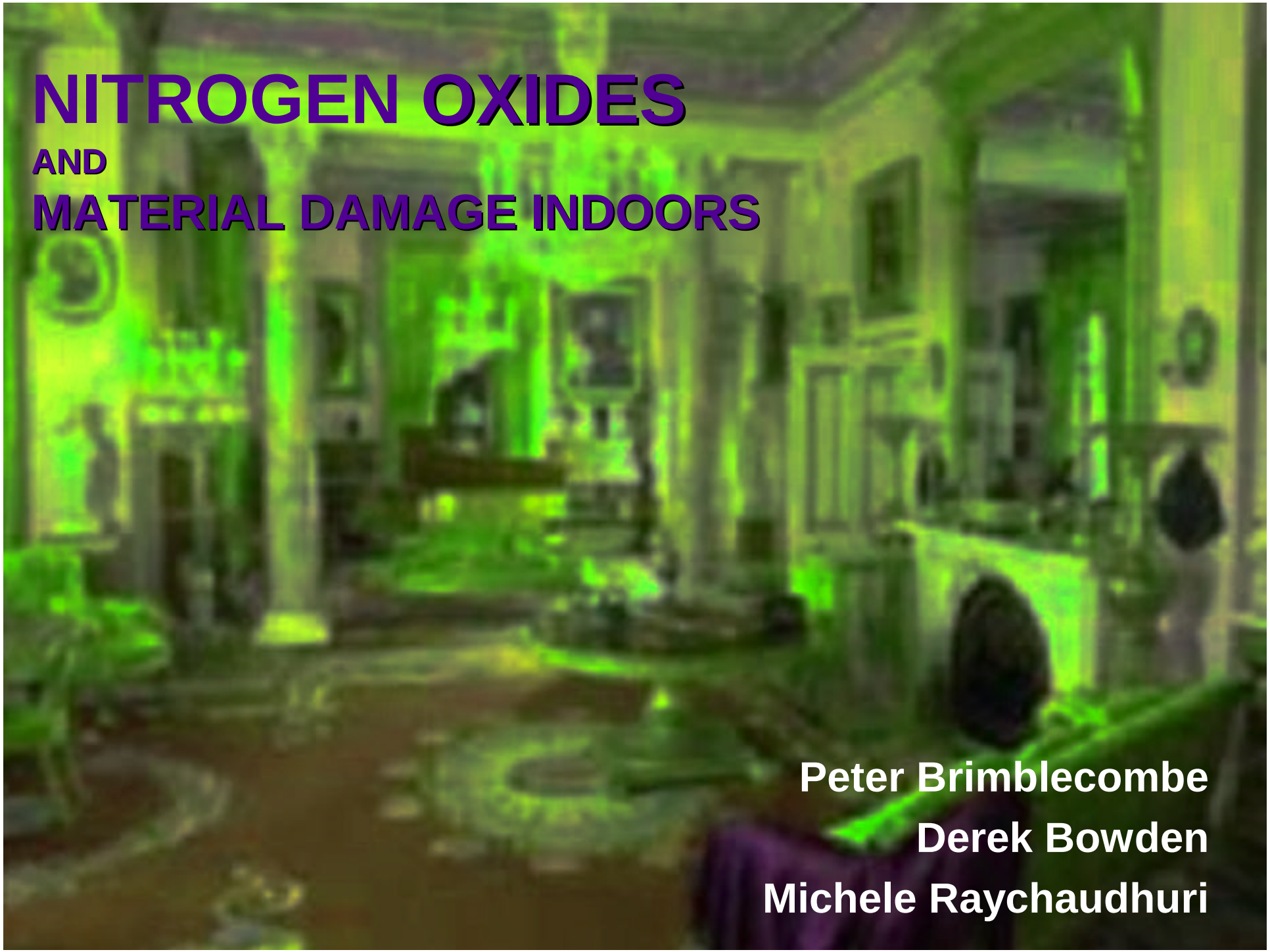


NITROGEN OXIDES
AND
MATERIAL DAMAGE INDOORS

Peter Brimblecombe
Derek Bowden
Michele Raychaudhuri

EFFECTS OF NO_2

- Fades dyes/colorants
- Weakens textiles/paper
- Damages leather
- Aids corrosion of copper/silver

…but it maybe nitric acid that is more important in some cases.

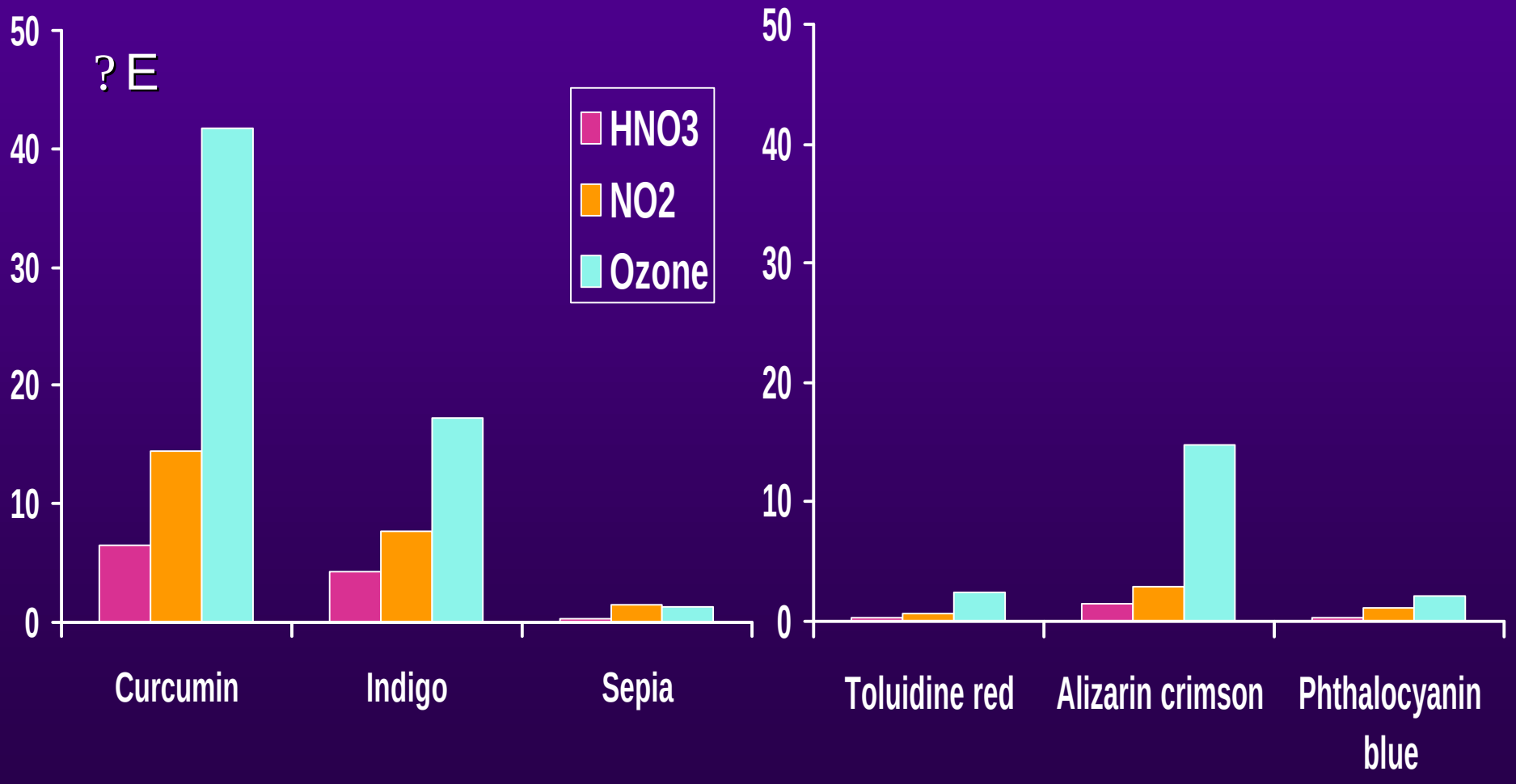
GAS FADING

- Loss of aerial perspective
- …but copper from verdigris (copper acetate) binds to fatty or resin acids
- Now a huge problem from ozone and ink jet printers

