

# NIOSH Lab and Field Research: Novel Methods to Detect and Remove Toxic Metals from Skin

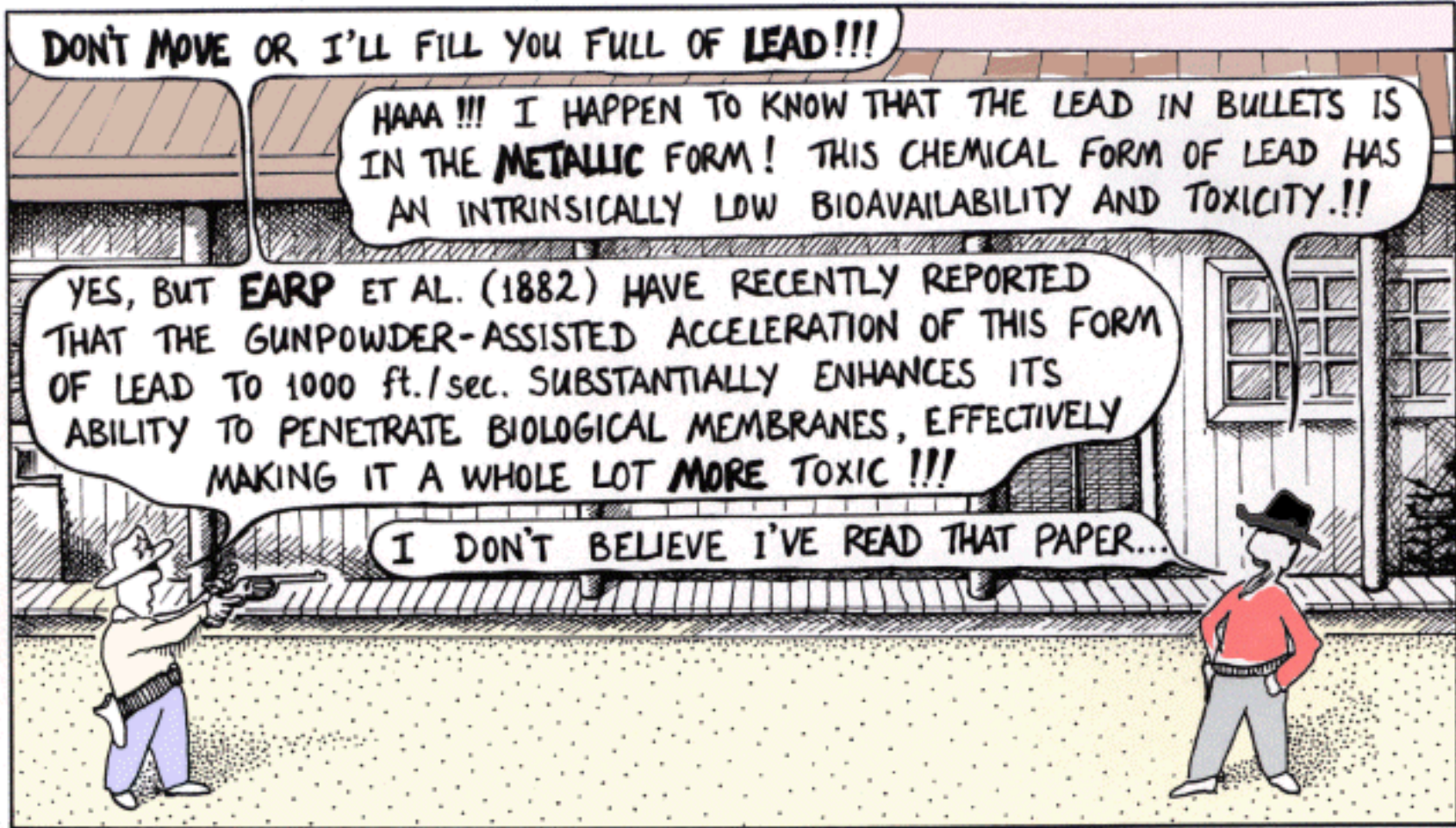
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# Outline

1. Describe NIOSH, NIOSH vs. OSHA
2. Development of Handwipe Disclosing Method for Presence of Lead
3. Development of Wipes and Methods for Removal of Toxic Metals from Surfaces
4. NIOSH Field Effort to Characterize Chemical Exposures to Gas & Oil Workers



ENVIRONMENTAL SCIENTISTS IN THE WILD WEST

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<http://strangematter.sci.waikato.ac.nz/>

# NIOSH Health Hazard Evaluation 94-0268-2618 San Antonio, TX



- ✦ Job shop, unique sized batteries
- ✦ 150 employees, 2,000-4,000 battery/day
- ✦ Not highly automated
- ✦ TX D.O.H. concerned about Pb exposures, requests NIOSH HHE

