

# Generating A More Analogous Lunar Regolith Simulant In Order To Better Understand Reactivity And Potential Toxicity



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# Purpose

- To understand the effects of lunar dust on human health
- Acquire better regolith simulants
- Real pristine samples are difficult to obtain in large quantities for meaningful analysis related to reactivity and toxicity



# Overview

- Improvement of JSC-1A as an analog to lunar samples
  - Focus on reactivity (OH\* generation) and cell toxicity
- Need an abundant alternative to hard to get lunar samples
- Use reduction method described in Allen et al. (1994)
- Compare OH\* generation of non-reduced vs. reduced
- Compare cell death between reduced vs. non-reduced samples



# Starting with JSC-1A: Widely Available

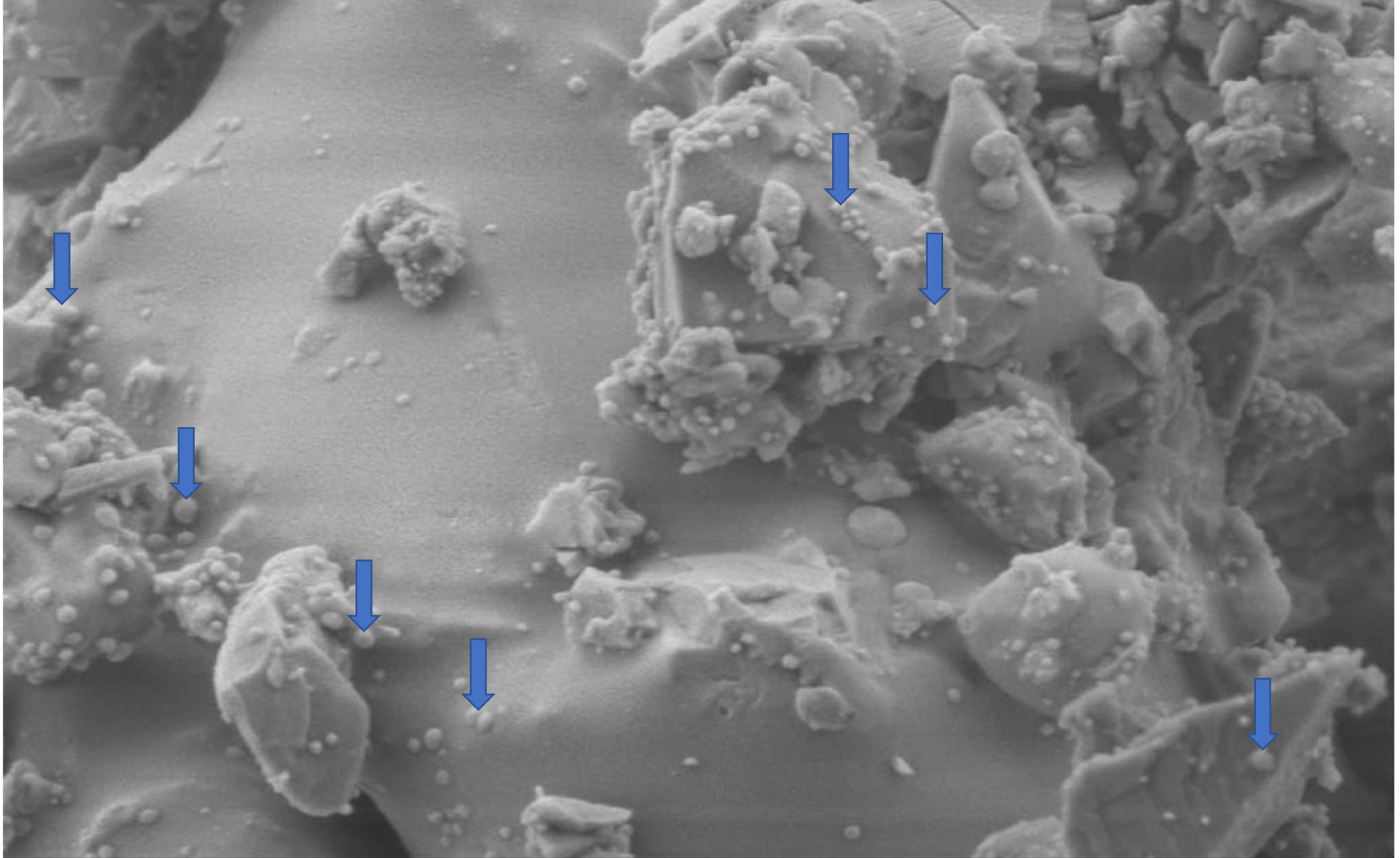
- Developed to aid in engineering projects related to Moon
- Suppose to simulate mare basalts.....but not so much
- Positives
  - Angularity/Grain Size
  - Specific Gravity
  - Glass
  - Electrical/Thermal Properties
  - Engineering- Rover testing
- Negatives\*
  - Minor hydrous phases
  - Water present
  - Large proportion of Fe<sup>3+</sup>
  - No agglutinitic glass
  - No metallic iron

