



HYDROGEN PEROXIDE AS A METHOD FOR BIOBURDEN REDUCTION IN FACILITIES WITH STRICT MATERIALS REQUIREMENTS.

A. B. Regberg , C.L. Amick, R. E. Davis, E.K. Lewis, F. Mazhari, J.L. Mitchell, D.L. Owens and, F. M. McCubbin



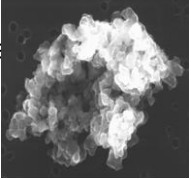
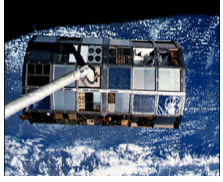
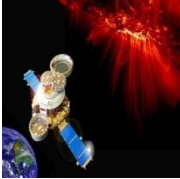
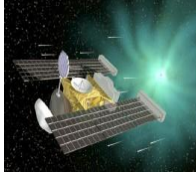

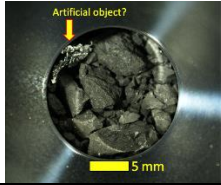
11/2021



THE ASTROMATERIALS ACQUISITION AND CURATION OFFICE

Our Past 50 years – planning for and curating multiple collections




<p>Lunar (1969) Apollo program lunar rocks and soils; Luna samples</p> 	<p>Meteorite (1977) Antarctic Search for Meteorites (ANSMET) program</p> 	<p>Cosmic Dust (1981) Cosmic dust grains from Earth's stratosphere</p> 	<p>Micro- particle (1985) Space exposed hardware from spacecraft</p> 	<p>Genesis (2004) Genesis solar wind samples at Earth-Sun L1 point</p> 	<p>Stardust (2006) Cometary and interstellar samples from Comet Wild 2</p> 	<p>Hayabusa (2012) Samples collected from JAXA asteroid mission to Itokawa</p> 	<p>Hayabusa II (2020) Subset of samples collected from JAXA asteroid mission to 162173 Ryugu</p> 
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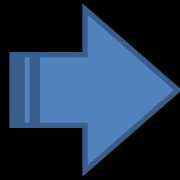

Our Near Future . . .

Our More Distant Future . . .


OSIRIS-REx
(2023)
Asteroid sample
return from
101955 Bennu



Artemis
(2025)
Lunar South
Pole. Cold
Sample return?



Mars
(~2030s)

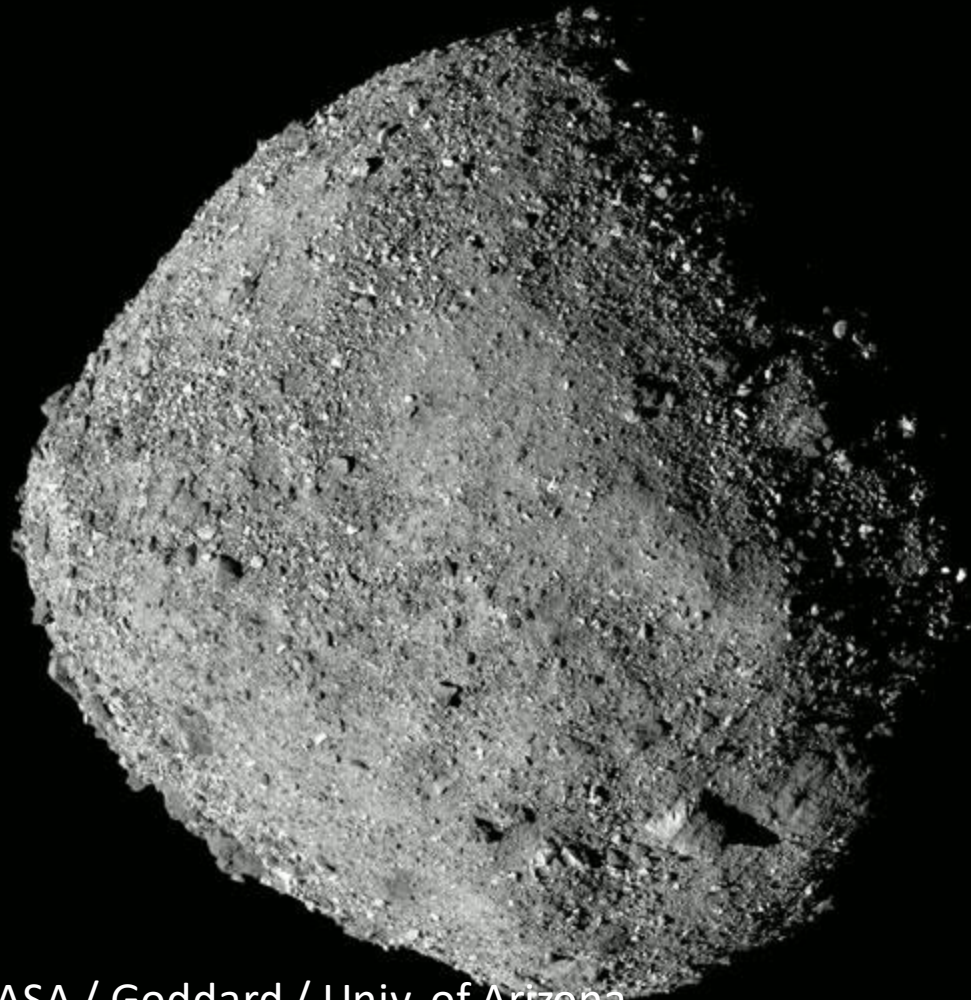


(est. 1964)


**Comet
Enceladus
Europa
Ceres**




OUR NEW COLLECTIONS WILL BE MORE SUSCEPTIBLE TO BIOLOGICAL CONTAMINATION



↳ Dr. Sarah Milkovich Retweeted

 **Nadia Drake** @nadiamdrake · 20h ▾

"Have any of you been up close with the Murchison meteorite and smelled it? It smells like an oil well. It's so filled with organics, that's what it smells of." -- @ltelkins, on the possibilities of life evolving on small rocky bodies #Discuss2019



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NASA / Goddard / Univ. of Arizona



SCIENCE REQUIREMENTS LIMIT THE SCOPE OF ACCEPTABLE CLEANING AGENTS



Did meteorites deliver the building blocks of life to Earth?

