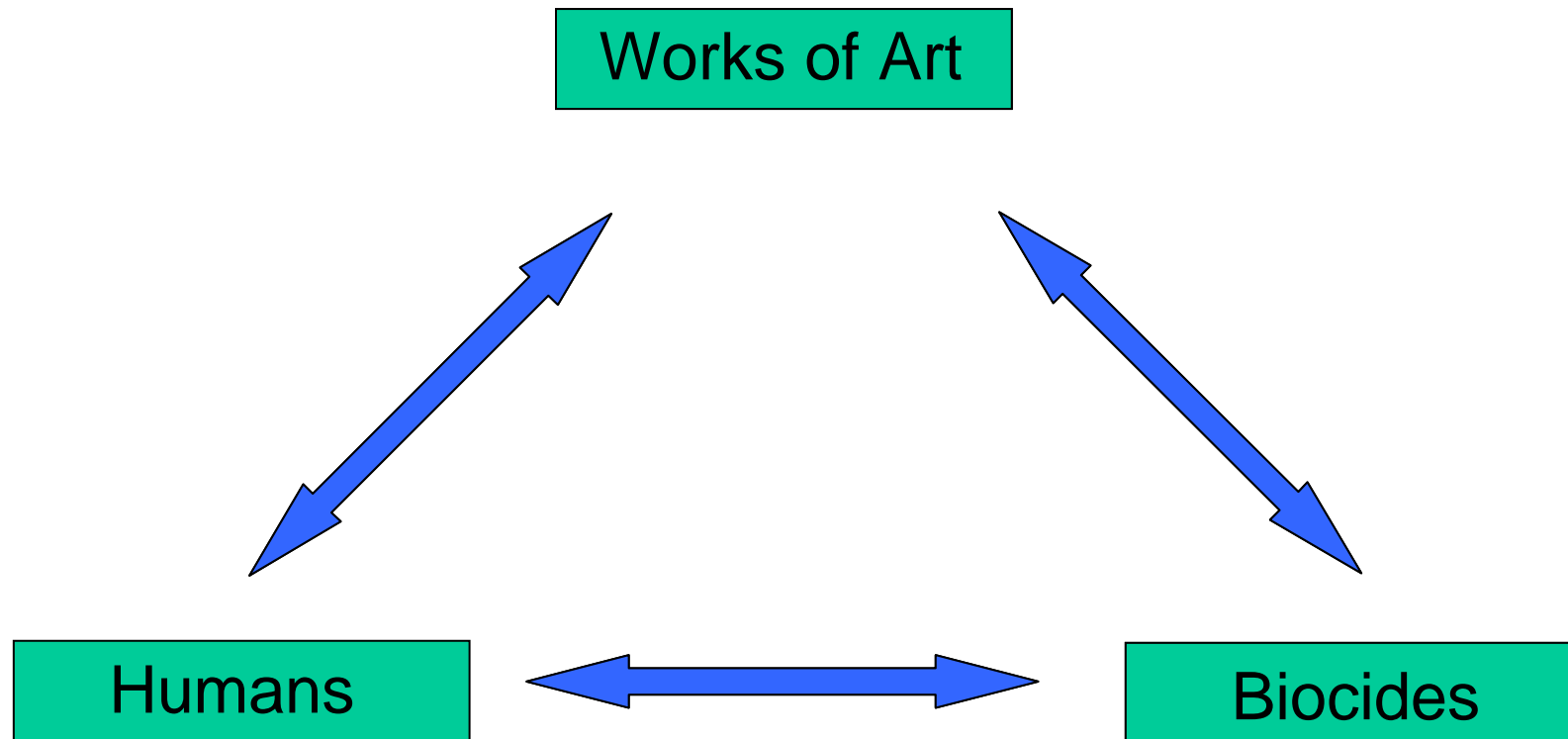


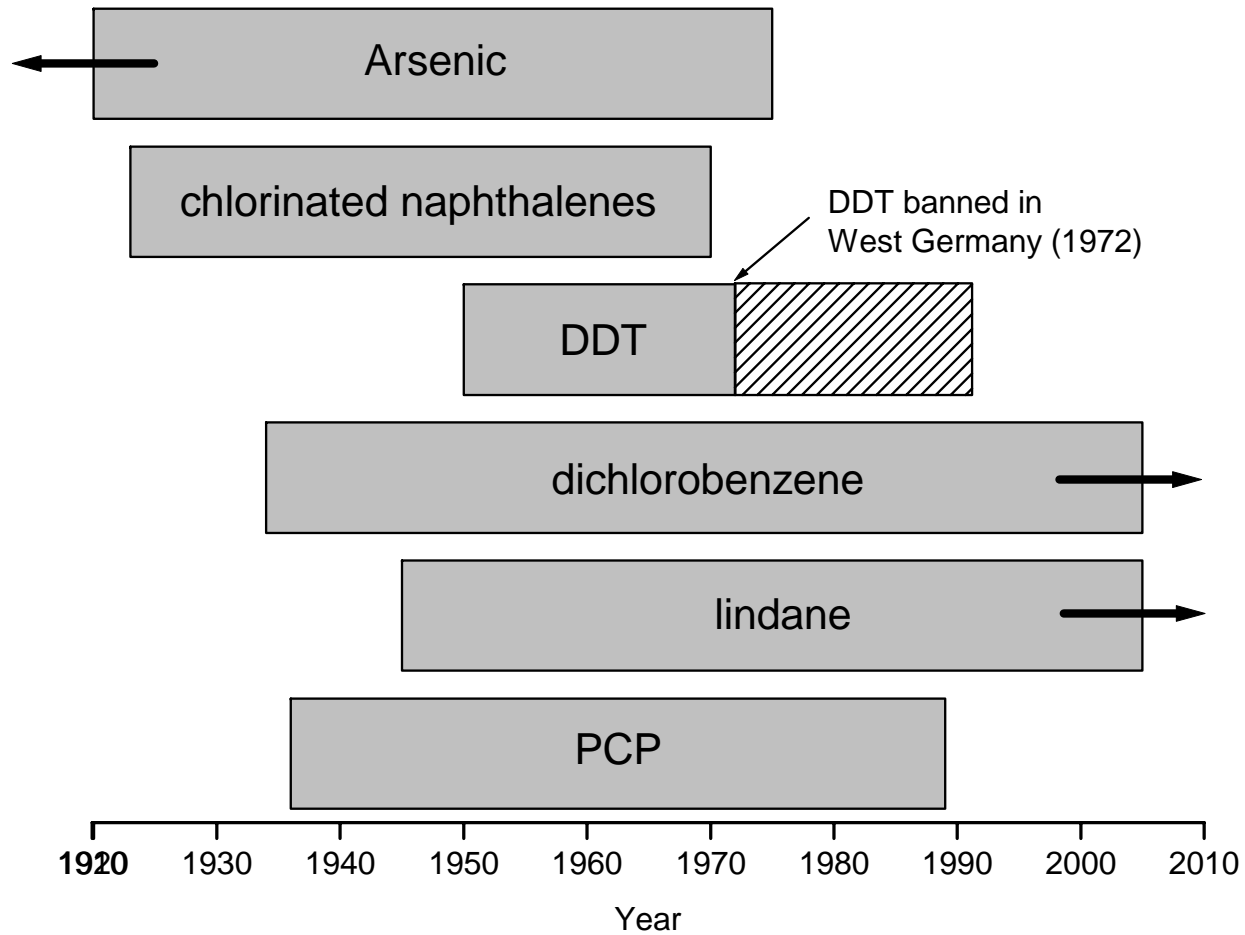
# Occurrence Of Organic And Inorganic Biocides In The Museum Environment

