

# Dust, Mold, and Heavy Metals: Health Hazards in Museums

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## Abstract

Museum collections and exhibit spaces often contain health hazards as a result of historic preservation treatments and environmental conditions within the buildings. These hazards present dangers to the health and safety of those charged with their care and display. In this study we analyze the diverse collections at three sites to help identify, assess, and mitigate exposure to hazards lurking in their collections. The team quantified the concentration of aerosolized dust, collected mold spores, and used X-ray fluorescence (XRF) to identify heavy metals such as arsenic and lead. Findings were used to introduce procedural changes to keep the staff safe when handling and maintaining the collections.

## Background

### Common Hazards in Museums

- ❖ **Dust:** Particulate matter can be aerosolized during tours or housekeeping and maintenance.
- ❖ **Molds:** Museum environments can lead to mold growth and become aerosolized.
- ❖ **Pesticides:** Many museum objects have been treated with heavy metals (e.g., arsenic and lead).
- ❖ **Inherent Hazards:** Objects' make-up includes heavy metals and other toxins.

### Health Effects

- ❖ Inhaled dust, mold and mycotoxins can trigger negative respiratory reactions including asthma and bronchitis.
- ❖ Exposure to heavy metals can cause adverse health effects in cardiovascular, muscular, digestive, and nervous systems as well as cancer.

### Purpose

- ❖ To better protect museum employees and visitors, we investigated the presence of environmental hazards within various collections.



Photo credit: Indiana Medical History Museum



Photo credit: Livescience. Sampled a window for the presence of mold using a Bio-Tape slide

