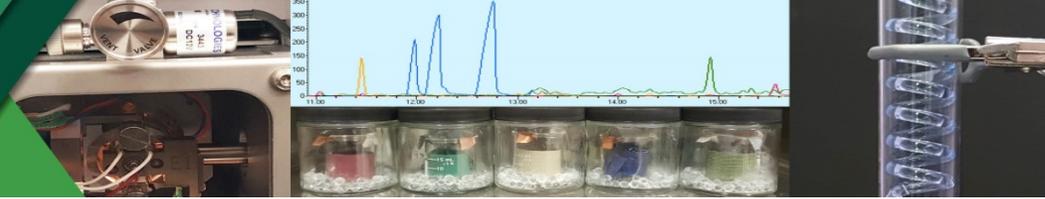


# Environment, Housing & Building Materials Testing to Protect our Collections

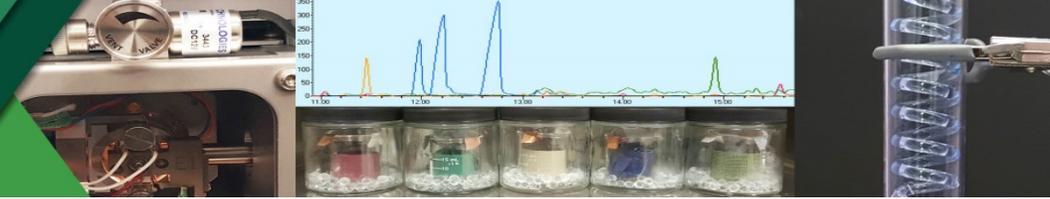
Eric B. Monroe

Preservation Research and Testing Division, Library of Congress



Analytical Service Requests • Research Projects • Quality Assurance



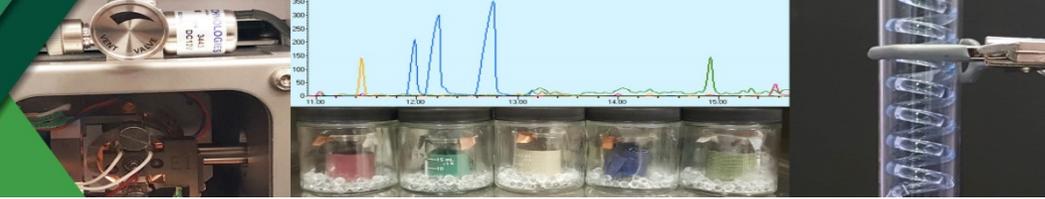


# Quality Assurance Program



Test materials that come in contact with collections prior to contract award and every shipment to reduce risk to collections





# Quality Assurance Program

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**Library of Congress Preservation Directorate  
Specification Number 300-311 – 16  
Specifications for Document Storage Boxes  
For the Storage of Artifacts**

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**1. Composition and Chemical Requirements**

**1.1 Fiber**  
The stock must be made from rag or other high alpha-cellulose content pulp, minimum of 87%. It must not contain any post consumer waste recycled pulp.

**1.2 Lignin**  
The stock must give a negative reading for lignin as determined by the phloroglucinol test when tested according to TAPPI T 401, Appendix F, and shall have a Kappa number of 5 or less when tested according to TAPPI T 236.

**1.3 Impurities**  
The stock must be free of metal particles, waxes, plasticizers, residual bleach, peroxide, sulfur (which will be less than 0.0008% reducible sulfur as determined by TAPPI T 406), and other components that could lead to the degradation of the box itself, or the artifacts stored therein.

**1.4 Metallic Impurities**  
Iron must not exceed 150 ppm and copper shall not exceed 6 ppm when tested according to TAPPI T 266.

**1.5 Optical Brighteners**  
The stock must be free of optical brightening agents.

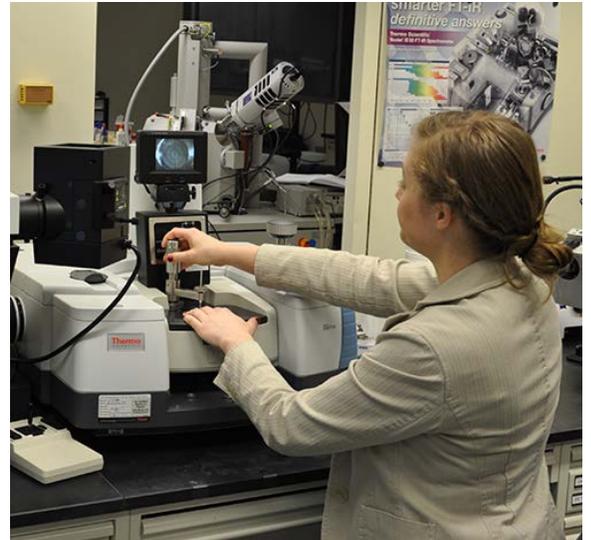
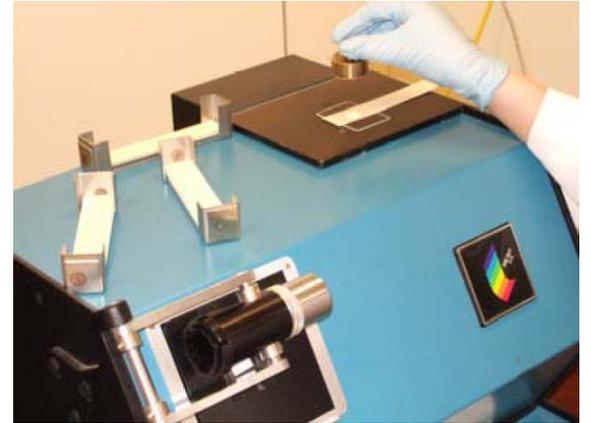
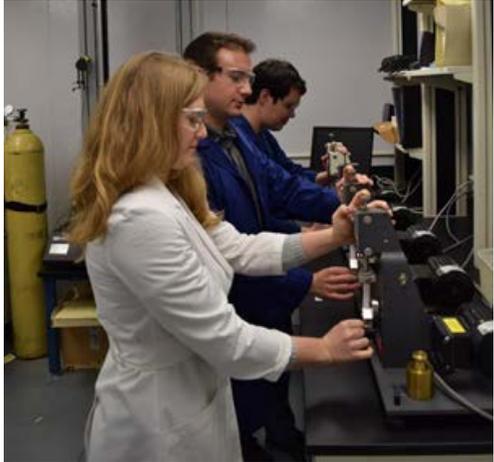
**1.6 pH**  
The stock must have a pH value within a range of 8.0 - 9.5 as determined by TAPPI T 509, cold extraction (modified by slurrying sample pulp before measurement).

**1.7 Alkaline Reserve**  
The stock must contain an alkaline reserve with a minimum of 2% and a maximum of 5% calculated as CaCO<sub>3</sub> when tested according to TAPPI T 553 (modified by slurrying sample pulp before measurement).

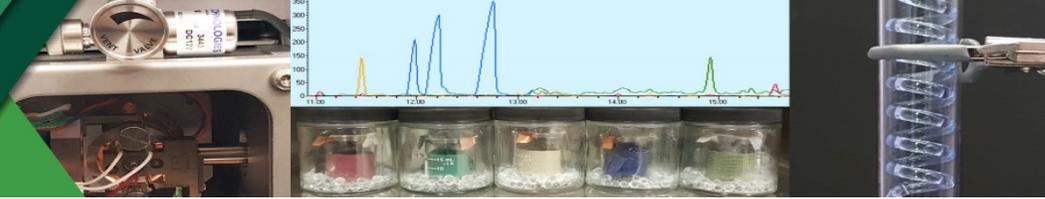
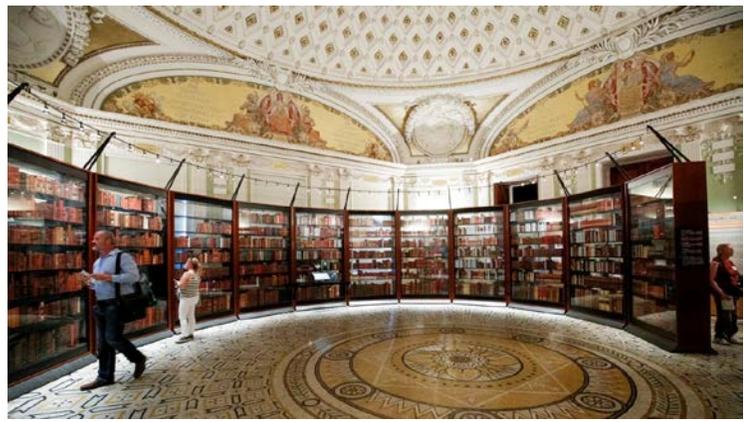
Library of Congress Preservation Directorate Specification 300-311 – 16

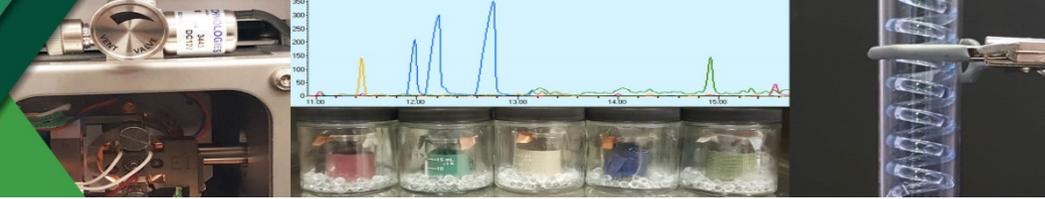
Property	Requirement	Test Method
Lignin	Negative / Kappa 5	TAPPI T 401, Appendix F or TAPPI T 236
Reducible Sulfur	< 0.0008%	TAPPI T 406
Iron	≤ 150 ppm	TAPPI T 266
Copper	≤ 6 ppm	TAPPI T 266
pH	8.0 – 9.5	TAPPI T 509, cold extraction, slurried pulp
Alkaline Reserve	2 – 5%	TAPPI T 553, slurried pulp
Alum Rosin Sizing	Negative	TAPPI T 408
Basis Weight	60 pt: 800 lbs./3,000 ft <sup>2</sup>	TAPPI T 410
Color Bleeding	No bleed in 48 hours	See section 2.3
Color Retention	≤ 5 pts	TAPPI T 452
Stiffness	60 pt: 5600 MD, 2500 CD	TAPPI T 489

# Chemical, Physical and Aging Testing for QA

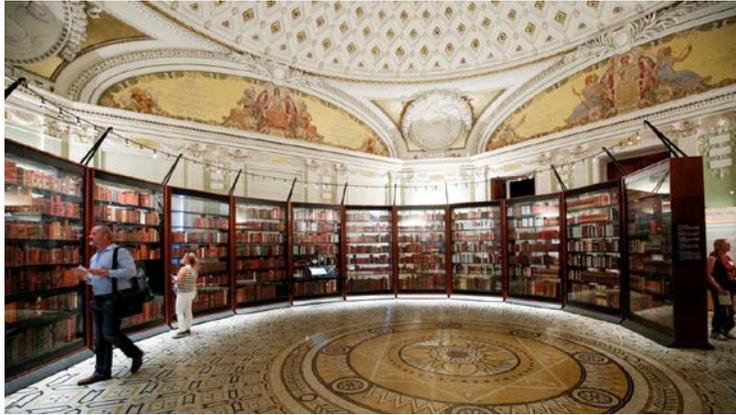


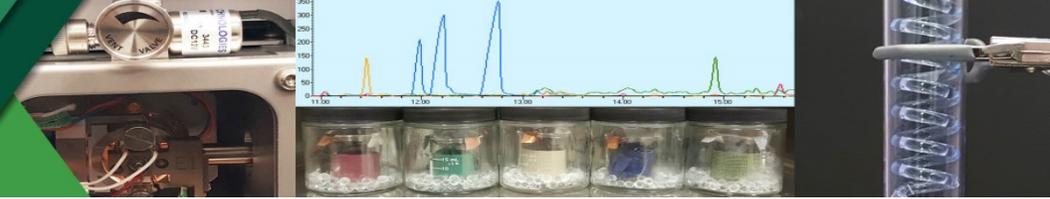
# Traditional QA - what comes in contact with collections



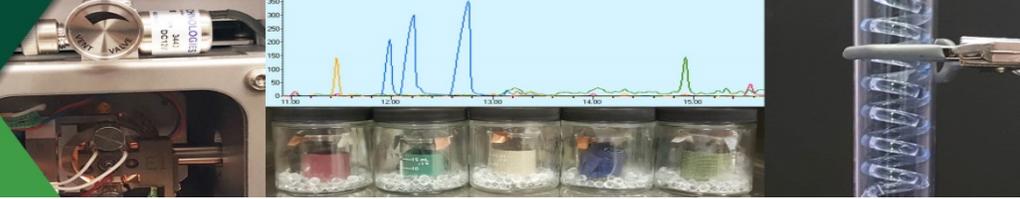


What else might we need to examine?

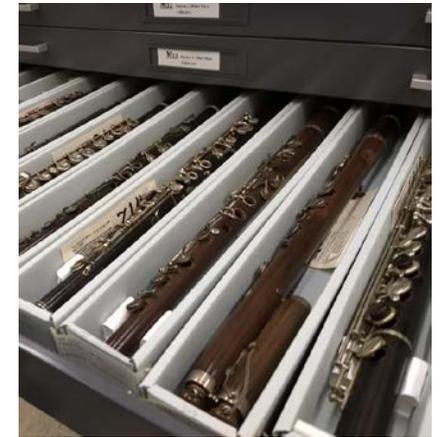
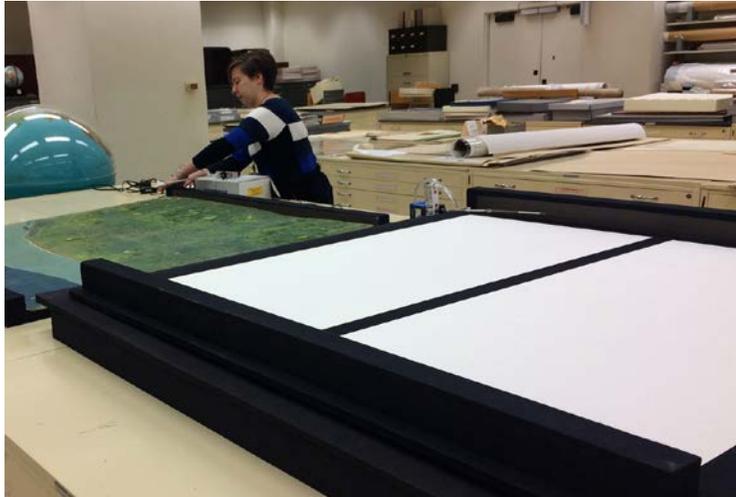
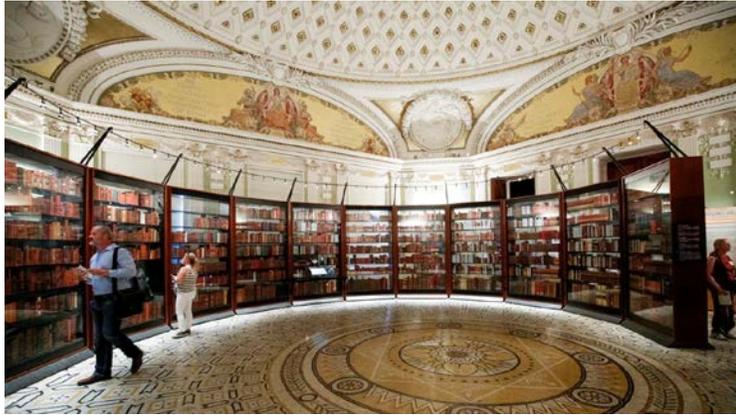


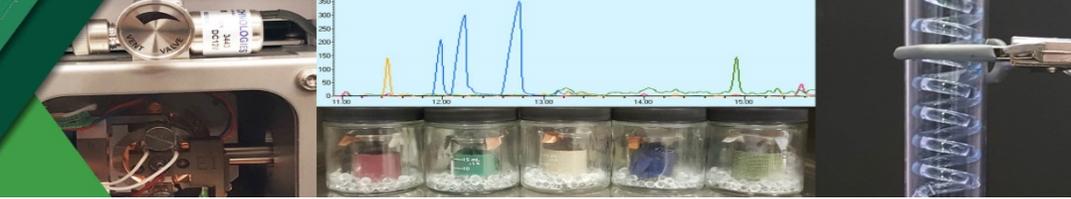


# Things Smell



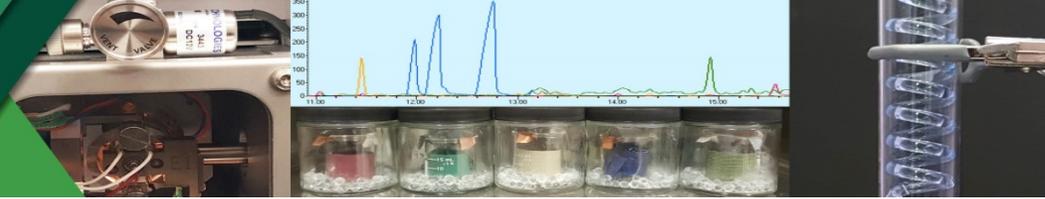
# Collections are in many different environments