Gunn *et al Studies in Conservation* 47 (1): 12-23 2002

ORGANIC COLORANTS

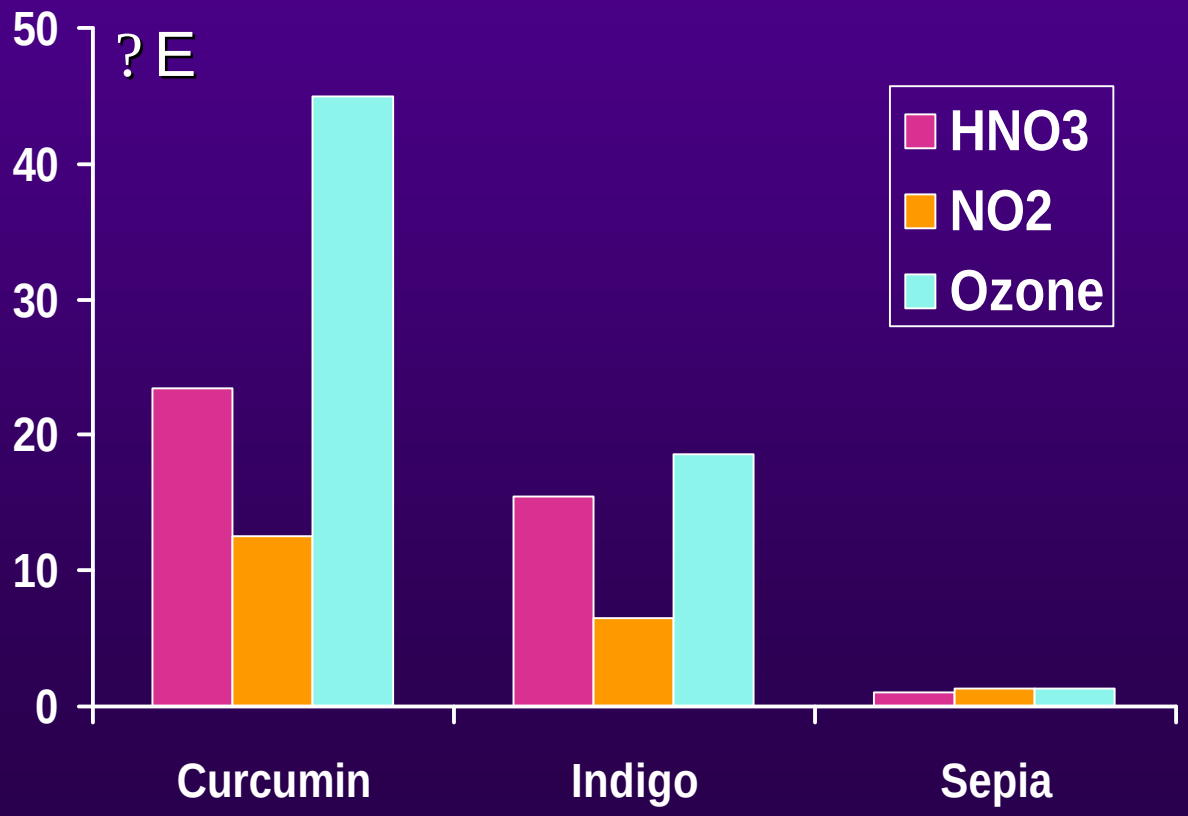
Exposures 12 week
HNO_3 12ppb
NO_2 500ppb
O_3 400ppb



Grosjean *et al* *Environ Sci Technol* **26**: 952-959 (1992)

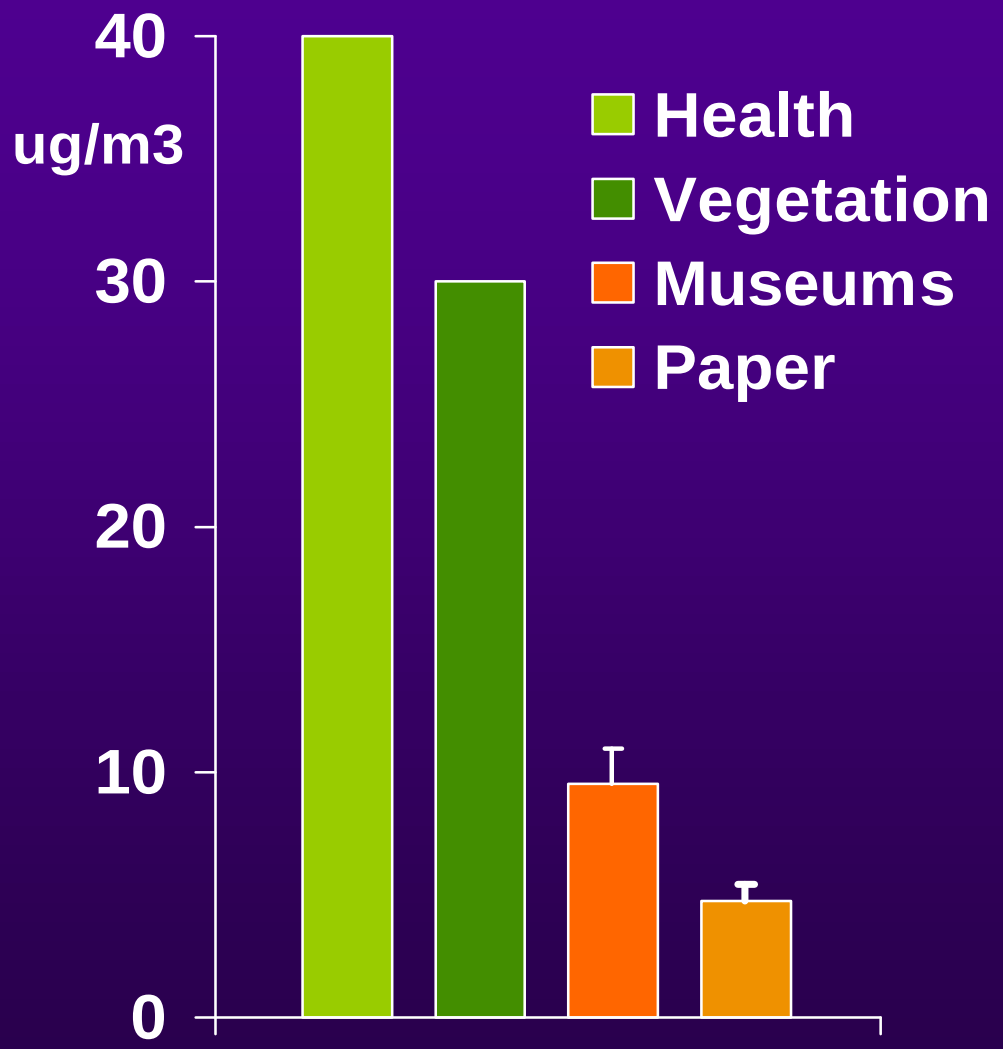
NATURAL ORGANIC COLORANTS @ AMBIENT CONCENTRATIONS

Exposures 10 year
HNO_3 1ppb
NO_2 10 ppb
O_3 10 ppb



NITROGEN DIOXIDE

Annual limits for health and vegetation (96/62/EC) much less stringent than suggested exposures for museum and paper archives

