

Faustini and Slater Craters: PSRs containing geologically young craters

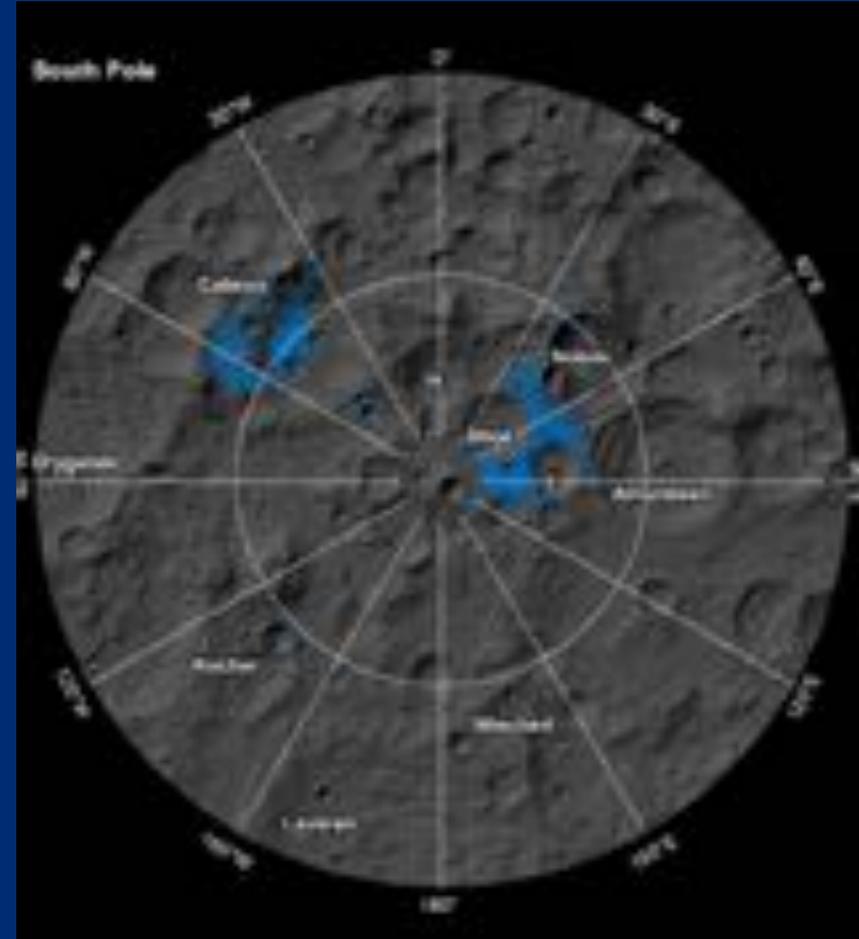
K. E. Mandt, D. Hurley, W. Patterson, M. Lemelin, B.
Greenhagen, A. Stickle, J. Cahill, K. Retherford, T. Greathouse,
R. Gladstone, A. Hendrix, P. Lucey, E. Fisher, M. Paul

Kathleen.Mandt@jhuapl.edu

[@mommascientist](#)

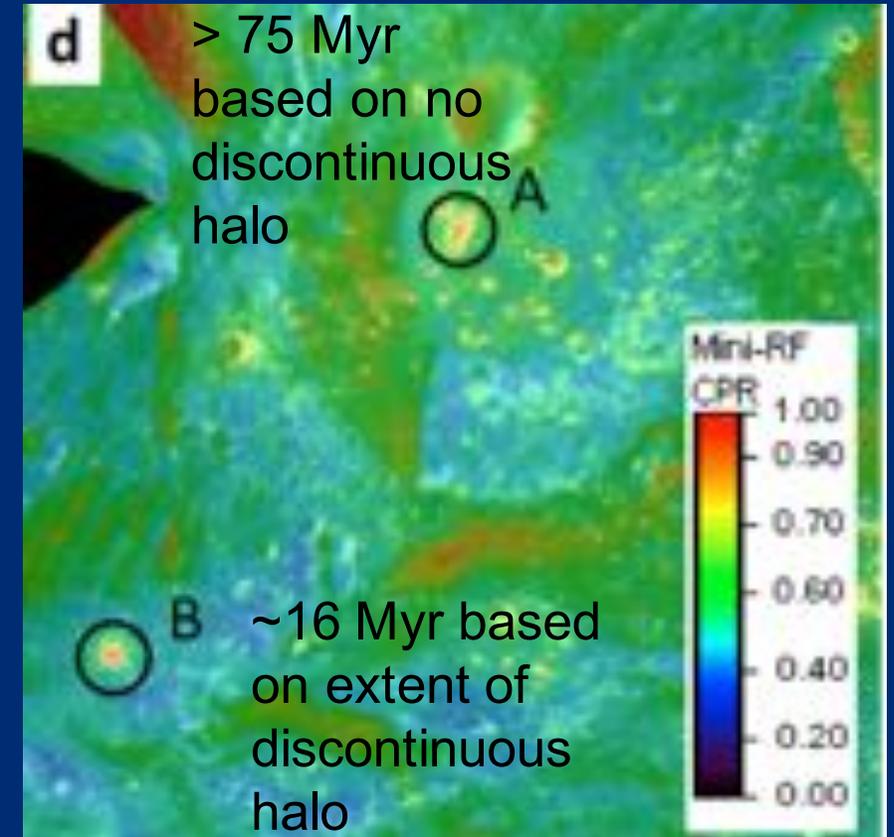
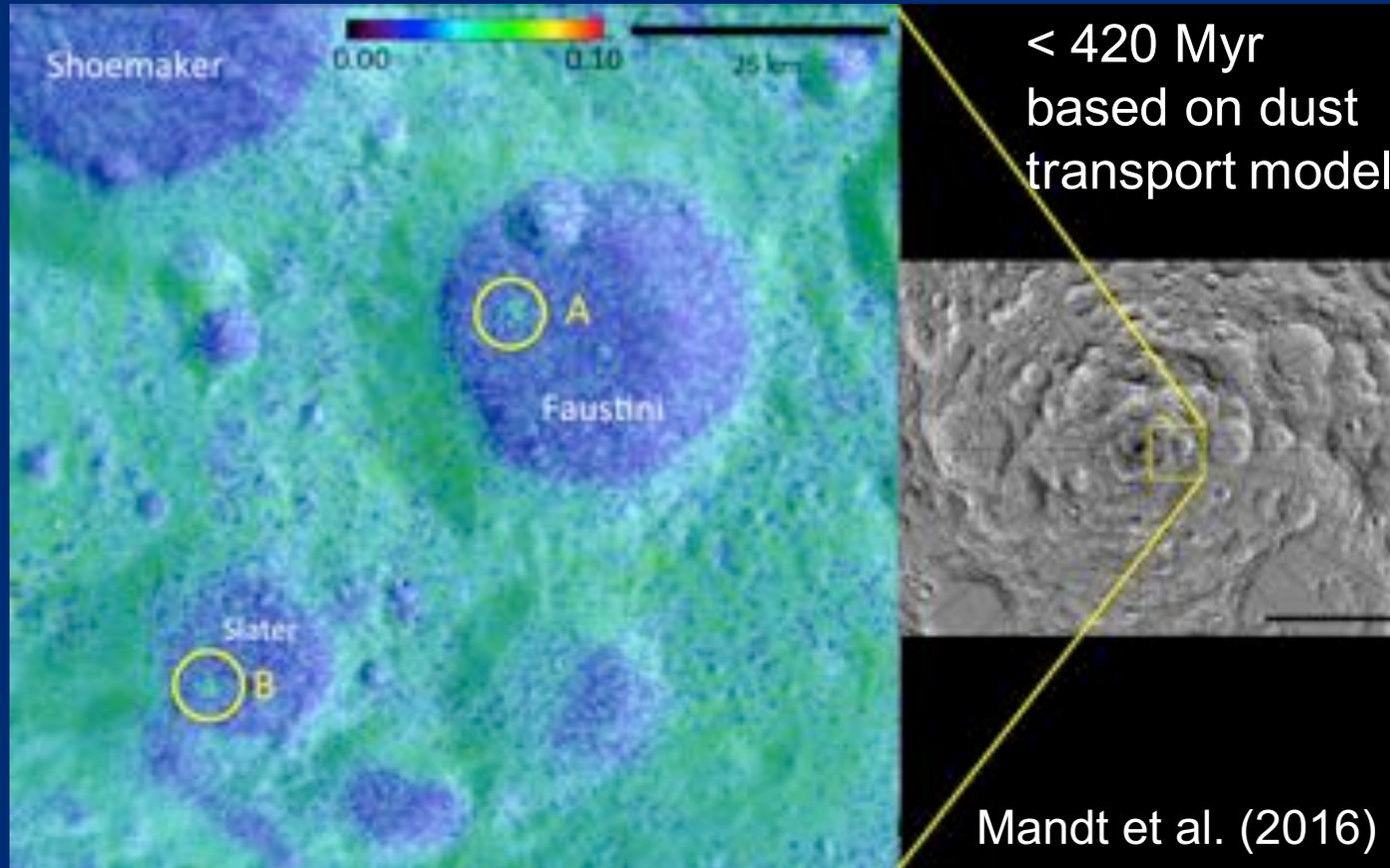
In-depth analysis of lunar volatiles requires landing in a PSR

