Volatile Organic Compounds in libraries atmosphere: effects on the written and printed cultural heritage.

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National Library of France

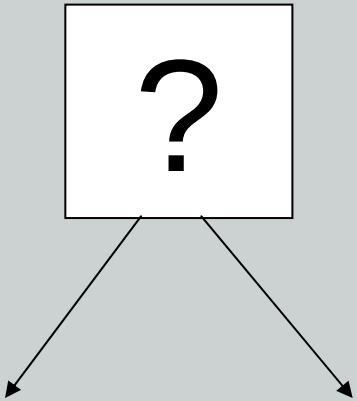
Libraries and archives : pollution indoors

Concentration (ug/m3)	*Magazines in boxes*	*19th newspapers in boxes*	*19th and 20th books*
Formaldehyde	17,7	18,6	17,3
benzaldehyde	41,9	26	10,1
hexanal	13,2	8,7	2,7
Alcanes	1,4	1,7	1,0
Acetic acid	33	34	24
Formic acid	<10	<10	<10
Sulfuric acid, hydrogen sulfide	<10	<10	<10

Pollutants emitted by :

- The collections themselves (acetic acid)
- Some kinds of conservation boxes

- Micro and macro environments



Effect of the pollution on the lifetime of paper-based collections ?

Quality control of the conservation materials

Quality control of materials

ISO 16 245 : Boxes, file covers and other enclosures, made from cellulosic materials, for storage of paper and parchment documents

↓

« Materials used shall not contain or form any substances […] which may be harmful to the documents being stored. »

???

Aim of the study

- Analysis of the composition of boards and papers (pH, fibers, lignin content, alcali reserve)
- Total sulfur quantification (UV fluorescence)
- SEM-EDS examination (filling and loading materials)
- Analysis of the VOC's they emit (SPME-GC-MS)
- Study of impact of these VOC's on paper cellulose (SEC)

Composition : results

•All the boards studied have alcaline pH and alcali reserve

• Lots of them are made from recycled materials. Among them, only 2 do not have lignin

• Only the certified « conservation grade » boards just contain calcium carbonate as inorganic species. Silicates, potassium, magnesium, sodium, sulfur containing inorganic species are observed in the others boards and especially, in those made from recycled materials.

Sulfur analysis

• Total Sulfur content : UV fluorescence of SO2 after complete burning of the sample at 1000°C in O2-Ar (0,0001-0,3%)

