
International Lunar Volatiles Mission Coordination Status

**NASA HQ/Nantel Suzuki
Global Exploration Roadmap Community Workshop
NASA ARC, Moffett Field, CA
Nov 30, 2017**

◆ **International Space Exploration Coordination Group (ISECG)**

- Voluntary, non-binding international coordination forum and mechanism among 15 space agencies

◆ **International coordination includes effort to address scientific knowledge gaps and exploration capability gaps related to lunar water ice and other polar volatiles**

- Website to consolidate lunar polar volatiles information
- Virtual workshops on focused topics concerning the exploration and utilization of lunar polar volatiles, using subject matter experts from the scientific and engineering communities
 - Lunar Datasets_ (Nov 18, 2015)
 - Where to Explore, and How_ (Jan 20, 2016)
 - Lunar Surface Prospecting Instruments_ (Jul 6, 2016)
 - Lunar Volatiles Acquisition Technologies_ (Sep 14, 2016)
- Lunar Polar Volatiles Mission Coordination Dialogue among agencies

◆ <http://lunarvolatiles.nasa.gov>

◆ Information Repository

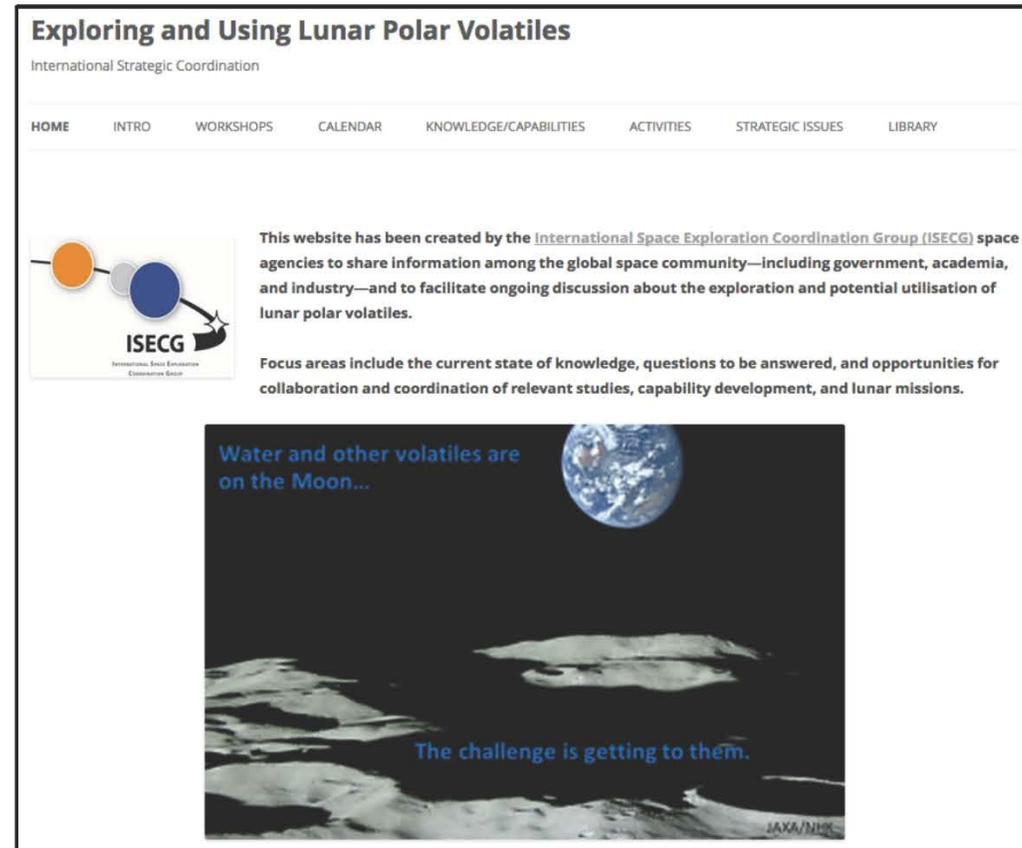
- The case for polar volatiles
- Strategic issues
- Knowledge/capability gaps
- Agency activities
- Calendar

◆ Virtual Workshops

- Hosted by NASA SSERVI
- Archived audio/video
- Archived presentations (.pdf)
- Findings

◆ Library

- Scientific data
- Engineering tests
- Architecture/mission concepts
- Links to journals/meetings



Exploring and Using Lunar Polar Volatiles
International Strategic Coordination

HOME INTRO WORKSHOPS CALENDAR KNOWLEDGE/CAPABILITIES ACTIVITIES STRATEGIC ISSUES LIBRARY

 This website has been created by the [International Space Exploration Coordination Group \(ISECG\)](#) space agencies to share information among the global space community—including government, academia, and industry—and to facilitate ongoing discussion about the exploration and potential utilisation of lunar polar volatiles.

Focus areas include the current state of knowledge, questions to be answered, and opportunities for collaboration and coordination of relevant studies, capability development, and lunar missions.


Water and other volatiles are on the Moon...
The challenge is getting to them.

