Program and Abstract Titles

Lunar Surface Science:
Structuring Real-Time Science Support of Artemis Crewed Operations
February 24–25, 2021
Virtual

Times listed are Eastern Standard Time (EST). Time Zone Converter

8:00 a.m. PST
9:00 a.m. MST
10:00 a.m. CST
11:00 a.m. EST
5:00 p.m. CEST
1:00 a.m. (the following day) JST

Wednesday, February 24, 2021
HQ PERSPECTIVES AND APOLLO KEYNOTE SESSION
11:00 a.m. EST
Chairs: Kelsey Young and Jose Hurtado

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Times (EST)	Authors (*Denotes Presenter)	Abstract Title and Summary
11:00 a.m.	Jose Hurtado, Kelsey Young *	*Welcome and Workshop Objectives*
11:10 a.m.	Schmitt H. H. * Eppler D. B. Petro N. E. Head J. W.	*Lessons Learned for Artemis from Science Back Room Support of the Apollo Missions* **[#3025]** Successful implementation of the Apollo Science Support Room for Apollo 11-17 offers precedents and lessons for similar support of Artemis mission science.
11:30 a.m.	Sarah Noble, Jacob Bleacher *	*HQ Status and Outstanding Questions*
11:40 a.m.	Renee Weber *	*Artemis 3 SDT Report Out*

11:50 a.m.	Jim Head *	*Structuring Real-Time Artemis Surface Science Support: Perspectives from Apollo Mission Operations*
12:10 p.m.		*Q&A*
12:20 p.m.		BREAK

Wednesday, February 24, 2021
HISTORICAL AND CURRENT PERSPECTIVES
12:35 p.m. EST
Chairs: Kelsey Young and Jose Hurtado
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Times (EST)	Authors (*Denotes Presenter)	Abstract Title and Summary
12:35 p.m.	Feist B. F. * Petro N. E. Barry W. P. Mavridis C.	*Lunar Extra Vehicular Activity (EVA) Science Support Operations — Learning from Apollo and Shuttle for Application to Artemis* **[#3035]** Studying how science support activities were conducted during Apollo and Shuttle provides important lessons, including the mistakes that were made, for the return to the Moon. Here, we use historical material to provide recommendations for Artemis.
12:50 p.m.	Dickerson P. W. *	*Crew, Capcom, and Back-Room Science Teams on the Ground: Rigorous Exploration Simulations — A View from the Back Room* **[#3034]** For Artemis, as for the "J" missions of Apollo,commitment to the fidelity of surface exploration simulations is essential for mission success. Back-room science teams must be adaptable in the face of unexpected discoveries.
1:00 p.m.	Jackie Kagey *	*Lessons Learned from Space Shuttle and International Space Station EVA Operations*
1:15 p.m.	Alex Kanelakos *	*Incorporating Historic Lessons Learned into an EVA Execution Model for Artemis*
1:30 p.m.	Ashwin Vasavada *	*The Value of Integrating Science and Engineering Teams in the Operation of NASA's Mars Science Laboratory Curiosity rover*
1:45 p.m.	Calef F. J. III * Abarca H. G. Parker T. J. Schroeder J. Williams N. Lethcoe H. Berger L. Deen R. G. Pariser O.	*Spatial Context is for Astronauts: Spatial Products, Tools, and Staff for Human Surface Operations Based on Mars In Situ Missions Experience* **[#3013]** Mars robotic surface missions have integrated science teams supporting operations like the "backroom" Apollo scientists. We discuss key advances made in spatial products, tools, and mapping teams from these missions adaptable to the Artemis program.
1:55 p.m.		*Q&A*
2:05 p.m.		BREAK

Wednesday, February 24, 2021
GUIDING PRINCIPLES AND EXPLORATION STRATEGIES
2:25 p.m. EST
Chairs: Kelsey Young and Jose Hurtado
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Times (EST)	Authors (*Denotes Presenter)	Abstract Title and Summary
2:25 p.m.	Heldmann J. L. * Lim D. S. S. Newman D. Shaw J. Colaprete A. Elphic R. C. Lees D. Zacny K. Coyan J. Mirmalek Z. Sehlke A. Wagner A.	*Guiding Principles to Optimize Real-time Scientific Productivity During Artemis Crewed Missions to the Moon* **[#3008]** NASA's Artemis missions will offer unprecedented opportunities for high priority lunar science. To optimize scientific return during crewed surface activities, we present several guiding principles that should be implemented at the earliest stages of the Artemis program.
2:35 p.m.	Kring D. A. * Head J. W. Hiesinger H. Needham D. H.	*An Exploration Operations System* **[#3016]** The Apollo and Constellation programs provide an outline of the major operational tenets needed for a sustainable Artemis exploration program on the lunar surface.