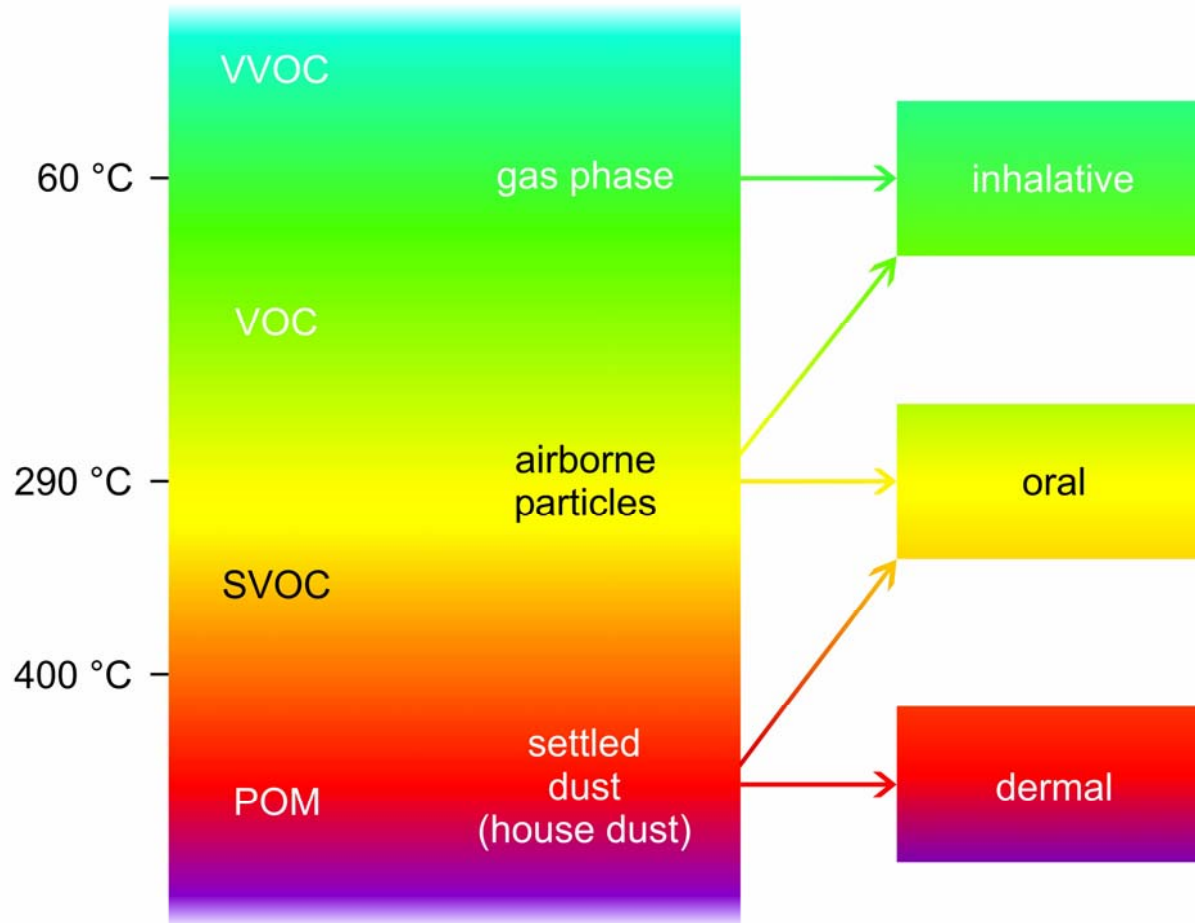


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## Sampling of settled dust



Dust sampling  
(Fresh and old dust)

Analysis of Elements  
by ICP-AES and AAS

Analysis of biocides  
by GC/MS



## Air sampling of VOC/SVOC

VDI 4300-6

6 - 10 l air volume

Flec- Pump

Tenax TA-Tube

Analysis by TDS-GC/MS



## Wipe samples



Extracted paper towel  
Soxhlet- Extraktion  
Analysis by GC/MS

## Screening analysis of elements in settled dust

	Geology		Zoology				Ethnology		Prehistory	
	Magazine		Magazine		Diorama Watt		Magazine		Magazine	
	Water	2% HNO <sub>3</sub>	Water	2% HNO <sub>3</sub>	Water	2% HNO <sub>3</sub>	Water	2% HNO <sub>3</sub>	Water	2% HNO <sub>3</sub>
<b>Cl</b>	2279	< 1	2760	n.b.	23167	< 1	2411	< 1	272	< 1
<b>As</b>	< 1	2	172	565	47	793	< 1	2	< 1	8
<b>Pb</b>	< 1	54	1?	259	< 1	48	< 1	38	< 1	230

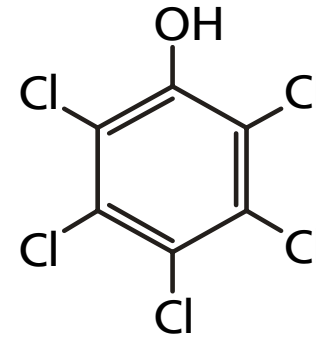




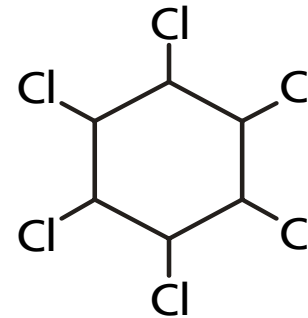
**Arsenic:** Analysis of settled dust and materials

