MAJOR ELEMENT GAS COMPOSITION OF THE APPOLO 7300 INNER (CSVC) AND OUTER (OVC) CONTAINERS.

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Introduction: As part of the ANGSA initiative, in late February, 2022 the inner core sample vacuum containers (CSVC) and outer vacuum container (OVC) from sample 73001 were opened and the gases therein were collected in multiple, liter-size bottles and two smaller tubes. The smaller tubes were designated to be analyzed for their major and minor gas composition using conventional gas source mass spectrometry. The gases were transferred to the University of New Mexico and admitted sequentially into a ThermoFisher Delta V mass spectrometer in the Center for Stable Isotopes (CSI). Three Faraday collectors were used for the scan, with resistors spanning a range of 3×10^8 to 1×10^{12} Ω. The most sensitive resistor was used for all masses except for nitrogen (mass 28 – N_2 and mass 14 – N_2^{2+}) which were saturated on both the high and intermediate sensitivity collectors. The relative nitrogen abundance was determined from the ratio of the amplifier resistance times the counts on the least sensitive resistor. The counts for each mass when no gas was admitted into the mass spectrometer were subtracted from the total counts for each mass to get a background-corrected count for each mass. No corrections were made for the ionization efficiency of the different gas species. The nitrogen isotope composition of the OVC was also measured.

Results: Count rates as a function of mass (amu) are given in Table 1. He (mass 4) was continuously introduced from a He microvalve and was not representative of the core gases. The relative abundances of gases are shown in Fig 1. No appreciable counts were seen above mass 46.

Conclusions: The $\delta^{15}N$ value of the outer container was measured to be -4.4‰ vs AIR. This is about 3‰ lower than the presumed value of the gas within the glove box There are several conclusions that can be reached on the basis of these data. First, the vast majority of gas is N_2 in both containers. The amount of gas in the OVC was significantly higher than the CSVC. Pressures within the tube were not quantified because we do not know the relative gas volumes of the two containers. (The inner container's volume is the total volume less the volume occupied by solid material within the core). There is a lower concentration of N_2 within the inner container (98.3%) compared to the outer container (99.9%). This is due to the larger relative proportion of H_2O, H_2 and Ar in the inner container and suggests that some of the H_2O, H_2, and Ar are indigenous within the inner container. (Note: The H_2 may be derived from degassing from the steel sample container). The N_2 is presumably sourced by leaks both into the outer container and then into the inner container. The low $\delta^{15}N$ value of the outer container is consistent with preferential incorporation of the light isotope across small leaks.

The large amount of N_2 in the CSVC indicates that there was leakage during storage. There are minor differences between the OVC and CSVC, however that suggest that there was not complete communication between the two vessels. As a result, it is possible that some of the rare gases, such as Xe and Kr may partially preserve their lunar isotope values.

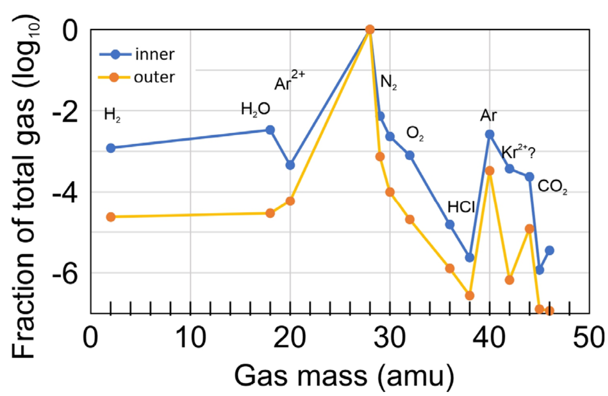

Figure 1. Relative mole fraction of different gases in the outer container (orange) and the inner CSVC (blue). There is an overall larger abundance of N_2 in the OVC. The CSVC has a higher relative abundance of H_2 and H_2O.

Table 1. Count and fraction of gases from the CSVC and OVC.

	Inner Container		Outer container	
amu	count rate	mole frac.	count rate	mole frac.
2	1023	0.00121	11120	0.000023
4	32400		134800	
7	2218		18249	
8	3		18	
12	51		299	
13	0		20	
14	272840		4230000	
15	995		11199	
16	798	0.00094	4520	0.000000
17	1050		5610	
18	2850	0.00336	13755	0.000029
19	-4		165	
20	386	0.00046	27853	0.000059
22	0		47	
24	0		100	
25	0		80	
28	833020	0.98265	473000000	0.998620
29	6230	0.00735	349500	0.000738
30	1960	0.00231	47050	0.000099
31	15		1200	
32	670	0.00079	9652	0.000020
33	0		15	
34	6		48	
35	6		430	
36	13	0.00002	603	0.000001
37	0		130	
38	2	0.00000	130	0.000000
40	2214	0.00261	156986	0.000331
42	315	0.00037	315	0.000001
43	0		70	
44	199	0.00023	5729	0.000012
45	1	0.00000	60	0.000000
46	3	0.00000	55	0.000000