Will Key Lunar Decadal Objectives be Missed in the Lunar Land Rush?

A Planetary Science Decadal Survey White Paper

Stephen Bailey

Between Apollo-17 in 1972 and LRO, launched in 2009, only a single NASA-led Lunar mission was undertaken, the 1998 Lunar Prospector. These first two NASA polar orbiting missions helped close an appalling gap in Lunar science that remained from Apollo. Although arguably the greatest achievement in human history, the many billions of dollars spent on Apollo failed to include the very basic science subsequently performed almost accidentally by Clementine. This DoD mission led to NASA's delayed but more deliberate efforts with Lunar Prospector, LRO, GRAIL, and LADEE which resulted in the dawning realization that there is water ice on our Moon – lots of it.

The implications of this are truly jaw dropping in terms of how we view the Moon today, and the potential for in-situ resource utilization in cis-lunar space.

How is it that we landed humans on the Moon and failed to notice this?

Is it possible that we are about to make similar errors of omission as NASA's Artemis program returns humans to the Moon?

In the human exploration community, there is intense interest and focus on Lunar Polar Volatiles, as demonstrated by Artemis landing site selection, the CLPS VIPER Rover, CLPS Task Order-19C, and the recently released CLPS PRIME-1 RFP.

However, Lunar South Pole-Aitken Basin (SPA) Sample Return and Lunar Geophysical Network are premier decadal science objectives that are unaddressed in NASA's lunar exploration and science portfolio, with no explicit missions or pathway yet identified. It may seem unbelievable that these fundamental and foundational science objectives could be missed as billions of dollars flow into Artemis and hundreds of millions flow into CLPS. Surely copious amounts of samples will be returned from the Lunar South Pole, and surely many CLPS robotic landers will land in other regions as well as the poles. Is this this not SPA Basin Sample Return? Won't this create a Lunar Geophysical Network?

Without strong guidance from the decadal community it is quite possible these answers are substantially “no” or only partly “yes”.

Unlocking the secrets of solar system evolution held within the vast South Pole-Aitken Basin requires a methodical campaign of selective sampling at many locations. An effective Lunar Geophysical Network requires long lived surface stations operating simultaneously. How will these needs be addressed? Each of these efforts are beyond the scope of NASA's Discovery Program and are at or beyond the practical limit of a New Frontiers budget, unless somehow formulated within CLPS, where the conventional relationships between cost, risk and scope seem to be in the process of being radically rewritten.

With so much of NASA's and industry's resources going to Lunar exploration and commercial development, it is easy to imagine that a New Frontiers selection or new SMD Flagship mission would be more inclined to go to any of the other important inner or outer solar system science missions. Thus, without intentional inclusion within the Artemis program, including CLPS, it is somewhere between possible and likely, maybe inevitable, that Lunar South Pole-Aitken Basin Sample Return and a true Lunar Geophysical Network could be put off for a generation or more, as was the case for lunar polar orbiting science and Apollo.

The scope of the SPA Basin Sample Return effort is such that international participation should be actively sought with the intention of all efforts enhancing and expanding the range, diversity, quantity

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and quality of surface samples obtained. For example, future Chinese Yutu rovers and Chang'e landers, already operating on the far side of the Moon over multiple lunar days, could be part of a collaborative sample acquisition strategy, similar to Mars 2020 mission and Perseverance rover.

Likewise, Lunar Geophysical Network science packages, designed for long duration operation and synchronized measurements, should be a part of domestic and international missions, both human and robotic, and woven into the fabric of US Space Policy and the Artemis program.

As there is a Mars Exploration Program driven by Mars Planetary science objectives, so should the Artemis Program embrace and be driven by Lunar decadal science objectives, with a mandate and direct accountability to accomplish SPA Basin Sample Return and Lunar Geophysical Network within their program scope, with mission enhancing international participation as guiding principle.