Museum	Material	Unit	Arsenic	This work
M2	D1 – old dust	$\mu\text{g m}^{-2}$	29	Schieweck et al. (2006)
M2	D2 – old dust	$\mu\text{g m}^{-2}$	52	Schieweck et al. (2006)
M2	D3 – old dust	$\mu\text{g m}^{-2}$	< 5	Schieweck et al. (2005)
M2	Storage room – old dust	$\mu\text{g m}^{-2}$	<b>565</b>	Schieweck et al. (2005)
M2	Bird - plumage	$\text{mg kg}^{-1}$	45	Schieweck et al. (2006)
unknown	Mummy 3	$\text{mg kg}^{-1}$	29	Schieweck et al. (2006)
unknown	Mummy 4	$\text{mg kg}^{-1}$	9	Schieweck et al. (2006)

Pentachlorophenol (PCP)

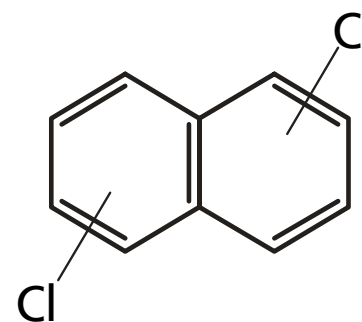


Lindane

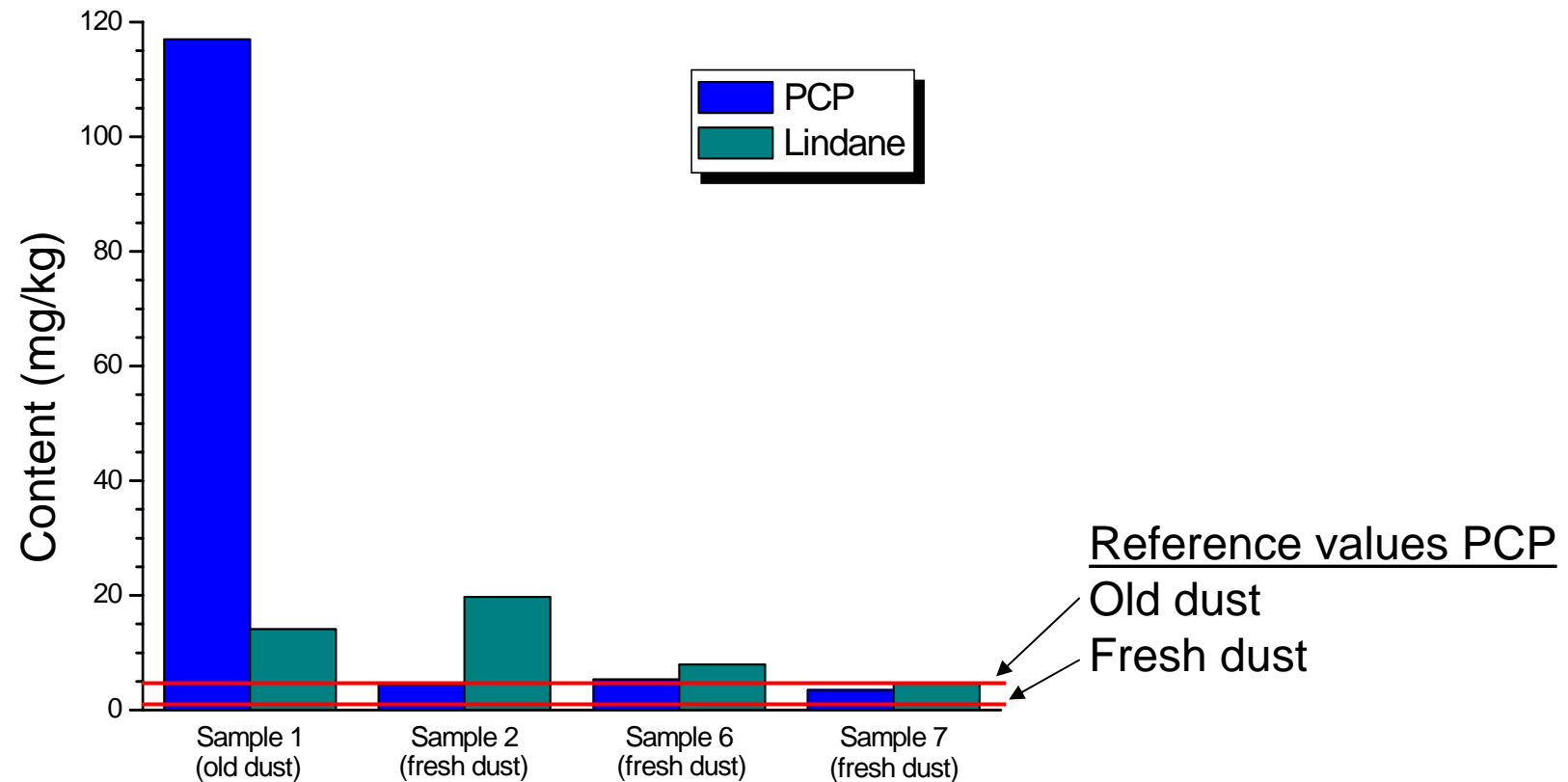


Monochloronaphthalene (MCN)

Dichloronaphthalene (DCN)



## Exhibition room with wooden sculptures



## Biocides: Analysis of settled dust in different locations

Location	Source	Dust type	MCN	DCN	PCP	Lindane	DDT
			mg kg <sup>-1</sup> dust				
Exhibition room	Sculpture	Old	< 1	< 1	117	14	n.d.
Exhibition room	Floor 1	Fresh	< 1	< 1	30	5	n.d.
