Abstract # 1142

Reactive Oxygen Species Generation by Lunar Simulants

Authors: Jasmeet Kaur[1,3], Douglas Rickman[2], Martin A. Schoonen[1,3]. [1]Department of Geosciences, Stony Brook University, Stony Brook-11794-2100; [2]Earth Science Office, National Aeronautics and Space Administration, Marshal Space Flight Center, Alabama-35812; [3]RIS[4]E, Stony Brook University, NY-11794-2100

Abstract

NASA is considering establishing a base on the Moon to support the development of future space missions. Human explorer might be at the base for prolonged stay (e.g., 15-90 days) and exposure to dust particles is inevitable. Building on earlier work on mineral toxicity, we have started a research program focused on the reactivity of lunar dust in the context of inhalation exposures.

While the mineralogical composition of lunar regolith has been well documented, other factors, such as partial melting due to space weathering, UV irradiation, and dryness may also contribute to the toxicity of lunar dust. For example, the presence of elemental iron "nano-particles" in agglutinic material in the respirable size fraction has been recognized as a possible health concern. As a first step, we have evaluated the generation of Reactive Oxygen Species (ROS) by several Lunar simulants.

Background and Objectives

ROS are chemically reactive molecules containing oxygen and include superoxide ($O_2^{\bullet-}$), hydrogen peroxide (H_2O_2), and hydroxyl radicals ($^{\bullet}OH$). Previous studies have shown that mineral dust can generate ROS when dispersed in water. Minerals generate ROS either by surface defects or step-wise reduction of molecular oxygen. In the human body, ROS are produced by various endogenous systems and they play an important role in the normal functioning of cells. However, increased levels of ROS as a result of exposure to mineral dust can lead to oxidative stress, inflammation, genotoxicity (DNA damage) or apoptosis (programmed cell death). Therefore, our aim is to study:

- H_2O_2 formation by a suite of lunar simulants dispersed in water and in Simulated Lung Fluid (SLF) using a real-time electrochemical probe
- $^{\bullet}OH$ radical formation using a spin-trap technique followed by detection using Electron Spin Resonance (ESR) spectroscopy

