LMS-1 Lunar Mare Simulant | **Fact Sheet**

002-02-001-0621

Simulant Name: LMS-1 Mare Simulant
Simulant Type: General purpose
Reference Material: Average lunar maria
Uncompressed Bulk Density: 1.56 g/cm^3
Mean Particle Size: 91 µm
Median Particle Size: 60 µm
Particle Size Range: <0.04 µm – 1000 µm

Geotechnical Properties

Grain Density: 2.92g/cm^3
Void Ratio: 0.8718
Porosity: 46.6%
[1]**Max Angle of Repose:** 38.3°
[2]**Cohesion:** 0.393 kPa
[2]**Angle 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_2O_3	12.4
FeO	8.6
MnO	0.2
MgO	16.8
CaO	7.0
Na_2O	1.7
K_2O	0.7
P_2O_5	0.2
LOI*	0.9
Total**	99.0

* Loss on ignition
** Excluding volatiles and trace elements

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

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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

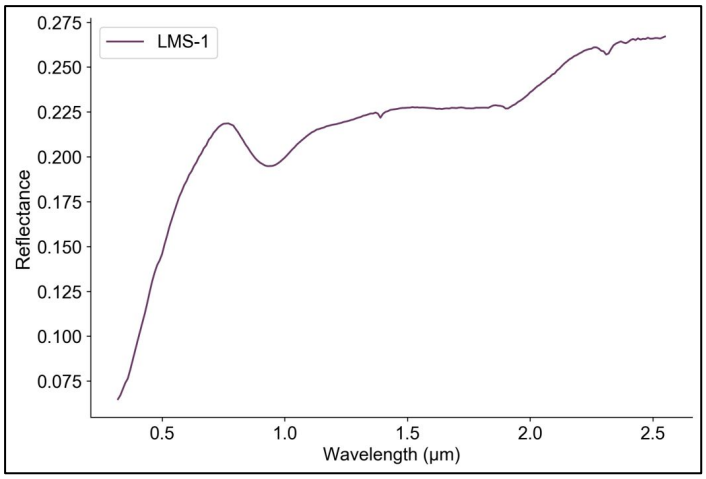
Measured by XRF

Compound	Wt%
F	≥0.06
Cl	≥0.008
SO_3	≥0.01

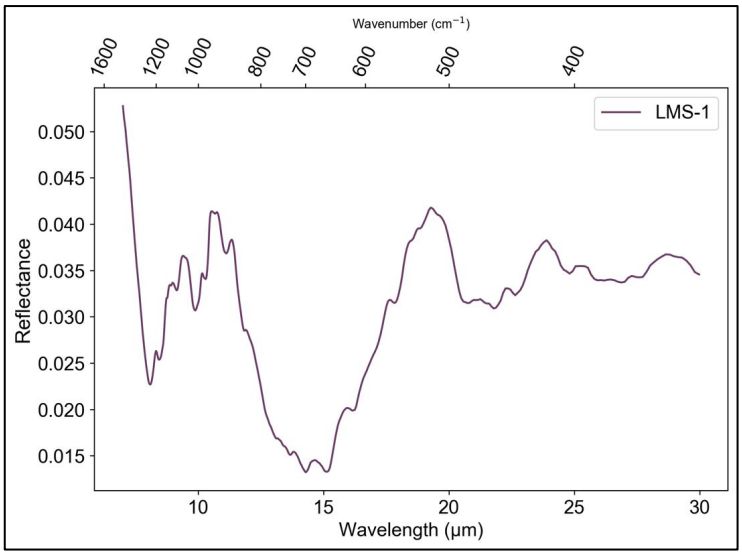
Compound	ppm
Br	≥1
As	≥0

Reflectance Spectrum

Incidence angle 30°, emission angle 0°



Mid-Infrared FTIR Spectrum



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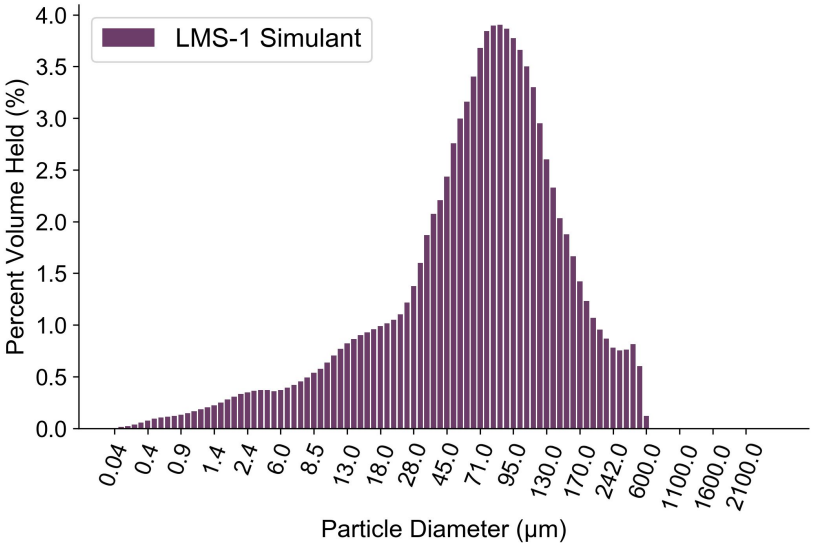
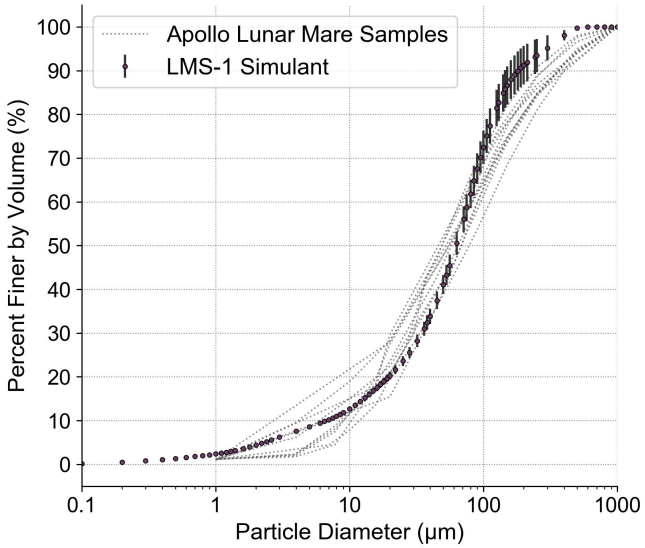
Volumetric Particle Size Distribution

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