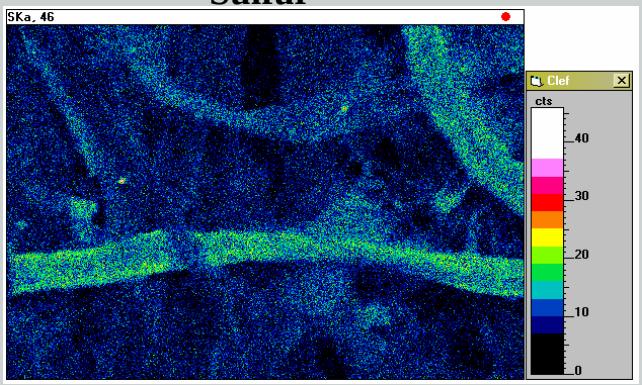
•Sulfur distribution : SEM-EDX mapping

Sulfur content

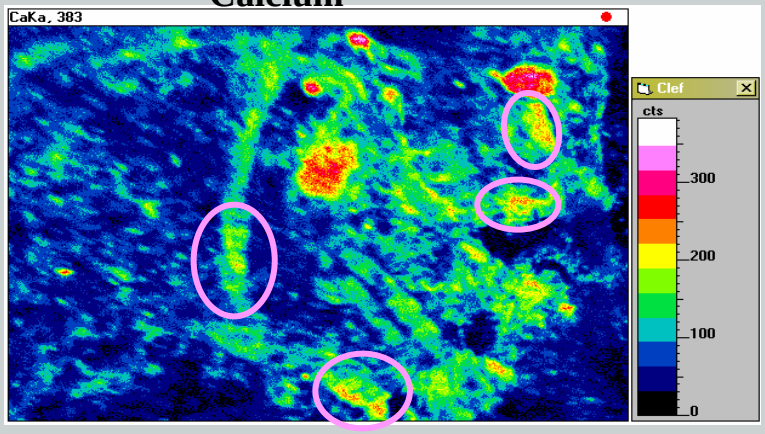
- Total sulfur content
  - 0,03 % to 0,18 %
  - Higher contents : boards made from recycled material

SEM-EDX elemental mapping : sulfur distribution

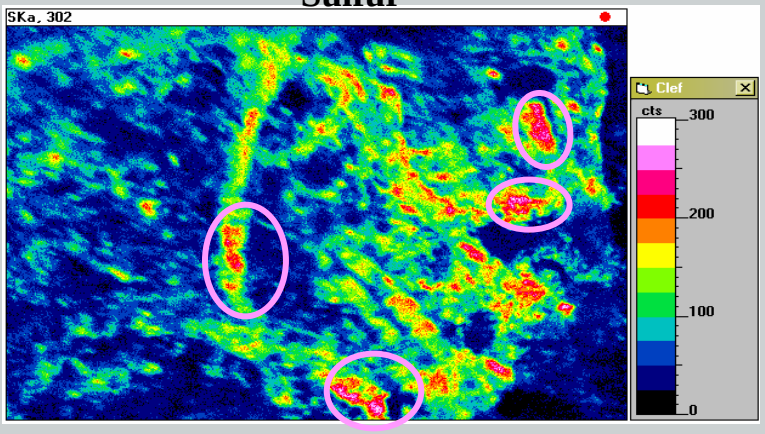
Sulfur



Calcium



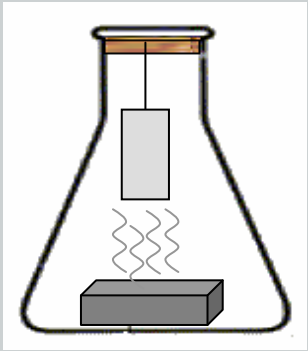
Sulfur



Calcium sulfate ($CaSO_4$) – gypsum

CORRELATION BETWEEN SULFUR CONTENT, VOLATILES AND EFFECTS ON PAPER CELLULOSE ?

