

Imaging Artifacts in the Louvre Museum

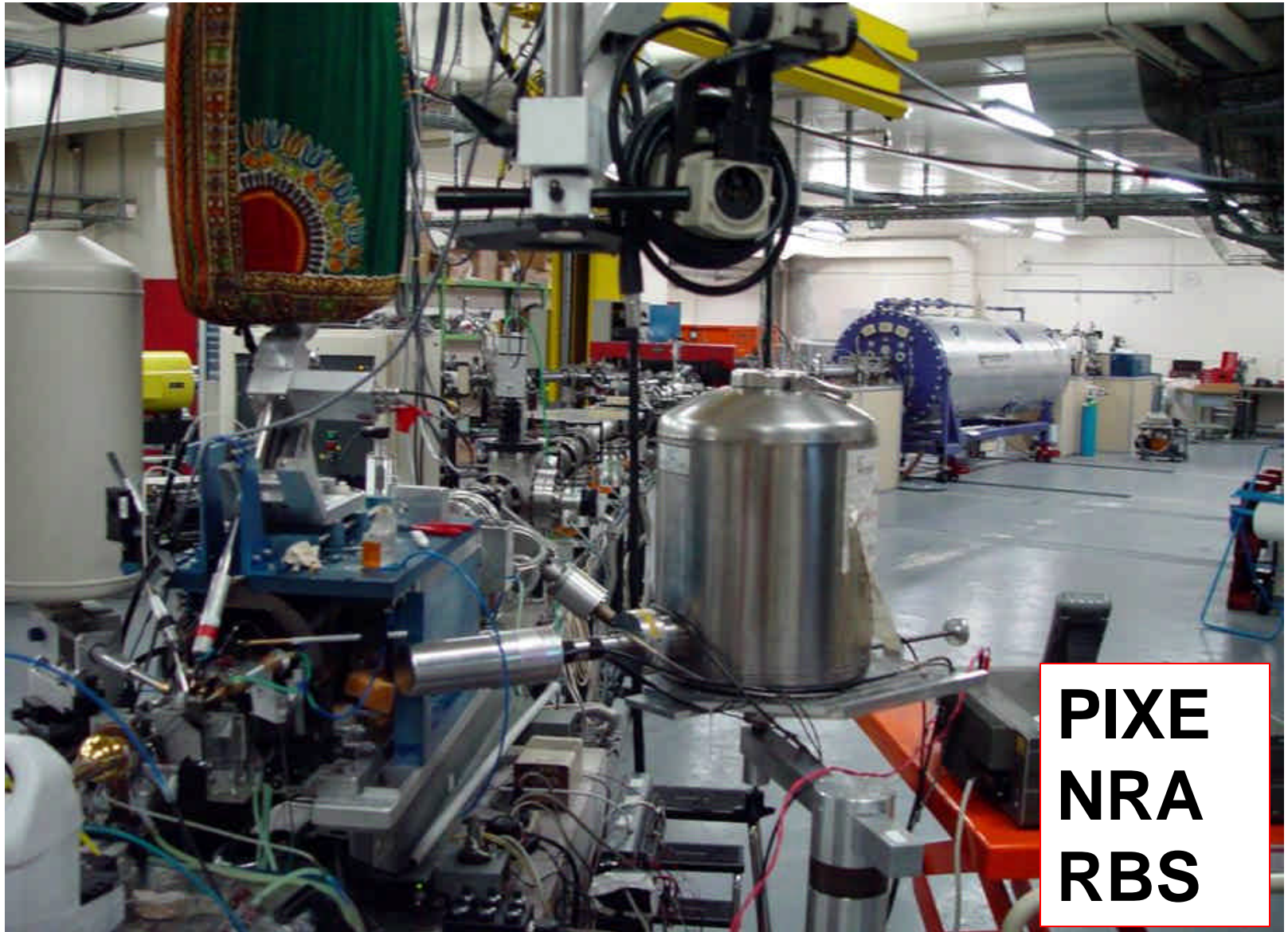
P. Walter

Centre de Recherche et de Restauration
des Musées de France - CNRS

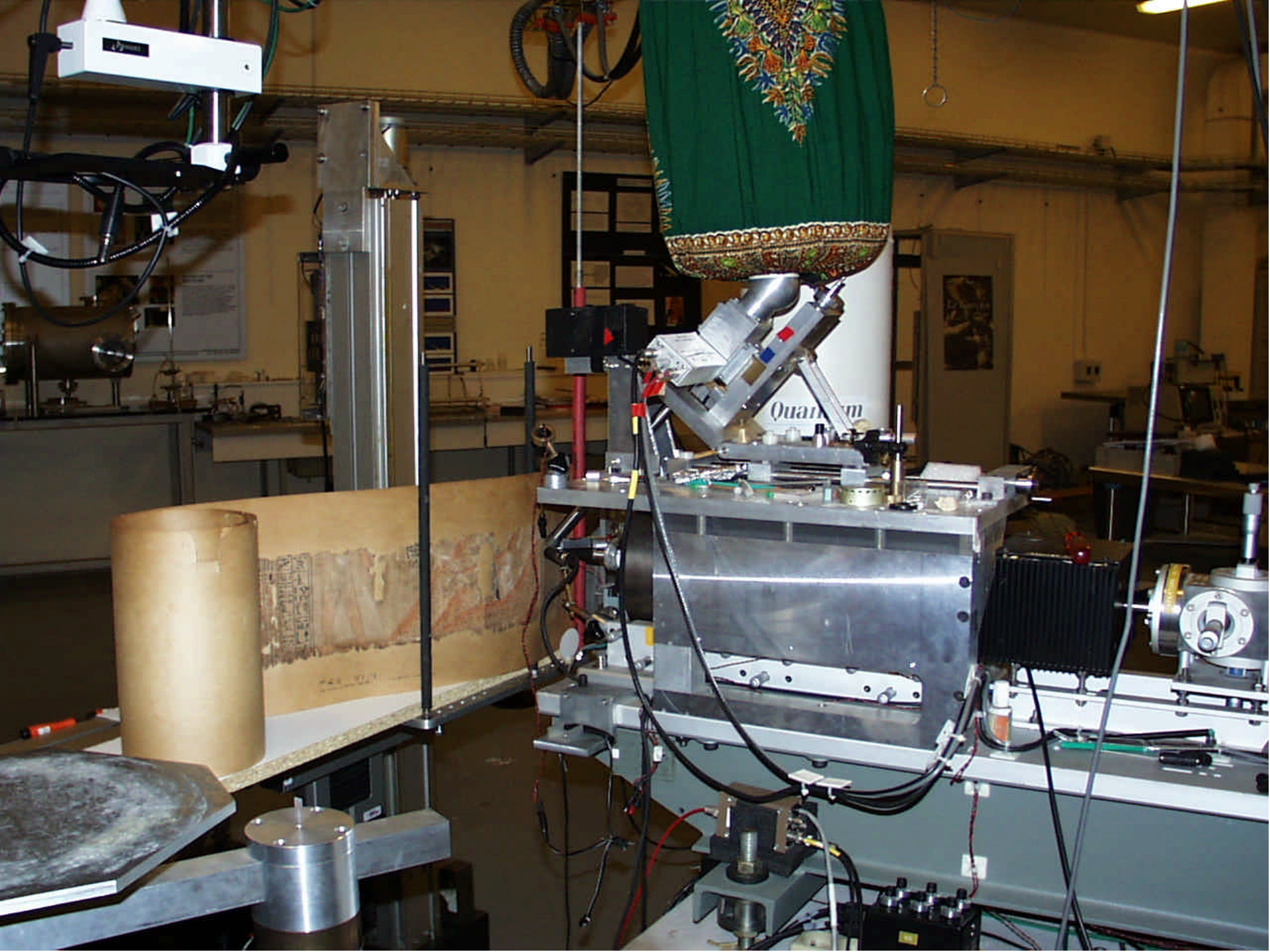
CENTRE DE
RECHERCHE
ET DE
RESTAURATION
DES MUSÉES
DE FRANCE

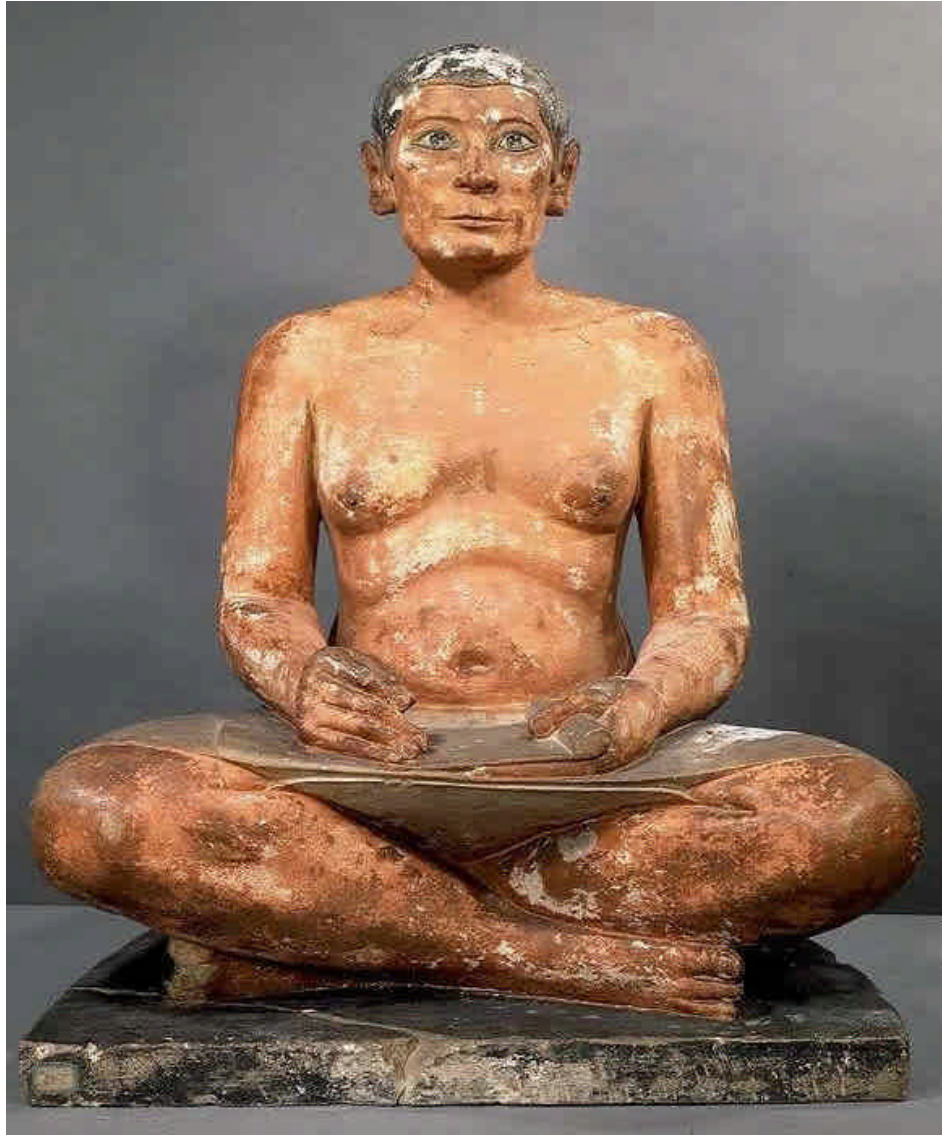
philippe.walter@culture.gouv.fr





PIXE
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The EU-ARTECH Program...

... provides the possibility for researchers in the field of Cultural heritage to submit proposals to obtain AGLAE beam time.