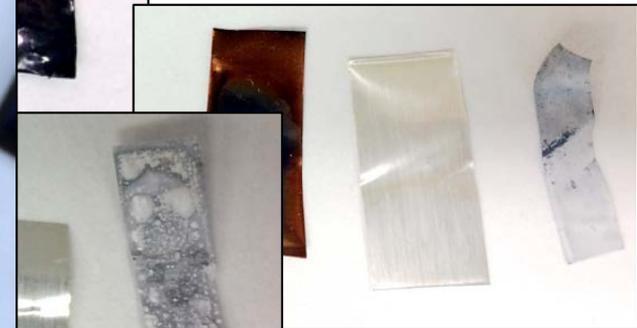
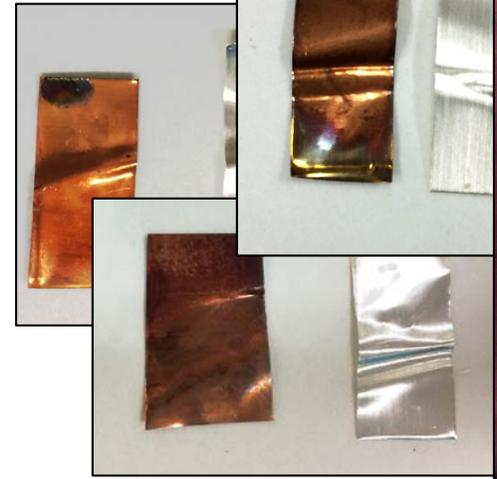


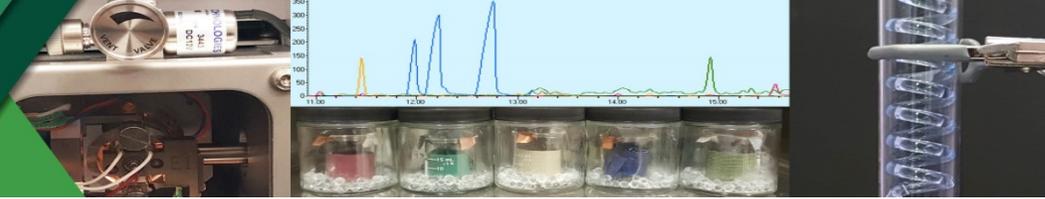
# Traditional predictive testing – Oddy Test



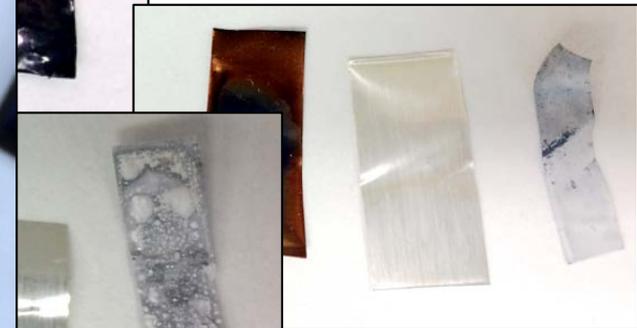
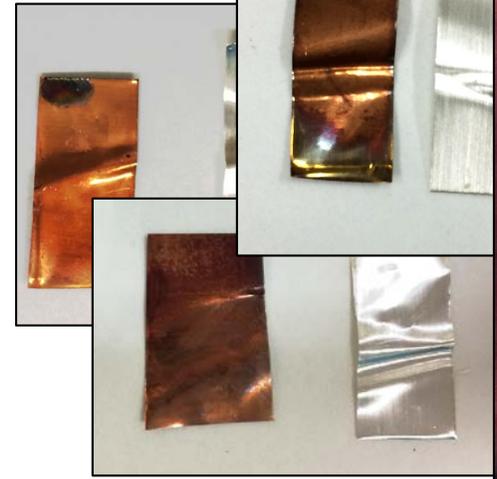


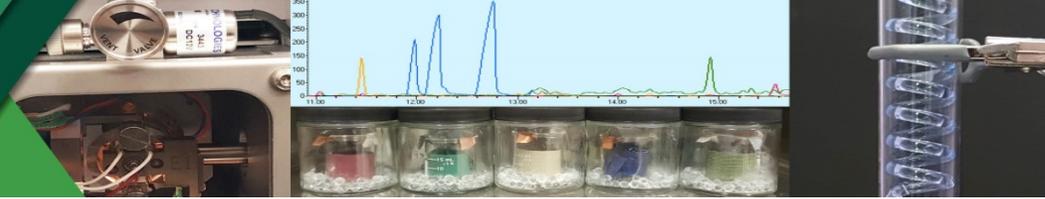
# Oddy test results





# Oddy test results





# Adapting VOC methods from industrial standards

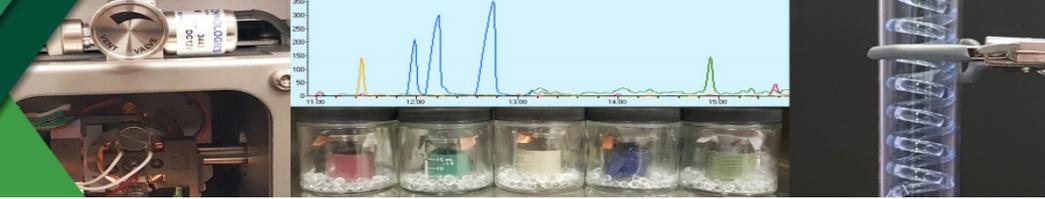


**VDA** | Verband der Automobilindustrie  
VDA278

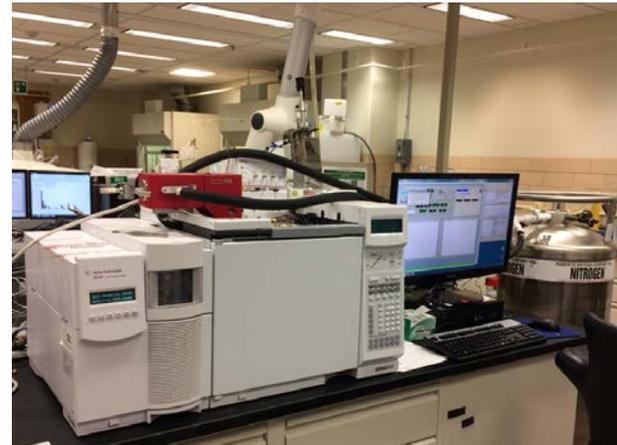
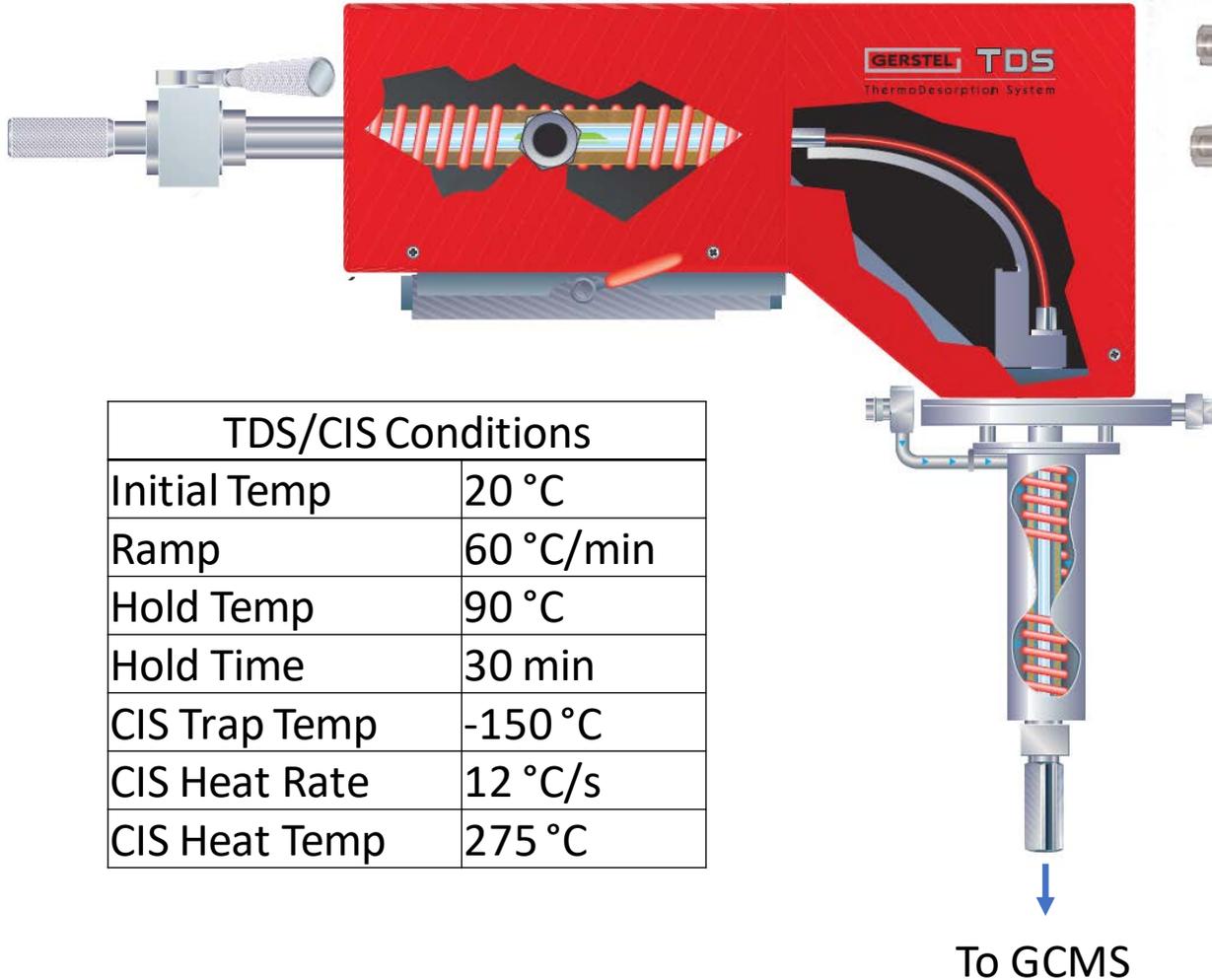


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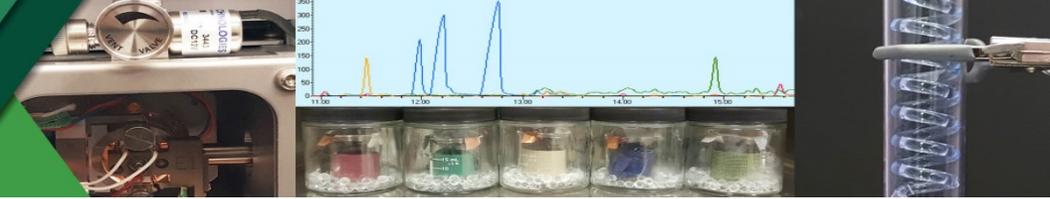


# Direct thermal desorption GCMS



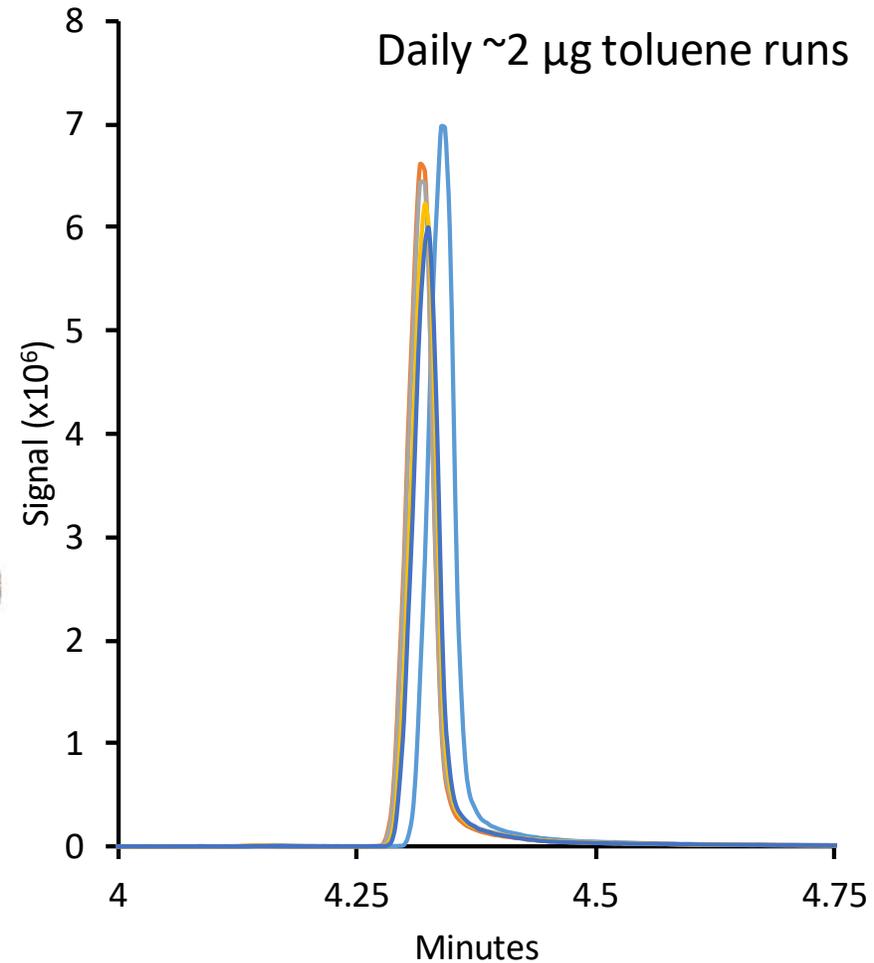
TDS/CIS Conditions	
Initial Temp	20 °C
Ramp	60 °C/min
Hold Temp	90 °C
Hold Time	30 min
CIS Trap Temp	-150 °C
CIS Heat Rate	12 °C/s
CIS Heat Temp	275 °C

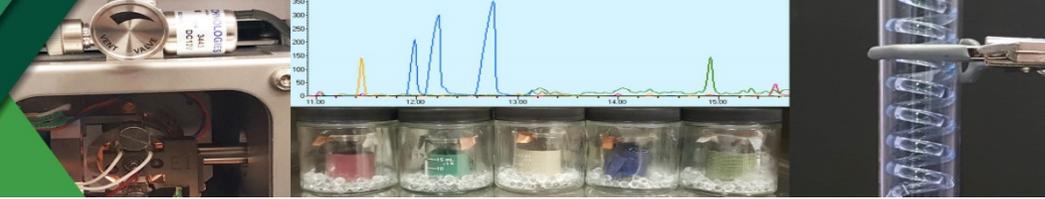
GC Conditions	
Runtime	63 min
Initial Temp	40 °C
Initial Time	2 min
Heat Rate 1	3 °C/min
Temp Step 1	92 °C
Heat Rate 2	5 °C/min
Temp Step 2	160 °C
Heat Rate 3	10 °C/min
Temp Step 3	310 °C
Hold Time	15.07 min