Artificial ageing



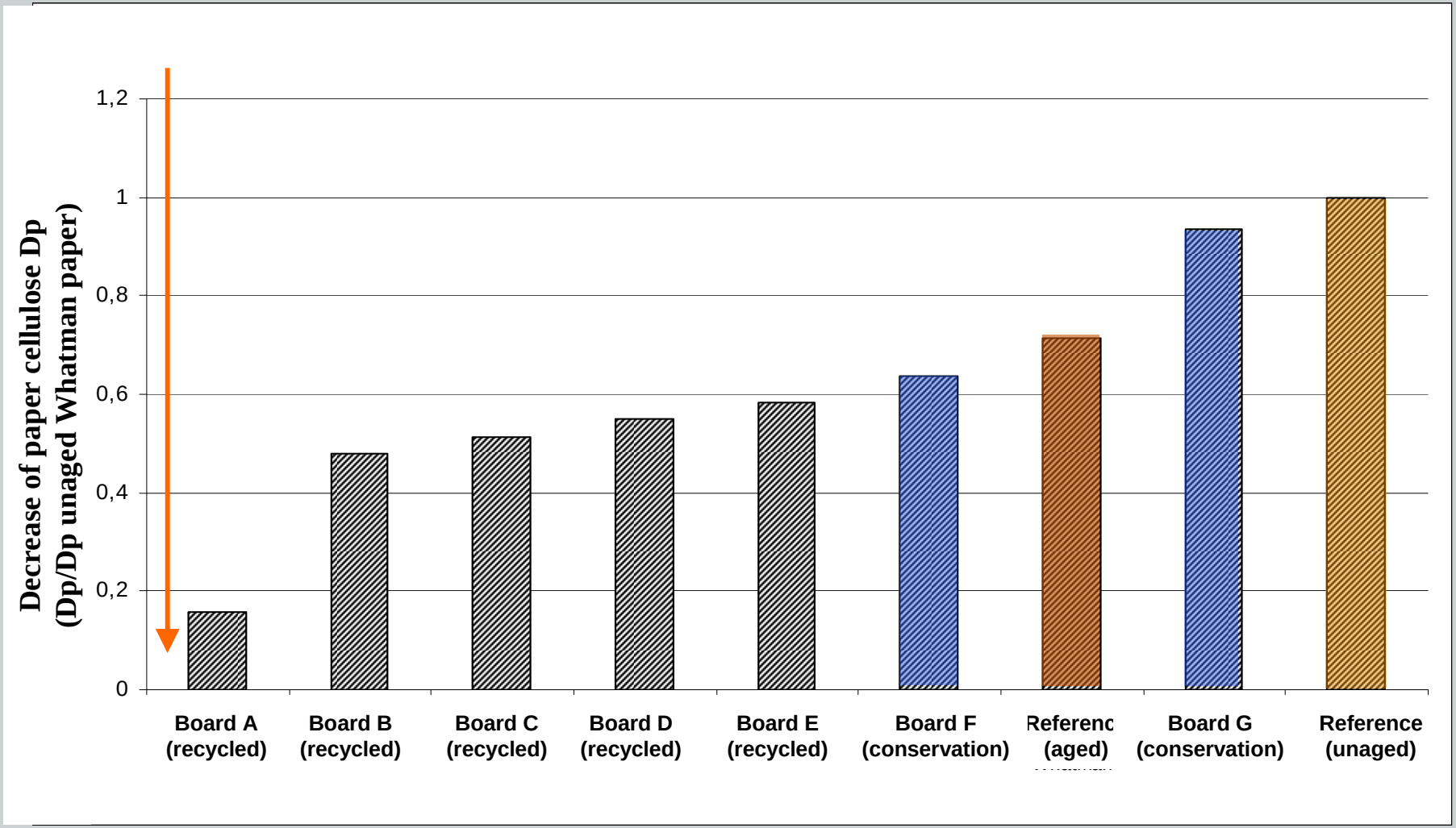
100 °C -50 % relative humidity
5 days*

Size exclusion chromatography of aged Whatman paper cellulose
→ Determination of cellulose Dp