- Human activity on the Moon
 - Lunar volatiles needed for future human missions
 - Abundance, distribution and composition are a critical Strategic Knowledge Gap (SKG)
- Science potential
 - Origin of volatiles in the inner solar system
 - Transport and trapping of volatiles
 - Unique environment
- The first LEAG Volatile Specific Action Team (VSAT) focused on areas adjacent to PSRs (right) rather than inside of PSRs



The greatest exploration and science potential is found within a PSR

In 2016 we reported discovery of two “geologically young” craters in Faustini and Slater PSRs using observations from LRO-LAMP and LRO-Mini-RF



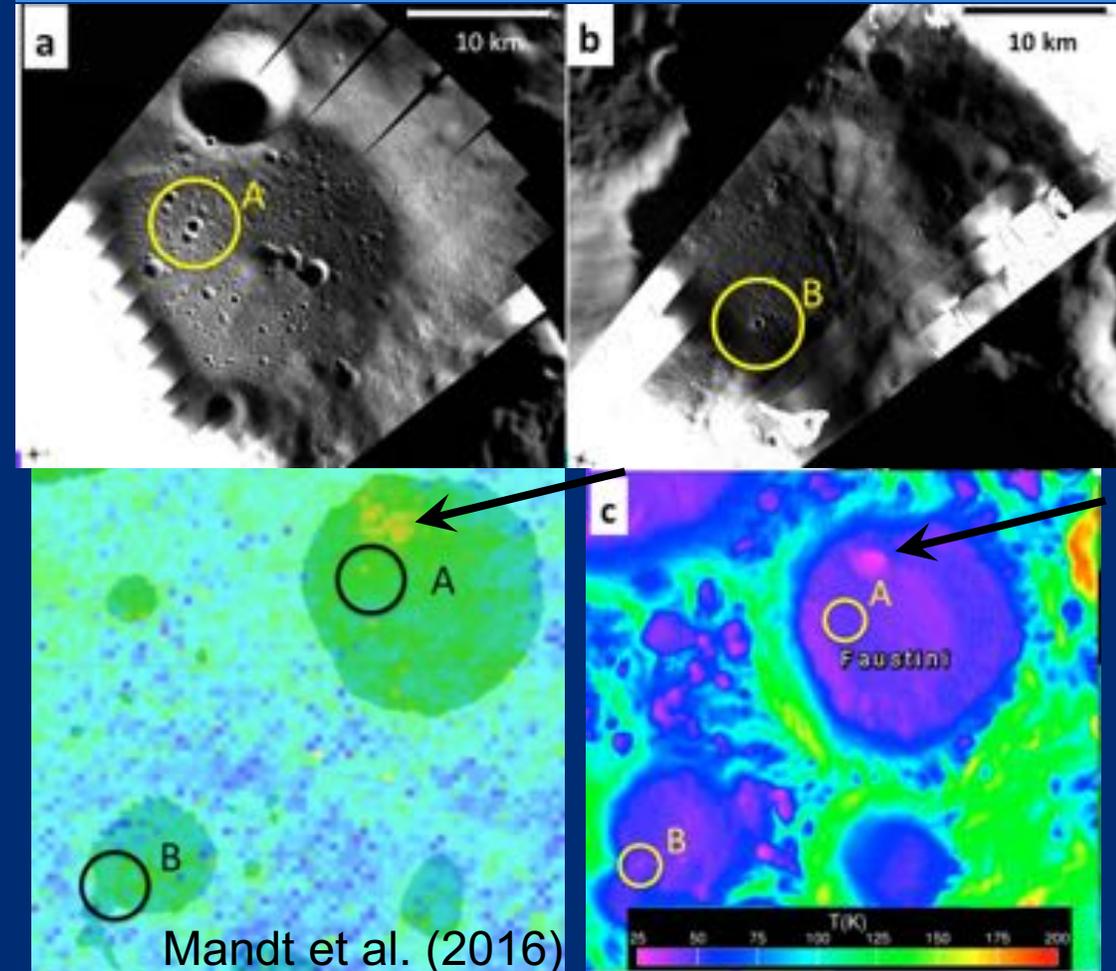
We found that the craters' ejecta had higher Lyman- α albedo (left) and Circular Polarization Ratio (CPR-right) than the surrounding PSR, indicating lower porosity and higher surface roughness

Each location has unique advantages for exploration

- Either crater
 - Provides in situ access to PSR volatiles
 - Provides in situ access to a geologically young crater in an unique environment
- Faustini
 - Age of young crater less constrained
 - Another crater within Faustini is one of the coldest areas and has higher LOLA Normal Albedo
- Slater
 - Youngest of the two "fresh" craters
- Science objectives divided into three categories
 - Volatiles
 - Regolith processes
 - Impact processes

Mobility is necessary to maximize the science return of a mission to these craters

These craters have sharper rims in LROC images, but do not stand out in LOLA NA or average temperature



Focused objectives on Lunar Volatiles

- How does water ice vary spatially and with depth within a PSR?
 - Relevant to origin and retention of water in lunar cold traps
- What is the bulk composition of other volatiles relative to water?
 - Origin of water on the Moon and in the Earth system
- How does the PSR environment influence volatile stability?
 - Transport of volatiles in exosphere
 - Illumination conditions within the PSR
 - Temperature variability with space and depth

Table 2. Abundances derived from spectral fits shown in Fig. 3. The uncertainty in each derived abundance is shown in parenthesis [e.g., for H₂O: 5.1(1.4)E19 = 5.1 ± 1.4 × 10¹⁹ cm⁻²] and was derived from the residual error in the fit and the uncertainty in the radiance at the appropriate band center.