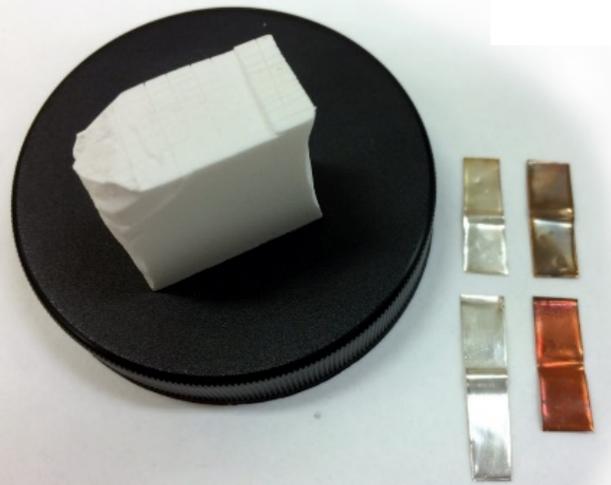
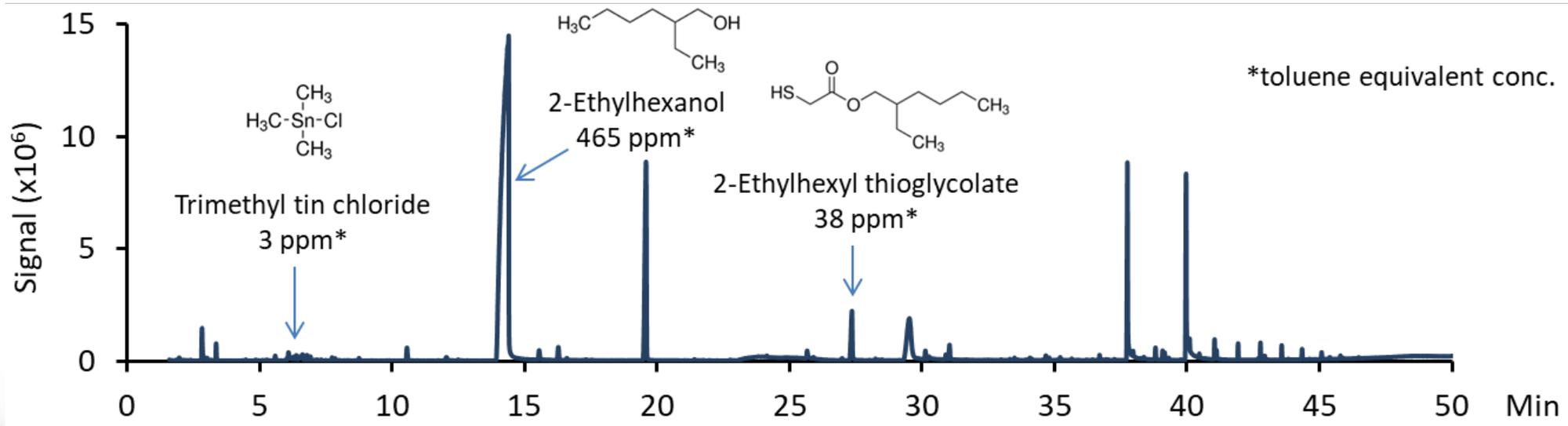
# Toluene as a quantifying standard

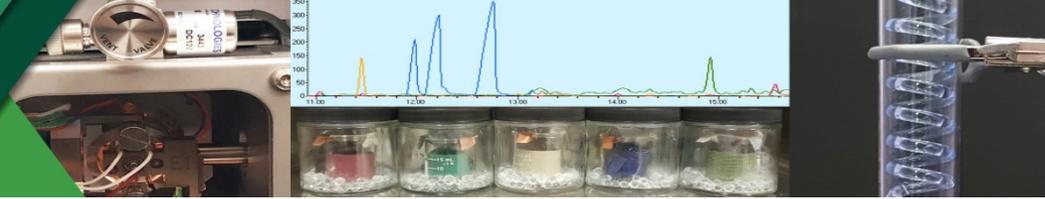
TDS/CIS Conditions	
Initial Temp	20 °C
Ramp	60 °C/min
Hold Temp	300 °C
Hold Time	12 min
CIS Trap Temp	-150 °C
CIS Heat Rate	12 °C/s
CIS Heat Temp	275 °C



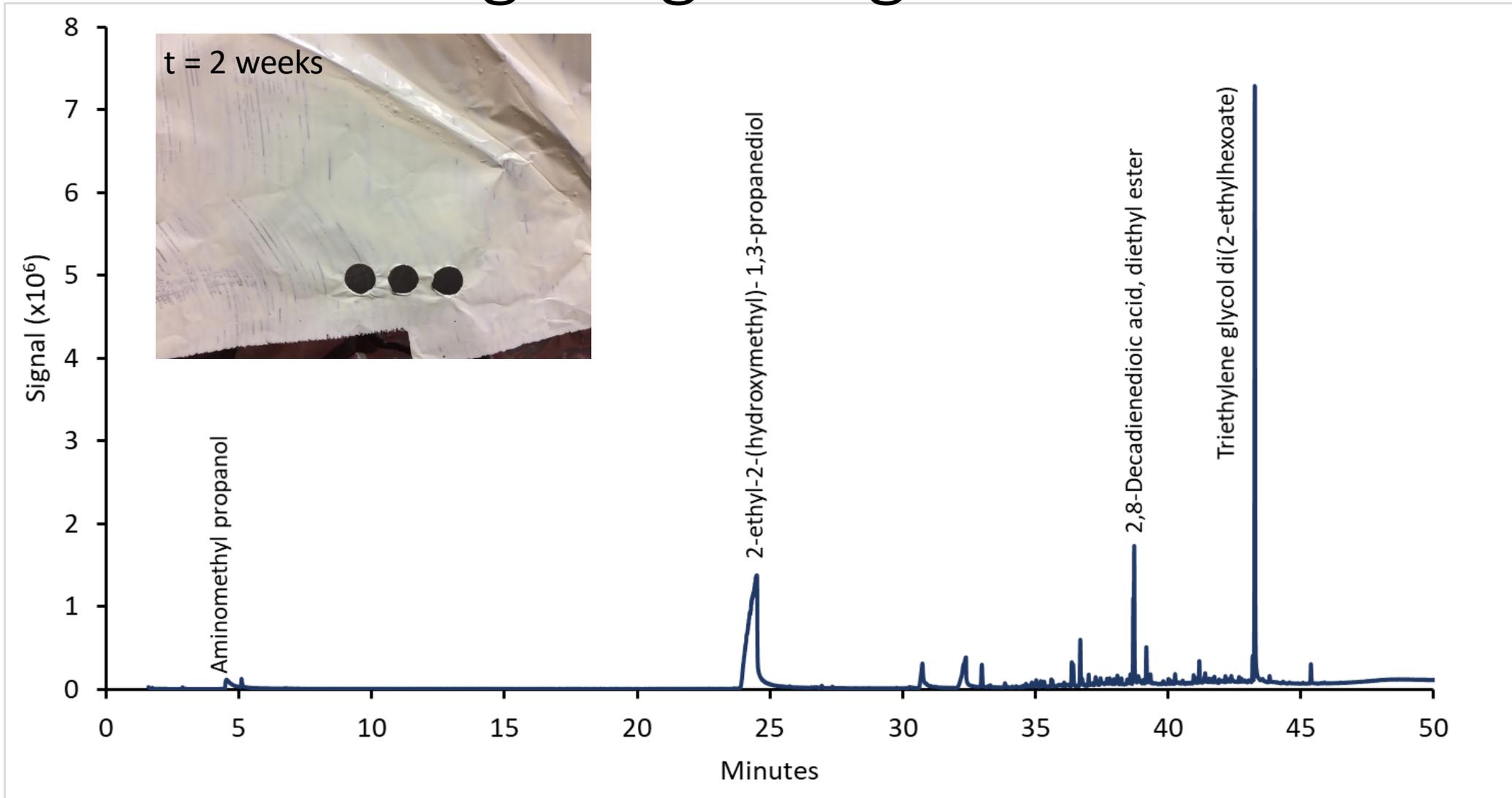


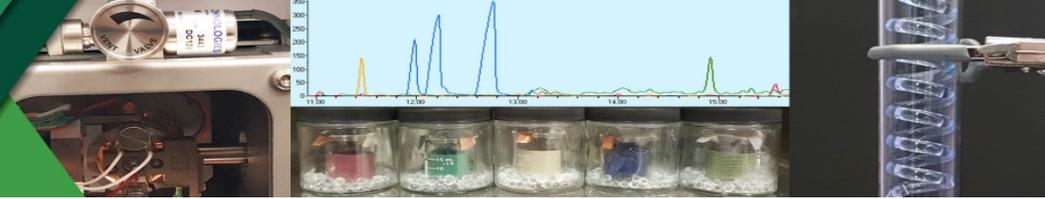
# Rapid screening of PVC board for exhibition cases



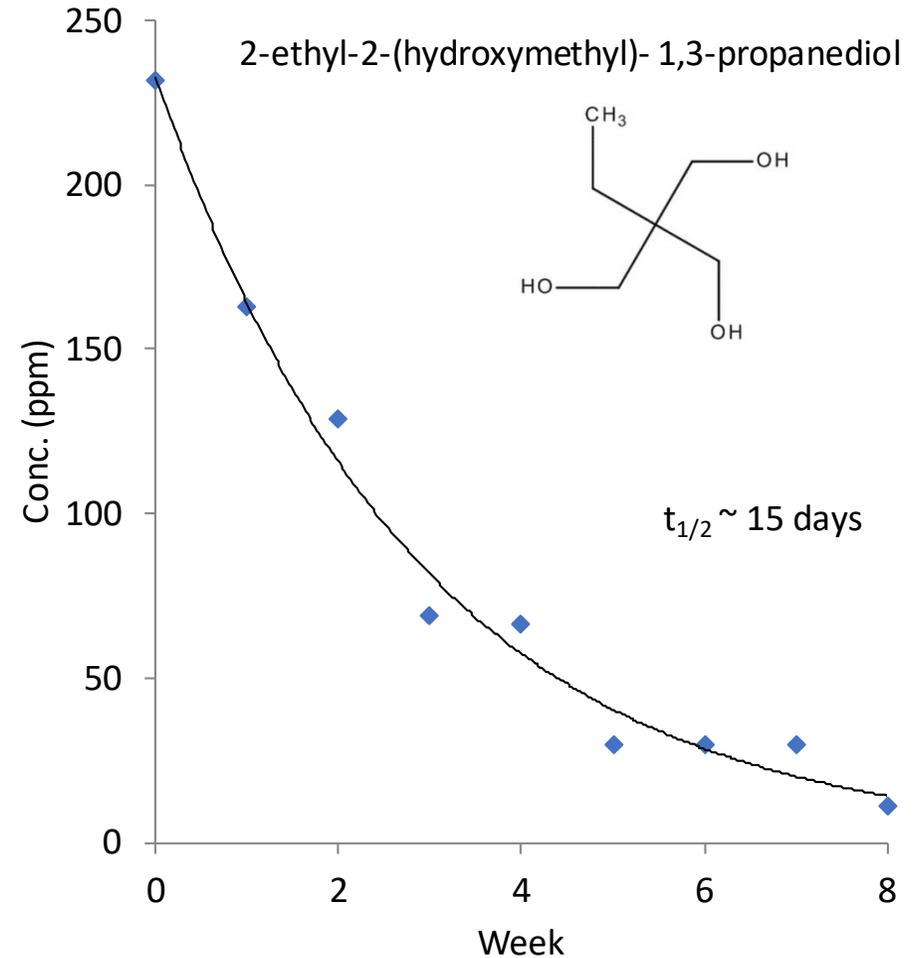
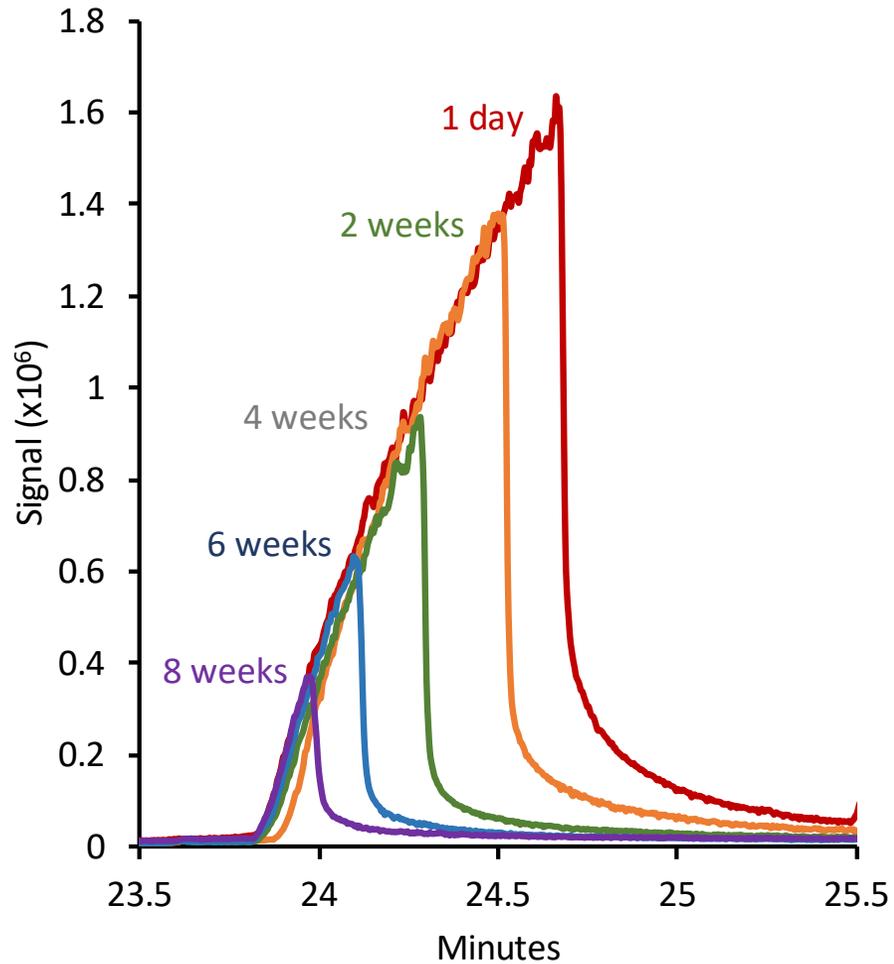


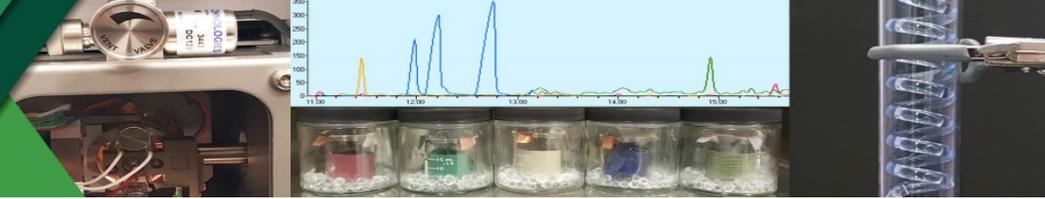
# Tracking off-gassing of materials





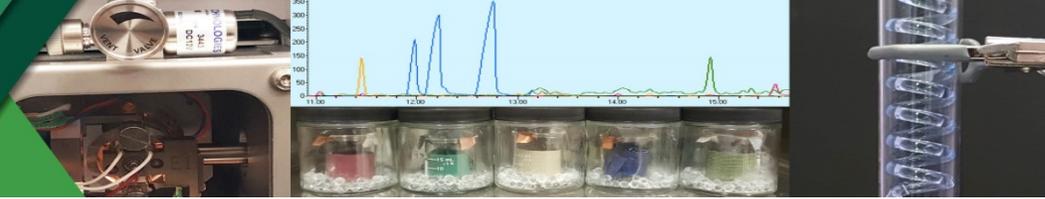
# Tracking off-gassing of materials





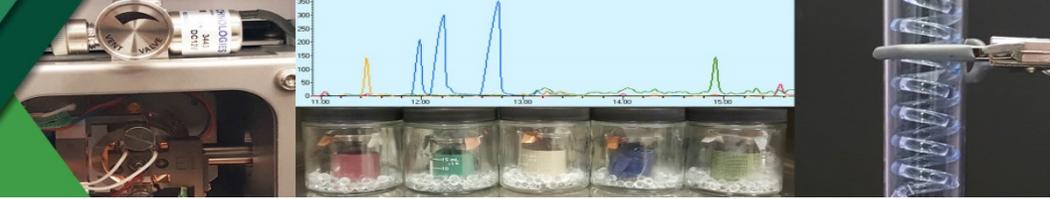
# Construction material testing for vault renovation