Formation of ROS by mineral dusts and its implication on human cells

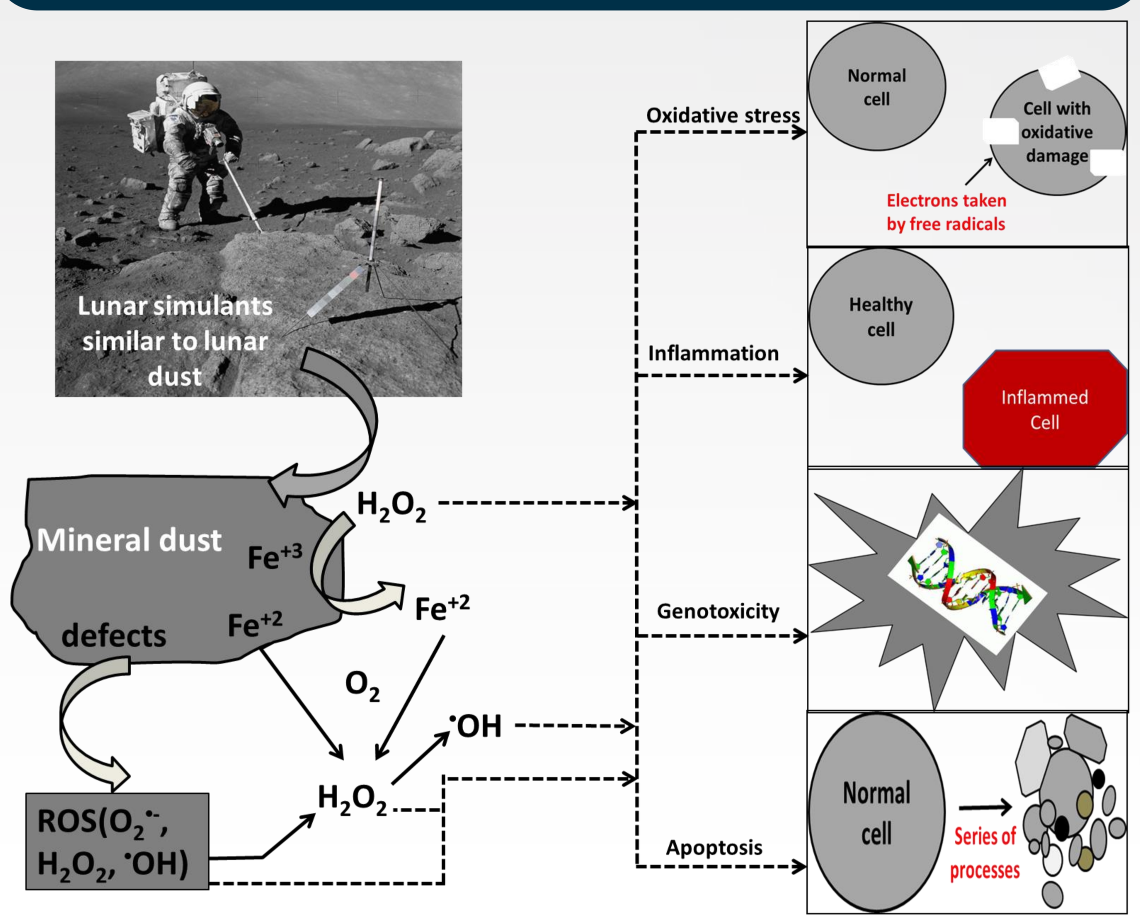

Figure 1. Formation pathways of ROS by Lunar Simulants and its effect on human cells

Lunar Surface is airless, we compared the reactivity of these simulants prepared in air and inert atmosphere.

Lunar surface is constantly under the impacts of micrometeorites,, we studied the effect of mechanical crushing on reactivity of simulants for a period of nine days