Compound	Molecules cm ⁻²	% Relative to H ₂ O(g)*
H ₂ O	5.1(1.4)E19	100.00%
H ₂ S	8.5(0.9)E18	16.75%
NH ₃	3.1(1.5)E18	6.03%
SO ₂	1.6(0.4)E18	3.19%
C ₂ H ₄	1.6(1.7)E18	3.12%
CO ₂	1.1(1.0)E18	2.17%
CH ₃ OH	7.8(42)E17	1.55%
CH ₄	3.3(3.0)E17	0.65%
OH	1.7(0.4)E16	0.03%

*Abundance as described in text for fit in Fig. 3C.

Table 1. Elemental contributions to the plume spectrum observed by the LAMP. Relevant information on each element's brightest one or two resonance lines in the LAMP bandpass is given, including wavelength, oscillator strength, and *g*-factor. A least-squares fit or 2σ upper limits to the line-of-sight column density are given, along with the corresponding soil mass abundance (assuming a heated soil mass of 10,000 kg). These abundances are for the atomic form of each element only (except for H₂ and CO); other forms of each element may also be present in the plume. LTV, low-temperature volatile (<600 K); HTV, high-temperature volatile (600 to 1300 K); CON, early condensate; SIL, silicate; MET, metal (25). N/A, not applicable.