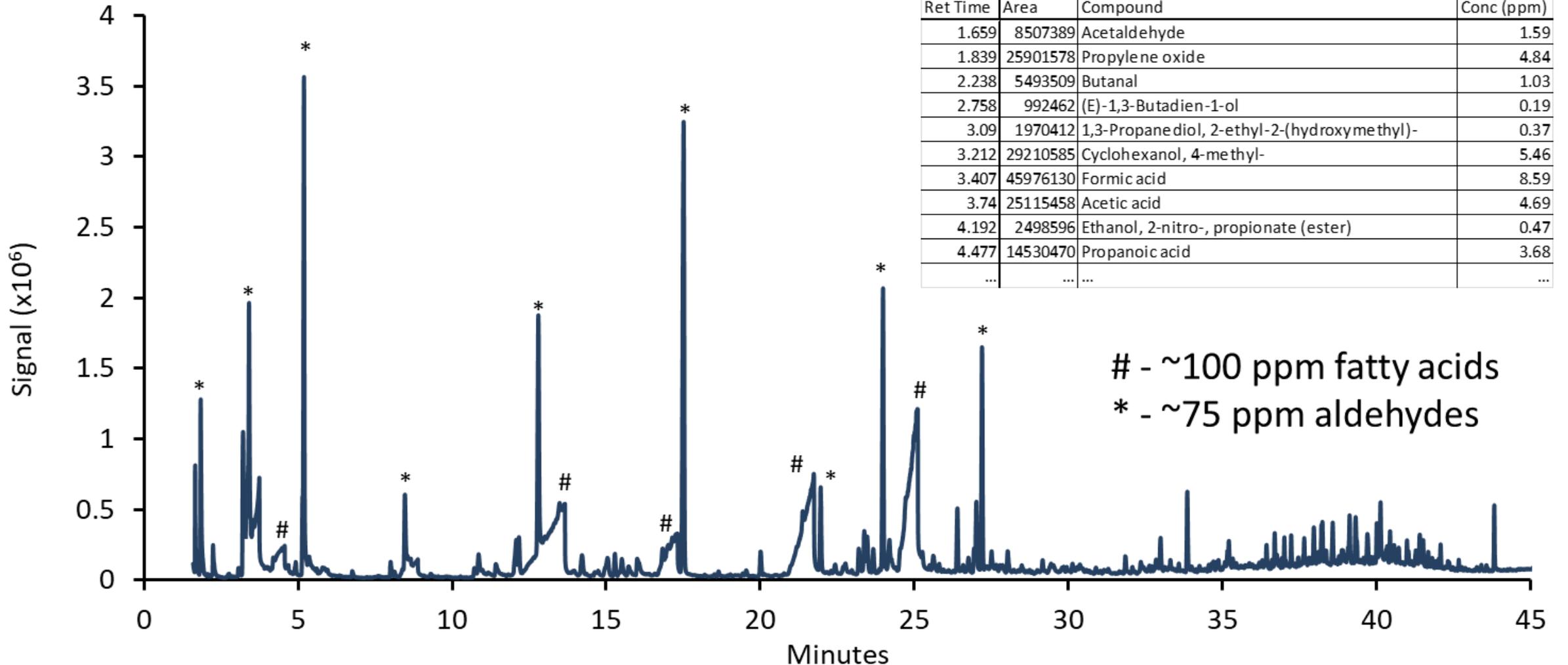


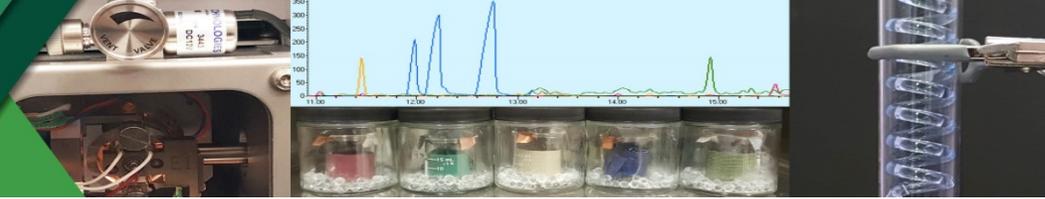
# A proposed floor tile fails Oddy tests spectacularly



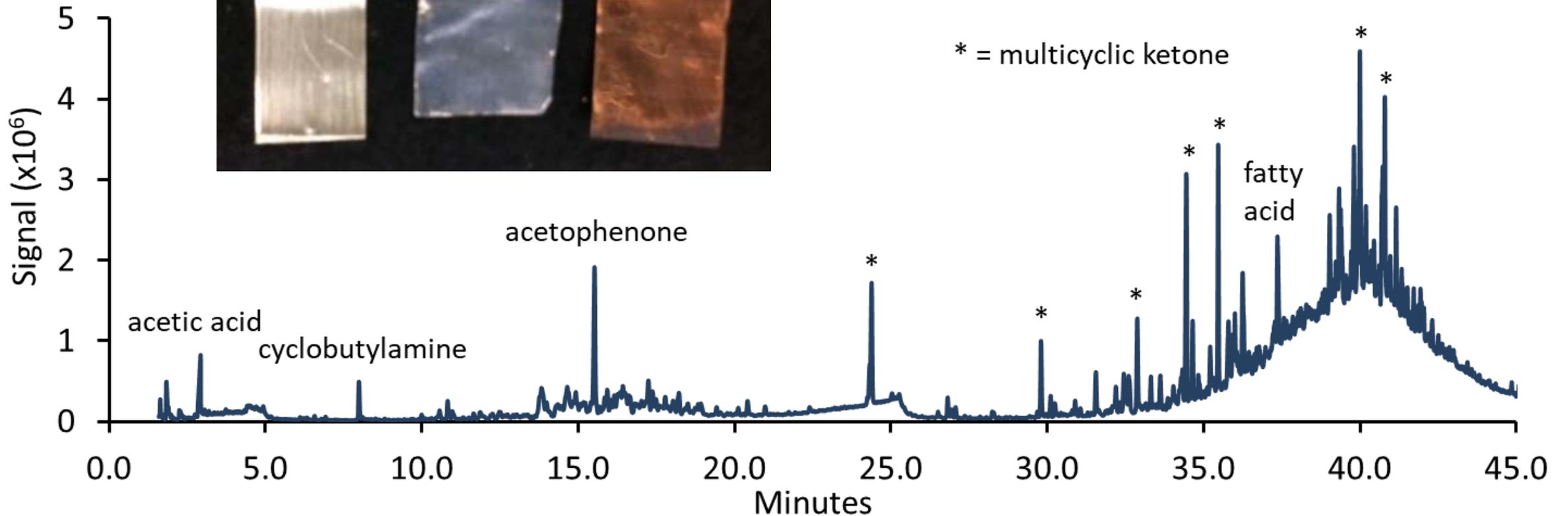
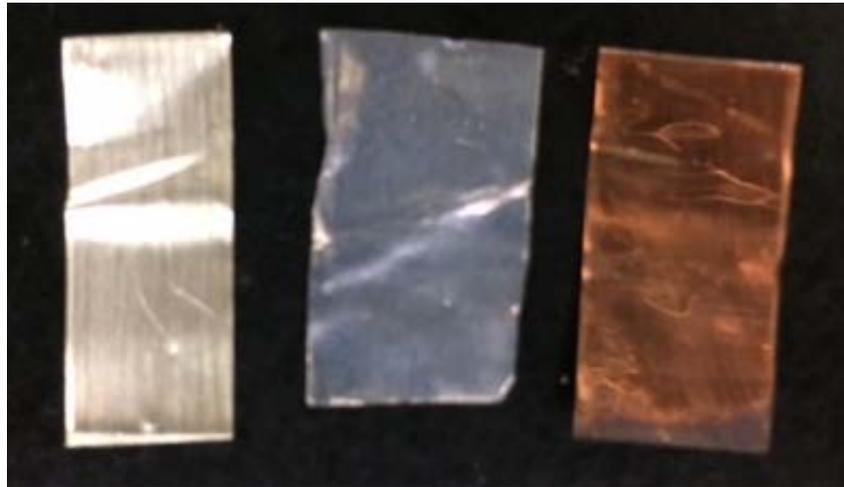


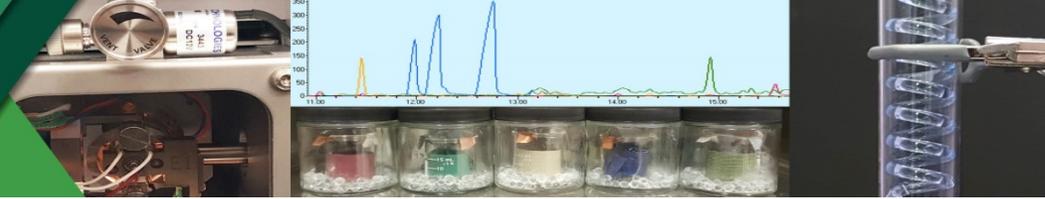
# Tile releases fatty acids and aldehydes



