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Exploring the Schrödinger and South Pole-Aitken basins on the lunar farside

D. A. Kring, Center for Lunar Science and Exploration, USRA-Lunar and Planetary Institute, Houston, Texas, USA (kring@lpi.usra.edu)

Abstract

One or more missions to the Schrödinger and South Pole-Aitken basins can address the majority of scientific objectives in lunar research, while also providing technical challenges required to re-develop and expand our capability to explore beyond low-Earth orbit.

1. Introduction

The Moon remains largely unexplored. No traverses or sampling have occurred around either lunar pole, nor anywhere on the lunar farside. Intriguingly, the few samples returned to Earth from the nearside and to have fallen as meteorites indicate the Moon is probably the best and most accessible place in the Solar System to deduce processes associated with planetary accretion, differentiation, formation of primitive planetary crust, and impact modification of that crust. There is broad international consensus that exploration of the Moon can address fundamentally important scientific questions (e.g., [2, 8]) while providing a credible path that carries exploration beyond low-Earth orbit (e.g., [3, 7]).

One of the most comprehensive studies of lunar science objectives was produced by the US National Research Council (NRC) of The National Academies [8]. The report outlined eight scientific concepts and thirty-five prioritized investigations. While that study was conducted at the request of NASA, there is broad international support for those objectives (e.g., [2]). Beginning in 2008, a series of studies were conducted to determine the locations on the lunar surface where each of those investigations could be addressed. The final summary of those studies [5] revealed that the majority of objectives could be addressed within the South Pole-Aitken basin if exploration was limited to that region. Furthermore, the Schrödinger basin, which is within the South Pole-Aitken basin, is the best location anywhere on the Moon for addressing the highest priority and largest number of objectives. The study also found that Amundsen crater, also within the South Pole-Aitken basin, may be a better landing site than the often discussed Shackleton crater to study polar volatiles. Here I will outline the attributes of sample return missions to the Schrödinger Basin.

2. Schrödinger Basin

The Schrödinger basin is ~320 km in diameter and located in what is likely to be the modification zone of the 2500 km diameter South Pole-Aitken basin. Schrödinger is the second youngest basin, within the oldest basin, so a sample return mission to that location has the potential of determining the duration of the basin forming epoch and addressing the two highest science priorities in the NRC [8] report. Moreover, it is also the best preserved basin of its size and, thus, a perfect target for discerning basin formation processes.

The basin-forming impact uplifted material from great depth, producing a peak ring of crystalline rock massifs suitable for testing the lunar magma ocean hypothesis. That material, when combined with material within impact breccias and exposed in the basin walls, will provide a cross-section through a substantial portion of the lunar crust. Furthermore, the bulk composition of that crust can be derived from the composition of the Schrödinger impact melt.

Magmas eventually erupted onto the basin floor, producing mare basalt flows and a spectacular pyroclastic vent, providing an opportunity to probe the thermal and magmatic evolution of the Moon's mantle.

The pyroclastic vent may have important in situ resource potential (ISRU) too, producing volatile deposits and fine-grained material that is easily excavated, transported, and processed for a sustainable exploration effort.

Thus far, three landing sites have been identified for those missions [9] and other options are being located as more detailed geologic studies are conducted [4, 6].

3. Potential Mission Concept

To adequately address the lunar objectives of [8], sample return missions are required. The best results would be obtained by a trained crew on the lunar surface. Unfortunately, we do not currently have the capability of landing crew on the surface, so efforts to provide an alternative architecture using integrated robotic and human capability are being investigated.

Burns et al. [1] outlined a plan to deploy robotic assets to Schrödinger basin and teleoperate them with crew hovering above the lunar farside at the Earth-Moon L2 position in the Orion Multi-Purpose Crew Vehicle. The robotic asset could conduct geologic reconnaissance, collect samples, and return them to Earth. In that same mission or a complementary mission, the robotic asset could deploy a low frequency telescope to address astrophysical science objectives.

4. Summary and Conclusions

The diversity of geologic exposures in Schrödinger basin provides several attractive landing sites for one or more sample return missions. That farside location is also an excellent target for an integrated human and robotic exploration program designed to enhance capabilities for long duration missions beyond low-Earth orbit.

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References

[1] Burns, J.O., Kring, D.A., Hopkins, J.B., Norris, S., Lazio, T.J.W., and Kasper, J.: A lunar L2-farside exploration and science mission concept with the Orion Multi-Purpose Crew Vehicle and a teleoperated lander/rover, Advances in Space Research, in press.

[2] Crawford, I.A., Anand, M., Cockell, C.S., Falcke, H., Green, D.A., Jaumann, R., and Wieczorek, M.A.: Back to the Moon: The scientific rationale for resuming lunar surface exploration, Planetary & Space Science, Vol. 74, pp. 3-14, 2012.

[3] International Space Exploration Coordination Group (ISECG): The Global Exploration Roadmap, NASA, NP-2011-09-766-HQ, 2011.

[4] Kramer, G.Y., Kring, D.A., Nahm, A.L., and Pieters, C.M.: Spectral and photogeologic mapping of Schrödinger basin and implications for post-South Pole-Aitken impact deep subsurface stratigraphy, Icarus, Vol. 223, pp. 131-148, 2013.

[5] Kring, D.A. and Durda, D.D. (editors): A Global Lunar Landing Site Study to Provide the Scientific Context for Exploration of the Moon, Lunar and Planetary Insitute, Contribution No. 1694, 2012.

[6] Kumar, P.S., Keerthi, V., Kumar A.S., Mustard, J., Krishna, B.P., Amitabh, Ostrach, L.R., Kring, D.A., Kumar, A.S.K., and Goswami, J.N.: Gullies and landslides on the Moon: Evidence for dry-granular flows, Journal of Geophysical Research, Vol. 118, pp. 206-223, 2013.

[7] Lunar Exploration Analysis Group (LEAG): Lunar Exploration Roadmap v. 1-1, www.lpi.usra.edu/leag/ler_draft.shtml, 2011.

[8] National Research Council (NRC): The Scientific Context for Exploration of the Moon, The National Academies Press, 1997.

[9] O'Sullivan, K.M., Kohout, T., Thaisen, K.G., and Kring, D.A.: Calibrating several key lunar stratigraphic units representing 4 b.y. of lunar history within Schrödinger basin, in Geological Society of America Special Paper 477, pp. 117-127, 2011.