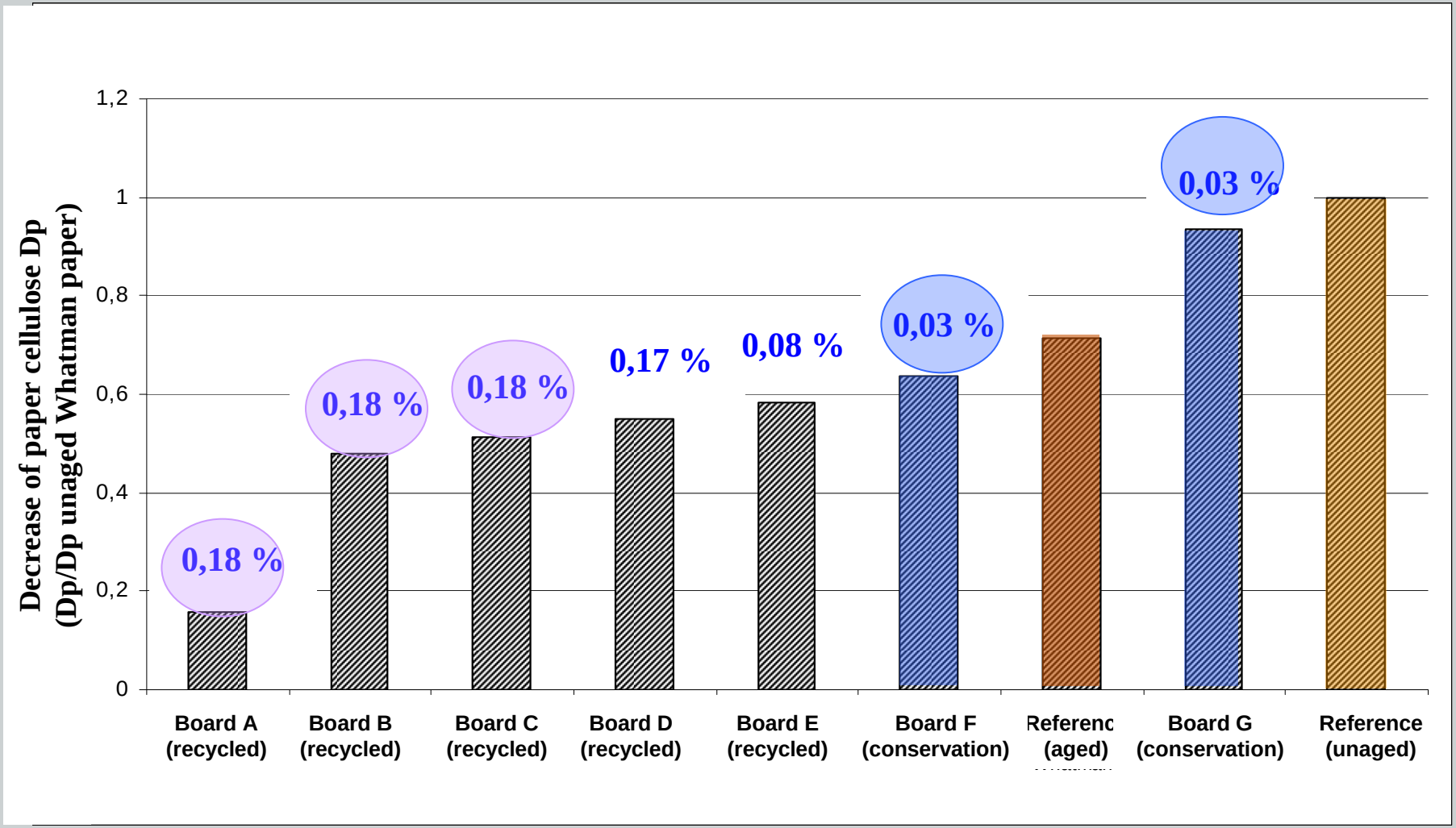
**** ASTM D6819-02 :2007Standard Test Method for Accelerated Temperature Aging of Printing and Writing Paper by Dry Oven Exposure Apparatus***