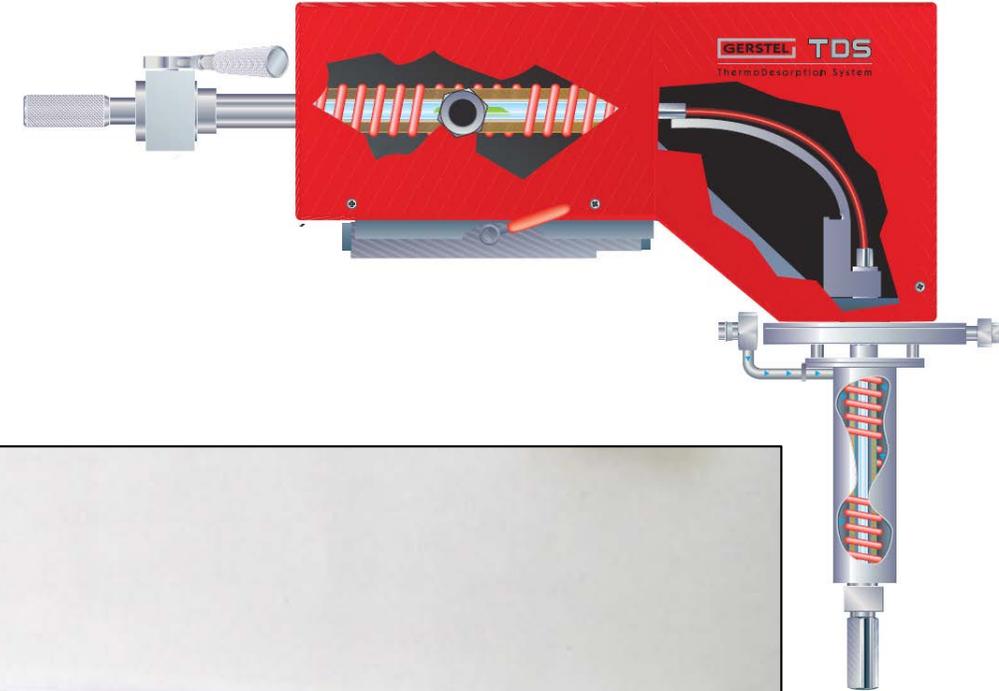


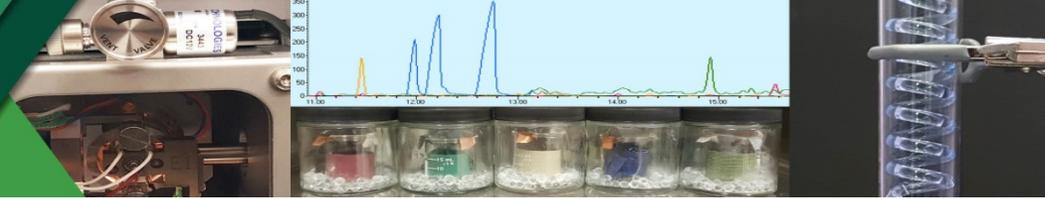
# Selecting the least bad tile adhesive



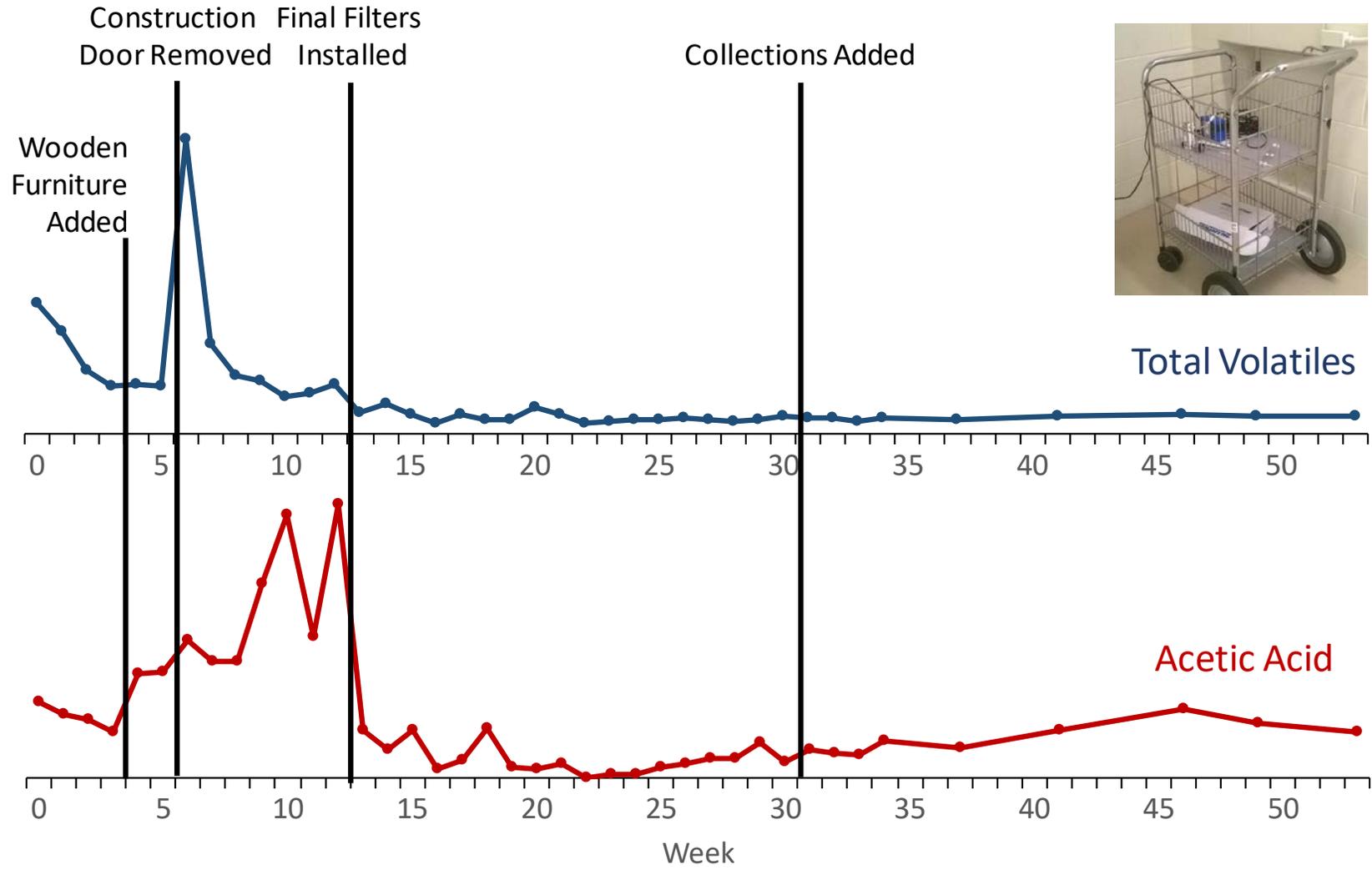


# Field air sampling using TenaxTA tubes

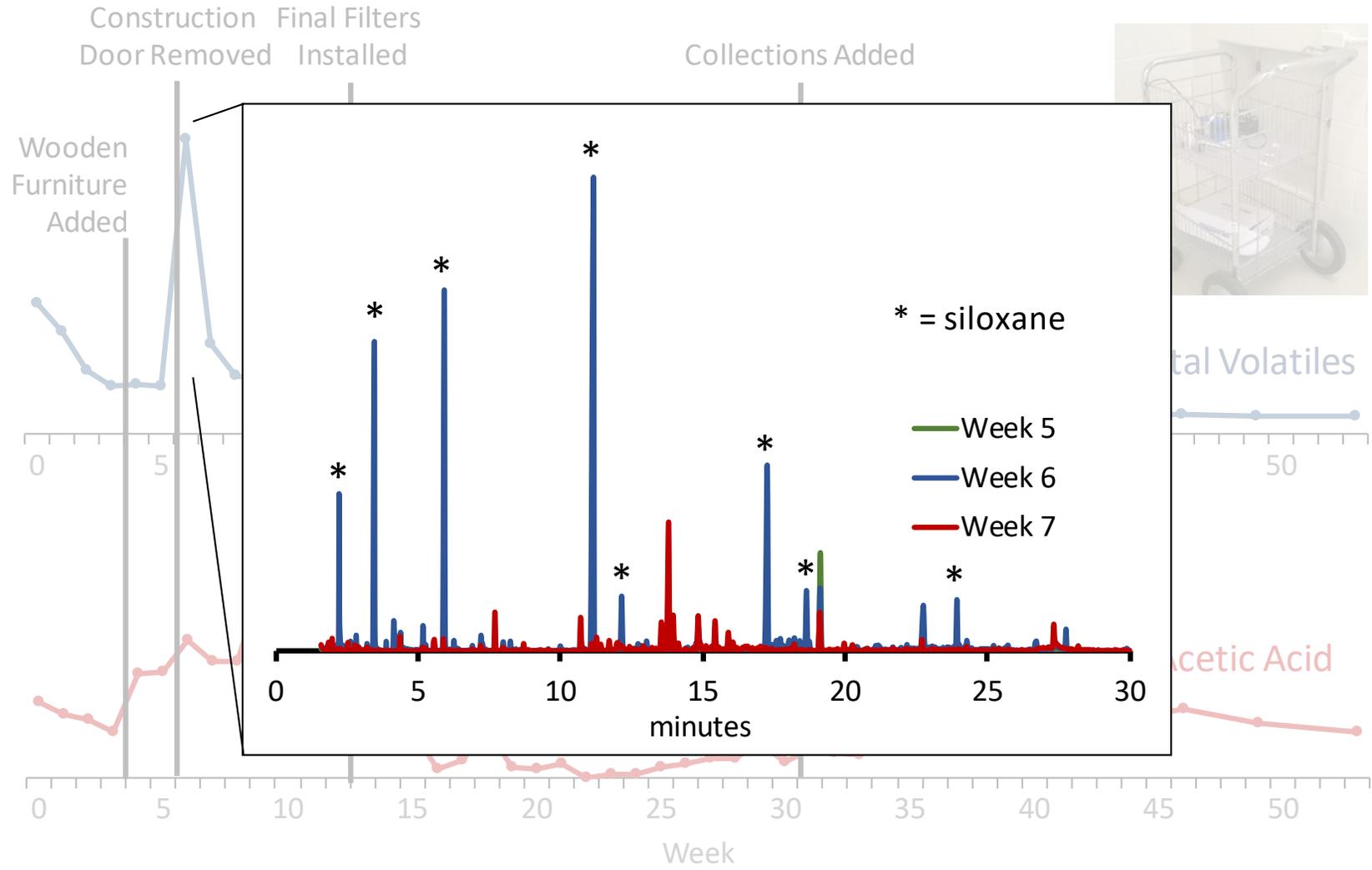


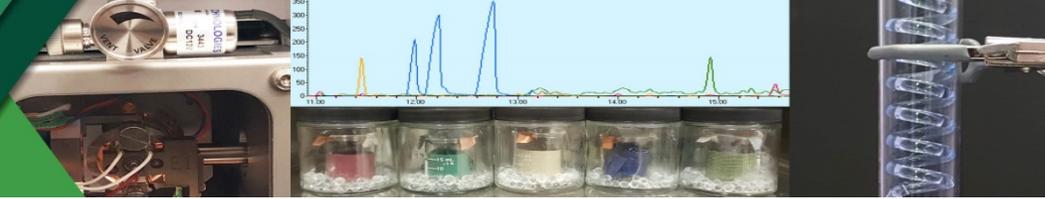


# Some surprises during SSF field sampling

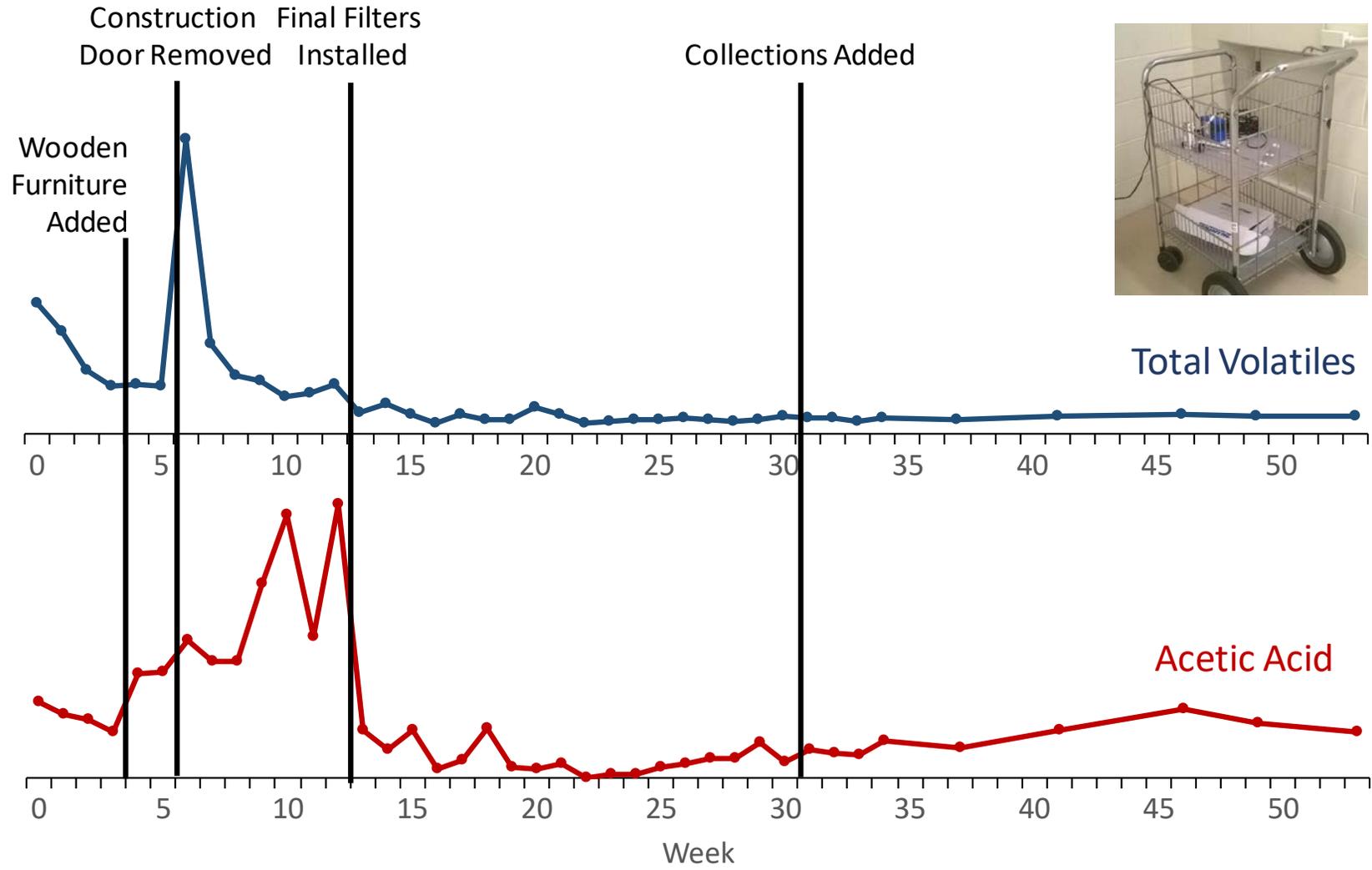


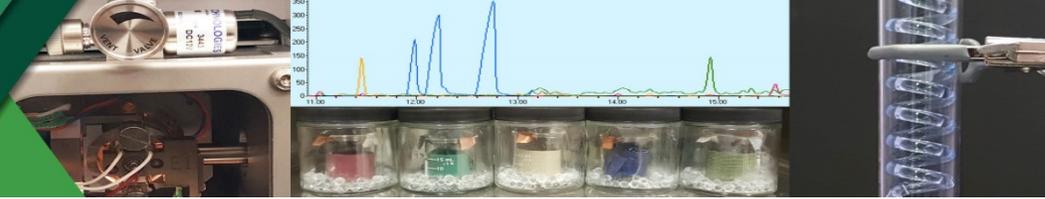
# Some surprises during SSF field sampling



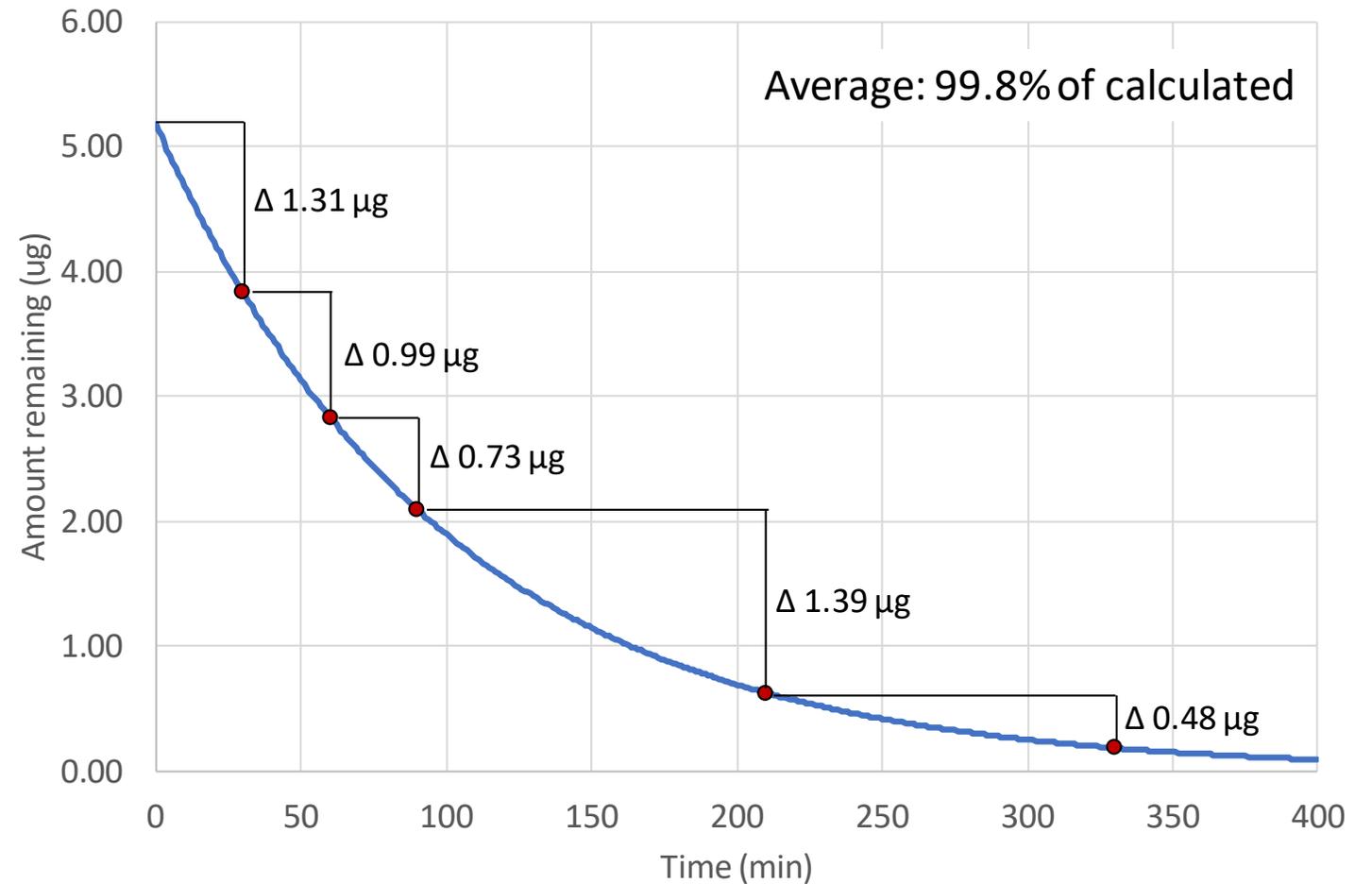


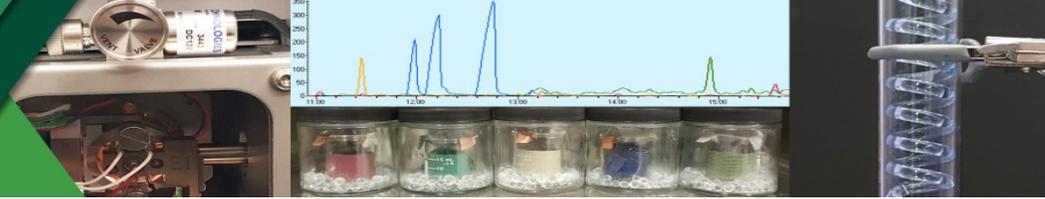
# Some surprises during SSF field sampling





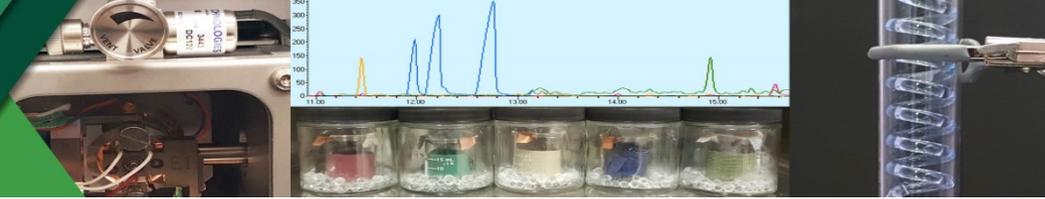
# How quantitative is field sampling?



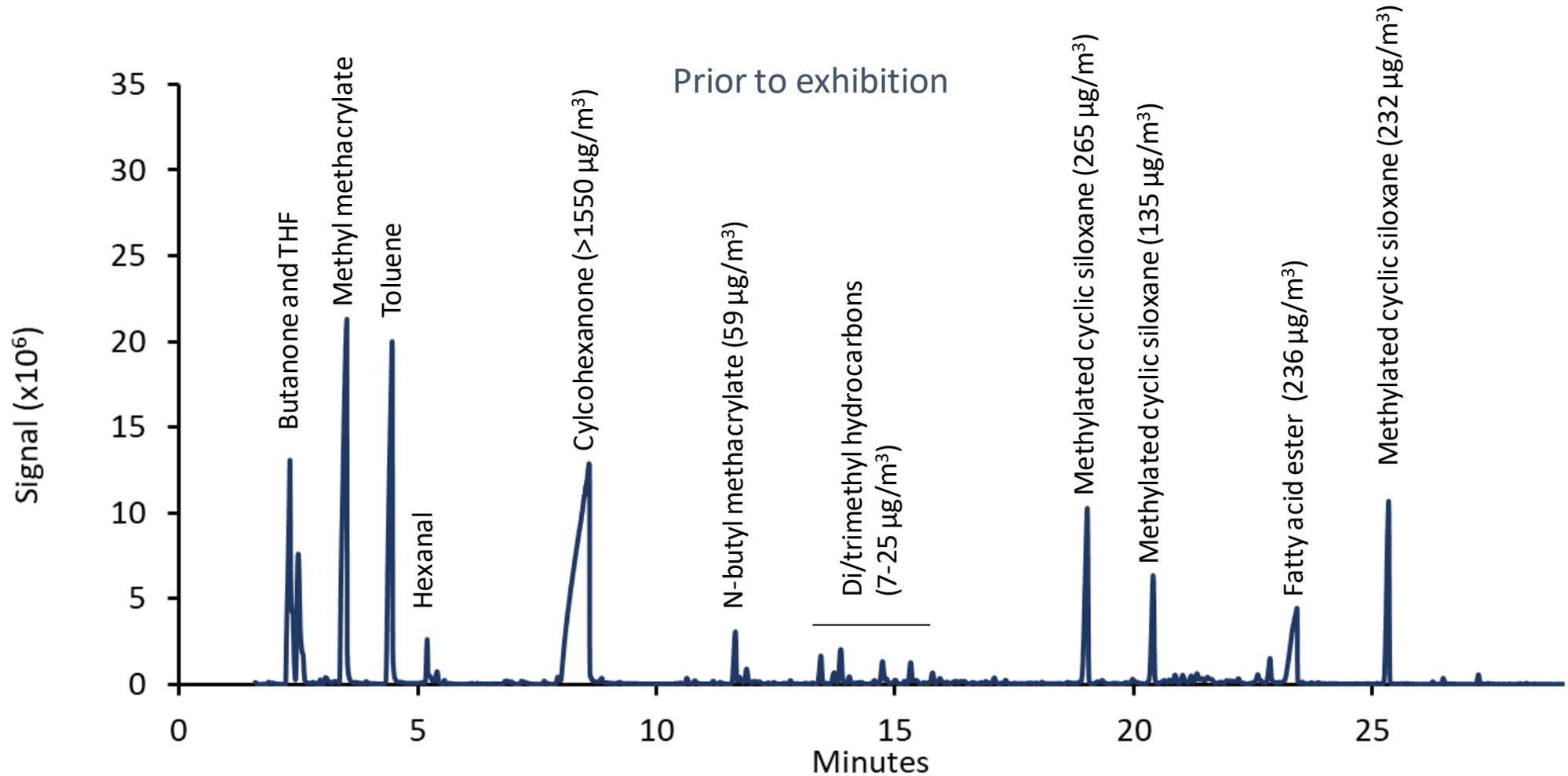


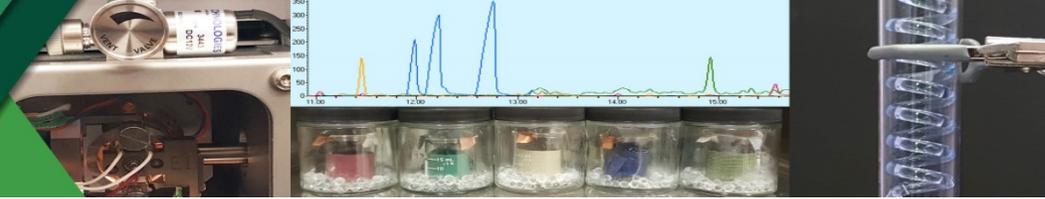
# Unusual odors during exhibition install