Exhibition room	Floor 2	Fresh	< 1	< 1	8	5	n.d.
Exhibition room	Floor 3	Fresh	< 1	< 1	4	5	n.d.
Storage room	Cabinet 1	Old	10 - 100 *	10 - 100 *	10 - 50 *	10 - 50 *	n.d.
Storage room	Cabinet 2	Old	10 - 100 *	10 - 100 *	10 - 50 *	10 - 50 *	n.d.
Storage room	Cabinet 3	Old	10 - 100 *	10 - 100 *	10 - 50 *	10 - 50 *	n.d.
Depot	floor	Old	< 5	< 5	400	26	5
Reading room	floor	Old	< 5	< 5	300	22	< 1
Other rooms	floor	Old	< 5	< 5	4 - 25	3 - 128	< 1 - 19



Material (soil)	mg/kg
1-Chloronaphthalene	41.5
Dichloronaphthalene	37.5
Lindane	9.5
PCP	4
DDT	81.5

**Wipe sample:**

DDT: 17  $\mu\text{g}/\text{m}^2$



## Biocides: Analysis of materials

Material	PCP	Lindane	DDT	$\Sigma$ PCB <sup>1)</sup>
	mg kg <sup>-1</sup>			
Twisted column	41	4	n.d.	n.d.
Mummy 1 (head)	4	< 1	21	n.d.
Mummy 2	2	< 1	< 1	n.d.
Wine cask	415 – 423	38	n.d.	3180 – 3400
Wedge	77	2	n.d.	60

$\Sigma$ PCB = (PCB28 + PCB52 + PCB101 + PCB138 + PCB153 + PCB180) x 5

PCB nomenclature after Ballschmiter and Zell (1980).

