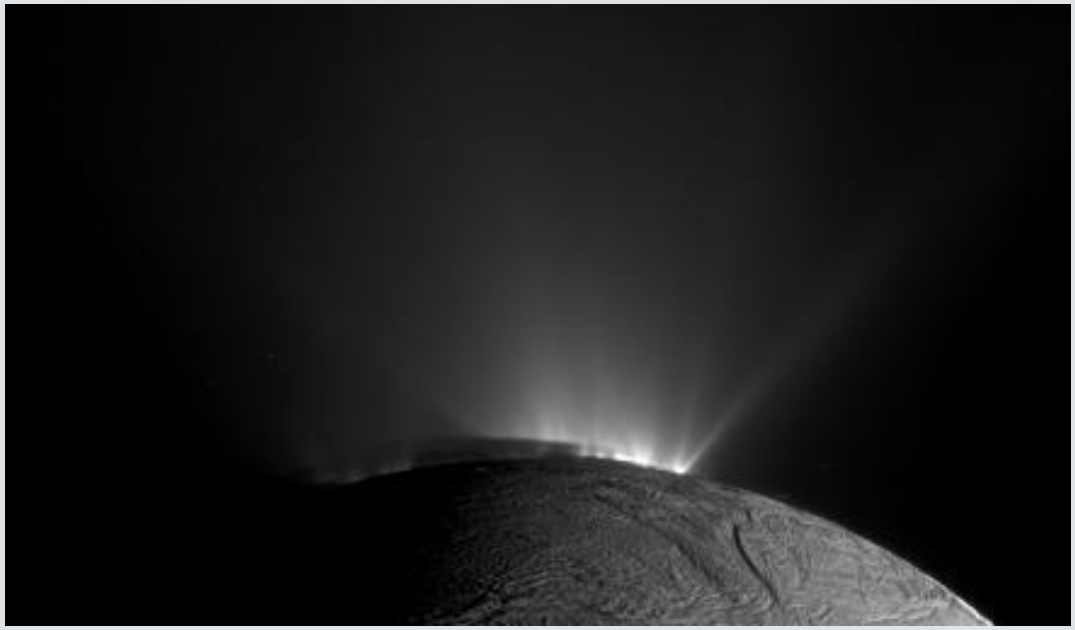
Committee on Planetary Protection
4 September 2020

NASA's Office of Planetary Protection

Lisa M. Pratt

Planetary Protection Officer
Office of Safety and Mission Assurance



Based on the Doppler effect and the magnitude of Enceladus' slight wobble as it orbits Saturn, scientists infer jets are supplied by a global ocean beneath the moon's ice shell.

Planetary Protection Authority Transition

Agency Program Management Council (APMC)

Decision Memorandum

It is recommended the Planetary Protection Officer (PPO) function including all roles and responsibilities be transitioned from the Science Mission Directorate (SMD) to the Office of the Safety and Mission Assurance (OSMA).

Further, it is recommended the responsibilities of the PPO be divided into policy and research such that focus on development of tools and technics with regard to the avoidance of organic-constituent and biological contamination can be maximized. This transition strengthens the Planetary Protection role and gives it greater visibility across the Agency and the stakeholders.

May 2017

Office of Safety and Mission Assurance (OSMA)

The safety of our personnel and site is our core value. This value is ingrained in our everyday conversations and day-to-day operations. It is reflected in the attitudes and behaviors of our workforce creating a strong safety culture.

Office of Planetary Protection (OPP)

Planetary protection enables scientific discoveries and assures validity in planetary searches for evidence of extra-terrestrial life. We work collaborative with mission engineers to develop customized solutions, proactively eliminate problems, and improve operational performance.

NASA Headquarters

Deputy Planetary Protection Officer
Elaine Seasly, Ph.D.

Previously at Langley Research Center as lead for contamination control and planetary protection. Engineer with specialization in probabilistic risk assessment and patent law. Prior employment with Raytheon.

Program Scientist for Planetary Protection Research
Becky McCauley-Rench, Ph.D.

Previously at NASA Headquarters working on Space Act Agreements in procurement. Life scientist with specialization in microbiology of extremophile communities in anoxic subsurface environments.