<http://www.cdc.gov/niosh/hhe/reports/pdfs/1994-0268-2618.pdf>



# Results: hand wipe samples, 9 workers, 3X day

Figure 1

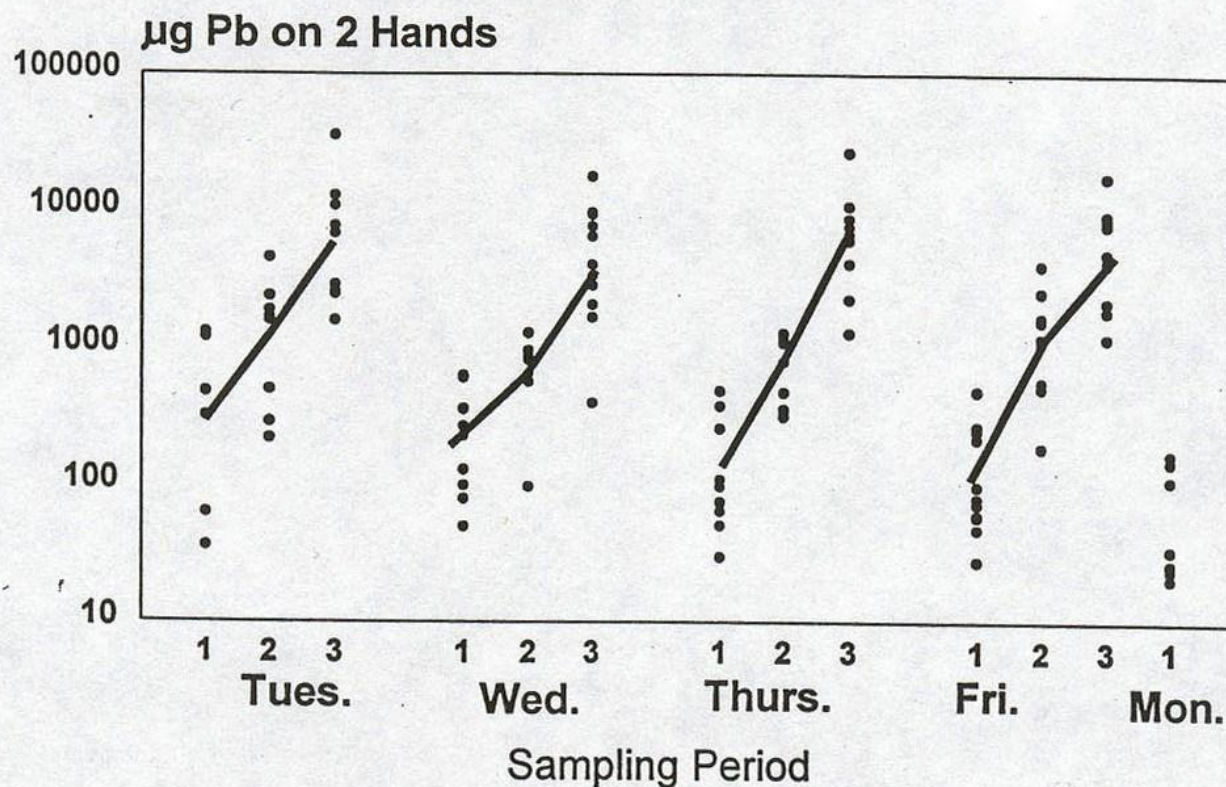
HETA 94-0268

Standard Industries

San Antonio, Texas

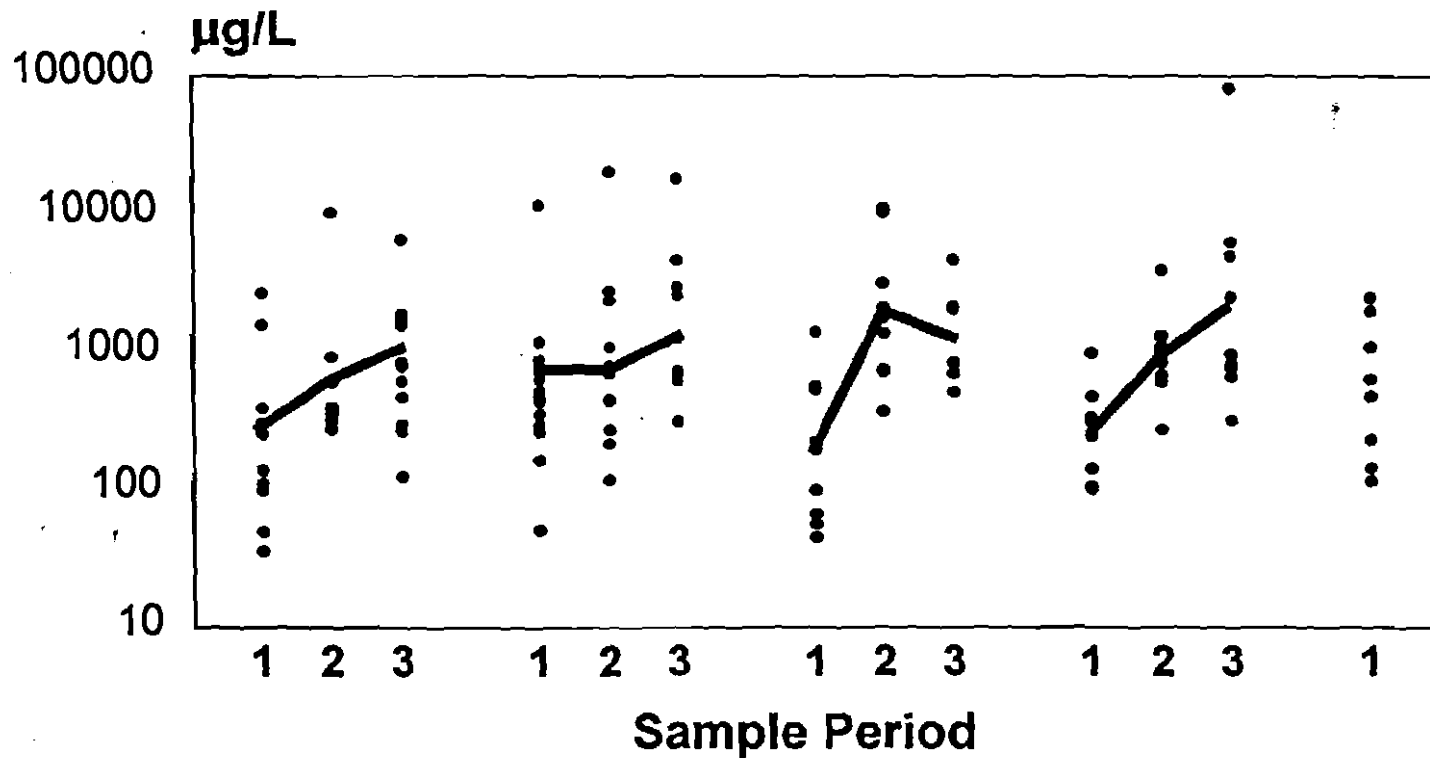
March 27-31, 1995

## Pb on Hands by Time Period



# Results: saliva sampling, 9 workers, 3X day

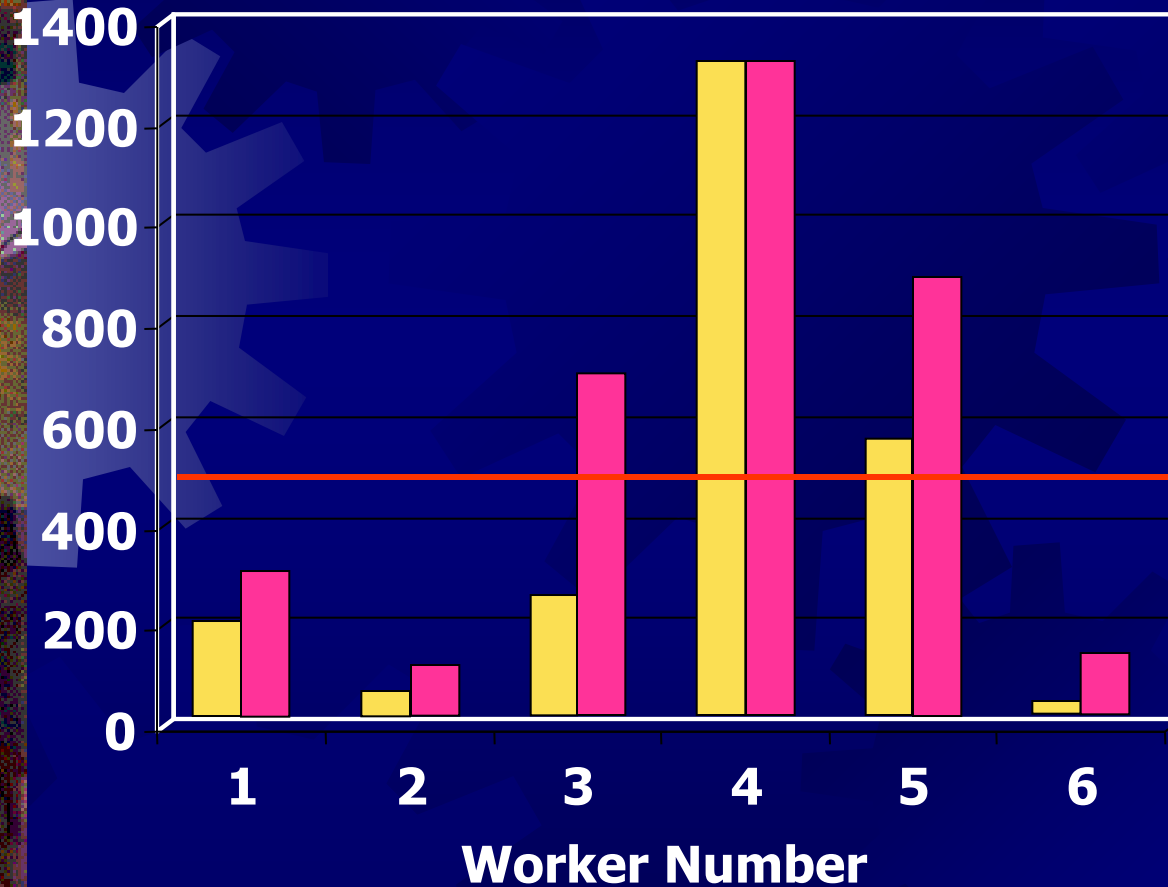
Distribution of GFAAS Saliva Results  
by Period and Day



nine participants

# Results: hand wipes, before and after eating, lead battery plant #1

Pb ( $\mu\text{g}$ )



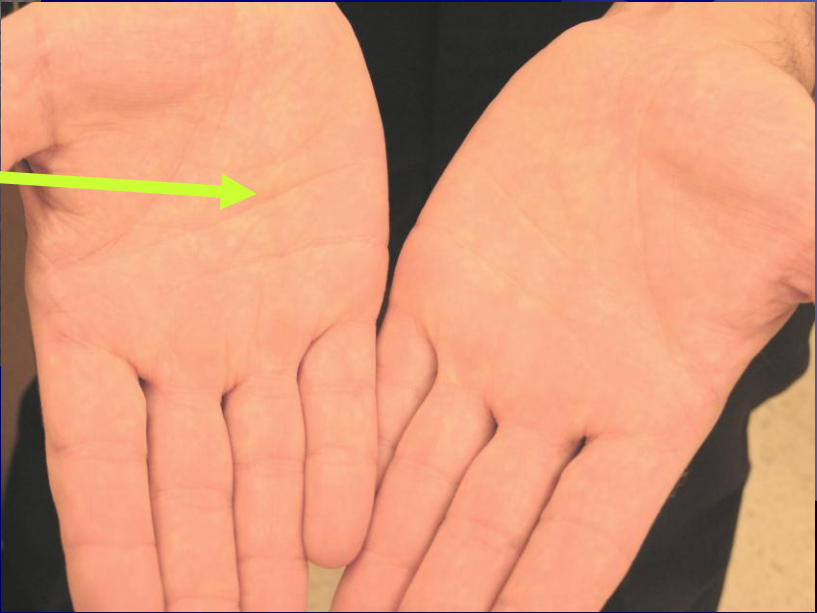
■ Before Lunch  
■ After Lunch

← Inhalation Dose @ OSHA PEL

$p=0.03$  (1 tailed)



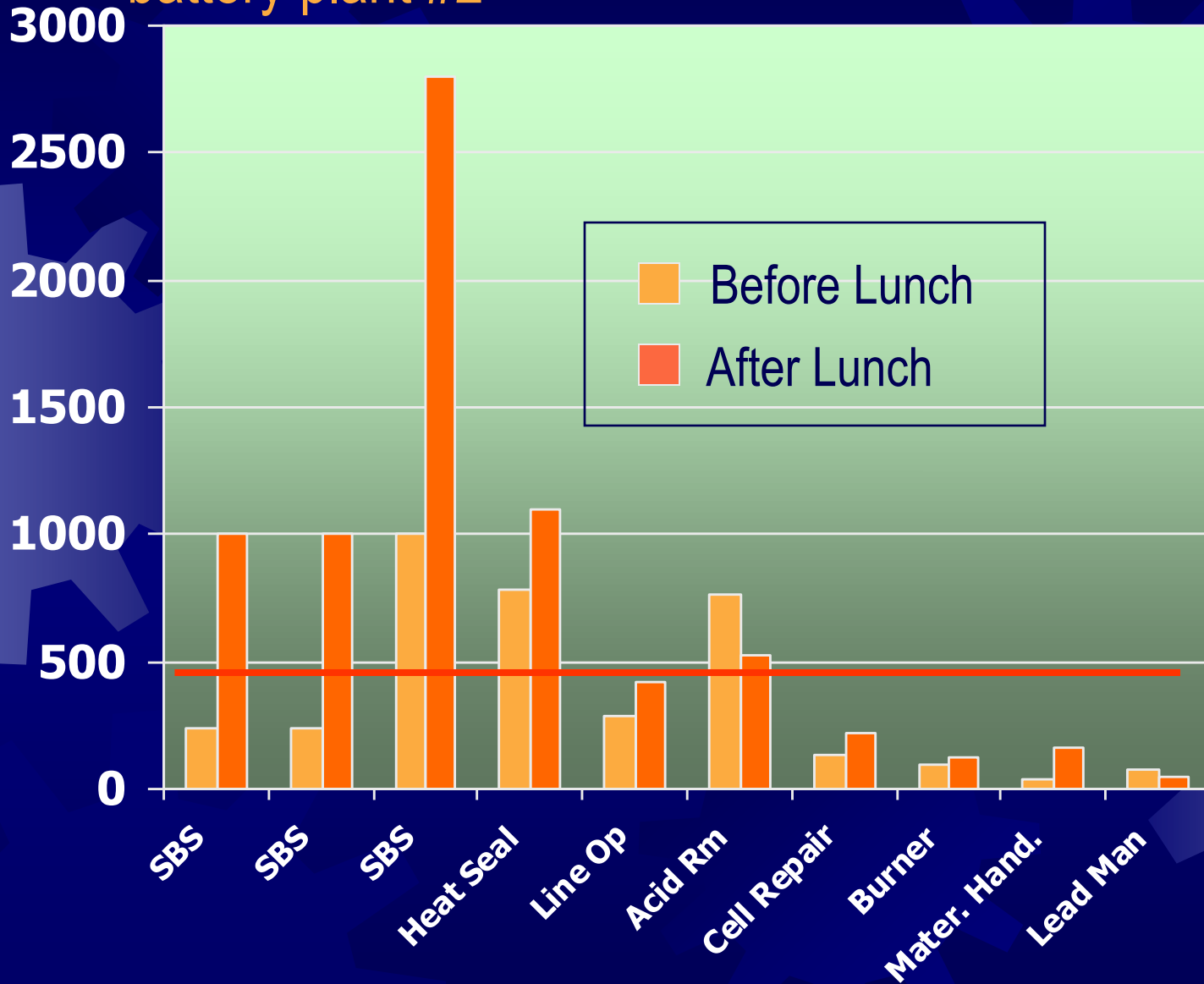
500  $\mu\text{g}$  PbO rubbed into palmer surfaces



500  $\mu\text{g}$  PbO



# Results: hand wipes before and after eating lunch battery plant #2



# Results: hand wipe assessment during lunch

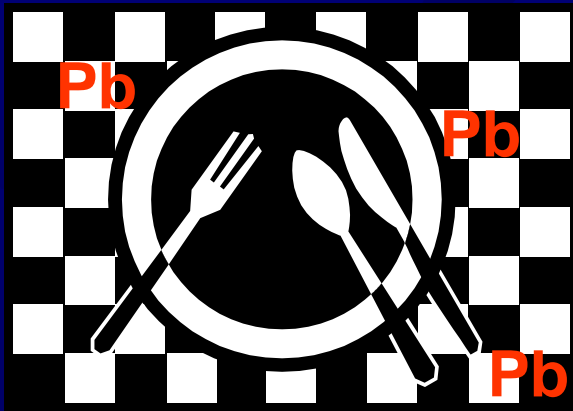


HETA 91-0366-2453 Delaware County Resource Recovery Facility. Esswein, E, Tepper, A.

