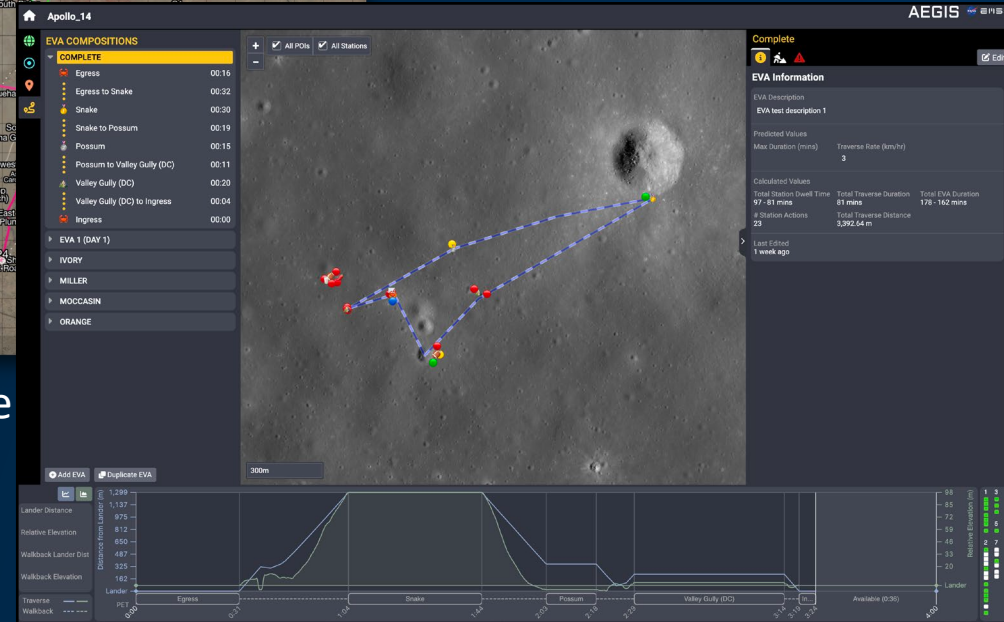
Annotated PDF
Jun 2020 FCPTT



Google Web Earth
April 2021 FCPTT

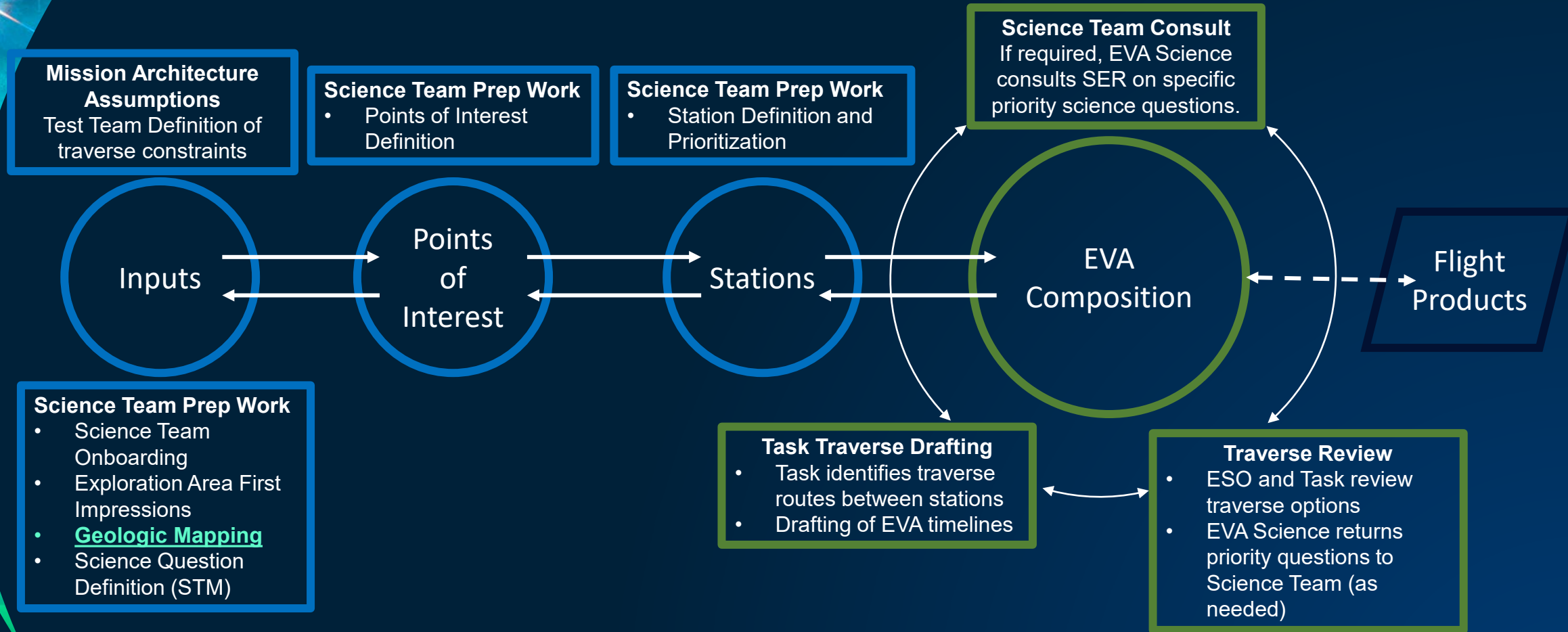


MMGIS prototype
for DRATS 2021,
JETT2/3 2022



AEGIS for JETT5+ 2023

EMSS Team has been iteratively discovering and enabling relevant EVA mission operations capabilities on top of and interacting with underlying map data

[illegible]

Geologic Maps become a foundational input upon which EVA plans are developed

Specific Map Products Currently being Handled in Field Testing

JETT3 Map Product Summary