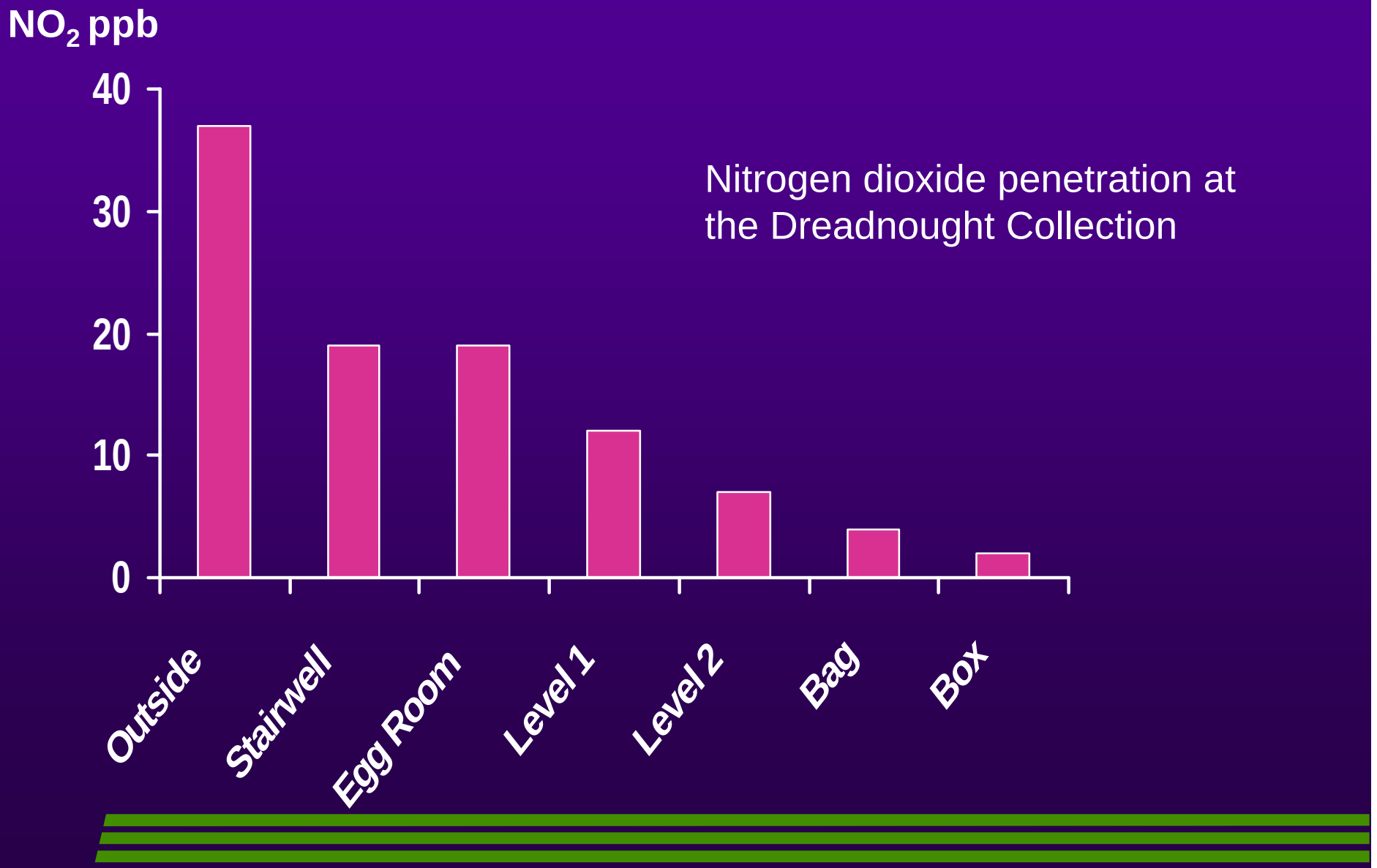


NO_2 OUTDOOR SOURCES

Museum of London	0.18	a/c & filtration
Correr (winter)	0.43	closed windows
Residenz, Wurzburg	0.62	
Kunsthistorisches Museum	0.64	
Correr (summer)	0.75	open windows
SCVA (winter)	0.79	
V&A, London	0.99	
SCVA (summer)	1.32	

$$I/O = Ac/(Vd(S/V)+Ac)$$

INDOOR AIR POLLUTION



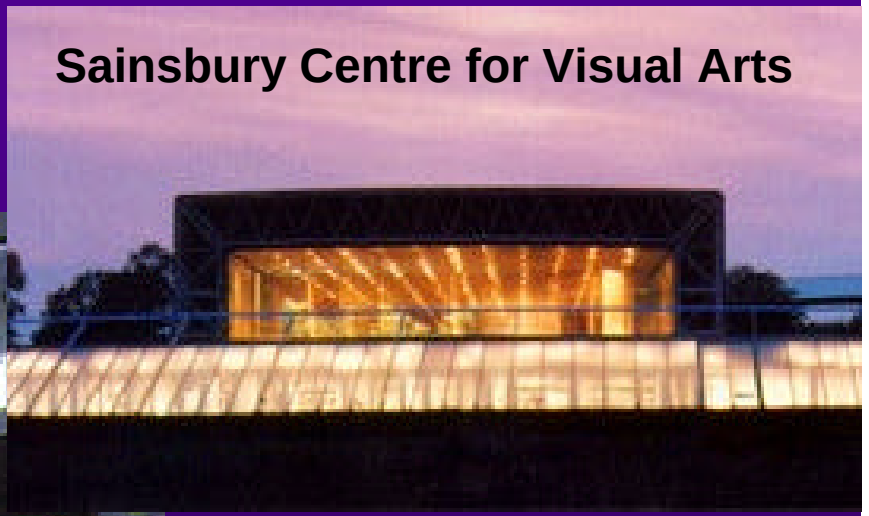
Nitrogen dioxide penetration at the Dreadnought Collection

INDOOR NO_2 SOURCES

- Combustion
- Leather
- Cellulose nitrate

INDOOR AIR CHEMISTRY

Indoor reactions can elevate summer NO_2 concentrations



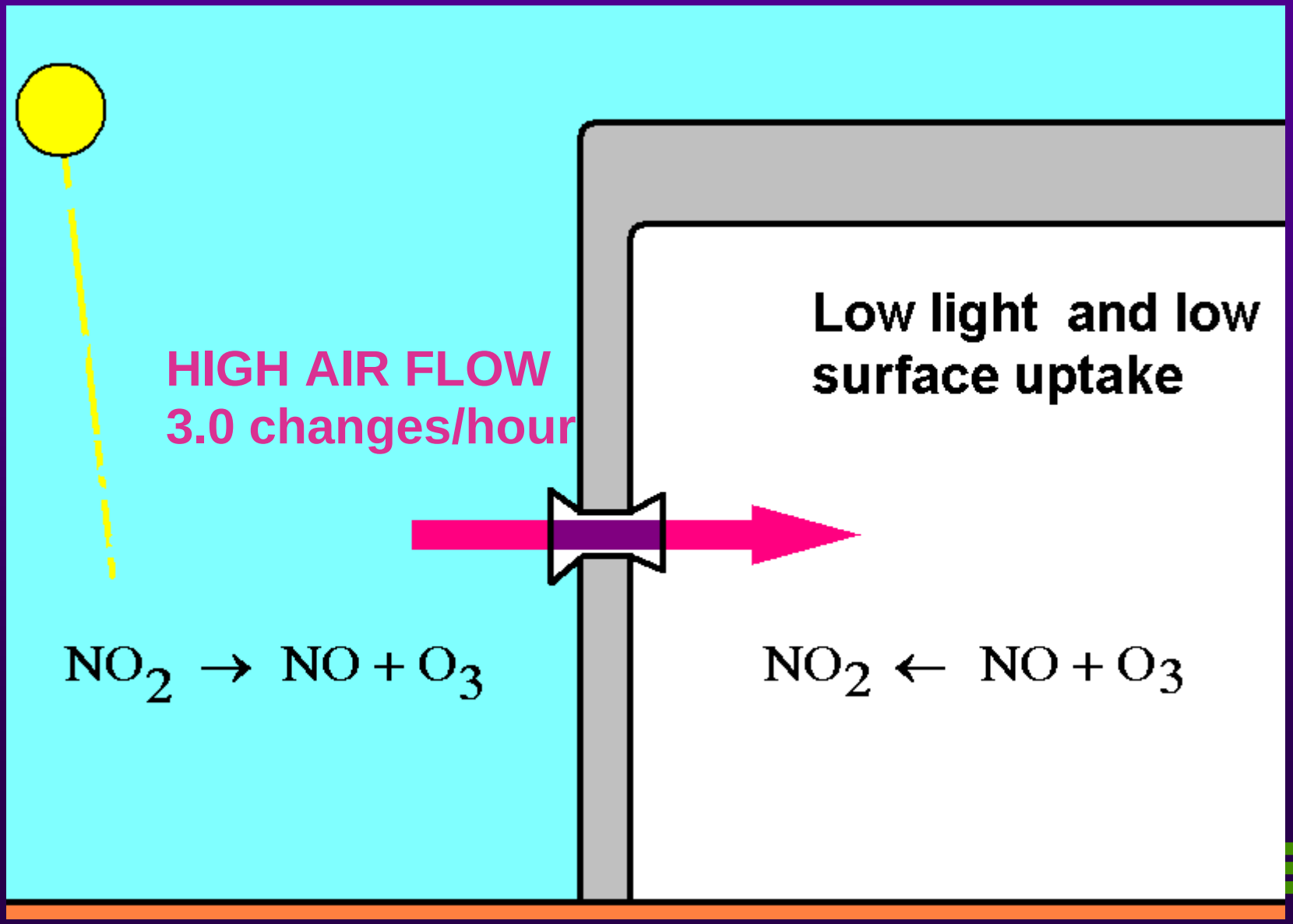
AER project studied air chemistry in museum environments