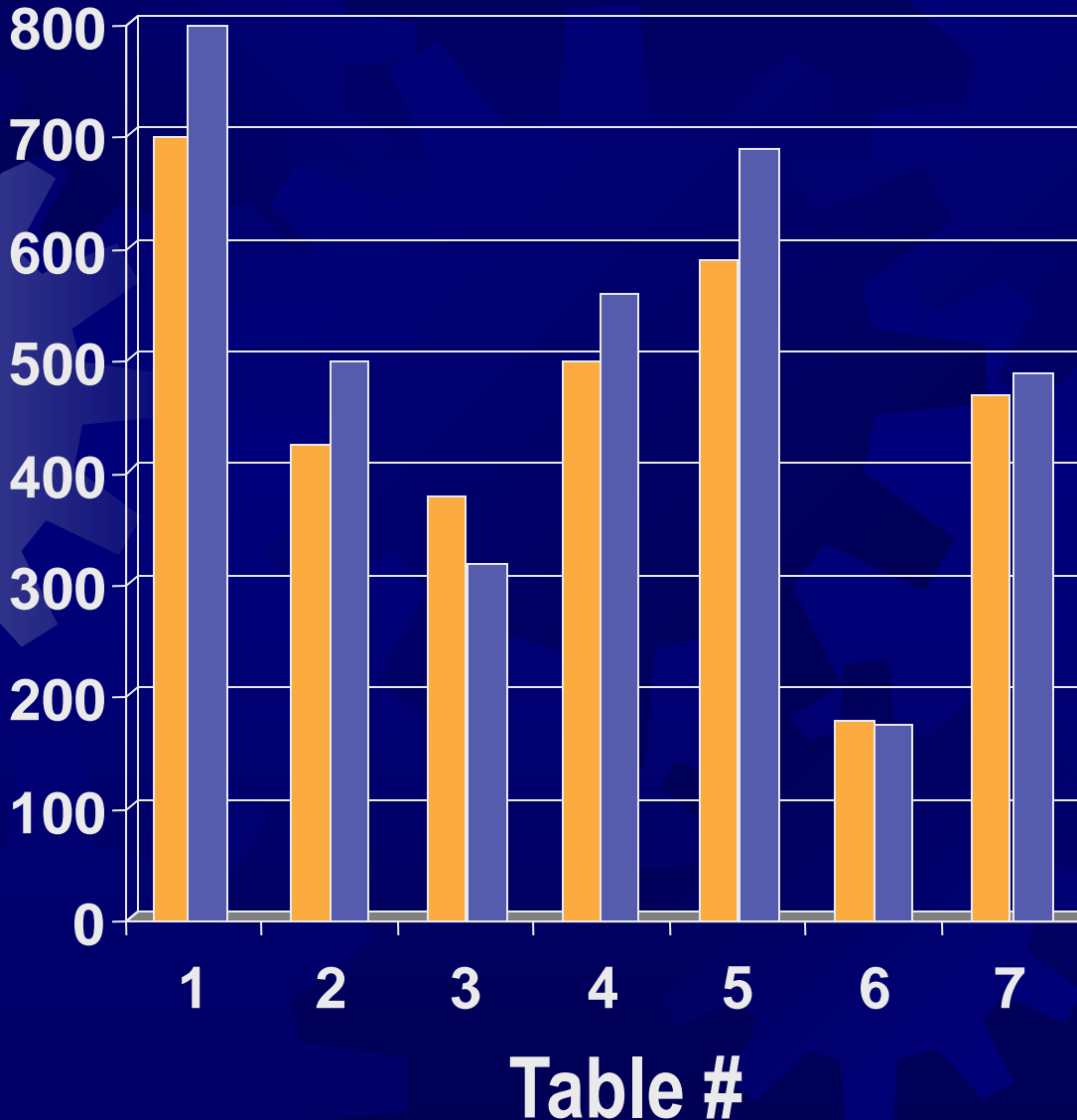
<http://www.cdc.gov/niosh/hhe/reports/pdfs/1991-0366-2453.pdf>

# Wipe sampling reveals lead-contaminated surfaces

- ☀ Cafeteria Tables: 140 – 770  $\mu\text{g}/\text{ft}^2$
- ☀ Cafeteria Doorknobs: 90 – 160  $\mu\text{g}/\text{ft}^2$
- ☀ Railing (Food Service Line): 3700  $\mu\text{g Pb}$
- ☀ Steam Table: 140 & 320  $\mu\text{g}/\text{ft}^2$
- ☀ Kitchen Cutting Boards: 9 – 130  $\mu\text{g}/\text{ft}^2$



# Lead-contaminated tabletops: Paired wipes from 7 tables ( $\mu\text{g Pb}/\text{ft}^2$ )

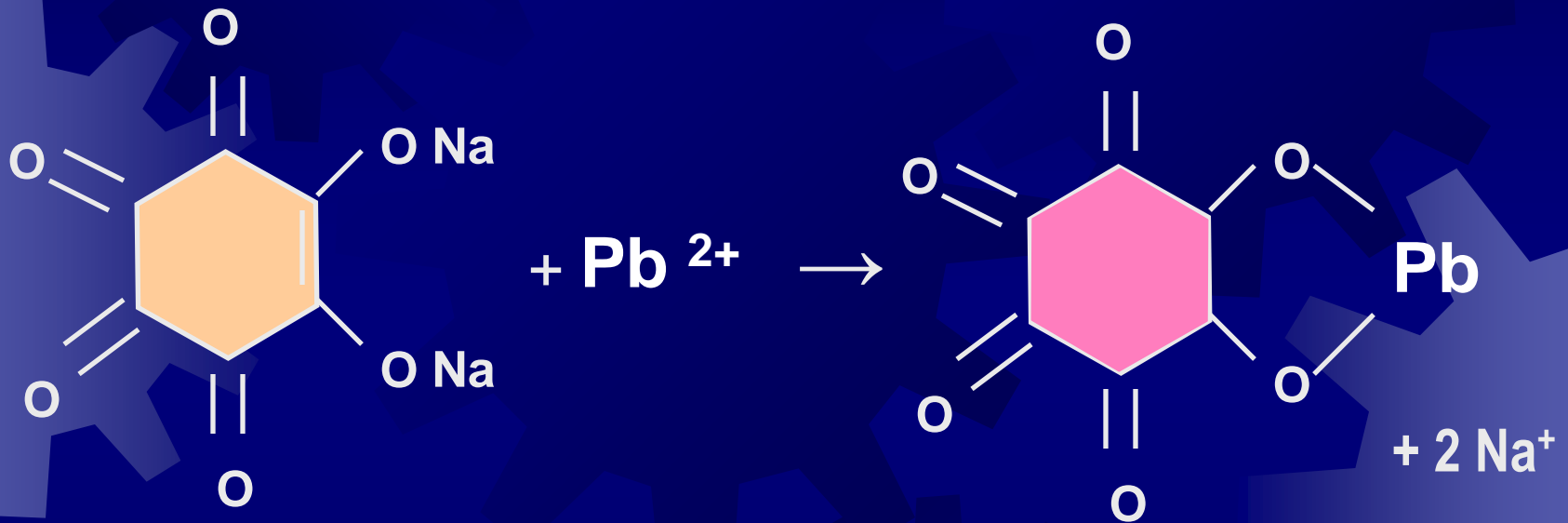


■ Sample 1  
■ Sample 2

Student's t-test:  
 $P = 0.2$  (2-tailed)



# Sodium Rhodizonate – Lead Colorimetric Reaction (pH < 7)

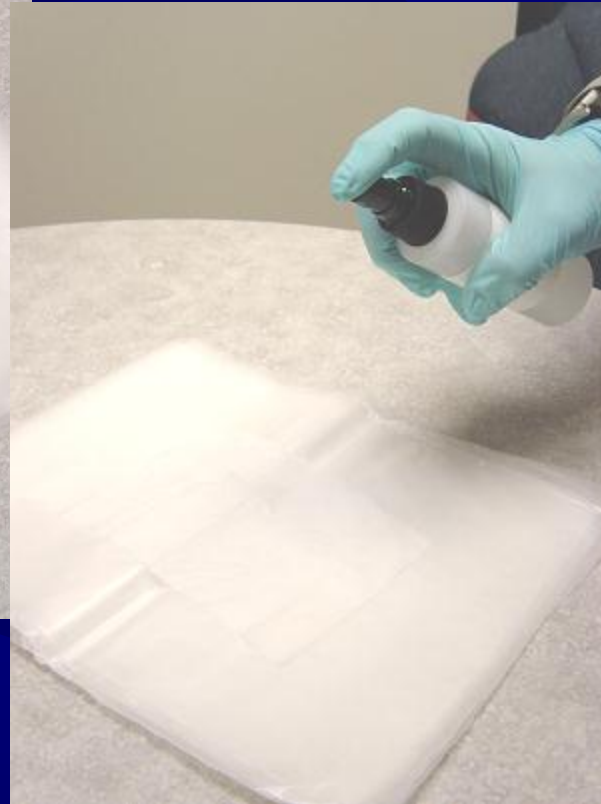


**Sodium rhodizonate**  
(yellow / orange)

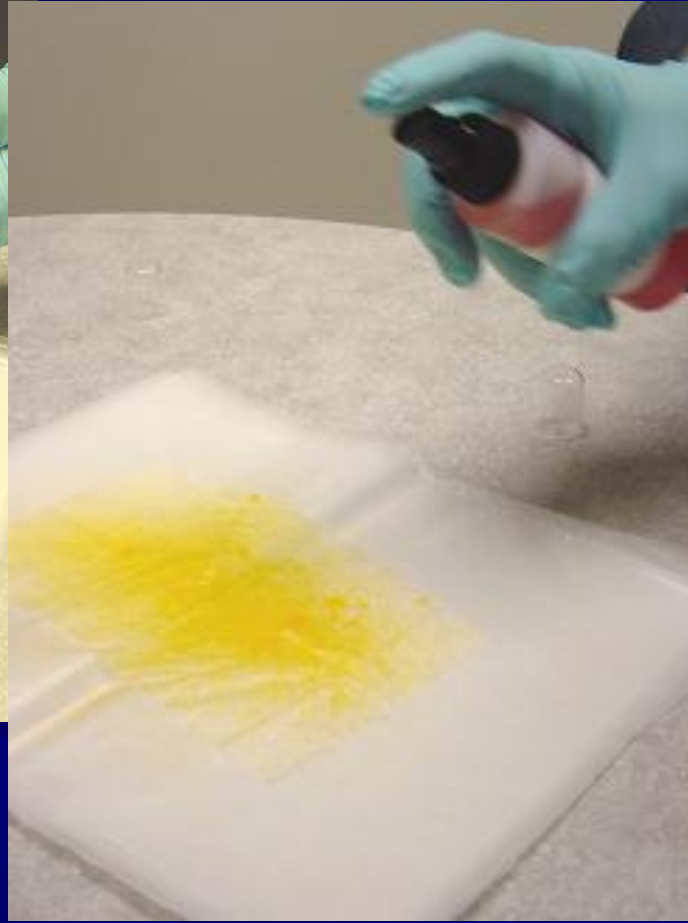
**Lead – rhodizonate complex**  
(pink / red)