More information

<http://www.eu-artech.org>

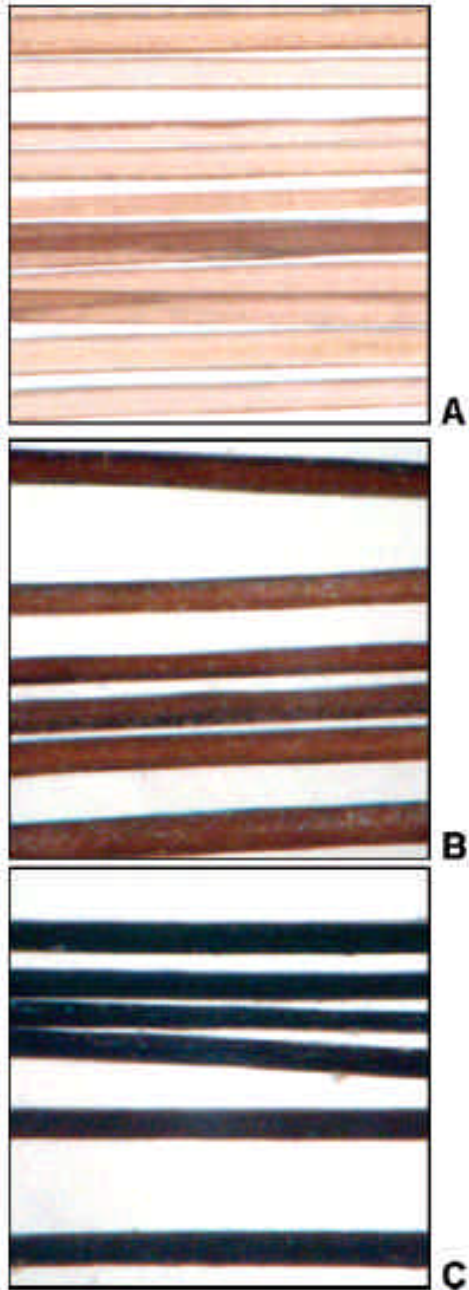
or

<http://www.c2rmf.fr>



EU-ARTECH

Access, Research and Technology for the conservation of the European Cultural Heritage



**1 – Early use of
nanotechnology**

**Italy,
2nd century.**

An ancient hair dyeing formula

*Taking as much as you will of **litharge (PbO)**,
& having wrapped it in white wool,
& putting in a new earthen vessel,
& putting water thereunto, (...)
the **wool grown black**.*



Dioscorides 1st. Century AD.

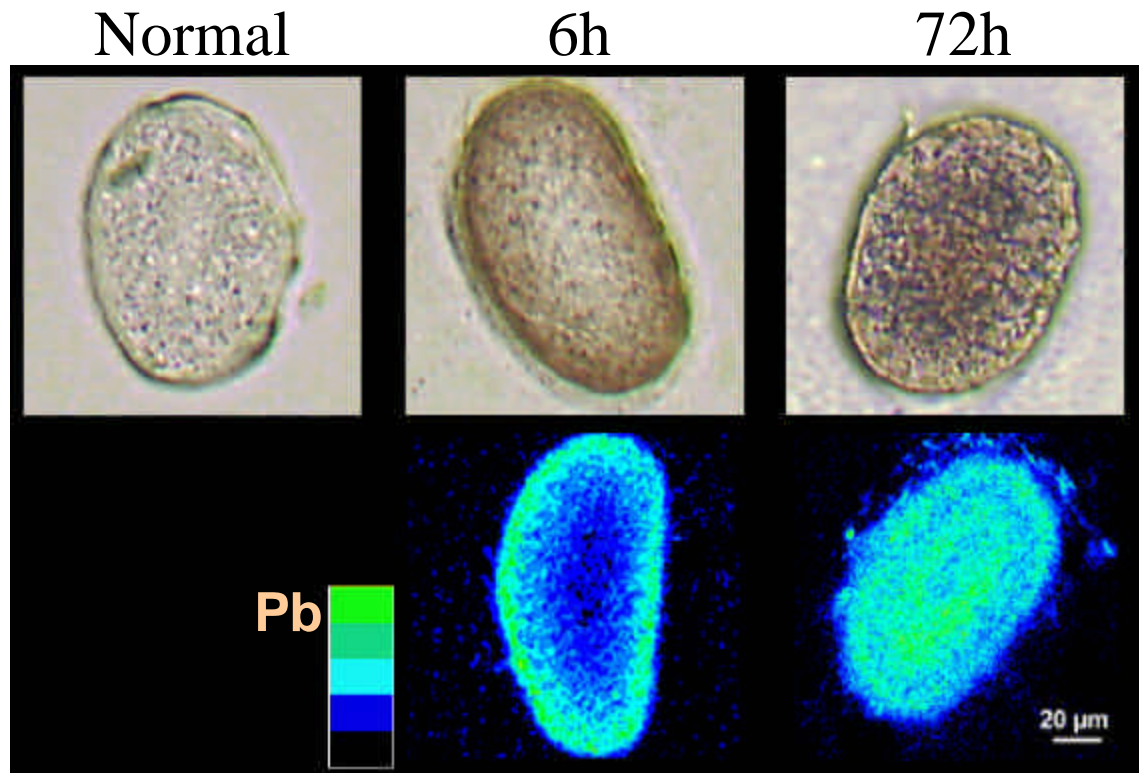
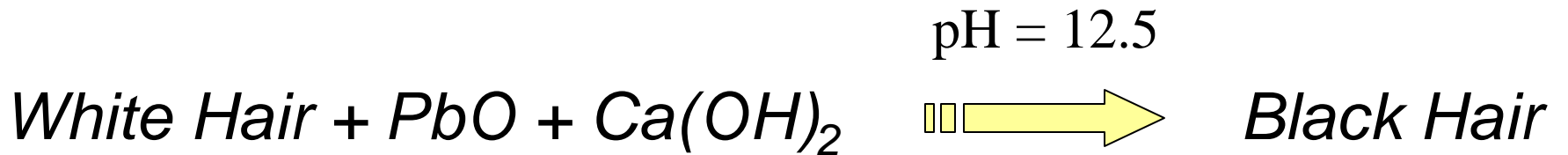


**Grecian[®]
Formula[™]**

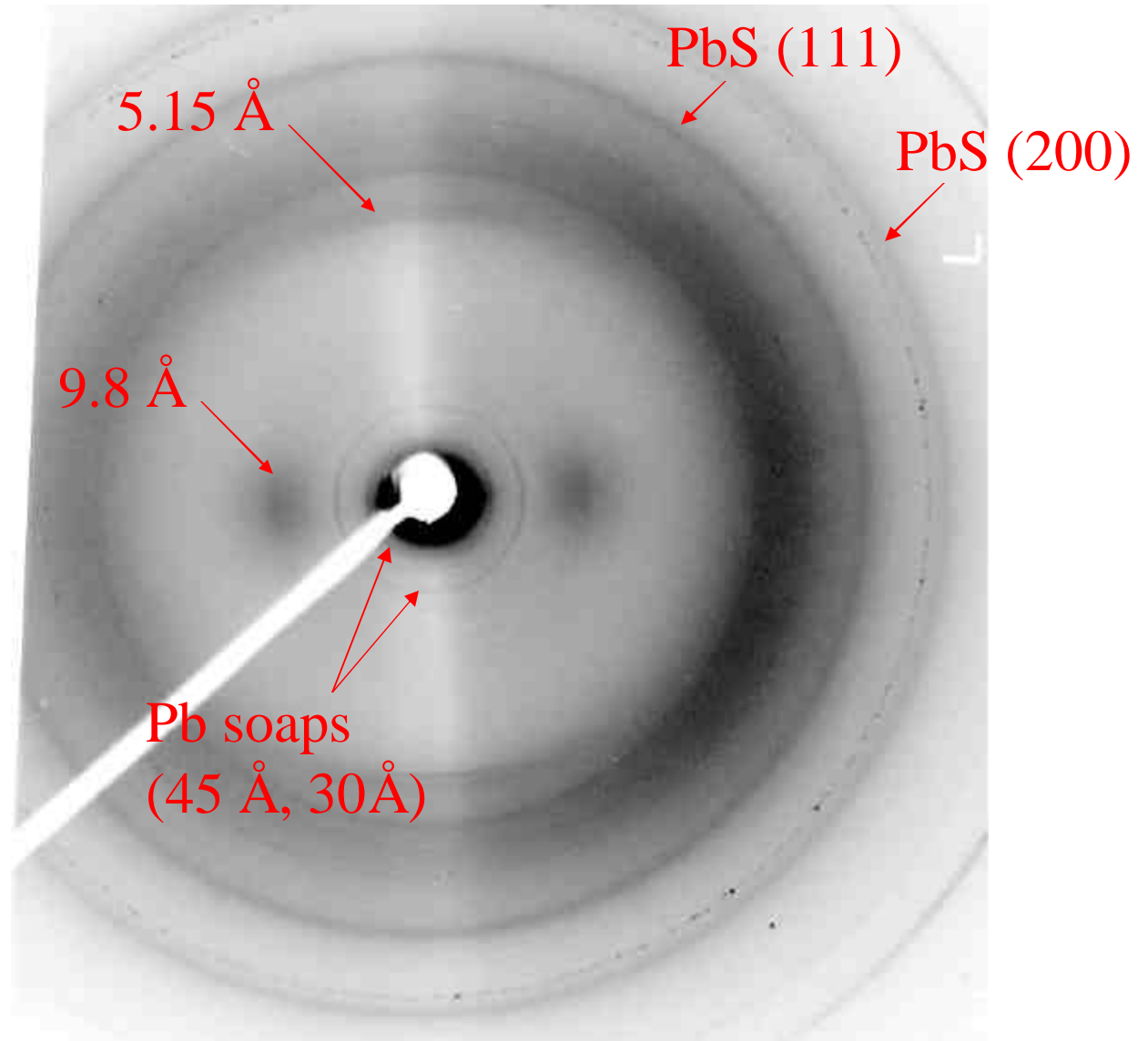
*Restore your
Natural Hair Color
in Just 3 Weeks!*

Combe Incorporated, USA, 2006.

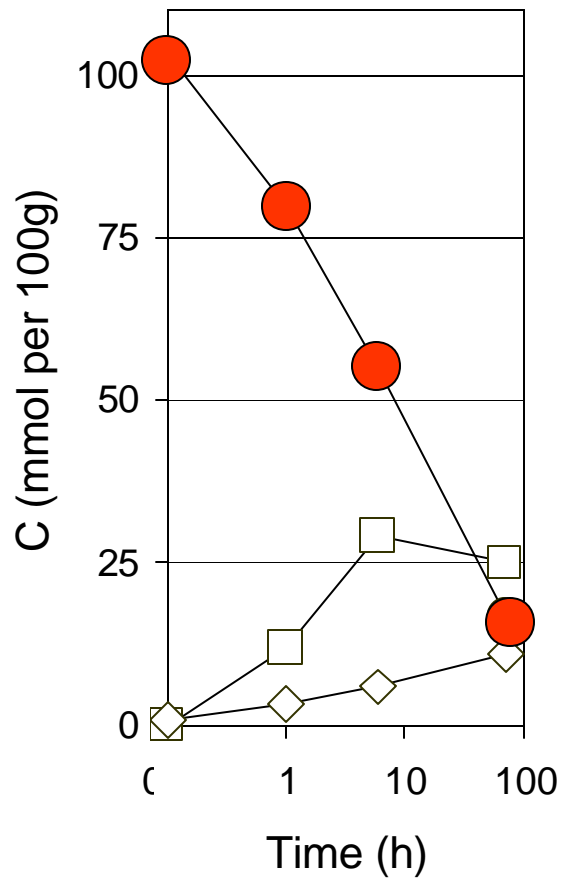
Principle of the reaction :



X-ray microdiffraction, 6h-treated hair

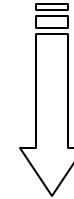
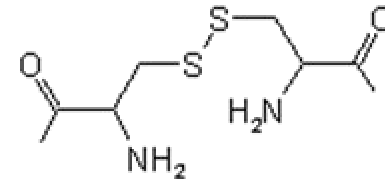


Keratin coiled-coil structure



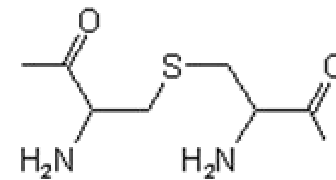
cystine ●
 lanthionine ?
 lysino-alanine ?

