PSS findings

Highest Ranking by PSS/LEAG:

- INTERNAL STRUCTURE and DYNAMICS - Geophysical/heat flow network - requires multiple sites, widely spaced (“global access”)
- COMPOSITION/EVOLUTION of LUNAR CRUST - requires extensive sampling at both local and diverse sites
- IMPACT FLUX - requires access to impact basins and sample return for age dating
- SOLAR EMISSIONS/GCR/INTERSTELLAR - requires drilling, regolith and core sample integrity, careful documentation
- CURATORIAL FACILITIES - development of sample documentation, environmental, and orientation controls needed
- SAMPLE ANALYSIS INSTRUMENTS AND PROTOCOLS - infrastructure for pristine sample collection, storage, documentation, and transport needed

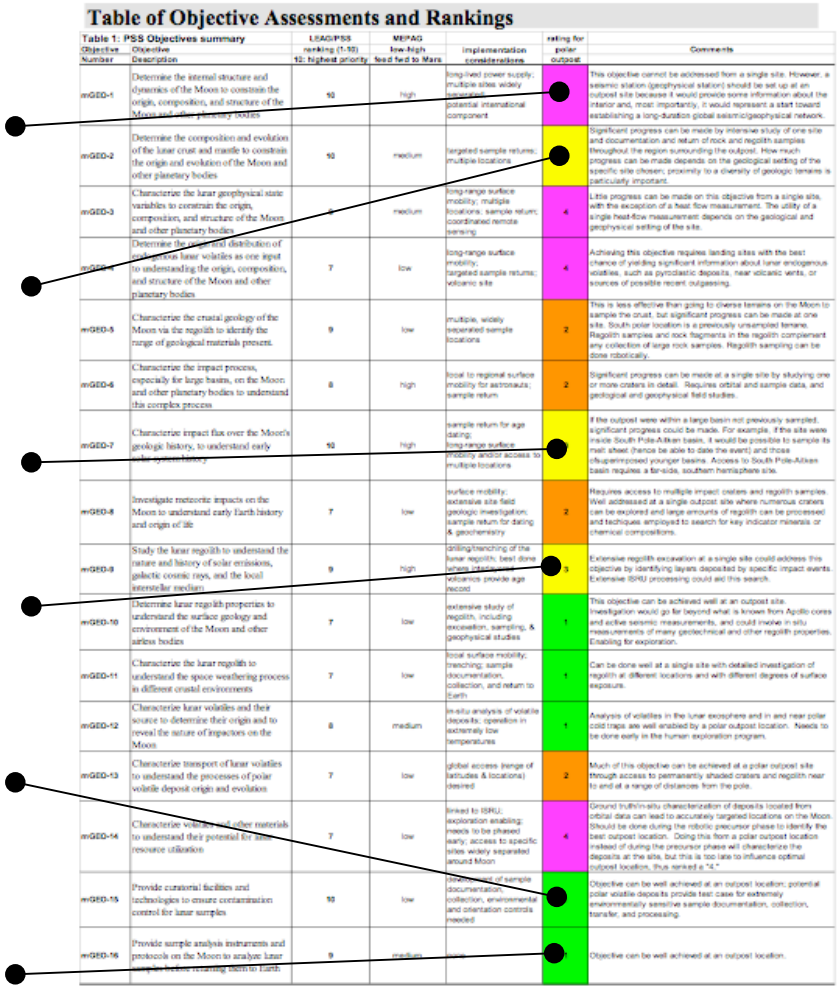

Table of Objective Assessments and Rankings

Table 1: PSS Objectives summary Objective Number	Objective Description	LEAG/PSS ranking (1-10) 10: highest priority	MEPAG low-high feed fwd to Mars	implementation considerations	rating for polar outpost	Comments
mGEO-1	Determine the internal structure and dynamics of the Moon to constrain the origin, composition, and structure of the Moon and other planetary bodies	10	high	long-lived power supply; multiple sites widely separated; potential international component	4	This objective cannot be addressed from a single site. However, a seismic station (geophysical station) should be set up at an outpost site because it would provide some information about the interior and, most importantly, it would represent a start toward establishing a long-duration global seismic/geophysical network.
mGEO-2	Determine the composition and evolution of the lunar crust and mantle to constrain the origin and evolution of the Moon and other planetary bodies	10	medium	targeted sample returns; multiple locations	1	Significant progress can be made by intensive study of one site and documentation and return of rock and regolith samples throughout the region surrounding the outpost. How much progress can be made depends on the geological setting of the specific site chosen; proximity to a diversity of geologic terrains is particularly important.
mGEO-3	Characterize the lunar geophysical state variables to constrain the origin, composition, and structure of the Moon and other planetary bodies	8	medium	long-range surface mobility; multiple locations; sample return; coordinated remote sensing	4	Little progress can be made on this objective from a single site, with the exception of a heat flow measurement. The utility of a single heat-flow measurement depends on the geological and geophysical setting of the site.
mGEO-4	Determine the origin and distribution of [illegible] lunar volatiles as one input to understanding the origin, composition, and structure of the Moon and other planetary bodies	7	low	long-range surface mobility; targeted sample returns; volcanic site	4	Achieving this objective requires landing sites with the best chance of yielding significant information about lunar endogenous volatiles, such as pyroclastic deposits, near volcanic vents, or sources of possible recent outgassing.
mGEO-5	Characterize the crustal geology of the Moon via the regolith to identify the range of geological materials present.	9	low	multiple, widely separated sample locations	2	This is less effective than going to diverse terrains on the Moon to sample the crust, but significant progress can be made at one site. South polar location is a previously unsampled terrane. Regolith samples and rock fragments in the regolith complement any collection of large rock samples. Regolith sampling can be done robotically.
mGEO-6	Characterize the impact process, especially for large basins, on the Moon and other planetary bodies to understand this complex process	8	high	local to regional surface mobility for astronauts; sample return	2	Significant progress can be made at a single site by studying one or more craters in detail. Requires orbital and sample data, and geological and geophysical field studies.
