

Sample	Mass (g)	Low T ⁴ He mol/g	+/-	High T ⁴ He mol/g	+/-
He Soaked	0.029	4.02E-10	3E-12	1.32E-10	2E-12
He Soaked	0.030	3.00E-10	2E-12	1.18E-10	1E-12
He Soaked (sieved <50 μm)	0.016	1.310E-09	7E-12	2.80E-10	3E-12
N2 then He Soaked	0.027	8E-13	1E-13	2.2E-13	7E-14
N2 Soaked	0.031	3.5E-12	2E-13	1.9E-13	6E-14

Table S1: He measurements for the two-step extraction experiments shown in Figure 1, measured by isotope dilution on a quadrupole mass spectrometer. The He measurements are corrected for the chamber background. The uncertainties are calculated from the standard error of the 4/3 ratio measured on the ³He-spiked samples (2-σ). The concentrations are calculated by comparison to a calibrated ⁴He reference standard measured with the same ³He spike.

Sample	Mass (g)	⁴ He mV	+/-	³ He (cps)	+/-	⁴ He mol/g	+/-	³ He mol/g	+/-
He Soaked	1.27	112.3	0.2	0.49	0.08	1.305E-09	6E-12	1.3E-16	4E-17
He Soaked	0.84	43.4	0.5	0.20	0.04	7.66E-10	2E-11	8E-17	3E-17
HeNeArKr Soaked	4.19	50.5	0.3	0.21	0.04	1.78E-10	2E-12	1.7E-17	7E-18
HeNeArKr Soaked	4.1	49.4	0.2	0.30	0.05	1.78E-10	2E-12	2.4E-17	8E-18
He Soaked then Leached	1.78	10.9	0.5	0.01	0.03	9.05E-11	8E-12	2E-18	1E-17
Vacuum Crushed then He Soaked	3.98	14.2	0.5	0.03	0.04	5.28E-11	4E-12	3E-18	6E-18
N2 then He Soaked	4.09	3.8	0.2	0.05	0.02	1.3E-11	2E-12	4E-18	3E-18
Outside Air	8.13	7.0	0.2	0.11	0.04	1.3E-11	9E-13	5E-18	3E-18
Water with He headspace	6.38	5.2	0.2	0.01	0.05	1.2E-11	1E-12	5E-19	5E-18
Water with Air headspace	10.67	1.1	0.3	0.07	0.04	1.4E-12	8E-13	2E-18	2E-18
Lab Air	19.71	0.9	0.3	0.32	0.04	7E-13	4E-13	5E-18	1E-18
Uncrushed Olivine	10.19	3.3	0.5	0.16	0.04	4.8E-12	1E-12	5E-18	3E-18

Table S2: He measurements for the single extraction experiments shown in Figure 2, measured by sample-standard bracketing on an MAP 215-50. All samples are sieved to a size range of 37–50 μm . The He measurements have been corrected using procedural blanks. The uncertainties on the ^4He and ^3He signal measurements are calculated from the standard error of the gas evolution fit ($1-\sigma$) and the estimated uncertainty of the fit to the procedural blank from the furnace extraction. The He concentrations are calculated using measurements of a He-doped calibrated air standard (“Caltech Air”), and the concentration uncertainties are doubled to provide a 95% confidence interval.