JAXA/NASA

◆ Objective is to optimize lunar polar missions to more efficiently close Strategic Knowledge Gaps (SKGs) related to the resource potential of lunar polar volatiles

- Coordinated approach
 - Landing sites
 - Payloads/instruments
 - Data sharing
- Science teams
- Common infrastructure, etc

◆ ISECG MCD participants

CNSA, CSA, ESA, JAXA, KARI, NASA, Roscosmos

◆ Received input/findings from Lunar Exploration Analysis Group (LEAG)-led international expert team

- LEAG Lunar Polar Volatiles SAT Meeting (NASA JSC, Aug 14-16, 2017)
- Participants: LEAG scientists and ISRU experts, including international members, space agency and non-space agency (U.S., Canada, Europe, Japan, China, South Korea)

◆ ISECG agencies now assessing LEAG input

International Lunar Robotic Exploration Mission Timeline



	2017	2019	2021	2023	2025	2027	2029
		Chang'E-4 (Farside, +rover) Chang'E-5 (Nearside, Sample Return)		Polar and non-polar landing and sample return mission concepts under study			
						Participation w/HERACLES	
				Participation w/Luna 27 Lunar Pathfinder	ISRU Demo	Participation w/HERACLES	
		Chandrayaan 2 Chandrayaan 2 (Nearside, +rover)					
		EQUULEUS (EML2) OMOTENASHI (impactor)	SLIM	SELENE-R (+rover)		Participation w/HERACLES	
			KPLO				
		Lunar Flashlight Lunar Ice Cube LunaH-Map Skyfire (flyby)		Resource Prospector (+rover)			
			Luna 25 Glob (nearside)	Luna 26 Ressurs-1	Luna 27 Ressurs-1 South Pole	Luna 28 Grunt Sample Return (After 2025)	

 = Orbiting Missions

 = Polar Landed Missions, (> 85° lat)

 = Non-polar Landed Missions, (≤ 85° lat)

 = Landing Region TBD



- **Small Lunar Surface Payload Request for Information (Nov 2016)**
 - NASA RFI to assess availability of payloads that could be delivered to the Moon as early as the 2017-2020 timeframe using emerging U.S. commercial lunar cargo transportation service providers
 - Payloads should address NASA exploration or science strategic objectives and knowledge gaps
 - Indicated intent for significant cost-sharing between NASA and payload providers
 - **Potential Cost-Sharing with Private Lunar Transportation Service Providers**
 - **Moon Express (cost-sharing up to \$1.5M):**
“Will provide up to \$500,000 in funding for each instrument selected by NASA to fly aboard the company’s first three commercial lunar missions of opportunity, beginning in 2017”
 - **Astrobotic Technology (cost-sharing up to \$12M):**
“For every payload selected by NASA to fly on Astrobotic’s first mission, Astrobotic will provide an additional flight to payload providers on the company’s second mission at no charge.”
 - **RFI Response (Dec 2016)**
 - 40 responses: Variety of relevant and viable payloads in the 2017-2020 timeframe
- **Lunar Cargo Transportation Services RFI (May 2017)**
 - Assess availability of U.S. vendors capable of providing NASA payload launch and landing services to the lunar surface, with the potential to also procure data or return payloads to the Earth, as early as FY 2018 and through the next decade
 - **RFI Response (Jun 2017)**
 - 14 responses: Variety of credible payload delivery/return, data services are emerging
- **Input informs potential plans to procure payloads and related lunar delivery services**

LEAG Volatiles Special Action Team (V-SAT) Findings

- ◆ **Finding #1 – V-SAT-1 Report:** The V-SAT-2 endorses the findings from the V-SAT-1 and the European Response to the V-SAT-1 report.
- ◆ **Finding #2 - Orbital Data:** Neutron measurements to ≤ 5 km/pixel; Contemporaneous orbital data supports interpretation of landed mission data.
- ◆ **Finding #3 – the KPLO mission:** The V-SAT-2 endorses the Korean KPLO mission as it will add important new data to our understanding of polar volatiles.
- ◆ **Finding #4 – Mission Coordination Dialogue:** The ongoing ISECG Mission Coordination Dialogue (MCD) has great value and should continue.
- ◆ **Finding #5 – Mission Distribution:** The set of missions specified for consideration by the V-SAT-2 should visit multiple sites.
- ◆ **Finding #6 – Communication Relay Satellite:** Enabling for farside polar missions, enhancing for polar missions in line-of-sight of Earth, and a potential commercial on ramp.
- ◆ **Finding #7 – Coordinated Resource Prospecting:** Prospecting for lunar polar volatiles should be executed as a coordinated two-phase approach: (1) a preliminary characterization followed by (2) a comprehensive characterization.
- ◆ **Finding #8 – Phase 2 Missions:** Missions that involve impactors and penetrators should be considered for Phase 2 to explore large (several km scale) PSRs.
- ◆ **Finding #9 – Essential Measurements** to evaluate a site for ISRU development potential.

LEAG Volatiles Special Action Team (V-SAT) Findings (cont'd)

- ◆ **Finding #10 – Complementary Measurements** (measurements that support the understanding of polar volatiles).
- ◆ **Finding #11 – Technology Development**. Technology development is required to enable rover systems with the capability to enter, survive, and operate for extended periods in PSRs for Phase 2 missions.
- ◆ **Finding #12 – Data Sharing 1**: Data from missions should be made available and accessible to the international community and archived in a documented format.
- ◆ **Finding #13 – Data Sharing 2**: Sharing data from missions enables comparison of observations at multiple sites and environments.
- ◆ **Finding #14 – Data Sharing 3**: Development and application of data fusion techniques can integrate data from multiple landing sites.
- ◆ **Finding #15 – Sample Return and Analysis**: Discussions regarding international sample allocations should be initiated at the appropriate time.
- ◆ **Finding #16 – Multilateral Investigation Teams 1**: Inclusion of co-investigators or participating scientists from multiple nations enhances the knowledge (science, exploration, and engineering) return from the missions.
- ◆ **Finding #17 – Multilateral Investigation Teams 2**: An openness to international payload contribution enables comparable instruments on multiple missions, providing consistent data sets.
- ◆ **Finding #18 – Multilateral Investigation Teams 3**: Interactions between the various international polar volatile mission teams would facilitate coordination efforts.