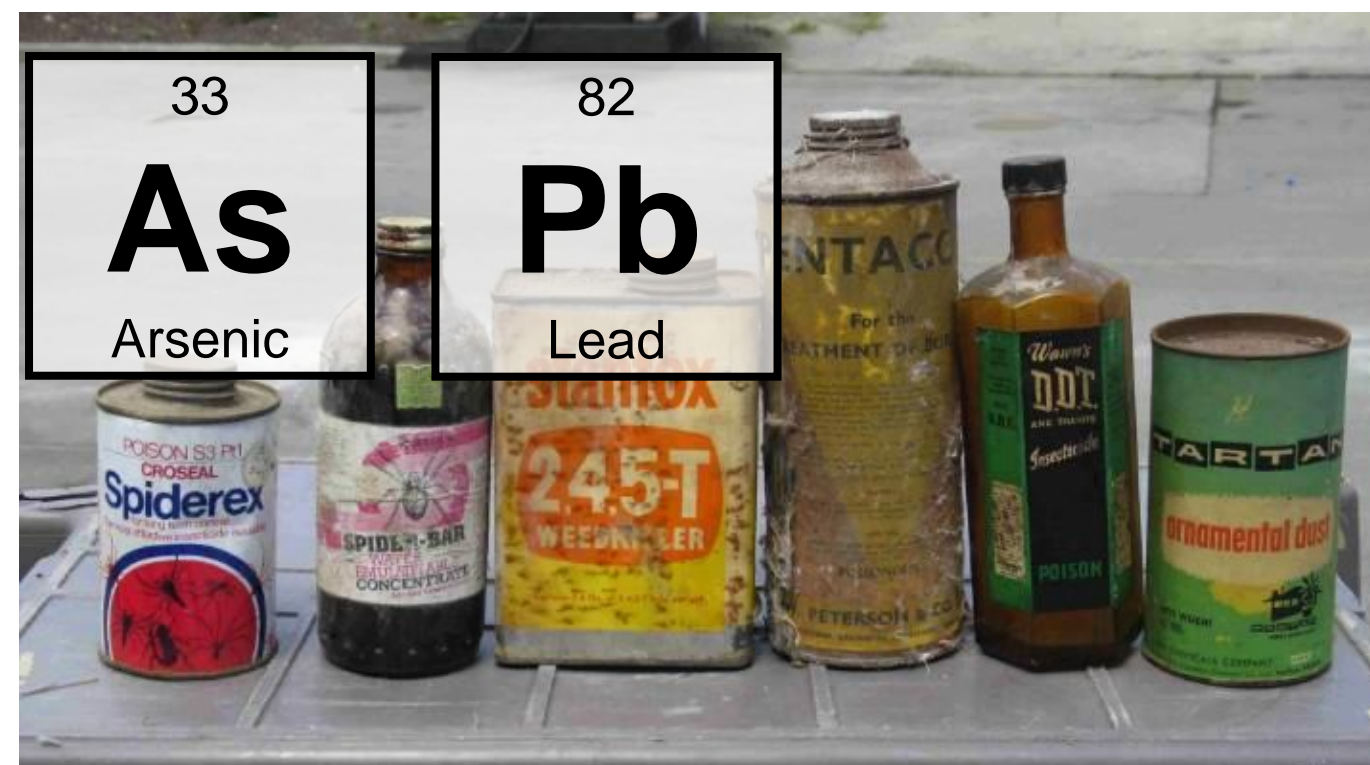


Photo credit: Meta NZ

## Objectives

### Identify Hazards in Various Collections

- ❖ Measure the concentration of airborne dust (< 2.5 µm) in the museum
- ❖ Investigate the presence of any mold within the collections
- ❖ Determine the presence of heavy metals within the collections

## Methods

### Sampling Approach

- ❖ Sampling locations
  1. Indiana Medical History Museum (IMHM) in Indianapolis, Indiana
  2. Eagle Creek Ornithology Center in Indiana
  3. FBI Art Crime collections site
- ❖ The team conducted sampling in areas and objects of concern, as identified by site directors.

