Astromaterials Research & Exploration Science

SIMULANT : OB-1

(https://www.nasa.gov/)

Overview

The OB-1 simulant is a simulant made by Deltion Innovations to replicate the lunar highlands regolith. It is derived from a granoblastic facies of the Archean Shawmere Complex of the Kapuskasing Structural Zone of Ontario, Canada. It consists of a mixture of 58% Shawmere Anorthosite (from a quarry in Foleyet, Ontario) and 42% fayalitic olivine slag glass[1]. It was crushed to a particle size distribution comparable to Apollo 16 regolith samples 64500/64501 and has a composition similar to lunar highlands regolith with an average plagioclase composition of An_{78} (bytownite). OB-1 has adequate geotechnical properties that will benefit the design and testing of drilling, excavation, and construction equipment for future lunar surface operations.[2]

A modified version referred to as CHENOBI (or Chenobi) used plasma-melted Shawmere Anorthosite for the glassy component instead of the olivine slag. Detlion contracted with Zybek Advanced Products to produce plasma slag. The Canadian Space Agency currently has approximately 500kg remaining from a 1 tonne lot purchased. NASA Glenn Research Center purchased 400kg and reportedly has 100kg pristine material remaining.[1]

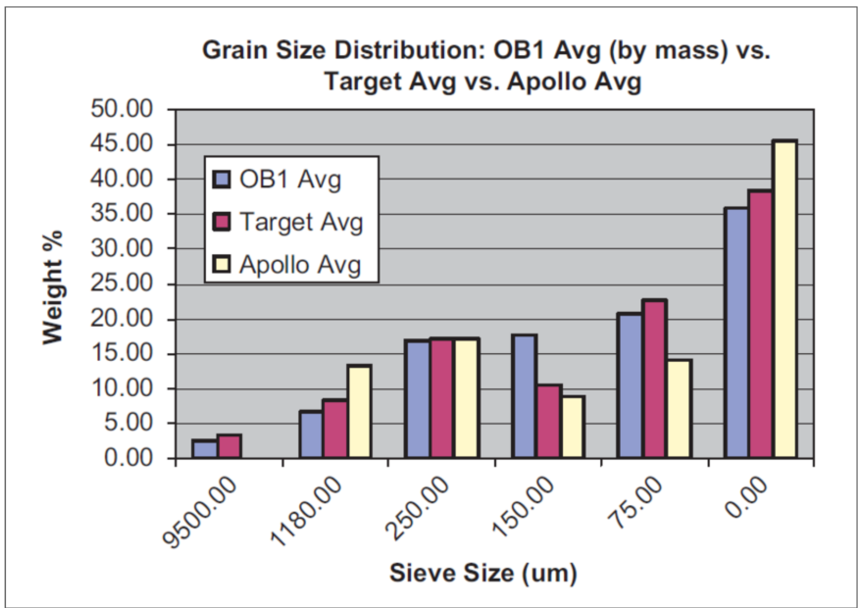
Deltion is currently looking to re-start OB-1 production.

Pros

Pros

- Similar particle size distribution to lunar highlands regolith
- Similar composition to lunar highlands
- Similar particle shape/abrasive properties to lunar highlands regolith

General Properties



Grain size distributions for OB-1 (anorthosite plus olivine glass slag combined) versus target Apollo 16 regolith 64500 (target) and Apollo regolith average. OB-1 data (sieve fractions by mass) from Batter (2008). [3]

General Properties

Particle Shape Range	Particle Size Range (μm)	Mean Particle Size (μm)
-	-	82.25
Particle Size Distribution (by site/sample)	**Chemical Composition (by sample/site)**	**Mineralogical Composition**
Apollo 16 regolith sample 64500[2]	-	-
Texture		
-		

Modal Mineralogy

Mineral	Apollo 16 64001/64002 (%) [4]	OB-1 Abundance (%)[4]	OB-1 (%)[5]	Shawmere Anorthosite[2]
Lithic fragments	31.1	-	-	-
Glass	8.9	52.6	43.22	-
Quartz	-	-	0.48	-
Agglutinates	32.5	-	-	-

