MOSCOVIENSE BASIN: A LANDING SITE TO STUDY SCIENCE GOALS ASSOCIATED WITH LUNAR REGOLITH PROCESSES AND SPACE WEATHERING. S. Quintana[1], S. Crites[2], A. Przepiórka[3], C. Santiago[4], T. Trabucchi[5], D. A. Kring[6], [1]Brown University, Providence, RI stephanie_quintana@brown.edu; [2]University of Hawai'i, Honolulu, HI; [3] Space Research Centre of the Polish Academy of Sciences, Warsaw, Poland; [4]University of Texas at El Paso, El Paso, TX, [5]University of New Brunswick, New Brunswick, Canada; [6]Lunar and Planetary Institute, Houston, TX.

Introduction: The National Research Council (NRC), in its report, *The Scientific Context for Exploration of the Moon*, identified four goals that need to be addressed to understand regolith processes, including space weathering, on the Moon and other airless bodies [1]. A global survey of the Moon determined that those processes can be studied at most locations on the Moon, though Moscoviense Basin is a particularly good region to do so. It is situated in the north-western region of the lunar farside within the Feldspathic Highland Terrane (FHT) [2], and is one of the few mare locations on the lunar farside. Moscoviense Basin is a Nectarian-aged, multi-ring basin with an outer ring of approximately 650 km diameter and an inner peak ring of approximately 185 km diameter, though the ring centers are asymmetric and need further analysis [3]. The inner ring is filled with mare units of Imbrian and Eratosthenian age, with varying compositions [3]. We propose a landing site within the inner ring of the basin that provides access to both mare and highland regolith, as shown in Figure 1. Additionally, the site is located near the boundary of two mare units of different ages and compositions [3]. We now describe how this site lends itself to studies that address each of the four NRC science goals.

Science Goal A: *Search for and characterize ancient regolith (regolith older than that exposed on the surface of the Moon today).* Ancient regolith may exist in two places: the walls of fresh craters or encapsulated between layers of basalt flows of different ages. A 1.1 km fresh crater located within 11 km of our proposed landing site (Figure 2) appears to have distinctive rim strata, which suggests layers of ancient regolith sandwiched by layers of basalt [4]. Considering the location of the crater and the mare units' ages in the surrounding area, ancient regolith layers in the wall of this fresh crater of Imbrian and perhaps even Eratosthenian age [3] may exist.

Science Goal B: *Determine the physical properties of the regolith at diverse locations of expected human activity.* Moscoviense Basin is a region of interest for human exploration because of its location on the lunar farside and its rare mare units [5]. In particular, its high-Ti mare regolith has *in situ* resource utilization (ISRU) potential and is, thus, among the Tier II sites examined by the Lunar Reconnaissance Orbiter mission for the Exploration Systems Mission Directorate (ESMD) [6]. Moscoviense Basin also represents a significantly different region of the Moon than has been sampled before, broadening our assessment of the lunar regolith properties. It presents an exceptional opportunity to collect material from both mare and highland units in a single mission. Because the basin

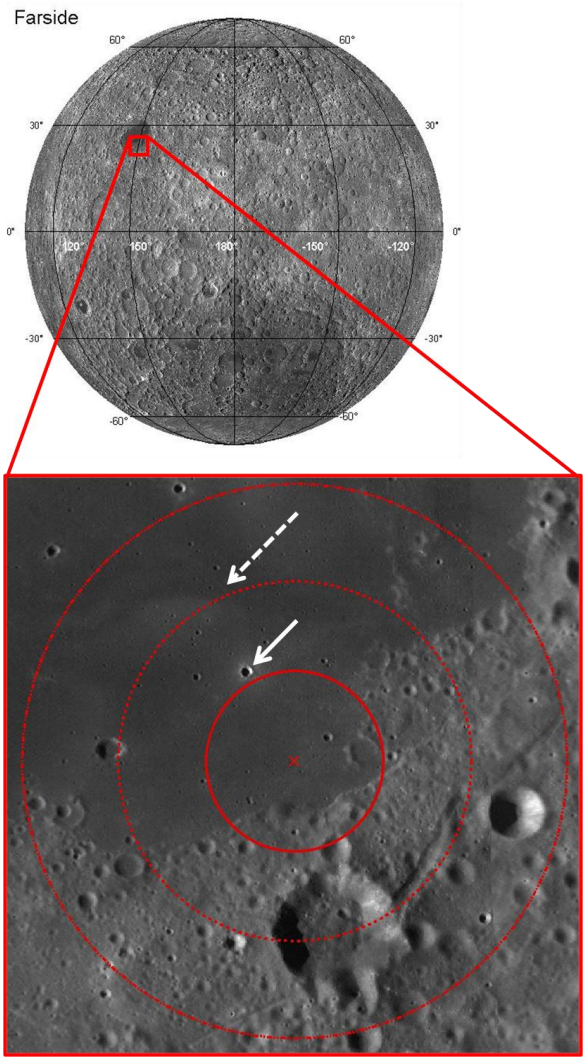

Figure 1: Location of Moscoviense Basin on the lunar farside, zoomed in to our landing site (LROC WAC Mosaic). The red circles of exploration are at 10, 20, and 30km from the landing site. A fresh crater is just outside the 10km circle (demarked by the solid arrow), and a lunar swirl is located within our exploration zone (shown by the dashed arrow).