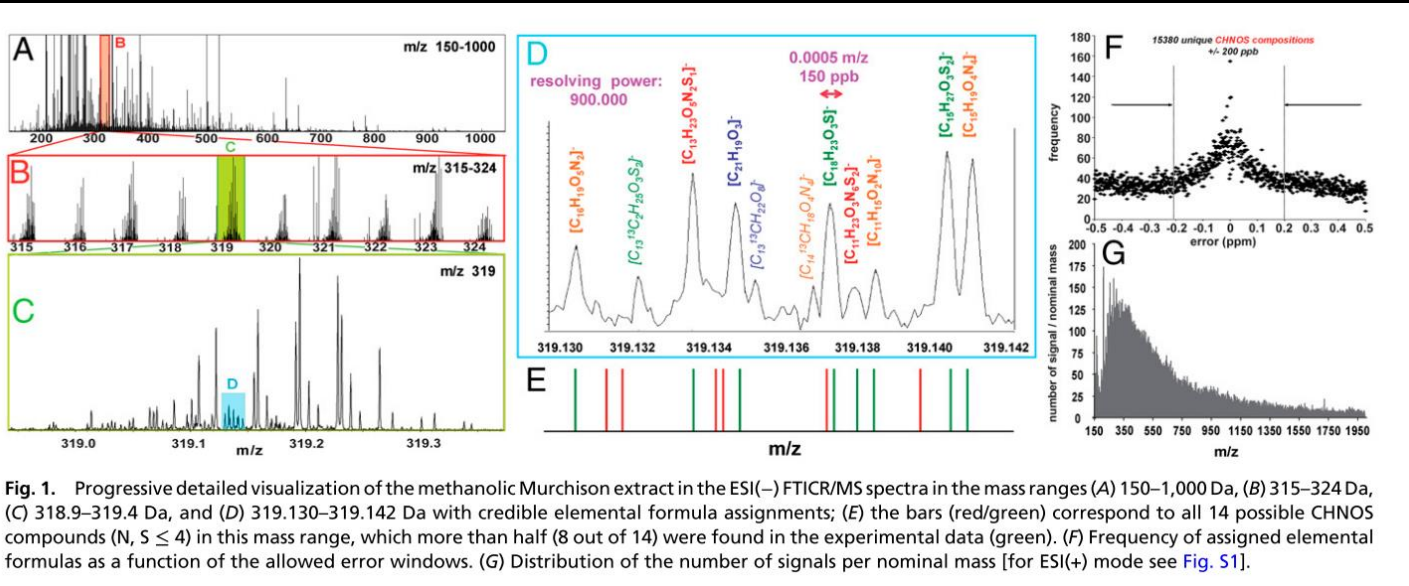


Fig. 1. Progressive detailed visualization of the methanolic Murchison extract in the ESI(-) FTICR/MS spectra in the mass ranges (A) 150–1,000 Da, (B) 315–324 Da, (C) 318.9–319.4 Da, and (D) 319.130–319.142 Da with credible elemental formula assignments; (E) the bars (red/green) correspond to all 14 possible CHNOS compounds ($N, S \leq 4$) in this mass range, which more than half (8 out of 14) were found in the experimental data (green). (F) Frequency of assigned elemental formulas as a function of the allowed error windows. (G) Distribution of the number of signals per nominal mass [for ESI(+) mode see Fig. S1].

Schmitt-Kopplin, P., Gabelica, Z., Gougeon, R. D., Fekete, A., Kanawati, B., Harir, M., Gebefuegi, I., Eckel, G., & Hertkorn, N. (2010). High molecular diversity of extraterrestrial organic matter in Murchison meteorite revealed 40 years after its fall. *Proceedings of the National Academy of Sciences of the United States of America*, 107(7), 2763–2768. <https://doi.org/10.1073/pnas.0912157107>

Quaternary Ammonia
 Peracetic Acid
 Formaldehyde
 Glutaraldehyde
 Orth-paraldehyde

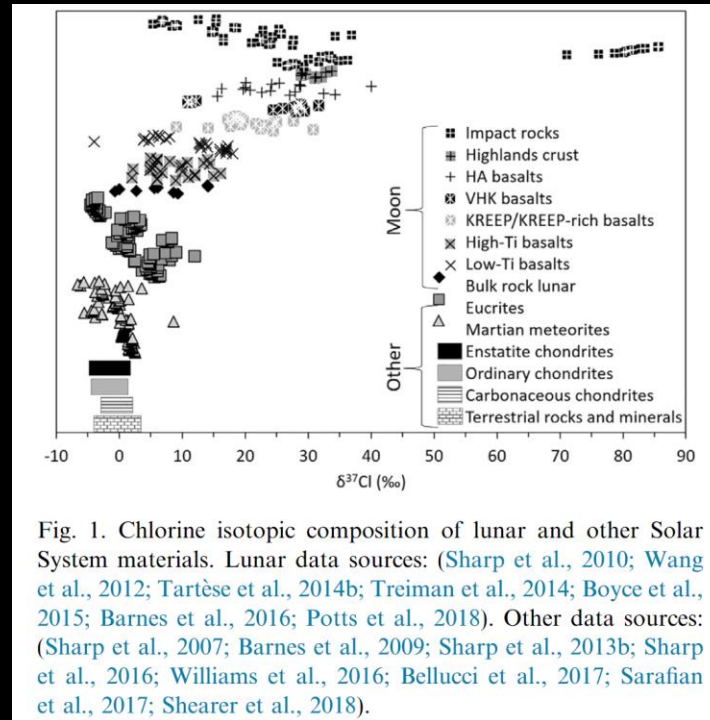
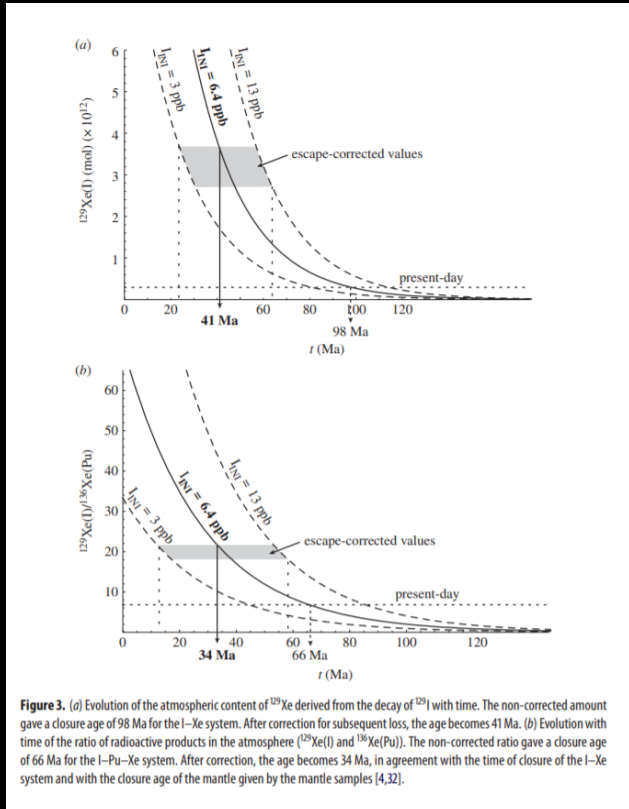