• \*Hill et al. (2007); Taylor et al. (2016)

## Reduction Methods

- JSC-1A exposed to  $H_2$  for 15 min - 900 °C
- Reduced JSC-1A is darker due to the formation of native iron
- Technique similar to that in Allen et al. (1994)
- Total of 3 separate reductions of JSC-1A





Mag = 50.00 K X  
WD = 10 mm

200nm  


File Name = 041219-259.tif

30°

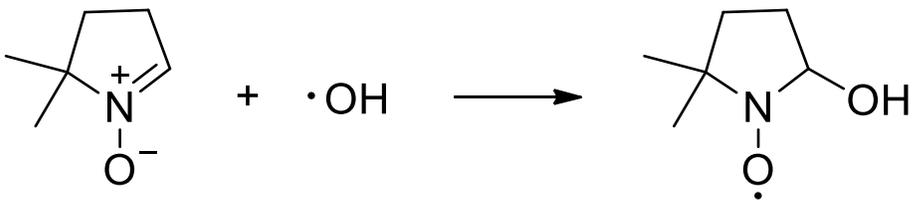
Signal A = SE2  
EHT = 2.50 kV

Date :12 Apr 2019  
Time :11:42:24



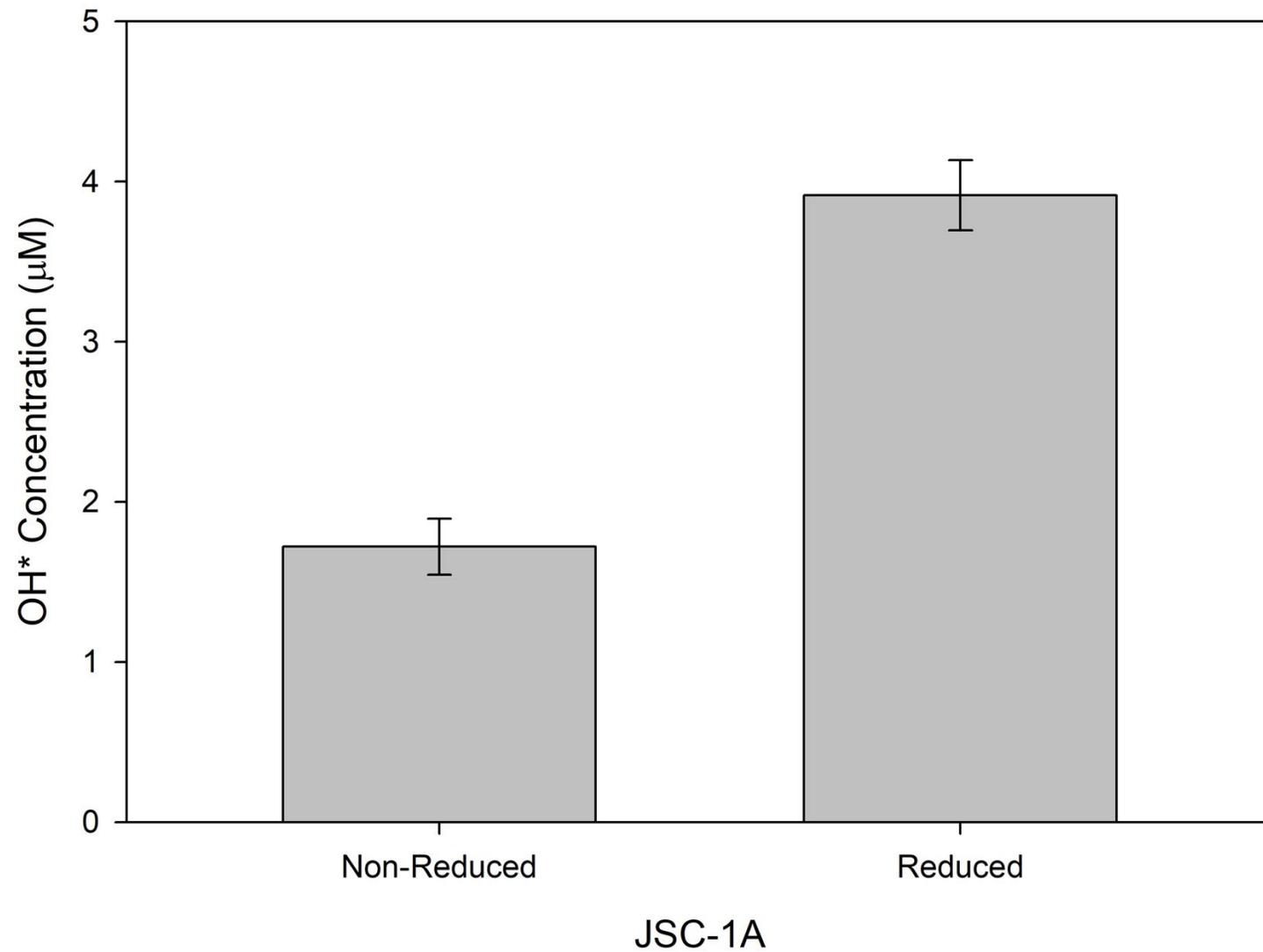
# OH\* Measurements

- Electron Paramagnetic Resonance (EPR) Spectroscopy
- Use DMPO to trap OH\*
  - Peak intensities calibrated to OH\* concentration
- Total of 9 ~200 mg reduced and non-reduced samples
  - Each was tested three times on EPR for total of 27 measurements

