Comparing zeolite adsorption properties
in cultural heritage contexts

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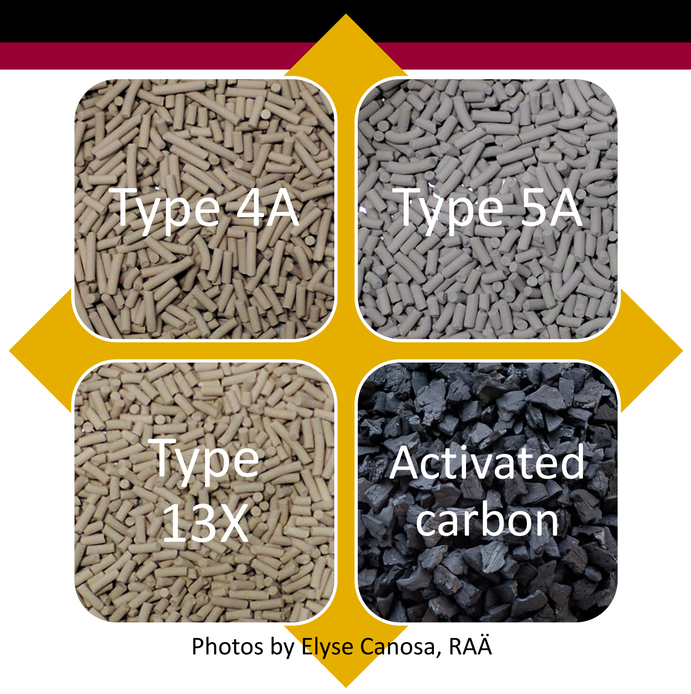
Purpose

To investigate the passive and active adsorption of acetic acid gas by different zeolites in comparison to activated carbon

Importance

- Acetic acid gas is harmful to museum objects but its reduction by adsorption is not well studied
- Little research exists on how different zeolites function in typical museum environments (i.e. low pollutant concentrations, low airflow, moderate humidity)



Photos by Elyse Canosa, RAÄ

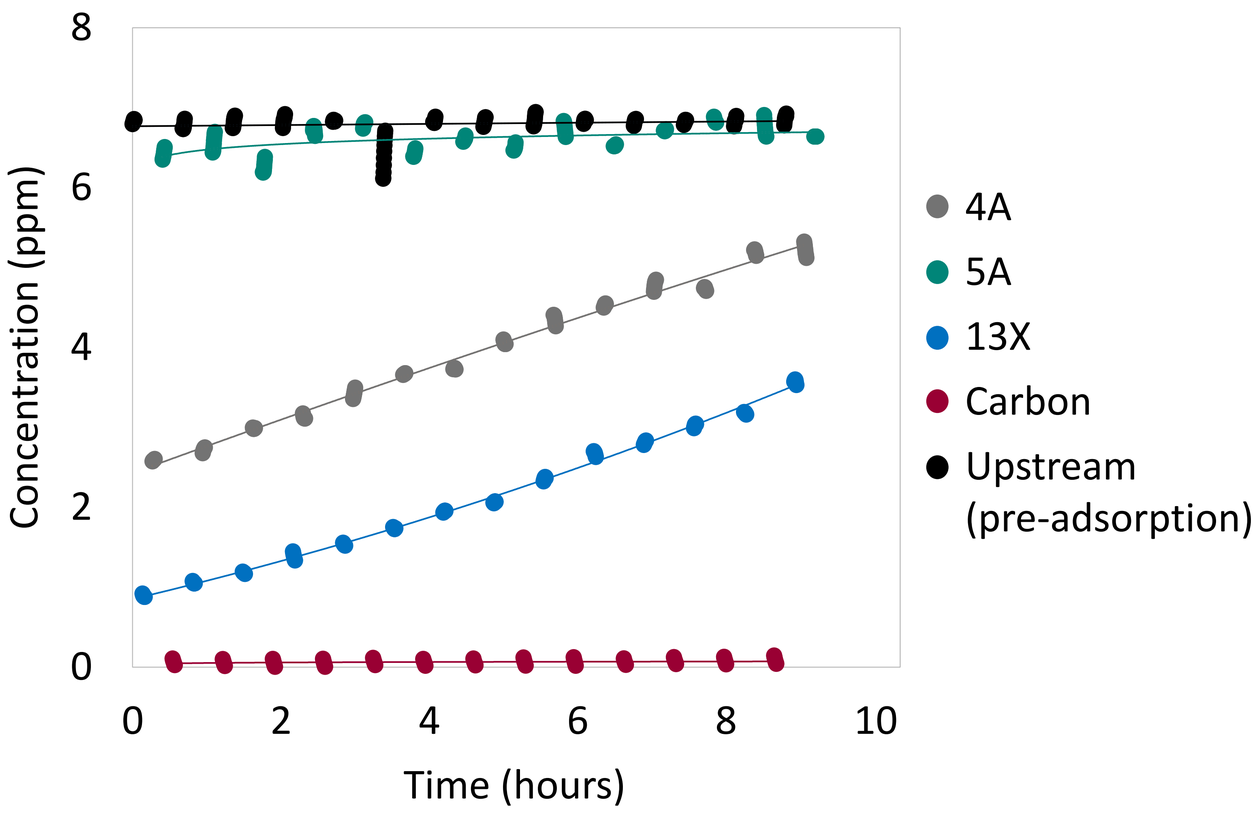
Properties of the investigated adsorbents:

Adsorbent	Pore size	Polarity	Particle diameter
Zeolite Type 4A	4 Å	Polar	1 - 2 mm
Zeolite Type 5A	5 Å	Polar	1 - 2 mm
Zeolite Type 13X	10 Å	Polar	1 - 2 mm
Granular activated carbon	10 – 25 Å	Nonpolar	2.4 - 4.8 mm