SCIENCE REQUIREMENTS LIMIT THE SCOPE OF ACCEPTABLE CLEANING AGENTS



How and when did the moon form?

Chlorine Compounds
Iodophors



Avice, G., & Marty, B. (2014). The iodine-plutonium- xenon age of the Moon-Earth system revisited. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 372(2024). <https://doi.org/10.1098/RSTA.2013.0260>

Barnes, J. J., Franchi, I. A., McCubbin, F. M., & Anand, M. (2019). Multiple reservoirs of volatiles in the Moon revealed by the isotopic composition of chlorine in lunar basalts. *Geochimica et Cosmochimica Acta*, 266, 144–162. <https://doi.org/10.1016/J.GCA.2018.12.032>



CAN HYDROGEN PEROXIDE BE USED AS A DISINFECTANT WITHOUT INTRODUCING CONTAMINATION?



Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008

William A. Rutala, Ph.D., M.P.H.^{1,2}, David J. Weber, M.D., M.P.H.^{1,2}, and the Healthcare Infection Control Practices Advisory Committee (HICPAC)³

¹Hospital Epidemiology
University of North Carolina Health Care System
Chapel Hill, NC 27514

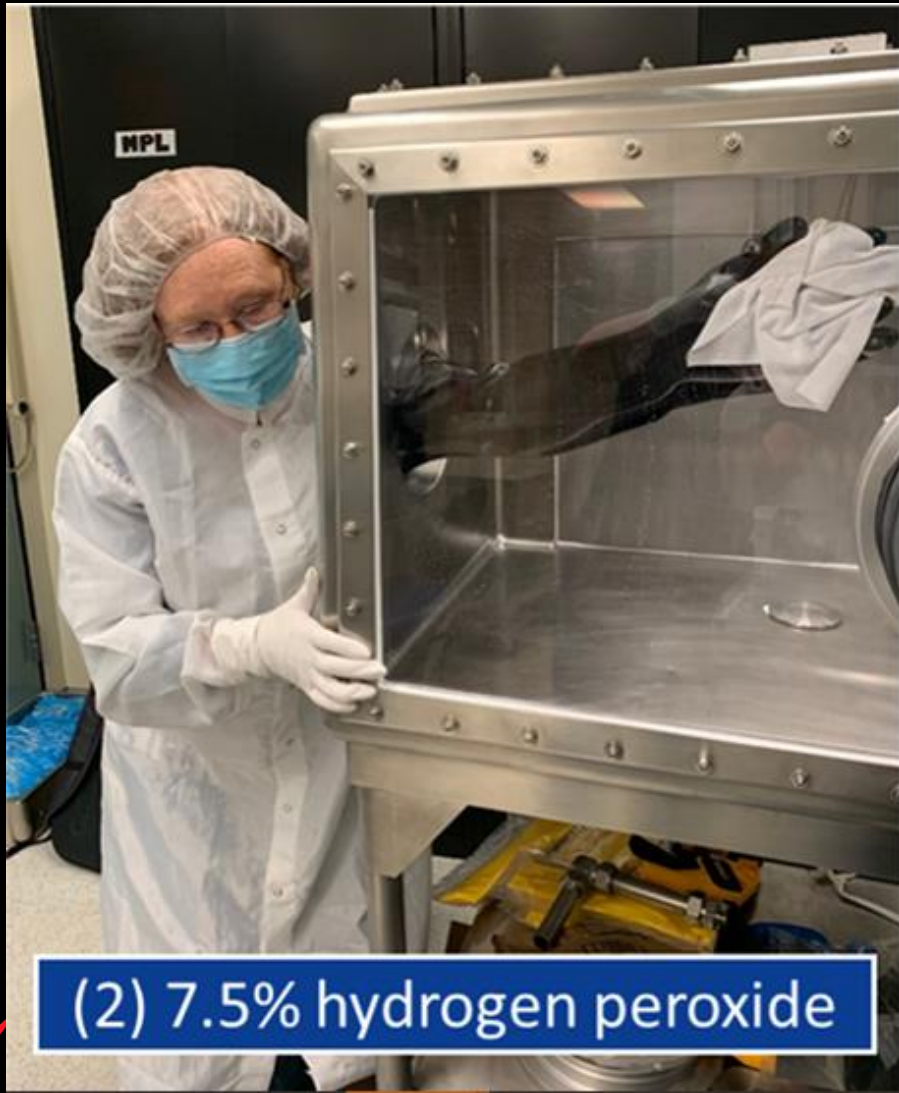
²Division of Infectious Diseases
University of North Carolina School of Medicine
Chapel Hill, NC 27599-7030

Available from:
<https://www.cdc.gov/infectioncontrol/guidelines/disinfection/>

- 7.5 wt. % Hydrogen Peroxide can be used as a high-level disinfectant with a 30 minute contact time or as a sterilant with a 6 hour contact time.
- Hydrogen Peroxide inactivates spores (bacterial and fungal) and viruses that isopropyl alcohol cannot
- Trace metal certified hydrogen peroxide is commercially available at 30 wt. %.
 - Dilute to appropriate concentrations with ultra-pure water already used for cleaning
- Medical grade peroxide is not monitored for trace metal contamination.