DG XII ENV4-CT95-0088

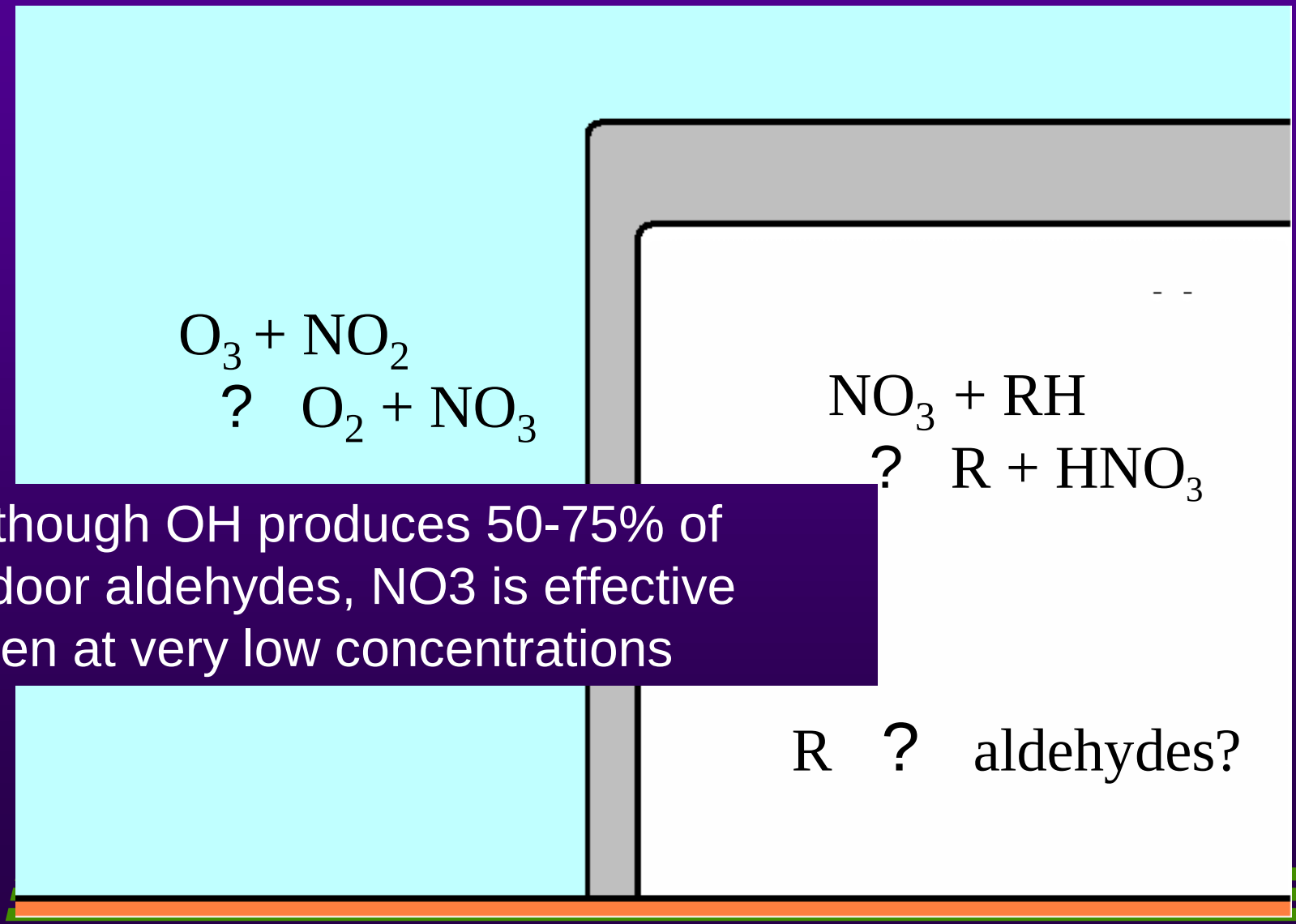
SYNERGISMS

INDOOR NO_2 FORMATION

0.79 winter
1.32 summer

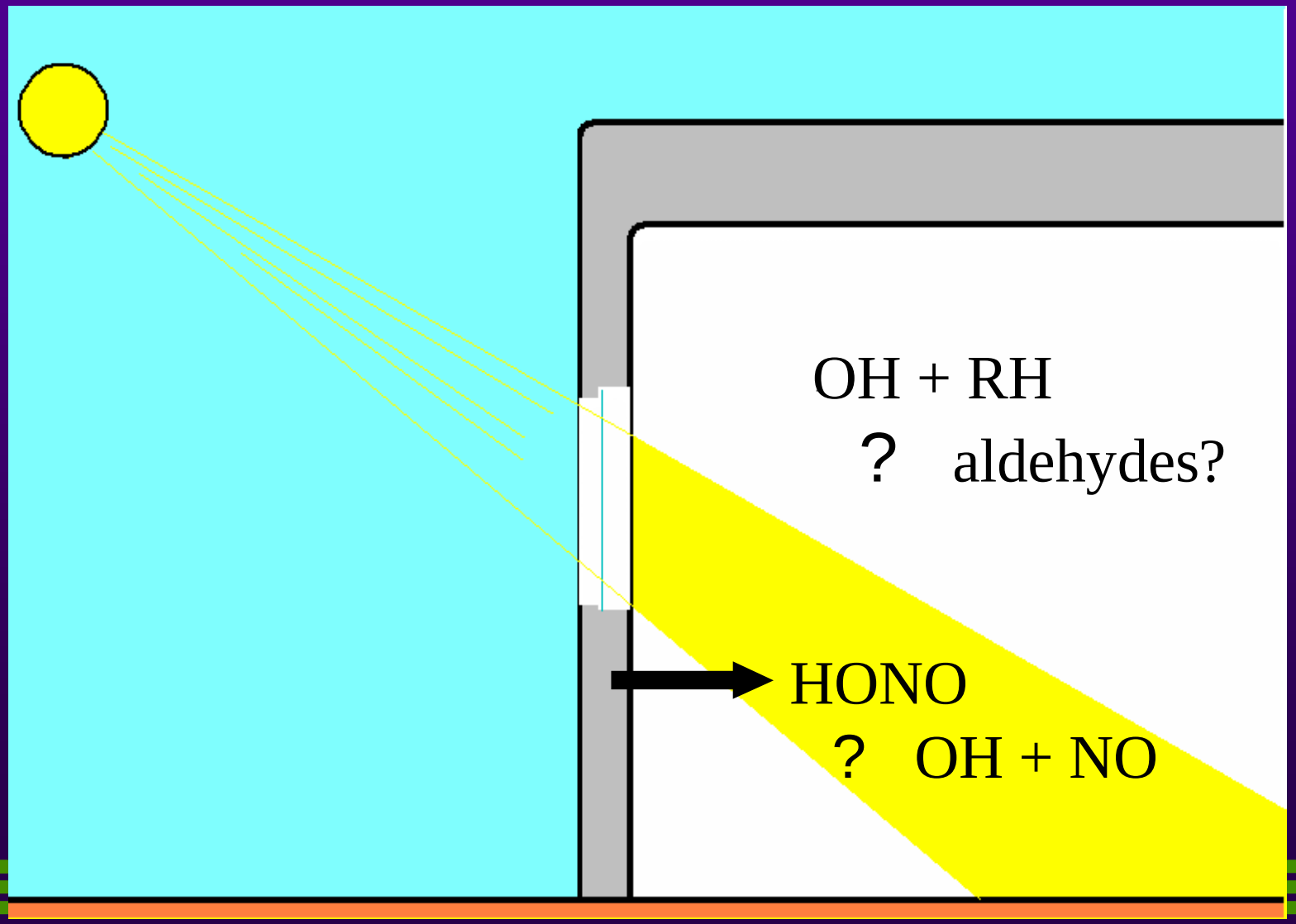


INDOOR HNO_3 FORMATION



Although OH produces 50-75% of indoor aldehydes, NO3 is effective even at very low concentrations

