**NOBLE GAS ISOTOPES IN THE APOLLO 17 73001 CORE SAMPLE VACUUM CONTAINER GAS.** R. Parai[1], J. Rodriguez[1], S. Patzkowsky[1], N. Solari[1], K. A. Woody[1], A. Meshik[1], O. Pravdivtseva[1], B. L. Jolliff[1], C. K. Shearer[2], Z. D. Sharp[3], W. Cassata[4], R. A. Zeigler[5], J. Gross[5], F. M. McCubbin[5], F. McDonald[6] and the ANGSA Science Team[7]. [1]Washington University in St. Louis, St. Louis, MO 63130; [2]Institute of Meteoritics, University of New Mexico, Albuquerque, NM 87131; [3]Dept. of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131; [4]Lawrence Livermore National Laboratory, Livermore, CA 94551; [5]ARES, NASA Johnson Space Center, Houston TX 77058; [6]ESA/ESTEC, Noordwijk, Netherlands, [7]https://www.lpi.usra.edu/ANGSA/teams (parai@wustl.edu)

**Introduction:** Apollo 17 Sample 73001 is the deep portion of a double drive tube core of the lunar regolith. The aluminum drive tube was sealed in a steel core sample vacuum container (CSVC) at low temperature [1] on the lunar surface upon collection. The sample was returned to Earth and sealed in a secondary container in a nitrogen cabinet and pumped to rough vacuum pressures [2]. The secondary container is referred to here as the outer vacuum container (OVC).

In the spring of 2022, samples of the OVC gas and CSVC gas were collected for analysis using a custom designed Gas Extraction Manifold [3]. Gas samples were collected in nine ~2L stainless steel bottles, and include the OVC gas, the CSVC gas directly after piercing the core sample vacuum container, and the CSVC gas after evacuation and several days of accumulation of offgassed sample under a low head gas pressure. In addition to these nine bottles, two 50 cc gas aliquots were collected: one containing the OVC gas, and another containing the CSVC gas collected directly after piercing. These two small aliquots of gas were split for analysis of major gas species at the University of New Mexico [4] and noble gases at Washington University.

**Methods:** The OVC and CSVC gas samples allotted to Washington University were transferred into stainless steel volumes constructed from standard ultra-high vacuum (UHV) conflat flange fittings and hardware. Two all-metal bakeable stainless steel valves were fitted onto each volume to create a pipette volume, used to draw aliquots from the larger sample volumes for repeated analysis. Samples were shipped from Johnson Space Center to Washington University. Gas aliquots were first analyzed on a Stanford Research Systems Residual Gas Analyzer (SRS RGA) on a small UHV gas line. A portion of the CSVC gas was then transferred to an automated gas extraction, purification and separation manifold for noble gas analysis. Reactive gases were removed by exposing a split of CSVC gas to two SAES NP10 getter pumps (one hot and one cold). Inert gases aside from helium were trapped on a Janis cryogenic trap fitted with a charcoal sorbent. He, Ne, Ar, and Xe were sequentially inlet to the mass spectrometer using the cryogenic trap to separate He, Ne, Ar and Xe. Noble gas isotopes and abundances were determined using a Nu Noblesse HR 5F5M.

**Results and Discussion:** The preliminary scans on the SRS RGA showed large peaks at masses 28, 2 and 40, with lesser peaks at masses 18, 44, and 20 in the CSVC gas. In order, these peaks likely correspond to $N_2$, $H_2$, $^{40}Ar$, $H_2O$, $CO_2$, and some combination of $^{20}Ne^+$, $^{40}Ar^{++}$, and $H_2{}^{18}O$ at mass 20. The $H_2$ and $CO_2$ are likely offgassed from the stainless steel of the CSVC over the course of 50 years' storage.

Noble gases in the CSVC gas were characterized using the Nu Noblesse HR 5F5M. The CSVC noble gas abundance pattern is notably poor in He: $^4He$ was just detectable, and $^3He$ was absent. Ne is isotopically distinct from Earth's atmosphere (Fig. 1), and may reflect a mixture of atmospheric Ne with solar wind [5] offgassed from the regolith or mass-fractionated atmosphere. Ar isotopes are also distinct from air: both $^{40}Ar/^{36}Ar$ and $^{38}Ar/^{36}Ar$ are low compared to atmosphere. Xe is abundant enough to measure, but Xe isotopes are not resolved from atmosphere.

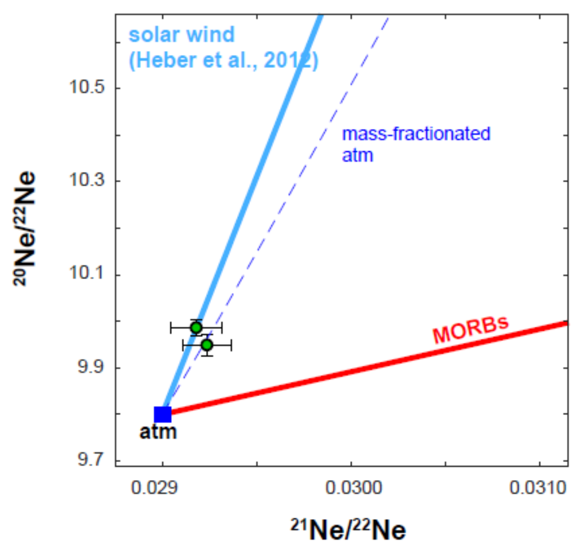


**Fig. 1 Ne isotopes in two repeat analyses of the CSVC gas, compared with solar wind, mass-fractionated atmosphere, and terrestrial mid-ocean ridge basalts.**

It is clear that atmospheric noble gases play some role in the CSVC gas mixture. The origin of the atmospheric Ne, Ar, and Xe in the CSVC is unknown, and potential sources are discussed: (a) atmospheric gas may have leaked into the OVC and then into the CSVC over time, but in this case we would also expect to see a large amount of $O_2$ accompanying the $N_2$; (b) the remnant cabinet nitrogen in the OVC may have contained trace atmospheric noble gases, which may have leaked into the CSVC over time in sufficient quantities to be apparent; (c) atmospheric gas may have leaked into the 50 cc volume during handling; (d) atmospheric gas may have leaked into the Washington University CVSC aliquot during handling or shipping from Houston.

**Conclusions:** The CSVC has a noble gas isotopic composition distinct from pure atmospheric gas. Atmospheric noble gases contribute to the measured compositions. It will be possible to distinguish between scenarios (a,b) and (c,d) outlined above by measuring CSVC gas trapped in the 2L bottles and comparing to these preliminary analyses. Further measurements of the CSVC gas (including Kr isotopes) and the OVC gas are planned.

**References:** [1] Keihm S.J. and Langseth M.G. (1973) *Proc. 4th Lunar Sci. Conf.* 2503-2513. [2] Butler P. (1973) *Lunar Sample Information Catalog*, NASA Johnson Space Center. [3] Parai R. et al. (2021) *52nd LPSC*, 2665. [4] Sharp et al. (2022), this meeting. [5] Heber et al. (2012) *ApJ*, 759:121.