Element	Type	Wavelength (nm)	Oscillator strength	<i>g</i> -factor (photons s ⁻¹)	Least-squares fit column density (cm ⁻²)	Soil mass abundance* (%)																																																																																																																																																																																																												
H	LTV	102.57	0.07906	3.84 × 10 ⁻⁰⁶	<4.3 × 10 ⁹	(See H ₂)																																																																																																																																																																																																												
		121.57	0.41588	2.88 × 10 ⁻⁰³			B	LTV	182.59	0.14893	9.14 × 10 ⁻⁰⁵	<3.2 × 10 ¹¹	<0.04	182.64	0.13550	8.15 × 10 ⁻⁰⁵	C	LTV	156.03	0.07603	3.67 × 10 ⁻⁰⁶	<6.2 × 10 ¹¹	<0.09	165.69	0.13397	1.97 × 10 ⁻⁰⁵	N	LTV	119.96	0.12940	9.30 × 10 ⁻⁰⁷	<3.9 × 10 ¹³	<6.6	120.02	0.08569	5.55 × 10 ⁻⁰⁷	O	LTV, SIL	130.49	0.04818	8.01 × 10 ⁻⁰⁶	<8.3 × 10 ¹⁰	<0.02	130.60	0.04786	8.08 × 10 ⁻⁰⁶	182.79	0.05495	3.20 × 10 ⁻⁰⁵	Mg	SIL	182.79	0.05495	3.20 × 10 ⁻⁰⁵	1.3 × 10 ¹² ± 5.3 × 10 ⁹	0.4	Al	CON	176.64	0.72101	2.03 × 10 ⁻⁰⁴	<2.8 × 10 ¹⁰	<0.009	176.91	0.15415	4.91 × 10 ⁻⁰⁵	Si	SIL	169.62	0.25170	3.32 × 10 ⁻⁰⁵	<6.0 × 10 ¹⁰	<0.02	184.55	0.27353	1.60 × 10 ⁻⁰⁴	P	MET	177.50	0.15415	5.05 × 10 ⁻⁰⁵	<9.3 × 10 ¹⁰	<0.04	178.28	0.10208	3.85 × 10 ⁻⁰⁵	S	HTV	180.73	0.12051	6.61 × 10 ⁻⁰⁵	<1.5 × 10 ¹¹	<0.06	182.62	0.10965	6.63 × 10 ⁻⁰⁵	Cl	LTV	116.72	0.20321	4.06 × 10 ⁻⁰⁷	<4.7 × 10 ¹¹	<0.2	133.57	0.02500	7.38 × 10 ⁻⁰⁶	Ca	CON	178.63	0.01016	3.99 × 10 ⁻⁰⁶	3.3 × 10 ¹² ± 1.3 × 10 ¹⁰	1.6	188.32	0.01698	1.62 × 10 ⁻⁰⁵	Sc	CON	173.90	0.10494	1.93 × 10 ⁻⁰⁵	<1.7 × 10 ¹¹	<0.09	174.47	0.10136	2.24 × 10 ⁻⁰⁵	V	CON	192.94	0.00310	4.11 × 10 ⁻⁰⁶	<4.0 × 10 ¹²	<2.4	Mn	HTV	178.53	0.01236	4.83 × 10 ⁻⁰⁶	<1.9 × 10 ¹²	<1.3	178.55	0.00912	3.57 × 10 ⁻⁰⁶	Fe	MET	185.17	0.02222	1.24 × 10 ⁻⁰⁵	<7.6 × 10 ¹¹	<0.5	190.34	0.00706	8.21 × 10 ⁻⁰⁶	Co	MET	181.42	0.01072	5.57 × 10 ⁻⁰⁶	<1.5 × 10 ¹²	<1.0	182.24	0.02234	1.36 × 10 ⁻⁰⁵	Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1	158.96	0.12190	3.77 × 10 ⁻⁰⁶	As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181
B	LTV	182.59	0.14893	9.14 × 10 ⁻⁰⁵	<3.2 × 10 ¹¹	<0.04																																																																																																																																																																																																												
		182.64	0.13550	8.15 × 10 ⁻⁰⁵			C	LTV	156.03	0.07603	3.67 × 10 ⁻⁰⁶	<6.2 × 10 ¹¹	<0.09	165.69	0.13397	1.97 × 10 ⁻⁰⁵	N	LTV	119.96	0.12940	9.30 × 10 ⁻⁰⁷	<3.9 × 10 ¹³	<6.6	120.02	0.08569	5.55 × 10 ⁻⁰⁷	O	LTV, SIL	130.49	0.04818	8.01 × 10 ⁻⁰⁶	<8.3 × 10 ¹⁰	<0.02	130.60	0.04786	8.08 × 10 ⁻⁰⁶			182.79	0.05495	3.20 × 10 ⁻⁰⁵			Mg	SIL	182.79	0.05495	3.20 × 10 ⁻⁰⁵	1.3 × 10 ¹² ± 5.3 × 10 ⁹	0.4	Al	CON	176.64	0.72101	2.03 × 10 ⁻⁰⁴	<2.8 × 10 ¹⁰	<0.009	176.91	0.15415	4.91 × 10 ⁻⁰⁵	Si	SIL	169.62	0.25170	3.32 × 10 ⁻⁰⁵	<6.0 × 10 ¹⁰	<0.02	184.55	0.27353	1.60 × 10 ⁻⁰⁴	P	MET	177.50	0.15415	5.05 × 10 ⁻⁰⁵	<9.3 × 10 ¹⁰	<0.04	178.28	0.10208	3.85 × 10 ⁻⁰⁵	S	HTV	180.73	0.12051	6.61 × 10 ⁻⁰⁵	<1.5 × 10 ¹¹	<0.06	182.62	0.10965	6.63 × 10 ⁻⁰⁵	Cl	LTV	116.72	0.20321	4.06 × 10 ⁻⁰⁷	<4.7 × 10 ¹¹	<0.2	133.57	0.02500	7.38 × 10 ⁻⁰⁶	Ca	CON	178.63	0.01016	3.99 × 10 ⁻⁰⁶	3.3 × 10 ¹² ± 1.3 × 10 ¹⁰	1.6	188.32	0.01698	1.62 × 10 ⁻⁰⁵	Sc	CON	173.90	0.10494	1.93 × 10 ⁻⁰⁵	<1.7 × 10 ¹¹	<0.09	174.47	0.10136	2.24 × 10 ⁻⁰⁵	V	CON	192.94	0.00310	4.11 × 10 ⁻⁰⁶	<4.0 × 10 ¹²	<2.4	Mn	HTV	178.53	0.01236	4.83 × 10 ⁻⁰⁶	<1.9 × 10 ¹²	<1.3	178.55	0.00912	3.57 × 10 ⁻⁰⁶	Fe	MET	185.17	0.02222	1.24 × 10 ⁻⁰⁵	<7.6 × 10 ¹¹	<0.5	190.34	0.00706	8.21 × 10 ⁻⁰⁶	Co	MET	181.42	0.01072	5.57 × 10 ⁻⁰⁶	<1.5 × 10 ¹²	<1.0	182.24	0.02234	1.36 × 10 ⁻⁰⁵	Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1	158.96	0.12190	3.77 × 10 ⁻⁰⁶	As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7		
C	LTV	156.03	0.07603	3.67 × 10 ⁻⁰⁶	<6.2 × 10 ¹¹	<0.09																																																																																																																																																																																																												
		165.69	0.13397	1.97 × 10 ⁻⁰⁵			N	LTV	119.96	0.12940	9.30 × 10 ⁻⁰⁷	<3.9 × 10 ¹³	<6.6	120.02	0.08569	5.55 × 10 ⁻⁰⁷	O	LTV, SIL	130.49	0.04818	8.01 × 10 ⁻⁰⁶	<8.3 × 10 ¹⁰	<0.02	130.60	0.04786	8.08 × 10 ⁻⁰⁶			182.79	0.05495	3.20 × 10 ⁻⁰⁵			Mg	SIL	182.79	0.05495	3.20 × 10 ⁻⁰⁵	1.3 × 10 ¹² ± 5.3 × 10 ⁹	0.4	Al	CON	176.64	0.72101	2.03 × 10 ⁻⁰⁴	<2.8 × 10 ¹⁰	<0.009	176.91	0.15415	4.91 × 10 ⁻⁰⁵	Si	SIL	169.62	0.25170	3.32 × 10 ⁻⁰⁵	<6.0 × 10 ¹⁰	<0.02	184.55	0.27353	1.60 × 10 ⁻⁰⁴	P	MET	177.50	0.15415	5.05 × 10 ⁻⁰⁵	<9.3 × 10 ¹⁰	<0.04	178.28	0.10208	3.85 × 10 ⁻⁰⁵	S	HTV	180.73	0.12051	6.61 × 10 ⁻⁰⁵	<1.5 × 10 ¹¹	<0.06	182.62	0.10965	6.63 × 10 ⁻⁰⁵	Cl	LTV	116.72	0.20321	4.06 × 10 ⁻⁰⁷	<4.7 × 10 ¹¹	<0.2	133.57	0.02500	7.38 × 10 ⁻⁰⁶	Ca	CON	178.63	0.01016	3.99 × 10 ⁻⁰⁶	3.3 × 10 ¹² ± 1.3 × 10 ¹⁰	1.6	188.32	0.01698	1.62 × 10 ⁻⁰⁵	Sc	CON	173.90	0.10494	1.93 × 10 ⁻⁰⁵	<1.7 × 10 ¹¹	<0.09	174.47	0.10136	2.24 × 10 ⁻⁰⁵	V	CON	192.94	0.00310	4.11 × 10 ⁻⁰⁶	<4.0 × 10 ¹²	<2.4	Mn	HTV	178.53	0.01236	4.83 × 10 ⁻⁰⁶	<1.9 × 10 ¹²	<1.3	178.55	0.00912	3.57 × 10 ⁻⁰⁶	Fe	MET	185.17	0.02222	1.24 × 10 ⁻⁰⁵	<7.6 × 10 ¹¹	<0.5	190.34	0.00706	8.21 × 10 ⁻⁰⁶	Co	MET	181.42	0.01072	5.57 × 10 ⁻⁰⁶	<1.5 × 10 ¹²	<1.0	182.24	0.02234	1.36 × 10 ⁻⁰⁵	Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1	158.96	0.12190	3.77 × 10 ⁻⁰⁶	As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7												
N	LTV	119.96	0.12940	9.30 × 10 ⁻⁰⁷	<3.9 × 10 ¹³	<6.6																																																																																																																																																																																																												
		120.02	0.08569	5.55 × 10 ⁻⁰⁷			O	LTV, SIL	130.49	0.04818	8.01 × 10 ⁻⁰⁶	<8.3 × 10 ¹⁰	<0.02	130.60	0.04786	8.08 × 10 ⁻⁰⁶			182.79	0.05495	3.20 × 10 ⁻⁰⁵			Mg	SIL	182.79	0.05495	3.20 × 10 ⁻⁰⁵	1.3 × 10 ¹² ± 5.3 × 10 ⁹	0.4	Al	CON	176.64	0.72101	2.03 × 10 ⁻⁰⁴	<2.8 × 10 ¹⁰	<0.009	176.91	0.15415	4.91 × 10 ⁻⁰⁵	Si	SIL	169.62	0.25170	3.32 × 10 ⁻⁰⁵	<6.0 × 10 ¹⁰	<0.02	184.55	0.27353	1.60 × 10 ⁻⁰⁴	P	MET	177.50	0.15415	5.05 × 10 ⁻⁰⁵	<9.3 × 10 ¹⁰	<0.04	178.28	0.10208	3.85 × 10 ⁻⁰⁵	S	HTV	180.73	0.12051	6.61 × 10 ⁻⁰⁵	<1.5 × 10 ¹¹	<0.06	182.62	0.10965	6.63 × 10 ⁻⁰⁵	Cl	LTV	116.72	0.20321	4.06 × 10 ⁻⁰⁷	<4.7 × 10 ¹¹	<0.2	133.57	0.02500	7.38 × 10 ⁻⁰⁶	Ca	CON	178.63	0.01016	3.99 × 10 ⁻⁰⁶	3.3 × 10 ¹² ± 1.3 × 10 ¹⁰	1.6	188.32	0.01698	1.62 × 10 ⁻⁰⁵	Sc	CON	173.90	0.10494	1.93 × 10 ⁻⁰⁵	<1.7 × 10 ¹¹	<0.09	174.47	0.10136	2.24 × 10 ⁻⁰⁵	V	CON	192.94	0.00310	4.11 × 10 ⁻⁰⁶	<4.0 × 10 ¹²	<2.4	Mn	HTV	178.53	0.01236	4.83 × 10 ⁻⁰⁶	<1.9 × 10 ¹²	<1.3	178.55	0.00912	3.57 × 10 ⁻⁰⁶	Fe	MET	185.17	0.02222	1.24 × 10 ⁻⁰⁵	<7.6 × 10 ¹¹	<0.5	190.34	0.00706	8.21 × 10 ⁻⁰⁶	Co	MET	181.42	0.01072	5.57 × 10 ⁻⁰⁶	<1.5 × 10 ¹²	<1.0	182.24	0.02234	1.36 × 10 ⁻⁰⁵	Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1	158.96	0.12190	3.77 × 10 ⁻⁰⁶	As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																						