- Sulfur content and Dp of cellulose after artificial ageing

More degraded

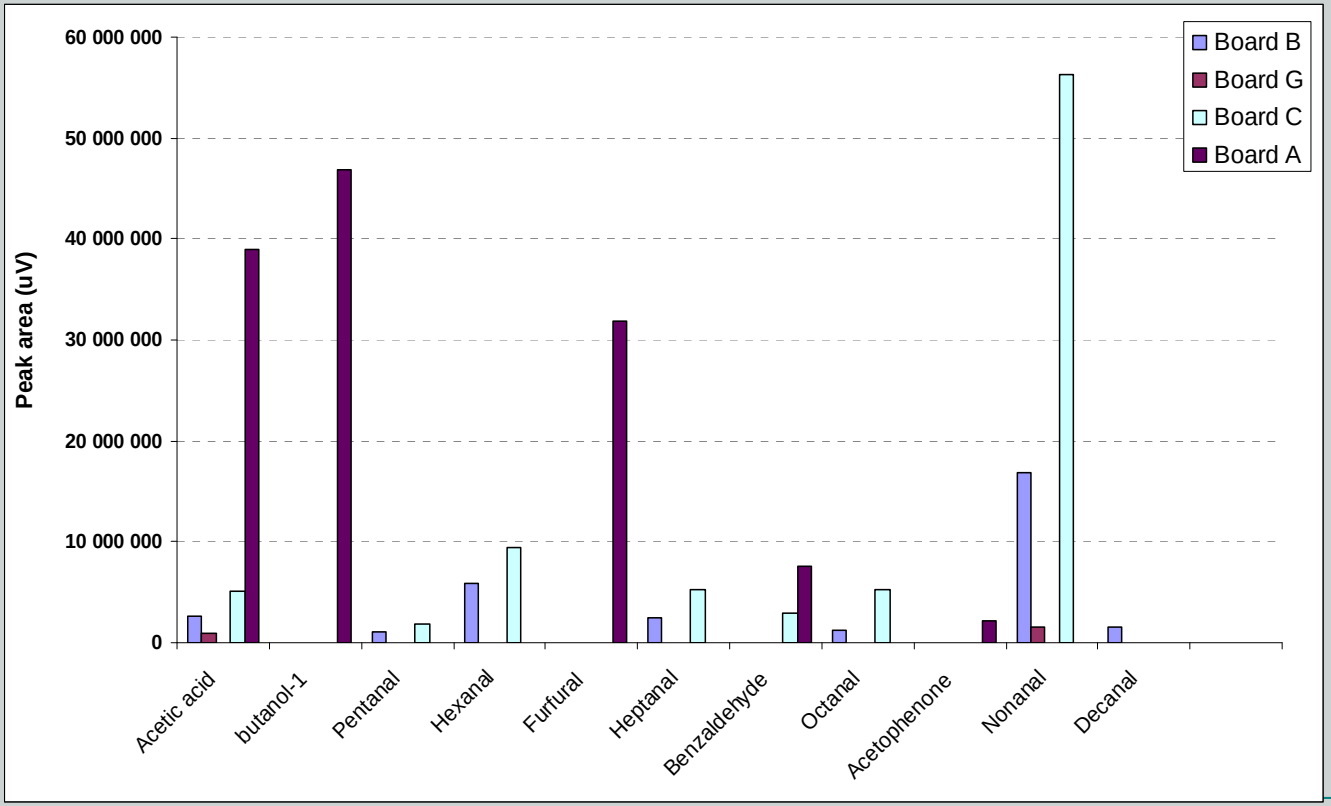


Sulfur content and Dp of cellulose after artificial ageing