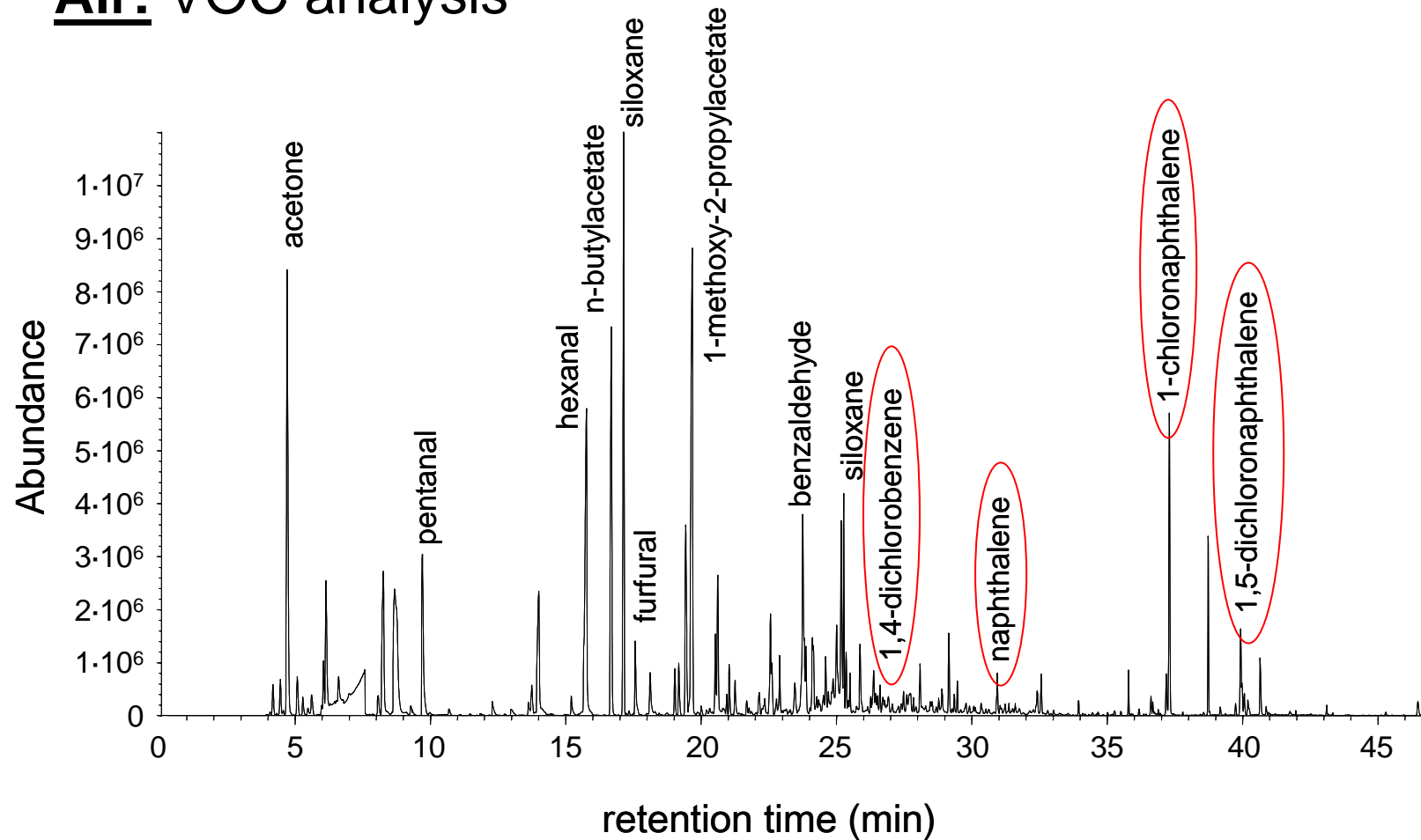
n.d. = not determined



Display case  
with wooden sculpture



## Air: VOC analysis





## Air: VOC analysis

Compound	Inside D1	Inside D2	Inside D3	Exhibition	Display case
	$\mu\text{g m}^{-3}$				
1,4-DCB	17	19	24	7	4
Naphthalene	3	3	3	3	3
MCN	3	3	27	2	32
DCN	< 1	< 1	30	< 1	23

D1, D2, D3 = Diorama

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## Guideline Values used in Germany:

PCP	indoor air	0,1 $\mu\text{g}/\text{m}^3$	(PCP-Guideline)
PCP	fresh dust	5 mg/mg	(PCP Guideline)
PCP	old dust	1 mg/kg	(PCP Guideline)
Naphthalene	indoor air	0,002 $\text{mg}/\text{m}^3$	(RW I)
MCN	indoor air	0,02 $\text{mg}/\text{m}^3$	(Hamburg)
1,4-DCB	carcinogen (Group 2 in Germany)		
As	carcinogen (Group 1 in Germany)		

## **Conclusions**

- It was demonstrated that storage and exhibition rooms, diorama and display cases of museums might be contaminated with numerous biocides.
- This situation provides a possible health risk of museum staff.
- We are convinced that our results do not represent isolated cases and that similar scenarios can be found in other institutions.
- Museums should be aware of these findings in order to protect employees and visitors.

→ [Schieweck et al. \(2006\), Atmospheric Environment, in press](#)

## Related work:

- Glastrup, J., 1987. Insecticide analysis by gas chromatography in the stores of the Danish National Museum's Ethnographic collection. *Studies in Conservation* 32, 59-64.
- Krooß J., Stolz P., 1993. Innenraumbelastung von Museumsmagazinen durch biozide Wirkstoffe. *Staub – Reinhaltung der Luft* 53, 301-305.
- Leimbrock, W., Wagner, B., 1998. Ermittlung der Gefahrstoffbelastung durch Insektizide und Konservierungsmittel bei Tierpräparatoren und Mitarbeitern in zoologischen Sammlungen und Ausstellungen. *Der Präparator* 44, 111-122.