Exploring a "New" Moon Now and Preparing for Future Lunar Exploration. A Consortium Study of "Special" Lunar Samples.

C.K. Shearer[1], C.R. Neal[2], R. Christoffersen[3] , L. P. Keller[3], S. J. Clemett[3], and S.K. Noble[4]. [1]Institute of Meteoritics and Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131 (cshearer@unm.edu). [2]University of Notre Dame, Notre Dame, IN 46556. [3]NASA Johnson Space Center, Houston, TX 77058. [4] NASA Goddard Space Flight Center, Greenbelt, MD 20771.

Introduction: The results from a variety of recent lunar missions carried out by NASA and other national space agencies together with numerous terrestrial laboratory studies provide a new view of the Moon that differs from assessments made prior to and immediately following the Apollo Program. This new view of the Moon will influence the further human exploration of the Moon and beyond. For example, many of these new missions and studies have questioned our understanding of the characteristics and distribution of lunar volatile reservoirs. By reducing launch mass to the lunar surface in support of human exploration, along with other benefits these volatile reservoirs could be a high value resource for future human exploration and eventual colonization [e.g. 1-3]. In addition, deciphering the origin and composition of these reservoirs has a high science value that is fundamental to understanding early Solar System processes and the evolution of the Earth-Moon system. The collection and return of new samples from robotic missions specifically designed to further understand these new scientific and exploration views of the Moon would be valuable, but appears unlikely in the near future. However, the far-sightedness of those associated with the Apollo Program over 4 decades ago has resulted in the preservation of potentially important samples that have current scientific and exploration importance. These "special" lunar samples may provide guidance for future decades of lunar exploration. The purpose of this abstract-presentation is to (1) identify potential science and engineering studies of these samples that could be conducted in a consortium framework, and (2) illustrate pathways for studying these valuable samples.

Special samples: During the Apollo Program samples were returned to Earth in several different types of sample containers. The containers were designed based on several requirements, but the success in meeting these requirements was variable [4,5]. Details of samples containers were documented by [4] and a list of examples follows: (1) A large volume of lunar samples were returned in Apollo Lunar Sample Return Containers (ALSRC). Two ALSRCs were used on each Apollo mission. (2) Drive tube core samples were sealed in a Core Sample Vacuum Container on the A-16 and A-17 missions. (3) The Special Environmental Sample Container was designed to ensure that samples were not exposed to terrestrial atmosphere or spacecraft cabin gases. (4) The Gas Analysis Sample Container used on A-11 and A-12 was designed to hold a small amount of lunar soil within a large volume. On Earth, most samples were stored under specific conditions selected to limit contamination and best preserve their integrity [5]. However, a subset of samples was stored under significantly different conditions for over 38 years (i.e. freezer samples, stored in He or vacuum). Some of these uniquely collected, stored, and curated lunar samples remain unopened and unstudied. They are very relevant to both current missions and future sampling as they potentially preserve lunar characteristics no longer preserved in most of the Apollo collection. Further, they illustrate alternative approaches to sampling and curating lunar materials.

Consortium studies:

Science goals. The first goal is to evaluate the nature of the samples to see if they are (relatively) uncompromised. If they are, a large number of measurements may be made that will provide a better understanding of volatiles on the lunar surface. For example: (1) gas composition in the container head space; (2) solar wind volatile species, some of which may be weakly bound to mineral surfaces; (3) volatile species in the lunar regolith that have limited terrestrial contamination; (4) other environmentally sensitive or fragile surface coatings on mineral and glass surfaces.

Exploration and engineering goals. The study of "special" samples provides high value for engineering and exploration as sample handling, processing, and experimental design can be taken into account these goals. For example: (1) reactivity of mineral surfaces that may be highly relevant to health issues and resource issues, (2) resource exploration (3) organic background for planetary protection, (4) dust studies, (5) design of sample containers that will preserve environmentally sensitive planetary samples.

Access to samples for consortium studies: Any consortium assembled to study these special samples will be required to provide a well-defined science and engineering rationale. A consortium study must define sample handling-processing protocols that will not compromise samples and define a logical sequence for conducting analyses-experiments.

References: [1] Jolliff et al. (2007) LEAG Workshop on Enabling Exploration. abst. # 3056. [2] Neal et al., (2007) LEAG Workshop on Enabling Exploration. abst. # 2109. [3] Committee on the Scientific Context for Exploration of the Moon, National Research Council (2008) 97pp. [4] Alton (1989) JSC-23454 97pp. [5] Lofgren (2011) Wet-Dry Moon Workshop, abst. # 6041.