Lunar Surface Innovation Consortium

Lunar Surface Innovation Consortium (LSIC): Homepage (https://lsic.jhuapl.edu/)

Lunar Surface Innovation Consortium (LSIC): Lunar Simulants Working Group (https://lsic.jhuapl.edu/Our-Work/Working-Groups/Lunar-Simulants.php)

NASA LSIC Simulant Survey (https://docs.google.com/forms/d/e/1FAIpQLSeHoq6_XvUPfY4jV5Z uohynKtu3RWzlVg/viewform)

Dust Testing Facilities

Summary of Lunar Dust Testing (/projects/simulants/lunar-dust-testing.html)

- Johnson Space Center (JSC) (/projects/simulants/dust-testing-facilities/johnson-space-center.html)
- Glenn Research Center (GRC) (/projects/simulants/dust-testing-facilities/glenn-research-center.html)
- Jet Propulsion Laboratory (JPL) (/projects/simulants/dust-testing-facilities/jet-propulsion-laboratory.html)
- Kennedy Space Center (KSC) (/projects/simulants/dust-testing-facilities/kennedy-space-center.html)
- Ames Research Center (ARC) (/projects/simulants/dust-testing-facilities/ames-research-center.html)
- White Sands Test Facility (WSTF) (/projects/simulants/dust-testing-facilities/white-sands-test-facility.html)
- Stennis Space Center (SSC) (/projects/simulants/dust-testing-facilities/stennis-space-center.html)
- Langley Research Center (LARC) (/projects/simulants/dust-testing-facilities/langley-research-center.html)
- Goddard Space Flight Center (GSFC) (/projects/simulants/dust-testing-facilities/goddard-space-flight-center.html)
- Marshall Space Flight Center (MSFC) (/projects/simulants/dust-testing-facilities/marshall-space-flight-center.html)
- External Environments (/projects/simulants/dust-testing-facilities/external-environments.html)
- Industry Facilities (/projects/simulants/dust-testing-facilities/industry-facilities.html)
- Non-NASA Facilities (/projects/simulants/dust-testing-facilities/non-nasa-facilities.html)
- Academia Facilities (/projects/simulants/dust-testing-facilities/academia-facilities.html)

Comprehensive Dust Testing Facility Table

(/projects/simulants/_resources/comprehensive_dust_testing_facility

Plagioclase	23.3	43.9	44.35	97.14
Orthoclase	-	-	0.08	1.02
Olivine	-	0.0	6.27	1.11
Diopside	-	-	-	0.18
Hypersthene	-	-		0.41
Clinopyroxene	0.6	0.1	2.95	-
Orthopyroxene	3.2	-	0.19	-
Spinel minerals	0.03	0.19	-	-
Fe-sulfide	0.01	-	-	-
Sulphides	-	-	0.35	-
Ca-phosphates	0.12	-	-	-
Ilmenite	0.1	0.0	0.00	0.06
Magnetite	-	-	0.07	0.07
Apatite	-	-	-	0.02
MgFeAl silicate	-	-	1.83	-
Native iron	0.01	-	0.01	-
Chromite	-	-	0.01	-
Calcite	-	-	0.08	-
Other (sim. only)	-	3.1	0.12	-
Total	100	100	100.00	100.01

Major Element Chemistry

Oxide	Apollo 16 Average Soil wt. %[6]	OB-1	Shawmere Anorthosite Avg. wt%[2]
SiO_2	45	-	48.28
Al_2O_3	26.7	-	32.01
FeO	-	-	1.34
Fe_2O_3	-	-	0.09
MgO	6.14	-	0.22
CaO	15.3	-	15.43
Na_2O	0.457	-	2.38
K_2O	0.12	-	0.16
TiO_2	0.595	-	0.05
P_2O_5	-	-	0.01
MnO	-	-	0.01
Cr_2O_3	-	-	-
V_2O_5	-	-	-
LOI + H_2O	-	-	0.39

Geomechanical and Physical Properties

Geomechanical Properties

Hardness (Mohs scale)	Specific Gravity (g/cm^3)	Angle of Repose (°)	Void Ratio
-	3.071	-	-

Density (g/cm^3)

Bulk	Relative Max	Relative Min
1.815	-	-

Triaxial: Shear Strength		Uniaxial	
Cohesion (kPa)	Friction Angle (°)	Young's Modulus (MPa)	Tensile Strength (kPa)
-	-	-	-

Simulant Development Lab Analytical Results

Pending analyses.