Collect 30 second hand wipe

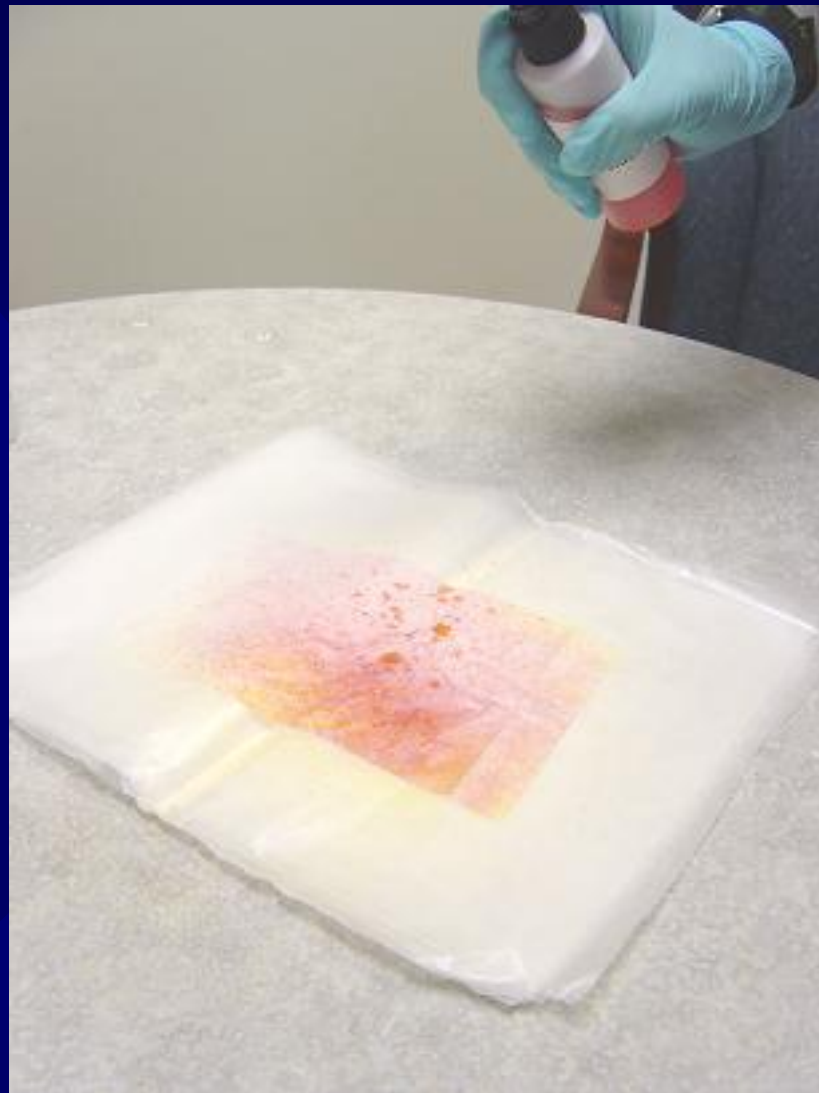


Spray ~3 pumps of extraction solution on center of wipe



Spray ~2 pumps of the disclosing solution onto wipe





Presence of  $Pb^{++}$  disclosed if sample shows a pink to red color

Negative control

Positive Sample

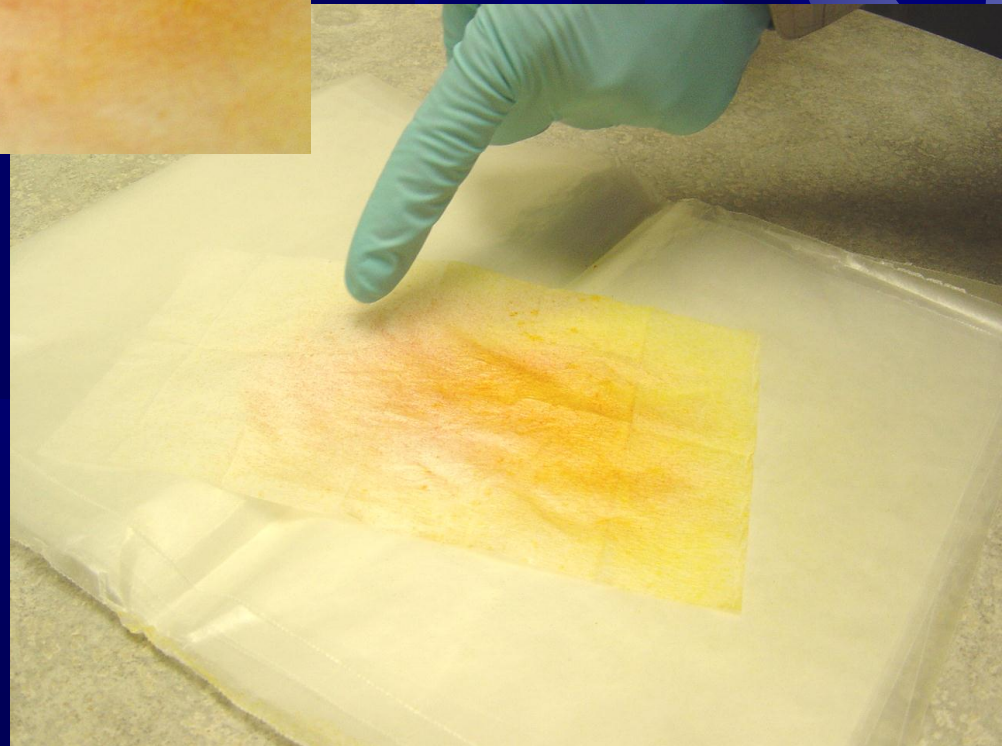


<i><b>Lead Compound</b></i>	<i><b>Response</b></i>
Pb metal	++
Pb[NO <sub>3</sub> ] <sub>2</sub>	+++
PbCl <sub>2</sub>	+++
PbBr <sub>2</sub>	+++
PbSO <sub>4</sub>	+++
PbO	+++
PbO <sub>2</sub>	++
Pb <sub>3</sub> O <sub>4</sub>	+
PbS	+
PbCrO <sub>4</sub>	—



**Wipe sample from  
“clean” hands**

***The method is  
sensitive ( $\rightarrow \mu\text{g}'\text{s}$ )  
and specific  
for lead***







# Use ASTM standard wipes

## ASTM E 1792

### Standard Specification for Wipe Sampling Materials for Lead in Surface Dust

#### Specs for:

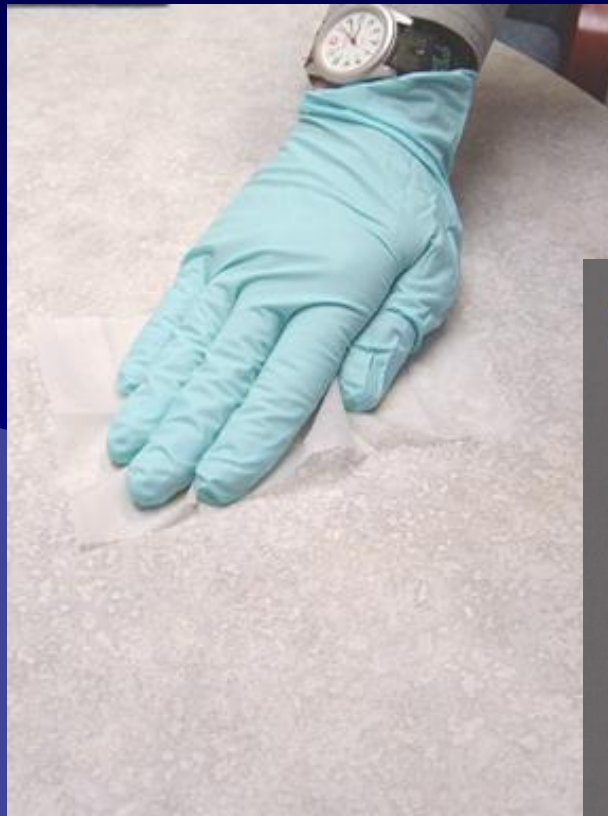
Background Pb level

Size: dimensions & thickness

Ruggedness

Mass & wetness consistency

Pb collection efficiency



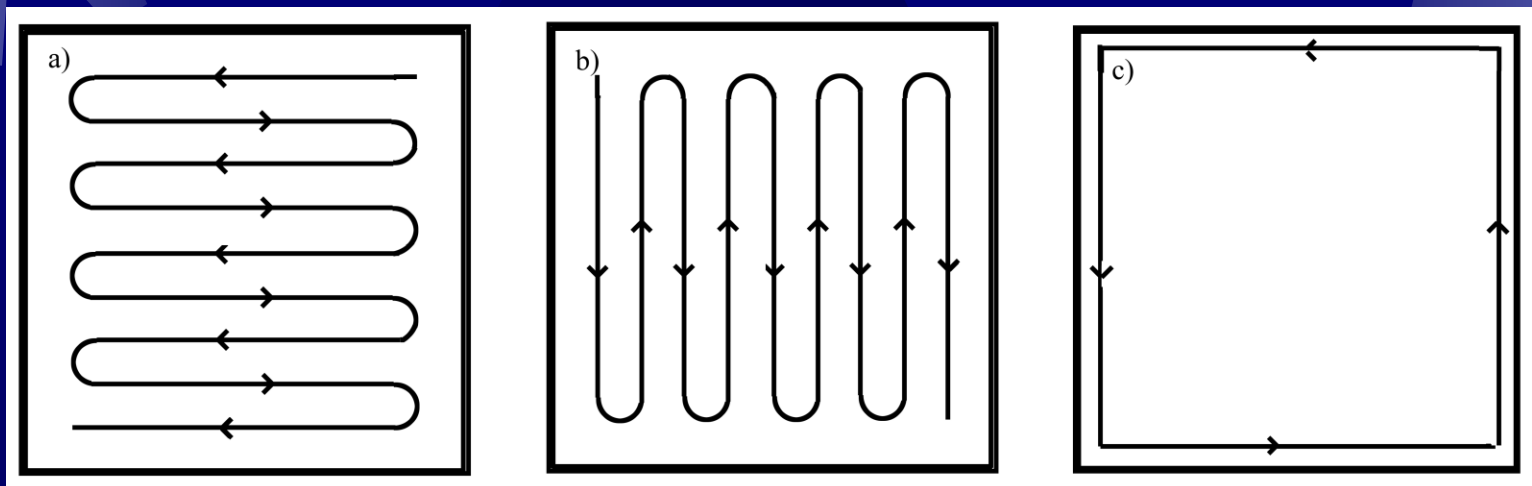
## *Disclose lead on hard surfaces:*

Floors & Window sills (pre-clearance)  
Shoes (take-home Pb), Car interiors,  
Tabletops, Toys, etc. ...

# Sample surfaces using ASTM standard procedure

ASTM E 1728

Standard Practice for Collection of Settled Dust Samples using Wipe Sampling Methods for Subsequent Lead Determination



# Summary (cont'd.)

- ★ Safe for workers
- ★ Easy to use
- ★ Easy to interpret: If red, it's lead

→ Can save samples for quantitative analysis



U.S. Patent 6,248, 593





# NIOSH Method 9105:

Lead in Dust Wipes by  
Chemical Spot Test  
(Colorimetric Screening  
Method)

[www.cdc.gov/niosh/nmam](http://www.cdc.gov/niosh/nmam)

# How To Effectively Decontaminate Skin for Pb, other Metals?

1. No Specific OSHA Guidance
2. Performance criteria for available products?
3. How do metals bind or adhere to skin?
4. What's required to remove them?