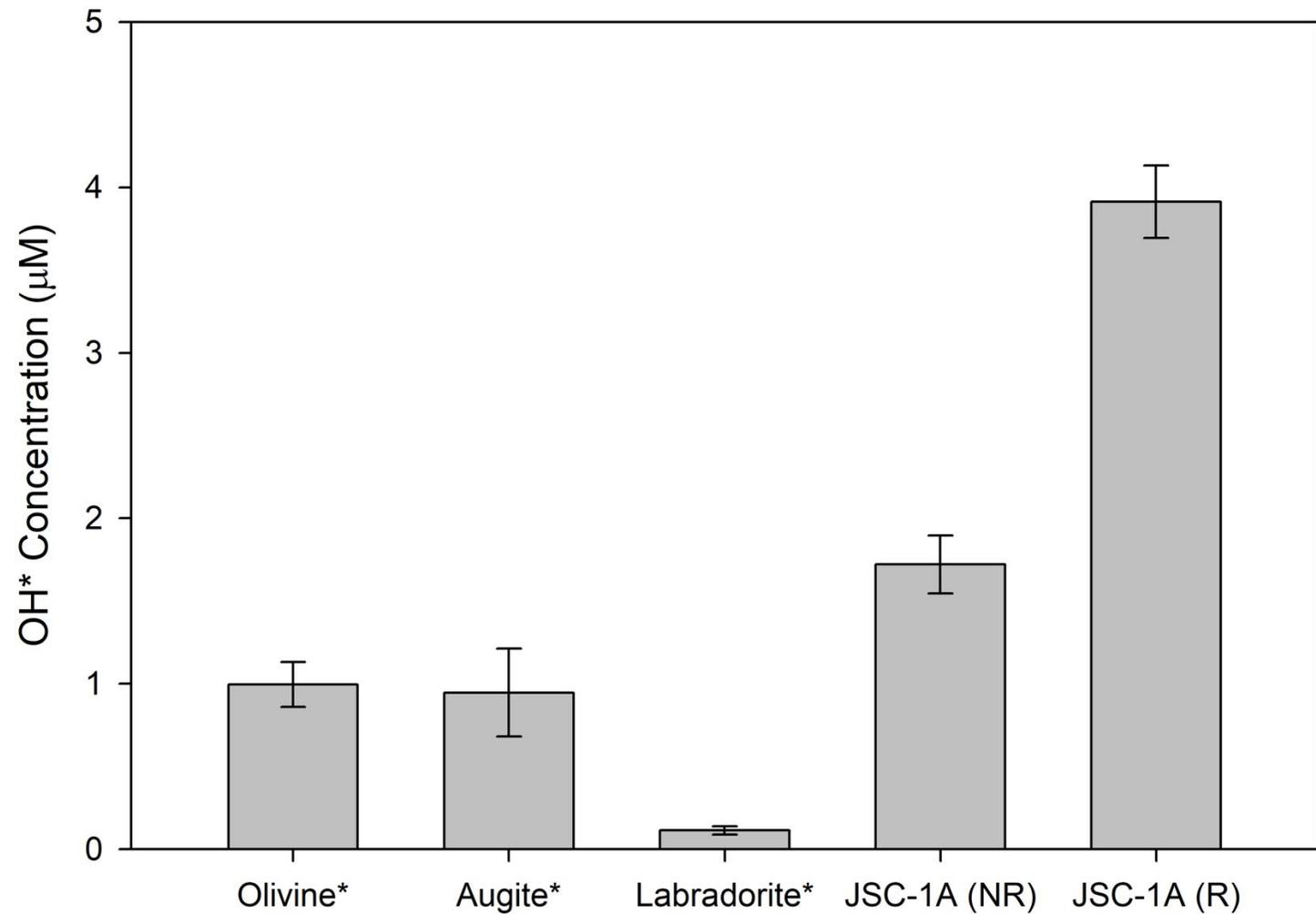


## Non-Reduced vs. H<sub>2</sub> Reduced JSC-1A

OH\*  
Generation  
Reduced vs.  
