PHYSICAL / CHEMICAL PROPERTIES & POTENTIAL TOXICITY OF LUNAR DUST

Lunar Airborne Dust Toxicity Advisory Group --- LAD-TAG

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Motivation: Humans at a Lunar Base with In-situ Resource Utilization (ISRU)

Power Source (solar cells)
Habitats for Astronauts
Mining Operations
Oxygen Production Facility
Rocket Landing Pads
Lunar Rover Vehicles

One Factor in Common?

Ubiquitous Lunar Dust: this will be a Major Problem
FATAL DISEASES FROM DUST PARTICLES

Well-known diseases in terrestrial environment
- Black Lung of coal miners
- Silicosis
- Asbestosis

Main problem is a decrease in efficiency of the surface-area of lungs
- Due to deposit of submicron particles
- Fibrous growth around particle

- **A healthy lung**: a tennis court in area
- **A diseased lung**: a few sq. meters
Approximately 50 wt% of Lunar Soil is < 50 µm;

**DUST** = <20 µm = ~20 wt%
Lunar Dust is ~20 wt.% of the average mature Lunar soil; then 2-5 wt% of that is <1 μm.

That is,

~1 wt% of a given Apollo Soil is <1 μm.
PARTICLE SIZE DISTRIBUTIONS OF LUNAR DUST

Apollo 11 Dust 10084

Apollo 17 Dust 70051

1wt% of lunar Soil = <1 μm

Max in # of Particles ~100-200 nm!

Park et al. (2006)
Max in Particles = ~700 nm

Lunar Dust Simulant, JSC-1Avf, is not suitable for Dust Studies, with regards to PSD.

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Park et al. (2006)
Glass abundances Increase as Grain-Size Decreases
Metallic Fe TOXICITY on Dissolution of Glass?

SEM
BSE

1 μm

Fe°

all white beads
Are metallic Fe°

Milky Way of Nanophase Size Metallic Fe°

Most Impact Glass Contains Nano-Sized Metallic Fe

Courtesy of Dave McKay

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Particle Size Distribution of the <10μm Dust of Apollo 11 Lunar Soil 10084; this is ~70-80% Impact Glass with nano-sized metallic Fe

Particle Size Distribution (by SEM imaging) Indicates that Mature Mare Soil may contain 0.5% of <100 nm grains

Park et al. (2006)
Synthesis of Lunar Glass Simulant with NanoPhase Metallic Fe

TEM Photos

Milky Way of np-Fe° SEM

1 μm

all white beads = Fe°

All Black Dots are Nanophase Fe

(b)

(d)

(c)
SEM Images

70051

10084

JSC-1Avf

Liu et al. (2006)
Increased reactive surface area

Liu et al. (2006)
Morphologic analysis of vesicular lunar dust

SEM images

Particle with vesicles

Vesicles

Apollo 17, 70051

Vesicles a

Area (μm²)

10.46

41.63

Ratio (a/b)

0.25

Vesicles a

Area (μm²)

20.33

79.63

Ratio (a/b)

0.26

Perimeter (μm)

134.73

29.04

4.64

Perimeter (μm)

85.64

38.46

2.23

ΣN = 145

ΣN = 39

Liu et al. (2006)

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TAKE HOMES

Dust (<20 μm) = ~20% of Lunar Soil;

<1 μm Fraction is ~1 wt% of soil;

Dust is Mainly Impact-Melt Glass;

Impact Glass contains NP Metallic Fe;

Dust PSDs have Modes at 100-200 nm;

Dust Morphologies are Complex.

Bottom Line: LOTS MORE RESEARCH TO DO