Active adsorption - forced airflow

- Acetic acid (6.8 ppm) forced through adsorbent bed (26 mm deep)
- Concentration measured upstream (before adsorption) and downstream (after adsorption) of adsorbent using a flame ionization detector
- Relative humidity: 54%, Temperature: 22 °C, Airflow: 1.8 m^3/h, Contact time: 0.1 s

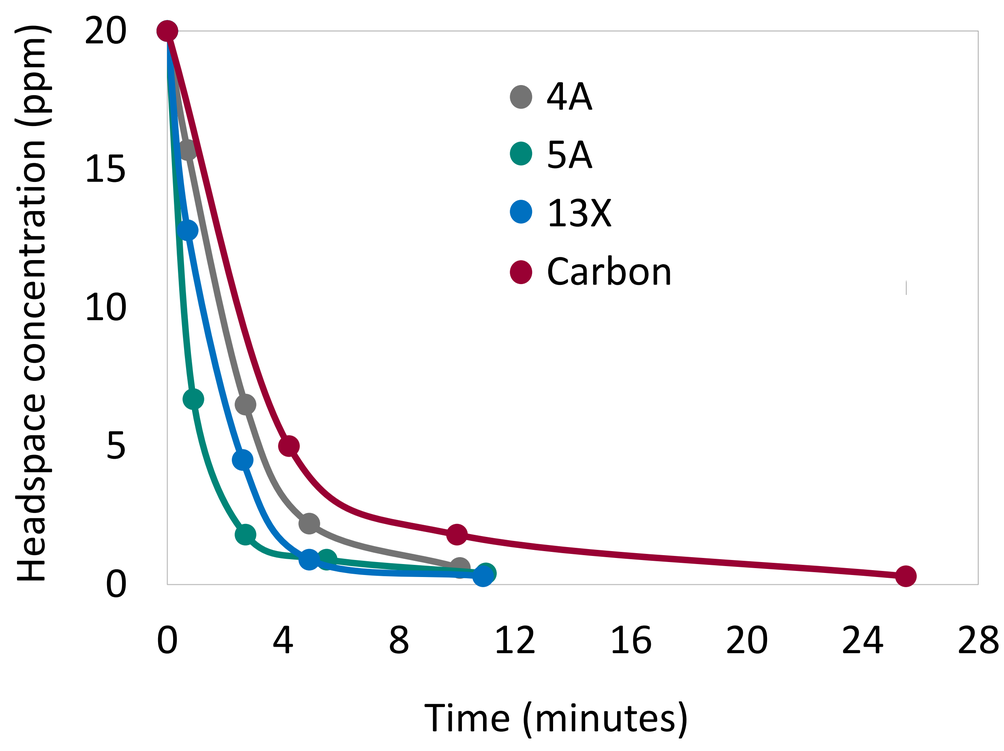
Downstream acetic acid concentrations



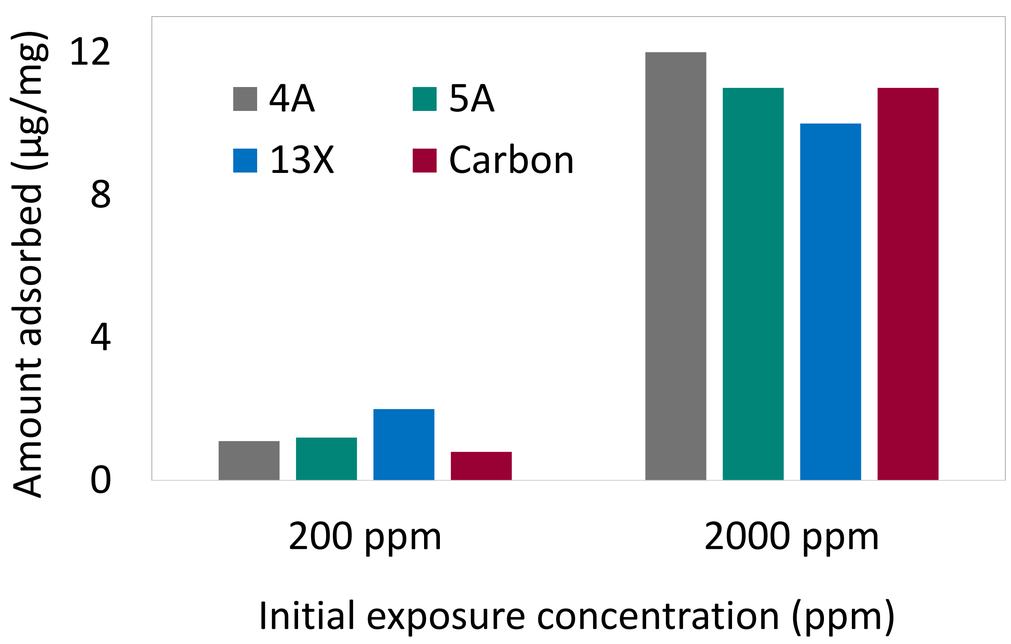
Passive adsorption – no forced airflow

- Measured via headspace gas chromatography – mass spectrometry
- 8 mg adsorbent in 20 mL headspace vial, one control vial
- 50% relative humidity, 23 °C, no forced airflow
- Data below accounts for acetic acid adsorption on vial walls

Uptake kinetics of 20 ppm acetic acid



Acetic acid adsorption after 1 day



Conclusions

- Zeolites were less effective than activated carbon during active adsorption, but had faster uptake rates during passive adsorption
- All adsorbents passively adsorbed comparable amounts of acetic acid after 1 day of exposure
- The three zeolites demonstrated different active adsorption capabilities, with 13X the most effective

- **Possible future work**: determine capacity and isotherms for the adsorbents, perform case studies

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