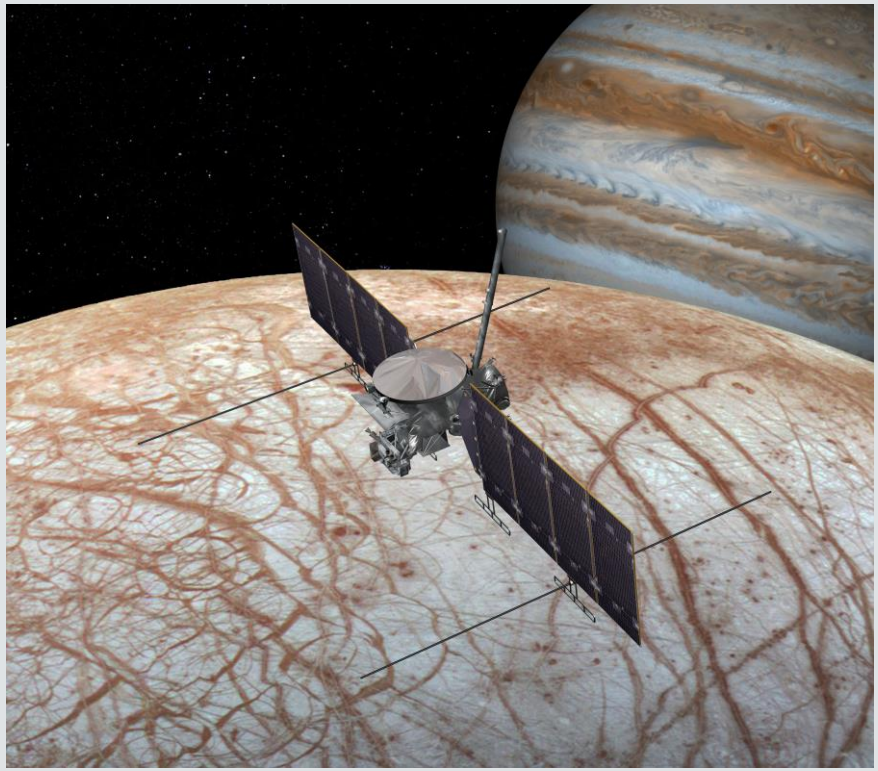
Meeting Obligations
1967 Outer Space Treaty

- NASA conducts exploration in compliance with Article IX: *"…States Parties to the Treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose…."*

- As commercial and private activities increase, NASA works with federal agencies to comply with Article VI: *"…The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty."*

Robotic Exploration for Evidence of Extraterrestrial Life

- Avoid forward biological contamination of other worlds by terrestrial organisms carried on spacecraft and in payloads and introduced to habitable environments.
- Prevent backward contamination of Earth by extraterrestrial life or bioactive molecules in samples returned for scientific study, including roundtrip terrestrial organisms potentially altered by space exposure.

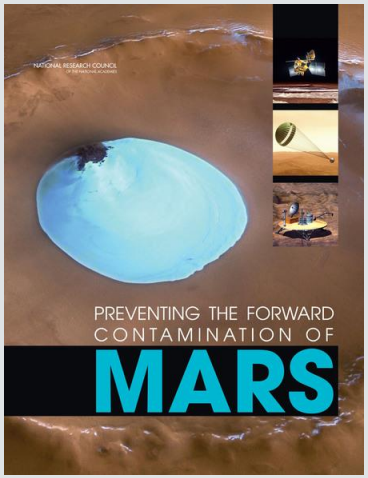


Artist vision of the Clipper spacecraft orbiting Europa which is an icy moon of Jupiter.

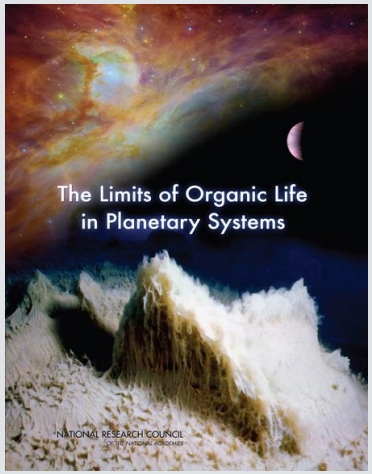
Categorization and Requirements

Planetary protection categorization and requirements for each NASA mission and target body are determined based on scientific advice from Space Studies Board (SSB) of the National Academies and on NASA policy which is guided by international technical standards established by the Committee on Space Research (COSPAR).