INDOOR HONO



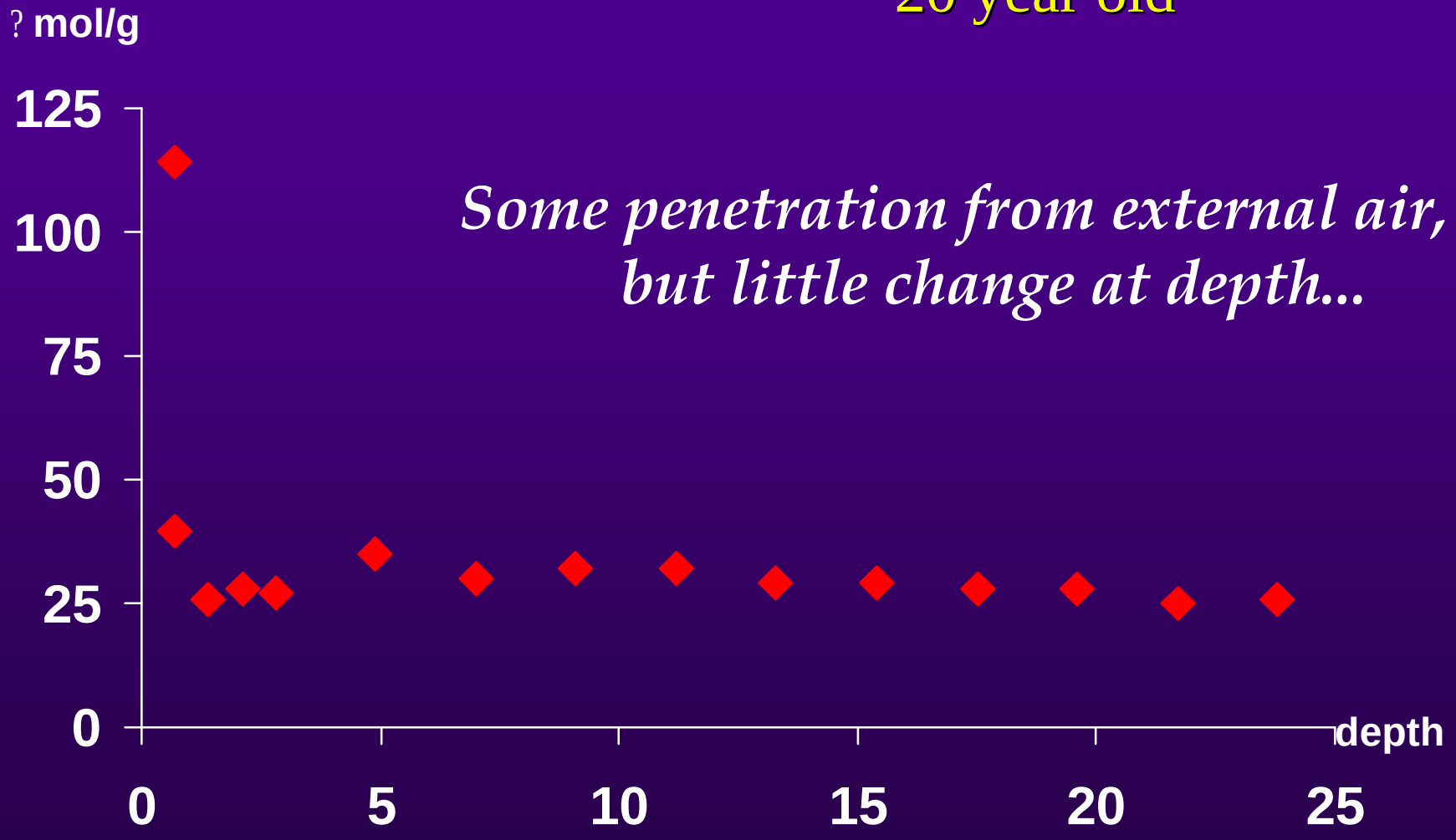
IMPORTANCE OF HONO and NITRITE – N(III)

- The rapid removal of NO2 and long lifetime of **HONO** suggest that **HONO** may represent a significant fraction of the oxidized nitrogen burden in **indoor** air.

NITRITE CONTENT OF MATERIALS

NITRITE IN A BREEZE-BLOCK

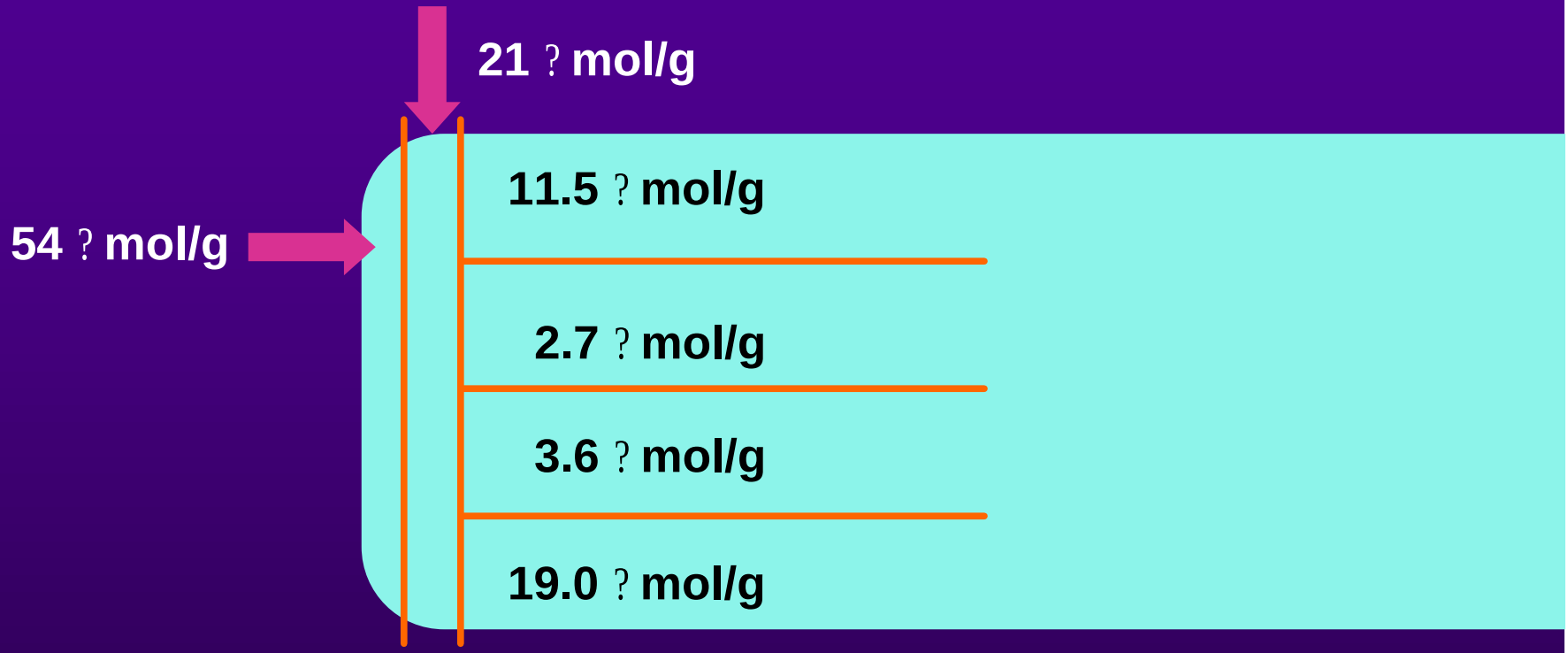
20 year old



Some penetration from external air, but little change at depth...