2:45 p.m.	Petro N. E. * Schmitt H. H. Feist B. F.	*Surface Operations Real-Time Replanning During Apollo 17: Examples of Rapid Decision Making and Implications for Artemis* **[#3009]** Apollo 17 is an exemplar case for field geology on the Moon. The Science Support Room is discussed, highlighted by changes to the plan and how those changes were communicated. For Artemis, direct communication between crew and a science lead is key.
2:55 p.m.	Bell E. Jr. * Schmerr N. Feist B. Richardson J. Whelley P. Young K.	*Recommendations for Real-Time Coordination for Artemis Lunar Surface Geophysical Science Investigations* **[#3028]** Discussion on the advantages and recommendations for real-time geophysical expertise within a MCC science backroom for Artemis missions to optimize the geophysical scientific return from lunar surface exploration operations.
3:05 p.m.	Edgar L. A. * Skinner J. A. Jr. Keszthelyi L. P. Hagerty J. J.	*Science Backroom Training for Lunar Exploration: Analog Training in Northern Arizona* **[#3020]** We review the involvement of scientists in field training during the Apollo program and discuss current capabilities to support science backroom training in northern Arizona.
3:15 p.m.		*Q&A*
3:25 p.m.	Kelsey Young, Jose Hurtado *	*Introduction to Breakouts*
3:30 p.m.		BREAK

Wednesday, February 24, 2021
BREAKOUT DISCUSSIONS #1
3:50 p.m. EST
#1 Chair: Jose Hurtado Facilitator: Ferrous Ward
#2 Chair: Kelsey Young Facilitator: Amanda Ostwald

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Times (EST)	Authors (*Denotes Presenter)	Abstract Title and Summary
3:50 p.m.		*Breakout #1: Historical Lessons Learned for Pre-Mission Activities and Breakout* *Leading Questions:* - *What traverse-planning strategies for robotic missions with time-delay are amenable to human exploration with increasing amounts of crew autonomy?* - *What traverse-planning strategies for Apollo worked best?* - *What lessons learned can we leverage from Apollo on ideal training activities/strategies for the crew and science team?* - *What are the best ways to integrate engineering, mission operations, and science in the runup to the mission?* *Breakout #2: Historical Lessons Learned for Mission Activities* *Leading Questions:* - *What worked well and what can be improved from the design and function of the Apollo Science Support Team structure during the Apollo missions?* - *What lessons learned can we leverage from Mars rover exploration?* - *What can we leverage into Artemis from how ISS operations work today?*
4:50 p.m.		*Adjourn*

Thursday, February 25, 2021
ANALOGS SESSION #1
11:00 a.m. EST
Chairs: Kelsey Young and Jose Hurtado
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Times (EST)	Authors (*Denotes Presenter)	Abstract Title and Summary
11:00 a.m.	Kelsey Young, Jose Hurtado *	*Recap of Day 1*
11:10 a.m.	Sauro F. * Turchi L. Payler S. J. Pozzobon R. Massironi M. Bessone L.	*Enhancing Science Backroom Situational Awareness: Lessons Learned During Astronaut Geological Training* **[#3014]** Since 2016 ESA has organized the PANGAEA astronaut training program for field geology. In this presentation, the main lessons learned from the prospective of the crew and science backroom are outlined.
11:20 a.m.	Kring D. A. * Janoiko B. A. Looper C. A. Ney Z. A. Young K. E. Eppler D. B. Graff T. G.	*Integrated Science and Flight Operations* **[#3017]** Several years of study during the Constellation program demonstrated that an integrated science and flight operations center enhances mission productivity and provides crew with needed lunar surface expertise when engaged in lunar surface operations.
11:30 a.m.	Evans C. A. * Bell M. S. Graff T. G. Calaway M. J.	*Science Backroom Support for Sustained Lunar Surface Operations* **[#3007]** Science backroom operational scenarios for sustained lunar surface missions were tested during the GeoLab analog tests, part of the 2010-12 Desert RATS analog missions. GeoLab was a geological glovebox integrated into the Habitat Demonstration Unit.
11:40 a.m.	Lim D. S. S. * Chappell S. Beaton K. H. Kobs Nawotniak S. Brady A. L. Mirmalek Z. Sehlke A. Newman D. Lees D. S. Abercromby A. Cockell C. S. Stevens A. Elphic R. Cohen T.	*Tactical and Strategic Science Support for Crewed Artemis Missions: Lessons Learned from the BASALT Research Program* **[#3019]** Science support systems for Artemis will require structured, continuous integration between science, operations, and engineering stakeholders. Our team's work on the BASALT research program provides a means to examine and scope these requirements.
11:50 a.m.	Osinski G. R. * Morse Z. R. Marion C. L. Newman J. D. Hill P. J. A. Simpson S. L. Pilles E. A. Caudill C. M.	*Mission Control Structure and Strategies: Lessons from the CanMoon Lunar Sample Return Analogue Mission* **[#3024]** Here we present lessons learned for mission control structure and strategies from the CanMoon Lunar Sample Return Analogue Mission.
12:00 p.m.		*Q&A*
12:10 p.m.		BREAK