Cystinyl



With alkali

Lanthionyl



+

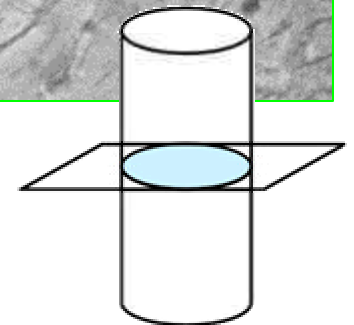
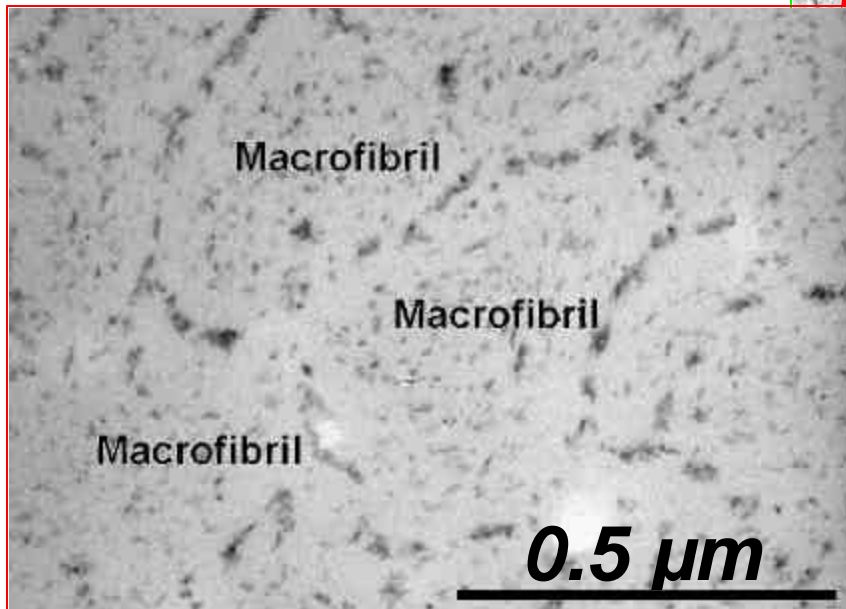
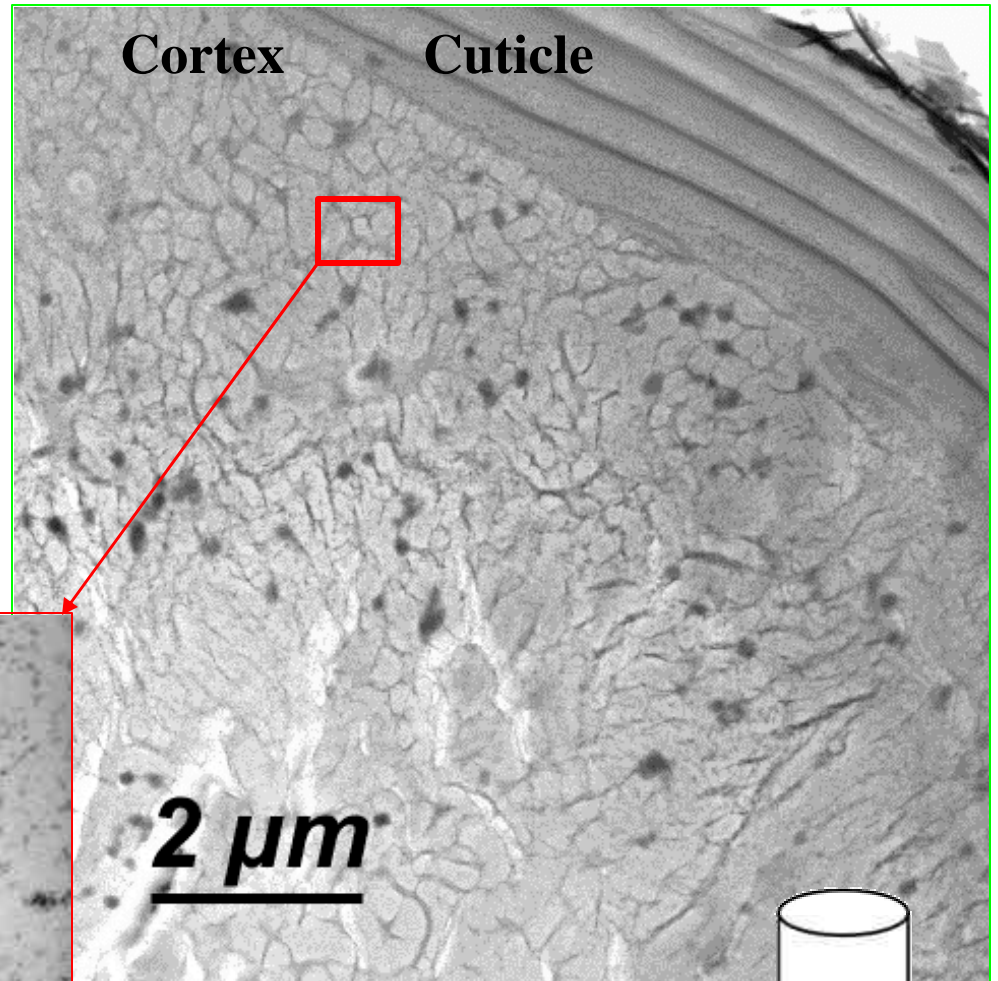
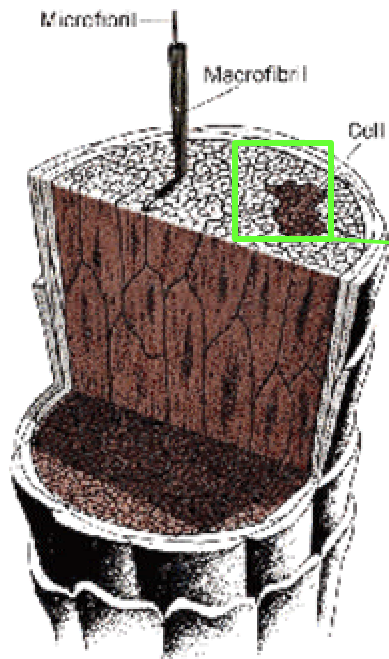
Sulphur

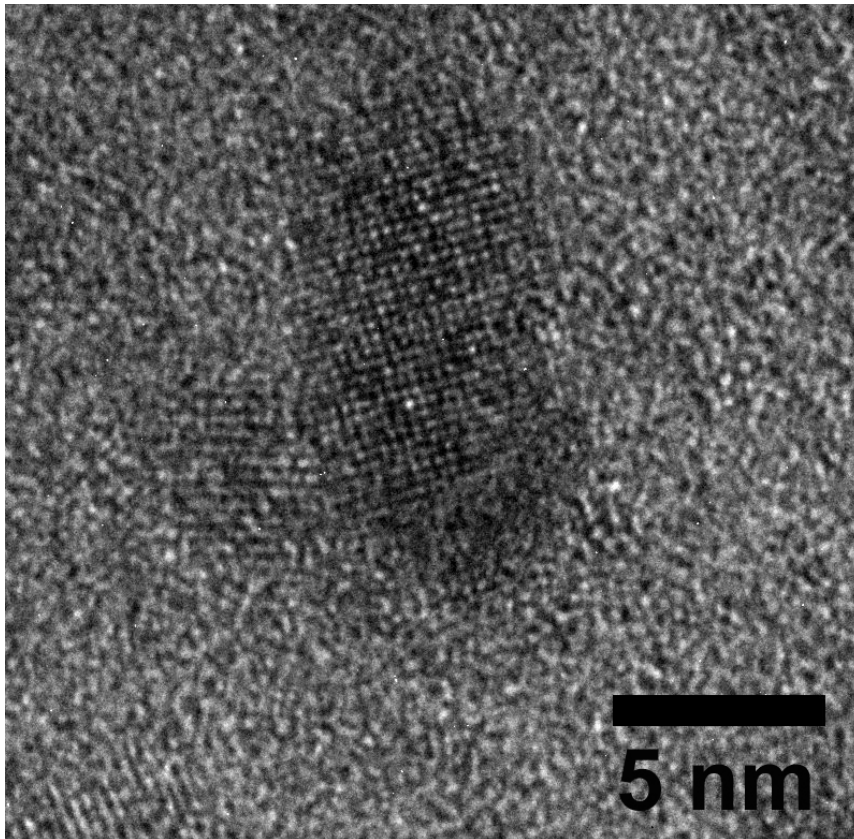
+

Lysinoalanyl

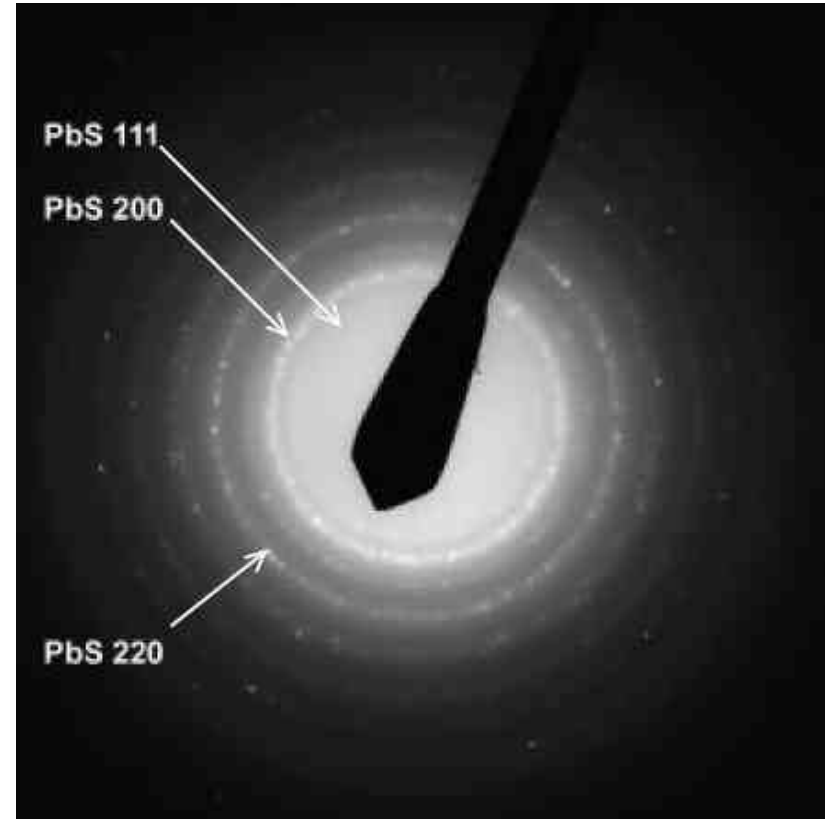
+

(...)