is in the FHT, it also offers a chance to study original highlands crust [3]. The region may be geochemically different from the Apollo highland sites, according to Jolliff et al., who distinguish the nearside and farside highlands as two separate terranes [2]. Also, due to the proximity of two volcanic vents in the area (located approximately 62 km and 136 km away), samples of pyroclastic material from the vents may be available at the landing site. The range of regolith materials (from mare, FHT, and pyroclastics) provides the diversification that the NRC seeks to more completely characterize the lunar regolith. Moreover, this site could provide the first regolith samples from the lunar farside.

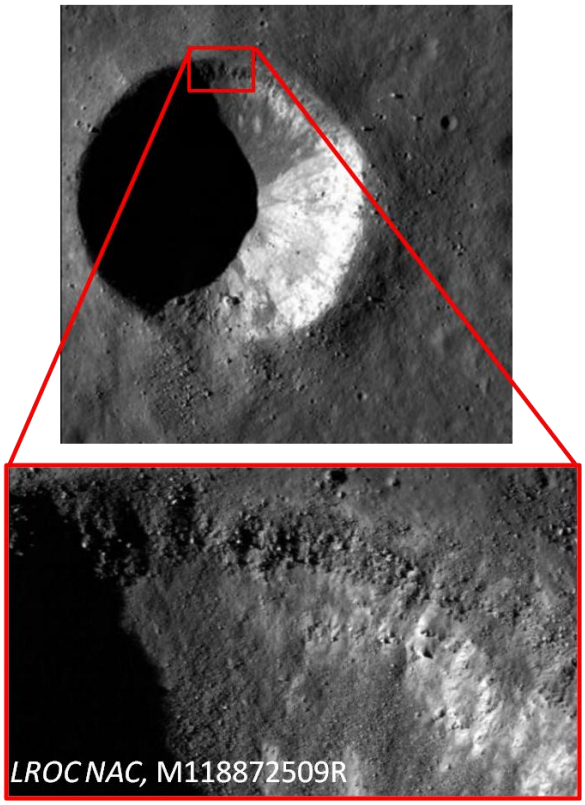

Figure 2: The fresh crater in Mare Moscoviense, zoomed in to show the layering in the crater wall.

Science Goal C: *Understand regolith modification processes (especially space weathering).* The proposed Mare Moscoviense landing site is within 20 km of a lunar swirl (Figure 1) and is well within the Moscoviense elevated magnetic field anomaly. Samples of regolith both on and off the swirls would provide insight into the effects of a magnetic field on space weathering, which could then be extrapolated to bodies with their own magnetic fields, like Mercury. Sampling the Moscoviense swirl could provide insight into the process and formation of lunar swirls, which is not fully understood. The Moscoviense basin contains mare basalt flows of varying age and composition, including low-titanium and high-titanium flows (e.g. [3], [7], [8]). Samples from Mare Moscoviense could be compared to mare samples in the Apollo and Luna sample suites to investigate first-order differences in weathering of mare regolith both with and without the influence of a magnetic field.

Science Goal D: *Separate and study rare materials in the lunar regolith.* "Rare material" here corresponds to either pieces of meteorites that have survived impact or lunar material that originated in a different location of the Moon (deposited, for example, in ejecta rays or secondary craters). Again, the fresh crater located near the proposed landing site offers an opportunity to search for rare materials. The freshness of the crater provides a greater chance of finding less modified pieces of the original impactor in impact melt and ejecta. Also, since the crater appears to penetrate different layers of mare flows, meteoritic traces from past periods might be found in the ancient regolith between these layers.

Discussion and Conclusions: ESMD targeted a potential landing site ~50 km from the one proposed here. It contained some of the same attributes (access to both mare and highland material). The site proposed here, however, also provides easier access to a fresh 1.1 km diameter crater and a lunar swirl, while facilitating studies of regolith produced on two types of mare surfaces of different ages and a highlands surface of yet another age, all within a 20 km radius. Furthermore, debris from two pyroclastic vents in the area may be sampled if their deposits reach the site. In all, this single landing site provides an excellent opportunity to study all of the Concept 7 science goals outlined in the NRC report.

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References: [1] National Research Council (2007), *The Scientific Context for Exploration of the Moon*. [2] Jolliff et al. (2000a), *J.Geophys. Res.* 105, 4197-4216. [3] Thaisen et al. (2011), *J. Geophys. Res.* 116 no E00G07. [4] Kring et al. (2011), *Lunar and Planetary Institute Contributions* 1618. [5] Lawrence (Jan 4, 2010), *LROC Featured Image*. [6] J. Gruener (2009), personal communication. [7] Gillis et al. (1998), *PhD Thesis*. [8] Kramer et al., (2008), *J. Geophys. Res.* 113 no. E01002.