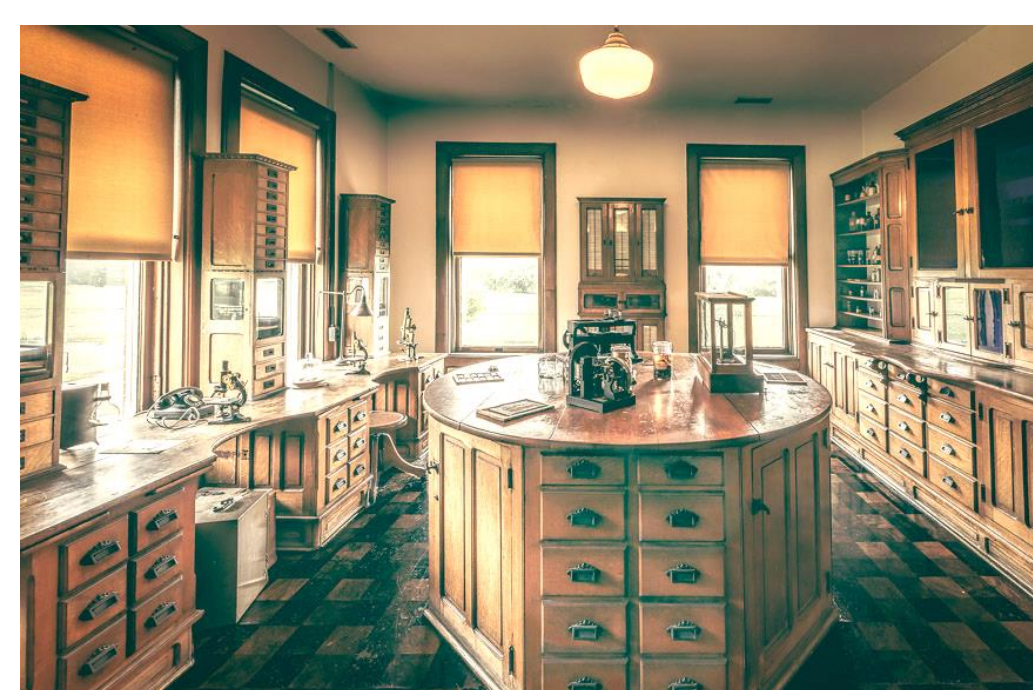


Photo credit: Indiana Medical History Museum



Photo credit: Eagle Creek Ornithology Center



Team following analysis of FBI art collection

### Dust Measurement

- ❖ An aerosol direct reading instrument (DustTrak, model 8520, TSI, USA) was used to measure the mass concentration of particulate matter smaller than 2.5 µm (PM<sub>2.5</sub>).
- ❖ PM<sub>2.5</sub> concentrations in two exhibit galleries were measured for 25 minutes during routine cleaning of the museum's exhibit spaces and collections in IMHM.



