



LMS-1 Lunar Mare Simulant | Fact Sheet

December, 2022

Simulant Name: LMS-1 Mare Simulant
Simulant Type: General purpose
Reference Material: Average lunar maria
Uncompressed Bulk Density: 1.56 g/cm³
Mean Particle Size: 91 µm
Median Particle Size: 60 µm
Particle Size Range: <0.04 µm – 1000 µm



Geotechnical Properties

Grain Density: 2.92g/cm³
Void Ratio: 0.8718
Porosity: 46.6%
¹Max Angle of Repose: 38.3°
²Cohesion: 0.393 kPa
²Angle of Internal Friction: 34.84°

Geotechnical Property Sources

¹[\(PDF\) Comparing the Effects of Mineralogy and Particle Size Distribution on the Angle of Repose for Lunar Regolith Simulants \(researchgate.net\)](#)

²[2038.PDF \(usra.edu\)](#)

Mineralogy

As mixed.

Component	Wt.%
Pyroxene	32.8
Glass-rich basalt	32.0
Anorthosite	19.8
Olivine	11.1
Ilmenite	4.3

Safety

See SDS for details.
Primary hazard is dust inhalation; wear a respirator in dusty conditions.

Bulk Chemistry

Relative abundances.
Measured by XRF.

Oxide	Wt.%
SiO ₂	46.9
TiO ₂	3.6
Al ₂ O ₃	12.4
FeO	8.6
MnO	0.2
MgO	16.8
CaO	7.0
Na ₂ O	1.7
K ₂ O	0.7
P ₂ O ₅	0.2
LOI*	0.9
Total**	99.0

* Loss on ignition

** Excluding volatiles and trace elements



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Trace Elements

Measured by XRF

Element	ppm
Ni	561
Cr	1728
V	155
Sc	20.7
Cu	26
Zn	66
Ga	18
Ba	173
Rb	14
Cs	0
Sr	265
Y	12
Zr	131
Hf	3.3
Nb	57.7
Ta	1
Mo	8
La	10
Ce	30
Nd	13
Sm	2.5
Dy	2.7
Yb	1.0
Th	3
U	3
Tl	0
Pb	15
Sn	1
Bi	0
Sb	1