H_2O_2 formation by simulants in Air

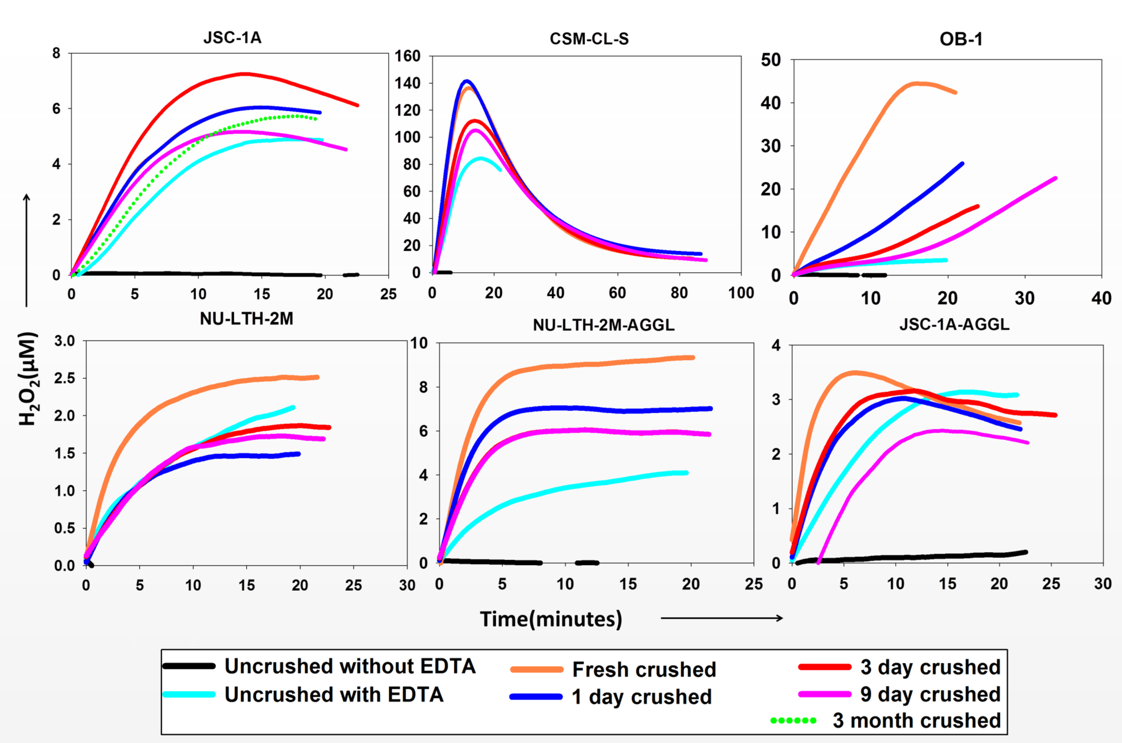

Figure 2. H_2O_2 formation by Lunar simulants in Air. H_2O_2 formation in the absence of EDTA were near or below the detection limit. Out of all simulants CSM-CL-S and OB-1 showed highest reactivity. Notice the decrease in reactivity of mechanically crushed samples with time

H_2O_2 formation by simulants in Inert Atmosphere

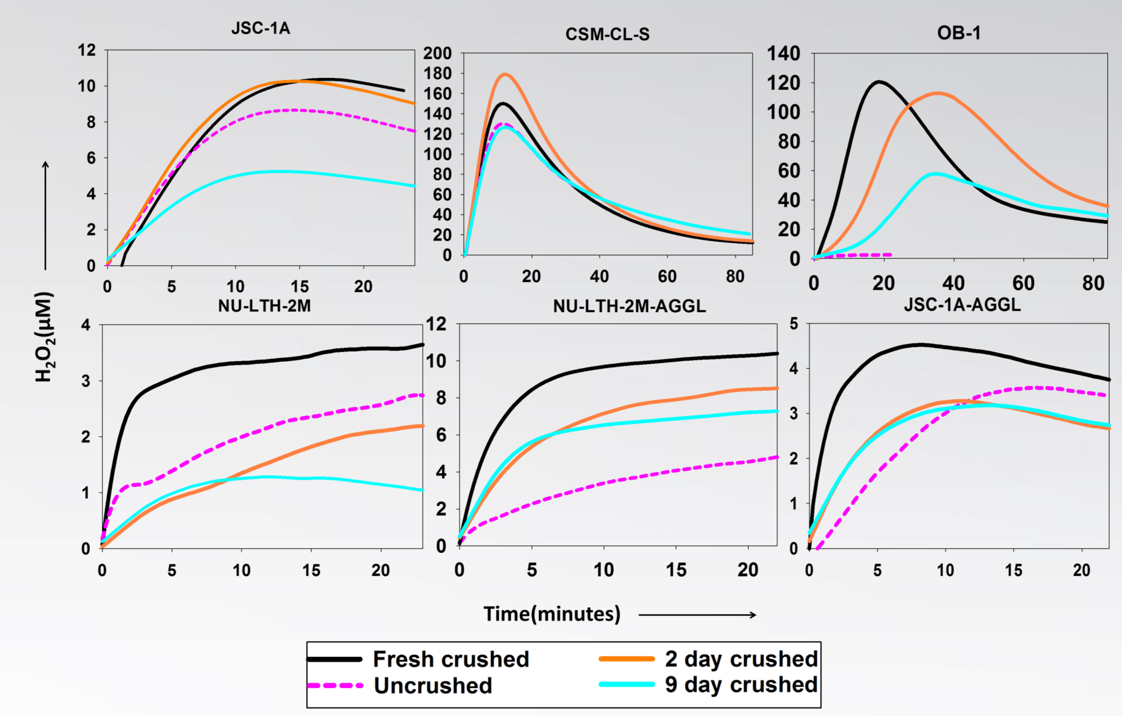

Figure 3. H_2O_2 formation by Lunar Simulants in Inert Atmosphere. CSM-CL-S and OB-1 showed highest reactivity. Notice the high reactivity of all samples in inert atmosphere compared to that in air

$^{\bullet}OH$ radical formation by simulants studied using Electron Spin Resonance (ESR) spectroscopy