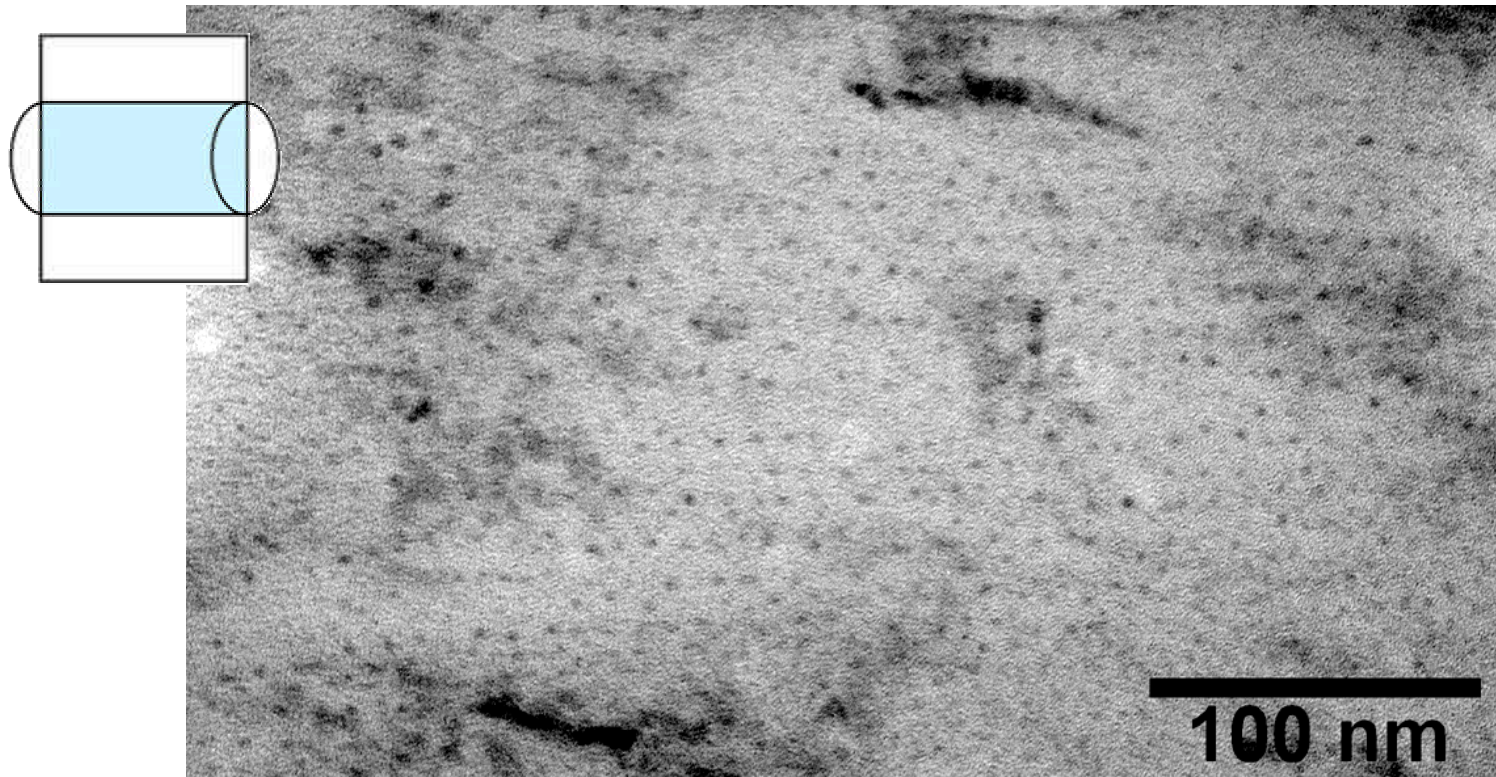




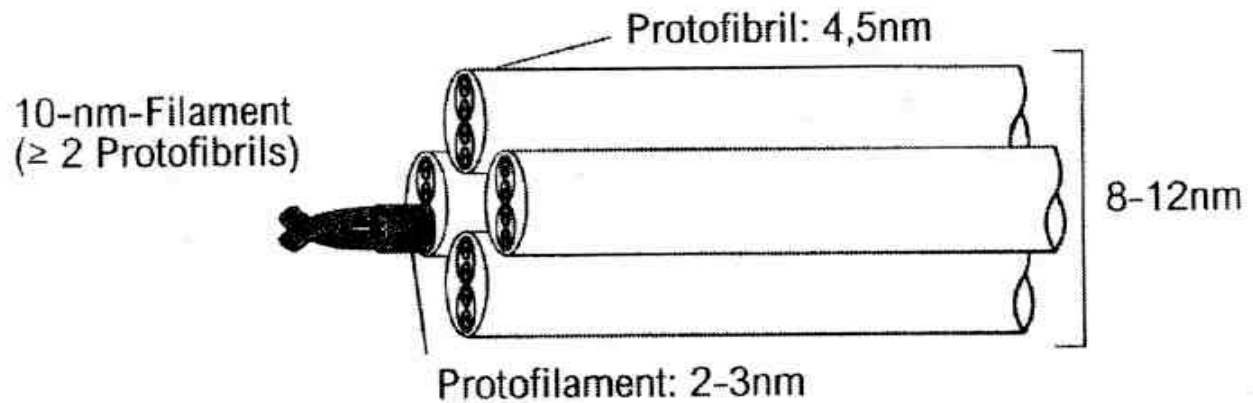
In the macrofibrils :
PbS nanocrystals



Electron diffraction



← Axis of the hair shaft



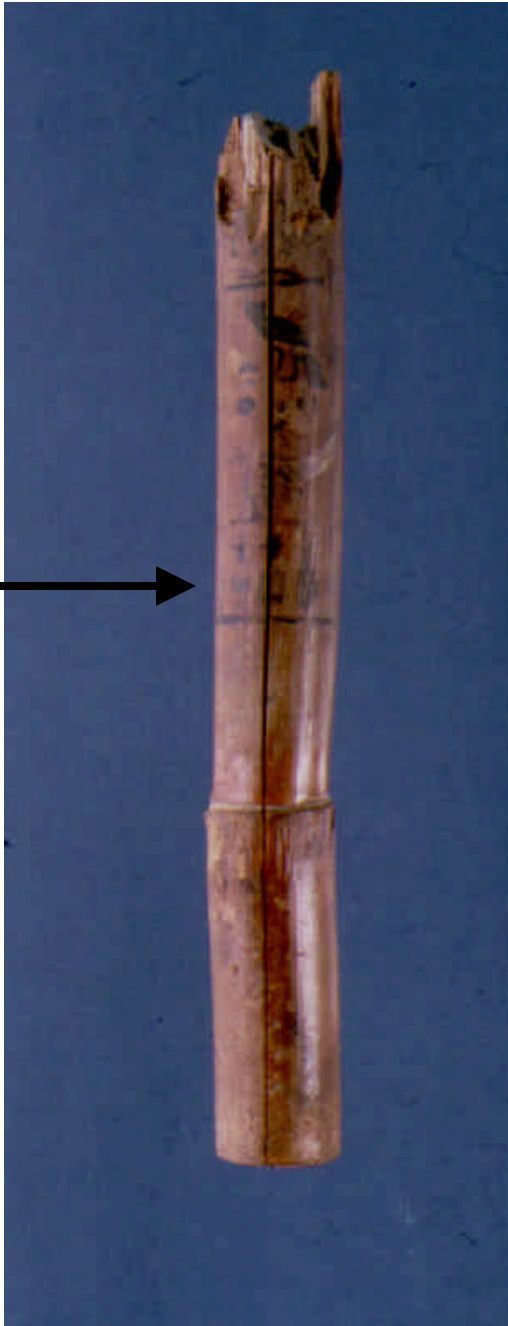
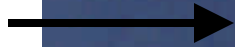


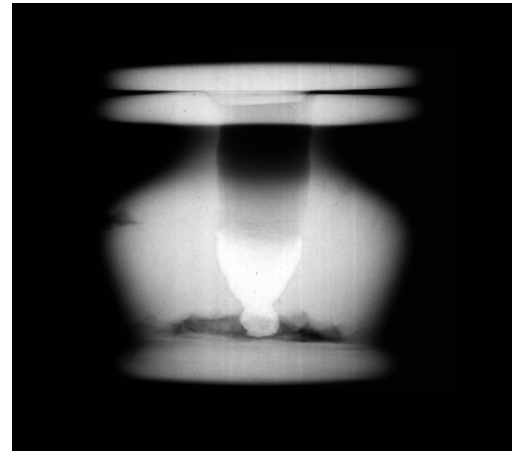
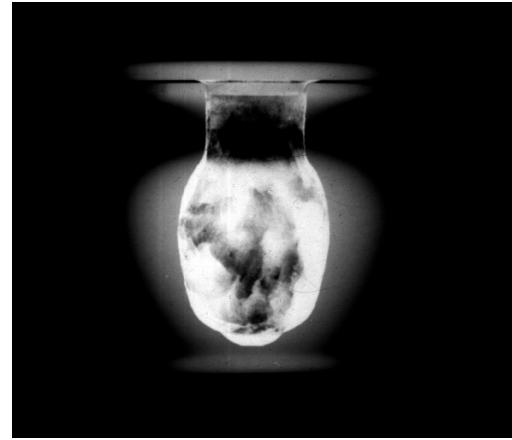
2 - Inventing a science of makeup

Egypt,

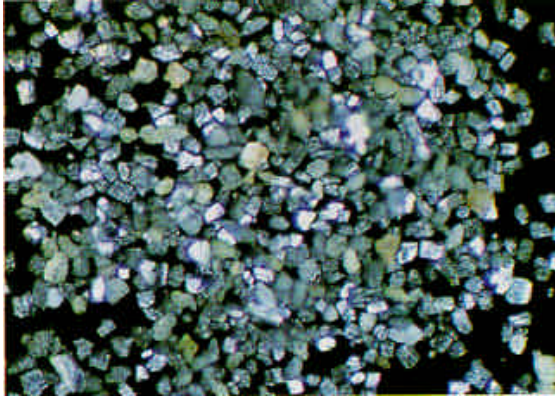
2000 B.C.