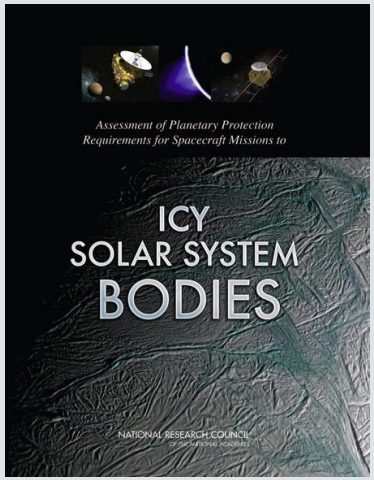
http://sites.nationalacademies.org/SSB/CompletedProjects/index.htm



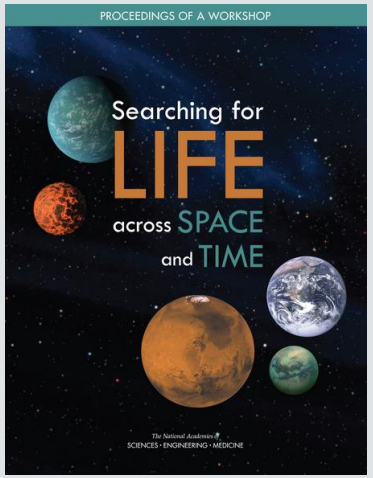
2006



2007



2012



2017

RECENT EXTERNAL REVIEWS OF NASA's PLANETARY PROTECTION POLICY

1. NASEM Review and Assessment of Planetary Protection Policy Development Processes (2018)

2. Review by the Science and Technology Policy Institute (STPI), *Towards the Development of a National Planetary Protection Policy (2019)*

3. Report from NASA's Planetary Protection Independent Review Board (2019)

4. NASEM Review of the Report of NASA's Planetary Protection Independent Review Board (2020)

NASEM Review of the Report from PPIRB

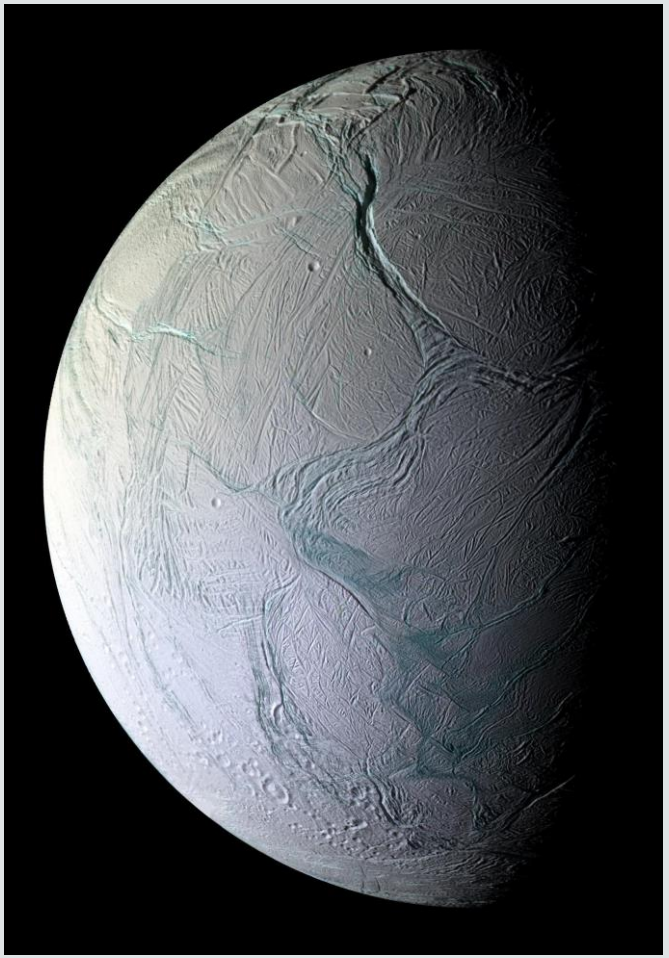
Review of the PPIRB identified three areas of strategic importance in the development of future planetary protection policy common to both NASEM (2018) and PPIRB (2019) reports:

- Establishing a new advisory process.
- Clarifying legal and regulatory issues.
- Building the scientific and technical foundations of planetary protection policies for human missions to Mars.

Habitable Destinations

Target bodies with liquid water inferred to be present at or near the surface are assumed to have the potential to support Earth-like life.

Spacecraft traveling to these rare places must undergo stringent cleaning processes and follow operating restrictions on which locations are visited and what depths are drilled or probed beneath the surface.



Oct. 9, 2008, NASA's Cassini spacecraft was just 25 kilometers (15.6 miles) from the surface of Enceladus. Image Credit: NASA/JPL/Space Science Institute.