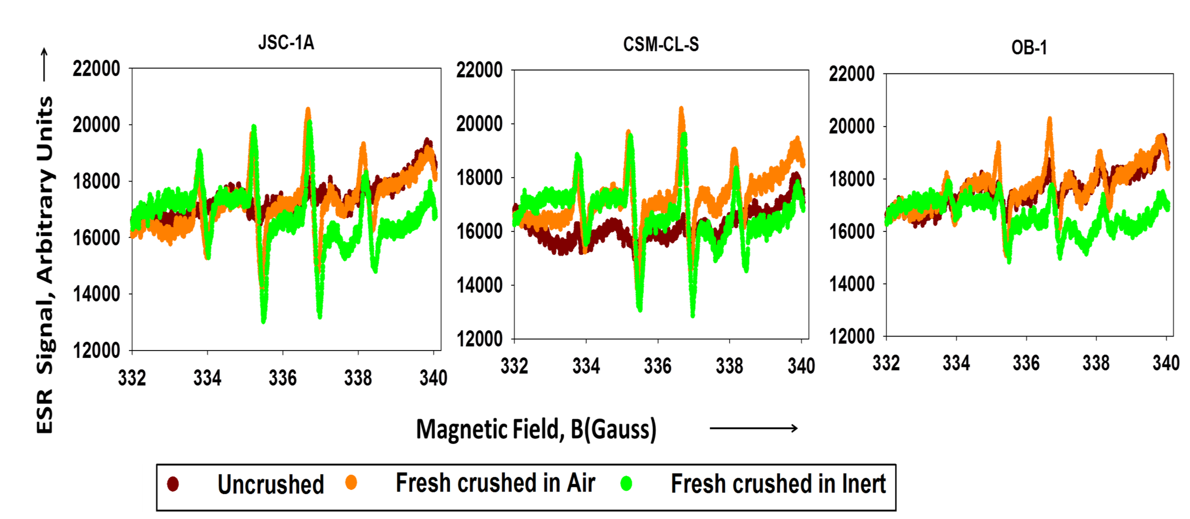

Figure 4. (A, B and C) ESR spectrum showing $^{\bullet}OH$ radical formation by JSC-1A, CSM-CL-S and OB-1 respectively.

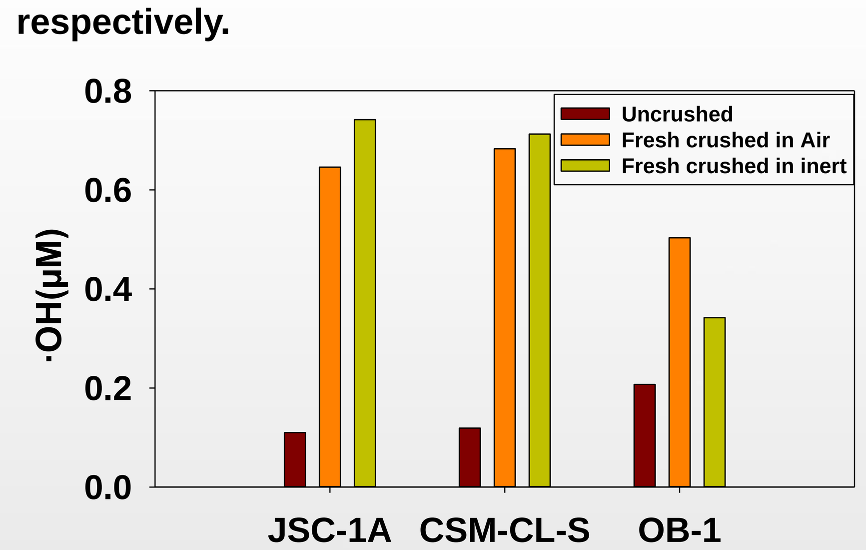

Figure 5. $^{\bullet}OH$ radical formation by uncrushed and fresh crushed JSC-1A, CSM-CL-S and OB-1 in air and inert atmosphere. Notice the significantly higher production of radical upon crushing the simulants.