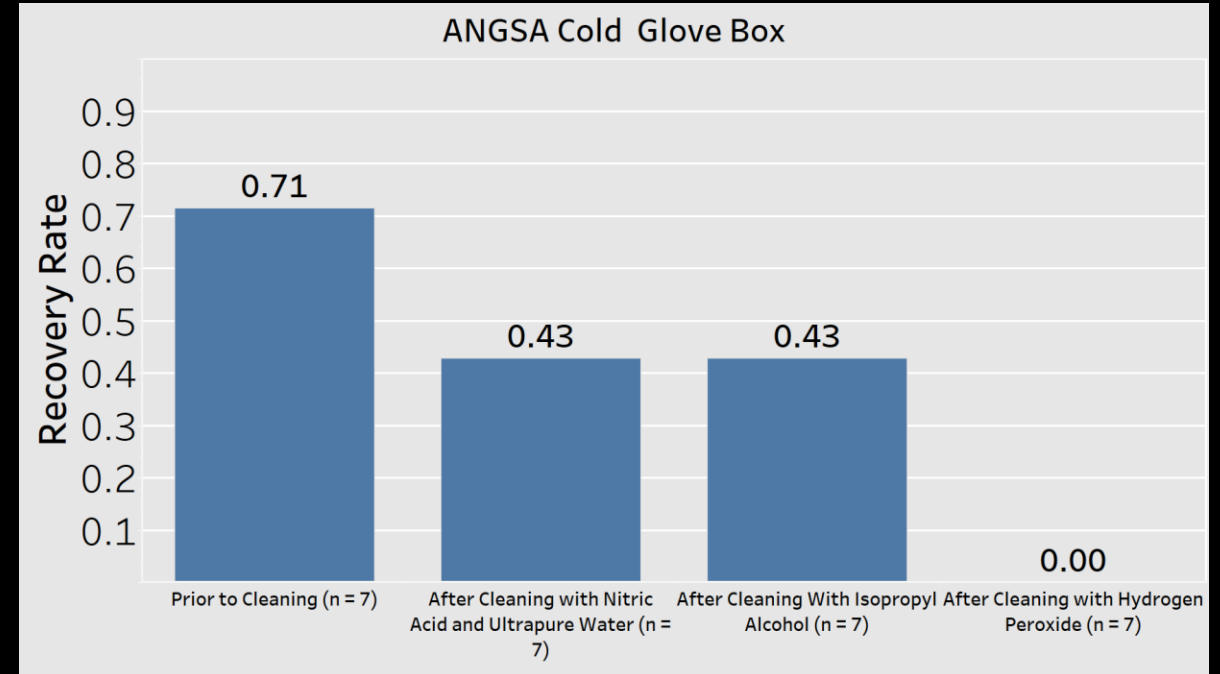
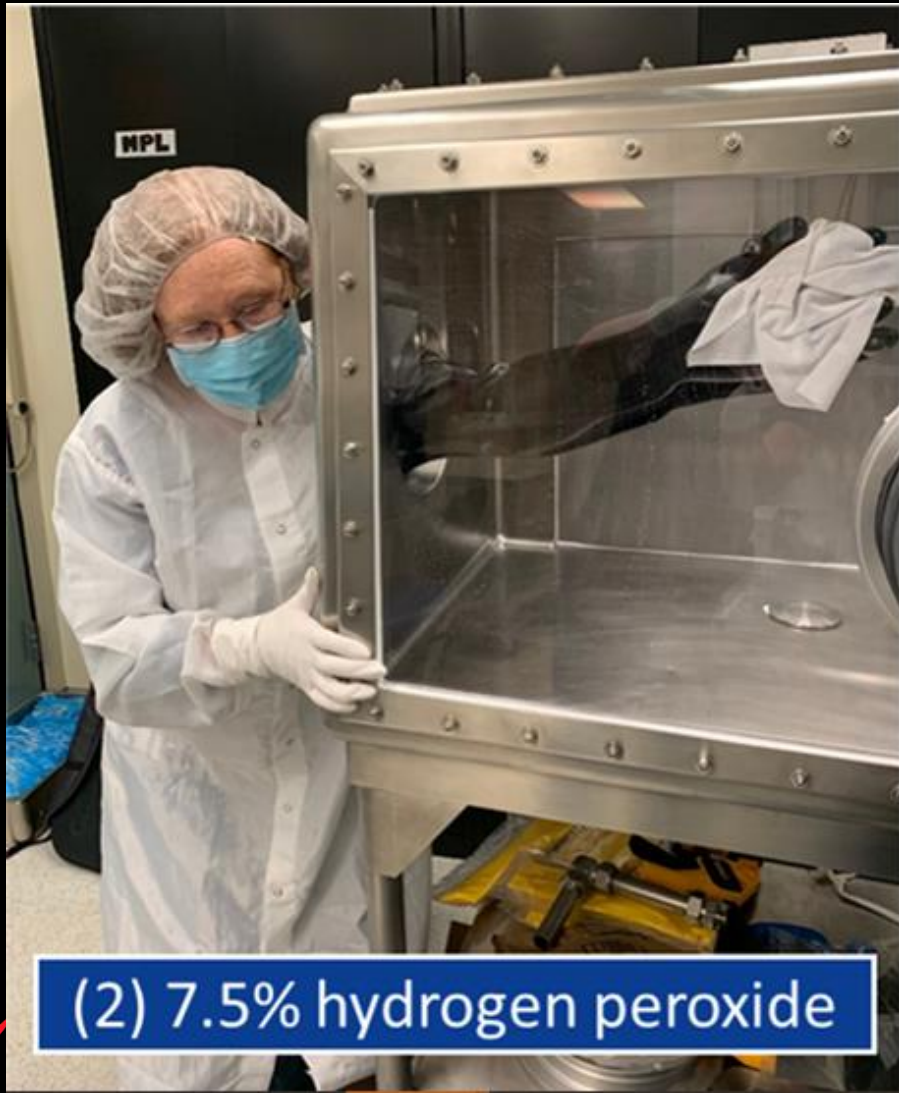
7.5 WT. % HYDROGEN PEROXIDE USED TO DISINFECT A CABINET FOR PROCESSING UNOPENED APOLLO SAMPLES (ANGSA)



- Saturate surfaces with peroxide
- 30 minute contact time
- Rinse with ultrapure water
- Sample cabinet between each cleaning step