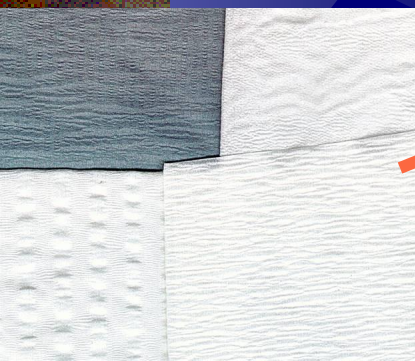
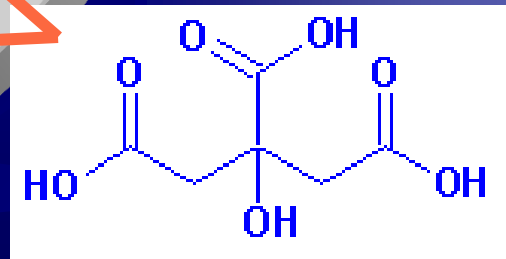
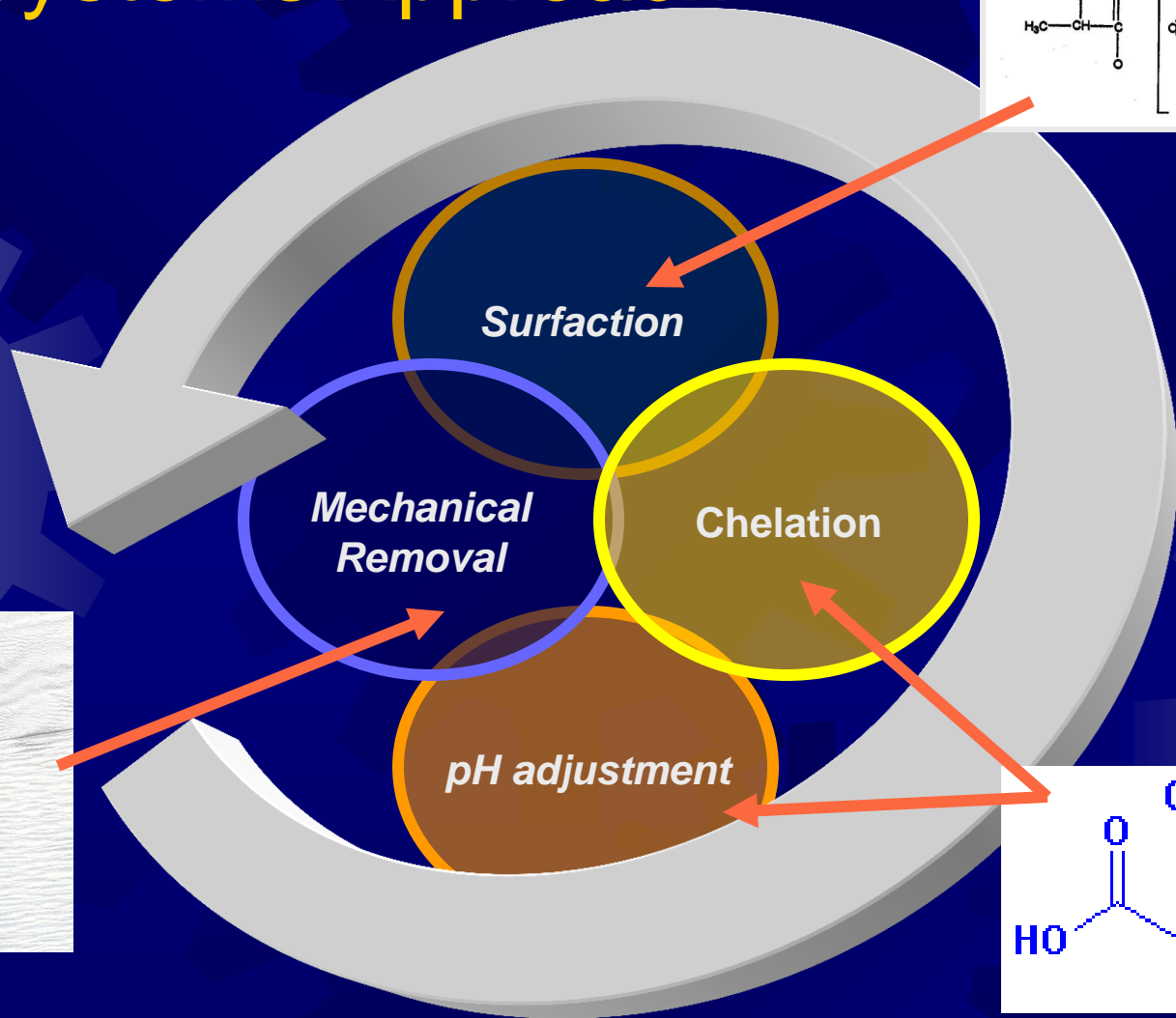
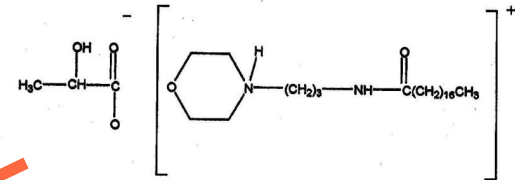


The background is a dark blue field with several light blue gear shapes of various sizes scattered across it. On the left side, there is a vertical strip with a textured, metallic appearance in shades of brown, orange, and red, featuring a gear-like pattern.

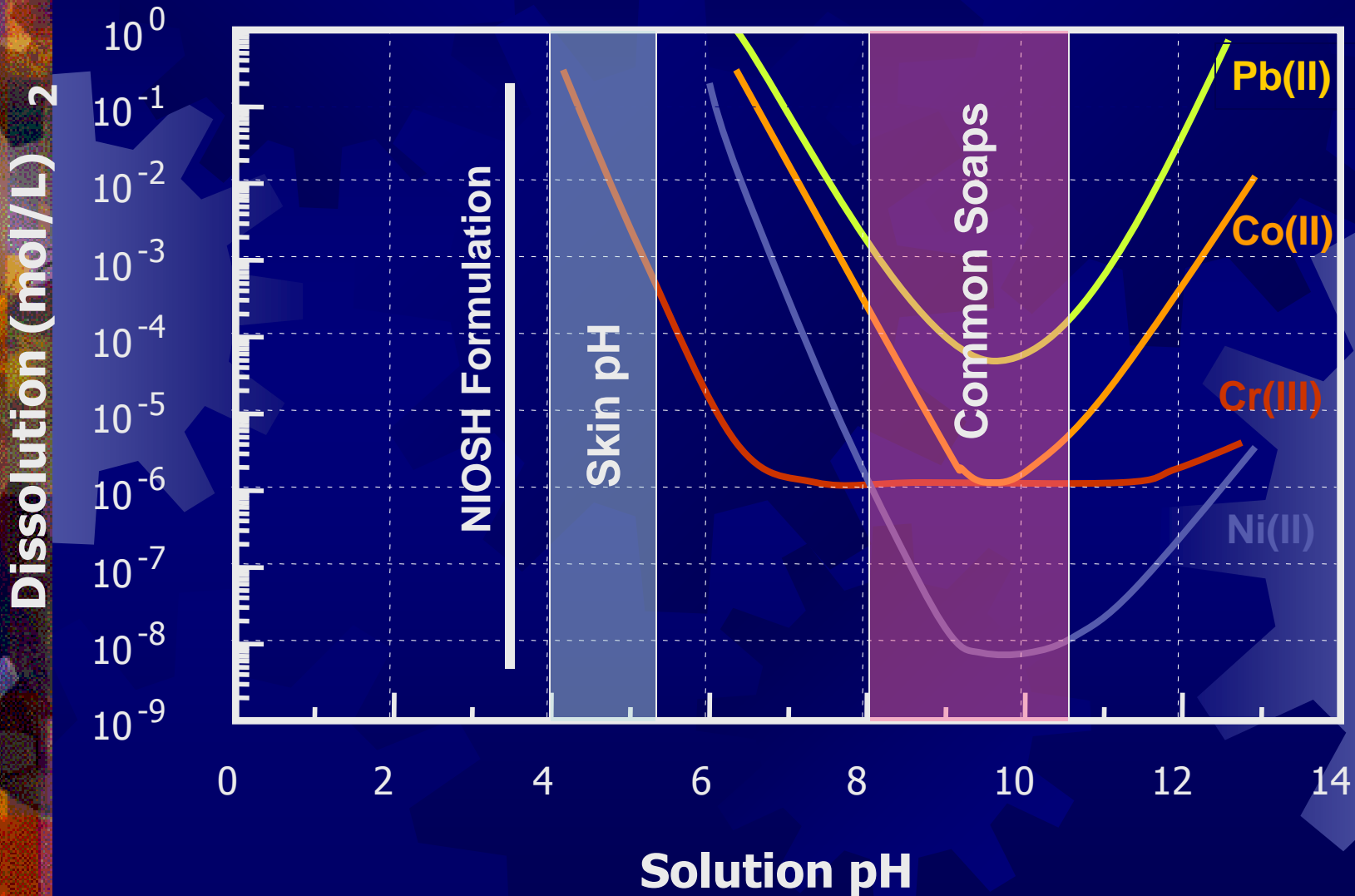
# NIOSH Design Intent: Handwipe Removal Method for Toxic Metals (pat. pend.)