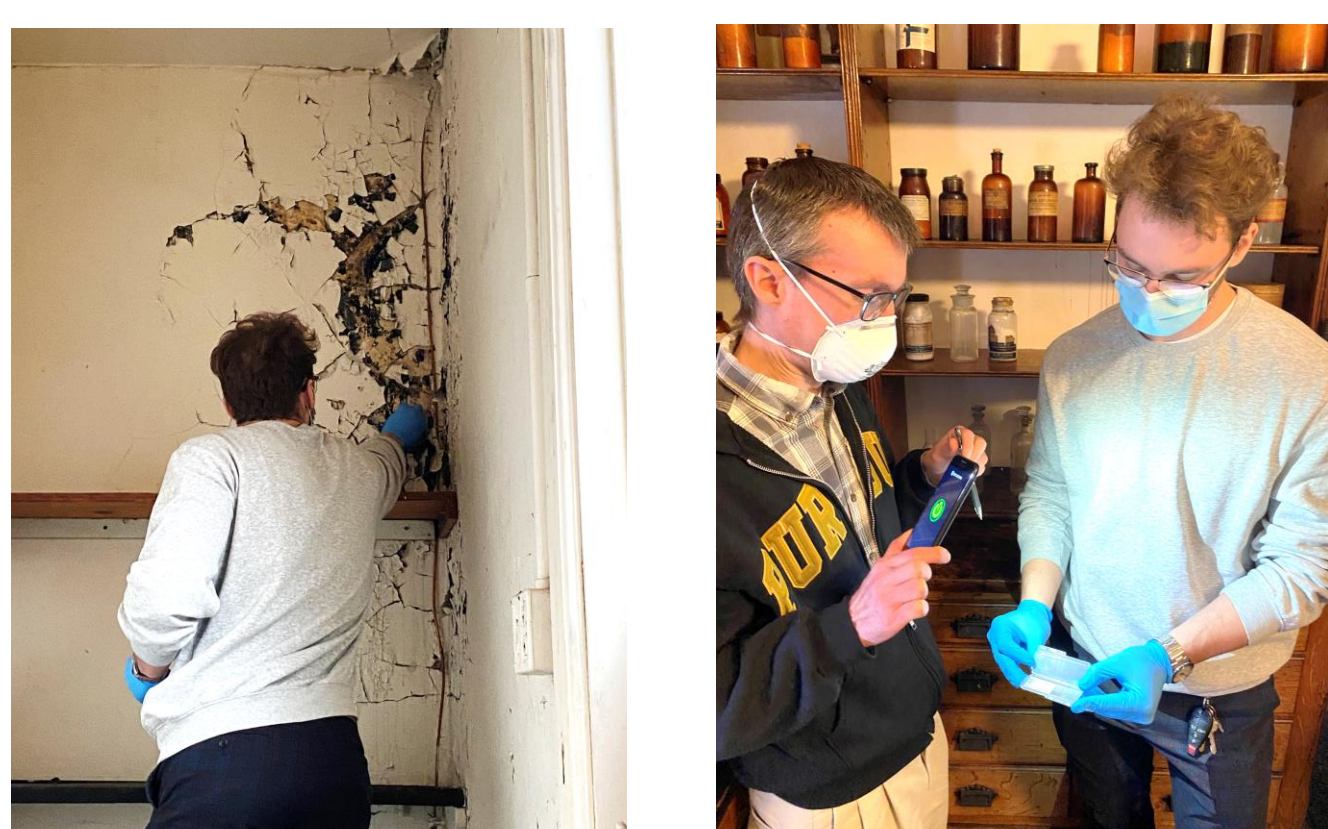
DustTrak

### Mold Sampling

- ❖ Bio-Tape slides (BT0050, Zefon International, USA) were used to capture mold spores on the surfaces of the IMHM and then analyzed using an optical microscope in the lab at Purdue University.