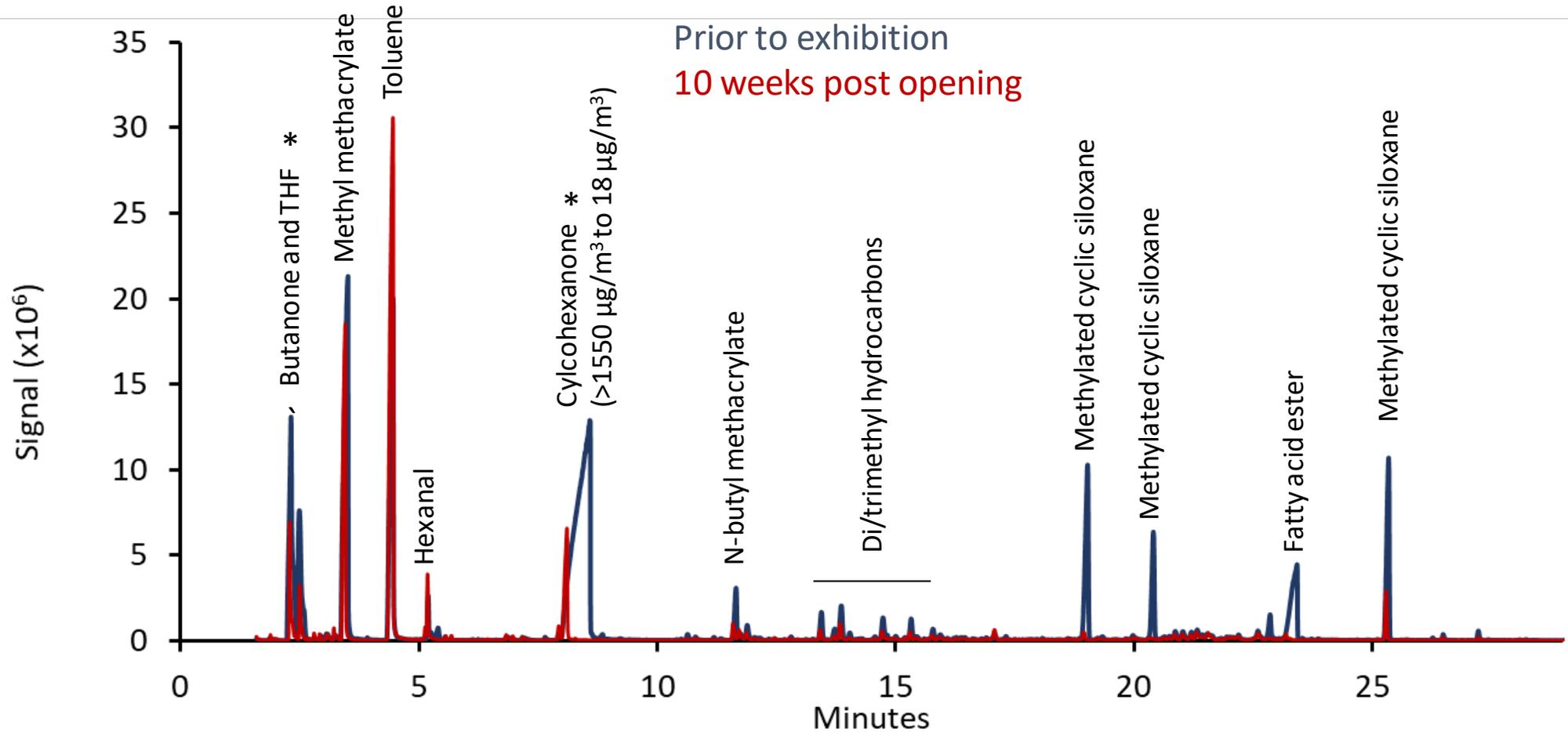


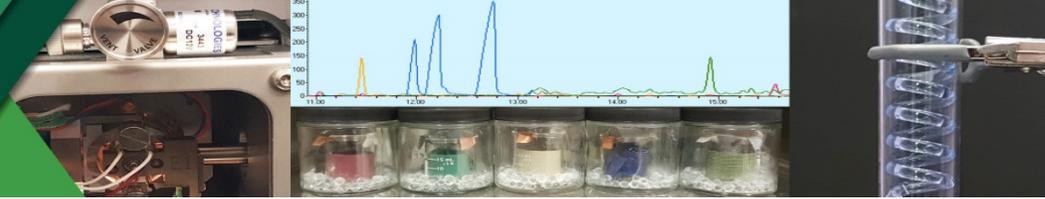
# Air sampling from inside silica chamber





# Air sampling from inside silica chamber

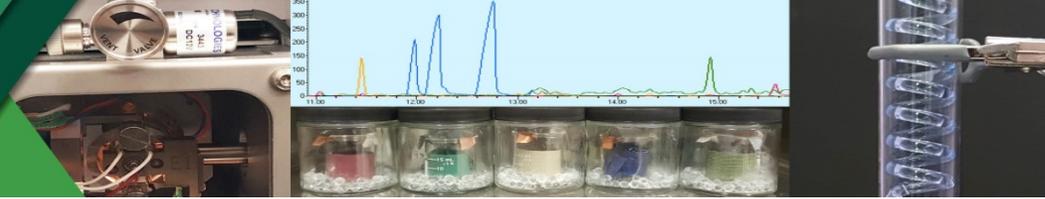




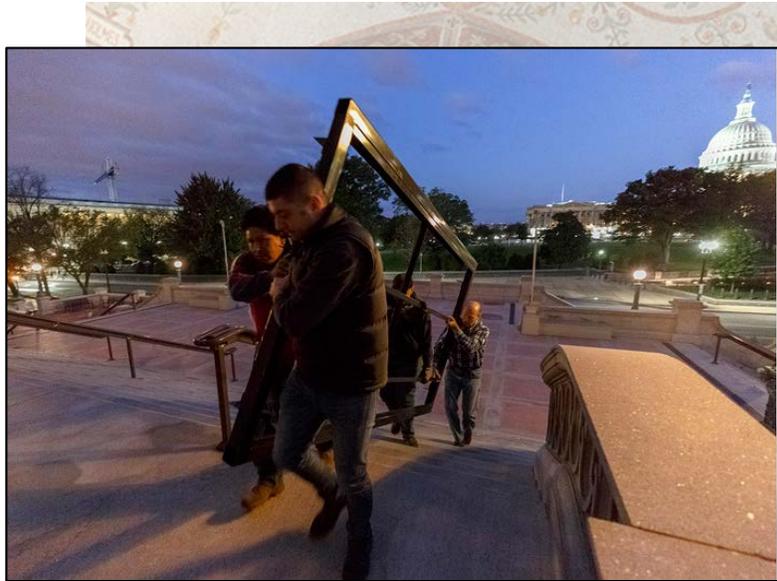
# The Gutenberg Bible gets a new case



Michaela McNichol



# The Gutenberg Bible gets a new case



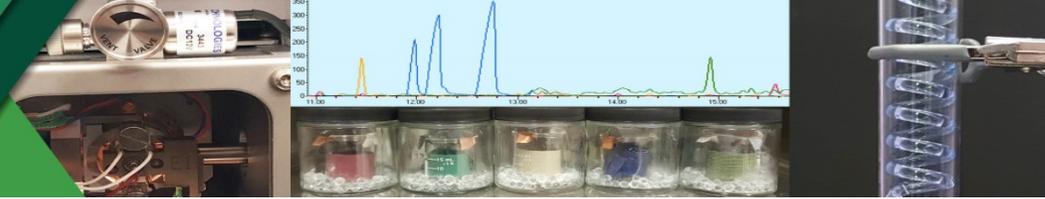
Shawn Miller



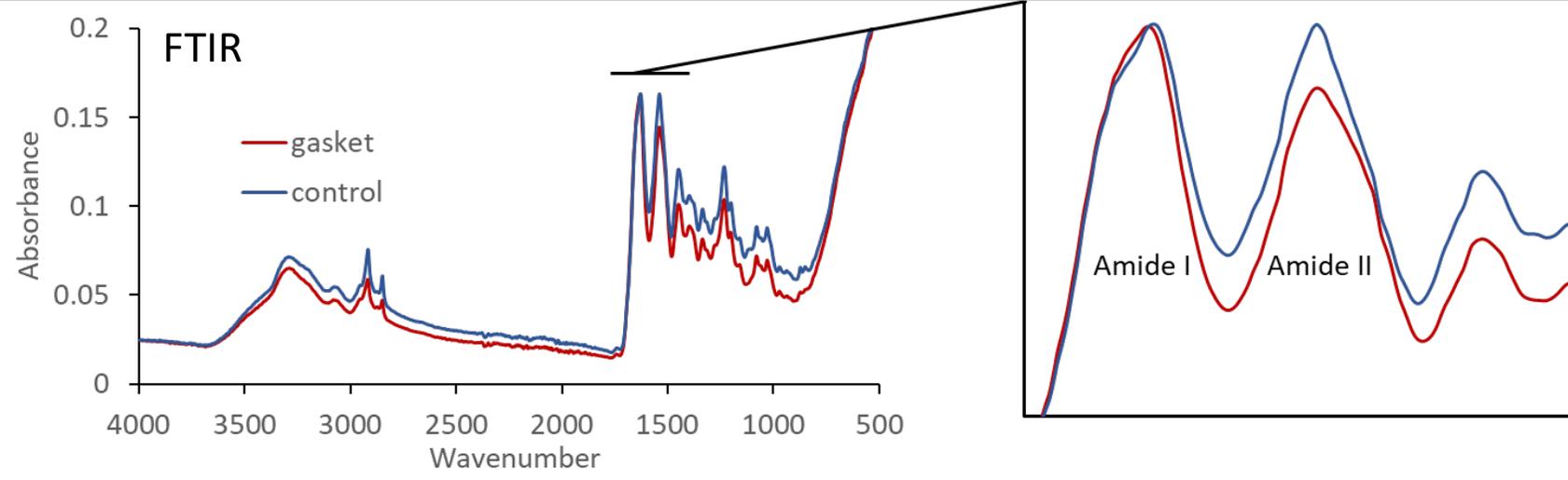
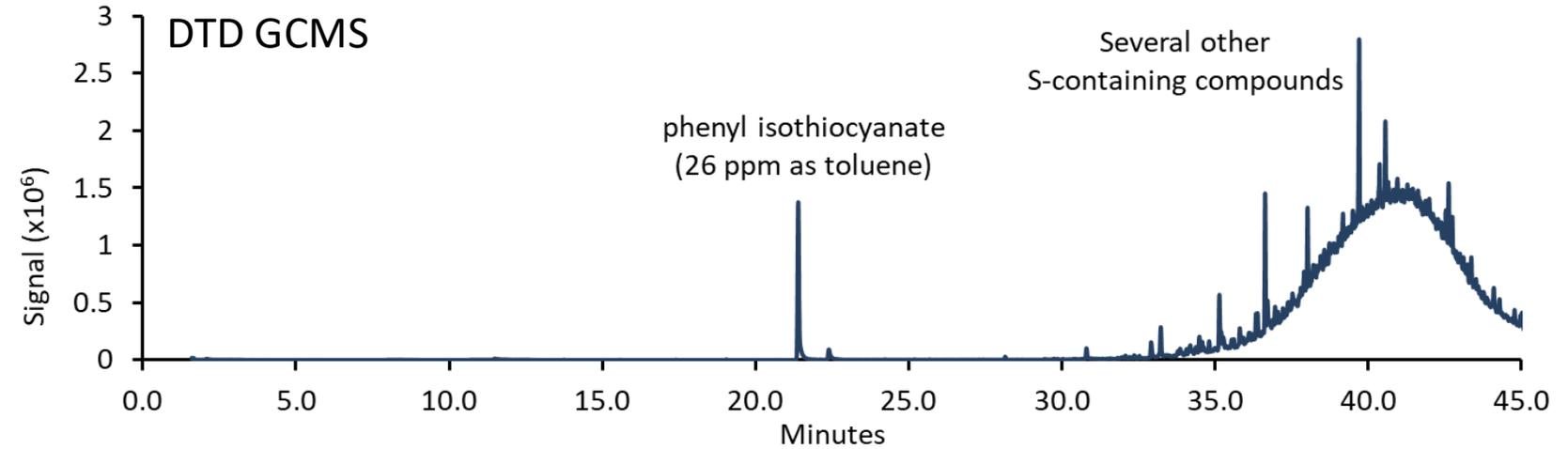
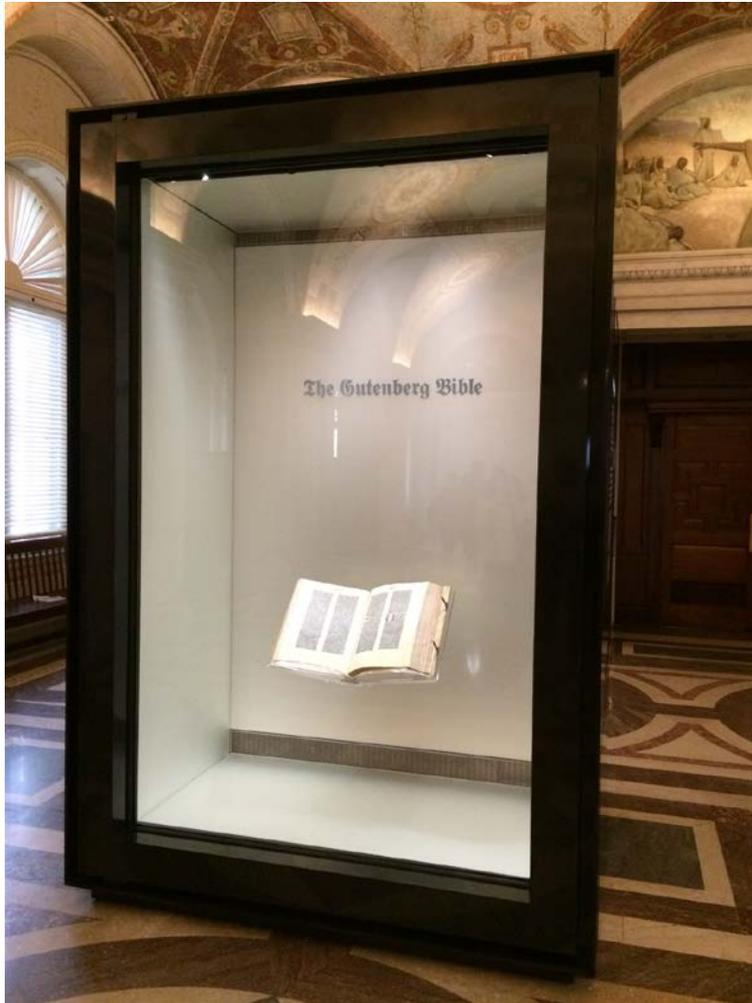
Shawn Miller