1. More effective than soap and water
2. Gentle on skin
3. No abrasives
4. No EDTA
5. Wipe based

# A Systems Approach

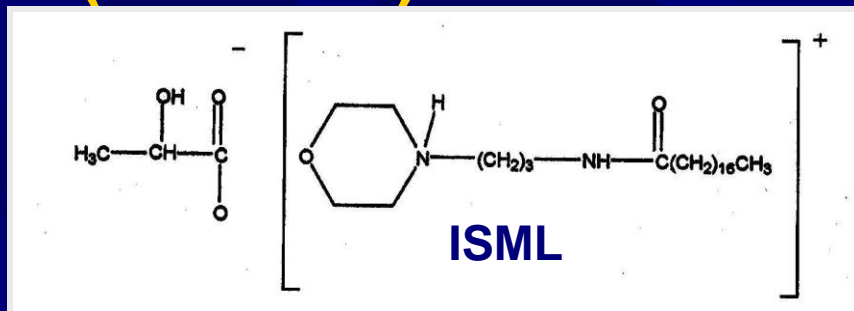


# Dissolution of elements in H<sub>2</sub>O is highly pH dependent






# Surfaction of elemental cations (Pb<sup>++</sup>)



## Desorption of Pb from Soil

		Agent Concentration (mole/L)									
		0.00625		0.0125		0.025		0.05		0.1	
Agent	pH	%Pb	pH	%Pb	pH	%Pb	pH	%Pb	pH	%Pb	
ISML	4.86	61.0	4.42	65.0	4.16	72.6	4.0	75.0	3.97	82.0	

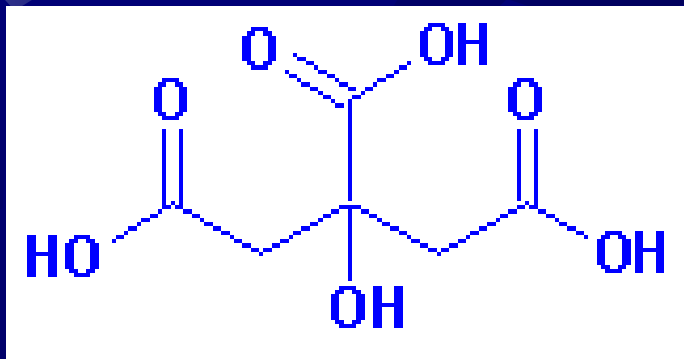
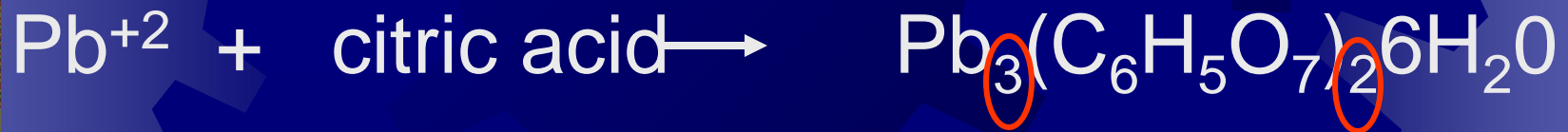
Isostearamidopropyl morpholine lactate (ISML)

- 
- ISML considered environmentally friendly
  - Not listed substance US, TSCA
  - Not listed EU Inventory of New and Existing Chemical Substances (AICS)
  - Swedish Society for Nature Conservation  
“Good Environmental Choice”

CIR: ISML considered safe for use in rinse-off cosmetic products

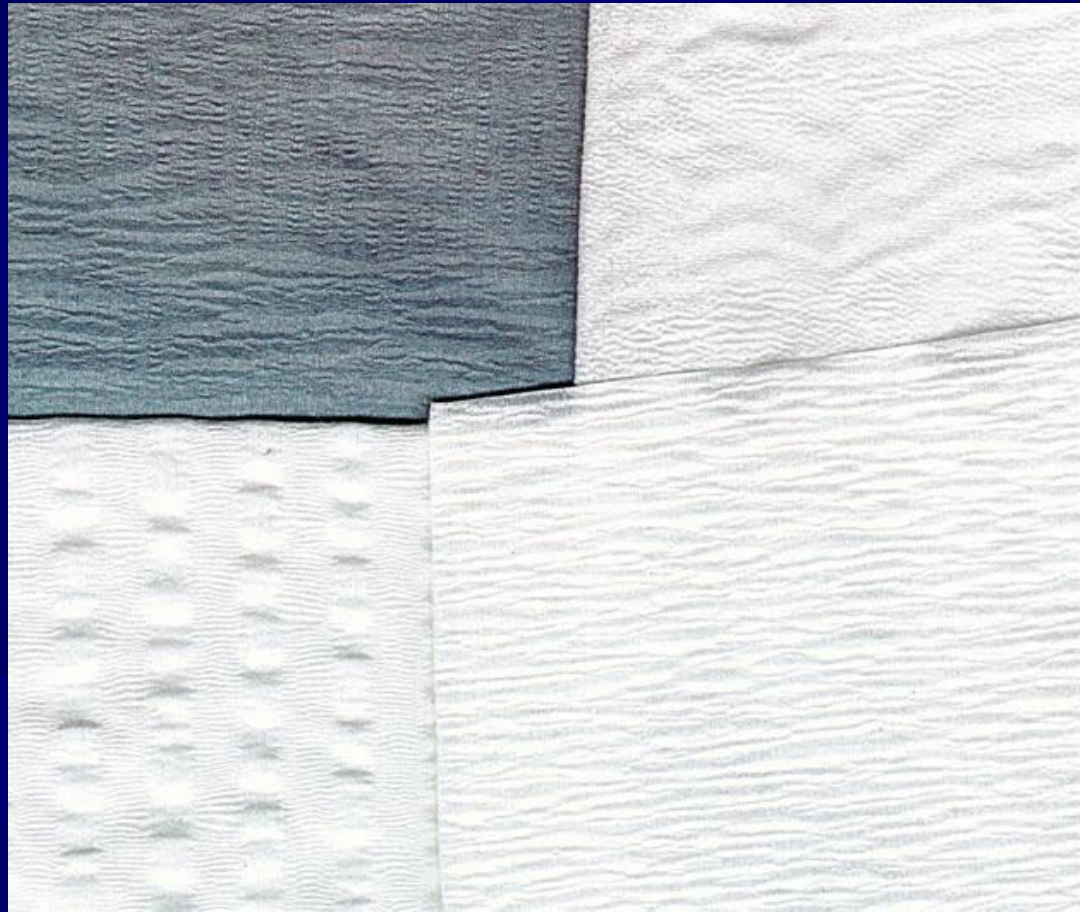
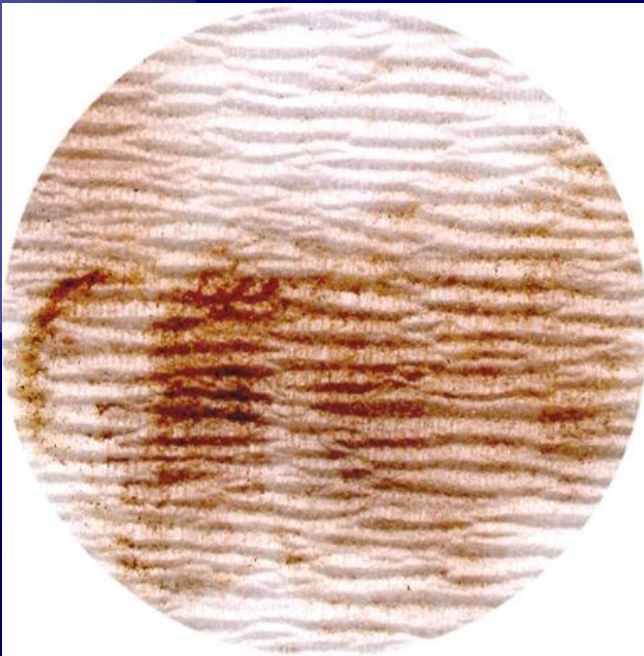
# pH adjustment and chelation: citric acid

Effectively extracts Ba, Cd, Cr, Ni, As, Sn, Zn, Co, Cu, Sr, Th and U by formation of water soluble, metal-citrate complexes

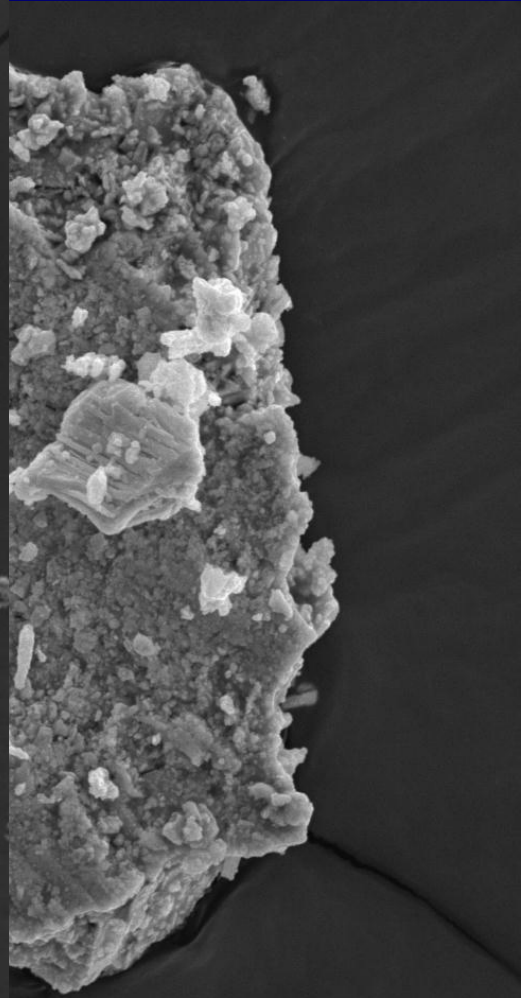
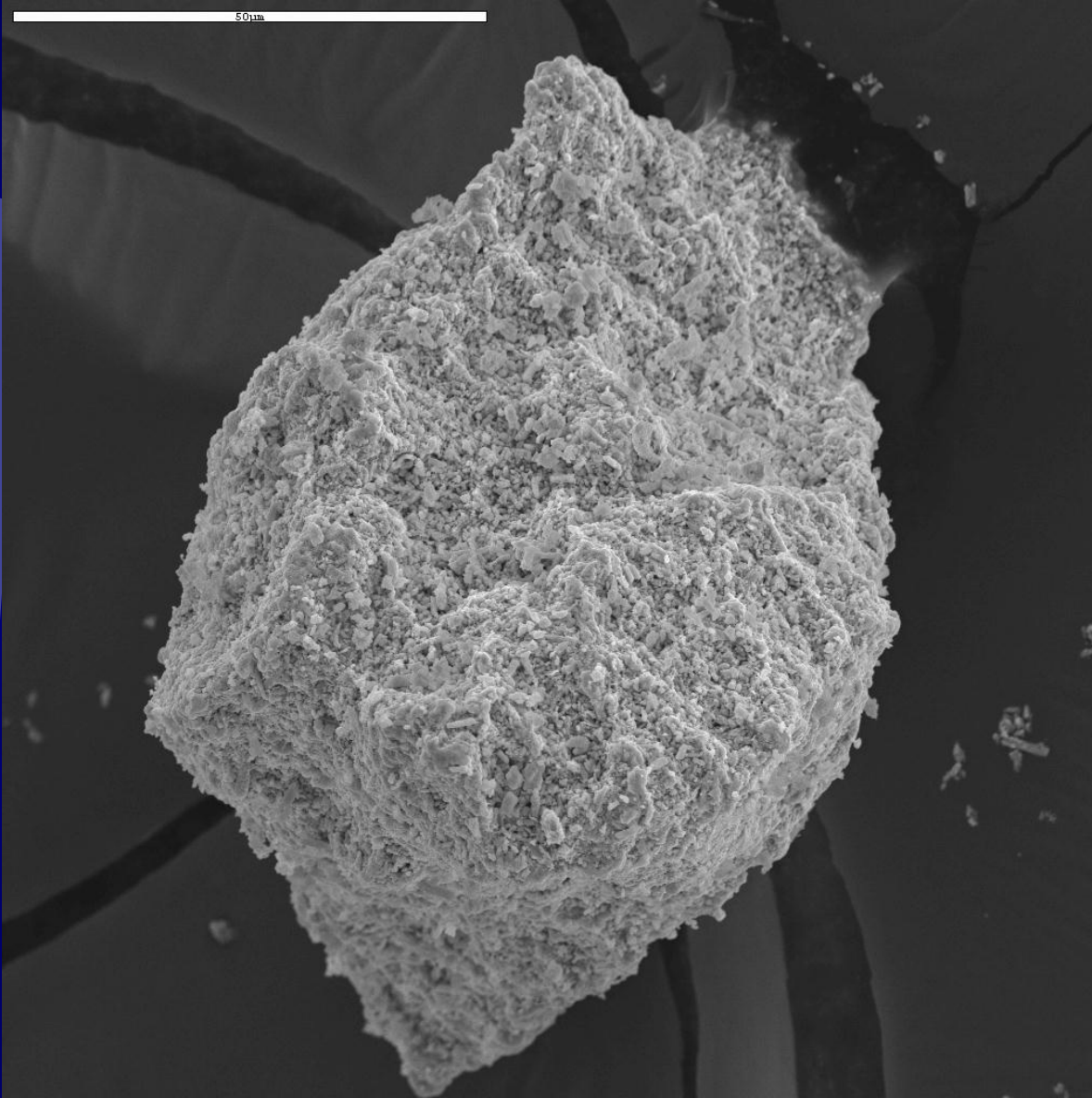
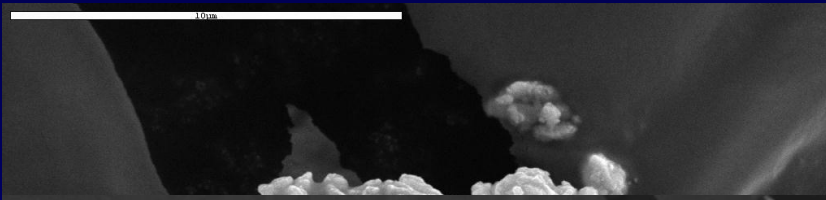