O	LTV, SIL	130.49	0.04818	8.01 × 10 ⁻⁰⁶	<8.3 × 10 ¹⁰	<0.02																																																																																																																																																																																																												
		130.60	0.04786	8.08 × 10 ⁻⁰⁶																																																																																																																																																																																																														
		182.79	0.05495	3.20 × 10 ⁻⁰⁵																																																																																																																																																																																																														
Mg	SIL	182.79	0.05495	3.20 × 10 ⁻⁰⁵	1.3 × 10 ¹² ± 5.3 × 10 ⁹	0.4																																																																																																																																																																																																												
Al	CON	176.64	0.72101	2.03 × 10 ⁻⁰⁴	<2.8 × 10 ¹⁰	<0.009																																																																																																																																																																																																												
		176.91	0.15415	4.91 × 10 ⁻⁰⁵			Si	SIL	169.62	0.25170	3.32 × 10 ⁻⁰⁵	<6.0 × 10 ¹⁰	<0.02	184.55	0.27353	1.60 × 10 ⁻⁰⁴	P	MET	177.50	0.15415	5.05 × 10 ⁻⁰⁵	<9.3 × 10 ¹⁰	<0.04	178.28	0.10208	3.85 × 10 ⁻⁰⁵	S	HTV	180.73	0.12051	6.61 × 10 ⁻⁰⁵	<1.5 × 10 ¹¹	<0.06	182.62	0.10965	6.63 × 10 ⁻⁰⁵	Cl	LTV	116.72	0.20321	4.06 × 10 ⁻⁰⁷	<4.7 × 10 ¹¹	<0.2	133.57	0.02500	7.38 × 10 ⁻⁰⁶	Ca	CON	178.63	0.01016	3.99 × 10 ⁻⁰⁶	3.3 × 10 ¹² ± 1.3 × 10 ¹⁰	1.6	188.32	0.01698	1.62 × 10 ⁻⁰⁵	Sc	CON	173.90	0.10494	1.93 × 10 ⁻⁰⁵	<1.7 × 10 ¹¹	<0.09	174.47	0.10136	2.24 × 10 ⁻⁰⁵	V	CON	192.94	0.00310	4.11 × 10 ⁻⁰⁶	<4.0 × 10 ¹²	<2.4	Mn	HTV	178.53	0.01236	4.83 × 10 ⁻⁰⁶	<1.9 × 10 ¹²	<1.3	178.55	0.00912	3.57 × 10 ⁻⁰⁶	Fe	MET	185.17	0.02222	1.24 × 10 ⁻⁰⁵	<7.6 × 10 ¹¹	<0.5	190.34	0.00706	8.21 × 10 ⁻⁰⁶	Co	MET	181.42	0.01072	5.57 × 10 ⁻⁰⁶	<1.5 × 10 ¹²	<1.0	182.24	0.02234	1.36 × 10 ⁻⁰⁵	Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1	158.96	0.12190	3.77 × 10 ⁻⁰⁶	As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																																																								
Si	SIL	169.62	0.25170	3.32 × 10 ⁻⁰⁵	<6.0 × 10 ¹⁰	<0.02																																																																																																																																																																																																												
		184.55	0.27353	1.60 × 10 ⁻⁰⁴			P	MET	177.50	0.15415	5.05 × 10 ⁻⁰⁵	<9.3 × 10 ¹⁰	<0.04	178.28	0.10208	3.85 × 10 ⁻⁰⁵	S	HTV	180.73	0.12051	6.61 × 10 ⁻⁰⁵	<1.5 × 10 ¹¹	<0.06	182.62	0.10965	6.63 × 10 ⁻⁰⁵	Cl	LTV	116.72	0.20321	4.06 × 10 ⁻⁰⁷	<4.7 × 10 ¹¹	<0.2	133.57	0.02500	7.38 × 10 ⁻⁰⁶	Ca	CON	178.63	0.01016	3.99 × 10 ⁻⁰⁶	3.3 × 10 ¹² ± 1.3 × 10 ¹⁰	1.6	188.32	0.01698	1.62 × 10 ⁻⁰⁵	Sc	CON	173.90	0.10494	1.93 × 10 ⁻⁰⁵	<1.7 × 10 ¹¹	<0.09	174.47	0.10136	2.24 × 10 ⁻⁰⁵	V	CON	192.94	0.00310	4.11 × 10 ⁻⁰⁶	<4.0 × 10 ¹²	<2.4	Mn	HTV	178.53	0.01236	4.83 × 10 ⁻⁰⁶	<1.9 × 10 ¹²	<1.3	178.55	0.00912	3.57 × 10 ⁻⁰⁶	Fe	MET	185.17	0.02222	1.24 × 10 ⁻⁰⁵	<7.6 × 10 ¹¹	<0.5	190.34	0.00706	8.21 × 10 ⁻⁰⁶	Co	MET	181.42	0.01072	5.57 × 10 ⁻⁰⁶	<1.5 × 10 ¹²	<1.0	182.24	0.02234	1.36 × 10 ⁻⁰⁵	Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1	158.96	0.12190	3.77 × 10 ⁻⁰⁶	As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																																																																		
P	MET	177.50	0.15415	5.05 × 10 ⁻⁰⁵	<9.3 × 10 ¹⁰	<0.04																																																																																																																																																																																																												
		178.28	0.10208	3.85 × 10 ⁻⁰⁵			S	HTV	180.73	0.12051	6.61 × 10 ⁻⁰⁵	<1.5 × 10 ¹¹	<0.06	182.62	0.10965	6.63 × 10 ⁻⁰⁵	Cl	LTV	116.72	0.20321	4.06 × 10 ⁻⁰⁷	<4.7 × 10 ¹¹	<0.2	133.57	0.02500	7.38 × 10 ⁻⁰⁶	Ca	CON	178.63	0.01016	3.99 × 10 ⁻⁰⁶	3.3 × 10 ¹² ± 1.3 × 10 ¹⁰	1.6	188.32	0.01698	1.62 × 10 ⁻⁰⁵	Sc	CON	173.90	0.10494	1.93 × 10 ⁻⁰⁵	<1.7 × 10 ¹¹	<0.09	174.47	0.10136	2.24 × 10 ⁻⁰⁵	V	CON	192.94	0.00310	4.11 × 10 ⁻⁰⁶	<4.0 × 10 ¹²	<2.4	Mn	HTV	178.53	0.01236	4.83 × 10 ⁻⁰⁶	<1.9 × 10 ¹²	<1.3	178.55	0.00912	3.57 × 10 ⁻⁰⁶	Fe	MET	185.17	0.02222	1.24 × 10 ⁻⁰⁵	<7.6 × 10 ¹¹	<0.5	190.34	0.00706	8.21 × 10 ⁻⁰⁶	Co	MET	181.42	0.01072	5.57 × 10 ⁻⁰⁶	<1.5 × 10 ¹²	<1.0	182.24	0.02234	1.36 × 10 ⁻⁰⁵	Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1	158.96	0.12190	3.77 × 10 ⁻⁰⁶	As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																																																																												
S	HTV	180.73	0.12051	6.61 × 10 ⁻⁰⁵	<1.5 × 10 ¹¹	<0.06																																																																																																																																																																																																												
		182.62	0.10965	6.63 × 10 ⁻⁰⁵			Cl	LTV	116.72	0.20321	4.06 × 10 ⁻⁰⁷	<4.7 × 10 ¹¹	<0.2	133.57	0.02500	7.38 × 10 ⁻⁰⁶	Ca	CON	178.63	0.01016	3.99 × 10 ⁻⁰⁶	3.3 × 10 ¹² ± 1.3 × 10 ¹⁰	1.6	188.32	0.01698	1.62 × 10 ⁻⁰⁵	Sc	CON	173.90	0.10494	1.93 × 10 ⁻⁰⁵	<1.7 × 10 ¹¹	<0.09	174.47	0.10136	2.24 × 10 ⁻⁰⁵	V	CON	192.94	0.00310	4.11 × 10 ⁻⁰⁶	<4.0 × 10 ¹²	<2.4	Mn	HTV	178.53	0.01236	4.83 × 10 ⁻⁰⁶	<1.9 × 10 ¹²	<1.3	178.55	0.00912	3.57 × 10 ⁻⁰⁶	Fe	MET	185.17	0.02222	1.24 × 10 ⁻⁰⁵	<7.6 × 10 ¹¹	<0.5	190.34	0.00706	8.21 × 10 ⁻⁰⁶	Co	MET	181.42	0.01072	5.57 × 10 ⁻⁰⁶	<1.5 × 10 ¹²	<1.0	182.24	0.02234	1.36 × 10 ⁻⁰⁵	Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1	158.96	0.12190	3.77 × 10 ⁻⁰⁶	As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																																																																																						
Cl	LTV	116.72	0.20321	4.06 × 10 ⁻⁰⁷	<4.7 × 10 ¹¹	<0.2																																																																																																																																																																																																												
		133.57	0.02500	7.38 × 10 ⁻⁰⁶			Ca	CON	178.63	0.01016	3.99 × 10 ⁻⁰⁶	3.3 × 10 ¹² ± 1.3 × 10 ¹⁰	1.6	188.32	0.01698	1.62 × 10 ⁻⁰⁵	Sc	CON	173.90	0.10494	1.93 × 10 ⁻⁰⁵	<1.7 × 10 ¹¹	<0.09	174.47	0.10136	2.24 × 10 ⁻⁰⁵	V	CON	192.94	0.00310	4.11 × 10 ⁻⁰⁶	<4.0 × 10 ¹²	<2.4	Mn	HTV	178.53	0.01236	4.83 × 10 ⁻⁰⁶	<1.9 × 10 ¹²	<1.3	178.55	0.00912	3.57 × 10 ⁻⁰⁶	Fe	MET	185.17	0.02222	1.24 × 10 ⁻⁰⁵	<7.6 × 10 ¹¹	<0.5	190.34	0.00706	8.21 × 10 ⁻⁰⁶	Co	MET	181.42	0.01072	5.57 × 10 ⁻⁰⁶	<1.5 × 10 ¹²	<1.0	182.24	0.02234	1.36 × 10 ⁻⁰⁵	Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1	158.96	0.12190	3.77 × 10 ⁻⁰⁶	As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																																																																																																