Reactivity of simulants in Simulated Lung Fluid (SLF) was continuously increasing in contrast to experiments in deionized water

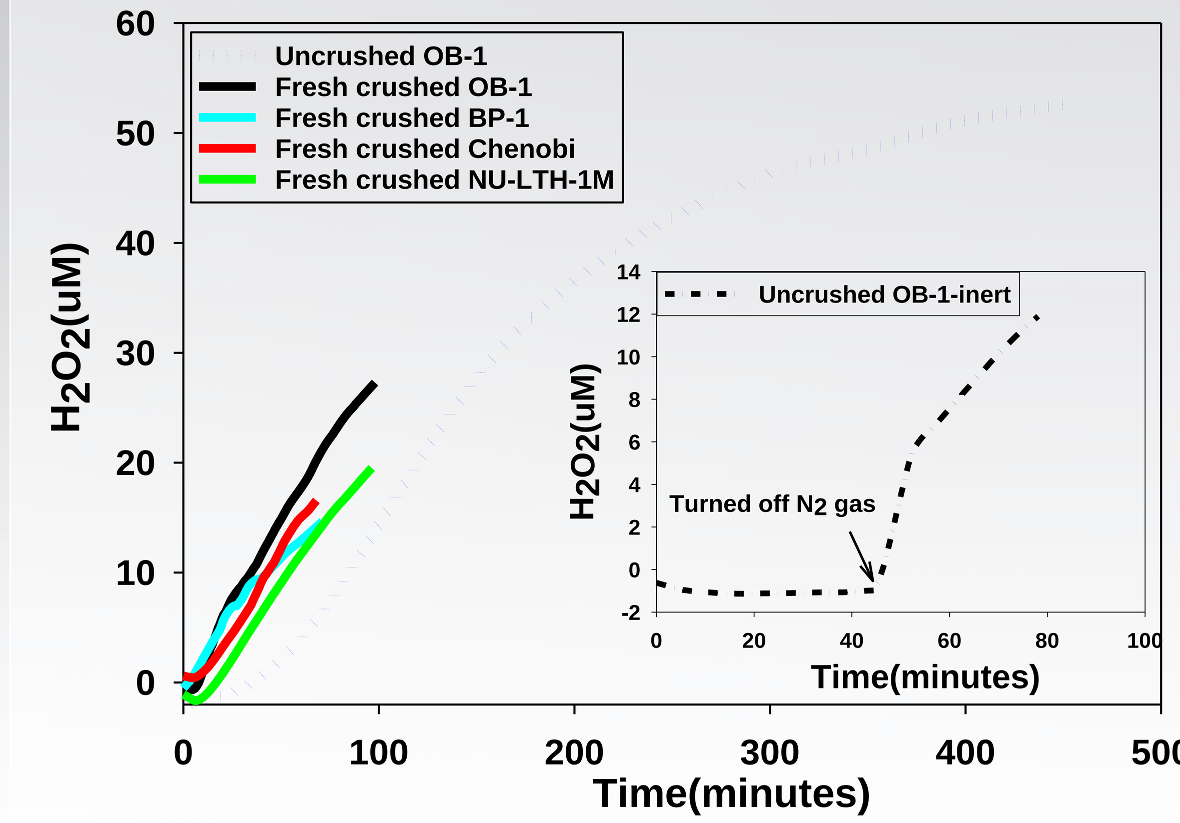

Figure 6. Formation of H_2O_2 by uncrushed and fresh crushed OB-1 and fresh crushed BP-1, Chenobi and NU-LTH-1M. Inset shows the control experiment with uncrushed OB-1 in inert atmosphere. Notice the rise in H_2O_2 concentration after turning off of N_2 gas and allowing air into the slurry.

Summary and Conclusion

- Fresh crushed samples are more reactive than uncrushed samples
- Reactivity decreases over time
- H_2O_2 and $^{\bullet}OH$ formation is higher in N_2 atmosphere compared to that in air
- Highest reactivity shown by fresh crushed CSM-CL-S and OB-1 in N_2 environment (highest glass content)
- Preliminary results with SLF showed continuous formation of H_2O_2 as compared to that in DI where H_2O_2 concentration after reaching peak values in 10-20 minutes starts to decline

Acknowledgement

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