Categorization

Mission Categories I to IV are based on significance of the planetary destination for:

- Understanding prebiotic chemistry and/or origin of life
- Sensitivity of each destination to contamination by terrestrial microbes, including subsurface missions operations.

Planetary Protection Mission Categories (COSPAR Policy)

Types of Planetary Bodies	Mission Type	Misson Category
Not of direct interest for understanding the process of chemical evolution. No protection of such planets is warranted.	Any	I
Of significant interest relative to the process of chemical evolution, but only a remote chance that contamination by spacecraft could jeopardize future exploration. Documentation is required.	Any	II
Of significant interest relative to the process of chemical evolution, and/or the origin of life or for which scientific opinion provides a significant chance of contamination which could jeopardize a future biological experiment. Substantial documentation and mitigation is required.	Flyby, Orbiter *Mars, Europa, Enceladus*	III
Same as Cat III	Lander, Probe *Mars, Europa, Enceladus*	IV *IVa, IVb, Ivc Mars*
Any solar system body. Unrestricted applies only to bodies deemed by scientific opinion to have no indigenous life forms.	Earth Return *Restricted or Unrestricted*	V

Documentation

Mission-specific documentation and requirements are negotiated during project discussions with the Planetary Protection Officer and the assigned point of contact for the mission in the Office of Planetary Protection.

Final requirements are established currently in a lengthy planetary protection plan for the mission.

Anticipate NASA requirement revision to ensure clear understanding and applicability of planetary protection requirements to system engineering.

Spores

NASA and ESA Metric for Bioburden on Spacecraft

- All bioburden constraints are defined with respect to the number of aerobic microorganisms that survive a heat shock of 353 Kelvin (80°C) for 15 minutes and are cultured on Trypticase Soy Agar at 305 Kelvin (32°C) for 72 hours.
- Culturing is an industry standard for sterility assurance in human health. Heat shock is specific to assessing spacecraft in order to remove vegetative cells so only hardy organisms are enumerated.
- Spore metric is not applicable to COSPAR Category II or new NASA II-L.

New NASA Interim Directive (NID)
Robotic and Crewed Missions to the Earth's Moon

Purpose:

- Directive sets forth NASA requirements applicable to robotic and crewed missions travelling to the Earth's Moon
- Directive specifically addresses the control of terrestrial biological contamination associated with space vehicles intended to land, orbit, flyby, or otherwise encounter Earth's Moon

New NASA Categories I-L and II-L

All missions to the Moon designated as NASA Mission Planetary Protection Category I-L except:

- Permanently Shadowed Regions (PSRs): Include areas of the Moon south of 79°S and areas north of 86°N, based on Lunar Reconnaissance Orbiter mapping
- Apollo landing and other lunar historic sites

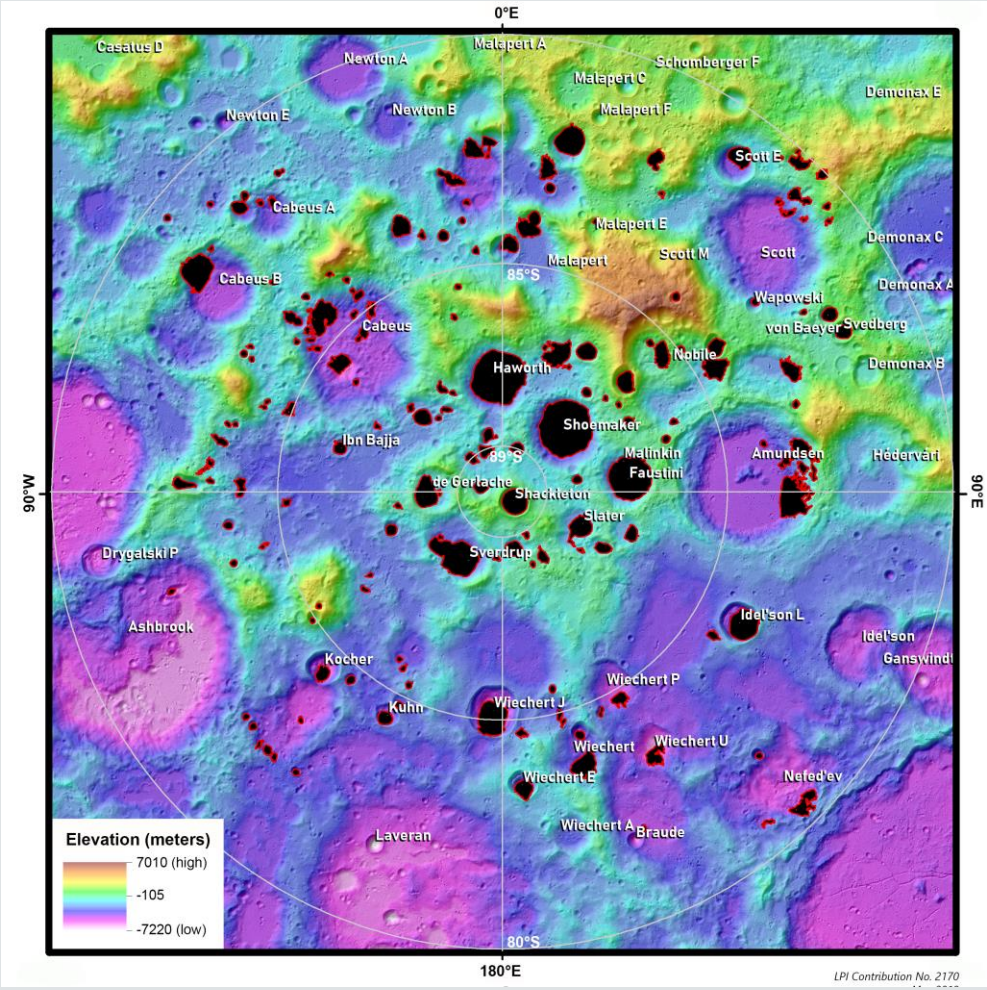
Missions to the two exceptions designated as NASA Mission Planetary Protection Category II-L and must provide:

- Inventory of biological materials (living and dead) included in spacecraft hardware and payloads
- For crewed missions only, a listing of amount and disposition of biological waste to remain in the lunar environment

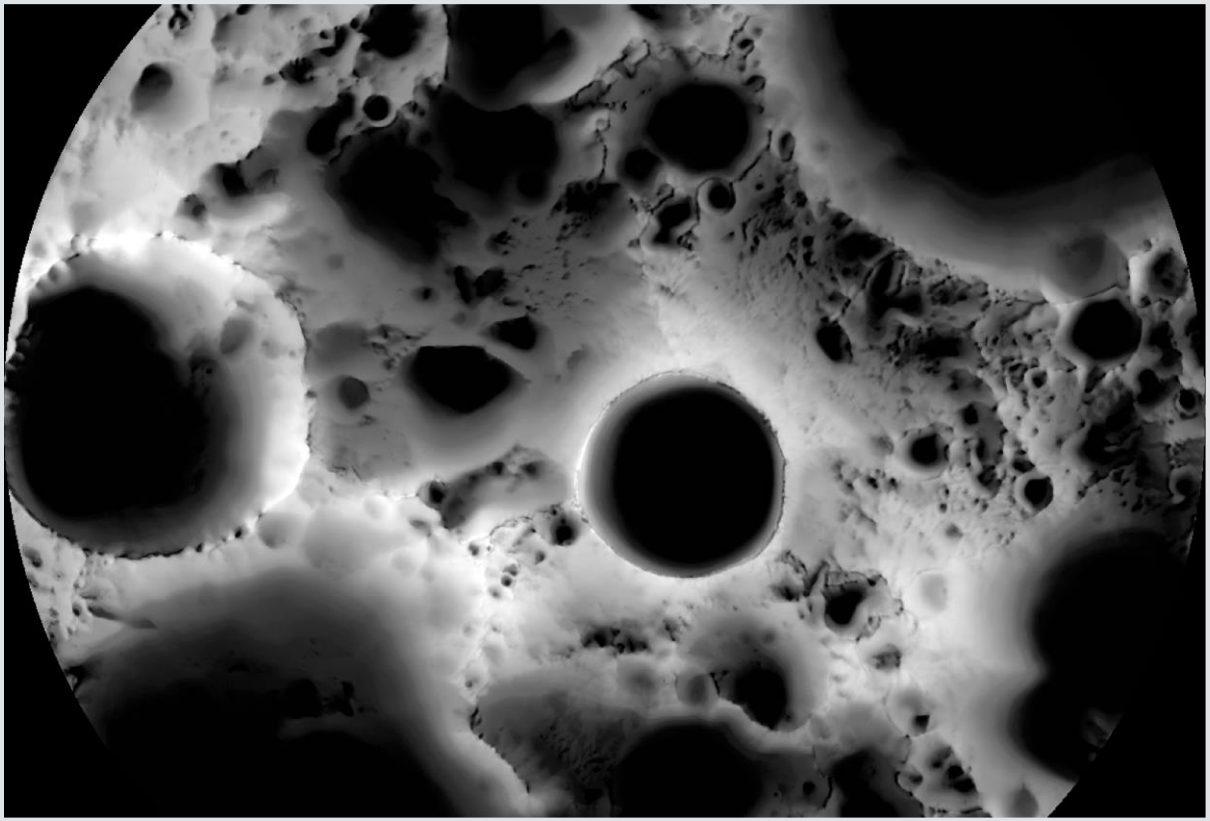
79°S Delineation in Moon NID

Topography and Permanently Shadowed regions (PSR's) of the Moon's South Pole .

Map shows 80°S to Pole.



Illumination Map of Lunar South Pole



Shackleton crater (19 km diameter) is in the center. Darkest regions are permanently shadowed regions and brightest regions are nearly always in sunlight.