Ca	CON	178.63	0.01016	3.99 × 10 ⁻⁰⁶	3.3 × 10 ¹² ± 1.3 × 10 ¹⁰	1.6																																																																																																																																																																																																												
		188.32	0.01698	1.62 × 10 ⁻⁰⁵			Sc	CON	173.90	0.10494	1.93 × 10 ⁻⁰⁵	<1.7 × 10 ¹¹	<0.09	174.47	0.10136	2.24 × 10 ⁻⁰⁵	V	CON	192.94	0.00310	4.11 × 10 ⁻⁰⁶	<4.0 × 10 ¹²	<2.4	Mn	HTV	178.53	0.01236	4.83 × 10 ⁻⁰⁶	<1.9 × 10 ¹²	<1.3	178.55	0.00912	3.57 × 10 ⁻⁰⁶	Fe	MET	185.17	0.02222	1.24 × 10 ⁻⁰⁵	<7.6 × 10 ¹¹	<0.5	190.34	0.00706	8.21 × 10 ⁻⁰⁶	Co	MET	181.42	0.01072	5.57 × 10 ⁻⁰⁶	<1.5 × 10 ¹²	<1.0	182.24	0.02234	1.36 × 10 ⁻⁰⁵	Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1	158.96	0.12190	3.77 × 10 ⁻⁰⁶	As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																																																																																																										
Sc	CON	173.90	0.10494	1.93 × 10 ⁻⁰⁵	<1.7 × 10 ¹¹	<0.09																																																																																																																																																																																																												
		174.47	0.10136	2.24 × 10 ⁻⁰⁵			V	CON	192.94	0.00310	4.11 × 10 ⁻⁰⁶	<4.0 × 10 ¹²	<2.4	Mn	HTV	178.53	0.01236	4.83 × 10 ⁻⁰⁶	<1.9 × 10 ¹²	<1.3	178.55	0.00912	3.57 × 10 ⁻⁰⁶	Fe	MET	185.17	0.02222	1.24 × 10 ⁻⁰⁵	<7.6 × 10 ¹¹	<0.5	190.34	0.00706	8.21 × 10 ⁻⁰⁶	Co	MET	181.42	0.01072	5.57 × 10 ⁻⁰⁶	<1.5 × 10 ¹²	<1.0	182.24	0.02234	1.36 × 10 ⁻⁰⁵	Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1	158.96	0.12190	3.77 × 10 ⁻⁰⁶	As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																																																																																																																				
V	CON	192.94	0.00310	4.11 × 10 ⁻⁰⁶	<4.0 × 10 ¹²	<2.4																																																																																																																																																																																																												
Mn	HTV	178.53	0.01236	4.83 × 10 ⁻⁰⁶	<1.9 × 10 ¹²	<1.3																																																																																																																																																																																																												
		178.55	0.00912	3.57 × 10 ⁻⁰⁶			Fe	MET	185.17	0.02222	1.24 × 10 ⁻⁰⁵	<7.6 × 10 ¹¹	<0.5	190.34	0.00706	8.21 × 10 ⁻⁰⁶	Co	MET	181.42	0.01072	5.57 × 10 ⁻⁰⁶	<1.5 × 10 ¹²	<1.0	182.24	0.02234	1.36 × 10 ⁻⁰⁵	Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1	158.96	0.12190	3.77 × 10 ⁻⁰⁶	As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																																																																																																																																					
Fe	MET	185.17	0.02222	1.24 × 10 ⁻⁰⁵	<7.6 × 10 ¹¹	<0.5																																																																																																																																																																																																												
		190.34	0.00706	8.21 × 10 ⁻⁰⁶			Co	MET	181.42	0.01072	5.57 × 10 ⁻⁰⁶	<1.5 × 10 ¹²	<1.0	182.24	0.02234	1.36 × 10 ⁻⁰⁵	Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1	158.96	0.12190	3.77 × 10 ⁻⁰⁶	As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																																																																																																																																															
Co	MET	181.42	0.01072	5.57 × 10 ⁻⁰⁶	<1.5 × 10 ¹²	<1.0																																																																																																																																																																																																												
		182.24	0.02234	1.36 × 10 ⁻⁰⁵			Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1	158.96	0.12190	3.77 × 10 ⁻⁰⁶	As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																																																																																																																																																									
Zn	HTV	145.76	0.02897	2.09 × 10 ⁻⁰⁷	<4.0 × 10 ¹²	<3.1																																																																																																																																																																																																												
		158.96	0.12190	3.77 × 10 ⁻⁰⁶			As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02	189.04	0.79057	8.67 × 10 ⁻⁰⁴	Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																																																																																																																																																																			
As	MET	188.20	0.00250	2.24 × 10 ⁻⁰⁶	<2.0 × 10 ¹⁰	<0.02																																																																																																																																																																																																												
		189.04	0.79057	8.67 × 10 ⁻⁰⁴			Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6	187.98	0.02506	2.18 × 10 ⁻⁰⁵	Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																																																																																																																																																																													
Au	MET	169.93	0.05000	6.87 × 10 ⁻⁰⁶	<6.8 × 10 ¹¹	<1.6																																																																																																																																																																																																												
		187.98	0.02506	2.18 × 10 ⁻⁰⁵			Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2	H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4	CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																																																																																																																																																																																							
Hg	LTV	184.95	1.15080	6.29 × 10 ⁻⁰⁴	5.0 × 10 ¹¹ ± 2.9 × 10 ⁸	1.2																																																																																																																																																																																																												
H ₂	LTV	110–170	N/A	N/A	5.8 × 10 ¹³ ± 1.0 × 10 ¹¹	1.4																																																																																																																																																																																																												
CO	LTV	139–181	N/A	N/A	1.7 × 10 ¹³ ± 1.5 × 10 ¹¹	5.7																																																																																																																																																																																																												