Safety

Please view the OB-1 Safety Data Sheet (SDS) for specifications, PPE requirements, and hazards.

Recommendation[4]

OB-1 is recommended for geotechnical testing that involves loose or compacted simulant. OB-1 is also recommended for abrasion testing and ISRU testing. View the Simulant Testing Matrix (/projects/simulants/lunar-dust-testing.html) and/or contact the JSC Simulant Development Laboratory (/projects/simulants/development-lab.html) for information concerning simulant recommendations.

Excavation / Flow

OB-1 | Recommended
Good PSD at coarse end. Lack of lithic fragments or pseudo-agglutinates may affect flowability or angle of repose. This should be examined.

CHENOBI | Recommended
Good PSD at coarse end. Lack of lithic fragments or pseudo-agglutinates may affect flowability or angle of repose. This should be examined.

Drilling

OB-1 | Most Recommended
Fidelity to mineral and glass% should yield appropriate abrasiveness, best PSD for coarse fractions.

CHENOBI | Most Recommended
Fidelity to mineral and glass % should yield appropriate abrasiveness, best PSD for coarse fractions.

Abrasion / Wear

OB-1 | Most Recommended
Fidelity to mineral and glass% should yield appropriate abrasiveness, best PSD for coarse fractions.

CHENOBI | Most Recommended
Fidelity to mineral and glass % should yield appropriate abrasiveness, best PSD for coarse fractions.

Oxygen Production

OB-1 | Not Recommended
It is expected that the abundance of Fe-rich glass will result in unrealistically high oxygen yields per energy input; no glass analyses are available.

CHENOBI | Recommended for highlands with reservations
Will serve, in a way, as a worst-case example of the highlands regolith with the highest anorthositic fraction and that with the least mare contamination (i.e., very low FeO).

Human Health Studies

OB-1 | Unsuitable composition
This is due to high Fe-glass. May be acceptable for testing where abrasiveness is of primary importance.

CHENOBI | Partially suitable composition
It lacks added phosphates and sulfides, and it represents one end-member of regolith composition; good PSD in fine fraction.

Availability

OB-1 is currently available at the JSC Simulant Development Laboratory (/projects/simulants/development-lab.html) in bulk quantities.

1. ↑ [1.0] [1.1] https://simulantdb.com/simulants/ob1.php (https://simulantdb.com/simulants/ob1.php)
2. ↑ [2.0] [2.1] [2.2] [2.3] Battler, M. M., and Spray, J. G. (2009). The Shawmere anorthosite and OB-1 as lunar highland regolith simulants. Planetary and Space Science, 2128-2131.
3. ↑ Battler, M. M., 2008. Development of an anorthositic lunar regolith simulant: OB-1. University of New Brunswick, unpublished M.Sc. thesis, 137pp.
4. ↑ [4.0] [4.1] [4.2] Schrader, C. M., Rickman, D. L., McLemore, C. A., and Fikes, J. C. (2010). Lunar Regolith Simulant User's Guide. NASA/TM-2010-216446
5. ↑ https://www.nasa.gov/sites/default/files/atoms/files/conf_pres_ptmss2008_schrader.pdf (https://www.nasa.gov/sites/default/files/atoms/files/conf_pres_ptmss2008_schrader.pdf)
6. ↑ Korotev, R. L., (1997). Some things we can infer about the Moon from the composition of the Apollo 16 regolith. Meteoritics & Planetary Science, 32, 447-478.

Eileen K. Stansbery (mailto:eileen.k.stansbery@nasa.gov)
Responsible NASA Official

ARES Developers (mailto:jsc-ares-developers@mail.nasa.gov?subject=Site: /projects/simulants/ob-1.html&body=This message originates from visiting the page: https://ares.jsc.nasa.gov/projects/simulants/ob-1.html)
Website Curators