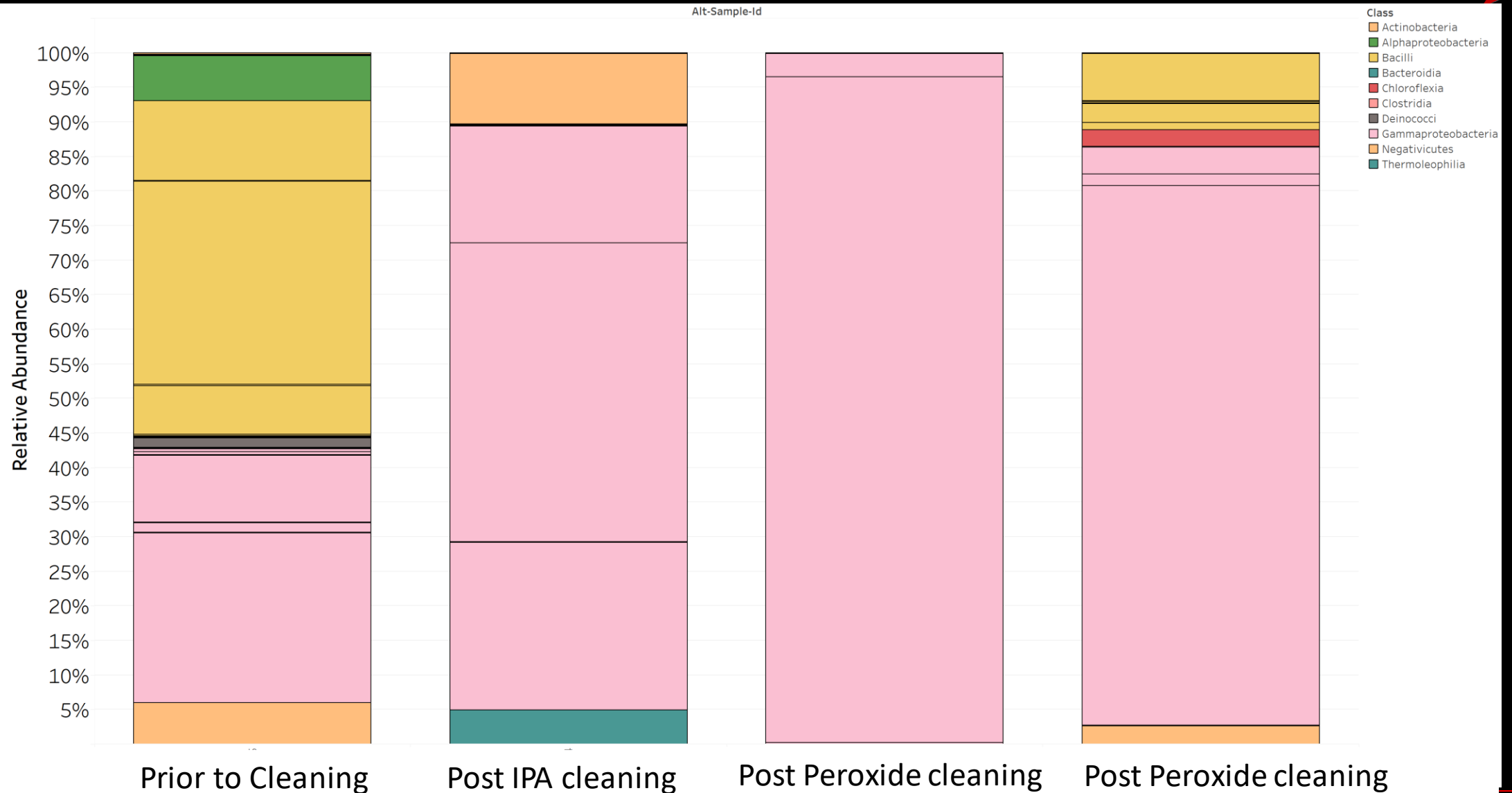
7.5 WT. % HYDROGEN PEROXIDE USED TO DISINFECT A CABINET FOR PROCESSING UNOPENED APOLLO SAMPLES (ANGSA)



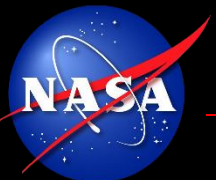
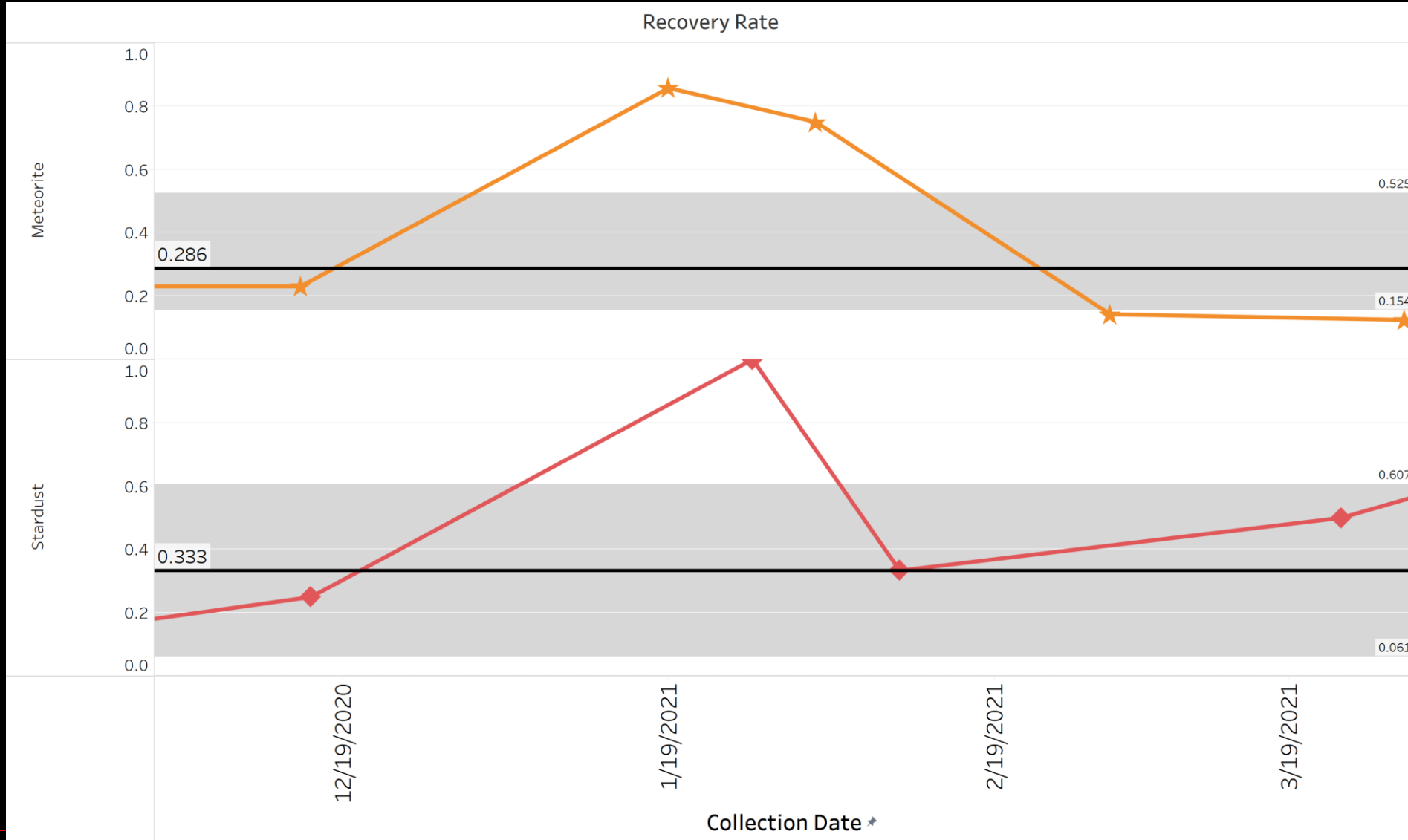
$$\text{Recovery Rate} = \frac{\# \text{ of samples with } > 0 \text{ CFU}}{\# \text{ total number of samples collected during a sampling event}}$$