*Estimated weight percent of element thermally desorbed in atomic form (plus H₂ and CO), assuming that 10,000 kg of soil was impact-heated to a temperature of 1000 K.

Colaprete et al. (2010; above) and Gladstone et al. (2010; right) report a rich volatiles composition within the LCROSS Plume

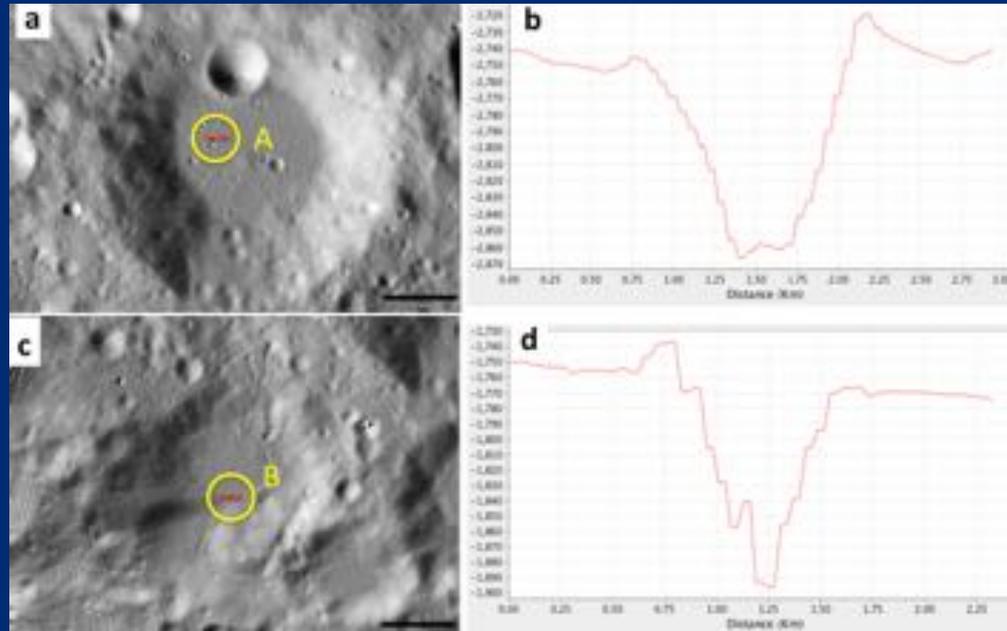
Focused Objectives on Regolith and Impact Processes in the unique environment of a PSR

- Regolith processes

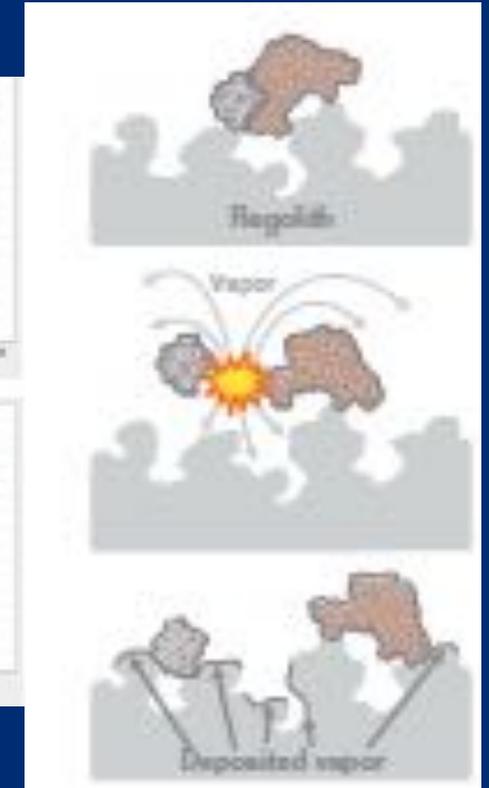
- How does the PSR plasma environment compare to sunlit areas?
- How does grain size and porosity in the PSR compare with sunlit regions?
- How is space weathering different in a PSR?
- Does dielectric breakdown occur?
- What is the rate of dust transport?

- Impact processes

- What are the exact ages of these craters and what do they tell us about impact rates at the poles?
- Do craters in PSRs form and degrade differently?
- What happens to volatiles in impacts?



Mandt et al. (2016)



Jordan et al. (2015)

Regolith and impact processes within PSRs may be different. Studying state of the regolith in these PSRs and the ejecta blankets of these craters would address high priority objectives