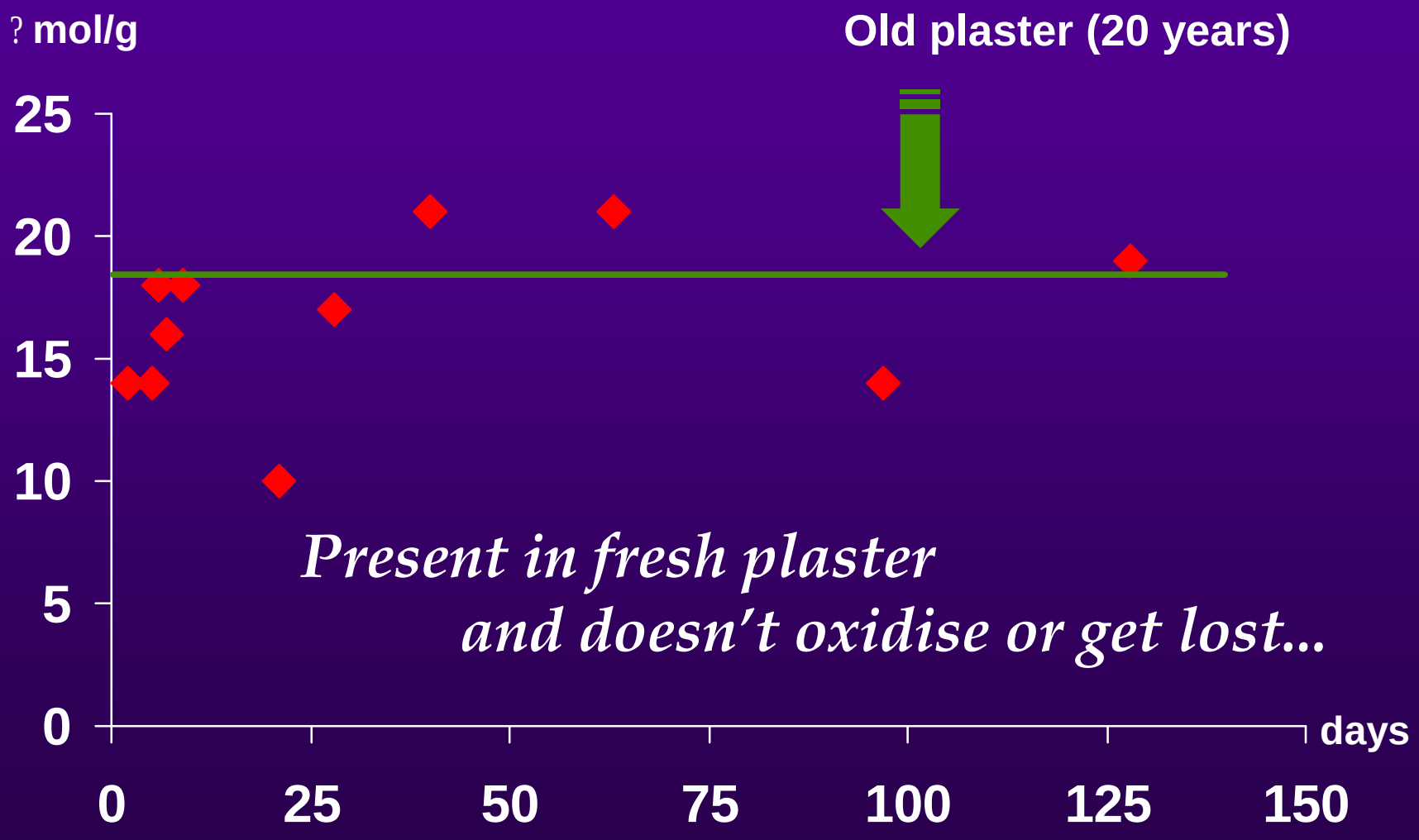
Michele Raychaudhuri UEA

NITRITE IN CONCRETE TILE



Exterior is at high concentration, especially on rough surfaces...