# Mechanical Removal

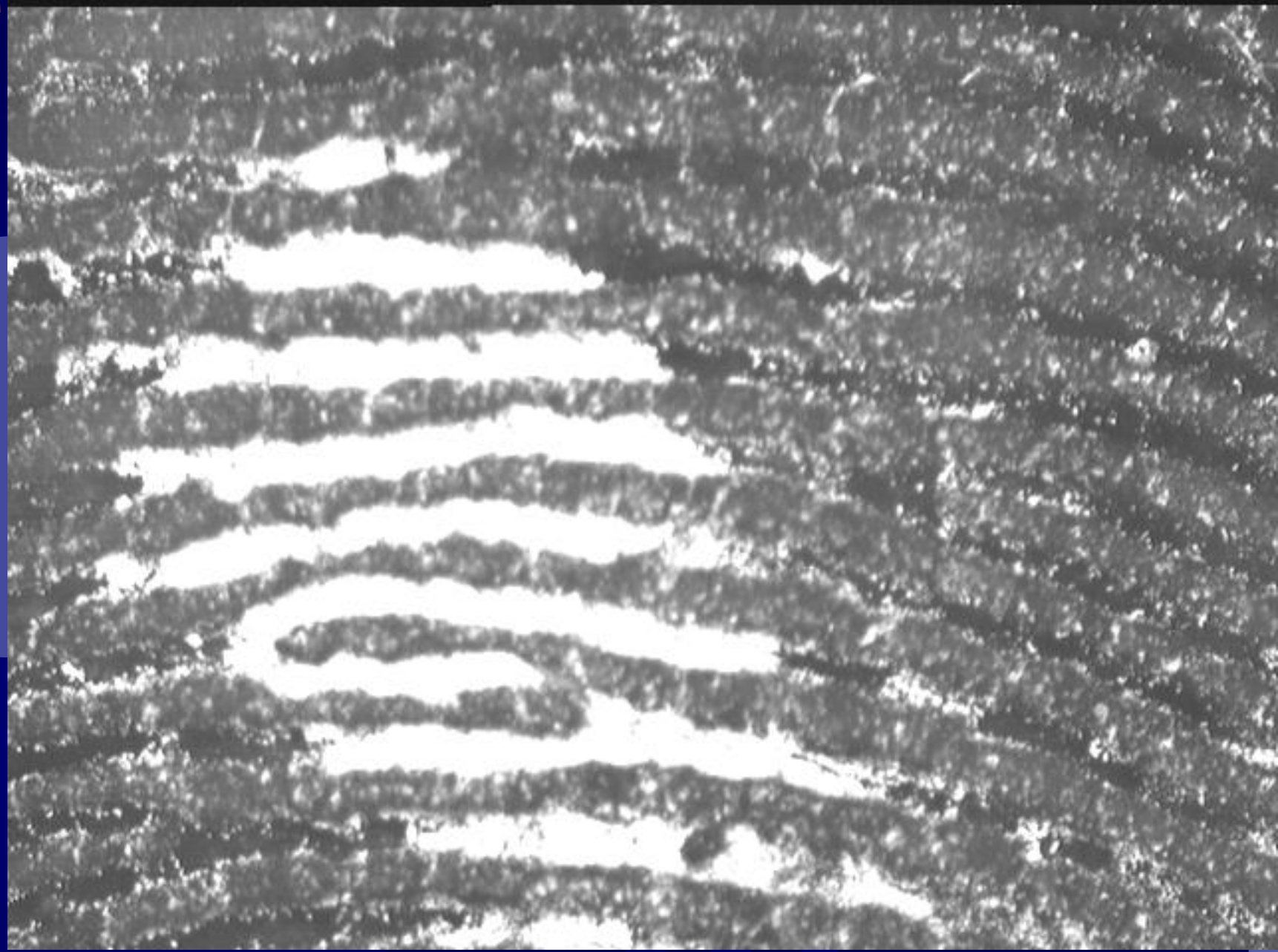
## ★ Engineered cloth



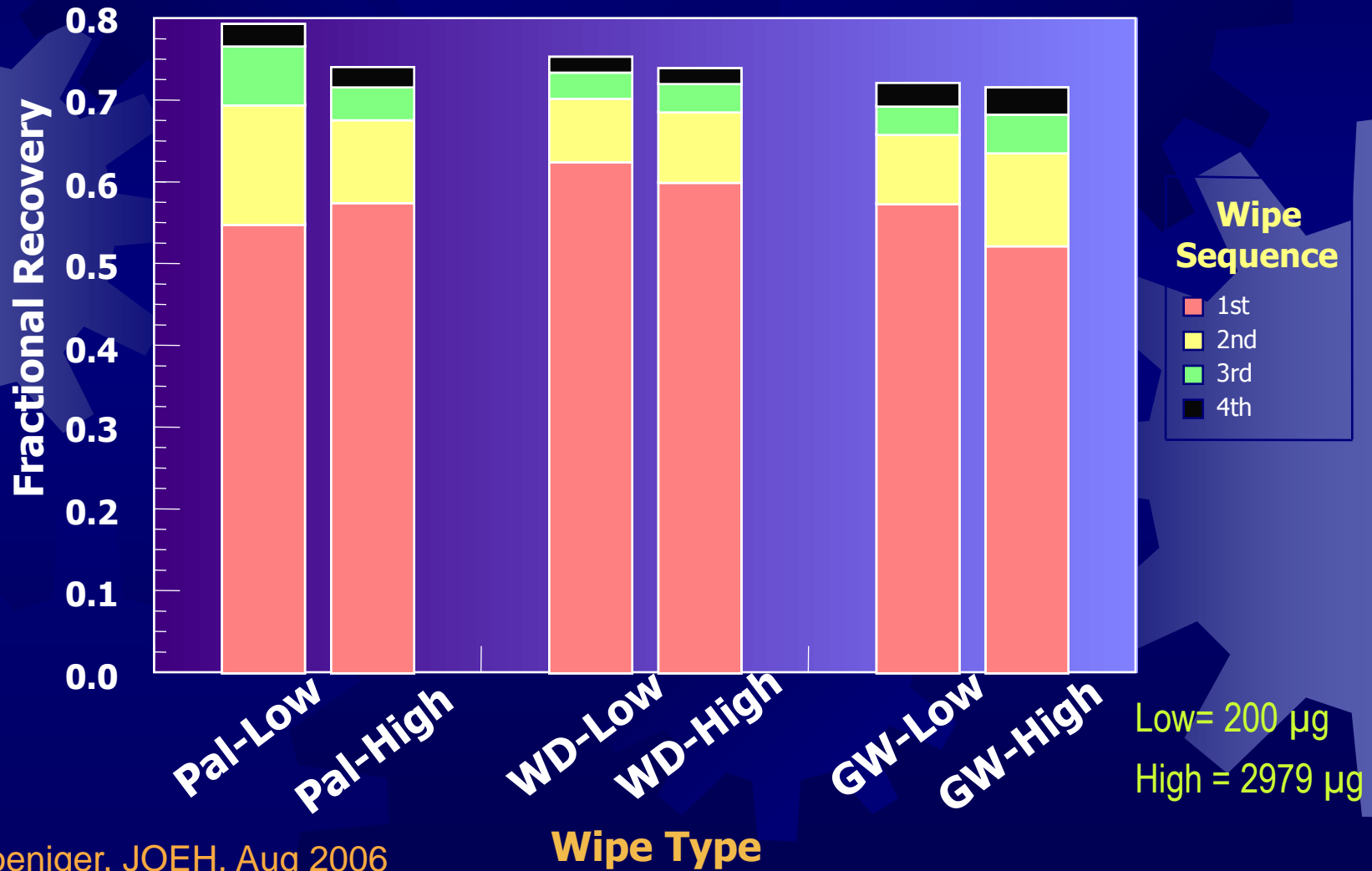








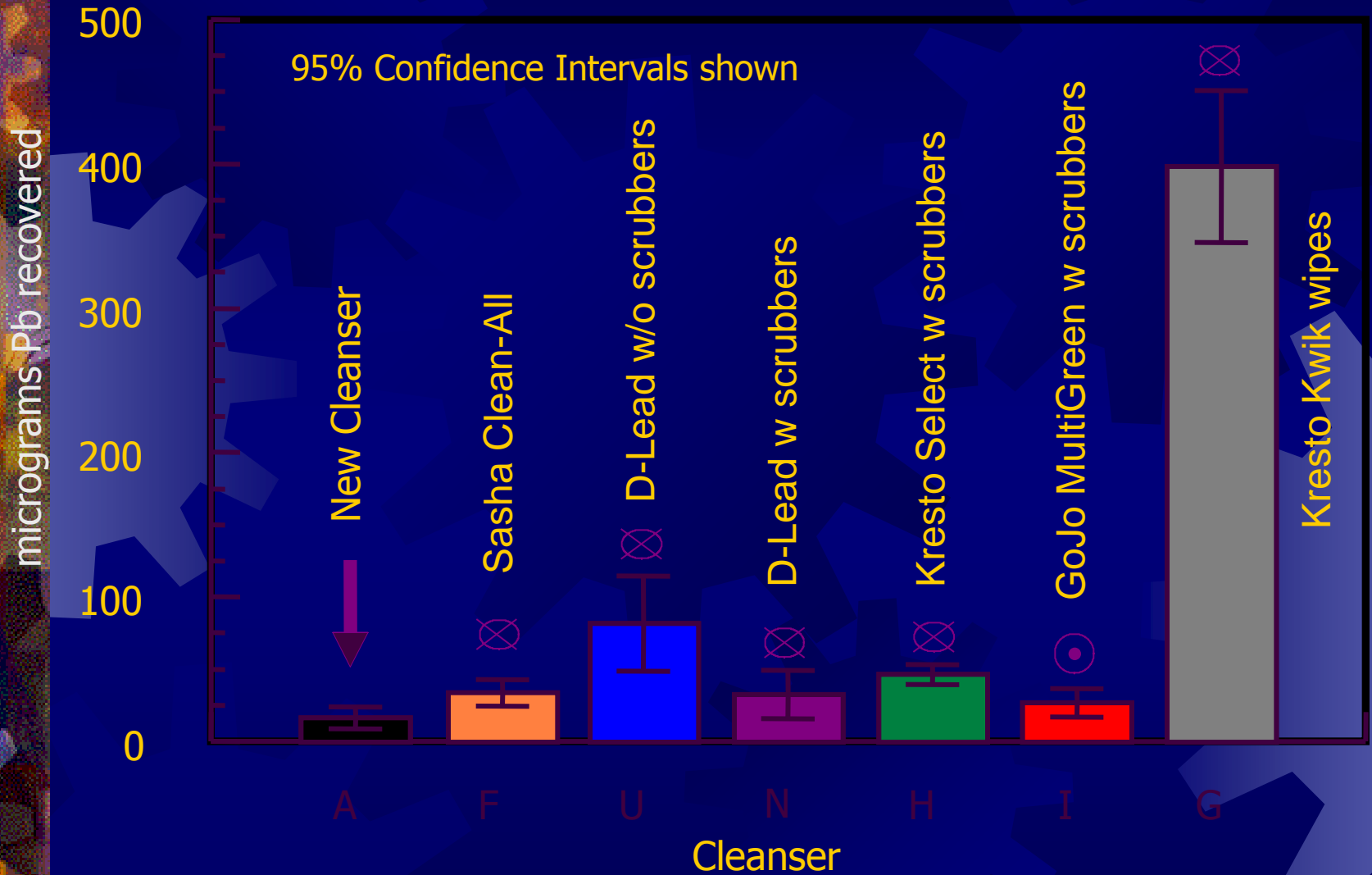
# Pb recovery in 4 consecutive wipes from hands: Palintest, Wash-n-Dry, Ghost wipes



# Non-Blinded Cleanser Efficiency Protocol

1. Apply 3000  $\mu\text{g}$  PbO to palms of both hands, 30 seconds
2. Apply 3 mL soap solution, or use NIOSH formula towellette for 30 seconds, rub hands together to cleanse
3. Rinse, running water, 30 seconds
4. Pat dry, paper towel
5. Sample palms, three consecutive samples to quantify Pb

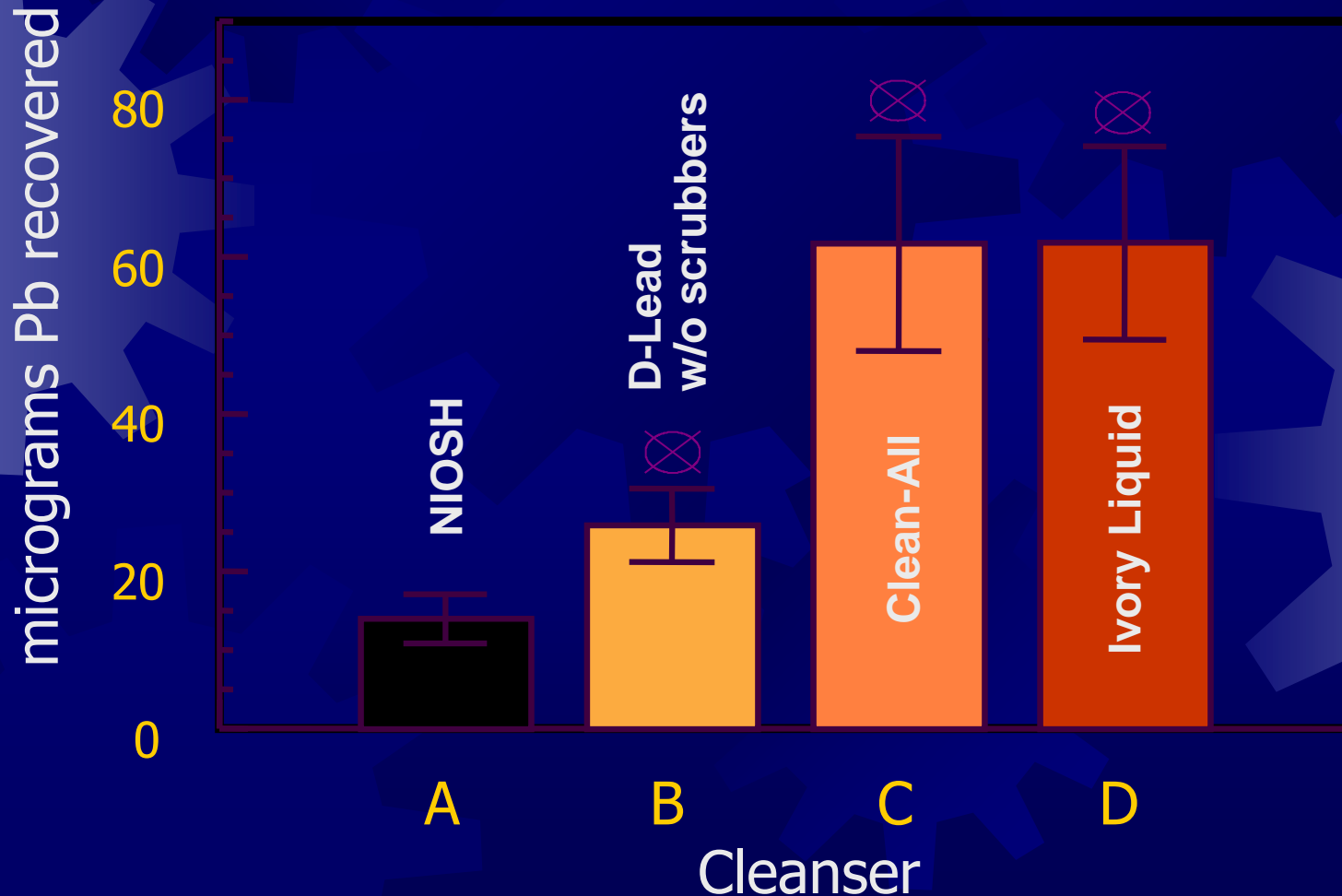
# Non-Blinded Pb Removal Tests



⊗ = Statistically significant difference,  $p < 0.01$

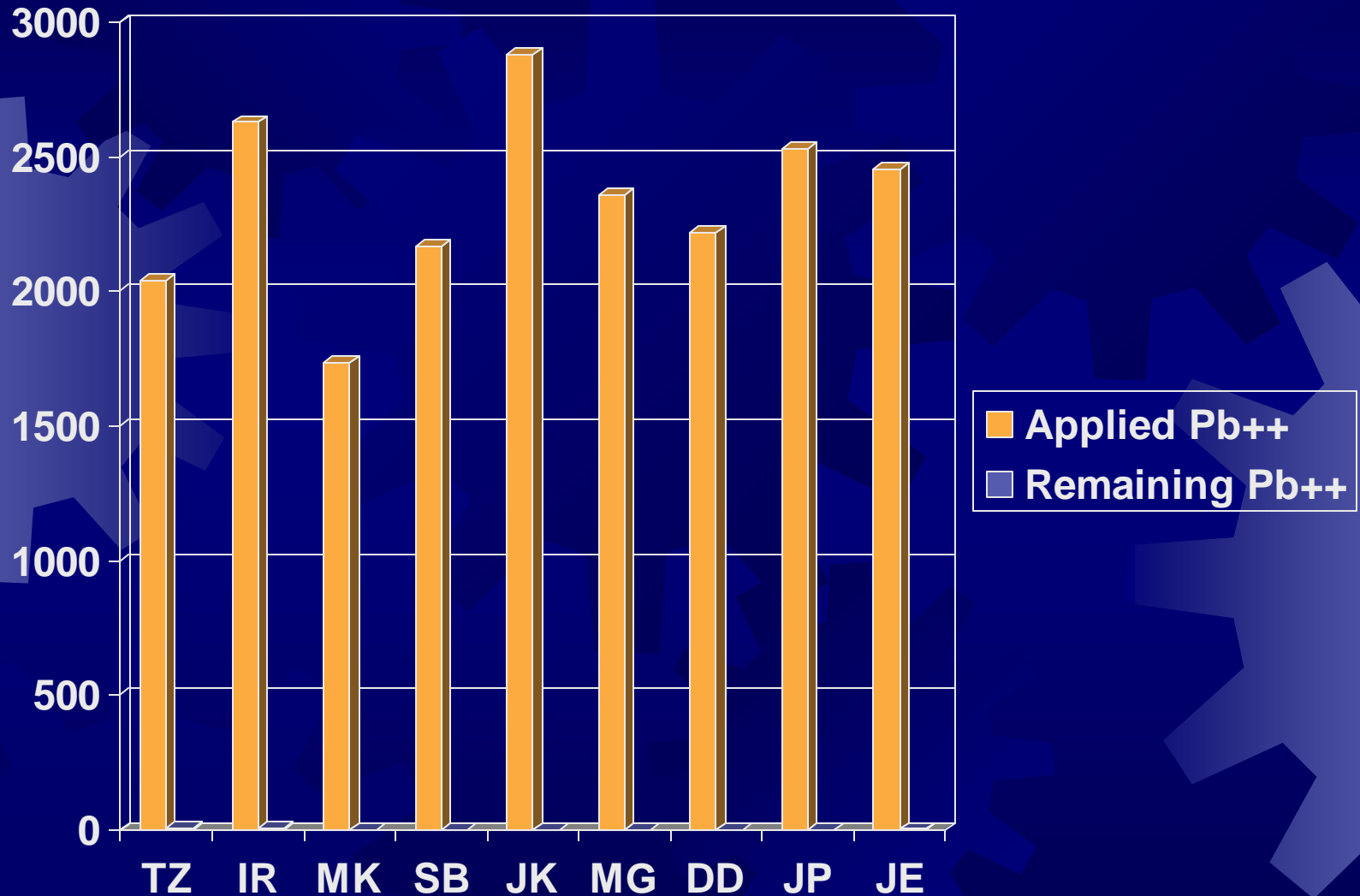
⊙ = Statistically significant difference,  $p < 0.05$

Blind participants comparison of the new NIOSH cleanser (A), to two Pb-specialty industrial cleansers (B and C), and Ivory Liquid soap (D)





# Beta version: New NIOSH Wipe Removal Efficiency = 99.8%



n = 9

2,338 µg effective skin loading

# NIOSH Design Intent: Handwipe Removal Method for Toxic Metals

- ✓ More effective than soap and water
- ✓ Gentle on skin
- ✓ No abrasives
- ✓ No EDTA
- ✓ Wipe based



U.S. Patent granted 6/09  
pending USPTO number

# Acknowledgements

- ★ Geoffrey S. Plumlee, Ph.D. USGS
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The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the National Institute for Occupational Safety and Health