nfr

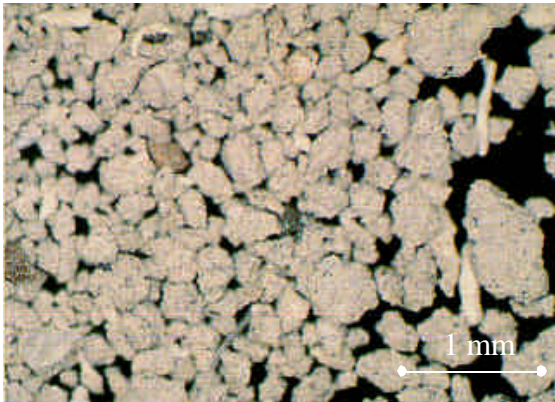




Main components : black and white minerals

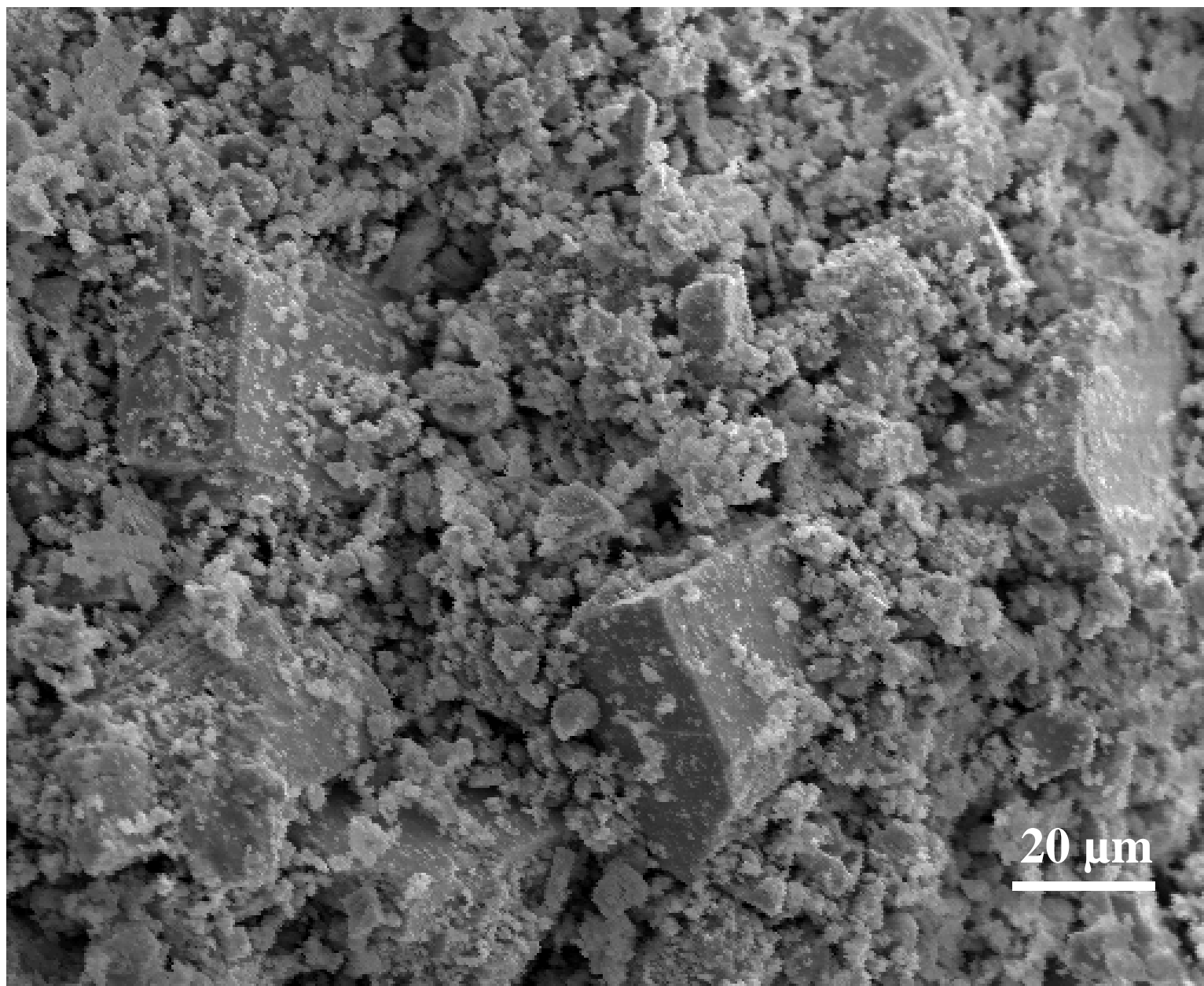


Galena PbS

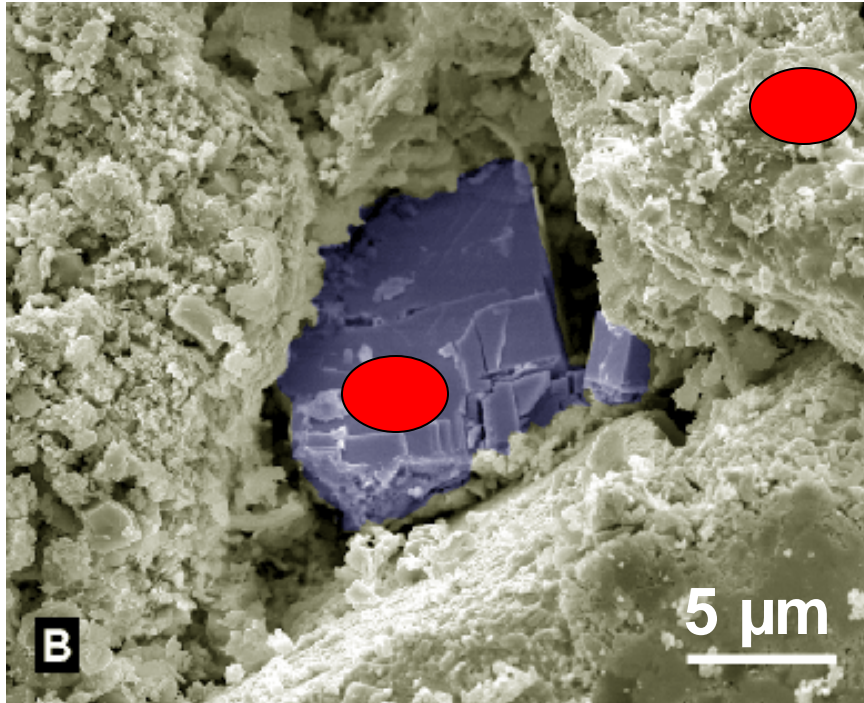


Cerussite PbCO₃

Phosgenite Pb₂Cl₂CO₃
Laurionite PbOHCl



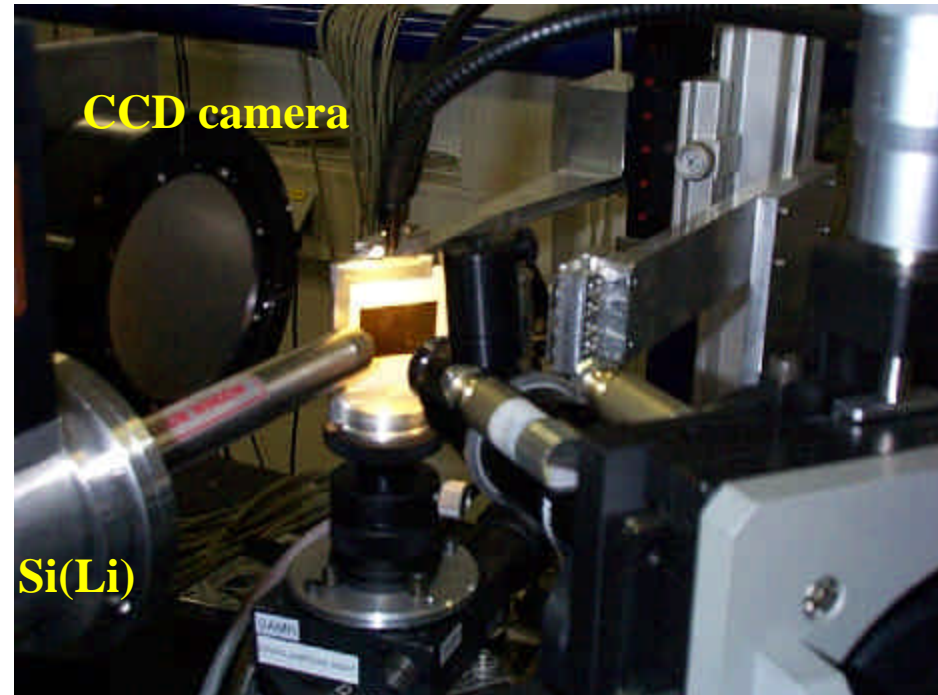
➤ Analysis of trace elements by Sy- μ XRF



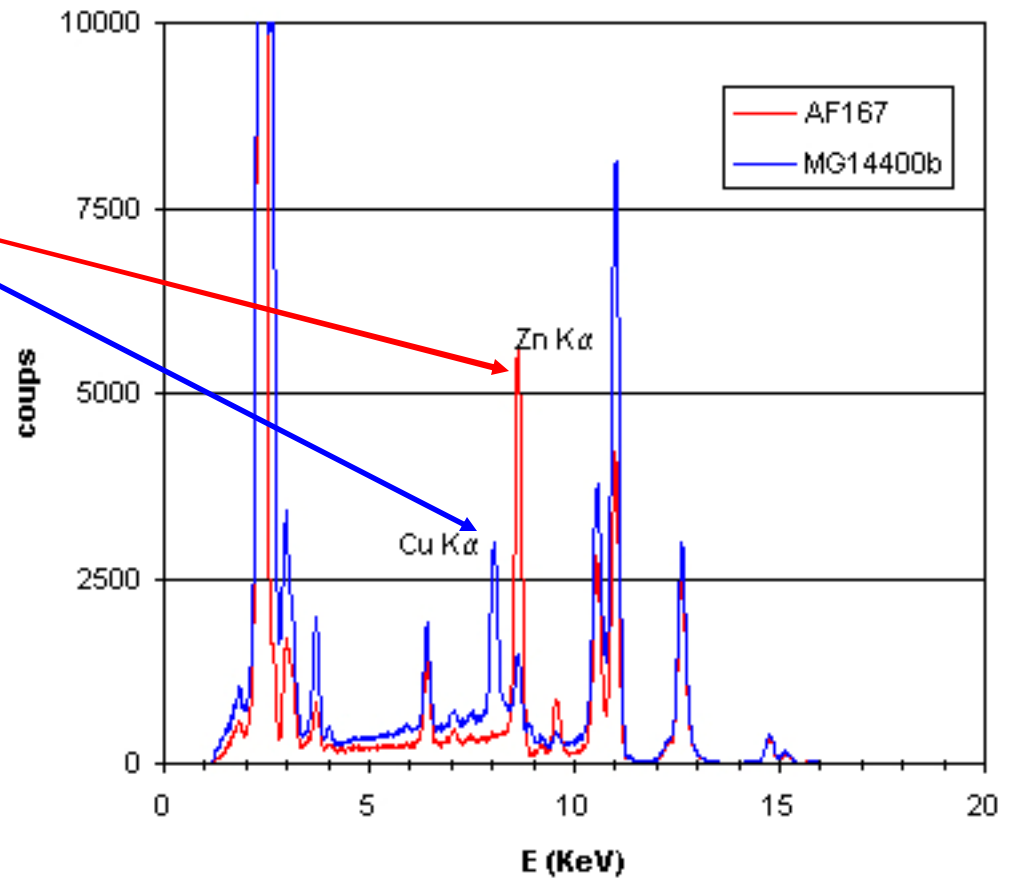
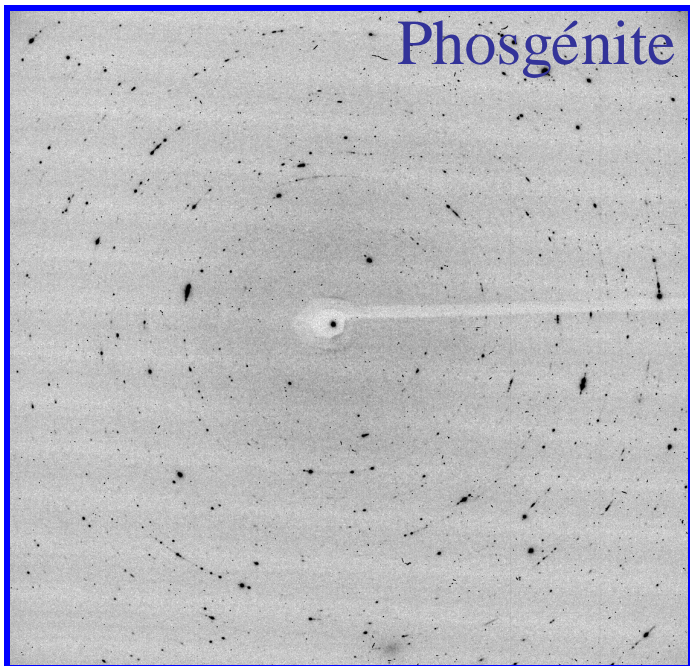
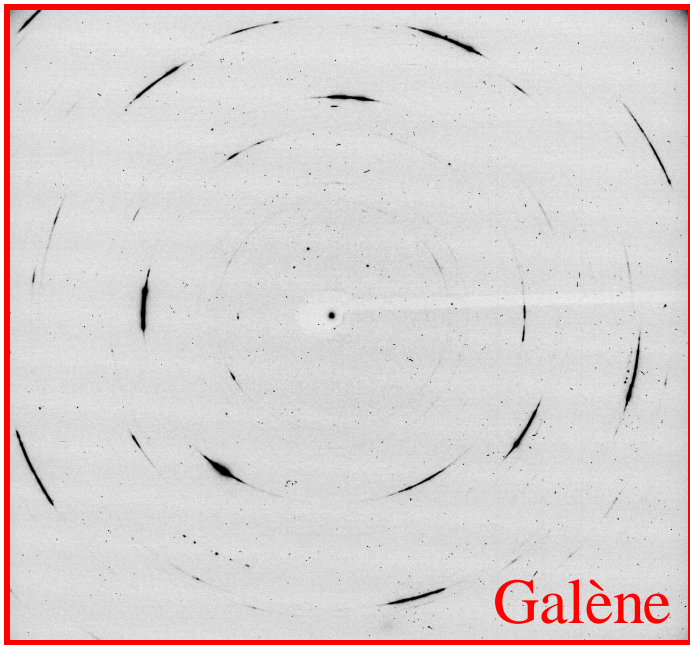
ESRF-ID22

$3 \times 5 \mu\text{m}^2$

$E=32 \text{ keV}$ and 11 keV



ESRF, ID22



Dioscorides

1st century A.D.