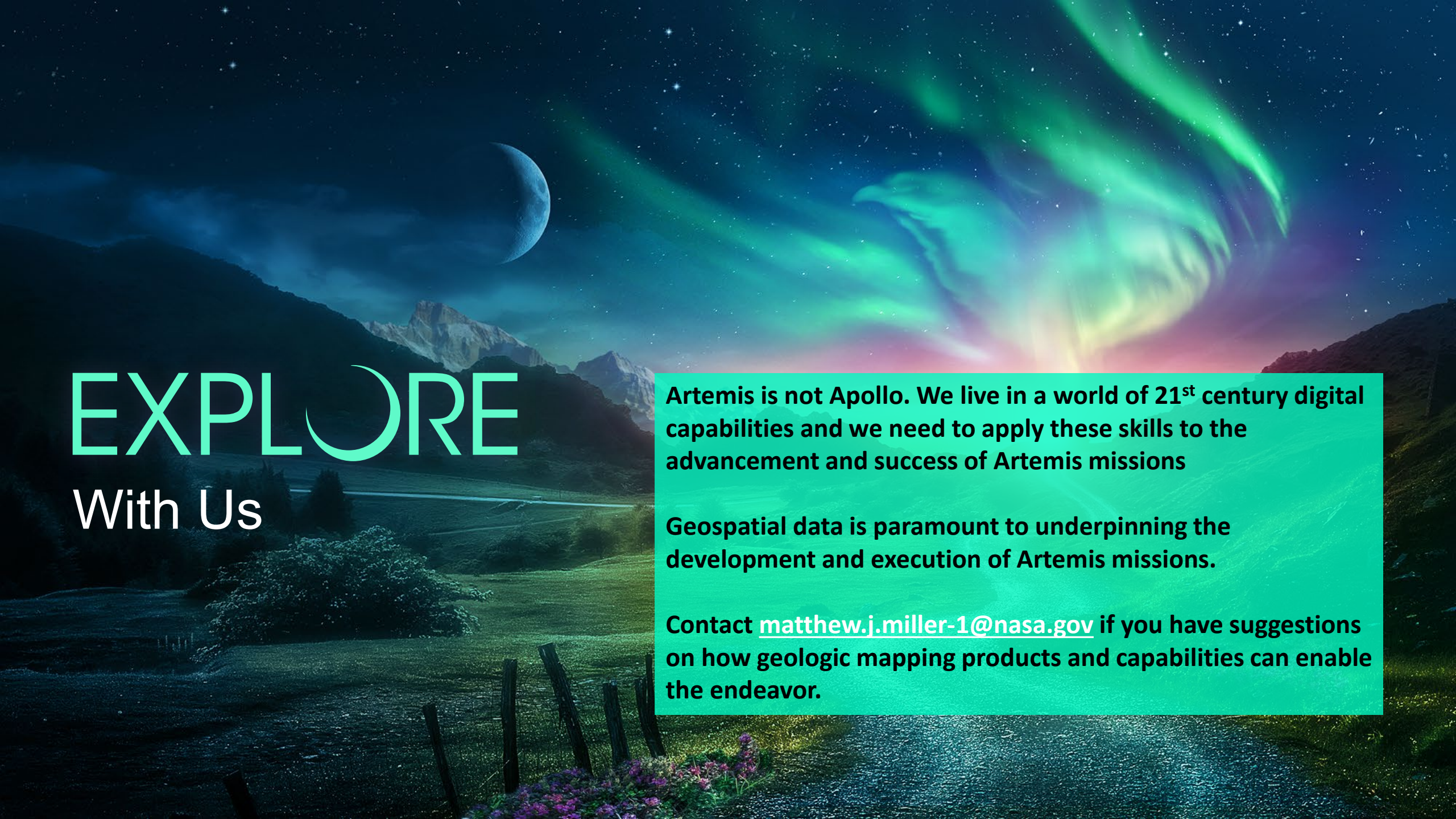
Data Type	Product Description
Foundational Data	1 m/pix aerial image
	0.5 m/pix grayscale orthoimage (SER team only)
	1.5 m/pix Digital Elevation Model (DEM)
Derived Data Products	Geologic Maps (1:4k and 1:20k scales)
	Contours at 5m, 50m and 100m intervals
	Communication Coverage maps using various viewshed and DEM configurations
	Terrain Ruggedness index (at 10 m/pix and 1.5 m/pix)
	Aspect Map (at 10 m/pix and 1.5 m/pix)
	Slope Map (at 10 m/pix and 1.5 m/pix)
	Elevation (at 10 m/pix)
	Hillshade (at 10 m/pix, 1.5 m/pix, and shadow maps)