Non-  
Reduced



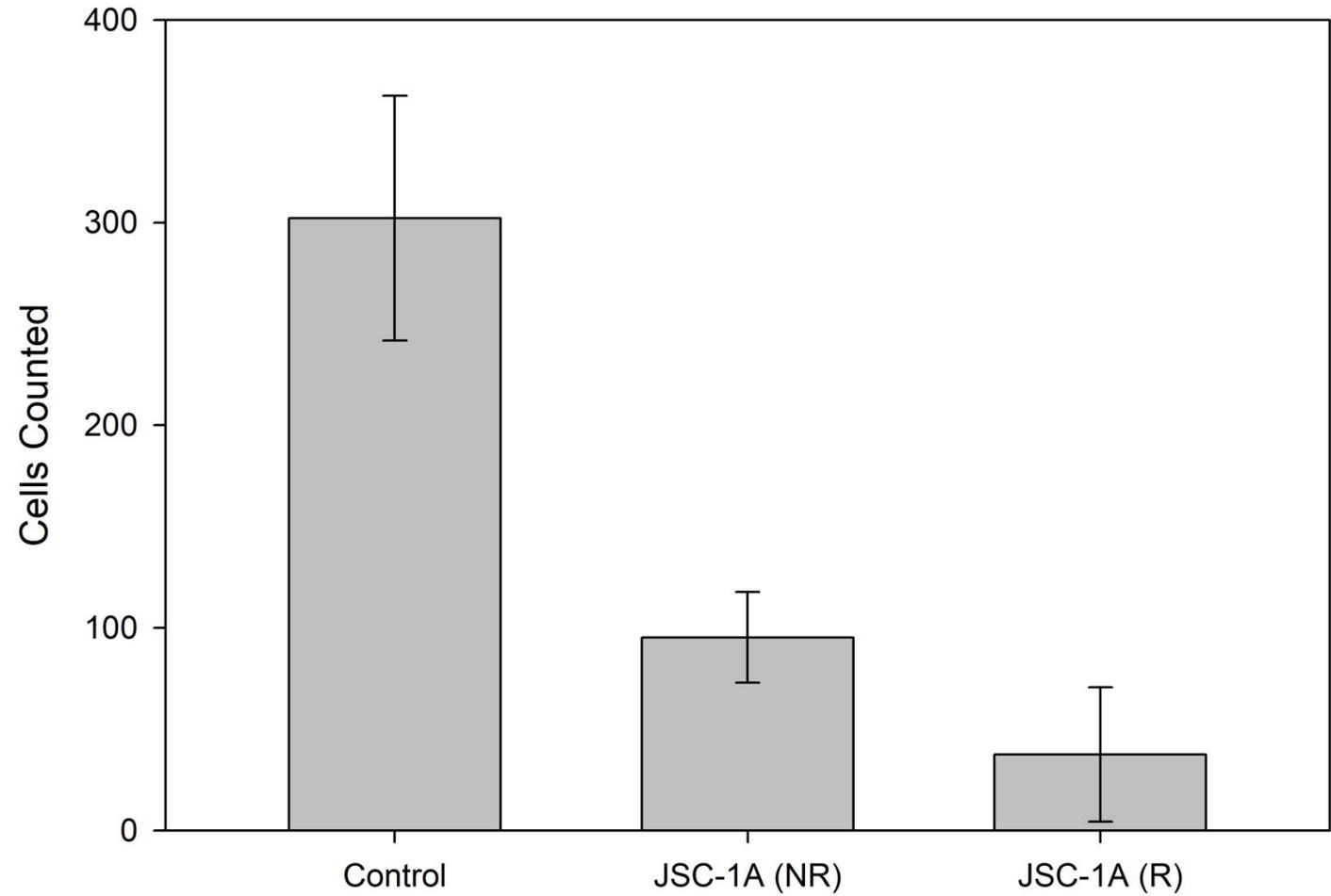
Comparison  
to Pure  
Mineral  
Phase OH\*  
Generation