Volatiles

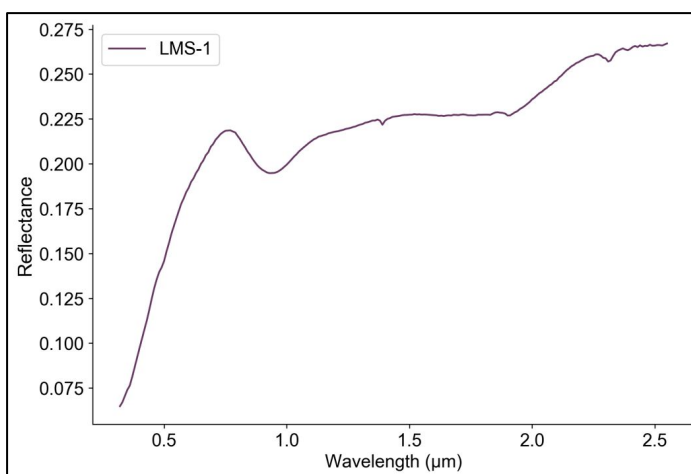
Measured by XRF

Compound	Wt%
F	≥0.06
Cl	≥0.008
SO ₃	≥0.01

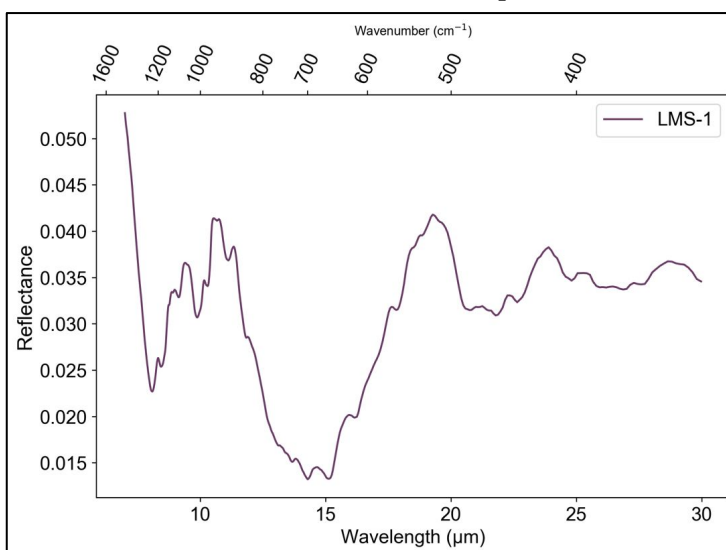
Compound	ppm
Br	≥1
As	≥0

Reflectance Spectrum

Incidence angle 30°, emission angle 0°



Mid-Infrared FTIR Spectrum



XRF data obtained by Hamilton Analytical Lab using fused bead sample preparation. FTIR spectrum courtesy of Dr. Takahiro Hiroi, NASA RELAB, Brown University.

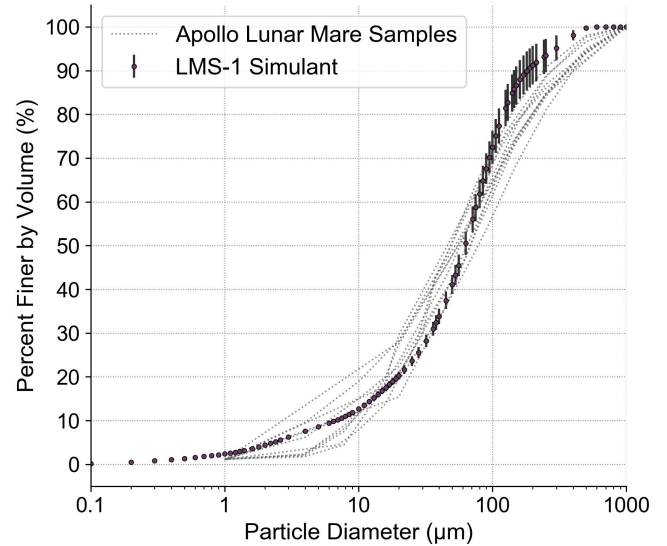
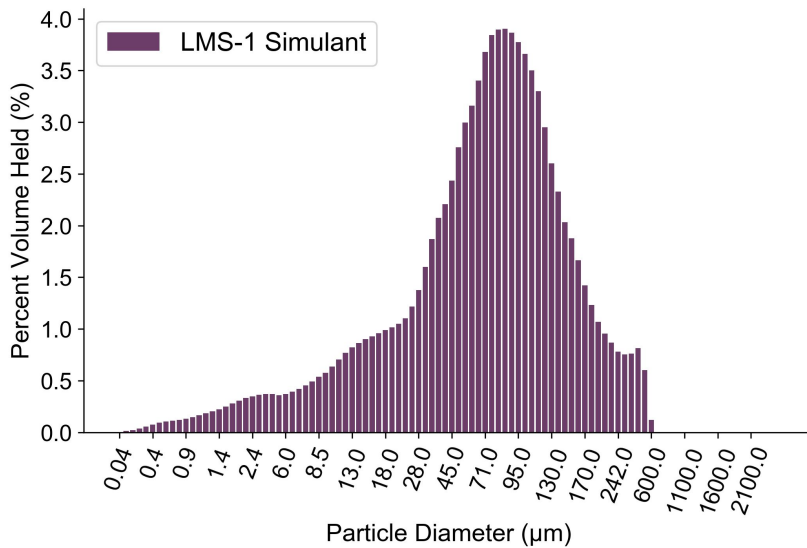


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Volumetric Particle Size Distribution

From CILAS 1190 laser diffraction particle size analyzer



Sieve Analysis

Following ASTM Standard E11 using RO-TAP RX-30 sieve shaker

Sieve Number	Diameter (μm)	Mass of Soil Retained on Each Sieve (g)	Percent Retained by Mass (%)	Cumulative Retained by Mass (%)	Percent Finer by Mass (%)
18	1000	0.0	0.0%	0.0%	100.0%
25	710	82.2	8.3%	8.3%	91.7%
35	500	82.2	8.3%	16.6%	83.4%
45	355	84.8	8.6%	25.2%	74.8%
70	212	133.7	13.5%	38.7%	61.3%
140	106	239.7	24.2%	62.9%	37.1%
200	75	149.5	15.1%	78.1%	21.9%
270	53	133.5	13.5%	91.6%	8.4%
PAN		83.5	8.4%	100.0%	0.0%

Sieve analysis skews particle size larger, as many of the fines cling to the larger pieces of regolith. This is measured by mass percent rather than volume