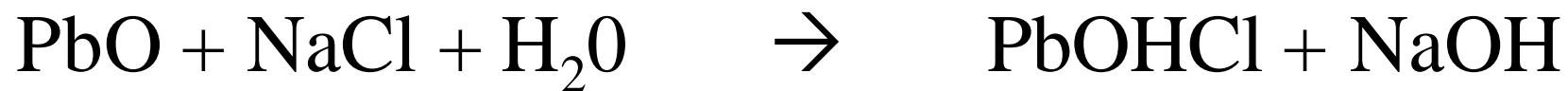
Book 5, 102

« ... Having mixed to a pound of silver foam (PbO) 5 dragms of rock salt, and pouring on warm water, beat it 3 times a day, straining out the old, and mixing new water ... »

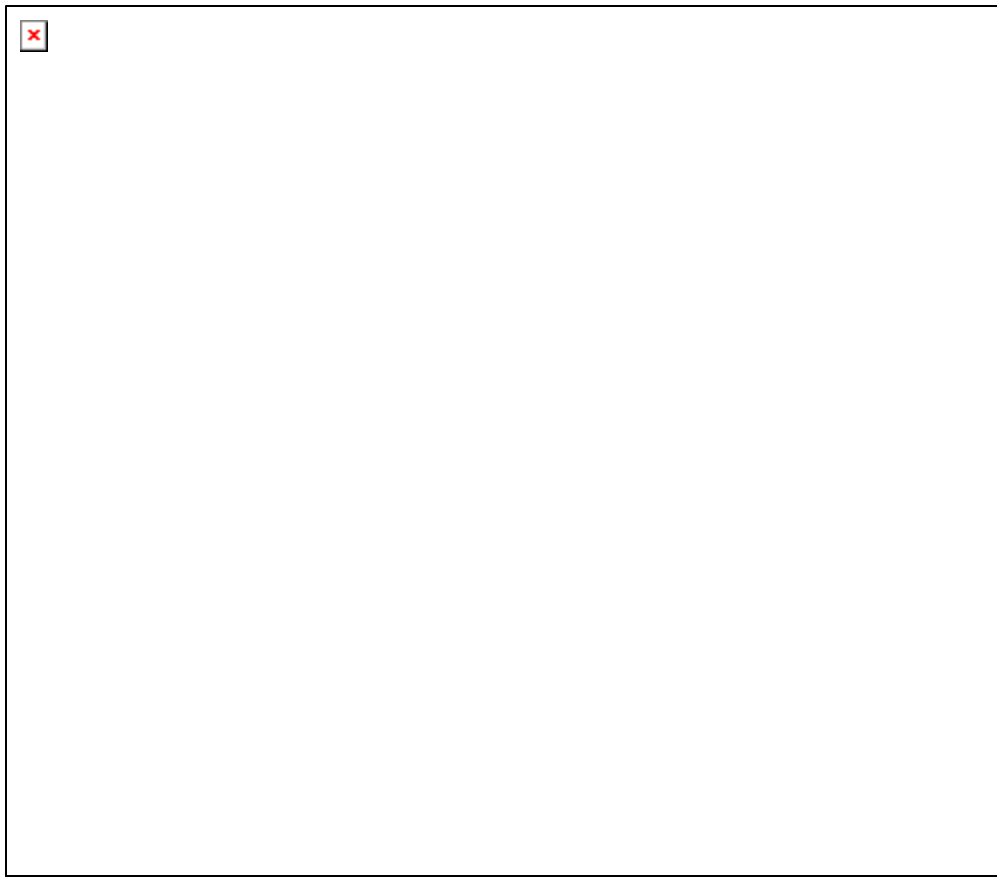
= synthesis of laurionite

The chemical reaction

litharge

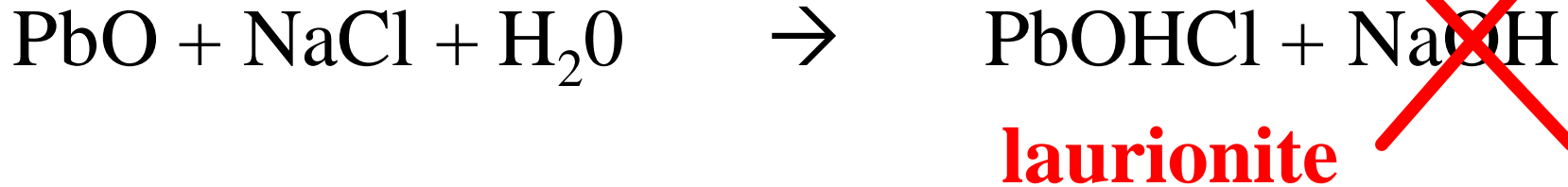


laurionite



The chemical reaction

litharge



“... allowing the **mixture to settle**, then removing excess water, then adding fresh salted solution, and repeating the operations three times per day during thirty days, until the new solution is free of alkalinity.”

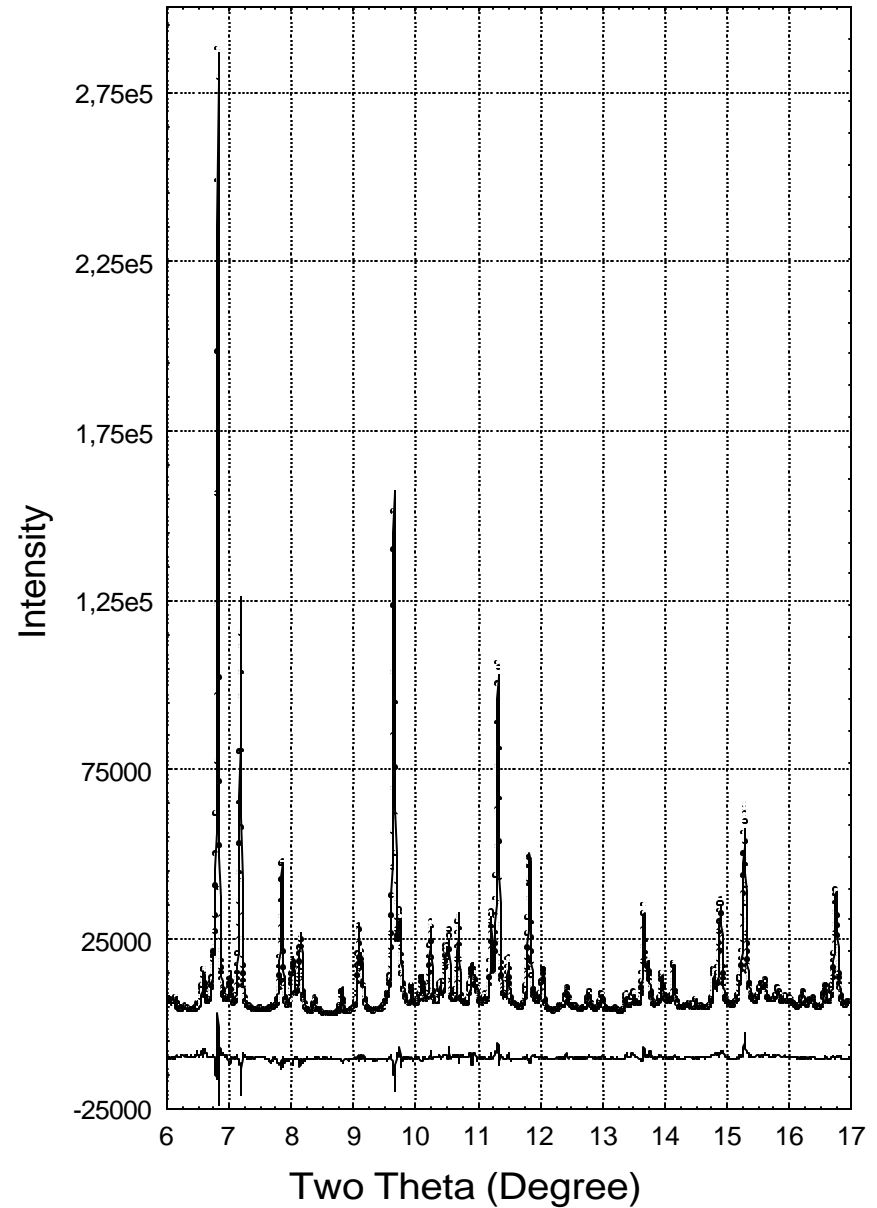
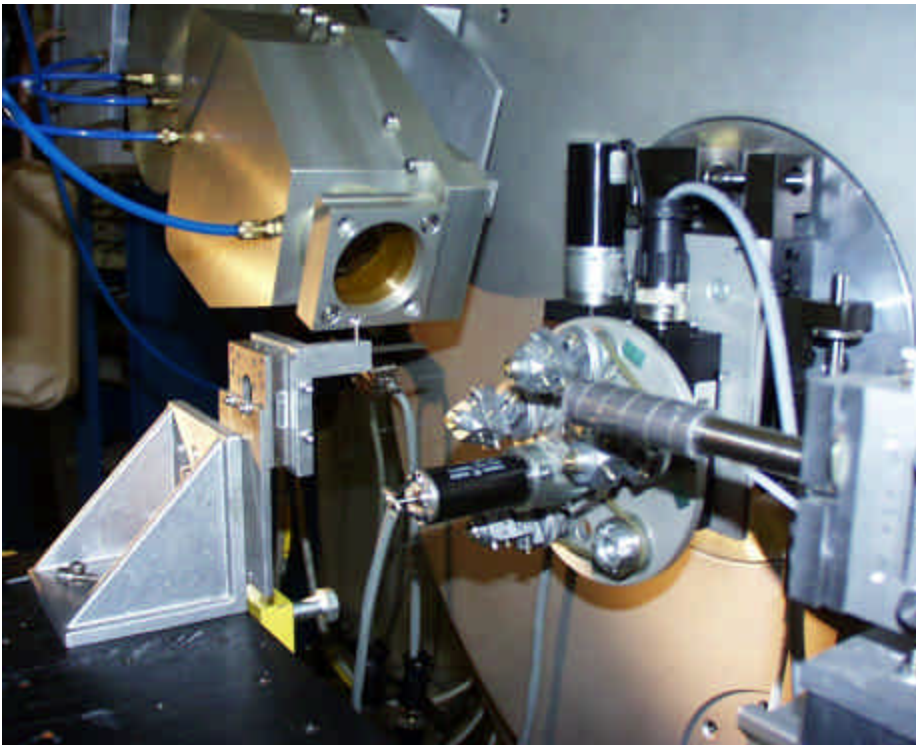
Three main components :

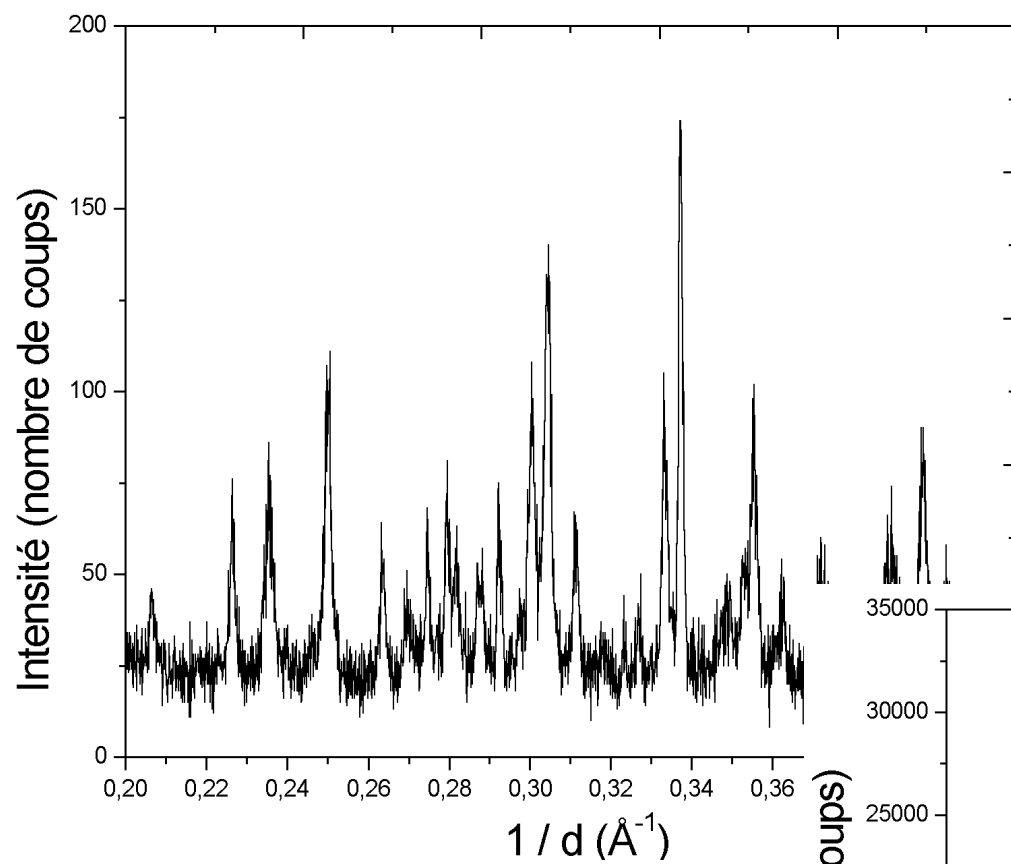
- Natural cerussite
- Synthetic compounds
- Powder of galena

Are the cosmetic preparation specific formulation ?