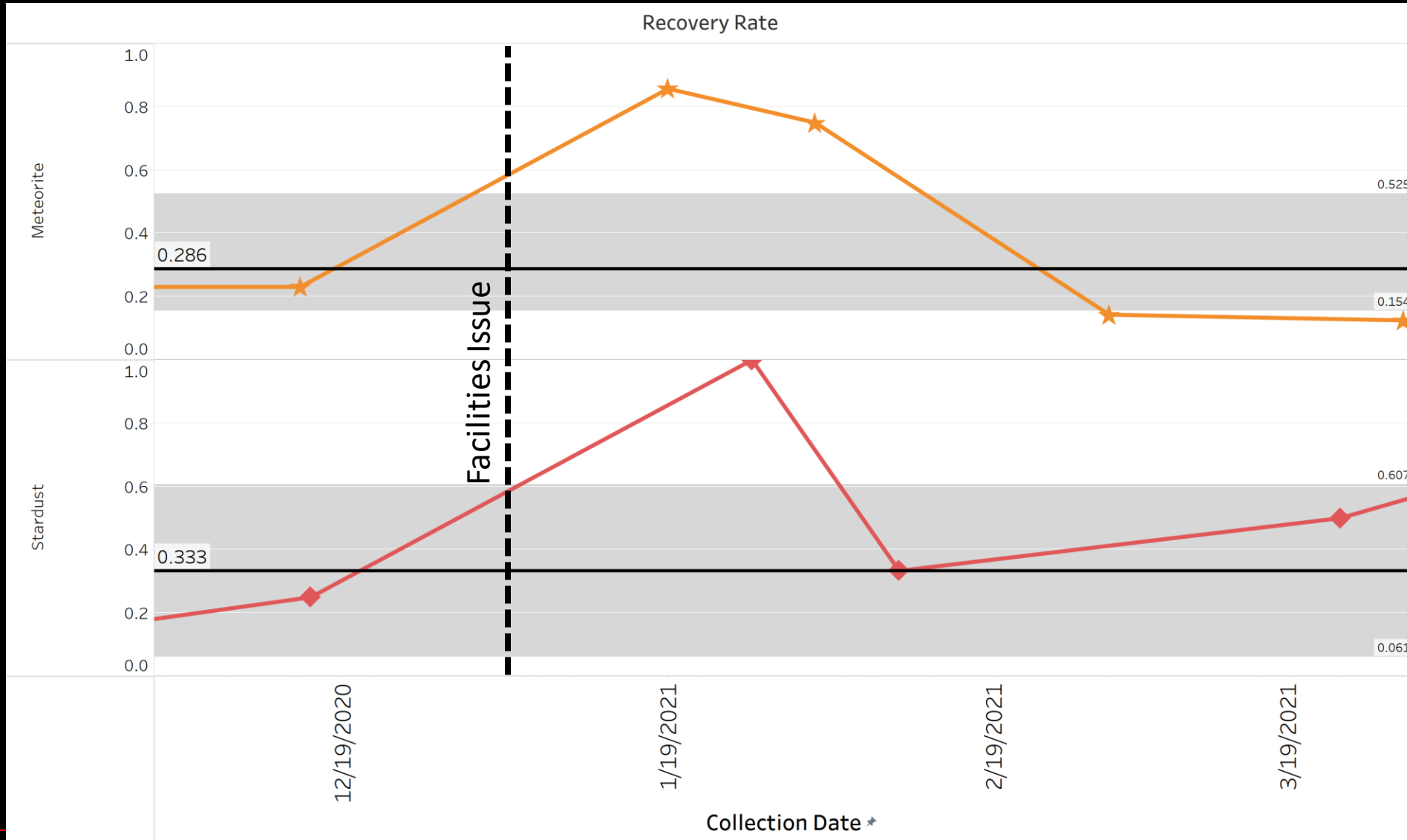
NEXT GENERATION DNA SEQUENCING SHOWS A DECREASE IN COMMUNITY DIVERSITY AFTER CLEANING