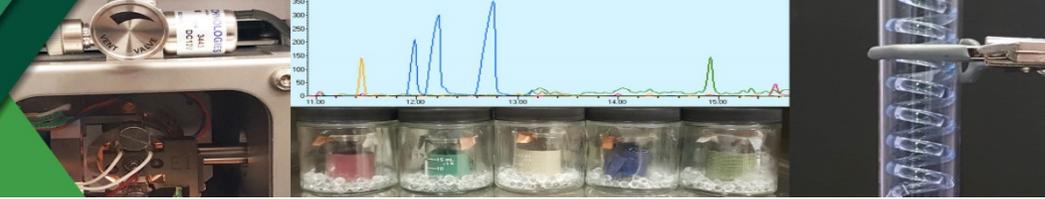


Michaela McNichol

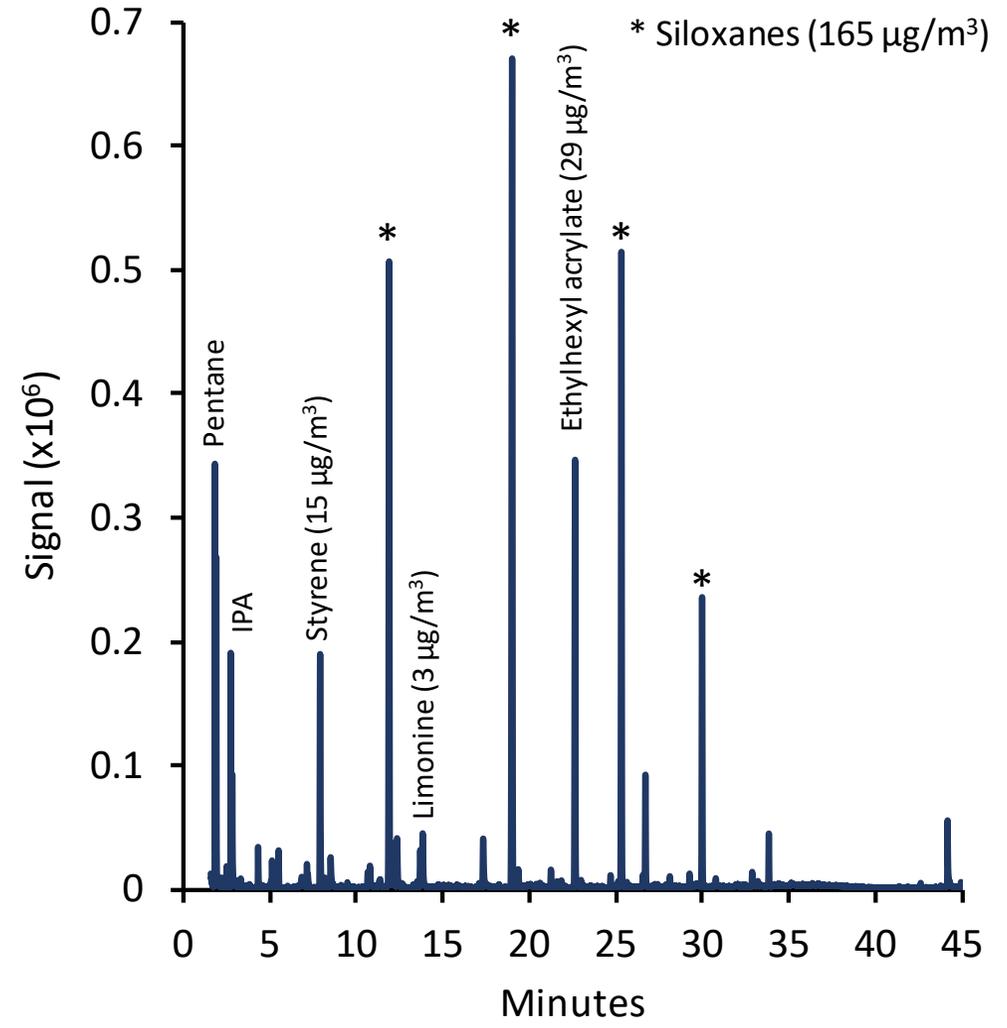


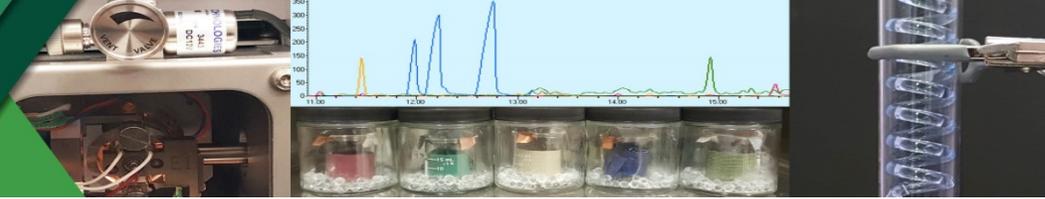
# Testing materials for the Gutenberg Bible case





