BUILDING ON THE CORNERSTONE: DESTINATIONS FOR NEARSIDE SAMPLE RETURN

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Introduction: Discoveries from LRO have transformed our knowledge of the Moon (e. g., [1-3]), but LRO's instruments were originally designed to collect the measurements required to enable future lunar surface exploration [3]. Compelling science questions and critical resources make the Moon a key destination for future human and robotic exploration.

Lunar surface exploration, including rovers and other landed missions, must be part of a balanced planetary science and exploration portfolio. Among the highest planetary exploration priorities is the collection of new samples and their return to Earth for more comprehensive analysis than can be done in-situ [4]. The Moon is the closest and most accessible location to address key science questions through targeted sample return. The Moon is the only other planet from which we have contextualized samples, yet critical issues need to be addressed: we lack important details of the Moon's early and recent geologic history, the full compositional and age ranges of its crust, and its bulk composition [5].

Rationale: The importance of sample return from South Pole-Aitken basin is well-established [6], but there are numerous other locations where either robotic or human sample return can lead to important advances in planetary science. Automated sample return from the Moon must be a key part of any coherent Solar System exploration strategy. Automated sample return missions, such as those flown in the 1970s by the Soviet Union, can address key planetary science issues and prepare for future human exploration.

Methods: To identify desirable sample return sites, using LRO data we have deployed an in-depth data fusion process described in [7-12] to define an achievability envelope based on the physical characteristics of locations where spacecraft have successfully landed on the Moon [13]. The defined achievability envelope provides a useful starting point to constrain plausible near-term destinations for robotic and human exploration missions.

Results: The resulting achievability envelope was then used to define 1 km x 1 km geographic regions of interest where automated sample return would be feasible. Rationale for these locations was previously discussed at length in [14]. Briefly, automated sample return from these locations will enable dramatic advances in planetary science by addressing fundamental planetary science questions about the evolution of the lunar interior, lunar volcanic processes, lunar time-stratigraphy, and lunar resource potential. These locations include:

Young Procellarum basalts (22.1ºN, 53.9ºW); Nectaris basin rim (16.34ºS, 26.38ºE); Gruithuisen domes (36.1ºN, 39.7ºW); Dewar cryptomare (2.2ºS, 166.8ºE): Aristarchus regional pyroclastic deposit (24.8ºN, 48.5W); Sulpicius Gallus formation (19.9ºN, 10.3ºE); Sinus Aestuum pyroclastic deposit (5.2ºN, 9.2ºW); Compton-Belkovich volcanic complex (61.5ºN, 99.9ºE); Ina Irregular Mare Patch (18.7ºN, 5.3ºE); and the Marius Hills volcanic complex (13.4ºN, 55.9ºW).

Conclusions: The Moon is an especially attractive and accessible target for future mission proposals to competitive announcements of opportunity, particularly as Discovery missions. In terms of preparing for future mission proposals, all of the locations reported here are feasible landing sites where sample returns are needed to advance planetary science [15-18]. Accordingly, automated sample return missions to the nearside destinations described here need to be seriously considered.

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