Image credit NASA/GSFC/IKI
https://lunar.gsfc.nasa.gov/images/lithos/LRO%20litho5-shadowedFinal.pdf

Neutron Detection of Water Ice on the Moon

Exploration Neutron Detector (LEND) data show that ice is not confined to permanently shadowed regions.

Hydrogen in water form can stay frozen in permanently shadowed regions for long periods of time.

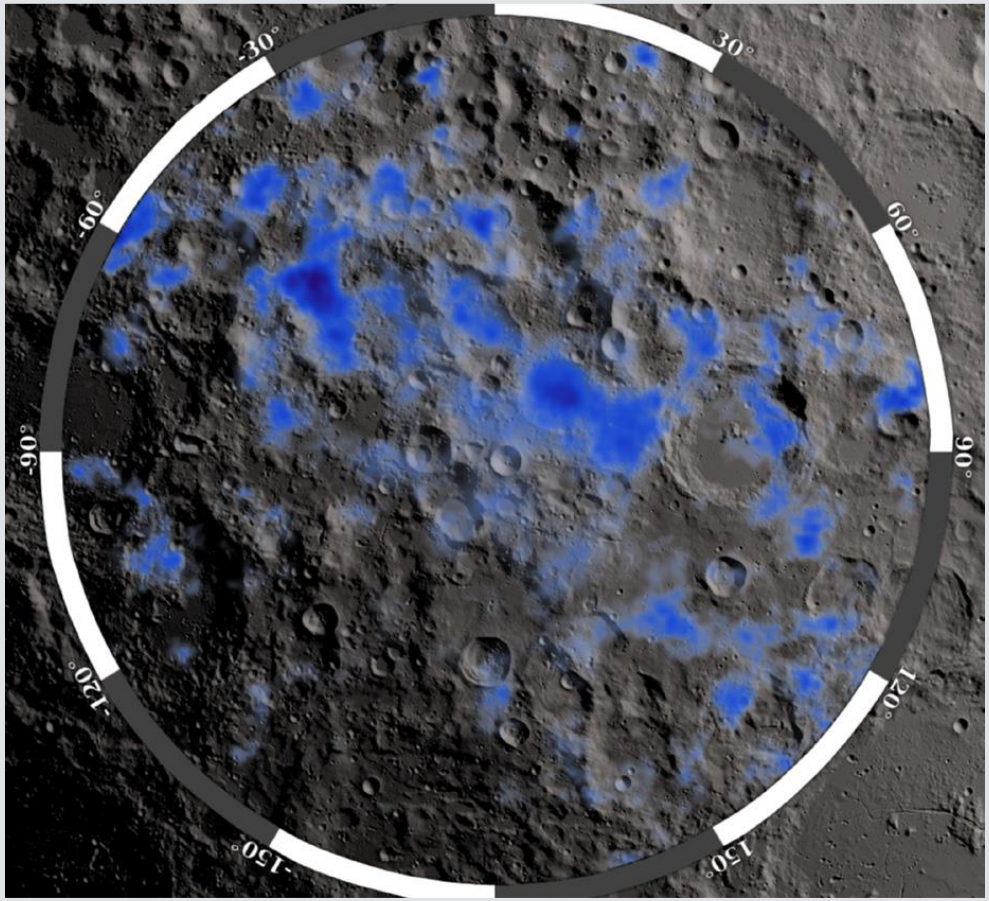


Image credit NASA/GSFC/IKI
https://lunar.gsfc.nasa.gov/images/lithos/LRO%20litho5-shadowedFinal.pdf

Artemis : Landing Humans On the Moon in 2024