NITRITE IN AGEING PLASTER



Michele Raychaudhuri UEA

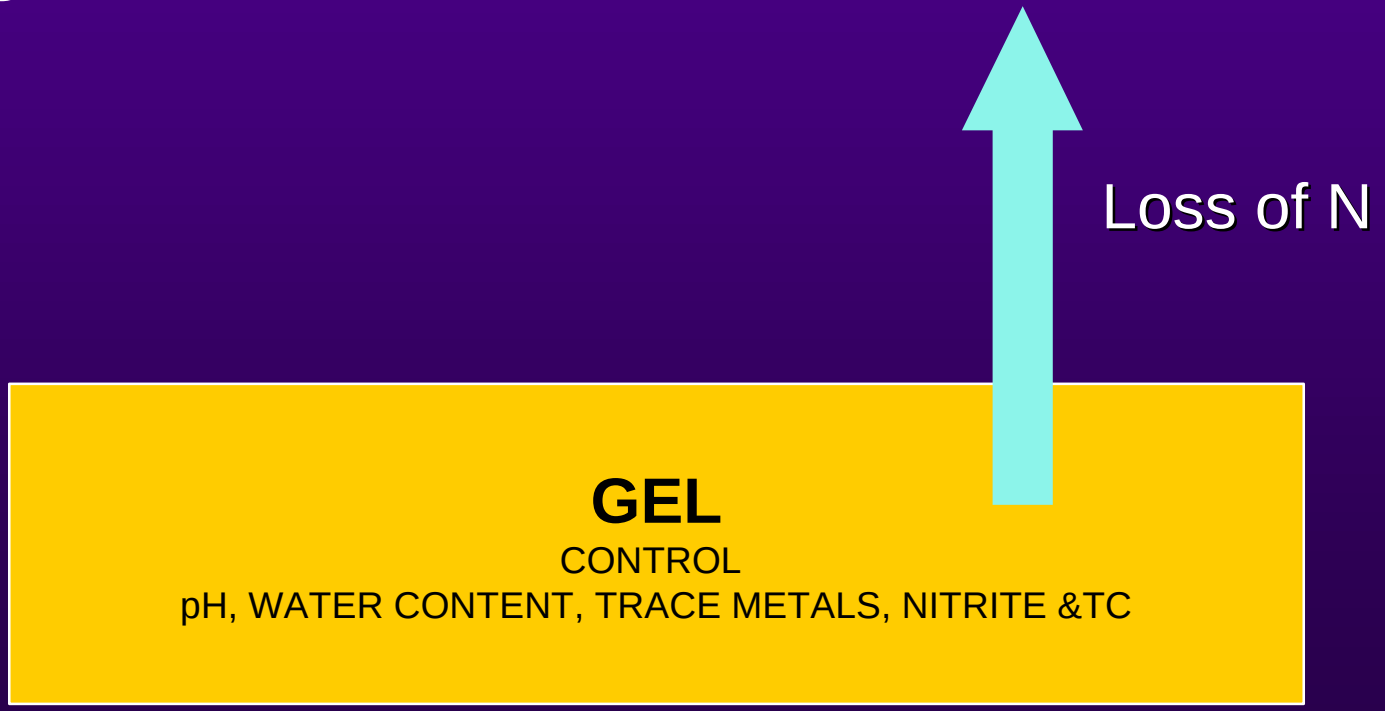
NITRITE FREE WOOL

Gain of nitrite over 17 days

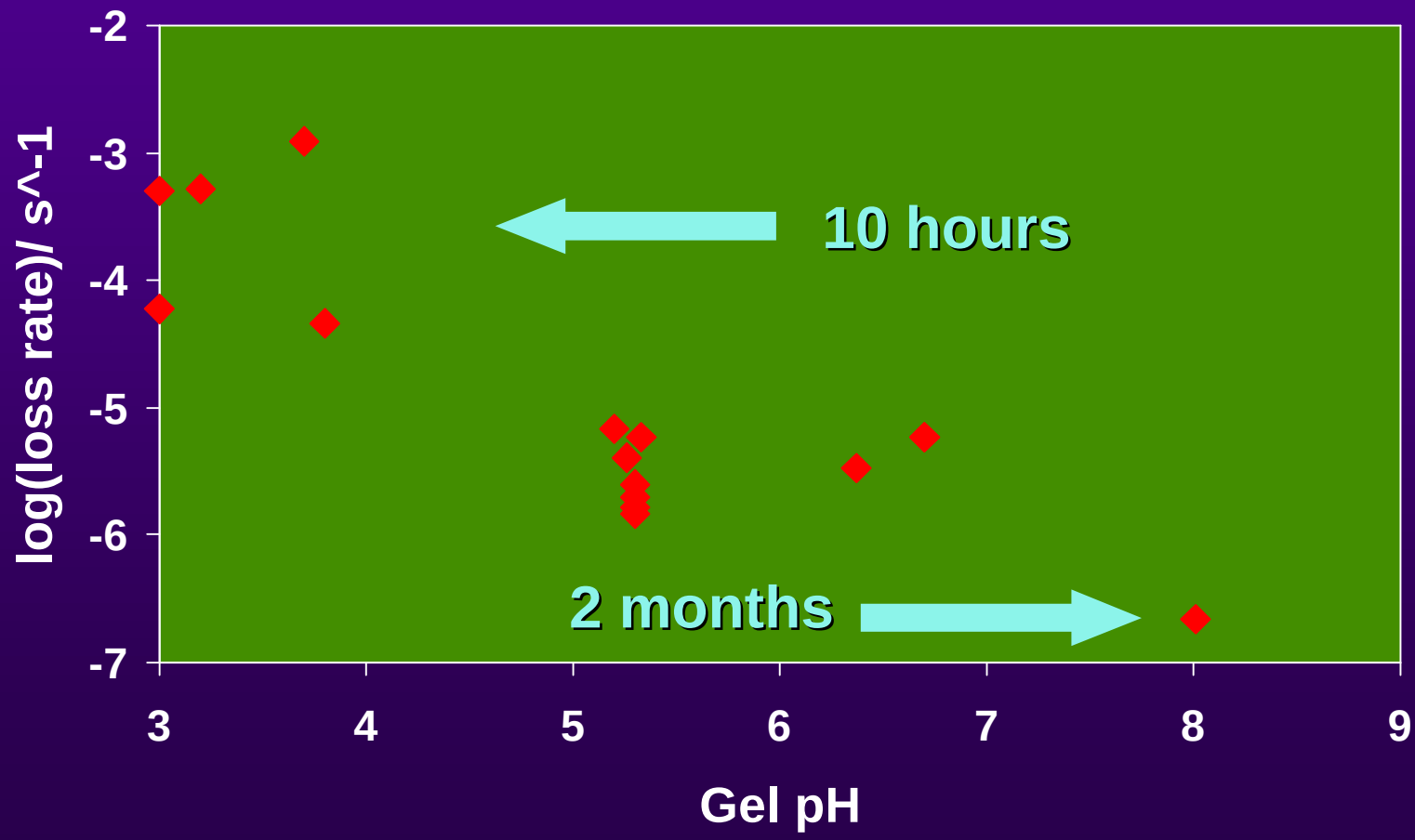
wool gains nitrite from the air…

GELS as SURROGATES

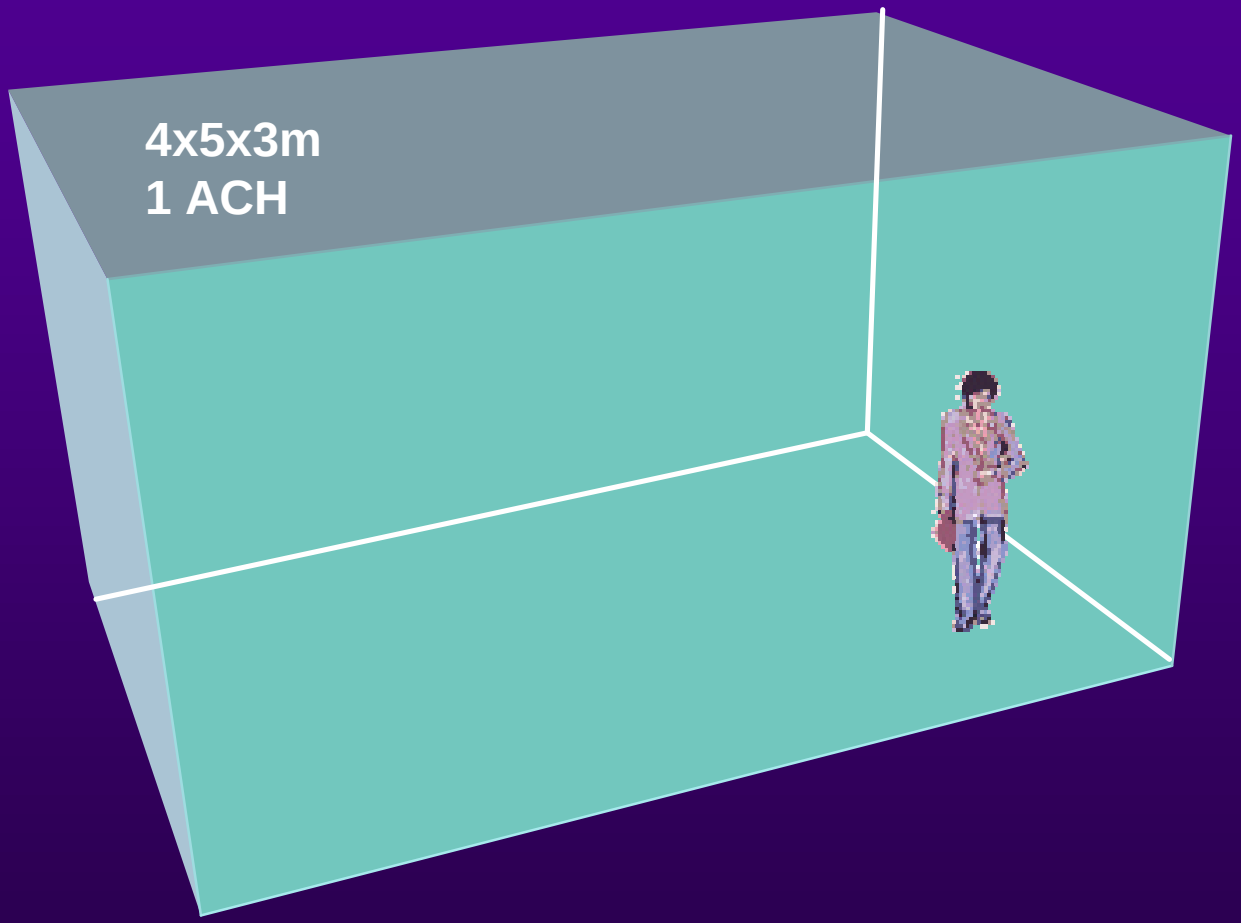
- Experiments convenient when using gels to model organic materials