Short Term Experiments and Long Term Monitoring

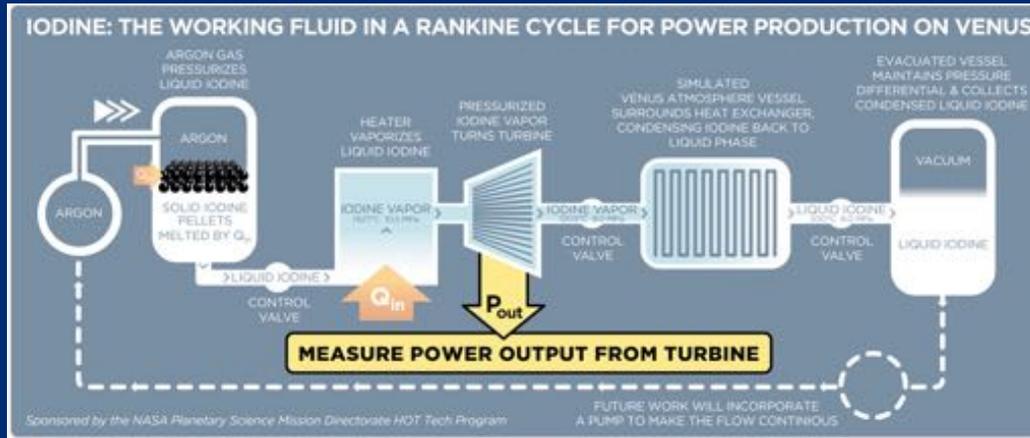
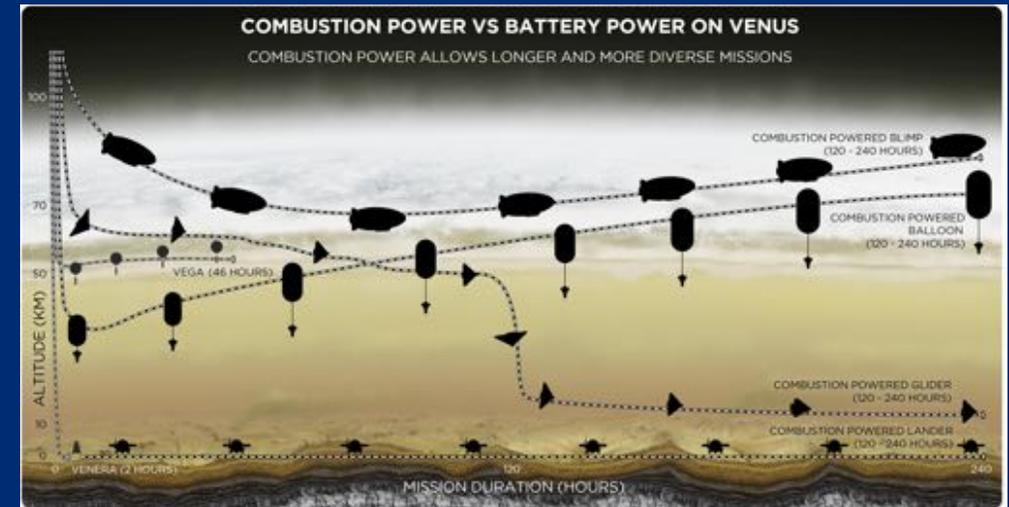
- Short term reconnaissance and surface science experiments (less than one day)
 - Water abundance with depth at and near landing site
 - Volatile composition with depth at and near landing site
 - Regolith properties with depth at and near landing site
 - Minerology of regolith at and near landing site relative to ejecta blanket extent of young crater
- Short term measurements used to characterize
 - Landing site to constrain local characteristics
 - A site near the landing site to evaluate differences and constrain the influence of landing on the local environment
- Long term monitoring (days, months)
 - Water abundance and volatile composition with depth at multiple locations
 - Volatile abundance and composition with distance from young crater
 - Regolith properties and minerology of regolith at multiple locations relative to ejecta blanket extent of young crater
 - PSR environment including atmosphere, dust transport and plasma conditions
- Long term monitoring used to characterize
 - Volatile abundance and composition throughout the PSR
 - Age of young crater and crater formation in PSRs compared to sunlit areas
 - Plasma environment and search for dielectric breakdown
 - Illumination and thermal conditions

Short term reconnaissance would address some objectives, but long term monitoring is needed to maximize the science return

The Unique Environment of a PSR Requires Technology development

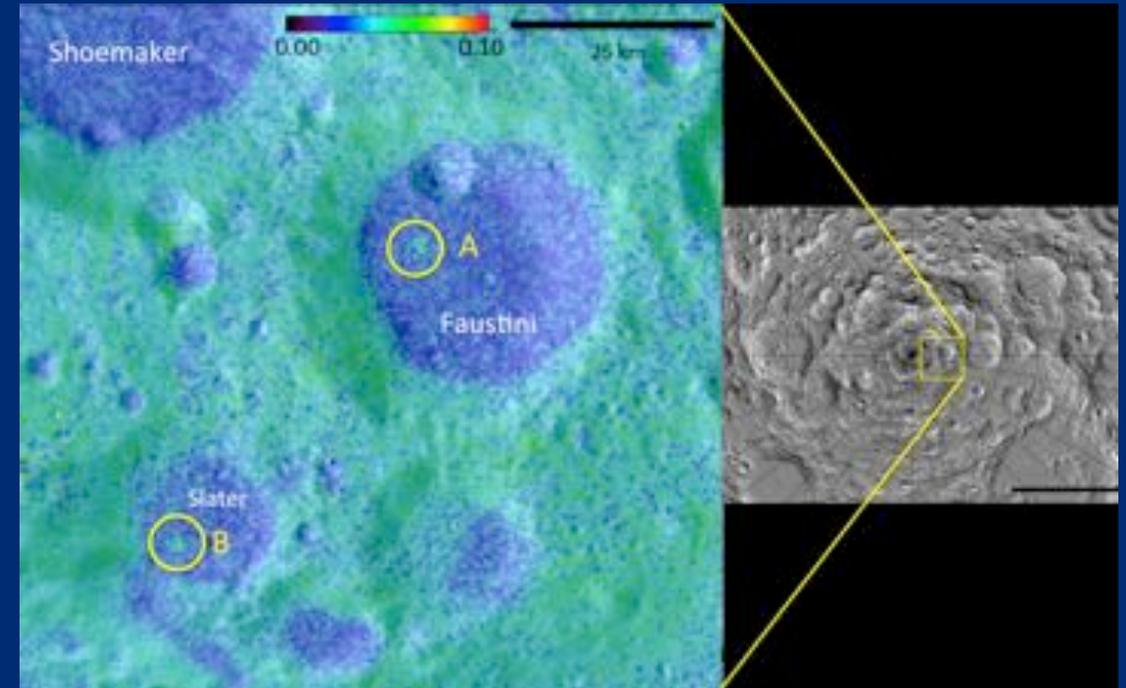
- Power sources
 - Major concern in a PSR – no solar power
 - Batteries have limited life
 - APL/Penn State developing combustion-based power that could work in extreme environments from Venus to Europa to PSRs

The APL/Penn State Rankine power system could provide power for 240 hours in an extreme environment

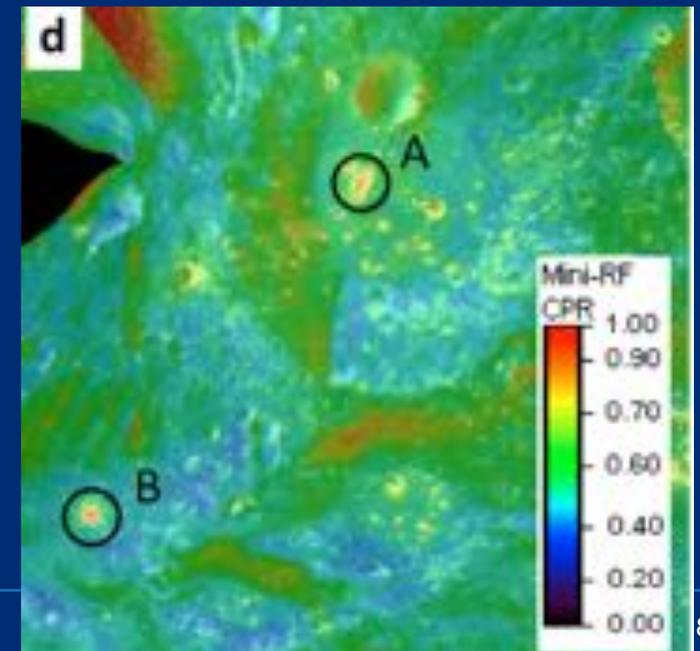


Summary

- A landed mission inside a PSR is needed to maximize understanding of lunar volatiles
- Faustini and Slater PSRs: high value environment for volatiles and regolith and impact cratering processes
- Mobility is necessary to maximize the science
- Technology development in the area of power supply is critical – work is ongoing



These geologically young craters provide a unique environment for lunar science





JOHNS HOPKINS
APPLIED PHYSICS LABORATORY