- \*Hendrix et al. (2019)

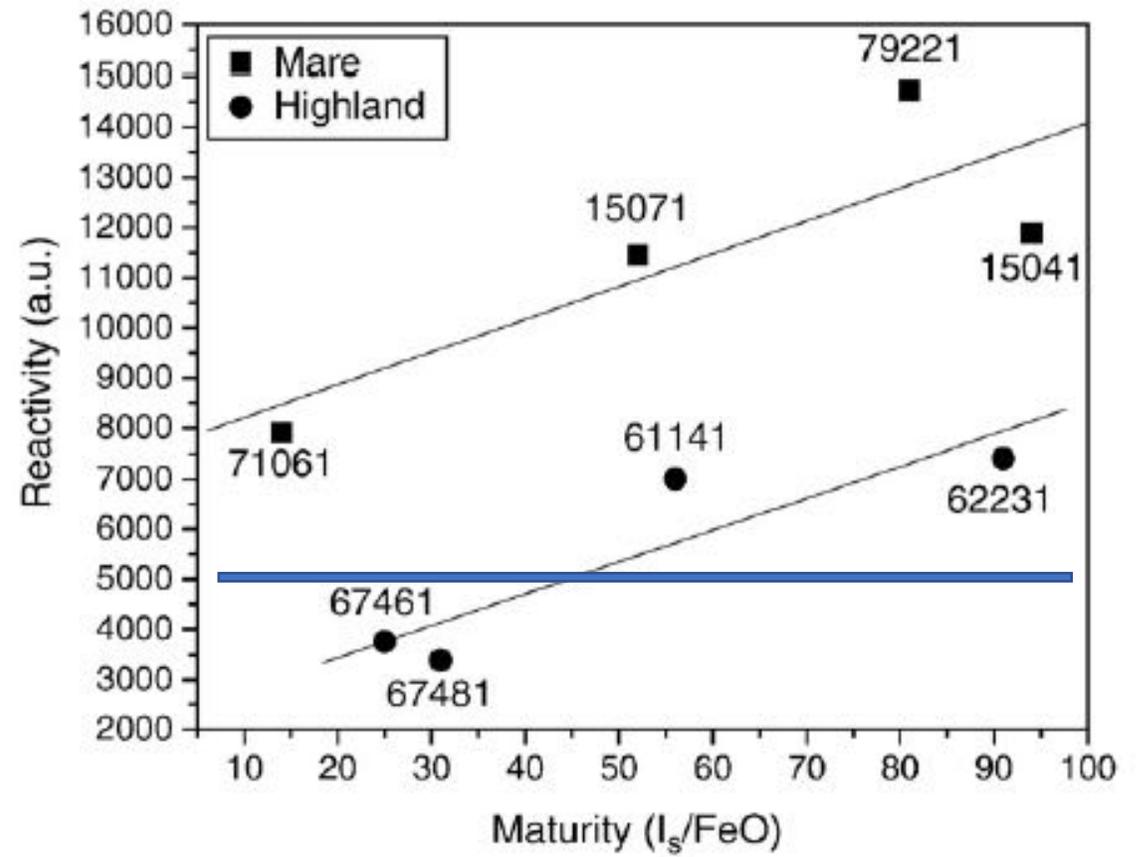
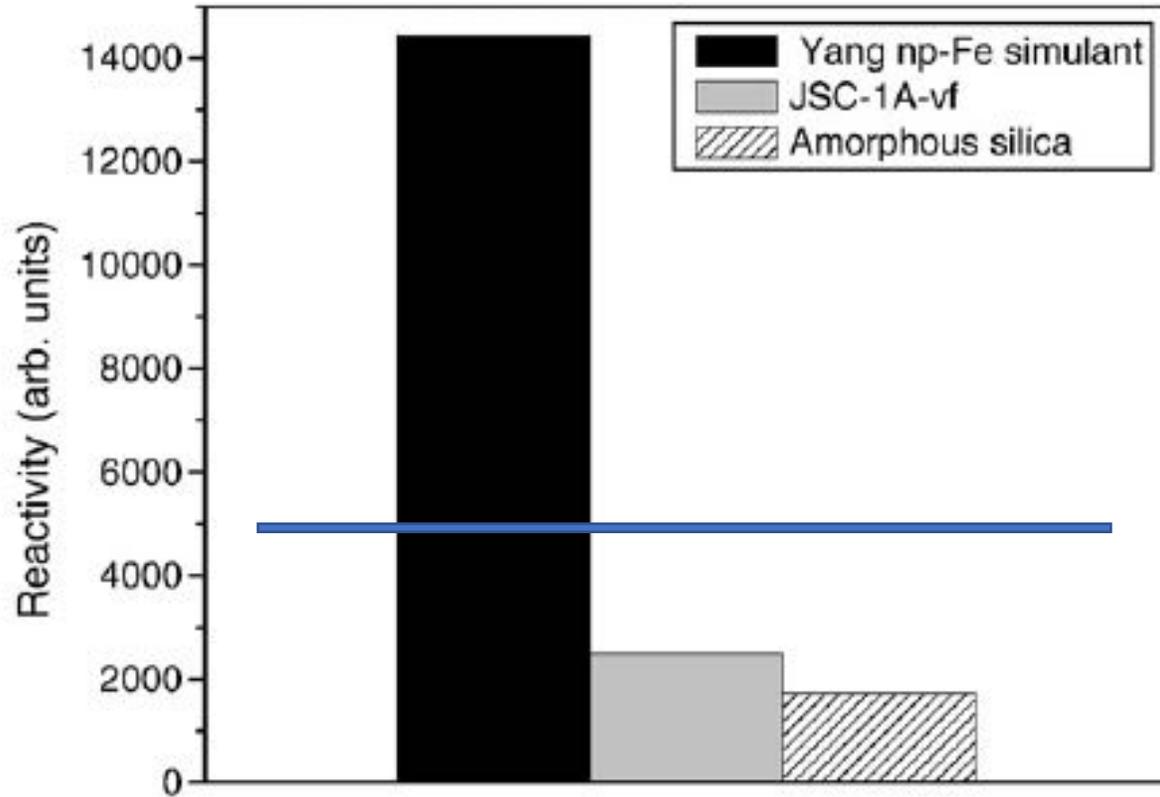
Preliminary  
Toxicity Data

Cell Death Experiments



- Data from Dr. Rachel Caston, Bruce Demple Group, Dept. Pharmacology SBU

# Comparison to real regolith



- Wallace et al. (2010)

# Conclusions

- SEM image show iron metal blebs in our work similar to Allen et al. (1994)
- Reactivity and cell death experiments overall consistent
  - 27 OH\* measurements with little error
  - OH\* generation doubles for reduced JSC-1A
  - Likely due to metallic iron blebs on surface
  - Significantly larger cell death for reduced sample
  - OH\* generation higher for reduced JSC-1A than for non-reduced mineral phases

# Future Work

- Results with JSC-1A shows our methods are reproducible
  - Use these methods to make better analogs than JSC-1A (i.e. mix of individual mineral phases)
- Reduction of pure mineral phases is the potential next step
  - OH\* generation
  - Cell death
- Heat treatment of JSC-1A in inert gas
  - Assess other factors that may contribute to reactivity/toxicity
  - Besides H<sub>2</sub>
- Use of a simulant such as the Yang np-Fe simulant used in Wallace et al. (2010)
  - Results similar to observed reactivities in Wallace et al. (2010)

# Acknowledgements

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