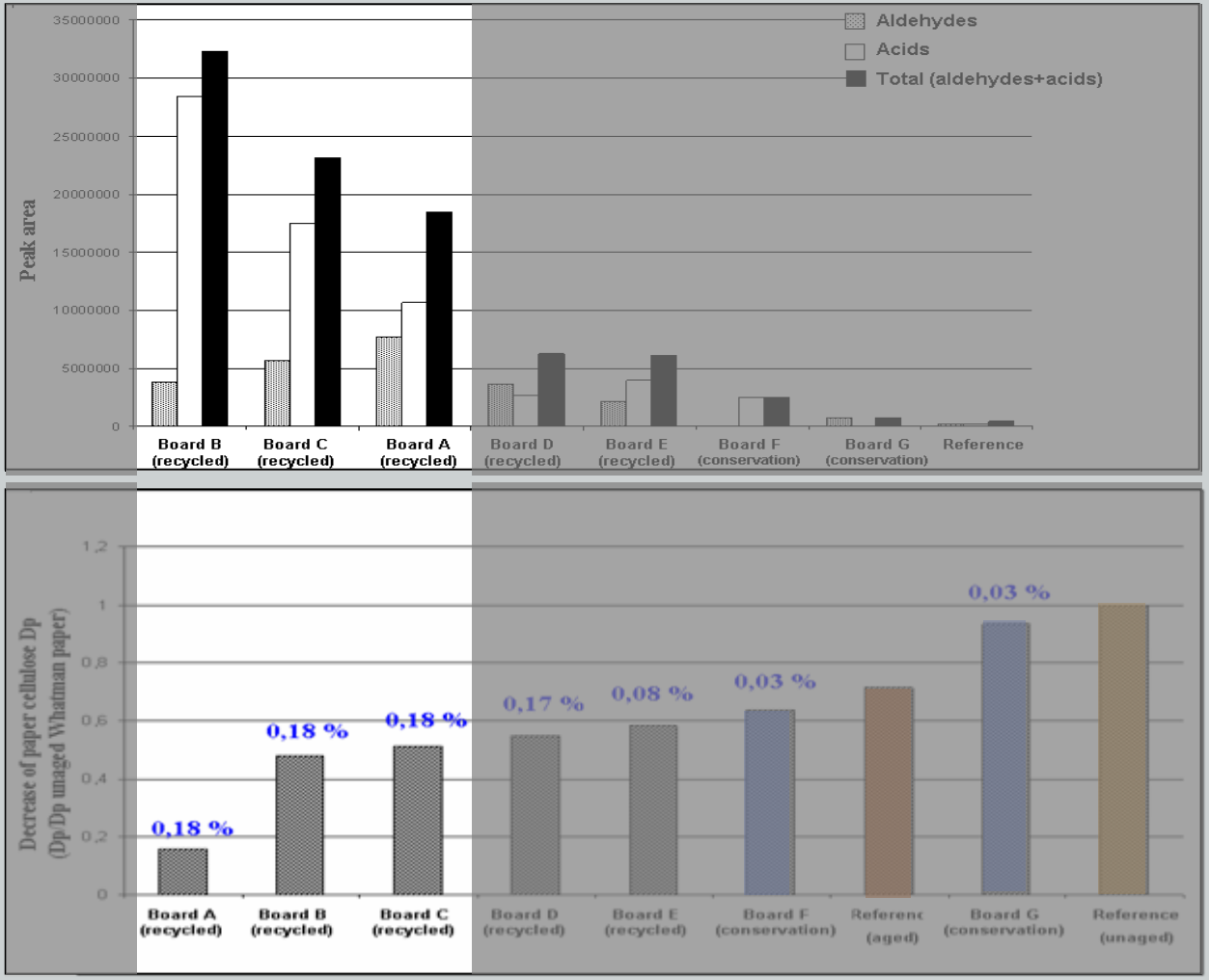


VOC's analysis

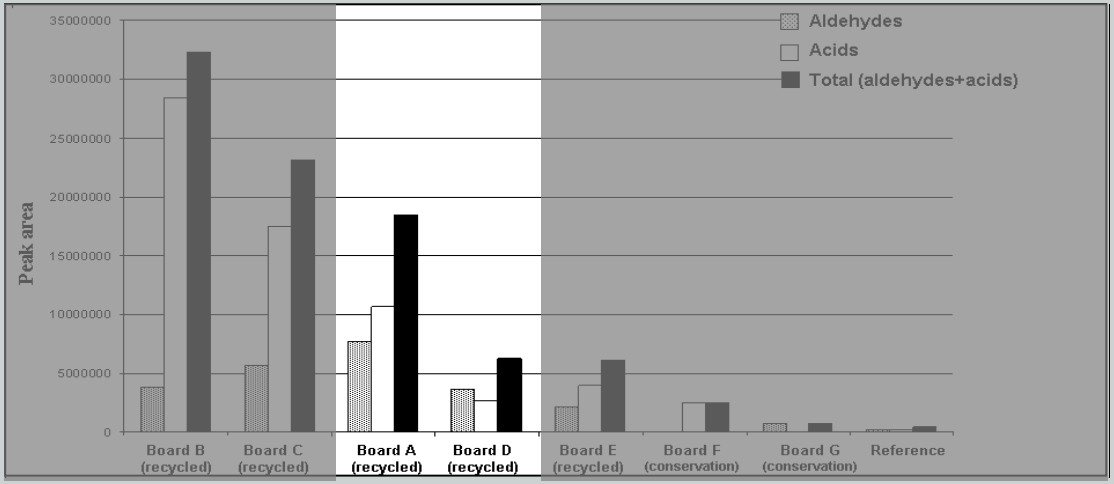
- Extraction 1h 60°C head space – SPME fiber (85um Carboxen/PDMS stable flex)
- GC-MS analysis