High resolution powder X-ray diffraction

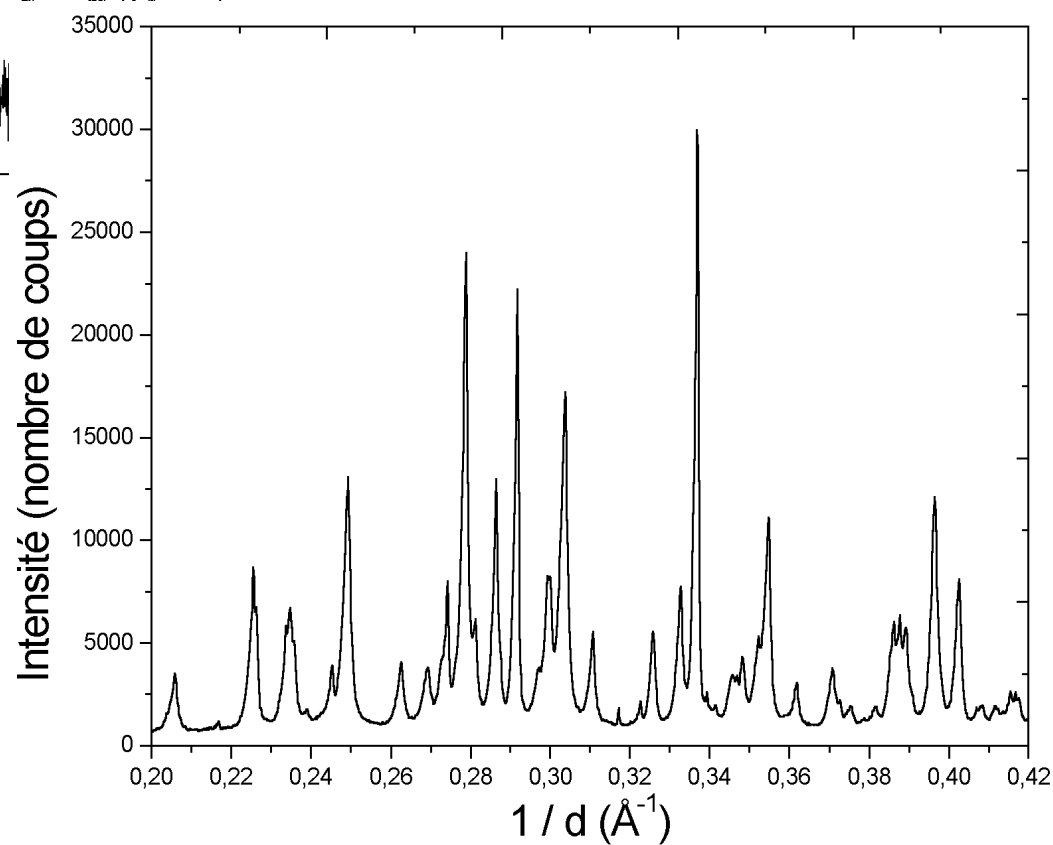
ESRF, BM16 – ID31

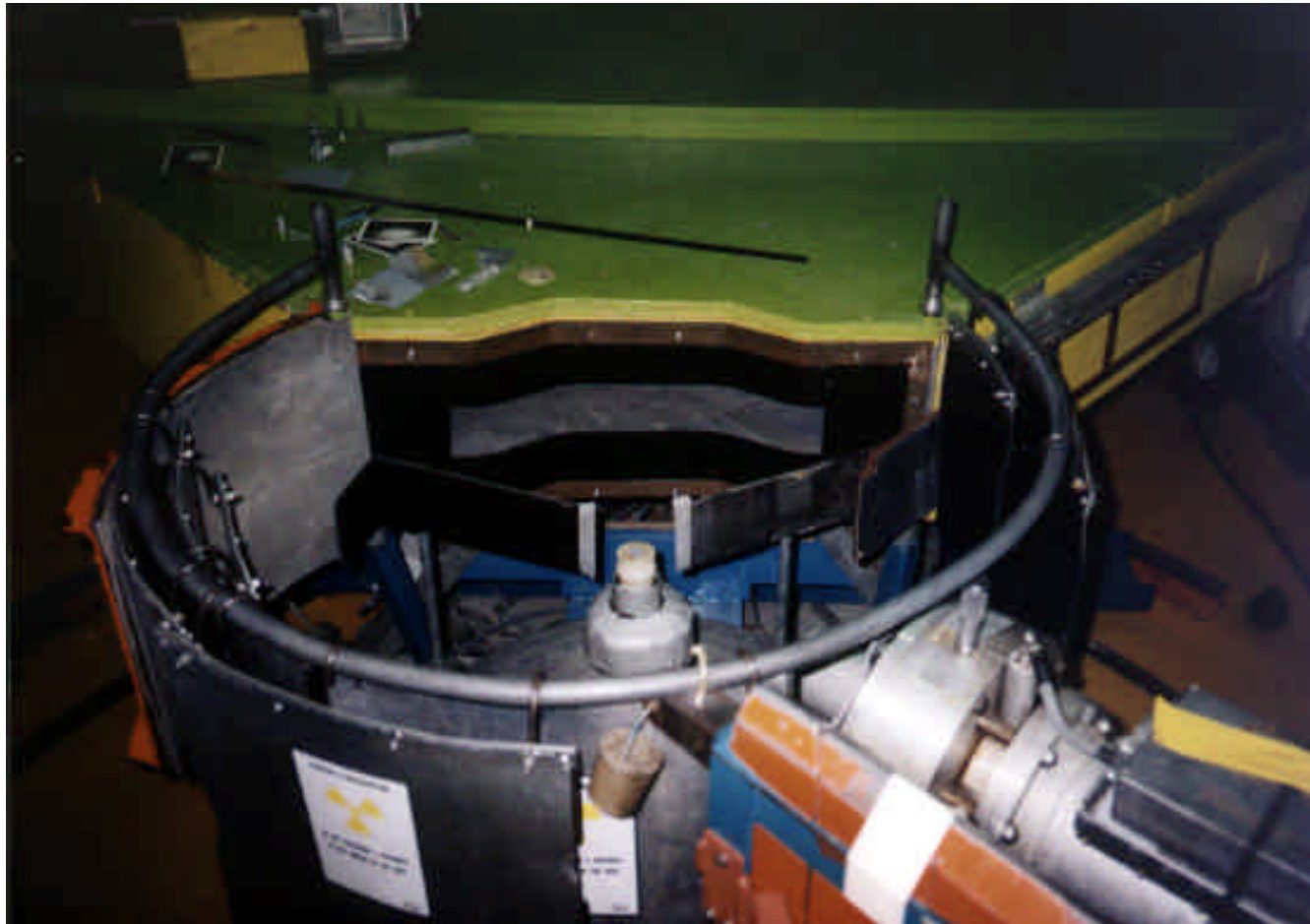




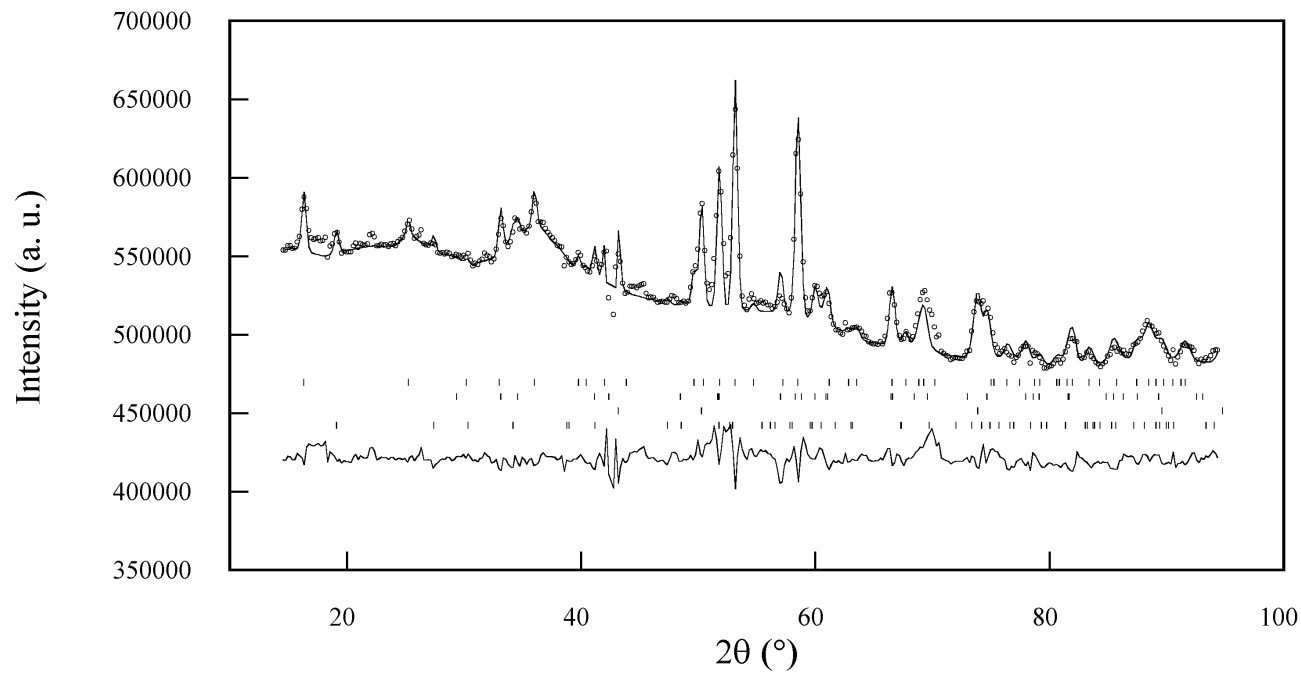
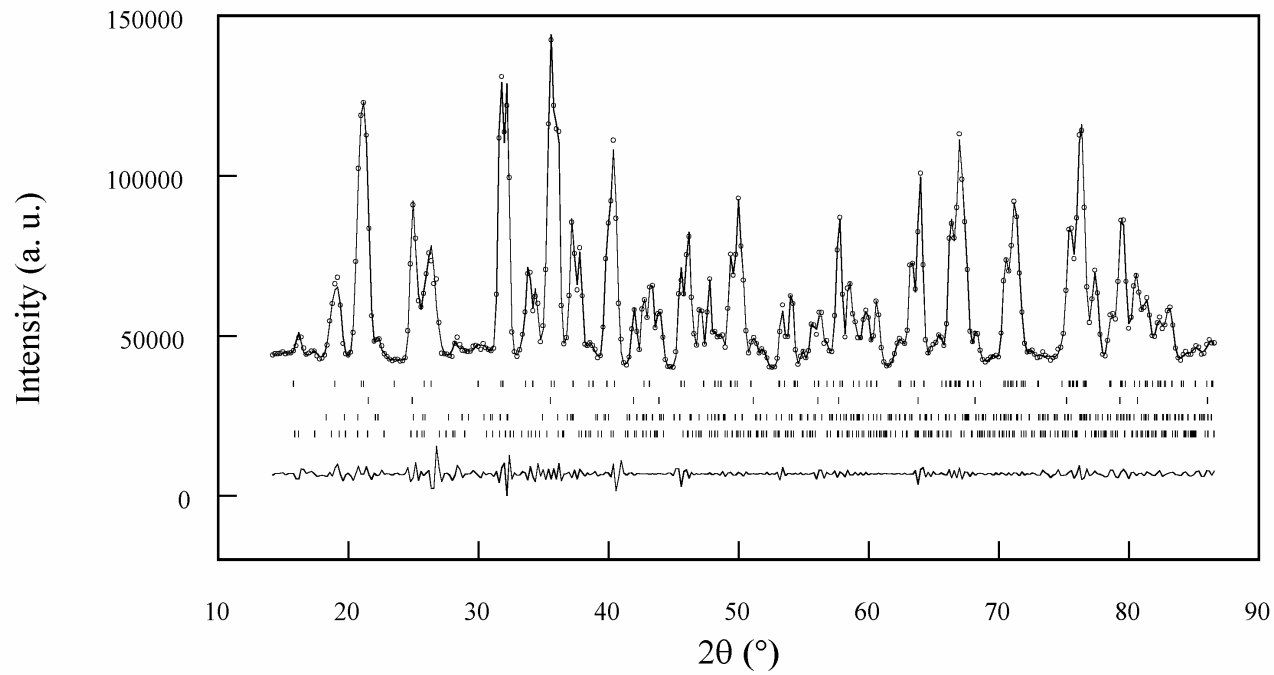
ESRF, BM16
4 hours