Bio-Tape Slide



(Left and Right): Mold sampling a wall and shelving of the Indiana Medical History Museum

## Heavy Metal Analysis

- ❖ Field Portable X-Ray Fluorescence (FP-XRF; XL3t Ultra Analyzer, ThermoScientific, USA) was used to analyze metals in collections at all three locations.
- ❖ Organic artifacts believed to have been treated with heavy metals underwent FP-XRF analysis.
- ❖ Early 20<sup>th</sup>-century medical equipment was scanned in areas associated with historical uses of heavy metals (paint, shielding, etc.).
- ❖ Each sample was scanned with soil mode for 120 sec.



(Left to Right) K. Burnell, J. Klicker-Weichmann, E. Daugherty, and M. Griem measure the levels of arsenic present in a taxidermy mount using a portable XRF device at the Eagle Creek Ornithology Center.

## Results and Discussion

### PM<sub>2.5</sub> Concentrations in IMHM

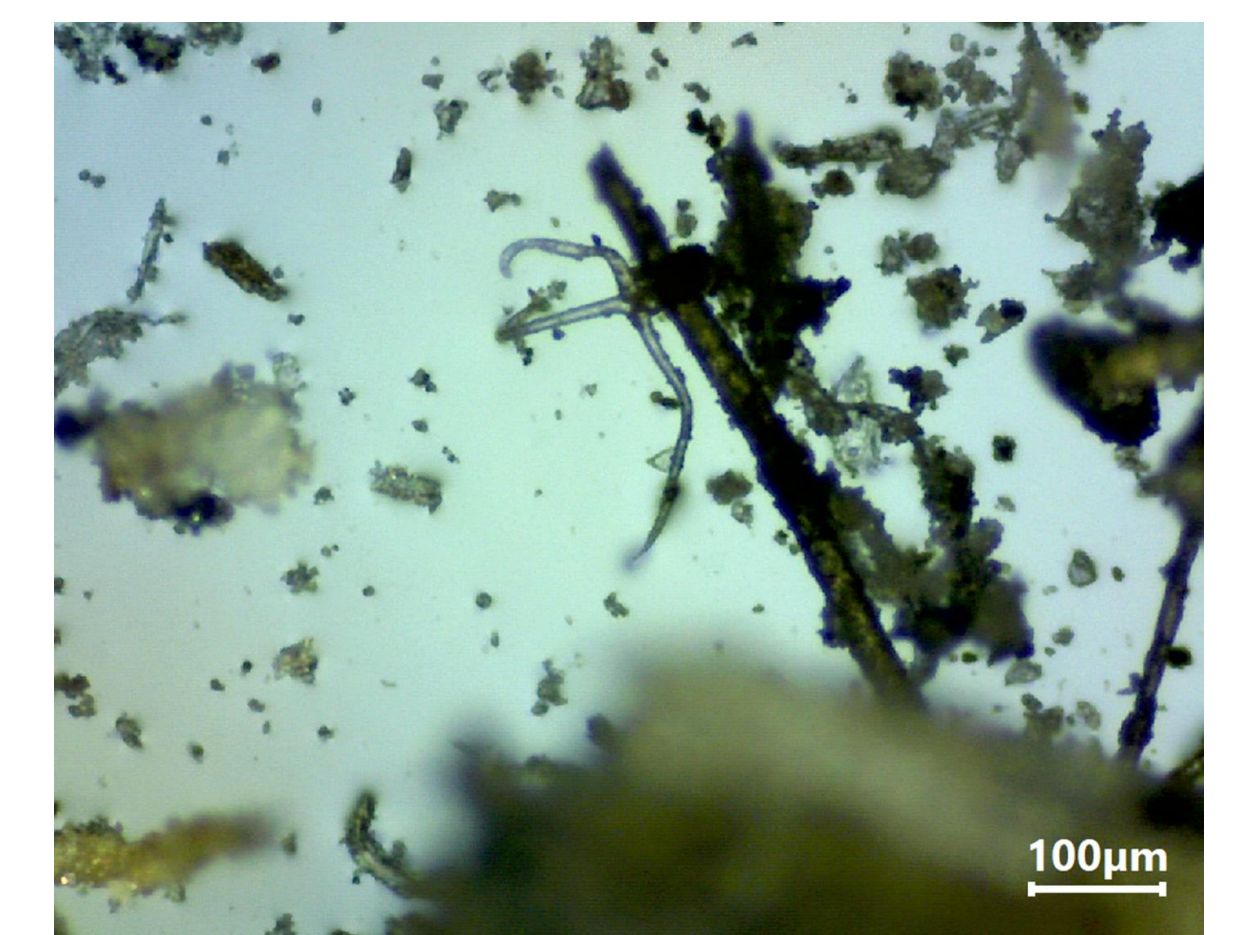
- ❖ Historic Pathology Laboratory
  - Average concentration: 0.19 mg/m<sup>3</sup>
  - Range: 0.01 - 0.518 mg/m<sup>3</sup>
- ❖ Historic Library
  - Average concentration: 0.05 mg/m<sup>3</sup>
  - Range: 0.012 - 0.425 mg/m<sup>3</sup>