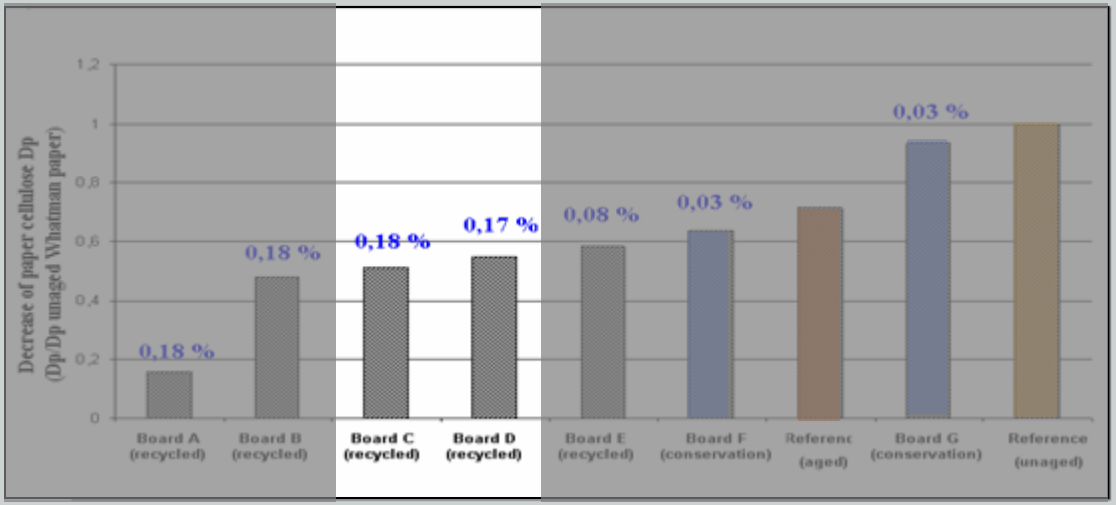


- The role of VOC's



The role of VOC's





Conclusions

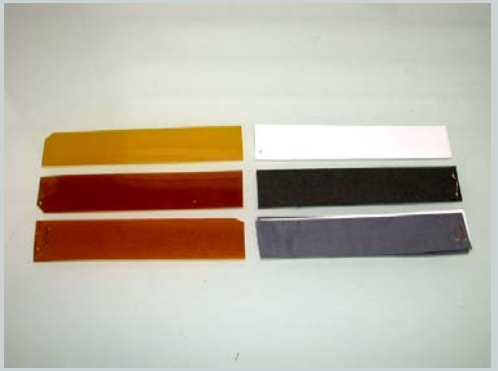
- It is very difficult to anticipate any simple relationship between VOC's emissions, composition of a material, and its effects on paper-based artefacts

- « Performance tests » → more interesting approach

Photoactivity test* (PAT)

