MOONRISE: SOUTH POLE-AITKEN BASIN SAMPLE RETURN MISSION FOR SOLAR SYSTEM SCIENCE. B. L. Jolliff[1], C. K. Shearer[2], D. A. Papanastassiou[3], L. Alkalai[3], and the MoonRise Team. [1]Department of Earth and Planetary Sciences, Washington University, St. Louis, MO; [2]Institute of Meteoritics, University of New Mexico, Albuquerque, NM, 87131; [3]Jet Propulsion Lab, Pasadena, CA 91109. (blj@wustl.edu)

Introduction: MoonRise is a New Frontiers III mission concept currently in Phase A. MoonRise would land in the South Pole-Aitken (SPA) Basin, collect samples, and return them to Earth for analysis to address issues of significance for Solar System history. Goals are to (1) better understand early impact bombardment and test the Cataclysm hypothesis [1], (2) elucidate the characteristics of the Moon's lower crust and crust-mantle transition [2], and (3) gain a better understanding of giant impact processes and how giant basin formation affected the early crust of the Moon [3]. These goals have important implications for early Earth and the development of its crust, habitable environments, and early life [4]. Implications include constraining the process(es) that led to the heavy bombardment (e.g., Nice model [5]). In this abstract, we summarize science objectives, present an overview of the mission, and follow the samples from landing-site selection through surface operations and return to Earth, to preliminary examination and curation.

Science Objectives. MoonRise has five specific objectives: (1) determine the age of SPA Basin formation and test the Cataclysm hypothesis; (2) improve understanding of giant impact-basin processes by providing ground truth for orbital remotely sensed data (mineralogy, composition, lithologic components) for SPA; (3) determine compositional and lithologic characteristics of lower crust and possibly upper mantle components recorded in impact-melt rocks and breccias of the Basin and thus better understand the crust-mantle transition; (4) determine the lithologic hosts and compositional characteristics of radiogenic heat-producing elements to better understand thermal evolution on a planetary scale; and (5) determine compositions of basalts and volcanic glasses that occur in the Basin and thus test for variability of far-side mantle compared to near-side volcanics of mantle origin sampled by Apollo and Luna. Return and analysis of samples from SPA Basin will enable additional understanding of the SPA Terrane through correlation with lunar meteorites whose origin may be shown to be from within SPA once we have firm ground truth. These objectives will be achieved through analysis of SPA samples by a wide variety of techniques in the best terrestrial laboratories.

Mission: MoonRise would launch in 2016 and, following a low-energy trajectory to the Moon, land in the interior of the SPA Basin at a location determined by analysis of existing orbital data and safety considerations. MoonRise will document the geologic context of the landing site with descent imaging; wide-angle, stereo, multispectral surface imaging; and monoscopic, high-resolution images of selected targets [6]. A volume of soil near the lander will be sieved to collect thousands of rock fragments. The regolith, well-mixed from impact processes, is expected to yield small rock fragments that represent a broad area of the SPA Basin interior. The main anticipated lithologic components are impact-generated rocks from the Basin formation, and from the formation of other large impact craters and basins within SPA, subsequent to SPA formation. An unsorted bulk regolith sample will also be collected to determine characteristics for orbital ground truth and to search for components that may be absent from the coarse, sorted rock fragments, such as volcanic glass. Sample materials will be returned to Earth for mineralogical, chemical, and petrologic analyses, and isotopic age determinations in state-of-the-art laboratories. Following a complete preliminary examination and documentation by the MoonRise science team at the JSC Curatorial Facility, MoonRise samples will be made available for allocation to the scientific community worldwide.

Benefits of MoonRise. Although much is known about the Moon from previous missions and samples, it is because of that knowledge that we can ask – and address – fundamental questions about the early history of the Earth-Moon system and impact history and dynamics of the early Solar System. The Moon is a strongly differentiated planetary body, with a crust, mantle, and core, and demonstrated global heterogeneity the cause of which is not well understood. The potential payoff is high for a MoonRise sample to advance current understanding to the next level, and to provide substantial and key new knowledge about the first 500-600 million years on Earth when life was emerging and continents were taking shape.

In addition to the tremendous science potential of a returned SPA Basin rock and regolith sample, MoonRise would constitute several important "firsts" – including the first far-side landed spacecraft, the first US robotic sample return mission from a planetary body, and demonstration of a cost-effective capability to deliver 900 kg payloads to the lunar surface.

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