Laboratory : Bruker D5000
63 hours



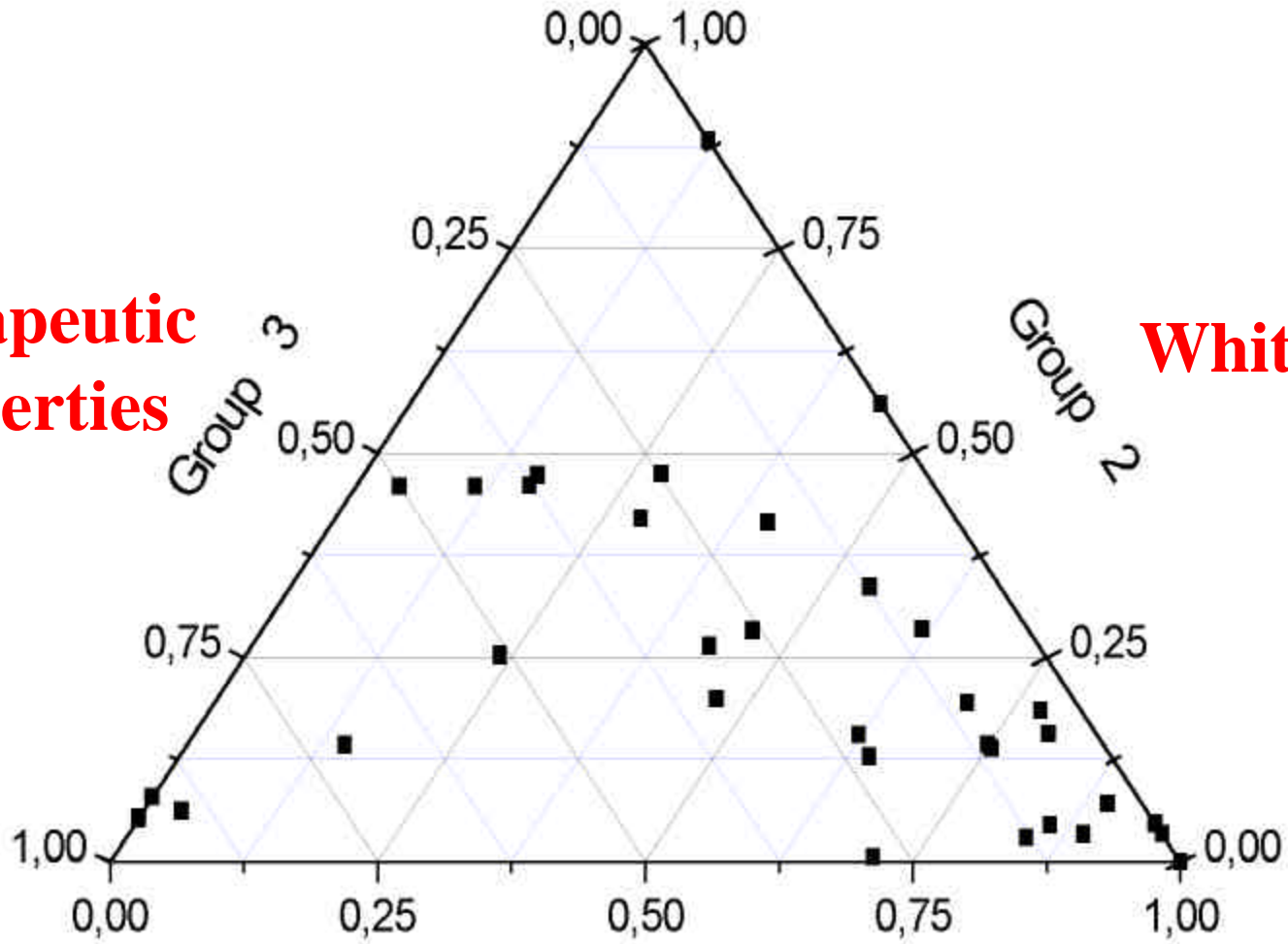


CRG-CNRS D1B, ILL, Grenoble
Powder diffractometer with a position sensitive detector
Collaboration O. Isnard



	<i>Neutrons</i>			<i>X-rays</i>
	Global analysis (reed)	Local analysis (top of reed)	Local analysis (bottom of reed)	Analysis on micro-extraction
PbS	32	29	31	42.4
Pb ₂ Cl ₂ CO ₃	44	44	47	29.8
PbCO ₃	24	27	22	27.8

**Therapeutic
properties**



White

Group 1

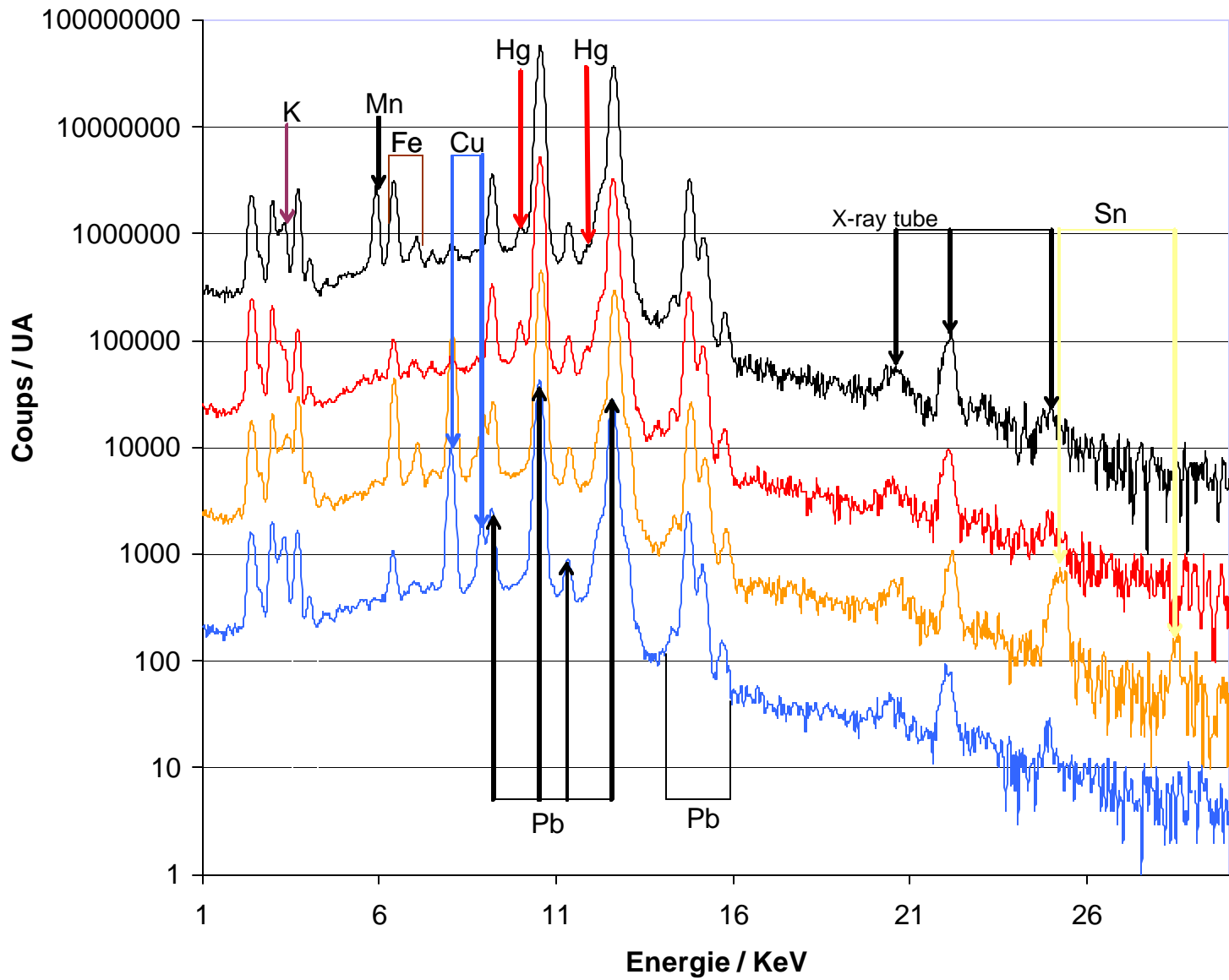
Black

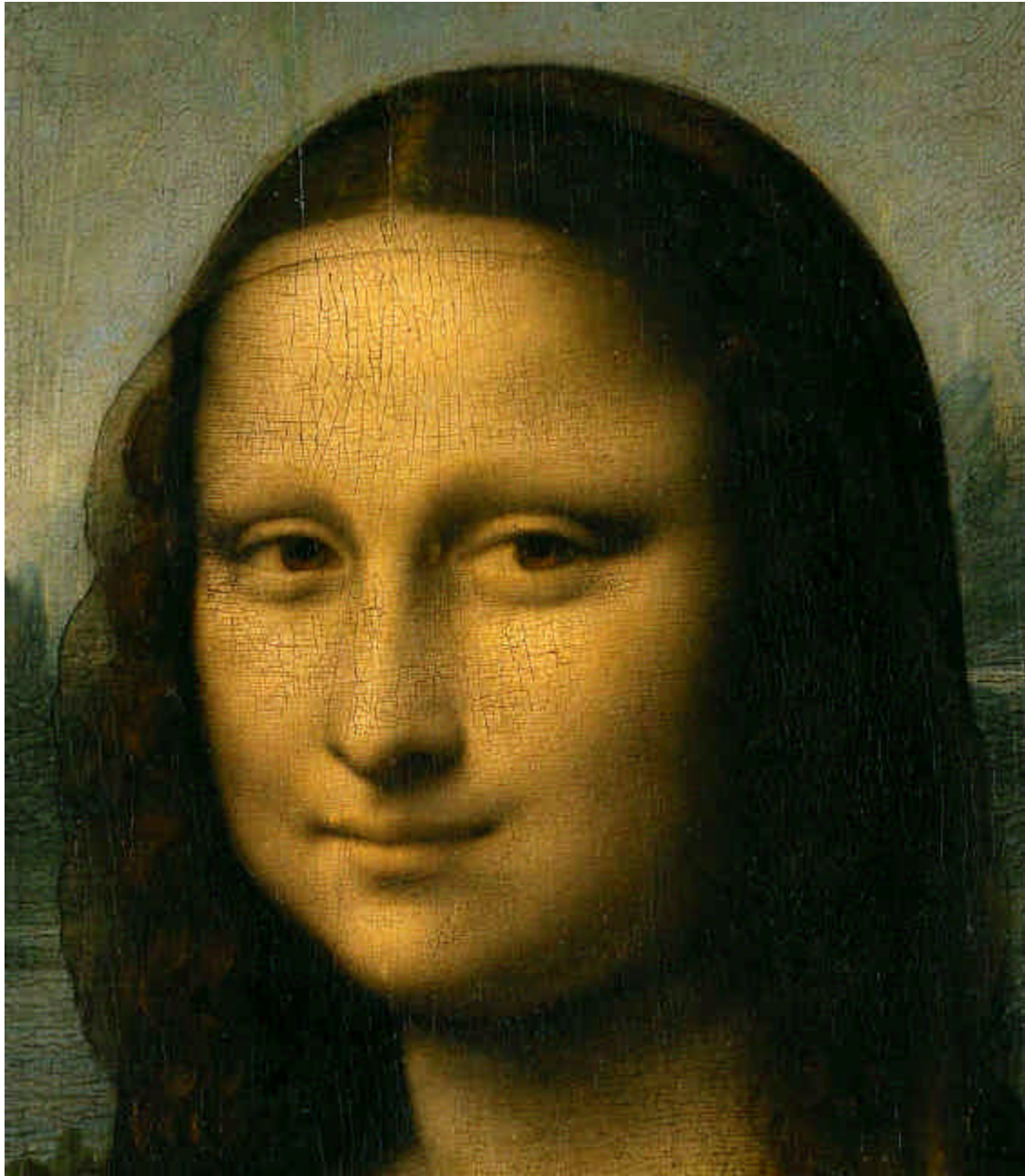


**3 – Mona Lisa
Inside the
painting**

**Italy
1503**









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Copper alloys
Iron
Silver
Gold
Gemstones
Glass
Stone
Paper and ink
Bone
Wood
Amber
Silk, wool
Textile fibers
Painting
etc.

Origin of materials
1D-2D-3D reconstruction
Structure determination
Weathering
Mechanical treatment
etc.

Diffraction
Texture analysis
Radiography
Tomography
Inelastic neutron scattering
Small angle neutron scattering
Neutron activation analysis
etc.

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- **ILL**: O. Isnard
- **L'Oréal Recherche** : J.L. Lévèque, R. Bréniaux, G. Richard, Ph. Hallégot ...
- **Argonne National Laboratory** : N. Zaluzec

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