Colloïdal silver films
Photographic paper

86% HR-70°C
2 weeks

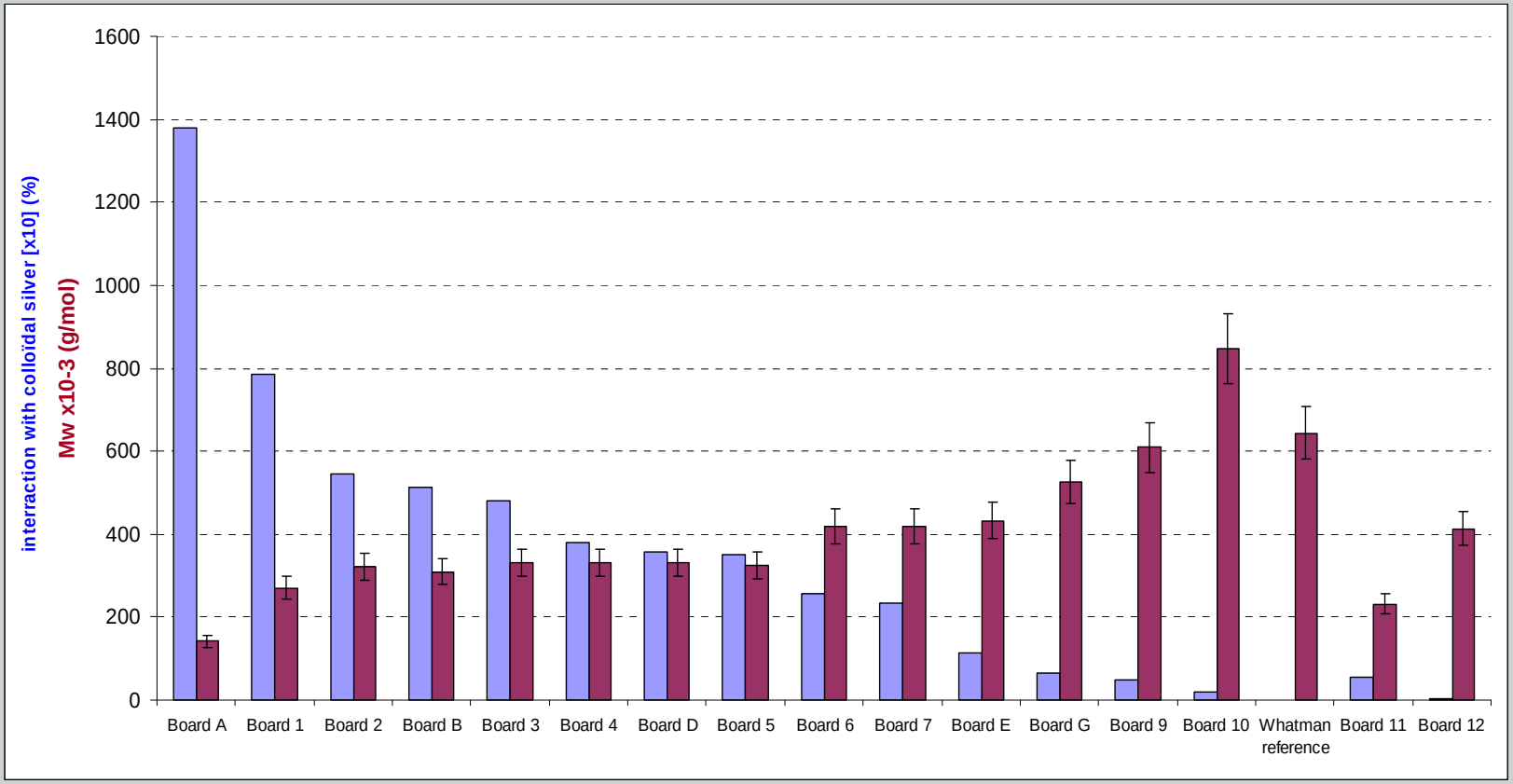


Photographic density measurements. Comparison with a control incubated with Whatman filter paper.

High % image interaction difference = Chemical effect of the board

** ISO Standard 18902: Imaging Materials—Processed photographic films, plates, and papers—Filing enclosures and storage container*

Photoactivity test *vs* Molecular weight of cellulose



For most of the boards tested, good correlation between the PAT results and the harmfulness on paper cellulose

Conclusion

Next future : development of a photo-cellulo-activity test ?

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