A Consortium to Study "Special" Lunar Samples. Exploring Volatile Reservoirs on the Moon Now and Preparing for Future Lunar Exploration. C.K. Shearer[1] and C.R. Neal[2], [1]Institute of Meteoritics and Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131 (cshearer@unm.edu. [2]University of Notre Dame, Notre Dame, Indiana. 46556.

Introduction: The results from a variety of recent lunar missions carried out by NASA and other national space agencies and numerous terrestrial laboratory studies have demonstrated that a high priority for future lunar exploration will be the collection of lunar samples that potentially contain a record of volatile reservoirs on the Moon. These volatile reservoirs could be a high value resource for future human exploration and eventual colonization and reduce the launch mass from the Earth to the lunar surface. The preservation of this volatile record during collection, transport, and curation is a high science and engineering priority for lunar surface activities [i.e. 1-4]. Numerous lessons learned from the Apollo Program and extracted from Apollo samples may be directly applicable to the future return of lunar samples. Samples were returned to Earth in several different sample containers. A catalog of Apollo lunar surface geological sampling tools and containers has been prepared [5]. The different sample containers were designed for specific purposes although their success was variable. The Apollo Lunar Sample Return Container (ALSRC or rock box) was an aluminum box with a triple seal. Two ALSRCs were used on each Apollo mission. Two 4-cm drive tube core samples were sealed in a Core Sample Vacuum Container (CSVC) on the Apollo 16 and Apollo 17 missions. Special Environmental Sample Container (SESC) was designed to ensure that samples were not exposed to terrestrial atmosphere or spacecraft cabin gases. They were used on all of the Apollo missions. The Gas Analysis Sample Container (GASC) was designed to hold a small amount of lunar soil within a large volume. The GASC was used only on the Apollo 11 and 12 missions. Most samples were stored under conditions selected to limit contamination and best preserve their integrity [6]. As noted earlier, the volatile element record in these samples were disturbed to varying degrees. However, a subset of samples was stored under significantly different conditions for over 38 years (i.e. freezer samples, stored in vacuum or He) and these samples may provide insights for future sample collection. A detailed discussion of these special samples is provided by Lofgren [7]. These uniquely collected, stored, and curated lunar samples are very relevant to both current missions and future sampling of lunar volatiles as they potentially preserve lunar characteristics no longer present in most of the Apollo Program collection and illustrate alternative approaches to sampling lunar materials. The purpose of this abstract is to (1) identify potential science and engineering studies that could be conducted in a consortium framework, (2) illustrate pathways for studying these valuable samples and (3) engage the community's interest in participating in such a consortium study.

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 (that could be a mixture of both captured exosphere and released from sample); (2) solar wind volatile species that are 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.

Engineering goals. These goals are to gain an understanding of what types of sample containers will preserve environmentally sensitive lunar samples. Establishing sampling protocol and designing sample containers feeds forward to exploring other planetary bodies (NEOs, Mars). We envisage that such understanding will also aid in the development of cryogenic sample collection and storage. If these Apollo sample containers are compromised, several of science goals and all of the engineering goals may still be accomplished.

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 for the study of these rare and valuable samples. A consortium study must define sample handling-processing protocols that will not compromise samples and define a logical sequence for conducting analyses-experiments. For example, analyses of gas from the containers and curation and documentation of container contents must occur before the allocation and analysis of solid samples.

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] OSEWG (2009) Unpublished NASA whitepaper NP-2009-00-00-HQ, 58pp. [5] Alton (1989) JSC-23454 97pp. [6] Heiken et al., (1991)) Lunar Source Book. Cambridge Press, New York, 736pp. [7] Lofgren (2011) abstracts for this meeting.