Citations of Interest, See Joint EVA Test Team 3 (JETT3): Preparing for the Artemis III Campaign at the LPSC 2023 website, see References [HERE](#) and [HERE](#)

JETT5 Map Product Summary (in work)

- two 1:5,000-scale geologic maps (one for each site) using expected lunar equivalent data and spatial resolution:
 - GeoEye grayscale orthoimagery (1 m/pix) and associated digital elevation model (DEM; 1.5 m/pix);
 - Maxar grayscale ortho-imagery (1 m/pix) and DEM (1.5 m/pix);
 - National Agricultural Imaging Program (NAIP) contrast-stretched 3-band color aerial images (1 m/pix);
 - NEXT Map X-band (3 cm) radar imagery (1 m/pix).
- Contacts and features were exclusively drawn on a grayscale image base (NAIP Band 3 (red) data for Primary, GeoEye for Secondary) comparable to lunar images from the Narrow Angle Camera.
- Units and outcrops were defined and described using all the data available.

See [Upcoming LEAG 2023 paper](#): JETT5 Geologic Mapping In Support Of Simulated Artemis Surface Operations: Process And Preliminary Products. Additional publications summarizing JETT5 mapping efforts will follow



EXPLORE

With Us

Artemis is not Apollo. We live in a world of 21st century digital capabilities and we need to apply these skills to the advancement and success of Artemis missions

Geospatial data is paramount to underpinning the development and execution of Artemis missions.

Contact matthew.j.miller-1@nasa.gov if you have suggestions on how geologic mapping products and capabilities can enable the endeavor.

Artemis Internal Science Team

Artemis Lunar Science Lead: Sarah Noble
Deputies: Debra Needham, Amanda Nahm

- 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 - **Andy Needham**
 - 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**

