

SAMPLING SOUTH POLE-AITKEN BASIN: THE MOONRISE APPROACH. B. L. Jolliff¹, C. K. Shearer², and B. A. Cohen³, ¹Dept. of Earth & Planetary Sciences, Washington University, St. Louis, MO 63130, blj@wustl.edu; ²Institute of Meteoritics, University of New Mexico, Albuquerque, NM 87131; ³NASA Marshall Space Flight Center, 320 Sparkman Dr., Huntsville AL 35805.

Introduction: The South Pole-Aitken basin (SPA) is the largest of the giant impact basins in the inner Solar System, and its location on Earth's Moon makes it the most accessible. Exploration of SPA through direct collection and analysis of representative materials addresses issues as fundamental as the characteristics of the chemical reservoir from which the Moon originated, early differentiation and production of crust and development of global asymmetry, relationships between magmatic activity and internal thermal evolution, and effects of giant impact events on the terrestrial planets.

Owing to its great size and superposition relationships with other lunar impact basins, SPA is the oldest and as such anchors the lunar chronology. Moreover, numerous large impact craters and basins are contained within it such that materials (rocks) of the SPA basin contain a record of the early impact chronology, one less likely to have been affected by the large, late near-side basins (*e.g.*, Imbrium). Understanding the early basin chronology is key to deciphering the sequence and effects of early giant impact bombardment of the inner Solar System. That record exists on the Moon, and materials of the SPA basin will allow us to read that record. Knowledge of the early bombardment history will test – and may reshape – a key paradigm relating to early Solar System evolution. Did the planets form with the alignment of today, or was there a major reorientation of the giant planets that led to destabilization of asteroid orbits, and a cataclysmic bombardment of the inner Solar System hundreds of millions of years after accretion of the planets? Implications include understanding environments for early life-supporting habitats on Earth and Mars, and relationships to new observations of extra-solar planetary systems.

Scientific Priority: The 2003 NRC Decadal Survey listed sample return from SPA as among the highest priorities for Solar System science. This priority was reaffirmed in 2007 by the NRC (SCEM Rpt.) and again in the 2012 Decadal Survey. The high priority stems largely from the idea that the 'cataclysm' can be tested by determining ages of impact-melt from an SPA sample that would include rock materials produced or affected by the impact event. SPA is far distant from the nearside Apollo and Luna landing sites where all of the samples of known origin were collected. Materials excavated and reset by late nearside basin impacts, especially Imbrium, dominate those samples. A sample from the interior of SPA will be dominated by materials formed in the SPA event, with contributions from

smaller basins and large craters that occur within it, thus providing a fresh and independent record of ages associated with the early parts of the lunar heavy bombardment record.

Sample return and investigation of the diversity and distribution of materials within SPA will address other issues of high science priority as well. Analysis of materials derived from the deep crust and upper mantle will enable new tests of models for lunar differentiation, especially as linked to GRAIL results. Knowing the age and characteristics of the impact that produced SPA basin will help illuminate the basin-impact forming process and the role it played in modifying early planetary crusts. Volcanic rocks also occur within SPA, some of which are ancient volcanics covered by later crater deposits. Knowing their age and composition is key to the thermal history of the Moon, the composition of the deep interior, and relationships between basin formation and later volcanism. Because of impact-ejecta redistribution, fragments of these rocks will be found mixed in the regolith at most locations within the SPA interior.

MoonRise Approach: Determining the age of the SPA Basin is a primary goal, but selecting an area that will allow determination of the ages of other large impact events (*i.e.*, more recent basins or craters within SPA) will provide additional dates to anchor the chronology. The MoonRise sampling strategy leverages the "natural" sampling mechanism afforded by the impact cratering process, which delivers diverse rock samples from the surroundings to the regolith where they can be accessed from a surface lander at a single point. Regolith samples from Apollo missions provide ample statistics on the rock content, diversity, and representativeness relative to local and regional geology that can be expected in a given location. Recent remote sensing missions provide sufficient geologic and topographic information to enable a sound site geology determination as well as landing-site safety assessment.

The MoonRise approach leverages the small rock content of lunar regolith by scooping and sieving a sufficient volume of regolith to collect >1 kg of rock fragments, which are needed for age determinations. Using modern, state-of-the-art analytical techniques, capabilities exist now to analyze very small quantities of rock samples and determine not only their chemical and mineral compositions, but also their ages and petrologic history. Larger fragments can even be split, and portions of the samples retained for future analyses.