The team uses XRF to test treated ethnographic artifacts to detect the use of heavy metals by collectors.

### Presence of Mold in IMHM

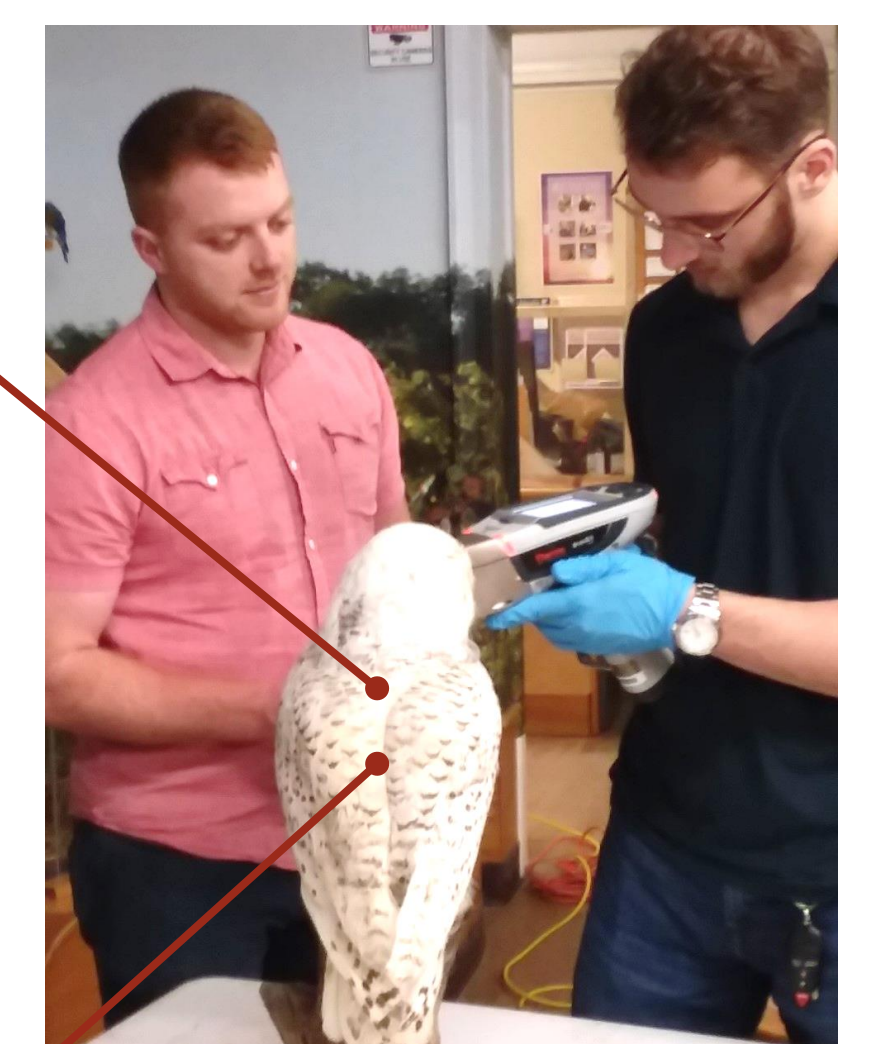
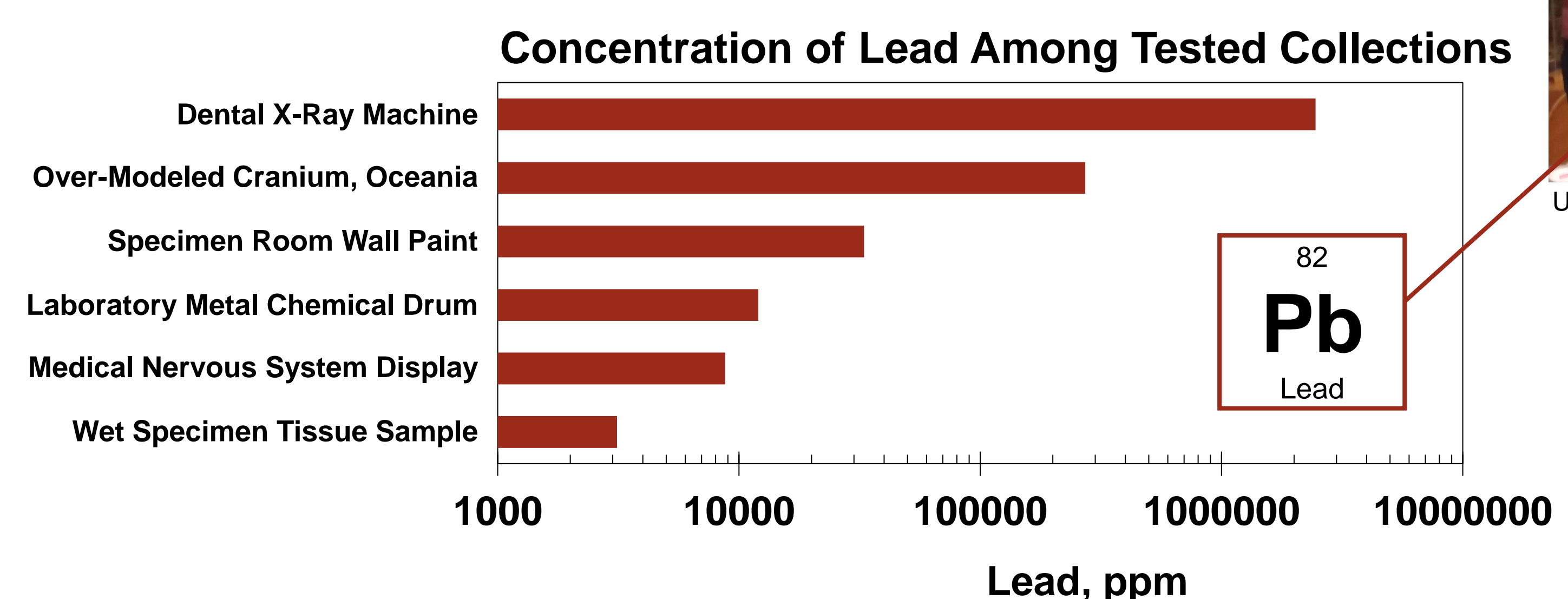
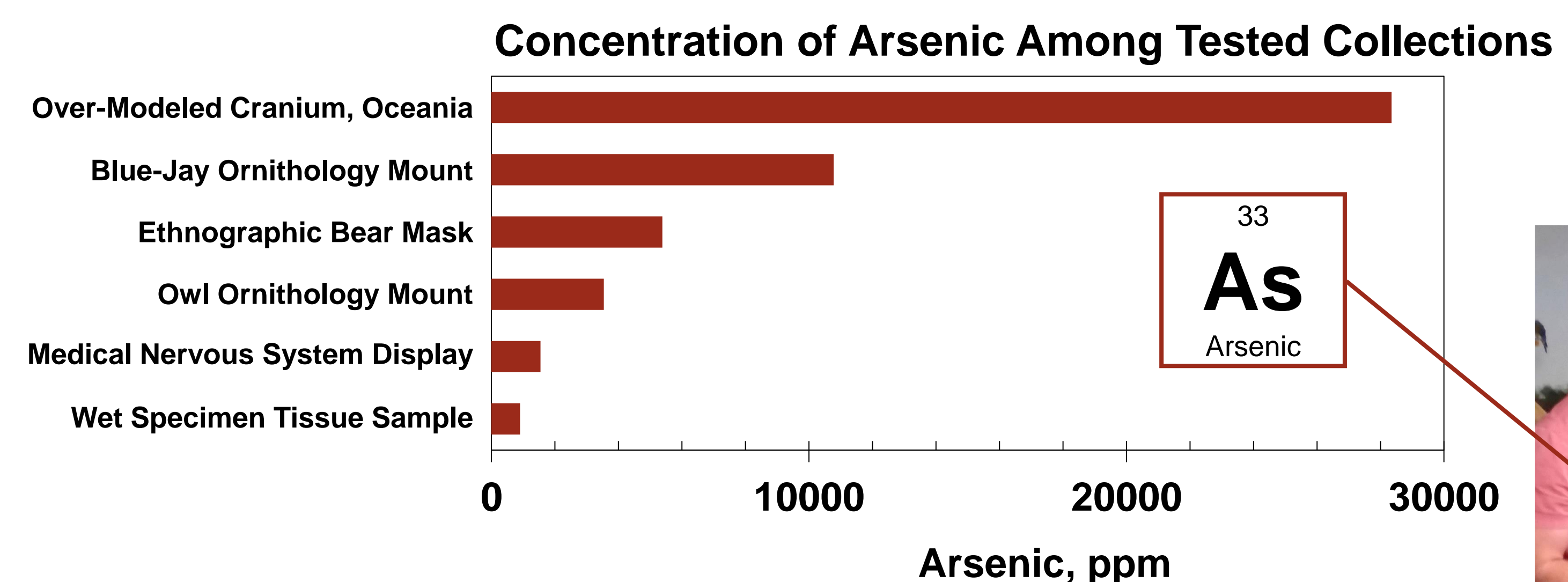
- ❖ Visual patches of suspected mold were found on artifacts and structural components of the museum.
  - Microscopic identification of mold was inconclusive due to the level of dust accumulated by the Bio-Tape slides.



Dust collected on the Bio-Tape (sampled from the floor of the IMHM)

### Heavy Metals in Collections

- ❖ As and Pb were found across all collections.
  - As concentration was highest on organic samples.
  - Pb was found on inorganic and organic artifacts.



Using a FP-XRF to analyze the heavy metals in a taxidermy mount at the Eagle Creek Ornithology Center

## Conclusions

- ❖ This assessment found the presence of hazardous agents such as dust, heavy metals, and mold.
  - The concentration of dust was below OSHA's standard (5 mg/m<sup>3</sup>).
  - The presence of As and Pb could be concerning. For these reasons, safety measures such as disposable gloves and respirators should be implemented.
- ❖ Further mold sampling will be conducted.
- ❖ Future studies will incorporate:
  - Air sampling for organic vapors
  - Elemental analysis of dust samples
  - Measuring mold concentration of indoor air



Communicating identified hazards and risks to museum staff and students.

## Acknowledgements

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