Thursday, February 25, 2021
ANALOGS SESSION #2
12:25 p.m. EST
Chairs: Kelsey Young and Jose Hurtado
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Times (EST)	Authors (*Denotes Presenter)	Abstract Title and Summary
12:25 p.m.	Lee P. *	*Science Support for Artemis Crewed Operations on the Moon: Lessons from the Haughton-Mars Project, Devon Island, Arctic, and a Mars Forward Strategy* **[#3033]** Science support for Artemis crewed operations will build on, but must also evolve away from, Apollo, as lunar sortie missions make way for a fixed base approach and Mars crewed missions.

12:35 p.m.	Perrier I. R. * Foing B. H. Kołodziejczyk A. M. Komenda K. Clain M. Forgues--Mayet E. Podolsky T. Bardin-Codine J. Castaing H. Gouault Q. Landolina R.	*EMMPOL (Euro Moon Mars POLand) Moon Analog Mission* **[#3030]** IPSA Air and Space Engineering School in France joined the ILEWG Euro Moon Mars programme. We will present here a part of our experiments conducted during the October 2020 EMMPOL analog Moon mission in Poland.
12:45 p.m.	Foing B. H. * Euromoonmars Team N.	*ILEWG EUROMOONMARS Field Campaigns: Lessons for ARTEMIS Crew and Science Support Collaboration* **[#3031]** The ILEWG EuroMoonMars programme includes research activities instruments tests and development, field tests, analogue astronaut simulations, supporting the preparation for Artemis collaboration between crew, mission control and science support.
12:55 p.m.	Evans M. E. * Nguyen H. T. Needham D. H.	*Lessons Learned Using the Mission Control Center (MCC) Geoscience (GeoSci) Console for NASA's NextSTEP Habitation Module Crew Testing (2017-2019)* **[#3010]** Lunar GeoSci / Needs orbiting hab hardware / Can get great results!
1:05 p.m.	Young K. E. * Graff T. G. Welsh L. D. Wray S. Naids A. Akker T. Coan D. Bergman H. Miller M. Miller M. Downs M. Caswell T. E. Mavridis C. Kagey J. Korona S. Matula E. Kanelakos A.	*NASA Testbed Environments for Artemis Lunar Surface Operations* **[#3023]** We provide a description of an integrated team of NASA engineers, flight controllers, and scientists conducting initial Artemis lunar surface testing at NASA JSC facilities.
1:15 p.m.		*Q&A*
1:25 p.m.		BREAK

Thursday, February 25, 2021
SUPPORT TOOLS
1:40 p.m. EST
Chairs: Kelsey Young and Jose Hurtado

