THE SCIENTIFIC VALUE OF LUNAR SAMPLE EXCHANGE. J. J. Barnes[1], C. Crow[2], B. L. Jolliff[3], K. H. Joy[4], T. Lapen[5], J. Gross[6,7], J. Mitchell[6], R. Zeigler[6] and A. L. Fagan[8], [1]University of Arizona, AZ 85721, jjbarnes@arizona.edu, [2]University of Colorado Boulder, CO 80309, [3]Washington University St Louis, MO 63130, [4]University of Manchester, M13 9PL, UK, [5]University of Houston, TX 77204, [6]NASA's Johnson Space Center, TX 77058, [7]Rutgers University, NJ 08854, [8]Western Carolina University, NC 28723.

Introduction: Our understanding of how the Moon formed and evolved to its current state has been revolutionized through the study of samples collected between 1969 and 1976 by the six Apollo and three Luna surfaces missions and augmented by the growing lunar meteorite sample set. Over the last fifty years, these returned lunar materials have given us a glimpse into the early history and broad-scale petrogenesis of the Earth-Moon system, planetary formation, evolutionary processes, and the history of the formation of our Solar System [e.g., 1]. Many of these key discoveries have been made in the last decade due to advances in laboratory instrumentation. Long-term curation of the returned materials and sustained availability to the scientific community has enabled us to continue to advance knowledge of planet formation and Solar System processes. As we consider the future of lunar science and exploration in the next five years and beyond, we emphasize the benefit of sample exchange and sample sharing between all nations. Here we draw attention to the past exchange of Apollo and Luna samples between different countries.

Geographical Context: The six Apollo surface missions returned ~382 kg of material from six different locations on the lunar nearside. Approximately 320 g of soil was returned by the three Luna surface missions from the eastern lunar nearside. Importantly, the Apollo samples derived largely from locations within or near the Procellarum KREEP Terrane (PKT), dominated by a geochemical anomaly that is enriched in elements like Th, Ti, and Fe [2]. The Luna samples expand the geographical coverage of sampling beyond that of the Apollo missions and to locations outside of the PKT.

US-USSR agreement: In 1971 the Low-Keldysh agreement was made to enable the exchange of science and pristine NASA Apollo and Soviet Luna samples. Under this agreement, approximately 11 g of soils spanning all three Luna missions were sent to the US between 1971 and 1987. Luna samples were also shared by the Soviet government with the French (CNES) and UK (Royal Society) scientific communities as goodwill gestures between nations [e.g., 3]. Technological improvements and new sample handling knowledge gained on Apollo samples enabled investigators to conduct state-of-the-art chemical, isotopic and petrological investigations on the small-sized Luna samples (typically fine fraction of lunar soil < 2 mm in size). The scientific results from analysis of such limited Luna samples remain impressive and provide important context for the analysis of future robotic and crewed missions to the lunar surface [e.g., 4]. In addition, such sample sharing could provide opportunities for inter-laboratory analytical verification, cross-pollination of ideas, and enable inclusive scientific collaboration.

Modern Lunar Sample Return: Several space agencies are now conducting or planning lunar sample-return missions. In December 2020 the Chinese Chang'e-5 spacecraft returned the first lunar samples since the 1970s. They collected 1.731 kg of regolith from one of the youngest lava flows on the Moon, from a location north of the Aristarchus Plateau [5]. In the next decade, it is anticipated that among others the CNSA and NASA will return to the Moon with the intent to collect more samples. These missions are following a hypothesis-driven design with a view to filling strategic knowledge gaps in our understanding of the Moon and its potential to harbor exploration-enabling resources [6-7]. The lunar South Pole in particular is an important target for sample return as the polar regolith likely harbors volatile species, samples of mantle rocks, and impact melt from South Pole-Aitken Basin. In addition to lunar samples, several groups are producing lunar analog materials and simulants. These are crucial to interpreting remotely sensed data (e.g., ice-regolith mixtures) and to design, development, and testing of hardware, tools, and sampling devices for use on the Moon.

Today Apollo and Luna samples curated by NASA's Curation Office are still in high demand for study by the international scientific community. The legacy of the bilateral exchange of lunar samples as diplomatic gestures of goodwill transcends generations of lunar scientists. As we enter this new golden era of lunar exploration, the US and other nations must recognize the lasting legacy and benefit of the Apollo-Luna sample exchange program of the 1970s and explore new opportunities to share returned samples in the future.

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