# Testing prior to Gutenberg Bible installation

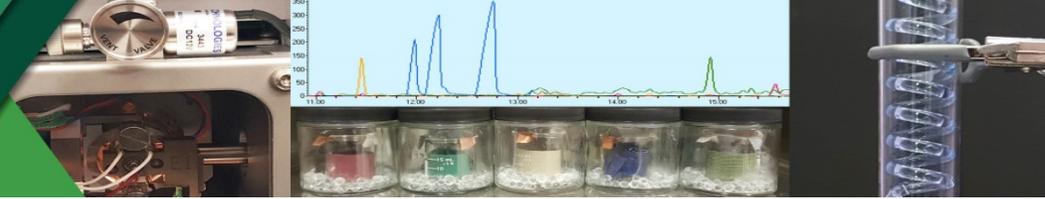




# Thomas Jefferson's Library exhibit

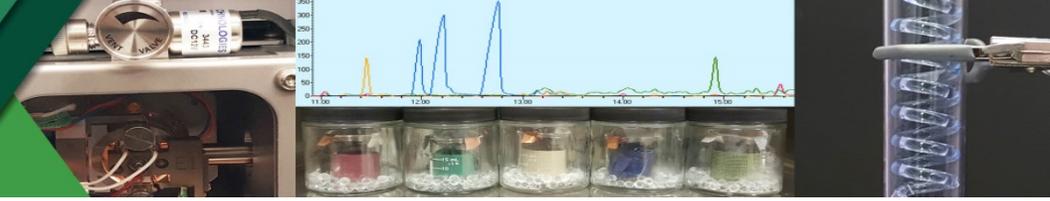


Shawn Miller

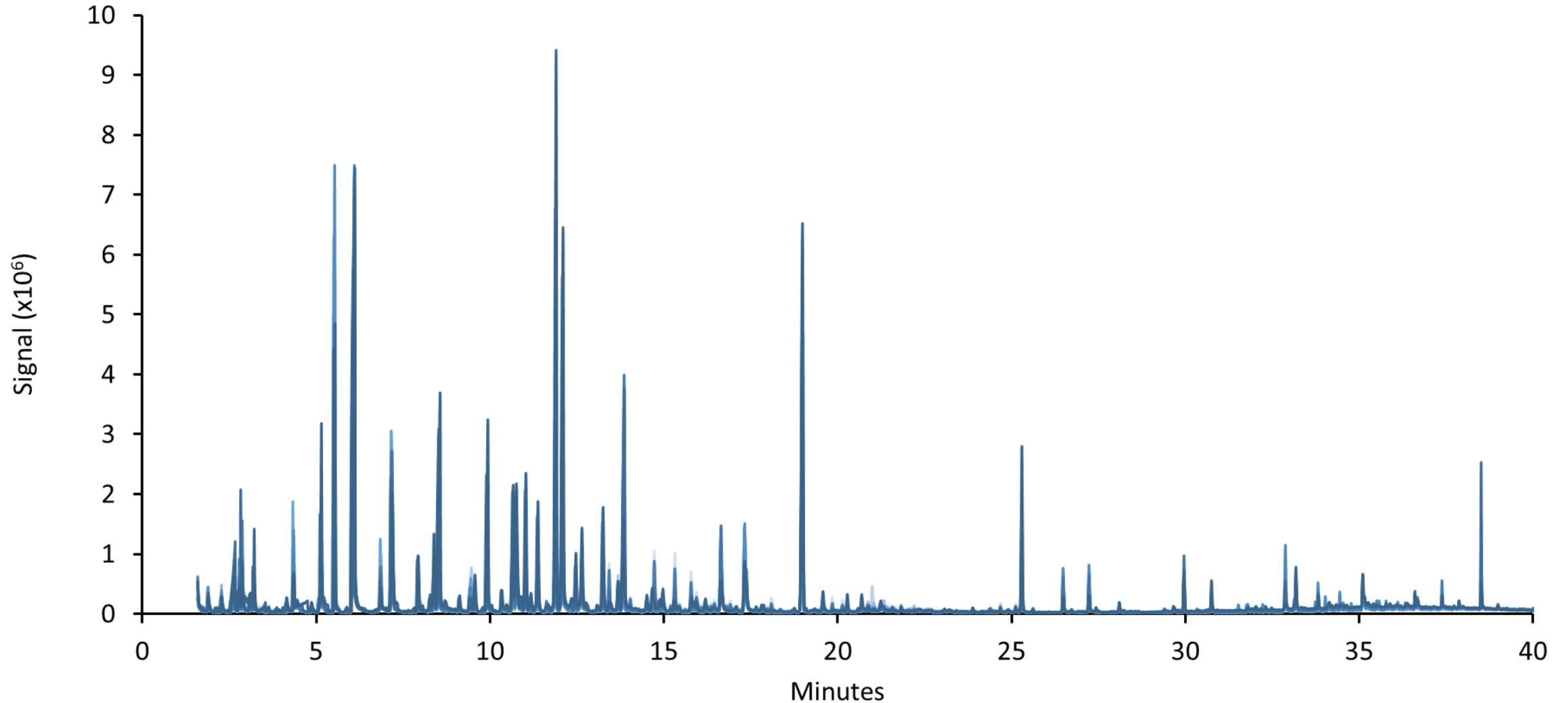


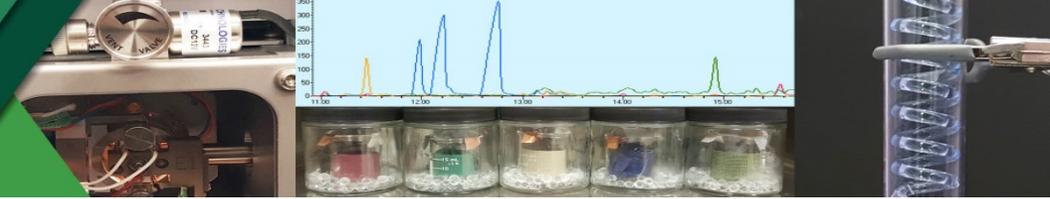
# Sampling the Jefferson Library cases



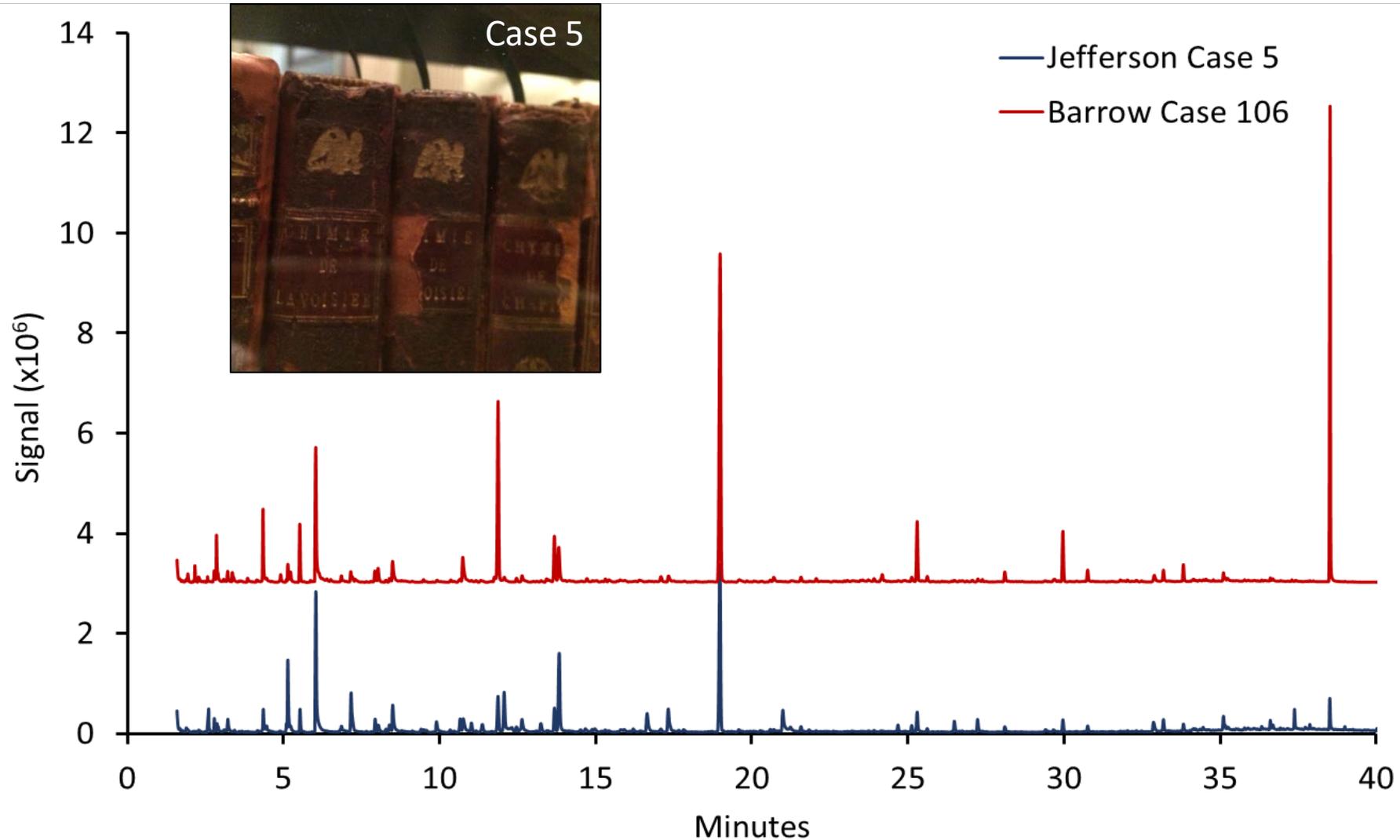


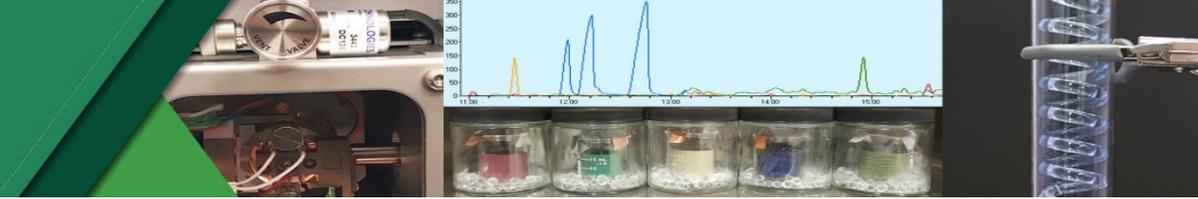
# Comparisons across 16 of 20 Cases



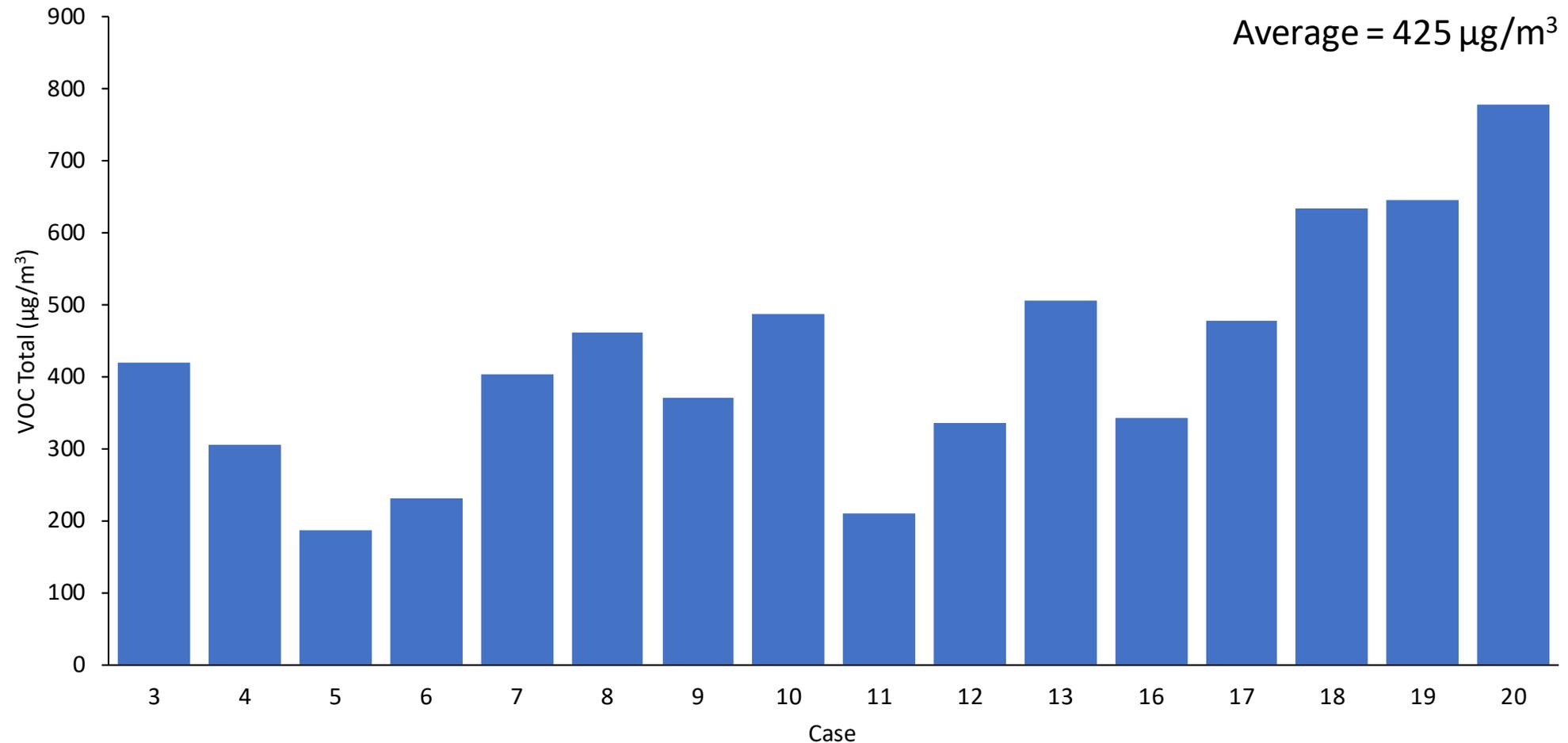


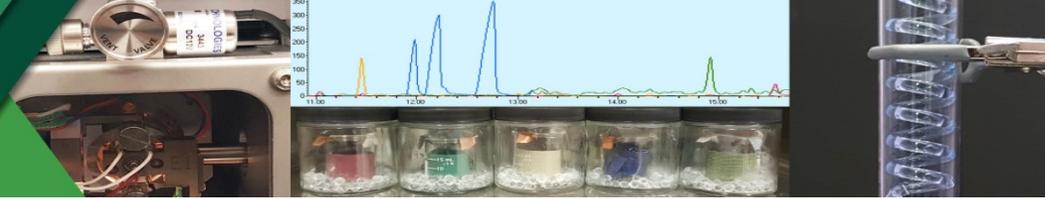
# Comparing Jefferson and Barrow Cases



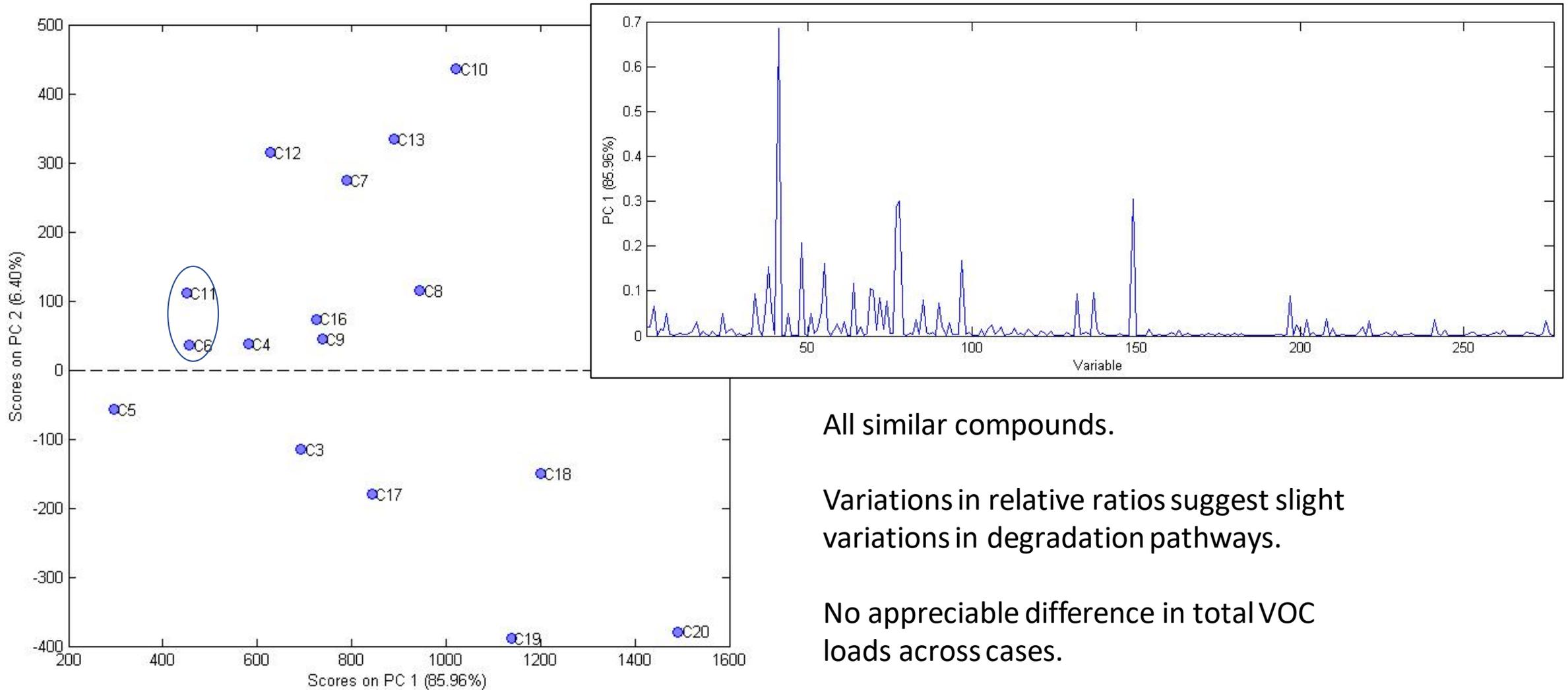


# Total volatile compound concentrations





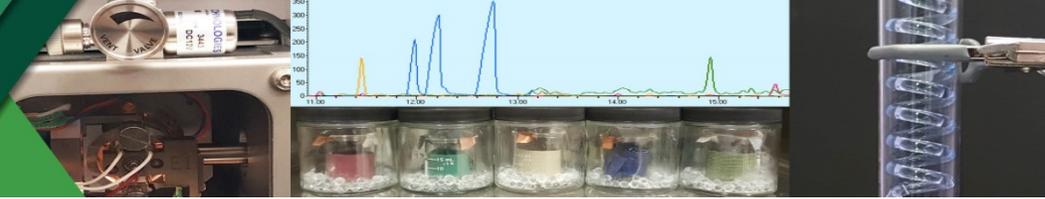
# PCA to examine variations across the cases



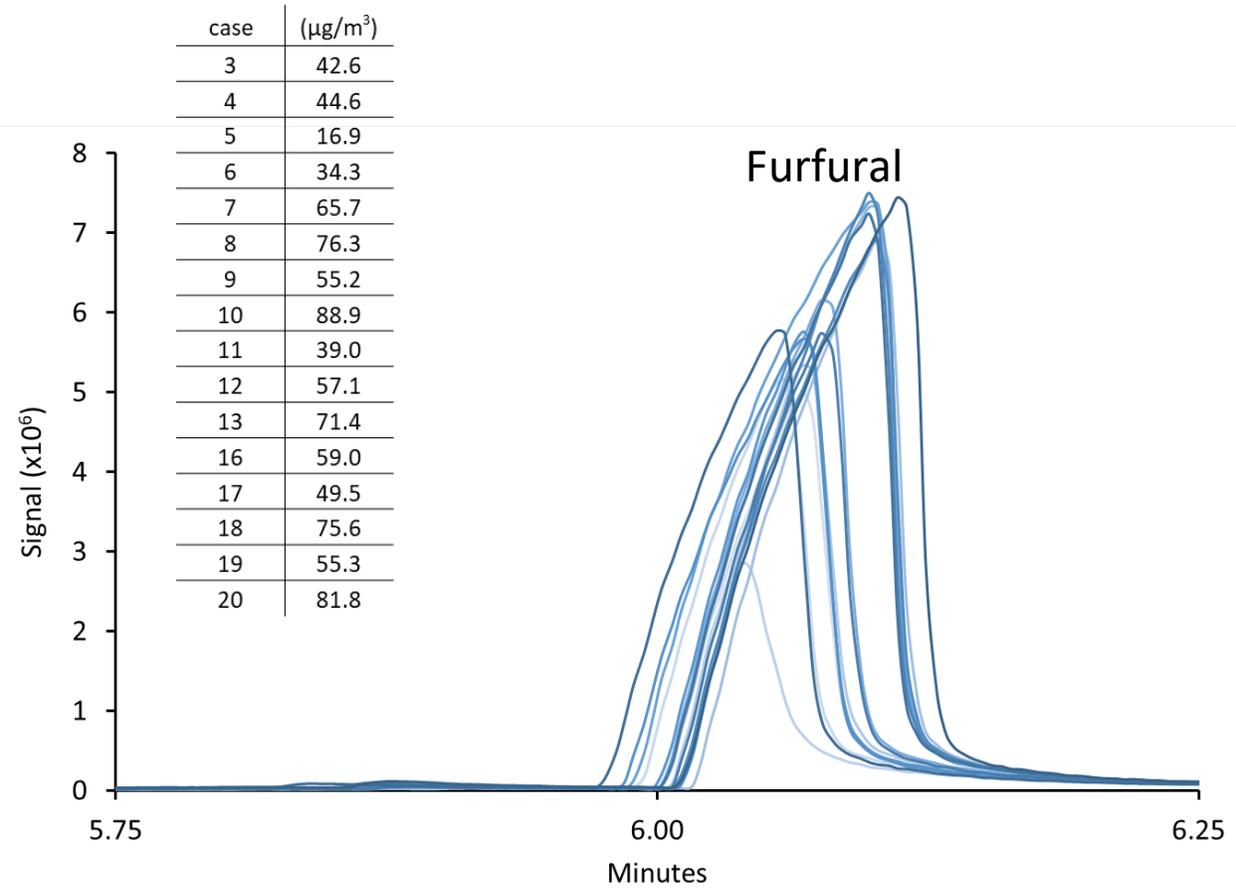
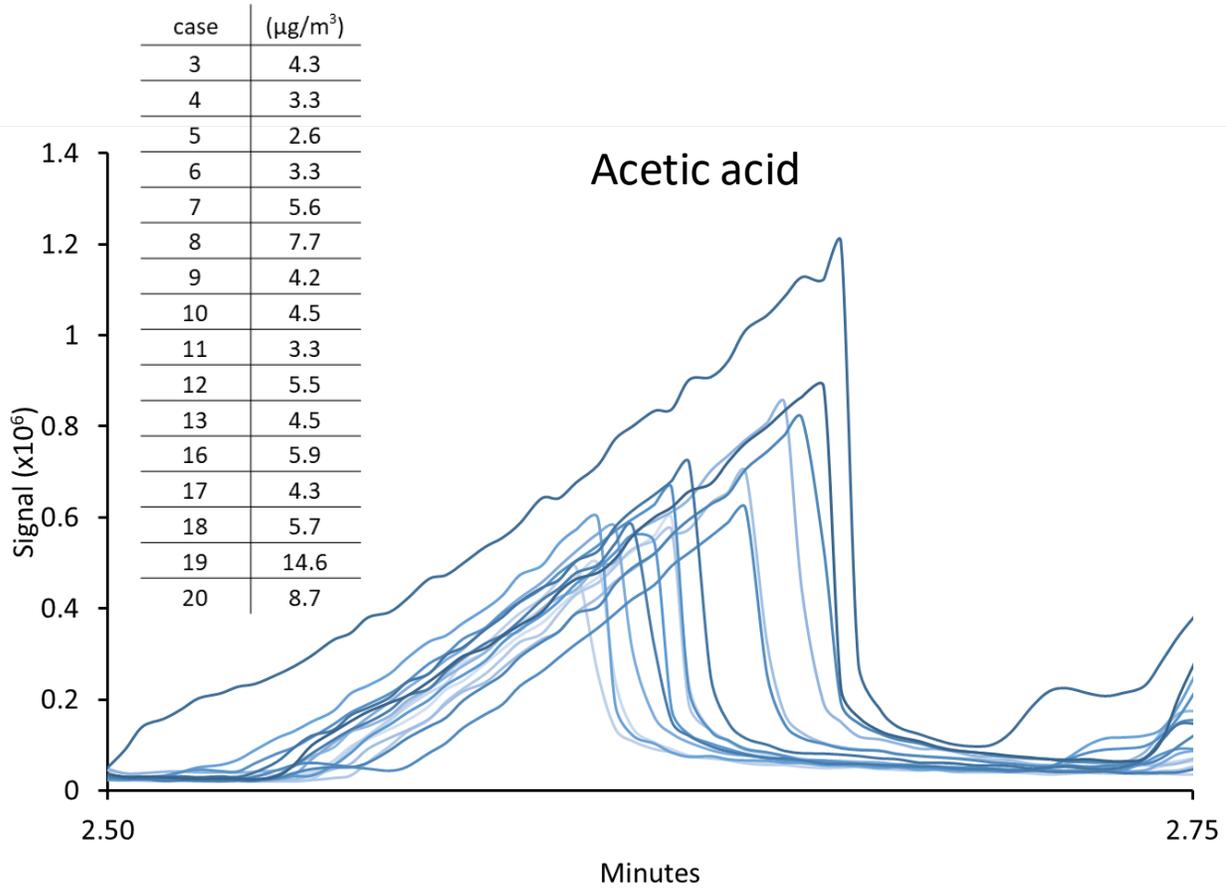
All similar compounds.

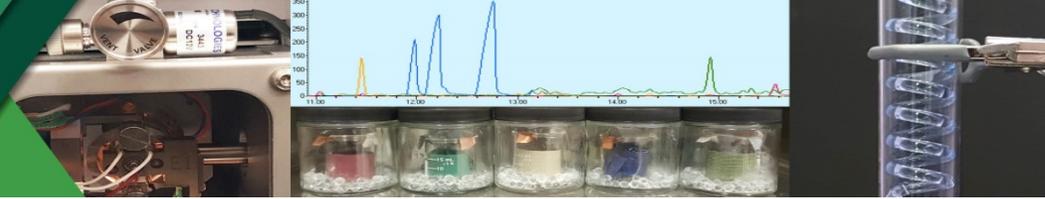
Variations in relative ratios suggest slight variations in degradation pathways.

No appreciable difference in total VOC loads across cases.



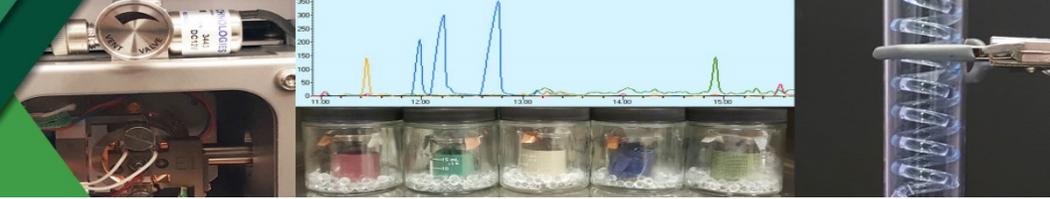
# Examining common cellulose degradation products





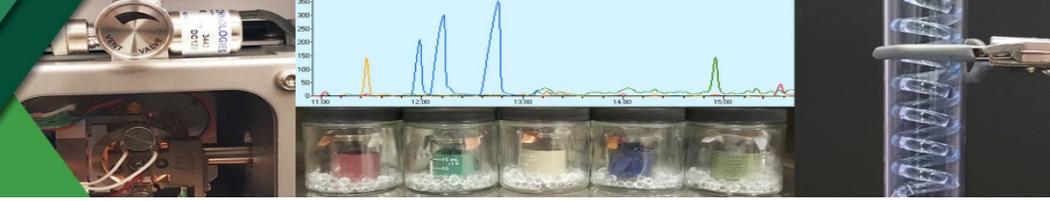
# Using the data to plan for the future





## Wrapping up...

- Semi-quantitative analysis of volatile compounds from construction materials and objects can shed light on potential state of and/or damage to collections.
- Field sampling of volatile compounds using similar techniques and sorbent tubes enable sampling of encasements and storage areas in a similarly semi-quantitative manner.
- Combining volatiles testing with traditional tests regularly are enabling the creation of a 'watch list' of sorts to aid in planning, response, and speeds the testing process.



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- Rare Books & Special Collections Division



The background image shows the interior of the Library of Congress reading room. It is a large, circular, two-story space with a high, vaulted ceiling. The room is filled with rows of wooden study tables and chairs. The architecture is classical, featuring large columns and arched windows. The lighting is warm and focused on the study areas.

# Questions?

You can ask us preservation questions at any time!

<https://www.loc.gov/rr/askalib/ask-preserv.html>

-or-

[ampar@loc.gov](mailto:ampar@loc.gov)