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Times (EST)	Authors (*Denotes Presenter)	Abstract Title and Summary
1:40 p.m.	Clark P. E. * Calef F. J. Dahl L.	*Effective Approaches and Tools to Support ARTEMIS Surface Activities Based Apollo Lessons Learned and Successful Recent Surface Exploration* **[#3006]** We incorporate lessons learned from the Apollo Program [1] and Mars surface missions with human interactive components to propose approaches and tools to structure interactions between a science backroom and flight personnel including astronauts.
1:50 p.m.	Miller M. J. * Feist B. Pittman C. W. Alexander A. Heinemann K. Britton A. Jagge A. Montalvo J. Graff T. Abercromby A. Kanelakos A.	*Enabling Modern Flight Control and Ground Science Support Teams Using Software Support Systems* **[#3022]** Modern-day tools and technologies are vastly more complex than the analog systems employed during Apollo. How might Artemis mission support teams be supported by using modern era software support systems to successfully perform Artemis EVA?
2:00 p.m.	Pittman C. W. * Feist B. F. Miller M. J. Glotch T. D.	*Supporting Real-Time EVA Science Via Horizontally Integrated Informatics Structure Across Artemis Activities* **[#3026]** Horizontally integrated scientific data products will enable real-time science operations support and will enable the preservation of the data's mission context for generations to come.

2:10 p.m.	Sauro F. * Drozdovkiy I. Payler S. J. Turchi L. Bessone L.	*Decision Support Tools for Planetary Exploration Using Bespoke Databases and Machine Learning* **[#3015]** Here we present how an analytical database of planetary minerals and a set of machine learning algorithms can identify minerals from spectra and provide relevant information for fast decision making processes during geological traverses.
2:20 p.m.	Vargas Fernández E. *	*Use of Artificial Intelligence "GPT-3" for Science Backroom, Orion Module, and Space Station Gateway for the Space Program Artemis* **[#3004]** In this report you will find the possible use of Open AI GPT-3 Artificial Intelligence.
2:30 p.m.	Joshi D. R. * Blair B. R. Rostami J. Eustes A. W. III	*Patten-Recognition Enabled Drilling and Geotechnical Science Support* **[#3027]** This work demonstrates a possible application of data-driven techniques to enhance the Artemis crewed operations by providing real-time estimations of the geotechnical properties using the drilling data collected during subsurface sample capture.
2:40 p.m.	Runyon K. D. * Seelos K. D. Matiella Novak A. Hibbitts C. A. Nord M. E. Stickle A. M. Handelman D. A. Kraft K. L. Meyer H. M. Tucker A. O. IV Núñez J. I.	*Lunar Avatar: The Other Artemis Astronaut* **[#3021]** An Earth-bound robotic Avatar operator would alternately isolate from or be embedded with the science backroom during Artemis missions.
2:50 p.m.	Hurtado J. M. Jr. *	*Virtual and Collaborative Exploration by the Artemis Science Operations Team* **[#3029]** A "virtual explorer" role in the science operations team can collaboratively explore the lunar surface along with the astronauts, giving the science operations team powerful capabilities for supporting science activities on the Moon.
3:00 p.m.		*Q&A*
3:10 p.m.	Kelsey Young, Jose Hurtado *	*Introduction to Breakouts*
3:15 p.m.		BREAK

Thursday, February 25, 2021
BREAKOUT DISCUSSIONS #2
3:35 p.m. EST
#1 Chair: Jose Hurtado Facilitator: Marie Henderson
#2 Chair: Kelsey Young Facilitator: Tess Caswell
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Times (EST)	Authors (*Denotes Presenter)	Abstract Title and Summary
3:35 p.m.		*Breakout #1: Infrastructure* *Leading Questions:* - *What sort of physical space is required to support the Backroom/Science Operations Center during Artemis missions? Where should this be in relationship to other mission support?* - *What are the computing resources, including software and visualization tools, that the Backroom/Science Operations team will need during Artemis missions?* - *What communications infrastructure, as well as other tools deployed on the lunar surface, will specifically enable the science team to do their work in supporting Artemis missions?* *Breakout #2: Architecture* *Leading Questions:* - *How should the Backroom/Science Operations Center be structured during Artemis lunar surface exploration (i.e. team structure, physical location, interfaces to support infrastructure, etc.)?* - *What should Roles and Responsibilities look like in the Artemis Science Team? What kind of positions should exist? How should the Science Team be selected and what backgrounds are needed?* - *What role will the 'Science Operations Center' play in real-time surface operations (crew autonomy versus the decisions the Science Team will want to feed input into)?* - *What is the role of strategic versus tactical science teams? What does the shift structure and staffing roster look like?*
4:35 p.m.	Kelsey Young, Jose Hurtado *	*Breakout Report-Out and Workshop Wrap-Up*
4:50 p.m.		*Adjourn*