mGEO-7	Characterize impact flux over the Moon's geologic history, to understand early [illegible]	10	high	sample return for age dating; long-range surface mobility and/or access to multiple locations	3	If the outpost were within a large basin not previously sampled, significant progress could be made. For example, if the site were inside South Pole-Aitken basin, it would be possible to sample its melt sheet (hence be able to date the event) and those ("superimposed younger basins. Access to South Pole-Aitken basin requires a far-side, southern hemisphere site.
mGEO-8	Investigate meteoritic impacts on the Moon to understand early Earth history and origin of life	7	low	surface mobility; extensive site field geologic investigation; sample return for dating & geochemistry	2	Requires access to multiple impact craters and regolith samples. Well addressed at a single outpost site where numerous craters can be explored and large amounts of regolith can be processed and techniques employed to search for key indicator minerals or chemical compositions.
mGEO-9	Study the lunar regolith to understand the nature and history of solar emissions, galactic cosmic rays, and the local interstellar medium	9	high	drilling/trenching of the lunar regolith; best done where [illegible] volcanics provide age record	3	Extensive regolith excavation at a single site could address this objective by identifying layers deposited by specific impact events. Extensive ISRU processing could aid this search.
mGEO-10	Determine lunar regolith properties to understand the surface geology and environment of the Moon and other airless bodies	7	low	extensive study of regolith, including excavation, sampling, & geophysical studies	1	This objective can be achieved well at an outpost site. Investigation would go far beyond what is known from Apollo cores and active seismic measurements, and could involve in situ measurements of many geotechnical and other regolith properties. Enabling for exploration.
mGEO-11	Characterize the lunar regolith to understand the space weathering process in different crustal environments	7	low	local surface mobility; trenching; sample documentation, collection, and return to Earth	1	Can be done well at a single site with detailed investigation of regolith at different locations and with different degrees of surface exposure.
mGEO-12	Characterize lunar volatiles and their source to determine their origin and to reveal the nature of impactors on the Moon	8	medium	in-situ analysis of volatile species; operation in extremely low temperatures	1	Analysis of volatiles in the lunar exosphere and in and near polar cold traps are well enabled by a polar outpost location. Needs to be done early in the human exploration program.
mGEO-13	Characterize transport of lunar volatiles to understand the processes of polar volatile deposit origin and evolution	7	low	global access (range of latitudes & locations) desired	2	Much of this objective can be achieved at a polar outpost site through access to permanently shaded craters and regolith near to and at a range of distances from the pole.
mGEO-14	Characterize volatiles and other materials to understand their potential for [illegible] resource utilization	7	low	linked to ISRU; exploration enabling; needs to be phased early; access to specific sites widely separated around Moon	4	Ground truth/in-situ characterization of deposits located from orbital data can lead to accurately targeted locations on the Moon. Should be done during the robotic precursor phase to identify the best outpost location. Doing this from a polar outpost location instead of during the precursor phase will characterize the deposits at the site, but this is too late to influence optimal outpost location, thus ranked a "4."
mGEO-15	Provide curatorial facilities and technologies to ensure contamination control for lunar samples	10	low	development of sample documentation, collection, environmental and orientation controls needed	1	Objective can be well achieved at an outpost location; potential polar volatile deposits provide test case for extremely environmentally sensitive sample documentation, collection, transfer, and processing.
mGEO-16	Provide sample analysis instruments and protocols on the Moon to analyze lunar samples before returning them to Earth	9	medium	[illegible]	1	Objective can be well achieved at an outpost location.

Appendix 5-12