LOSS OF NITRITE FROM COLLAGEN GELS



WALLS AS A SOURCE



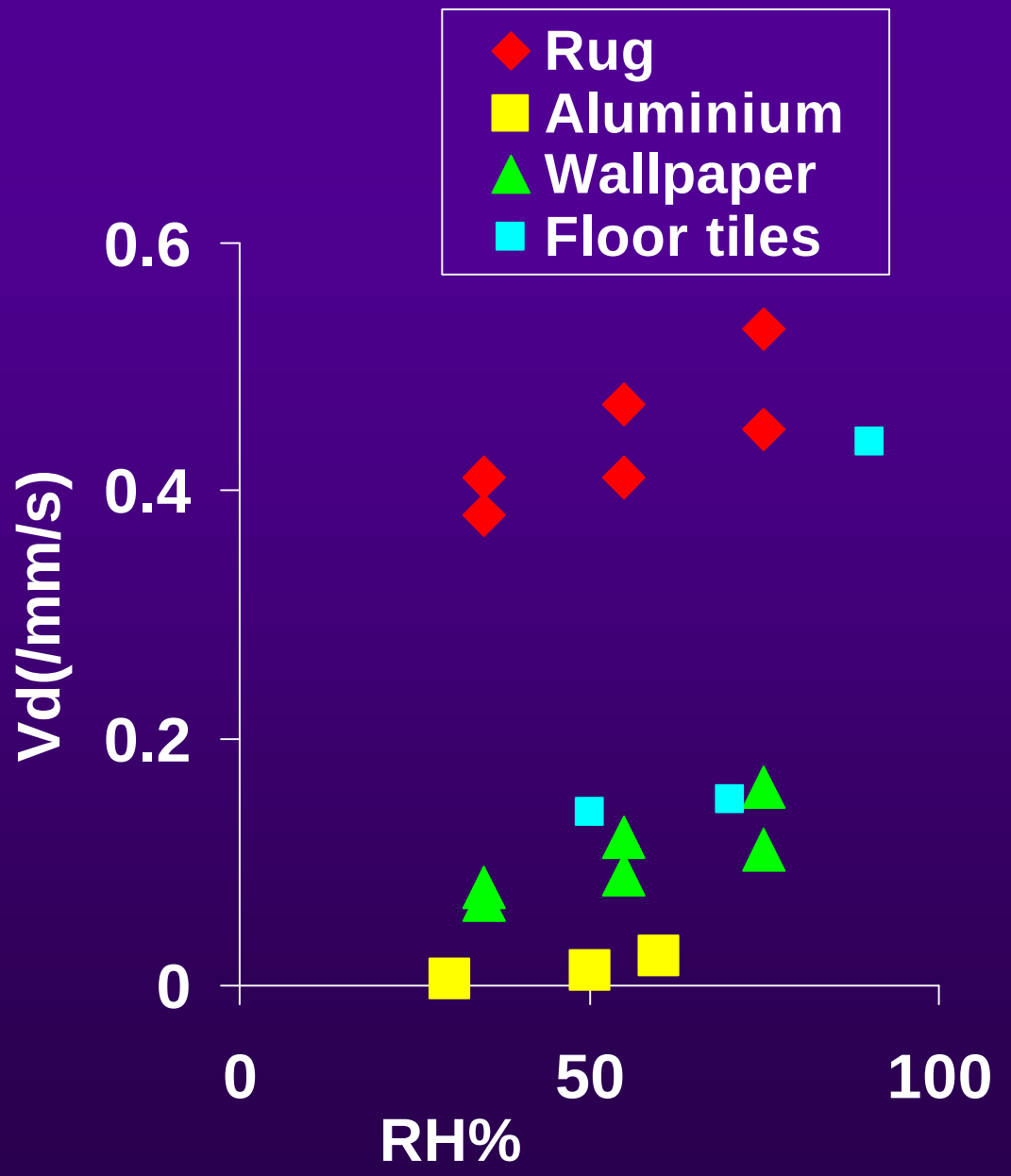
Wall plaster can contain about 17 mol nitrite

Released over 100 years would maintain HONO at ~6 ppb

RH EFFECTS

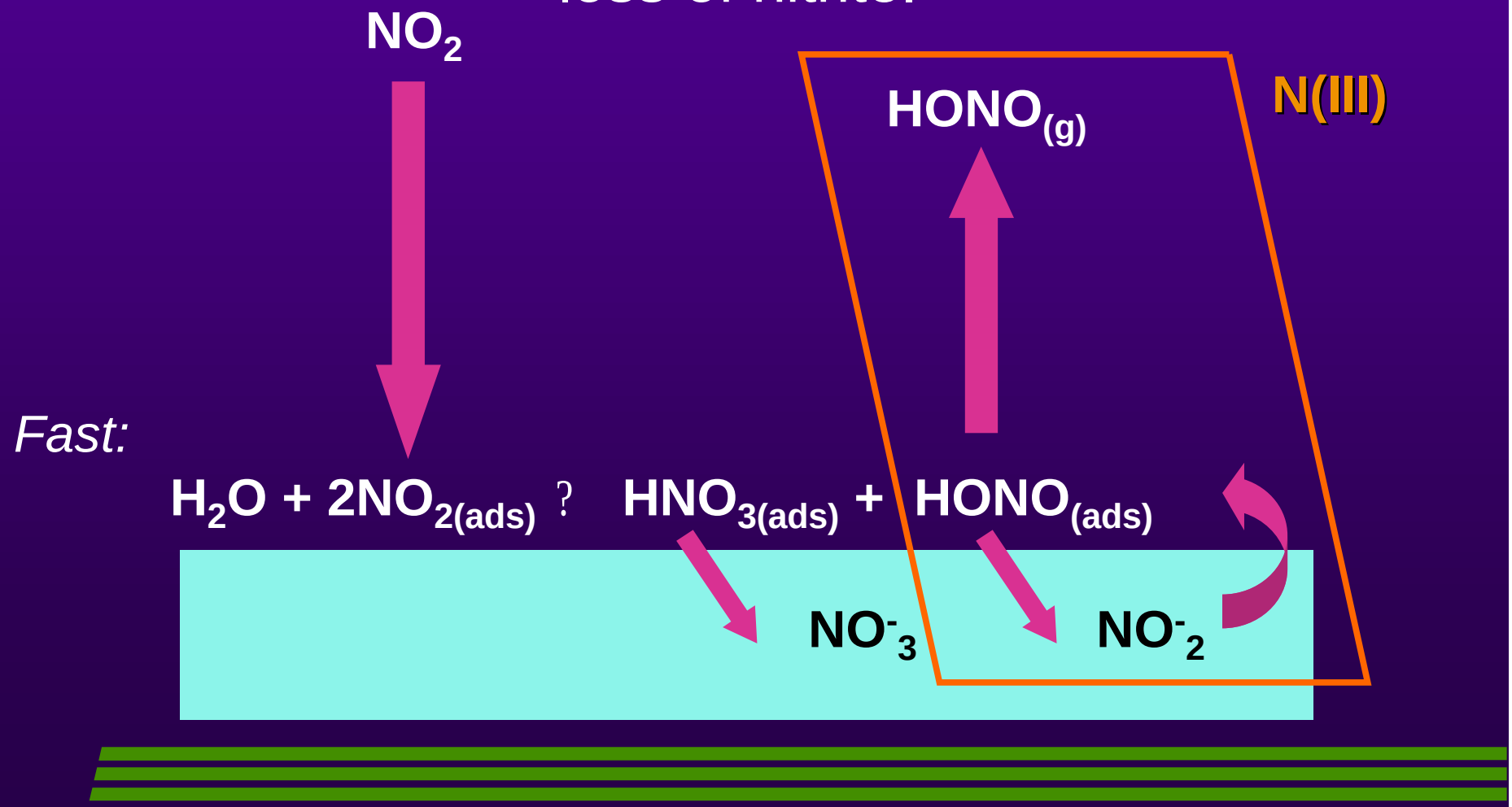
- Generally observe an increase in V_d with RH

Floor tiles from NILU work



REACTIONS INVOLVE WATER

Raw wool higher moisture content increases the rate of loss of nitrite.



NITRITE in ORGANIC MATERIALS

- Loss often not the dominant process
- Oxidation to nitrate (metals/S[IV])
- Via the NO^+ – gives nitroso compounds (often yellow)

CONCLUSIONS

- Nitrate interactions with heritage complex and involve a number of species
- Some new interior building and furnishing materials contain nitrite.
- Alkaline materials accumulate nitrite from the atmosphere (e.g. depth profiles)
- Loss of N(III) is fastest under acid conditions
- Loss of N(III) to the atmosphere may be less important than internal reactions in organic materials