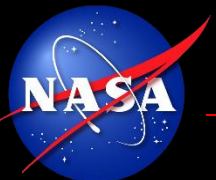
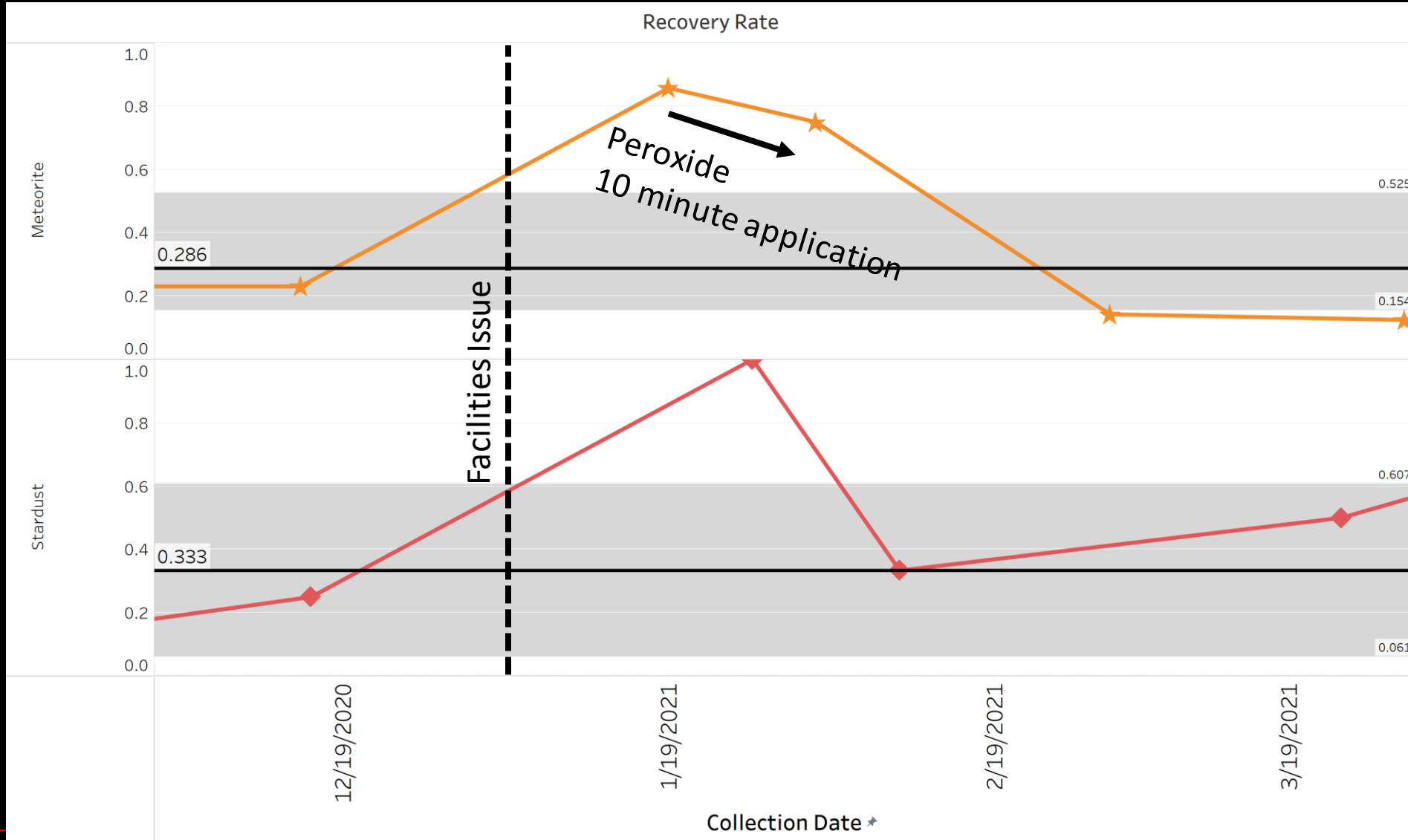
PEROXIDE TREATMENT ALSO REDUCED MICROBIAL CONTAMINATION IN CURATION LABS



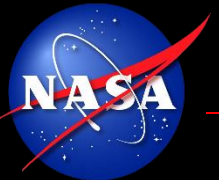
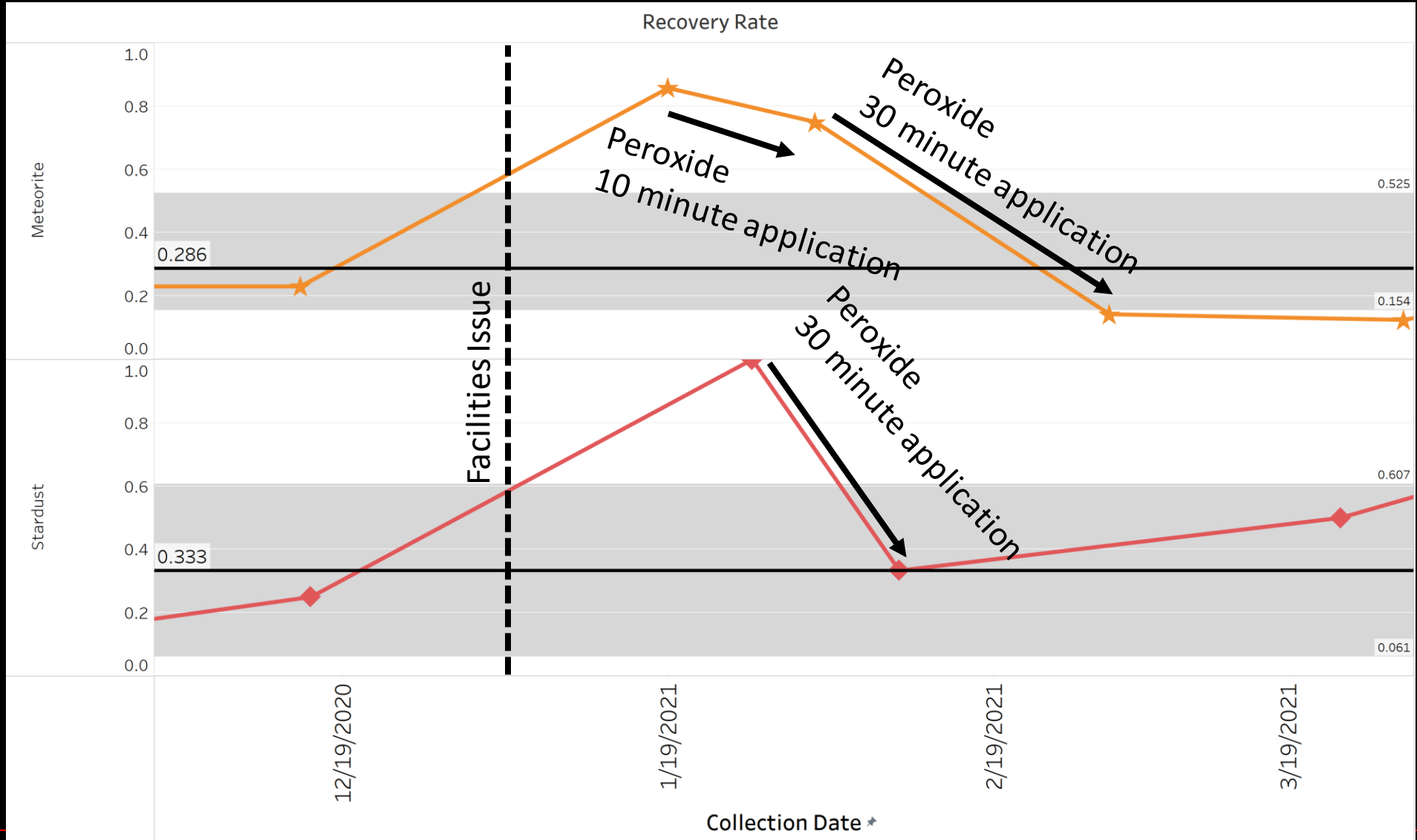
PEROXIDE TREATMENT ALSO REDUCED MICROBIAL CONTAMINATION IN CURATION LABS



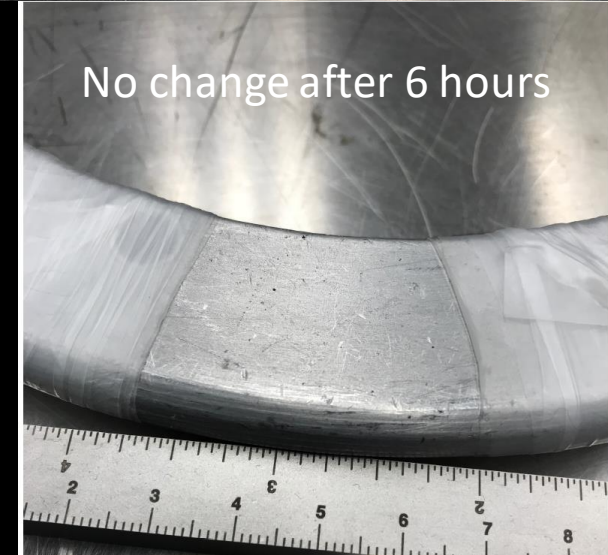
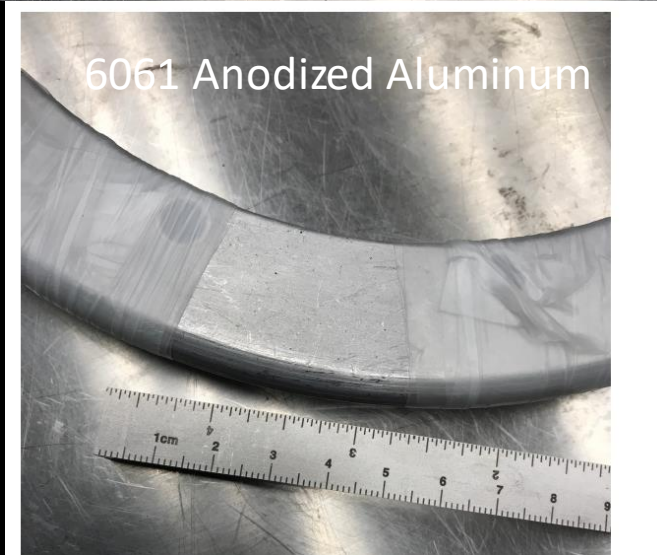
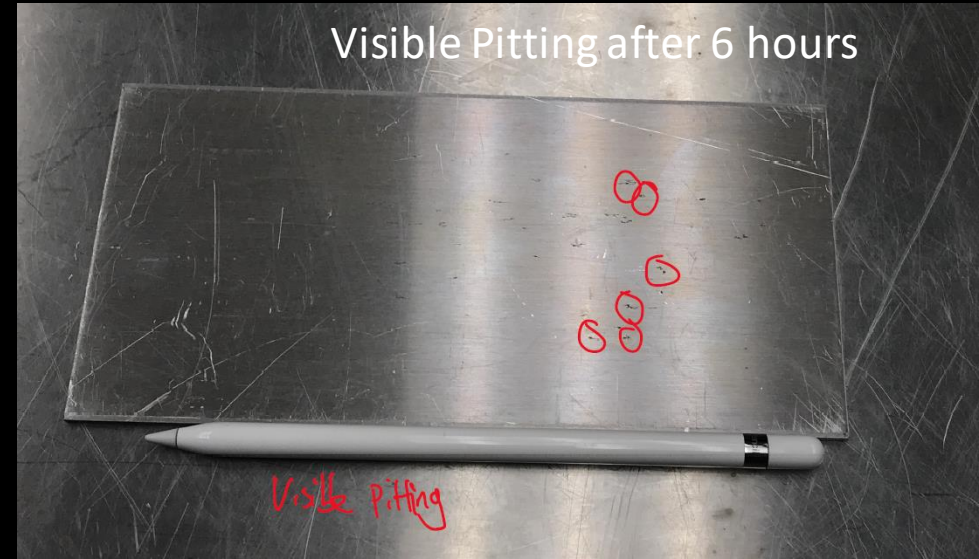
PEROXIDE TREATMENT ALSO REDUCED MICROBIAL CONTAMINATION IN CURATION LABS



PEROXIDE TREATMENT ALSO REDUCED MICROBIAL CONTAMINATION IN CURATION LABS



6 HOUR CONTACT TIME CAN CAUSE PITTING IN UN-ANODIZED ALUMINUM



CONCLUSIONS



- 7.5 wt% peroxide can be used to reduce bioburden without introducing unwanted trace-metal or organic contamination.
- Peroxide can inactivate spore forming bacteria and viruses that are resistant to alcohol-based cleaning agents.
- Peroxide is compatible with:
 - Stainless steel
 - Glass
 - Teflon
 - Anodized aluminum
- Care should be taken with un-anodized aluminum

